

## BALES ENERGY ASSOCIATES

# ENERGY STUDY For the Ashby Highway Department DPW Building 1



Date: October 21, 2014 (Revised 12/5/14)

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

**Completed By:** 

Bales Energy Associates 50 Miles Street Greenfield, MA 01301 bart.bales@balesenergy.com 413-863-5020

### **Table of Contents**

Introduction	3
Executive Summary	3
Energy Conservation Opportunities Evaluated	3
Executive Summary Chart	4
Existing Conditions	1
Facility Description	4
Utility Energy Use	5
Building Enclosure	5
Heating, Ventilating & Air Conditioning Systems	5
Unit Heater	5
Heating Distribution System	6
Cooling System	6
Temperature & Ventilation Control System	5
Domestic Hot Water System	5
APPENDICES	7
UTILITY INFORMATION	8
ECM 1: ENCLOSURE MEASURE 10	0
ECM 2: HEATING SYSTEM MEASURE 1	1
GREENHOUSE GAS EMMISSIONS12	2
HEAT BALANCE INFORMATION1	3

### **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 the Green Communities Program of the Massachusetts Clean Energy Center. The building evaluated in this report is Building 1 of the Highway Department, the primary structure housing the office and main maintenance garage bays. It is located at 92 Breed Road.

Bart Bales, PE, MSME, senior engineer at BEA, visited the site, reviewed energy usage and 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.

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 any of the following methods: plan-specification-bid process or performance specification-design-build process.

### **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.

Heating and enclosure system improvements were the focus of the study at this Highway Department Facility.

Key conclusions are the following:

1. Enclosure Systems Recommendation Re-install existing insulation that has become detached.

#### 2. Heating System Replacement

Replace existing heating system with a propane-fired condensing unit heater. Install town-owned propane tank. (Note: This tank will also be used to serve DPW Building #2.)

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 Chart represent the savings with measures taken in the order of economic feasibility shown. The calculations supporting each measure are included in the appendices.

#### **Executive Summary Chart**

	Natural Gas	Propane	Oil	Electricity			Executi	ve Summai	y Chart	]				
	per therm	\$2.05 per gal	\$3.30 per gal	per kWh			Gree	n Communities S	Study	]				
	Me	asure Descript	tion		Fuel Energy	Annual		Full C	lost			Incremental (	Cost Difference	*
Measure		newable Thermal	· ·	Available	Savings	Savings			After I	ncentive			After I	ncentive
#	(ECM = End	ergy Conservation	n Measure)	Incentive (\$)	(% of base)	(\$ / yr)	Cost (\$)	Payback (yrs)	Cost (\$)	Payback (yrs)	Cost (\$)	Payback (yrs)	Cost (\$)	Payback (yrs)
ECM 1	Enclosure EC!	M		\$-	2%	\$ 149	\$ 480	3.2	\$ 480	3.2	\$ 480	3.2	\$ 480	3.2
ECM 2	Heat With Cor	ndensing Unit I	Heater	\$-	17%	\$ 1,801	\$ 10,309	5.7	\$ 10,309	5.7	\$ 7,521	4.2	\$ 7,521	4.2
			Totals:	\$ -	19%	\$ 1,950	\$ 10,789	5.5	\$ 10,789	5.5	\$ 8,001	4.1 Ill Cost) - (Replaceme	\$ 8,001	

			Fuel Energ	gy Impact				
		Natural Gas	Propane	Oil	Electricity			
		100.0	92.5	138.7	3.413			
		kBtu / therm	kBtu / gal	kBtu / gal	kBtu / kWh			
				r	,	·		
	Baseline Energy Use	Natural Gas	Propane	Oil	Electricity	Fuel Energy		
	Space Heating			2,441		338,539		
	Measure Description		Fuel Usage Af	ter Measures		Fuel Energy	Fuel Energy	Savings
Measure	Measure Description (RTM = Renewable Thermal Measure)	Natural Gas	Fuel Usage Aft Propane	ter Measures Oil	Electricity	Fuel Energy Use	Fuel Energy Savings	Savings As % of
Measure #	-		0		Electricity (kWh / yr)	0.	0.	6
	(RTM = Renewable Thermal Measure)	Natural Gas	Propane	Oil	· ·	Use	Savings	As % of
	(RTM = Renewable Thermal Measure)	Natural Gas	Propane	Oil	· ·	Use	Savings	As % of
#	(RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure)	Natural Gas	Propane	Oil (gal/yr)	· ·	Use (kBtu / yr)	Savings (kBtu / yr)	As % of Baseline
# ECM 1	(RTM = Renewable Thermal Measure) (ECM = Energy Conservation Measure) Enclosure ECM	Natural Gas	Propane (gal / yr)	Oil (gal/yr)	· ·	Use (kBtu / yr) 332,267	Savings (kBtu / yr) 6,272	As % of Baseline 2%

