ENERGY AUDIT REPORT

Prepared for the

Town of Fremont, New Hampshire

Ellis School

Fremont Safety Complex

Prepared and Submitted by

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Engineers and Consultants

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TABLE OF CONTENTS

1 INTRODUCTION 1

2 OVERVIEW OF ACTIVITIES AND FINDINGS 1

EXECUTIVE SUMMARY 1

GOALS AND OBJECTIVES 2

AUDIT ACTIVITIES 2

3 ELLIS SCHOOL – FACILITY DETAILS 8

DESCRIPTION OF EXISTING CONDITIONS 8

Building Envelope 9
HVAC System 12
Domestic Water Heating 13
Lighting 13

ENERGY USAGE 14

ENERGY EFFICIENCY MEASURES 20

ES-B1: Weatherization and Air Sealing 21
ES-H1: Retro-Commission HVAC System 22
ES-H2: Thermostat Temperature Setback 22
ES-H3: Replace AHU Time Clock in Penthouse 23
ES-L1: Lighting Controls (Daylight Harvesting Controls) 23
ES-O1: Computer Energy Savings (Thin Clients, Flat Screens, Power Management Software) 23
ES-O2: Smart Power Strips 24
ES-O3: Vending Machine and Reach-in Cooler Sensors 24
ES-R1: Geothermal Heat Pump System (Heating and Cooling) 25
ES-R2: Biomass Heating System (Woodchip) 26
ES-R3: Solar Photovoltaic System (Crystalline) 26
Additional EEM's for Consideration 29

4 SAFETY COMPLEX – FACILITY DETAILS 33

DESCRIPTION OF EXISTING CONDITIONS 33

Building Envelope 33
HVAC System 35
Water Heating 36
Lighting 36

ENERGY USAGE 36

ENERGY EFFICIENCY MEASURES 41

SC-B1: Weatherization and Air Sealing 42
SC-H1: Existing Building Commissioning 42
SC-H2: Thermostat Temperature Setback 43
SC-L1: Lighting Controls (Occupancy Sensors) 43
SC-O1: Computer Energy Savings (Thin Clients, Flat Screens, Power Management Software) 43
SC-O2: Smart Power Strips 44
SC-O3: Vending Machine Sensors 44
ES-R3: Expansion of Solar Photovoltaic System 45
Additional EEM's for Consideration 46

5 ENERGY EFFICIENCY AND RENEWABLE ENERGY FINANCING 48

6 ENERGY PROCUREMENT 50

APPENDICES

APPENDIX A – Lighting Analysis, Lighting Data Logger Results, and Sample Datasheets (ES-L1 and SC-L1)

APPENDIX B – Computer Energy Savings Analysis (ES-O1 and SC-O1)

APPENDIX C – Smart Power Strips Sample Datasheets (ES-O2 and SC-O2)

APPENDIX D – Vending Machine and Reach-in Cooler Sensors Sample Datasheets (ES-O3 and SC-O3)

APPENDIX E – Geothermal System Analysis (ES-R1)

APPENDIX F – Biomass Heating System RETScreen® Outputs and Analysis (ES-R2)

APPENDIX G – Solar Photovoltaic System Analysis and PVWATTS® Outputs (ES-R3 and SC-R1)

APPENDIX H – Solar Thermal Air Heating System Sample Datasheets

APPENDIX I – CO2 Data Logger Results

APPENDIX J – Sample Procurement Request for Proposals

1 INTRODUCTION

This study was conducted by GDS Associates under contract to the Town of Fremont, NH to perform energy audits of the two publicly owned buildings, the Ellis School and Fremont Safety Complex. The funding for the preparation of this report was provided by the American Recovery and Reinvestment Act and the NH Energy Efficiency and Conservation Block Grant as approved by the US Department of Energy and the NH Office of Energy and Planning. The report provides an evaluation of selected energy savings opportunities and renewable energy systems at these Town facilities.

The information presented in this report includes the following:

- An overview of audit activities and findings,
- A description of the existing facility conditions,
- A facility energy usage history and baseline analysis,
- Energy Efficiency Measure and renewable energy measure recommendations,
- A detailed list of available rebates/incentives, and
- An investigation of third party energy suppliers.

Other potential energy efficiency measures that were not fully evaluated are addressed as additional considerations following the Energy Efficiency Measures (EEMs). The information provided in this report may be used by the Town of Fremont as a reference for prioritizing and completing energy efficiency projects. Any reference to a manufacturer is intended to describe typical available technology, therefore a reference to a manufacturer should not be considered a recommendation of that manufacturer's product.

The findings and recommendations in this report are the result of what was observed at the time of visit. Every effort was made for accuracy in this process but as with all equipment compilations of this type, the actual quantities, names and locations may vary slightly.

The EEMs and associated costs and savings included in this study have been estimated based on GDS experience and industry standards and norms but in no way guarantee energy savings or performance. A more detailed analysis would be necessary to refine costs and savings values prior to initiating a project or performance contract. In addition, rebates and other incentives may be available for suggested measures. These and other potential funding sources are identified and discussed in more detail in Section 5.

2 OVERVIEW OF ACTIVITIES AND FINDINGS

Executive Summary

On December 28th 2010, Samuel Alpert, Richard Beard, and Steven Roy of GDS Associates met with Cheryl Rowell of the Town of Fremont Energy Committee, Dawn Lewis and Scott Brown of the Ellis School, and Mike of the Safety Complex, to conduct a comprehensive energy audit of these two Town of Fremont buildings. A blower door test and infrared scan was performed on the buildings, and lighting data loggers were installed to measure on-time of the existing lighting systems. A subsequent site visit was performed on January 17th, 2011 to pick up the light loggers, install CO_2 loggers in two classrooms, and gather additional information from the sites. A third site visit was performed on February 4th, 2011 to pick up the CO_2 loggers.

During the site visits a number of potential building envelope, heating and cooling, lighting efficiency, and other electrical plug load improvement opportunities were identified along with renewable energy system measures and ultimately led to the selection of the 19 EEMs analyzed in detail within this report. 15 measures are discussed generally as additional considerations. From our site visits it appears that the staff members of the facilities and the Town of Fremont as a whole is effectively focused on increasing its energy efficiency and reducing its energy usage.

Overall, GDS found over 50% of energy savings based on previous energy usage, which is a combination of low cost electricity and fuel oil savings measures, deep retrofit measures on the building envelopes and HVAC systems, and renewable energy systems for both buildings. Estimated annual savings from the 19 measures analyzed in this report total over **169,000 kWh, and 14,500 gallons of fuel oil,** with a total installed cost of approximately **$890,000** – representing a simple payback before incentives of **15.0 years** (see Table 2 for more information). The recommended order of implementation of these measures should start with the low cost measures, continue with deep retrofit measures when funds are available in the budget, and finally reach into the renewable energy systems after grant applications (and potential loans) are accepted.

Goals and Objectives

The goal of this Energy Audit was to investigate, identify and analyze potential energy saving and renewable energy opportunities (including electricity, fossil fuel, and cost reduction measures) at the town's Ellis School and Safety Complex buildings. The energy efficiency measures identification goal was met by performing an in-depth field survey of each facility, which included blower door infiltration testing as well as thermal image scanning. The analysis goal was met by conducting analysis of the 19 selected EEMs detailed in this report.

Audit Activities

Several major activities were conducted in completing this audit including:

- Energy Usage Assessment,
- Detailed Site Inspection,
- Blower Door Testing and Thermal Imaging,
- Lighting Data Logger Metering and CO_2 Sensor Metering,
- Measure Analyses and Recommendations Development,
- Investigation into Energy Efficiency Incentives and Financing Opportunities, and
- Assessment of Energy Procurement Options.

Each of these activities is described briefly below.

Energy Usage and Rates Assessment

Historical electrical, fuel oil and propane energy usage were given by the Town of Fremont for the Ellis School, and electricity and fuel oil usage were given for the Safety Complex. Historical energy consumption tables and charts are provided in Sections 3 & 4.

Historical annual energy usage is an estimate of future consumption and was based on the 2008-2010 data as given by the Town of Fremont. Fully blended (supply and delivery electricity and demand charges) average electricity costs given were used to develop the baseline rate of

$0.150/kWh as used for the Ellis School and **$0.147/kWh** for the Safety Complex[1]. Average fuel oil rates used for the Ellis School were **$2.36/gal** and **$2.16/gal** was used for the Safety Complex. 2010 rates for propane were approximately **$1.63/gal**. Additional details are given the Table 1.

Table 1: Utility Summary Data

Facility	Fuel	Units	Avg Rate Used	Annual Cost	Annual Usage	Baseline Years
Ellis School	Electricity	kWh	$0.150	$54,999	367,760	July 2008 - June 2010
Ellis School	Fuel Oil	Gallons	$2.36	$36,749	14,777	Jan 2008 - April 2010
Ellis School	Propane	Gallons	$1.63	$ 1,543	911	2010
Safety Complex	Electricity	kWh	$0.147	$10,994	74,896	2008 - 2010
Safety Complex	Fuel Oil	Gallons	$2.16	$ 6,922	3,200	Jan 2008 - April 2010

The following figures show the estimated breakdown of energy usage by equivalent unit energy (MMBtu) and energy cost by fuel source. The energy costs are based on the average rate over given 2008-2010 historical energy usage data.

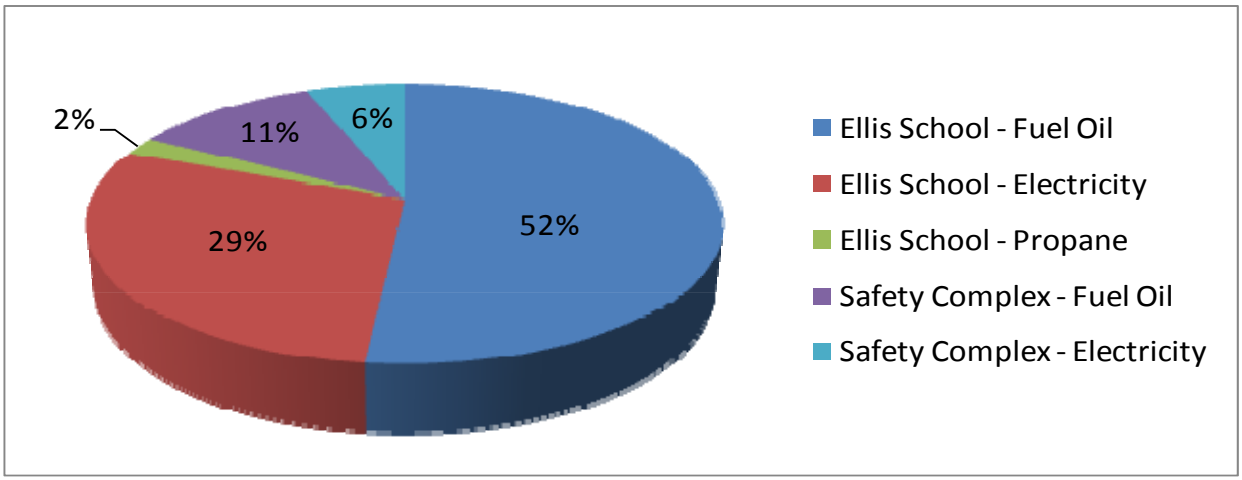


Figure 1: Energy Usage Comparison for Ellis School versus Safety Complex

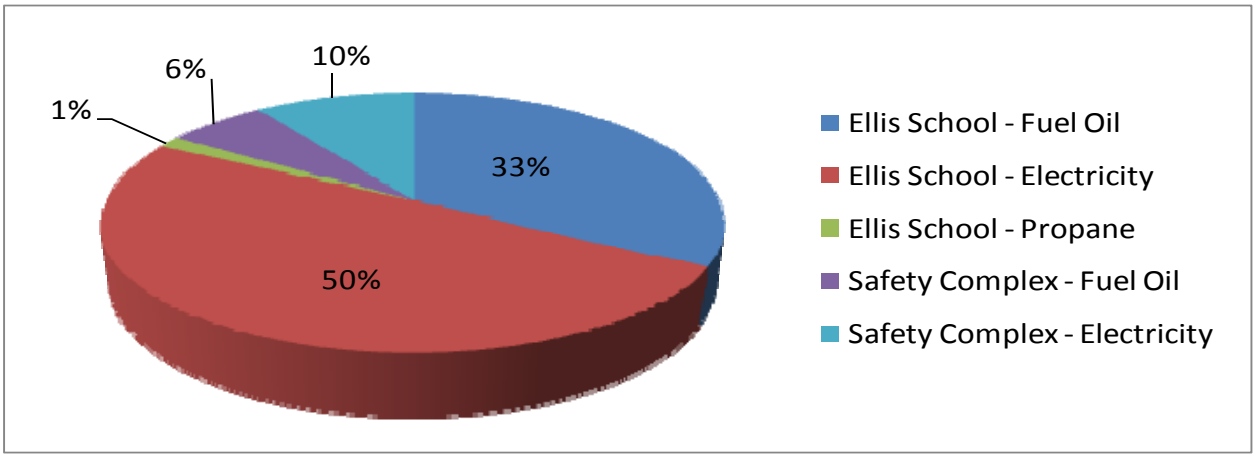


Figure 2: Energy Costs Comparison for Ellis School versus Safety Complex

[1] Safety Complex electricity rates were estimated using 2008-2009 costs only as 2010 costs were not given; they therefore underestimated and conservative in terms of actual simple payback analysis.

Energy usage and costs for the Ellis School versus the Safety Complex are shown in Figures 1 and 2 above as percentages. The pie charts show that approximately 84% of the total baseline annual energy costs and usage for the two buildings is from the Ellis School, where the highest dollar savings from EEMs are located. 50% of the total energy costs of the two buildings is from the Ellis School electricity consumption. Overall, it is noteworthy to observe that the school appears to be effectively implementing energy savings measures when available funding sources are identified, and that the intention of saving energy appears to be well ingrained within the culture at the school.

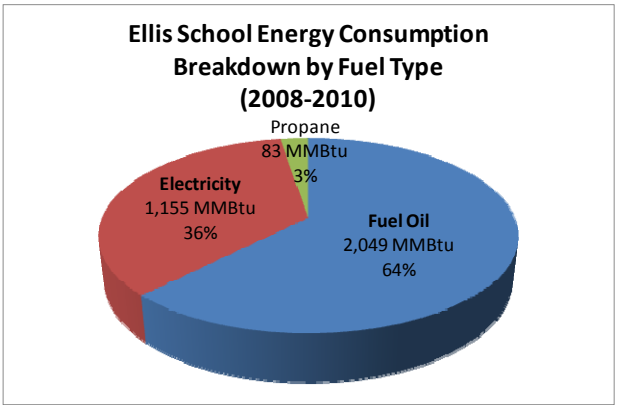


Figure 3: Ellis School - Energy MMBTU

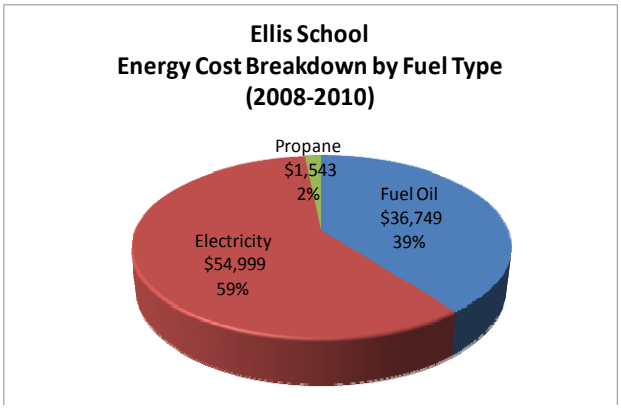


Figure 4: Ellis School - Energy Costs

Energy consumption data for the Ellis School, shown above in Figures 3 and 4, is based on energy usage data provided by the Town. The breakdown of energy usage and costs show that 64% of energy usage is from fuel oil, however this represents only 39% of the costs. The Electricity energy usage (in site MMBtu) is about 36%, while the electricity costs are 59%. Propane is a very small part of the overall costs (2%) therefore was not analyzed in detail.

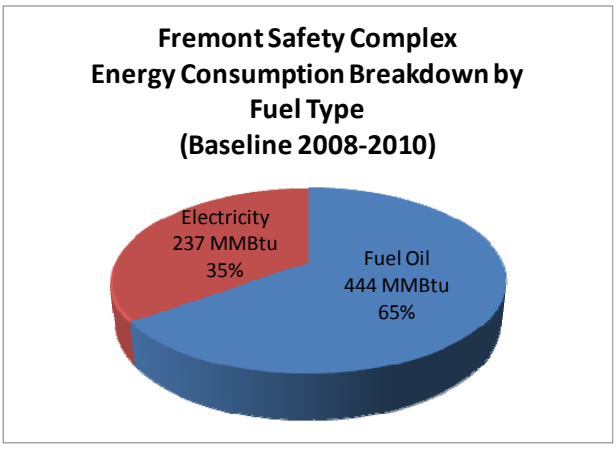


Figure 5: Safety Complex - Energy MMBTU

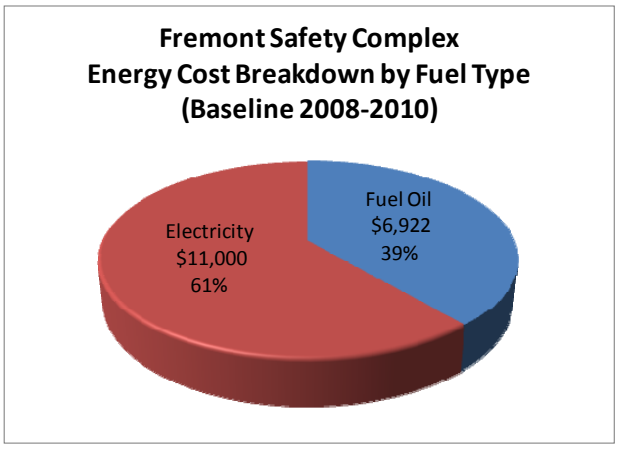


Figure 6: Safety Complex - Energy Costs

Energy consumption data for the Safety Complex, shown above in Figures 5 and 6, is also based on energy usage data provided by the Town. Electricity is required for the lighting systems, air conditioning, ventilation, computers, and other plug loads. Fuel oil is used primarily for space heating and domestic water heating for the bathroom sinks and showers. The breakdown of energy usage and costs show that 65% of energy usage is from fuel oil, however this represents only 39% of the costs. The Electricity energy usage (in site MMBtu) is about

35%, making up 61% of the Safety Complex's total energy cost. Both electricity and fuel oil usage were looked at for respective energy savings.

Detailed Site Inspection

A comprehensive inspection of each facility was conducted to gather information on existing conditions of the major energy using/mechanical equipment and building systems. This included gathering physical information on the building, such as: HVAC equipment nameplate data, lighting system inspection, and existing conditions of the thermal envelope. The site inspections allowed GDS to gain an understanding of how the buildings are currently being operated and maintained and to gather additional insight into the building operations.

Blower Door Testing and Thermal Imaging

GDS analyzed the thermal envelope in detail using four blower doors along with an infrared camera. The blower door testing and thermal imaging scans allowed GDS to determine the location of the infiltration and heat loss points in the facility and quantify the air flow in air changes per hour (ACH), (winter) heat loss, and temperature differential.

Lighting Data Logger Metering and CO2 Sensor Metering

GDS installed light level data loggers for two weeks to meter the on-time in both buildings to provide actual light usage metered data and determine more accurate energy savings for the lighting measures. Additionally CO_2 levels were logged in two classrooms at the Ellis School to analyze the indoor air quality in classrooms without mechanical ventilation.

Measure Analyses and Recommendations Development

Table 2 includes a summary of the 19 energy efficiency and renewable energy measures recommended to the Town of Fremont for potential implementation. Following Table 2 is a description of the methodology used by GDS for estimating costs and energy savings for the listed measures. Each Energy Efficiency Measure (EEM) is discussed in greater detail in the facility details sections, Section 3 and 4.

Table 2: Energy Efficiency Measure Payback Results[2]

ID	Energy Efficiency Measure Description	Simple Payback (Years)
Ellis School		
Building Envelope Measures		
ES-B1	Weatherization & Air Sealing	8.1
HVAC Measures		
ES-H1	Retro-commission HVAC System	2.6
ES-H2	Thermostat Temperature Setback	3.9
ES-H3	Replace AHU Timeclock in Penthouse	0.2
Lighting Measures		
ES-L1	Lighting Controls (Daylight Harvesting Controls)	4.3
Other Energy Efficiency Measures		
ES-O1	Computer Measures (Thin Clients, Flat Screens, Power Management Software)	1.7
ES-O2	Smart Power Strips	3.7
ES-O3	Vending Machine and Reach-in Cooler Sensors	0.7
Renewable Energy Systems		
ES-R1	Geothermal Heat Pump System (Heating and Cooling)	23.9
ES-R2	Biomass Heating Plant (Woodchip)	10.8
ES-R3	Solar Photovoltaic System (Crystalline)	37.4
Safety Complex		
Building Envelope Measures		
SC-B1	Weatherization & Air Sealing	5.8
HVAC Measures		
SC-H1	Existing Building Commissioning (HVAC System)	2.1
SC-H2	Thermostat Temperature Setback	3.1
Lighting Measures		
SC-L1	Lighting Controls (Occupancy Sensors)	0.0
Other Energy Efficiency Measures		
SC-O1	Computer Measures (Thin Clients, Flat Screens, Power Management Software)	0.3
SC-O2	Smart Power Strips	3.4
SC-O3	Vending Machine Sensors	0.7
Renewable Energy Systems		
SC-R1	Expansion of Solar Photovoltaic System	39.1
	Total Payback (Years)	**15.0**
	Savings as a Percentage of Baseline Costs	**55%**
	Total Baseline Costs	**$ 107,803**

Key: ES = Ellis School, SC = Safety Complex

[2] Geothermal (ES-R1) is not recommended unless the Biomass Heating System (ES-R2) is not pursued. No incentives or rebates are included in the simple payback column.

Methodology for Estimating Savings and Costs

In order to estimate the savings and costs associated with these energy efficiency and renewable energy measures GDS relied on standard engineering calculations, eQuest™ building energy modeling software, RETScreen® renewable energy system software, and equipment manufacturers' published information. EEM cost estimates were derived using budget estimates and quotes from HVAC and lighting contractors and manufacturers and their websites, 2008-2010 RSMeans® Cost Data books which provide related installed cost estimates, and information gathered from previous projects that involved similar energy efficient equipment recommendations.

Savings estimates and calculations were developed based on site conditions found during the walkthrough and subsequent site visits. The utility rates were based on the energy costs provided by the Town of Fremont and calculated to derive related baseline energy usage and costs. Rates were broken out as listed in Table 1 above. The rates used in the cost savings calculations reflect a conservative estimate for future costs.

While the overall payback value of 15 years provides a reasonably accurate reflection of the potential for cost savings by implementing all of these measures, there could be changes to this value in the event that costs and savings data become more refined. A more detailed analysis might be necessary before installing these measures or entering into a performance contract or similar guaranteed savings arrangement. All paybacks were based on operational assumptions and information presented at our site visit on Tuesday December 28th, 2010, subsequent site visits, and follow-up discussions with Cheryl Rowell and other Town representatives.

Investigation into Energy Efficiency Incentives and Financing Opportunities

Potential sources for measure installation incentives and other financing opportunities for the Town of Fremont were researched in this report, a summary of which is presented in Section 5. Identifying and tapping into potential measure installation incentives could greatly improve the payback periods calculated and identified in Table 2.

Energy Procurement

Information regarding third party energy suppliers and potential cost savings is presented in Section 6.

3 Ellis School – Facility Details

Figure 7: Ellis School Front Entrance

This section of the report includes the existing conditions of the Ellis School located at 432 Main Street. GDS evaluated the building envelope, HVAC, domestic water heating, lighting system, and other plug loads in the facility to identify potential EEM's. Also included in the EEM table are recommendations for renewable energy systems that may be implemented to further reduce the annual energy costs of the school as well as serve as educational tools for the students.

Description of Existing Conditions

The Ellis School is a Public Elementary and Middle School, also used for meetings and community facilities (recreation) during non-school hours. The building was originally constructed in 1950 and had five additions & renovations from 1966 through 2004. The original building housed five classrooms and a boiler room. The 1966 addition houses the library and two classrooms. The 1973 addition included the gymnasium/cafeteria with kitchen, four classrooms, a second boiler room, storage, and additional restrooms. The 1986 addition was for two additional classrooms. The 1998 additions expanded the library and added nine classrooms and the front offices and lobby area. The most recent addition, 2004, consisted of eight additional classrooms and storage areas. Temporary mobile units are on each side (left and right) of the building, and house two classrooms each; these have been used for about 7 years.

The school building is open for middle school, elementary school, and preschool, usually 5-6 days per week, 7am-5pm or 10 hours per day. In the summer operation is about 9 hours per day, 8am-5pm, 6 days per week for various camps and other occupants. Lighting is in use in the main common areas and hallways most days from 7am until around 10pm at night at times for athletic events.