### **Existing Conditions**

#### **Facility Description**

The Highway Department facility's main function is to serve as an office space, maintenance garage and vehicle/equipment storage space for the town's highway department. This building, one of two on the property, is a single story, metal fabricated, slab-on-grade structure that comprises three large garage areas and the department's office space. These garage bays serve as the regular maintenance areas and are the 'high use' bays for the department, as the second building is mostly used for enclosed storage of trucks and equipment. There is a modest office space, approximately 12' x 16', located in the south (front right) corner.

#### **Utility Energy Use**

Utility data for a multi-year period was collected. Data for the reference year used, May 2013 - April 2014, is tabulated and reported in the appendices. The electrical usage was 9,367 kWh and the #2 fuel oil consumption was 2,441 gallons for that time period. These utility/fuel values result in annual totals of 370,499 kBtu and 131.9 kBtu/ft<sup>2</sup>.

#### **Building Enclosure**

The building has a low sloped, rubber membrane roof on a plywood deck over a 2 x 8 wood rafter cathedral ceiling insulated with approximately 7.5" of fiberglass batt insulation in the rafter bays. Exterior walls are corrugated metal on a steel frame with a 1" layer of rigid foam on the inside face of the metal siding, though there were areas where the insulation had been compromised and should be repaired as necessary. Other than the major enclosure penetrations at the garage doors, there are limited other penetrations, including a gable end fan and vent (one on either side) and the chimney stack from the unit heater. The only windows are the small double pane units integrated in one section of the three 12' x 12' overhead garage bay doors. The overhead doors are insulated doors.

Below is a picture taken of the interior of the main maintenance garage showing the basic construction details.



#### Heating, Ventilating & Air Conditioning Systems

#### **Unit Heater**

The main DPW building is served by a relatively new oil-fired ceiling suspended unit heater. The unit is a Modine model POR185, installed in 2010. It has an oil input rate of 1.65 GPH (approx. 228 MBH), a listed efficiency rating of 81%, and provides an output of approximately 185 MBH.

An exhaust vent fan was installed in the gable wall (along with a paired, motorized louver on the other gable wall) for the purpose of removing harmful vehicle fumes during times when the space is being heated and the garage doors are closed. It is used on an as-needed basis and is manually operated by the maintenance staff.

The design heat load for this building is approximately 141,000 Btu/hr.

#### **Heating Distribution System**

The installed unit heater is not connected to any ducted distribution and therefore simply takes return air in the rear of the unit, heats it, and blows it across slanted fins on the front to circulate it back to the space. There is a single ceiling fan installed that, if used during the heating season, would assist in de-stratifying the heated air from the ceiling and help circulate it down to the occupied space near the floor, potentially improving occupant comfort.

#### **Cooling System**

There is currently no cooling equipment utilized at the Highway Department facilities.

#### **Temperature & Ventilation Control System**

The highway department staff installed a programmable thermostat sometime during the 2013-2014 heating season and indicated a plan to program it for 65° for occupied daytime temperature and setback to 55° during the unoccupied hours.

#### **Domestic Hot Water System**

An electric hot water tank serves the DHW demand at the Highway Department. Water use is modest, mainly for hand washing and occasional limited use for washing of tools and equipment. No recommendation is made with regard to domestic hot water.

## **APPENDICES**

## **UTILITY INFORMATION**

May	2013	- Apr	2014
-----	------	-------	------

### Billed Energy Use Table for Electricity & Fuel

Building Name	Highway Dep							
Owner	Town of Ashl	ру						
	-							
Account #								
	Electricity	Billed Demand	Delivery	Supplier	Electricity	Oil	Oil	Energy \$
Month	KWH	KW	Charged \$	Charged \$	Total \$	Gallons	\$	Totals
May 2013	649	5.5	\$113	\$41	\$155			\$155
Jun	640	6.5	\$121	\$45	\$166			\$166
Jul	655	5.0	\$105	\$50	\$154			\$154
Aug	666	5.0	\$105	\$51	\$156			\$156
Sept	708	6.0	\$117	\$50	\$166			\$166
Oct	628	4.5	\$95	\$43	\$138			\$138
Nov	807	4.5	\$106	\$57	\$163	341.6	\$1.086	\$1.249
Dec	913	5.0	\$118	\$84	\$202	452.6	\$1,491	\$1,693
Jan 2014	969	6.0	\$133	\$108	\$242	554.4	\$1,864	\$2,105
Feb	1,064	5.0	\$129	\$124	\$253	521.7	\$1,787	\$2,040
Mar	902	5.5	\$124	\$78	\$202	434.1	\$1,401	\$1,603
Apr 2014	766	5.0	\$110	\$55	\$165	136.4	\$432	\$597
		0.0	<b></b>	<del>,</del> ,,,,	<b>\$</b> 100		¢ .0_	
Annual (Units)	9,367		\$1,375	\$785	\$2,161	2,441	\$8,062	\$10,223
Heating Season (Units)	6,049		\$815	\$549	\$1,364	2,441	\$8,062	\$9,425
Annual (\$/Unit)			\$0.15	\$0.08	\$0.23		\$3.30	
Heating Season (\$/Unit)			\$0.13	\$0.09	\$0.23		\$3.30	
	Electricity			•		Oil	Energy Use	
	kBtu					kBtu	Totals (kBtu)	
Annual (kBtu)	31,960					338,539	370,499	Energy \$
Heating Season (kBtu)	20,639					338,539	359,178	Totals
		-			_		Totals (kBtu/sf)	(\$/sf)
Annual (kBtu/sf)	11.4					120.6	131.9	\$3.64
Heating Season (kBtu/sf)	7.4					120.6	127.9	\$3.36
Building Name	Highway Dep	t - Building 1				Heated	Square Footage	2,808

## ECM 1: ENCLOSURE MEASURE

	Summary of E	nergy Saving	S		
ECM 1	Wall Insulation	& Air Sealing			
			-		
	Baseline	After ECM 2	Savings	Reduction	
Net Building Demand (MMBtu/yr)	262.7	257.8	4.87	1.9%	
Existing Seasonal System Efficiency	78%	78%			
Fuel Energy Usage (MMBtu/yr)	338.5	332.3			
Energy Savings	% Reduction	Fuel Use	Gallons Saved	\$/Unit	\$ Saved
	1.9%	2,441	45	\$3.30	\$149
			T	otal Savings	\$149
				_	
	Cost	Savings	Payback (yr)		
	\$480	\$149	3.2		
Note:					