Figure 8: Ellis School Map

Building Envelope

The school is primarily cinder block and brick sided construction with an unknown level if any insulation in the air cavity between brick and block. The building has a mostly sloped perimeter roof with light brown asphalt shingles and grey-colored rubber membrane flat roof in the center replaced in 2005 with skylights. The 2x10, 24”o.c. attic is divided into two areas: half of which is insulated with a combination of R-30 fiberglass batt on the attic floor and 4” of blown fiberglass on top of the batts, the other half is insulated on the attic floor with about 8” of cellulose. The new roof in the most recent addition has rigid insulation, most likely 1” rigid board but this was not able to be verified.

Figure 9: Cellulose Attic Insulation

Figure 10: FG Batt and Blown FG Insulation

Large portions of the attic insulation appear to have been disturbed and not replaced properly, therefore provide an additional heat loss as it is not sealed flush with the thermal envelope. See figure to the right for an example.

Figure 11: Fiberglass Attic Insulation

Attic kneewalls are insulated with 2” of extruded polystyrene. See figure below.

Figure 12: Walls in Attic

The gymnasium/cafeteria has concrete block construction with a vaulted truss roof insulated with rigid foam roof panels. See photo (Figure 13).

The windows for the school are double paned, wood frame windows except for the newest addition which has aluminum frame windows. The doors are either insulated metal or glass entries with aluminum frames.

Temporary mobile units are vinyl clad with double pane windows and have unknown insulation levels in both the walls and ceiling.

The greenhouse has opaque short walls and clear poly long walls (inflatable with air pump) and is not heated.

Overall throughout the school, air sealing is a major issue, especially in the ceiling and attic areas.

Figure 13: Gymnasium Ceiling

During the site visit blower door diagnostic testing was done for the entire conditioned thermal envelope of the school (not including the portables). Four blower doors overall were used in four semi-isolated zones for the school by closing off the fire doors to provide a makeshift barrier between the zones. Zone 1 was located from rooms 307 & 306 through room 406 and the front entrance and included the administrative hallway and associated offices included the lobby; this area required three blower doors to be set up, two in the front and one on the left side of the school between rooms 410 and 409. Zone 2 was the right front side of the building, and included rooms 202 and 207, through room 112 on the front, including the library and classrooms lining the front and right-hand sides of the school and room 109; a total four blower doors were set up for this area. Zone 3 included the gymnasium and kitchen areas and required two blower doors. Zone 4 consisted of the rest of the classrooms in the rear of the buildings including the newest addition for the elementary school and preschool.

Table 3: Ellis School - Blower Door Testing Results

Site	Description	Volume	Measured Blower Door Infiltration Rate (CFM50)	Calculated ACH NAT
Ellis School	Whole Building	608,000	118,400	0.63

The Blower Door testing for all portions of the building measured an average to high air infiltration rate for the building. A target for existing buildings is less than or equal to 0.50 ACH_{nat} or 10 ACH_{50}. 10 ACH_{50} is a conservative target and was used as a reasonable goal. The method of testing the sections separately has a minor effect on increasing the infiltration by considering leakage to the adjacent zones to be outside of conditioned space. Therefore, the measured infiltration rate of the building was somewhat more than the expected air infiltration rate due to the cross infiltration between the attics above the tested sections and between adjacent sections.

HVAC System

The space heating source for the HVAC system at the Ellis School are three oil-fired cast iron hot water boilers located in two separate boiler rooms. The boiler rooms are Weil McLain (one - Model 488 and two – Model 588). One Model 588 boiler was installed in 1988 the other two were installed in 2003/2004. Both boiler rooms outwardly appeared well maintained but it was noted that there were pipes without insulation. Boiler inspection records were not reviewed but it was stated the boilers are regularly maintained by an outside service contractor. Weil McLain claims a thermal efficiency of 85% for this style boiler.

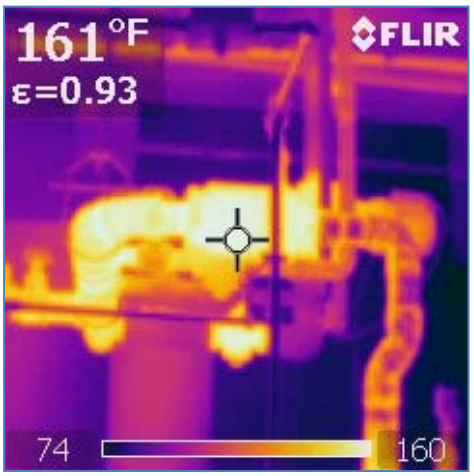


Figure 14: Infrared and Actual Photo of Non-insulated Boiler Room Piping

The HVAC systems serving spaces at the Fremont – Ellis School vary and are consistent with the HVAC systems that were popular at the time the portion of the school was constructed or renovated. There is not a central energy management system (EMS) at the Fremont School but there is a variety of standalone controls (programmable and non-programmable. **Error! Reference source not found.** describes the various HVAC systems and the areas that they served.

Table 4: HVAC Systems and Equipment Description

HVAC System ID	HVAC System Description	HVAC Equipment Description	Area Served
1	Hot water fin tube radiation in the space and attic area Energy Recovery Ventilators (disabled)	Fin original to the building and E-Z-Aire Super High Efficiency Air-to-Air Heat Exchangers (Model EZA-2285 and EZA-3085) installed in 1992.	Classrooms 104, 109, 110, 111, 112, 305, 306, 307, 308, 410, 411
2	Unit Ventilators with hot water coils	Trane Unit Ventilators (Model TUVA10VH6) of a 1988 vintage.	Classrooms 108, 406, 407, 408, 409 and 425
3	Central Air Handler with hot water heating coil & DX cooling coil	Trane Climate Changer AHU providing 12,000 CFM served by a 30 Ton Condenser Model RAUCC30G with an EER of 10.7	Core Administration areas, Library, OT/Speech, Kitchen area and classrooms 201, 202, 412 and 415
4	Hot water radiant ceiling panels and roof mounted Heat Recovery Ventilator	Heat Recovery Ventilator (Boss Air Model # BX1-4000-HW) providing 4500 CFM, installed in 2004.	2004 Addition (including classrooms 503, 504, 505, 506, 507, 508, 509 and 510)
5	Hot Water Unit Heaters	N/A	Gym, Kitchen and

			common areas
6	Electric baseboard heat, Air to Air heat exchanger and Through-the-wall air conditioning units	N/A	Portable Classrooms

During the site visit it was noted that occupant comfort complaints were typically due to excessive heat complaints and stuffiness (lack of fresh air). Investigation of the heating and ventilation systems found several issues that contributed to these complaints, specifically the lack of thermostats in each space as well as the two disabled energy recovery ventilators (ERV's) that were intended to provide fresh air to the classrooms.

Other energy saving opportunities identified were the time clock controlling the 30 Ton air handling unit was found in disrepair, there was air distribution issues identified in the core administration area (e.g. lack of a return air system in the principal's office) and the lack of night temperature setback which was due to the long warm-up time of the heating system, leading to the perceived inability to bring the building back to heating set point (68°F) the next day.

Domestic Water Heating

Domestic water heating is provided by two indirect-fired hot water tank-less coils in a boiler in each boiler room for the bathrooms and locker rooms. The DWH system outwardly appeared to be in good operating condition. In addition the kitchen utilizes a 74 gallon propane-fired A.O. Smith standalone tank water heater for its hot water needs. Hot water supply temperatures were not verified. Hot water piping was insulated in some places but not others. It is recommended to insulate all piping that lacks insulation.

Lighting

The lighting system for the entire building was converted by PSNH to high efficiency fluorescent fixtures in 2007. Lighting consists primarily of T-8 fluorescent fixtures for the classrooms/offices and other areas, and T-5HO fixtures for the gymnasium/cafeteria. Most rooms have wall-mount occupancy sensors controlling the lights and are on a 10-minute delay so that they do not generally turn off accidentally when there are still occupants in the space.

The storage rooms and attic spaces have a total of 11 incandescent bulbs (60W each), however these are used no more than 1 hour per day at the most on average and therefore not included as recommendations in our EEM list.

Exit signs throughout the school have been retrofit or replaced with LED bulbs or exit signs.

Kitchen:

The school kitchen was located adjacent to the cafeteria/gymnasium. Refrigeration equipment included a commercial refrigerator and freezer, two beverage display refrigerators, an ice cream cooler, and a walk-in cooler and freezer. All units should be considered for replacement with more efficient units on failure. There was one water vending machine near the gymnasium with lights on, which is a good opportunity for a VendingMiser® control which would lower energy usage when not in use.

Kitchen energy efficiency opportunities were not looked at in detail for this report due to the comparably lost cost for propane use for cooking equipment and because of the identification of higher areas of savings opportunity.

Energy Usage

Public Service of New Hampshire supplies and delivers electricity to the Ellis School. Various fuel oil delivery suppliers have been contracted with over the past three years due to varying prices, however the current 2010-2011 contract is with DiFeo Oil for 15,000 gallons. Propane is delivered to the school by Palmer Gas.

Electric usage and cost information was provided from July 2008 through June 2010. Fuel oil delivery information was provided from January 2008 through April 2010. Propane delivery information was provided from July 2009 through December 2010. Usage trends from the given data were developed to establish baseline usage utilizing the average of the given data, against which the savings for the EEM's are calculated. The average electric, oil and propane cost used as the basis for savings analysis is based on the average of available cost data to be conservative.

The current electricity rates are based on PSNH's GV General Delivery Service, and potentially charge for a low Power Factor (kW/kVA) through the kW to kVA comparison on page 3 of the utility bill, however currently the facility does not use many inductive loads (motors, etc.) therefore the Power Factor is approximately 97%[3]. If the school notices the Power Factor dropping far below 90% then it may be recommended to look into Power Correction devices, such as Power Correction Capacitors, however this is not a concern for the foreseeable future.

The tables and charts on the following pages describe monthly energy usage in more detail.

[3] Based on the December 2010 utility bill to the Ellis School (the only actual utility bill provided)

Table 5: Monthly Electric Usage[4]

Ellis School - Electric Use (kWh)				
Month	**2008**	**2009**	**2010**	**Baseline**
January		31,680	31,920	31,800
February		35,200	34,240	34,720
March		26,960	26,560	26,760
April		33,280	34,720	34,000
May		30,800	30,720	30,760
June		32,160	35,600	33,880
July	20,400	26,560		23,480
August	22,320	27,280		24,800
September	30,560	33,280		31,920
October	33,920	36,400		35,160
November	28,400	31,120		29,760
December	28,240	33,200		30,720
Total	**163,840**	**377,920**	**193,760**	**367,760**

Table 6: Monthly Electric Costs[5]

Ellis School - Electric Cost ($)				
Month	**2008**	**2009**	**2010**	**Baseline**
January		$4,641	$4,703	$ 4,672
February		$5,162	$4,927	$ 5,044
March		$4,157	$4,046	$ 4,101
April		$4,899	$5,221	$ 5,060
May		$4,752	$4,729	$ 4,740
June		$4,942	$5,266	$ 5,104
July	$3,243	$4,367		$ 3,805
August	$3,294	$3,984		$ 3,639
September	$4,524	$4,967		$ 4,745
October	$4,936	$5,365		$ 5,150
November	$4,145	$4,773		$ 4,459
December	$4,135	$4,823		$ 4,479
Total	**$ 24,278**	**$ 56,829**	**$ 28,891**	**$ 54,999**

[4] 2008 and 2010 totals are only for data given, and are not accurate for a total annual usage comparison
[5] 2008 and 2010 totals are only for data given, and are not accurate for a total annual costs comparison