	# hrs.	\$ / hr.	Со	ost (\$)
Replace falling insulation	8	\$40	\$	320
Air Sealing	4	\$40	\$	160
	Totals	40	\$	480

### ECM 2: HEATING SYSTEM MEASURE

Building-Related  Load  Usage  Usage  Fuel  Load  100    Heat Loads  (kBtu / year)  Gallons  Gallons  Cost  (kBtu / hr)  of design	ECM # 2	Space Hea		ith Condensing, P		tHeater	
\$3.30      Existing Condition:      New Condition:      \$2.05        Equipment Type      Space Heating      Space Heating      Image: Sp			Hig	hway Dept - Buildi	ng 1	r	1
Equipment Type      Unit Heater      Spec Heating      Spec Heating        Boiler #      1      1      1      1        Make      Modie      1      1      1      1        Make      Modie      Modie      1      1      1        Make      Model      PORS5B      PTC 215      1      1        Model      PORS5B      Condersing      1      1      1      1        Control Mode      on / off      0      - On / off single stage      1      1      1      1        Output kBtuffr      185      200      215      93%      1	Fuel Rate (\$/gallon)					Propane Rate (\$/gallon)	
Equipment Type      Unit Heater      Unit Heater        Boller #      1      1      1        Make      Modine      Modine      1      1        Make      Modine      Modine      1      1      1        Make      Modine      Modine      Modine      1      1      1        Make      POR185B      Condensing      1      1      1      1      1        Model      POR185B      Condensing      1      1      1      1      1      1        Model      Ontrait Khurfir      185      0      010      1 <td< td=""><td>\$3.30</td><td>Existing Condition:</td><td></td><td></td><td>New Condition:</td><td>\$2.05</td><td></td></td<>	\$3.30	Existing Condition:			New Condition:	\$2.05	
Boiler #      1      1      1        Make      Modie      Modie      Modie      Modie      Modie        Model      POR185B      PTC 215      Important Modie      Ar        Type      Annopheric      Condensing      Import Mode      Ar        Control Mode      on / off      Output kBut/Ir      155      200      Import Mathematication      Import Mathemathematication      Import Mathemathema							
Make  Modine  Modine    Model  POR1858  PTC 215    Type  Attraspheric  Condersing    Heating Medium  Air  Air    Control Mode  on / off  on / off single stage	Equipment Type	Unit Heater			Unit Heater		
Model      POR1858      POR1858      PTC 215      PTC 215        Type      Atmospheric      Condensing      PTC 215      PTC 215        Heating Medium      Air      Air      PTC 215      PTC 215        Control Mode      on / off      State Eff      PTC 215      PTC 215        Output kBtu/Hr      185      200      PTC 215      PTC 215        Output kBtu/Hr      185      99%      PTC 215      PTC 215        State Eff      81%      99%      PTC 215      PTC 215      PTC 215        State State Eff      81%      99%      PTC 215      PTC 215      PTC 215        State State Eff      78%      91%      PTC 215      PTC 215      PTC 215        State State Eff      78%      PTC 215      PTT 215      <		-			-		
Type  Atmospheric  Condensing    Heating Medium  Ar  Ar    Control Mode  on / off  0n / off single stage    Output kBtu/Ir  185  200    Steady State Eff  81%  93%    Input kBtu/Ir  185  200    Steady State Eff  81%  93%    Procentage of Load  121%  11%    Percentage of Load  121%  131%    Replacement In-Kind Costs  Installation  1,870    Nifi Capable Programmable Thermostat  \$ 770    Southout I  \$ 8,520    Subtotal  \$ 9,372    Subtotal  \$ 9,372    Totals  \$ 2,788    Contractor Oversign  \$ 9,372    Subtotal  \$ 10,309    Building  Projected    Fuel  Propane    Load  (kBtu / hr)    Building  Cost    Salotal  \$ 10,309    Space Heating Load  100							
Heating Medium  Air  Air    Control Mode  on / off  on / off single stage  on / off single stage    Output kBtu/Hr  185  200    Steads/State Eff  81%  93%    Input kBtu/Hr  229  215    Seasonal Eff  778%  91%    Percentage of Load  121%  131%    Replacement-In-Kind Costs  Installed System Costs    Boiler  \$2,788  Condensing Unit Heater    Viff Capable Programmable  \$ 3,280  (atainees stee), secondary heet excharger)    Installation  \$ 18,700  \$ statof secondary heet excharger)    Installed System Costs  Statof secondary heet excharger)  Installed System Costs    Frequences  \$ 2,788  Contingency  \$ statof secondary heet excharger)    Installed System Costs  Statof secondary heet excharger)  Installed System Costs    Summary of  \$ 9,372  Subtof all    Summary of  Doperating  Projected  New  Peak    Provid  Sage  \$ 10,309  S 1,801  100    Heating Load  250,942  2,396  \$ 7,912  153  15    Space Heating Load  250,942  2,396  \$ 7,912  153  15    Space Heatin							
Control Mode    on / off    on / off    on / off single stage    on / off single stage      Output kBu/Hr    185    200	7.4	<u>^</u>			0		
Output kBtu/Hr      185      200      1        Steady State Eff      81%      93%      1      1        Input kBtu/Hr      229      215      1      1        Seasonal Eff      78%      93%      1      1        Percentage of Load      121%      131%      1      1        Replacement-In-Kind Costs      Installed System Costs      3.280      (stainless steel, secondary heat excharger)        Boiler      \$2,788      Condensing Unit Heater      \$3,280      (stainless steel, secondary heat excharger)        Wiff Capable Programmable Thermostat      \$770      \$      \$,8,520      Subtotal        Summary of      Annual      Projected      New      \$      \$,9,372        Summary of      Annual      Projected      New      \$      \$,9,372        Building      Operating      Fuel      Propane      Heating      \$,000        Summary of      Annual      Building      Projected      New      \$,000      \$,000      \$,000        Heat Loads      (kBtn / year)      Gallons      Gallons      Cost      \$	Heating Medium	Air			Air		
Steady State Eff  81%  93%    Input kBur/Hr  229  215    Seasonal Eff  78%  91%    Precentage of Load  121%  131%    Replacement-In-Kind Costs  Installed System Costs    Boiler  \$2,788  Condensing Unit Heater \$3,280    Procentage of Load  1.870    Viii Capable Programmable Thermostad  \$2,700    \$8,520  \$subotal    \$93%  \$1,870    Summary of  Building    Projected  New    Propane  Heating    Building-Related  Load    Loads  (kBtu / year)    Gallons  Cost    Space Heating Load  250,942    2,396  \$1,801    Savings \$1,801  \$1,801	Control Mode	on / off			on / off single stage		
Input kBtu/Hr  229  215    Seasonal Eff  78%  91%    Percentage of Load  121%    Replacement-In-Kind Costs  Installed System Costs    Boiler  \$2,788  Condensing Unit Heaters  \$3,280    Boiler  \$2,788  Condensing Unit Heaters  \$3,280    Installed System Costs  Installed System Costs    Boiler  \$2,788  Condensing Unit Heaters  \$3,280    Vifi Capable Programmable Thermostal  \$770    \$ 8,520  Subtotal    \$ 9,372  Subtotal    \$ 9,372  Subtotal    Summary of  Building    Building-Related  Projected    Kest  Fuel    Usage  Fuel    Space  Fuel    Usage  \$7,912    Space  \$11    Space  \$1,801    Space  \$11    Building-Space  \$1,801    Space  \$1,801    Space  \$1,801    Space  \$1,801    Space  \$1,801	Output kBtu/Hr	185			200		
Seasonal Eff  78%  91%    Percentage of Load  121%  131%    Replacement-In-Kind Costs  Installed System Costs    Boiler  \$2,788  Condensing Unit Heater Installation  \$ 3,280    Wif Capable Programmable Thermosta  \$ 2,600    Wif Capable Programmable Thermosta  \$ 2,700    \$ 9,372  Subtotal    \$ 9,372  Subtotal    Summary of Existing  \$ 2,788    Annual Building-Related Load  Projected (kBtu / year)  New Gallons  Peak  Provid    Building-Related Load  Load  Sage  Fuel  Load  100    Space Heating Load  250,942  2,396  \$ 7,712  153  15    Savings \$  \$ 1,801  5.7  150	Steady State Eff	81%			93%		
Percentage of Load    121%    131%    131%      Replacement-In-Kind Costs      Boiler    \$2,788    Condensing Unit Heater Installation    \$3,280    stainless steel, secondary heat exchanger)      Installed System Costs    Stainless steel, secondary heat exchanger)    Installation    \$3,280    stainless steel, secondary heat exchanger)      Wifi Capable Programmable Thermostat    \$2,600    \$8520    Subtotal    \$3770    \$8527      Summary of Existing    \$2,788    Projected    New    \$937    \$10,309    Provid    Bailding    Provid      Building-Related    Load    Usage    Usage    Fuel    Provid    Bailons    Cost    \$7,912    153    153    153      Space Heating Load    250,942    2,396    \$7,912    153    153    153      Cost    Savings \$\$1,801    \$1,801    \$5,7    \$10,309    \$1,801    5.7	Input kBtu/Hr	229			215		
Replacement-In-Kind Costs  Installed System Costs    Boiler  \$2,788  Condensing Unit Heater Installation  \$3,280 \$1,870    Propane storage tank Wifi Capable Programmable Thermostat  \$2,600    \$8,520  Subtotal    \$9,372  Subtotal    \$10,309  \$1,309    \$10,309  \$10,309    \$10,309  \$1,901    Summary of  Building    Building-Related  Load    Load  (kBtu / year)    Gallons  Gallons    Gallons  Cost    \$1,801  \$57,912    \$153  \$10,309    \$1,801  \$57	Seasonal Eff	78%			91%		