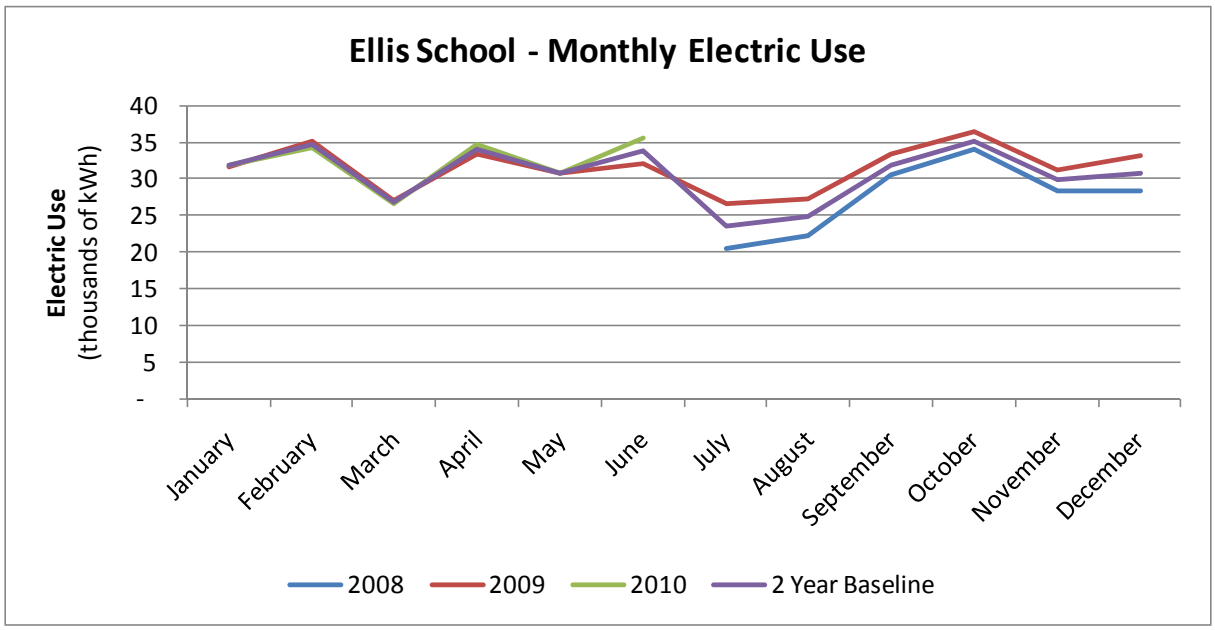


Figure 15: Electricity Consumption

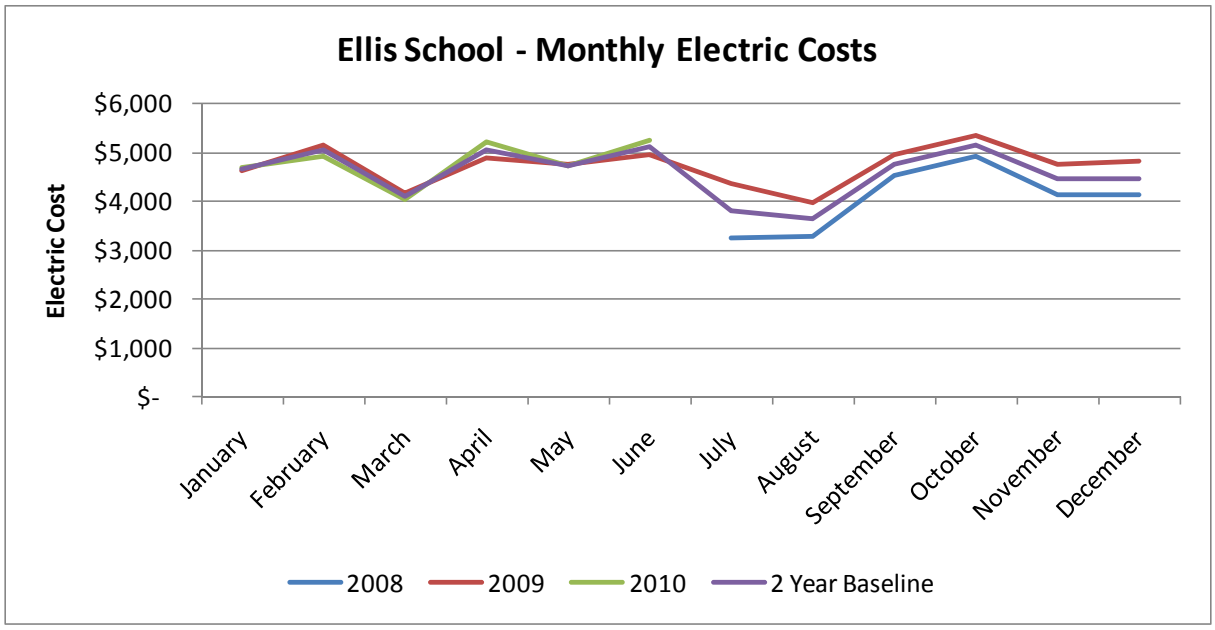


Figure 16: Electricity Costs

The Ellis School requires electricity for the lighting systems, air conditioning, ventilation, computers, and other plug loads.

Electricity consumption appears to be fairly stable throughout the year with a base load of approximately 25,000 kWh per month consisting of lighting, office equipment, refrigeration, ventilation and miscellaneous plug loads. The lowest usage is July and August when the students are out for the summer, even with the additional cooling load from air conditioning. Peak months of electricity usage coincide with the spring, fall, and winter seasons as these are the times the school is used the most frequently.

Table 7: Monthly Fuel Oil Usage[6]

Ellis School - Fuel Oil Usage (Gallons)				
Date	**2008**	**2009**	**2010**	**Baseline**
January	3,023	1,624	3,100	2,582
February	-	3,500	3,004	2,168
March	5,391	2,330	-	2,574
April	-	300	3,995	1,432
May	-	1,000		500
June	2,746	1,500		2,123
July	-	-		0
August	-	-		0
September	1,500	-		750
October	-	500		250
November	-	-		0
December	622	4,205	2,368	2,398
Total	**13,282**	**14,959**	**12,467**	**14,777**

Table 8: Monthly Fuel Oil Costs[7]

Ellis School- Fuel Oil Cost ($)				
Month	**2008**	**2009**	**2010**	**Baseline**
January	$8,677	$3,313	$6,817	$ 6,269
February	$8,814	$7,000	$6,485	$ 7,433
March	$8,814	$4,264	$4,792	$ 5,957
April	$3,515	$549	$4,792	$ 2,952
May	$3,515	$1,850		$ 2,683
June	$3,515	$2,730		$ 3,123
July	$ 1,680	$0		$ 840
August	$ 1,680	$0		$ 840
September	$1,680	$0		$ 840
October	$0	$995		$ 498
November	$0	$4,663		$ 2,331
December	$1,306	$4,663		$ 2,984
Total	**$ 43,196**	**$ 30,027**	**$ 22,886**	**$ 36,749**

[6] Monthly usage estimated based on fuel oil deliveries, December 2010 usage estimated using similar months' usage averaged. In December 2009 the delivery company went out of business, therefore total usage may have been understated based on the fact that the fuel oil ran out during that month.

[7] Monthly costs estimated based on averaged fuel oil deliveries, December 2010 usage estimated using similar months' usage averaged. 2008-2009 costs estimated based on actual charges from 2009-2010 versus NH OEP statewide average rates. In December 2009 the delivery company went out of business, therefore total usage may have been understated based on the fact that the fuel oil ran out during that month.

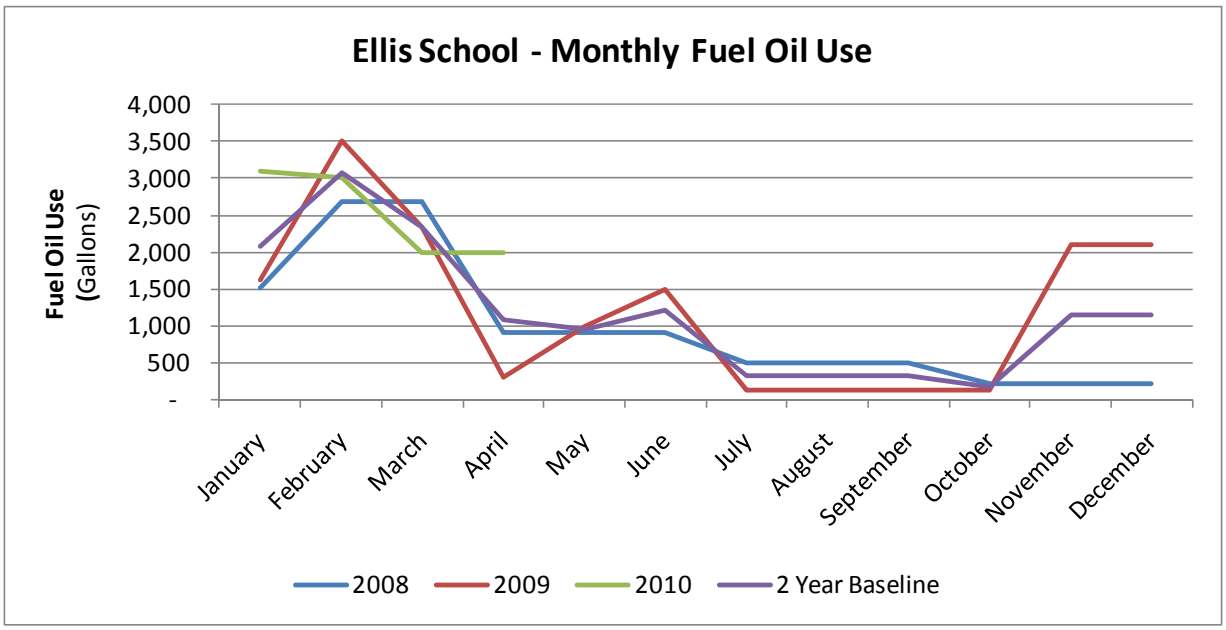


Figure 17: Fuel Oil Consumption

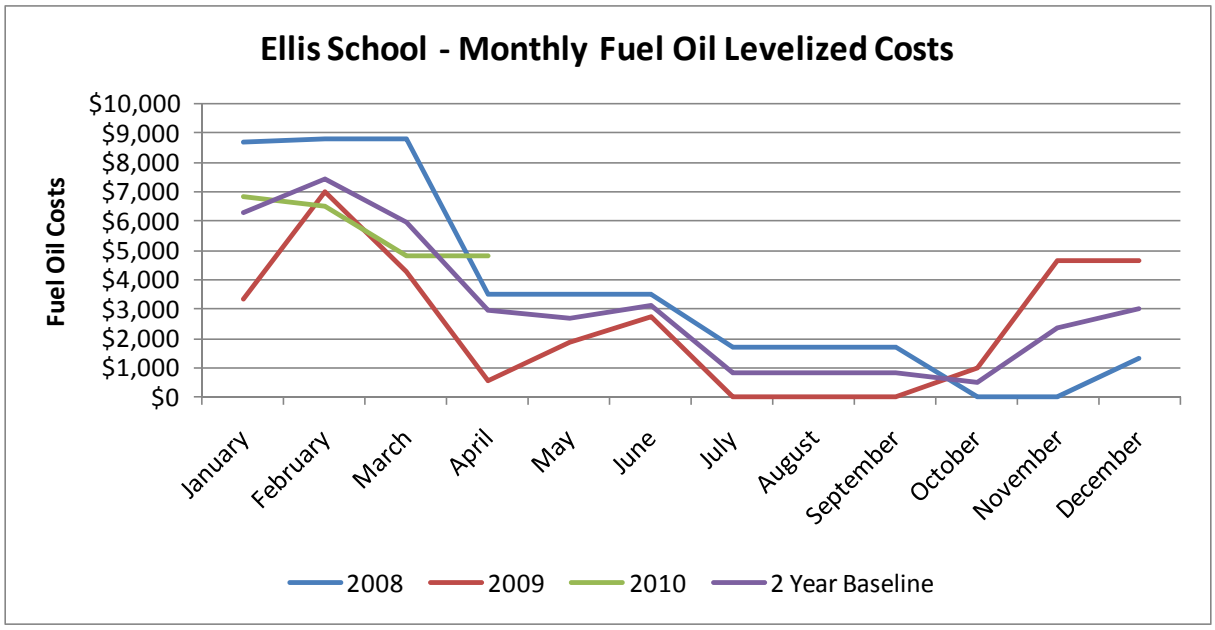


Figure 18: Fuel Oil Costs

Fuel oil is used primarily for space heating for the entire school and domestic water heating for the bathrooms. The oil delivery information shows an average base annual fuel usage of approximately 200 gallons for the domestic water heating load. Peak months are in the winter months due to space heating requirements.

Table 9: Monthly Propane Usage

Ellis School - Propane Usage (Gallons)			
Date	**2009**	**2010**	**Baseline**
January		55	55
February		70	70
March		110	110
April		63	63
May		55	55
June		130	130
July	50	12	31
August	-	21	11
September	58	45	52
October	133	134	134
November	60	70	65
December	129	146	138
Total	**430**	**911**	**912**

Table 10: Monthly Propane Costs

Ellis School- Propane Cost ($)			
Month	**2009**	**2010**	**Baseline**
January		$95	$ 95
February		$128	$ 128
March		$181	$ 181
April		$101	$ 101
May		$89	$ 89
June		$194	$ 194
July	$67	$20	$ 44
August	$0	$34	$ 17
September	$80	$71	$ 75
October	$195	$ 218	$ 206
November	$90	$ 121	$ 106
December	$208	$ 290	$ 249
Total	**$ 640**	**$ 1,543**	**$ 1,486**

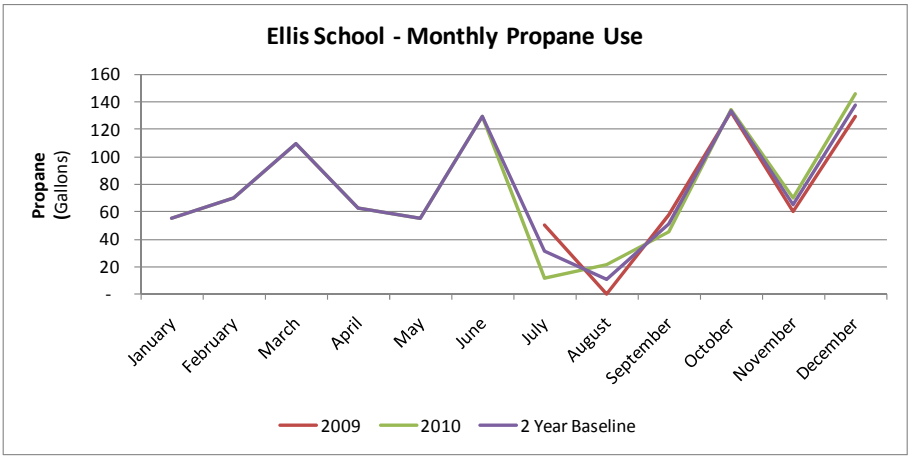


Figure 19: Propane Consumption

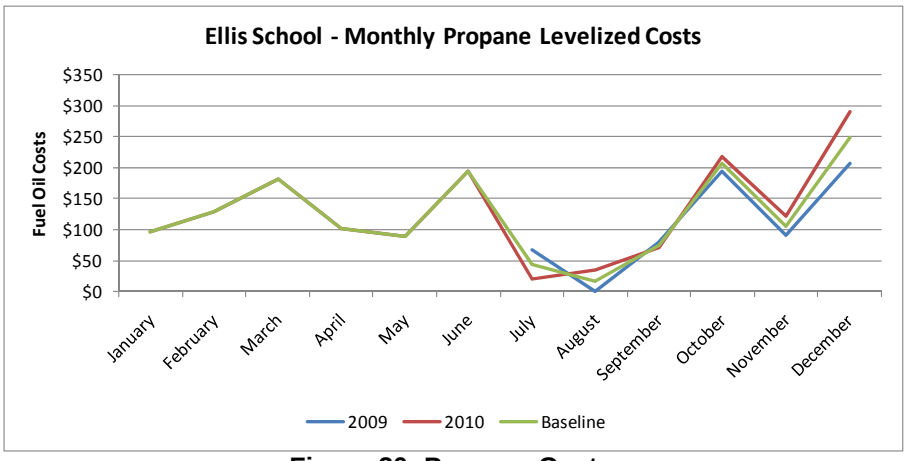


Figure 20: Propane Costs

Propane usage is for the hot water tank, ovens and stove in the kitchen. The propane delivery information shows an average hot water base usage of 20 gallons, however the peak usage is in the school season, fall through spring.

ENERGY EFFICIENCY MEASURES

The table below illustrates the 11 potential energy efficiency measures that have been targeted within this report for consideration at the facility. Additional energy efficiency measures that merit consideration are discussed at the end of this section.

Table 11: Ellis School Detailed EEM Table[8]

ID	Energy Efficiency Measure Description	Electricity (kWh/yr)	Fuel Oil (gal/yr)	Savings ($/yr)	Installed Cost ($)	Simple Payback (Years)
Ellis School						
	Building Envelope Measures					
ES-B1	Weatherization & Air Sealing	420	775	$1,892	$15,300	8.1
	HVAC Measures					
ES-H1	Retro-commission HVAC System	30,160	1,800	$8,760	$23,104	2.6
ES-H2	Thermostat Temperature Setback	10	1,035	$2,444	$9,500	3.9
ES-H3	Replace AHU Timeclock in Penthouse	21,434	0	$3,206	$500	0.2
	Lighting Measures					
ES-L1	Lighting Controls (Daylight Harvesting Controls)	616	0	$92	$400	4.3
	Other Energy Efficiency Measures					
ES-O1	Computer Measures (Thin Clients, Flat Screens, Power Management Software)	5,442	0	$814	$1,344	1.7
ES-O2	Smart Power Strips	9,000	0	$1,346	$4,950	3.7
ES-O3	Vending Machine and Reach-in Cooler Sensors	2,850	0	$426	$315	0.7
	Renewable Energy Systems					
ES-R1	Geothermal Heat Pump System (Heating and Cooling)	-88,260	14,000	$19,853	$474,000	23.9
ES-R2	Biomass Heating Plant (Woodchip)	0	13,707	$32,361	$350,000	10.8
ES-R3	Solar Photovoltaic System (Crystalline)	56,372	0	$8,430	$315,000	37.4
	Total Savings & Costs	**126,303**	**13,707**	**$51,250**	**$720,413**	**14.1**
	Savings as a Percentage of Current Usage	**34%**	**93%**	**57%**	**-**	**-**
	Total Baseline Usage & Costs	**367,760**	**14,777**	**$89,887**	**-**	**-**

[8] The Geothermal Heat Pump System (ES-R1) is not recommended unless the Biomass Heating Plant (ES-R2) is not pursued. No rebates or incentives are included as part of the simple payback calculation.

ES-B1: Weatherization and Air Sealing

There are 2 critical components to reducing the energy load on the building envelope. There is thermal sealing (insulation) to address conductive heat transfer, and there is air sealing (caulking, weather stripping) air barriers to address convective heat transfer.

GDS visually inspected the attic of the school and performed blower door testing and infrared imaging of the common areas throughout the building. The use of blower door testing helped to locate the areas of greatest convective loss and the thermal imaging camera helped to locate the areas with large conductive heat losses (also known as air infiltration).

The areas of highest air leakage appeared to be the attic hatches, common hallways, and above the acoustical tiles of some classroom areas. These areas, although insulated, did not have proper air sealing done and are recommended to be addressed by the school. In addition the windows and exterior doorways could utilize additional caulking and weather-stripping to reduce drafts in those locations. This measure includes a winter cover for the exhaust fan in the attic that allows for direct infiltration between outside and the attic space.

GDS recommends visually inspecting and sealing penetrations from the attic to the conditioned spaces and between the attics. GDS recommends that the Ellis School consider the use of closed cell foam insulation also known as high density foam or spray foam. Above the acoustical tiles is an ideal application for a spray foam product. Spray foam will allow the school to achieve air sealing while also increasing the thermal sealing. It is the only product that provides thermal sealing & air sealing. It is more expensive, however at $1/ft^2 estimated installed, it is worth the additional costs. Estimated air sealing costs in the analysis do not include spray foam costs for the entire facility, as only a portion of the school would be accessible by an insulation and air sealing contractor.

Use caulking for small gaps around duct venting, plumbing and wiring penetrations from the attics to the conditioned spaces. For larger gaps around framing and vent pipes use high density foam.

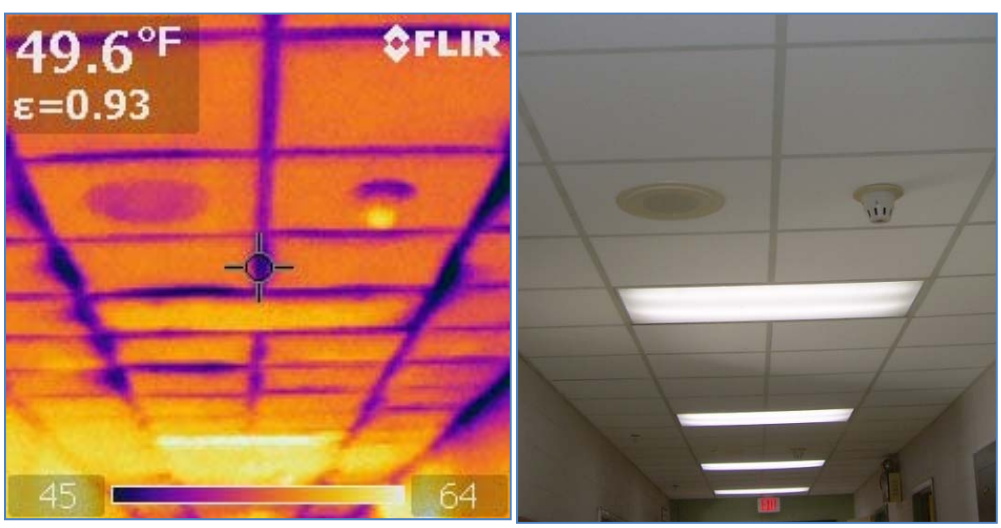


Figure 21: Infrared and Actual Photo of Hallway Ceiling Showing Heat Loss

Windows and doorways are common areas for air infiltration. Exterior doors should have weather stripping and door sweeps installed and replaced regularly about every 2-3 years of normal use. Access doors (hatches) to unconditioned spaces such as attics should have a weather strip and or a door sweep to reduce conditioned air losses to the space.

The energy savings for this measure are due primarily to the reduction in heating energy consumption, however there are some (minimal) cooling savings as well. Energy savings were estimated as a result of energy modeling using eQuest™ building energy modeling software. The savings are based on the assumed infiltration reduction to 10 ACH_{50} for this building. Costs were estimated using PSNH contractor costs, prior similar projects, and GDS field experience. The savings are based on the additional insulation value and the assumed infiltration reduction of 14% (17,000 CFM_{50}). This measure results in a simple payback of 8 years.

ES-H1: Retro-Commission HVAC System

Existing Building Commissioning is "a process that seeks to improve how building equipment and systems function together".[9] Performing retro-commissioning of the energy management system typically provides energy savings opportunities by confirming the lighting, hot water heating and HVAC system operational schedules and set point are optimized. It is recommended existing building commissioning (e.g. Retro-commissioning) on the HVAC and Lighting systems be performed at the school. This recommendation is based on a 2009 Research project by Lawrence Berkley National Lab that found virtually all existing building (commissioning) projects were cost-effective with average payback of less than 2 years. GDS has professional relationships with several local commissioning providers and can provide their contact information if the school board wishes to include them in an RFP for retro-commissioning the Fremont School.

ES-H2: Thermostat Temperature Setback

Currently the school utilizes primarily digital and dial thermostats for heating and most of the cooling controls are on the air conditioners themselves. The controls system currently is manual, therefore temperature setpoints are mostly maintained at occupancy temperatures when occupants leave the facility, however some thermostats are manually turned down at night.

GDS highly recommends replacing the current manual thermostats and installing at minimum a 7-day programmable thermostat for each current manual thermostat, therefore allowing the facility to automatically turn down space heating temperature setpoints (5 degrees recommended decrease to an average of 65°F) and increase space cooling temperature setpoints when the building is unoccupied (5 degrees recommended increase to an average of 80°F), therefore reducing electricity and fuel oil consumption. In addition the better control capability for the units will allow programs to be set on a daily basis, reducing the potential for the building to be heated or cooled when not needed. The issues previously with changing space temperatures when the building was unoccupied was with the building warm-up period. Programmable thermostats

Figure 22: Dial Thermostat

[9] Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions, Evan Mills, Ph.D., LBNL, Report Prepared for: CEC and PIER; July 21, 2009.

allow for a setback to operate so that warm-up time for the building is given and it is highly recommended that the setback temperatures a) not be set back drastically or over 10 degrees in either direction, and b) programs are set so that the building gets warmer for at least an hour before the building is planned to be occupied in the morning.

An advanced method of controlling the scheduled thermostat setpoints would be through an Energy Management System. Energy Management Systems (EMS) require communication cables or wiring or wireless control via ZigBee® (wireless protocols) or equivalent and provide remote access from a central computer station or through the internet so that setpoints and schedules would be changeable without ever touching the individual thermostats. This automated controls technology is more expensive than programmable thermostats alone, however the additional energy savings capabilities and functionality including more accurate/tighter controls are a large benefit to installing a system of this type. The more advanced system could also monitor the outdoor temperature and predict when cooling or heating might be needed or when economizer could be used to condition the space.

Energy savings for this measure was conservatively estimating using building energy modeling through eQuest™ and costs were obtained through local vendors of controls equipment. The programmable thermostat installation is recommended and would be approximately $250 per thermostat at $9,500 total with 38 thermostats being replaced. A similar EMS system would cost approximately five times the amount, or about $50,000 total installed and is not recommended at this time due to the longer payback period.

ES-H3: Replace AHU Time Clock in Penthouse

Repairing the time clock on the air handler serving the administration core area is expected to provide a quick payback of less than 1 year. The supply and return fans on the air handler were running constantly due to the time clock not operating properly. Energy savings for this measure are from the two motors being turned off when the building is unoccupied, which is equivalent to approximately 12 hours per day and over weekends. During the February 1st site visit, Scott Brown, Lead Custodian, stated a new time clock was ordered, on site and should be placed in service in the month.