Boiler    \$2,788    Condensing Unit Heater    \$3,280    (stainless steel, secondary heat exchanger)      Installation    \$1,870    \$2,600    \$1,870    \$2,600    \$4,870      Propane storage tank    \$2,600    \$8,520    \$4,8520    \$4,8520    \$4,8520      Wifi Capable Programmable Thermostat    \$770    \$8,520    \$4,8520    \$4,8520      Contingency    \$8,520    \$4,8520    \$4,8520    \$4,8520      Totals    \$2,788    \$701    \$2,852    \$4,8520    \$4,8520      Summary of    Building    Projected    New    \$10,309    \$1,801    \$2,788    \$10,309      Summary of    Building-Related    Load    Usage    Fuel    New    Peak    Provid      Building-Related    Load    Usage    Gallons    Cost    \$7,912    153    15      Space Heating Load    250,942    2,396    \$7,912    153    15      Savings \$1,801    \$1,801    \$7,712    153    15      Solopeita    \$10,309    \$1,801    \$7,712    153    15      Cost    Savings <td>Percentage of Load</td> <td>121%</td> <td></td> <td></td> <td>131%</td> <td></td> <td></td>	Percentage of Load	121%			131%		
Installation    \$ 1,870      Propane storage tank    \$ 2,600      \$ 2,600    \$ 2,600      \$ 8,520    \$ 8,520      \$ 8,520    \$ 8,520      \$ 9,372    \$ 8,520      \$ 9,372    \$ 8,520      \$ 9,372    \$ 8,520      \$ 9,372    \$ 9,372      \$ 9,372    \$ 9,372      \$ 0,309    \$ 10,309      Totals    \$ 2,788      Totals    \$ 2,788      Summary of    Building      Projected    New      Peak    Provid      Building-Related    Load      Load    Usage      Gallons    Gallons      Cost    \$ 7,912      Savings \$    \$ 1,801	Re	placement-In-Kind Cos	sts	1	Installed System Cost	s	
Propane storage tank    \$ 2,600      Wifi Capable Programmable Thermostat    \$ 770      \$ 8,520    Subtotal      Subtotal    \$ 8,520      \$ 9,372    Subtotal      \$ 9,373    Subtotal      \$ 9,370    Subtotal      \$ 9,370    Subtotal      \$ 10,309    Peak      \$ 9,370    Subtotal      \$ 10,309    \$ 1,801	Boiler	\$2,788	C	Condensing Unit Heater	\$ 3,280	(stainless steel, secondary heat e	exchanger)
Wifi Capable Programmable Thermostati    \$    770      \$    8,520    Subtotal      \$    9,372    Subtotal      \$    937    Totals    \$      \$    937    \$    10,309      \$    10,309    \$    10,309      \$    0perating    Projected    New    Propane      Building-Related    Load    Usage    Usage    Sage      \$    Fuel    Load    100    100      Heat Loads    (kBtu / year)    Gallons    Cost    (kBtu / hr)    of design      \$    250,942    2,396    \$    \$1,801    5      \$    Savings \$    <				Installation	\$ 1,870		
Wifi Capable Programmable Thermostat    \$    770      \$    8,520    Subtotal      \$    9,372    Subtotal      \$    9,372    Subtotal      \$    9,372    Subtotal      \$    937    Totals    \$2,788      Totals    \$2,788    Total:    \$    10,309      Summary of    Building    Projected    New    Peak    Provid      Existing    Operating    Fuel    Propane    Heating    Boile      Building-Related    Load    Usage    Usage    Sort    (kBtu / hr)    of design      Space Heating Load    250,942    2,396    \$    \$7,912    153    15      Savings \$    \$1,801    Savings \$    \$1,801    5.7				Propane storage tank	\$ 2,600		
Summary of    Annual    Projected    New    Space    10,309      Summary of    Building    Projected    New    Space    1      Building-Related    Load    Usage    Usage    Fuel    Load    100      Heat Loads    (kBtu / year)    Gallons    Gallons    Cost    \$7,912    153    15      Space Heating Load    250,942    2,396    \$7,912    153    15      Savings \$    \$1,801    5.7    Savings \$    \$1,801    5.7			Wifi Capable Pros	• •			
Contingency    \$    852    \$    9,372    \$    \$    937    \$    937    \$    937    \$    937    \$    10,309    \$    10,309    \$    \$    10,309    \$    \$    10,309    \$    \$    10,309    \$    \$    \$    10,309    \$    \$    \$    10,309    \$    \$    \$    10,309    \$				,		Subtotal	