ES-L1: Lighting Controls (Daylight Harvesting Controls)

The front classrooms especially Room 109 are a great opportunity for daylight harvesting. Natural daylight is already a constant in the space during the daytime on non-cloudy days due to the location of the windows in comparison to the location of the sun throughout the majority of the day, and there are lights in the space which can be controlled to turn off when enough daylight is provided. This would be an automatic control that could be bypassed if additional light is needed.

Details of daylight harvesting control recommendations, savings and costs are included in Appendix A. Metered results from the lighting data loggers are also included in the Appendix along with sample daylight harvesting control sensor data sheets.

ES-O1: Computer Energy Savings (Thin Clients, Flat Screens, Power Management Software)

This measure is a compilation of a few computer related energy efficiency measures that are recommended for the Ellis School. Thin clients, which run on Linux operating systems, are effective energy efficient replacements for most of the standard desktop and tower type computers that the Ellis School uses. These computers are in use by approximately 75% of the computers in the school, and the old types of computers are recommended to be replaced on

failure or on the current replacement cycle. Flat screen LED backlit monitors are the next step up in terms of monitor quality and energy efficiency, as the standard LCD monitors are fluorescent backlit, and they also are recommended to be replaced on failure or on the current replacement cycle. Energy usage calculations were based on estimated annual hours usage, in idle mode, and sleep mode. Energy usage was based on actual measurements of similar computers and monitors using a Kill A Watt® meter to measure wattage consumption, and published manufacturer specifications. Costs were based on incremental costs to install thin clients and LED monitors instead of the standard efficiency equipment. Additionally there are cost savings from installing thin clients instead of desktop computers, although these cost savings were not included in the payback calculations.

LED backlit monitors and thin clients' energy usage were researched and are recommended, however the highest energy savings come from replacing all desktop computers and monitors with laptops due to no additional computer monitor being required. The laptop replacements may only be useful for teachers because of theft concerns, unless the laptops are able to be properly locked to each desk or the floor, therefore this measure was analyzed but not recommended.

A third energy efficiency measure recommended to the school is a power management software tool. This tool is able to be installed on each computer in the school and similar to a building energy management system, these types of software tools can either run a computer in low energy mode or shut it down completely when not in use. IT departments that require computers to be on for upgrades also utilize these types of software tools as they allow for computers to be awakened on demand. It is recommended that the Ellis School research various manufacturers of these devices further as costs differ dramatically. The type that can be installed once and does not require an annual fee is most likely the preferred path for the school. Costs were estimated after researching a few manufacturers' prices.
Related software: PowerPro - http://www.powerpromanager.com/
PowerMinder - http://www.powerminder.com/
Power Manager - http://www.verismic.com/power_manager.html/

Details of computer energy savings calculations are included in Appendix B.

ES-O2: Smart Power Strips
Office-type plug loads at the Ellis School include computers and the peripherals, printers, task lamps, computer monitors, fax machines and phone systems. Plug loads consume electricity when no one is around. Even in "sleep" mode, plug loads may consume 2-10 watts out of necessity. GDS recommends an energy efficiency controls solution to automatically turn off plug loads during evenings and weekends. The recommendation is to install personal "smart power strips" or power strips with occupancy sensors. The Wattstopper® Isolé power strips are one option which schools have used to reduce their plug load electricity usage. At a conservative energy savings of 20% on 1,000 kWh per station the simple payback for these types of devices is estimated at less than 4 years. Only about half of the computers (45 estimated) are recommended to have these types of sensors installed as the rest of the computer stations do not have many peripherals. Sample data sheets for related products are listed in Appendix C.

ES-O3: Vending Machine and Reach-in Cooler Sensors
GDS recommends installing a VendingMiser® on the cold drink vending machine and a CoolerMiser® on its reach-in cooler. This low-cost energy efficiency measure has an occupancy sensor which reduces the power consumption of the vending machine and reach-in cooler when no one is around (power down the machine, monitors the room temperature, and repowers the

cooling system). Simple payback for these sensors is less than one year each. Sample data sheets for related products are listed in Appendix D.

ES-R1: Geothermal Heat Pump System (Heating and Cooling)

The Fremont School was investigated for a complete replacement of the central heating and cooling system with geothermal heating and cooling equipment. Currently only the central area including the library and a few offices have air conditioning. There are a few rooftop units that supply fresh air and the majority of the heating is baseboard supplied from three oil fired boilers. For this analysis GDS investigated the annual oil deliveries and based the geothermal system size on that usage. The annual oil deliveries were reported to be 14,000 gallons of No. 2 heating oil. GDS calculated the heating load to be 55 tons (660 kBtu/h) with an estimated annual energy usage of 1,939 MMbtu/yr.

Geothermal space conditioning systems in New England can be very cost competitive, especially when natural gas is not available. Typically electricity prices are much more stable (less volatile) over time than fuel oil and propane prices. The analysis performed by GDS used 2009/2010 oil contract prices of $2.36/gallon. The current average statewide price for oil is well over $3.00 per gallon. GDS used the lower price to be conservative but also included a sensitivity analysis that raised the price of oil to $3.50 per gallon and elevated electricity prices to $0.20/kWh.

This project scope of work did not include a full feasibility study to determine the earth condition around the school for the siting of wells. It is expected that a detailed study would cost between $6,000 and $12,000 depending the required scope and information available. The information included in this section should provide enough detail to help the school determine if geothermal is worth looking into from and order of magnitude as the cost to install will be significant.

Based on the conservative rates used ($2.36/gal) for # 2 heating fuel the current annual fuel oil cost is approximately $30,000. The calculated annual operating heating cost for a standing column geothermal heating system was estimated to be just under $20,000 with a fully blended electrical cost of $0.15/kWh. The cooling costs were based on the expected cost to cool the entire school even though less than ½ of the school is currently air conditioned. If the entire school was air conditioned, the estimated cost to cool the building annual is based on standard air cooled air conditioning rooftop units and $0.15/kWh for a total cost of just under $10,000 annually. A geothermal system is expected to cost just over $4,000 per year to air condition the entire school (less the kitchen). The total annual cost savings from a geothermal system is expected to be approximately $20,000.

The geothermal system cost is made of two major components. Unfortunately none of the existing equipment is worth salvaging to be converted to work with geothermal. The majority of the equipment is well past its expected life. The two major components are the outside of the building costs (wells, etc.) and the estimated cost for a 60 ton system is estimated at $174,000 for the earth couple installed. The inside building costs are significant and were based on an estimate of $5,000 per ton for a total cost of $300,000. This assumed the existing ERV can be repaired to supply fresh air and the water to air geothermal equipment would be used to condition the space temperatures. It might be necessary to consider an engineering firm to provide detailed retrofit drawing and specifications; the engineering design for this system could cost up to $60,000 and should be performed by an engineering firm with direct design experience of standing column geothermal systems. The total system cost is estimated at $474,000 and has a simple payback between 11 and 24 years depending on current oil and electrical costs. Related analysis is located in Appendix E.

ES-R2: Biomass Heating System (Woodchip)

A renewable opportunity to reduce operational energy costs can be accomplished by adding a biomass hot water boiler system to serve the schools heating needs. The existing oil-fired boiler system would remain to serve the heating needs during the shoulder seasons.

The State of New Hampshire Public Utilities Commission (NH PUC) and Renewable Portfolio Standard (RPS) define wood as a renewable energy source. Given that fact and that woodchips provide nearly three times the heat content per dollar than oil[10], this make heating wood attractive for schools in similar situations as the Ellis School. The estimated installed cost is based on discussions with biomass boiler manufactures and several past feasibility studies to estimate total installed system costs. The size of the system used in the analysis was a 1 MMBtuh capacity heating plant. GDS utilized RETScreen® renewable energy system analysis software to compare annual energy usage, operating and maintenance costs of the oil system and wood chip system. The total system cost used includes the wood chip boiler and material handling equipment at an estimated cost of $300,000 and an installed stack cost of $50,000 for a total system cost of approximately $350,000. Possible locations for the heating plant were not included the scope of work and was therefore not fully developed for this report.

The RETScreen® energy savings analysis resulted in annual cost savings of over $21,000 for annual heating costs. The simple payback before incentives was calculated to be 16 years. The school is a nonprofit organization and is not able to take advantage of federal renewable energy system tax credits, however the installing contractor may be able to take advantage of a 10-30% tax credit should the company's profitability be sufficient to meet the federal tax credit requirements. There are other programs that might be available for the school and/or installation contractor to take advantage of, but information is limited about these new programs at the writing of this report. RETScreen® outputs and related analysis are located in Appendix F.

Messersmith (www.burnchips.com), Chiptec (www.chiptec.com) and TARM Biomass (www.woodboilers.com) are possible woodchip boiler manufacturers. A boiler selection was not performed for this audit. If adding a biomass heating plant to the school is pursued it is recommended the school board and the Fremont Energy Committee interview several biomass boiler manufacturers to fully understand the costs and operational nuances of each manufacturer's systems.

ES-R3: Solar Photovoltaic System (Crystalline)

GDS examined the feasibility of installing a Solar Photovoltaic (PV) system at the Ellis School, particularly a crystalline system, which makes up a majority of the PV market in New Hampshire. This system would prove beneficial in three ways: (1) it would serve as a learning tool for the students to see the PV system in action and be able to analyze how much electricity the system is generating on a given day through access to the energy production website, (2) it would reduce the annual electricity costs to the school, and (3) it would reduce the cost impacts and volatility of electricity costs, allowing energy budgets to be more accurate going forward. It is estimated that the system would be able to provide approximately 56,000 kWh annually to the facility.

Crystalline PV systems have been in full commercial production for over 20 years, within which Crystalline technology has advanced. Crystalline module systems make up over 90% of the

[10] Based on $52 per ton of 50% moisture content woodchips and $2.36 per gallon of #2 heating fuel.

existing installed solar PV systems market[11]. Crystalline modules have no moving parts and have a current estimated average module efficiency of 17%. The crystalline module production cost prices have had a recent decline from nearly $4/watt in 2007, down to approximately $2/watt today[12]. Crystalline modules require a mounting/rack system and are likely to be ballasted to the roof of the facility. The total installed costs are estimated at $6,500 per kW[13]. GDS also estimated an average 20 degree tilt angle due to the current layout of the roof. An engineered installation drawing with the selected manufacturer's panel and racking system is required to determine the maximum number of panels that could fit on the roof, however a panel size of 40" x 60" is assumed.[14] The potential crystalline solar PV system size is approximately 50 kW, based on the limiting layout of roof slopes. It might be possible to install more, however to achieve maximum incentives GDS recommends installing a maximum of 50 kW. The cost of the system and a detailed financial sensitivity analysis are provided in Appendix G.

The building will need to be evaluated by a qualified and licensed professional structural engineer to ensure that the additional weight of the crystalline system can be supported by the building structure. The estimated weight of the crystalline modules and racking equipment is estimated to weigh between 5 and 15 pounds per square foot of space[15]. The wind load is also an important factor that will need to be taken into consideration.

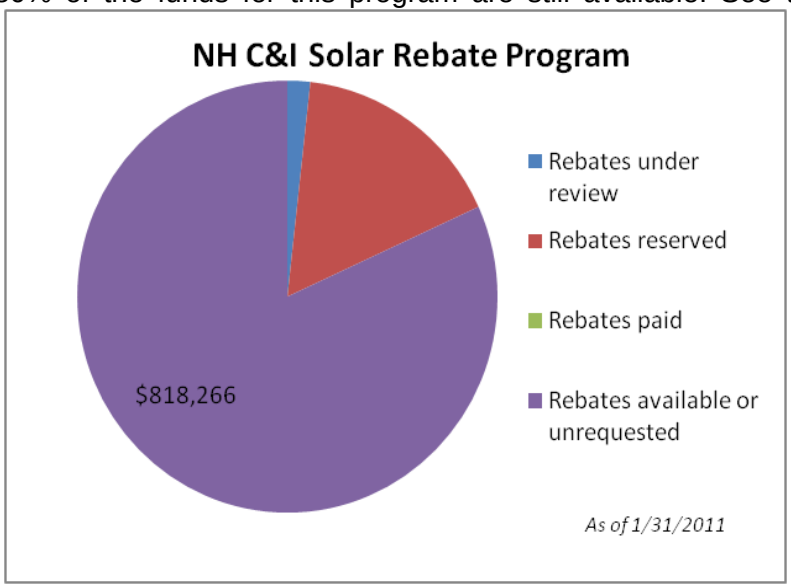
Crystalline module system can be affected by snow in this climate. At the suggested tilt angle of 20 degrees the estimated production lost due to snow cover is 4%[16].

DOE's PVWATTS® was used to calculate the expected annually kWh production for the closest location (Concord, NH). The tilt angle of 20 degree was used to be conservative on space requirements for crystalline modules since less space is required with higher tilt angles, however it results in slightly less kWh production. Due South (180°) was used as the expected orientation in the PVWATTS® software.

A rebate of a maximum of $50,000 (up to 25% of installed cost) is available from the State of New Hampshire Public Utility Commission (through RGGI funding) if an application is accepted.

[11] *Advanced Solar Electric System Training Business Programs Integration*, Presentation, Niels Wolter, Wisconsin Energy Conservation Corp.
[12] Ibid.
[13] Ibid; Solarbuzz trends; GDS estimate for large systems
[14] Suntech STP210-18/Ud Solar Product cut sheet copyright 2010.
[15] Wisconsin Focus on Energy "Ballasted Flat Roof Racks"
[16] "Selecting a solar electric system for a commercial building rooftop," fact sheet by Focus on Energy, 2008; ratio of snowfall from NOAA used for NH versus WI

As of January 31, 2011, over 80% of the funds for this program are still available. See the website listed in the footnote for Figure 23 for details.



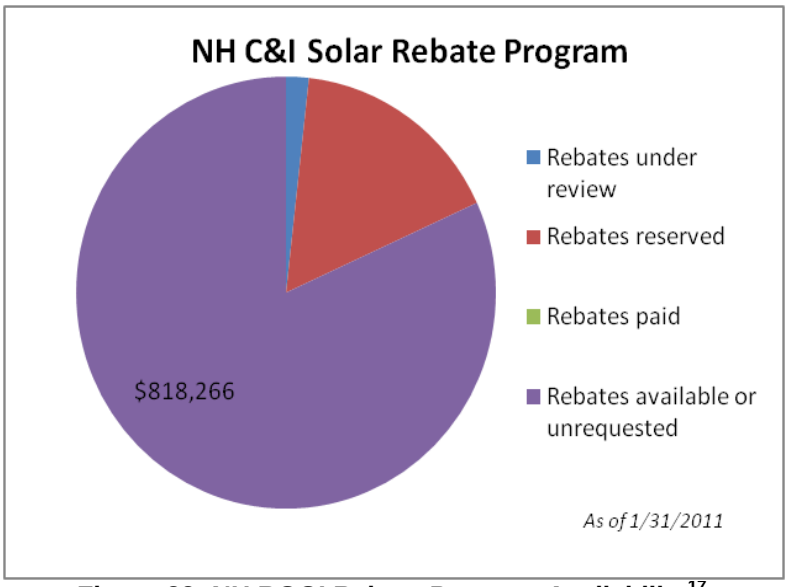


Figure 23: NH RGGI Rebate Program Availability[17]

The New Hampshire Community Development Finance Authority (CDFA) loan program is available to applicants that have had an energy audit or renewable energy feasibility study performed on their site, which this report is intended serve as representation for. The low interest (2.75% to 4%, depending on the length) loan is available for a variety of renewable energy and energy efficiency projects at a range of $10,000 to $500,000 per project.

The non-profit New Generation Energy also provides loans for solar projects through its Solar Lending Program. Typical loans are in the range of $10,000 to $50,000 and have terms of 1 to 5 years.

[17] http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-CI.html

In addition, Renewable Energy Certificates (REC's) are believed to be undervalued at the moment based on the recent decline in electrical demand on the grid from recent economic activities. National REC's are estimated at $15/MWh based on the 2005 NREL Emerging Markets for Renewable Energy Certificates report. State REC's from the NH Public Utility Commission are estimated at $150 per MWh based on the 2010 Class II Alternative Compliance Payment of $160.01 as set by the Renewable Portfolio Standard. Carbon Offset Credits (COC's) are listed at low rates today[18] and if REC's are sold it will be important and typically expected to include the emissions benefits of the REC's. In some cases selling the REC's and the carbon offsets could be considered double-counting the greenhouse gas reductions from solar PV therefore the COC's were not included in the rebate totals.

No incentives were included in the simple payback calculated in the EEM table. Reference Appendix G for detailed calculations and sensitivity analysis.

GDS included the NH PUC Solar Rebate Program grant and the Federal Tax Credit in the incentives for initial payback in the calculation in the appendix.

In addition a few different scenarios were analyzed. The first scenario used $150/MWh for one year of Class II Solar REC's from the NH PUC, and the annual national average cost of REC's of $15/MWh afterwords. The second scenario used only the conservative $15/MWh annual income from REC's and an average electricity rate increase to $0.20/kWh over the lifetime of the system. The third scenario utilized a combination of those first two scenarios to define a "best case" scenario.

There are several additional vehicles available to finance a Solar PV system for the school, including a Power Purchase Agreement, leasing the roof space, or leasing a solar system.

The Power Purchase Agreement (PPA) is an option that might work well for the school. The Ellis School would agree to pay a set amount for kWh produced from the Solar PV system and allow use of roof space. The PPA provider would own, install and maintain the system. The PPA provider would also take advantage of any tax credits and SREC's, etc.

Another option is to lease the roof space, allowing a connection to the grid for a PV system by a solar developer. The developer will then sell the power to the market and reap the tax credits and SREC's, etc.

The Ellis School could also lease a solar system in which case the leasing company might be able to use the tax credits and the lease agreement would need to be arranged so that if the Solar PV developer were to be able to sell the REC's then the payment would be lower to account for this added value to the system.

For financing or lump sum payments directly from the school, it would be possible to take advantage of all applicable incentives. This would need to be compared to the other options, as the school would reap all associated benefits from incentives, however the school would be required to maintain the system in question.

Additional EEM's for Consideration

A number of potential energy efficiency measures were identified during the site survey and in

[18] Bloomberg.com, referenced 9/3/2010 ICE ECX Emission market index

conversations with the Ellis School staff. Given the targeted scope of this project, 11 EEM's were identified for detailed evaluation for the Ellis School. This section briefly discusses the additional potential measures that were identified but not fully evaluated. Time and budget permitting, the Ellis School may choose to evaluate these potential measures in further detail.

Short (0-3 Year) Payback Items:

1) Pipe Insulation: Install 1" pipe insulation around any and all un-insulated hot water pipes where practical. During the initial site visit piping in boiler room lacked insulation and it was noted during the final site visit the boiler room in the original portion of the school had pipe insulation added and the temperature of the boiler room was noticeably cooler than during the previous site visits, indicating improved heating system efficiency.

2) Low Flow Water Savings Devices: Install low flow faucet aerators, and low flush water closets or flapper-less toilets to save water consumption and domestic hot water energy usage. Also, a low-flow pre-rinse spray valve in the kitchen should be considered.

3) Occupancy Sensors: It appeared that all areas that could utilize occupancy sensors had them installed, including all classrooms and some offices. However if the school determines that there are additional areas that could turn off lights automatically when no one is in the space, it is recommended to install them as they have a 3 year or less payback normally, unless they are located in closets or storage areas in which case it is not recommended.

Other Potential Energy Savings Opportunities:

1) Kitchen Exhaust Hood Controls: During the site visit an inspection of the kitchen found an exhaust hood above the cooking surface. The Melink Intelli-Hood Controls (www.melinkcorp.com) is an energy savings technology that is very popular in kitchens serving restaurants and college cafeterias. The estimated payback for the retrofit of the Ellis School kitchen exhaust system is over 10 years. If the kitchen increases its operating hours to 10 hours a day a Melink IntelliHood Controls type system should be considered.

2) Air Curtains: Another energy waste that GDS discussed with the school was the fact that the doors from the sides of the buildings are opened frequently when students go in and out of the classrooms in the mobile units. It is recommended that air curtains be researched to use in all entries to the school so that when the doors open there is a reduction of heat loss from the building.

3) Energy Management System: Install a central energy management system (EMS) to control the HVAC systems, boilers and lighting systems. By installing a central EMS approximately 75% of the energy usage at the Ellis School can be managed. Estimating the installed cost and expected energy savings associated with retrofitting the various existing controls at the Ellis School would be the next step. GDS recommends soliciting a bid from reputable controls contractors after the existing building commissioning is complete and the identified issues resolved. By doing this, the school district will be reasonably assured the building is tuned up prior to installing controls and the school district can share the gained building system knowledge with the bidding contractors.

4) Solar Thermal Water Heating: GDS analyzed the simple payback for this measure, as the kitchen hot water needs were deemed to be a candidate for a solar thermal water pre-heating system. A very long payback occurred due to the requirements of the facility and an estimated installed cost of $50,000 for the system based on similar projects.

The kitchen water heating needs were based on the propane bills provided to GDS and the number of students in the school (540) with ASHRAE standards. To determine if solar thermal is a viable option for the school, GDS estimated a desired water temperature of 120°F. The water temperature supplied to the solar thermal system was assumed to be 45°F on average.

For the analysis of the potential energy reduction for solar thermal, GDS utilized the renewable energy software tool RETScreen®. Glazed type collectors were modeled based on their ability to deliver higher temperature water. The solar thermal system was modeled with an output temperature of 100°F and the remainder of the heating was assumed to be achieved with a supplemental oil heating source.

The suggested location of the solar thermal system is directly above the kitchen area. Locating the solar thermal on the roof as close to the highest demand (which is the kitchen during the majority of the year) would help reduce potential system losses.

As a consideration for the Superintendent's Office, schools are typically not a good fit for solar thermal given that 50-60% of the solar thermal energy gains for water heating are in the two summer months when the kitchen is not being used. Conversely solar thermal air heating might be something to consider in the future, see below for details.

5) Solar Thermal Air Heating: Consider installing a Solar Thermal Hot Air Heating System to serve the makeup air needs of the kitchen exhaust system. This is a possibility for preheating the entering air on the HRV, ERV or make up air. The solar thermal air heating is utilized only during the heating season and school is usually in session when the sun is available. Even on the weekends the Ellis School is used during the day for many school and community events. Analysis of this renewable energy opportunity estimates a simple payback of 12 years which GDS does not feel is worth consideration based on financial impact alone, however this measure may prove to be more cost effective than a solar thermal water heating system and therefore would be the recommended approach if the Superintendent's Office supports adding a similar renewable energy system at the school. See Appendix H for additional information about solar thermal hot air heating systems.

Occupant Comfort & Indoor Air Quality Opportunities:

1) Re-commission the two Energy Recovery Ventilators (ERV's) that were disabled: During the initial site visit it was discovered that two ERV's serving several classrooms were disabled due to exterior odors that were believed to enter the classrooms due to the operation of the ERV's. The classrooms that are no longer served by the ERV's also had occupant comfort complaints, specifically stuffiness that caused the teachers and students to feel tired each afternoon. On January 17th GDS performed a second site visit and CO_2 data loggers were installed approximately 6" below the ceiling in two classrooms served by each ERV (Classroom #110 and #411). Ideally data loggers are installed in the breathing zone (e.g. ~ 3 to 6 feet above the floor) but due to the expected disruption to the classroom, installing them near the ceiling was prudent and are believed to have provided a reasonably accurate representation of the actual CO_2 levels in the classrooms.

   Data logging occurred for about three weeks (one of which had 4 snow days) and found the CO_2 level was approximately 500 ppm when the classrooms were unoccupied, and ranged between 1,000 and 2,000 ppm throughout the school day. The intention of this effort was to determine if the windows were opened in the classrooms to allow fresh air into the space during the school day, and if not then what level of CO_2 is typical in the classrooms without

fresh air being introduced to the classrooms. From the data logging it appears the windows were not opened during the school day therefore re-commissioning the ERV was not consider as an energy efficiency measure at this time. However, it should be noted that the current accepted standard for indoor air quality is ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality. ASHRAE Standard 62.1-2007 identifies the minimum ventilation (outside air) rates for an array of occupancy categories. Each occupancy category has a minimum ventilation rate per occupant (persons) and per floor area (ft^2) of the space where the occupants reside. The acceptable minimum ventilation per standard ASHRAE 62.1-2007 is the sum of those two rates in each space. Assuming each classroom served by the ERV's has 22 occupants, is 600 ft^2 and the occupants are sedentary, an acceptable CO_2 level above ambient can be calculated for each classroom following the procedure outlined in Appendix C of ASHRAE Standard 62.1-2007. Applying the above assumptions to the procedure described in the ASHRAE Standard, a CO_2 level 400 ppm above ambient is considered an acceptable level in the classrooms. GDS encourages re-commissioning the ERV's as part of the overall existing building commissioning of the school as described above in ES-H1, as the CO_2 levels reached by these classrooms during the afternoon greatly exceeds ASHRAE indoor air quality recommended levels. See Appendix I for graphs from the CO_2 logging.