Summary of Existing Building-Related Heat Loads    Annual Building Operating (kBtu / year)    Projected Fuel Gallons    New Propane Usage Gallons    Fuel Cost    Peak Space    Provid 1      Summary of Existing Building-Related Heat Loads    Load (kBtu / year)    Projected Gallons    New Propane Gallons    Peak Provid Space    Peak 1    Provid Boile      Building-Related Heat Loads    Load    Usage (kBtu / year)    Fuel Gallons    Cost    (kBtu / hr)    of design      Space Heating Load    250,942    2,396    \$7,912    153    15      Savings \$    \$1,801    S.7    Savings    \$1,801				Continuous	.,	Subiolui	
Contractor Oversight    \$ 937      Totals    \$2,788    Total:    \$ 10,309      Summary of    Building    Projected    New    Peak    Provid      Building-Related    Load    Usage    Fuel    Propane    Heating    Boile      Building-Related    Load    Usage    Fuel    State    Cost    (kBtu / hr)    of design      Space Heating Load    250,942    2,396    \$7,912    153    15      Savings \$    \$1,801    \$1,801    5.7				Contingency		a	
Totals    \$2,788    Total:    \$ 10,309      Summary of Existing    Building Operating    Projected    New    Peak    Provid Space    1      Building-Related    Load    Usage    Fuel    Propane    Heating    Boile      Heat Loads    (kBtu / year)    Gallons    Gallons    Cost    \$7,912    153    15      Space Heating Load    250,942    2,396    \$7,912    153    15      Savings \$    \$11,801    S    \$1,801    5.7						Subtotal	
Annual Summary of Existing  Annual Building  Projected  New  Peak  Provid    Building-Related  Load  Usage  Propane  Heating  Boile    Building-Related  Load  Usage  Usage  Fuel  Load  100    Heat Loads  (kBtu / year)  Gallons  Gallons  Cost  (kBtu / hr)  of design    Space Heating Load  250,942  2,396  \$7,912  153  15    Savings \$  \$1,801  Savings  \$1,801				0			
Summary of Existing Building-Related Heat LoadsBuilding Operating LoadProjected Fuel GallonsNew PropaneSpace1 Heating Boiled Boiled Boiled Boiled Boiled Boiled Building-Related (kBtu / year)Space GallonsSpace GallonsFuel GallonsSpace CostI KBtu / hr)Boiled Boiled Boiled Boiled Boiled Boiled Boiled Boiled Building-Related (kBtu / year)Broek GallonsFuel GallonsSpace CostI Space SpaceI Boiled 	Totals	\$2,788		Total:	\$ 10,309		
Summary of Existing  Building Operating  Projected Fuel  New  Space  1    Building-Related  Load  Usage  Usage  Fuel  Load  100    Heat Loads  (kBtu / year)  Gallons  Gallons  Cost  (kBtu / hr)  of design    Space Heating Load  250,942  2,396  \$7,912  153  15    Space Heating Load  250,942  2,396  \$1,801  5    Summary of  Cost  Savings  \$1,801  \$1,801		A				Deals	Ducarida (#)
Existing Building-Related  Operating Load  Fuel Usage  Propane Usage  Heating Fuel Gallons  Boile Cost    Heat Loads  (kBtu / year)  Gallons  Gallons  Cost  (kBtu / hr)  of design    Space Heating Load  250,942  2,396  \$7,912  153  15    Space Heating Load  250,942  2,396  \$7,912  153  15    Savings \$  \$1,801  \$1,801  \$1,801  \$1,801	C		Destated	N			
Building-Related Heat Loads  Load (kBtu / year)  Usage Gallons  Fuel Gallons  Load Cost  100 (kBtu / hr)    Space Heating Load  250,942  2,396  \$7,912  153  15    250,942  2,396  \$7,912  153  15    Savings \$  \$1,801  \$1,801  \$1	•	0	•			-	_
Heat Loads  (kBtu / year)  Gallons  Gallons  Cost  (kBtu / hr)  of design    Space Heating Load  250,942  2,396  \$7,912  153  15    250,942  2,396  \$6,111  5    Savings \$ \$1,801    Cost Savings Payback    ull Equipment Cost Basis:  \$10,309  \$1,801  5.7	0			-		0	Boiler @
Space Heating Load      250,942      2,396      \$7,912      153      15        250,942      2,981      \$6,111      \$      <	Building-Related	Load	Usage	Usage	Fuel	Load	100%
250,942      2,981      \$6,111        Savings \$      \$1,801        Cost      Savings      Payback        ull Equipment Cost Basis:      \$10,309      \$1,801      5.7	Heat Loads	(kBtu / year)	Gallons	Gallons	Cost	(kBtu / hr)	of design Loa
Savings \$  \$1,801    Cost Savings Payback    Full Equipment Cost Basis:  \$10,309  \$1,801  5.7	Space Heating Load	250,942	2,396		\$7,912	153	153
Cost  Savings  Payback    Sull Equipment Cost Basis:  \$10,309  \$1,801  5.7		250,942		2,981	\$6,111		
Cost  Savings  Payback    Full Equipment Cost Basis:  \$10,309  \$1,801  5.7				Savings \$	\$1,801		•
ull Equipment Cost Basis: \$10,309 \$1,801 5.7					· · /		
Sull Equipment Cost Basis:      \$10,309      \$1,801      5.7		[	Cost	Savings	Pavhack		
	ull Equipment Cost Basis			0	, v		
ncremental Equipment Cost Difference: \$7,521 \$1,801 4.2	un Equipric în Cost Dusis.		φ10,507	φ1,001	5.7		
ncremental Bouinment Lost Lutterence? \$7.571 \$1.81.801 4.7		ee	¢7.501	\$1.901	4.2		
	ncremental Equipment Cost Di	iierence:	\$7,521	\$1,801	4.2		

### **GREENHOUSE GAS EMMISSIONS**

	(	Greenhous	e Gas (G	HG) Impa	lct			
	Baseline Fuel Usage	Natural Gas	Propane	Oil	Electricity	MT eCO2		
	Space Heating			2,441		25.1		
	Measure Description	Fuel Us	age After M	easures		GHG	GHG	Savings
Measure	(RTM = Renewable Thermal Measure)	Natural Gas	Propane	Oil	Electricity	Emmissions	Savings	As % of
#	(ECM = Energy Conservation Measure)	(therms / yr)	(gal/yr)	(gal/yr)	(kWh / yr)	(MT eCO2)	(MT eCO2)	Baseline
ECM 1	Enclosure ECM			2,396		24.7	0.5	2%
ECM 2	Heat With Condensing Unit Heater		2,981			16	9	35%
						Totals:	9	37%

GHG Emmi	ssions	
10.3	MT eCO2 / 1,000	gallons of #2 Fuel Oil
5.3	MT eCO2 / 1,000	gallons of Propane (LPG)
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 A	ir Cool Planet Campus	Carbon Calculator (2013 value)

## **HEAT BALANCE INFORMATION**

	BASELINI	E:	HEAT BA	LANCE
GAINS AND L	OSSES	BTU/HEA	TING SEASO	N*1E6
CONDUCTION	LOSSES		-222.6	
INFILTRATIO	N LOSSES		-67.9	
VENTILATION	LOSSES		0.0	
SOLAR GAIN			7.6	
OCCUPANT G	AIN		0.6	
ELECTRICAL	GAIN		19.6	
NET HEAT	ING DEMA	ND	-262.7	
			•	
	Net Heating	/Energy	Seasonal	
	Demand	Required	Efficiency	
	(MMbtu)	(MMbtu)	%	
	262.7	338.5	78%	

BASELINE	2:	Temperatu	re & Schedu	le Information		
	B	uilding Name:	Highway Dept	- Building 1		
Total Heating Days	212			Floor SF		
<b>Outdoor Winter Temperature</b>	35			2,808		
				Htg		
				Htg System		Occ Level
Wing name	Occupied	Unoccupi	ed Temp.	8		Occ Level Heating
Wing name	Occupied Temp.	Unoccupi	ed Temp. Off days	System	Schedule	Occ Level Heating Days

	BASELINE:		CONDUCTION LOSSES					
			HOURS/	DAYS/	TEMP	LOSSES	Sub	
#	Zone	UA	DAY	-	DIFF	(* 1E6)	Total	
1	Whole Facility	1,326	8	151	33	53		
		1,326	16	151	33	106		
		1,326	24	61	33	64	222.6	
		•						
	Total UA	1,326	1	Conduction Total 222.6				

BASELINE:				INFILTRATION LOSSES						
			0.55							
				HRS/	DAYS/		TEMP	LOSSES	Sub	
#	Zone	VOLUME	ACH	DAY	YR	0.018	DIFF	(* 1E6)	Totals	
1	Whole Facility	37,620	0.55	16	151	0.018	33	29.7		
		37,620	0.55	24	61	0.018	33	18.0		
	Occ.	37,620	0.75	8	151	0.018	33	20.2	67.9	
Infiltration Total										