2) Window Shading: Window shading was originally researched as an EEM, however after performing building energy modeling on the school it was determined that there is not enough energy usage for cooling during the warm months in the front classroom windows to compensate for the increased heating load in the winter months due to installed shading. This is more of a comfort issue at the moment, however if an extensive amount of additional artificial cooling and ventilation is required for comfort then this would turn into an energy savings consideration. This project is worth looking at in the future if space needs change.

4 Safety Complex – Facility Details

Figure 24: Safety Complex Front Entrance

This section of the report includes the existing conditions of the Town of Fremont's Safety Complex located at 425 Main Street. GDS evaluated the building envelope, HVAC, lighting system, and other plug loads in the facility to identify potential EEM's.

Description of Existing Conditions

The Fremont Safety Complex was originally constructed in 1997 and has two distinct sections. There is a rectangular-shaped high bay garage connected to a smaller one-story section of primarily office space 5,600 ft^2 (seen in Figure 24 above) which houses an additional garage "sally port" for the police squad cars. The main usage of the building is for the Fire and Rescue and Police and Emergency Management Departments, and the 6,660 ft^2 attached garage is used to store fire trucks and other equipment and vehicles. The building additionally is used for public meetings, community use, and trainings (meeting room). In 2010, there was additional attic insulation added along with two PV panels.

The complex is open from 8am-4pm Monday through Friday to the public, although the building is occupied most every night by police personnel.

Building Envelope

The complex is wood framed with a truss framed roof and asphalt shingles; the building exterior has vinyl siding. The windows are double pane with vinyl cladding and in good overall condition.

The windows are double paned, low-e vinyl clad units in good condition. At the time of the audit the windows were all closed.

The stud walls are insulated with R19 fiberglass batt insulation. The Safety Complex has ten total garage doors – eight insulated overhead doors for the fire station garage and two in the

sally port. All garage doors have thermal loss at the folds of the doors, window frames and along the railings. During the air infiltration test the garage was very drafty and this connection was not noted to be a significant source of air infiltration. The exterior entrances to the building were proven to be in good condition. The exterior doors and doors to unconditioned spaces should all have weather-stripping and door sweeps. It is recommended to replace weather-stripping and door sweeps at the first sign of wear, usually every 2-3 years of normal use.

The upper thermal boundary of the Safety Complex is insulated along the attic floor all the way to the soffit of the building. This consisted of plywood flooring on about 50% and exposed insulation on the rest, see Figure 25. The insulation inspected was R30 fiberglass batts with 4" of blown fiberglass installed on top of R11 Fiberglass batts which are held up by strapping. At first inspection this sounds like a great thermal boundary. The problem is that there is no consistent air barrier between the living space and the attic. The blown fiberglass was seen falling through the R11 batts onto the back of the acoustical tiles as shown in Figure 25. This is a clear indication of a failed air barrier. Fiberglass batts are a thermal barrier, not an air barrier.

Figure 25: Area above Meeting Room

This area, although it looked like it was sealed well, performed poorly with the blower door test, implying much opportunity for air sealing and weatherization to tighten the building's thermal envelope.

Figure 26: Fiberglass Batt over Blown FG Attic Insulation and Insulated Flex ductwork

During the site visit, blower door testing was done on the Safety Complex. Two blower doors were used to de-pressurize the conditioned office area portion of the building. The conditioned garage was not included in our test as it was assumed that there would be excess leakage from that space. One blower door was placed in the meeting room door that led to the outside, and the other was placed in the exterior door from the lobby. The access door between the garage and the attic space over the office space and the interior door between the meeting room and garage were closed – this is how the building is currently being operated

Table 12: Safety Complex - Blower Door Testing Results

Site	Description	Volume	Measured Blower Door Infiltration Rate (CFM50)	Calculated ACH NAT
Safety Complex	Offices side (no garage)	56,000	11,300	0.65

The Blower Door testing yielded an air infiltration rate of about 11,000 CFM_{50} or approximately 0.65 natural air changes per hour (ACH_{nat}) for the Safety Complex. A reasonable target for existing buildings is less than or equal to 0.50 ACH_{nat}, or 10 ACH_{50}. 10 ACH_{50} is a more conservative target and was used as a more reasonable goal for the Safety Complex. The Blower Door testing measured an average to high air infiltration rate for the building.

This target is considered a safe limit to ensure proper indoor air quality and a safe limit for combustion exhaust. A commercial building of a similar size that has higher than 0.50 ACH_{nat} is considered to have larger amounts of air infiltration. This building has a large amount of air leakage with regards to the suggested tightness limits. Based on these calculations, GDS recommends performing air sealing measures to reduce conditioned air losses and help save energy.

HVAC System

The safety complex is heated by two oil-fired Buderus cast iron hot water boilers (Model # G-305-95-6) with a maximum input energy input of 2.95 Gallons per hour of No. 2 fuel oil with a name plate efficiency rating of 86%. The boilers provide hot water to two fan coil units and two radiant slab heating systems. The fan coil units serve the Police Department and Fire Department office areas. Fan Coil No. 1 (FCU-1) serves the Police Department and the Fire Department front offices. FCU-1 is controlled by programmable thermostat that is located in the interior hallway near the secretary's office. Fan Coil No. 2 (FCU-2) serves the interior storage rooms and the meeting room. FCU- 2 is controlled by a programmable thermostat that is located in the Meeting Room. Inspection of both FCU thermostats found an occupied heating set point of 68°F (Monday – Friday) and an unoccupied heating set point of 60°F (temperature setback on nights and weekends). The radiant slab heating systems serve the Fire Department garage area and the Sally Port in the Police Department. The radiant slab heating systems are controlled by thermostats in each space, and were set at 58°F during the site visit. Slab heating water temperatures were unable to be verified while on site.

The Fan Coil Units are Hydro-Pac Air Handlers (Model # VRHC95-60) and per the original construction documents each Fan Coil circulates 2,000 CFM and provides 260 CFM of fresh air. Each Fan Coil Unit has a DX cooling coil that is served by a dedicated 5 Ton condenser located

on a pad behind the complex. The 5 Ton condensers are Allegiance 10 (Model # 7C0060A300A1) manufactured by American Standard with a nameplate SEER of 10.0.

The Fan Coils Units and the Boilers are located in the attic area above the Police and Fire Departments.

A few issues specific to the HVAC system were noted during the site visit including incomplete pipe insulation in the boiler room, blocked supply air diffuser in the Evidence Room, lack of heat in the Police Chief office and the need for an override thermostat located outside the Fire Department Chief office.

Water Heating

Domestic hot water is provided to the safety complex sinks and showers by an indirect 80 Gallon water heater (Vaughn Model: S80PJHX20) located in the boiler room which runs off the oil-fired boilers. The DHW system outwardly appeared to be in good operating condition. Hot water supply temperature was not verified.

Lighting

The light fixtures throughout the Safety Complex are primarily linear 30W T8 fluorescent fixtures with electronic ballasts and 32 and 35 Watt U-tube fluorescents. There were a few incandescent and Compact Fluorescent Lamps (CFL's) in the attic space, however usage appeared to be very low therefore they are recommended to be replaced by CFL's on failure. The exit signs appeared to be updated to LED. In addition, about 95% of the office space utilizes lighting control occupancy sensors. Some lights in the garage are required to be on at all times, and the rest are turned off when not needed. It was observed that the occupancy sensors in the Squad Room and the Fire Department side of the hallway were not used. Energy savings would be attributable to the Squad Room occupancy sensor being re-instated, however the usage of the Meeting Room from the sampling of metered data gathered determined that the installation of an occupancy sensor there would not be cost effective.

Energy Usage

It is believed that Public Service of New Hampshire supplies and delivers electricity to the Safety Complex, although this level of detail was not available from the given data. Fuel oil is also delivered to the Safety Complex although GDS was not given actual bills therefore it is unknown what supplier the Town of Fremont is using.

Electric usage information was provided from January 2008 through November 2010, although costs information was only provided for February 2008 through December 2009. Oil delivery information was provided from January 2008 through April 2010. Usage trends were developed to establish baseline usage utilizing the average of the given data, against which the savings for the EEM's were calculated. The average electric and oil cost used as the basis for savings analysis and was based on the average of available data provided to GDS by the Town of Fremont to be conservative.

The tables and charts on the following pages describe monthly energy usage in further detail.

Table 13: Monthly Electric Usage[19]

Safety Complex - Electric Use (kWh)				
Month	**2008**	**2009**	**2010**	**Baseline**
January	7,600	4,786	6,200	6,195
February	8,200	7,120	5,760	7,027
March	7,920	5,960	5,120	6,333
April	5,880	5,800	5,880	5,853
May	5,400	6,080	5,400	5,627
June	6,280	5,080	5,680	5,680
July	6,520	5,920	7,480	6,640
August	6,880	8,200	6,920	7,333
September	6,600	6,760	6,040	6,467
October	6,400	6,480	6,440	6,440
November	5,640	5,240	5,960	5,613
December	6,461	5,800	6,131	6,131
Total	**79,781**	**73,226**	**73,011**	**75,339**

Table 14: Monthly Electric Costs[20]

Saftey Complex - Electric Cost ($)				
Month	**2008**	**2009**	**2010**	**Baseline**
January	$1,072	$686	$858	$ 872
February	$1,059	$1,040	$826	$ 975
March	$1,044	$904	$725	$ 891
April	$790	$874	$861	$ 842
May	$806	$925	$803	$ 845
June	$870	$800	$869	$ 846
July	$934	$1,004	$1,099	$ 1,012
August	$985	$1,227	$1,034	$ 1,082
September	$987	$1,060	$906	$ 984
October	$959	$960	$1,001	$ 973
November	$816	$839	$712	$ 789
December	$930	$815	$902	$ 882
Total	**$ 11,252**	**$ 11,134**	**$ 10,596**	**$ 10,994**

[19] December 2010 data estimated based on previous usage during similar months
[20] 2010 costs not given, January 2008 data estimated based on usage and average 2008 rates

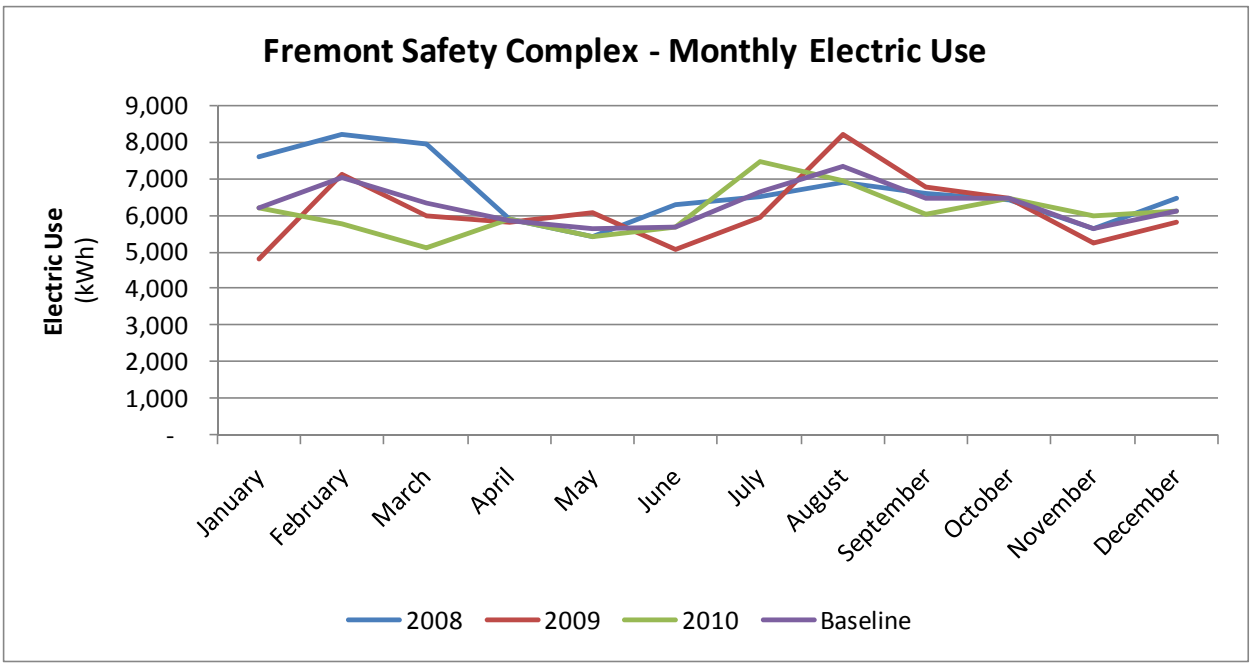


Figure 27: Electricity Consumption

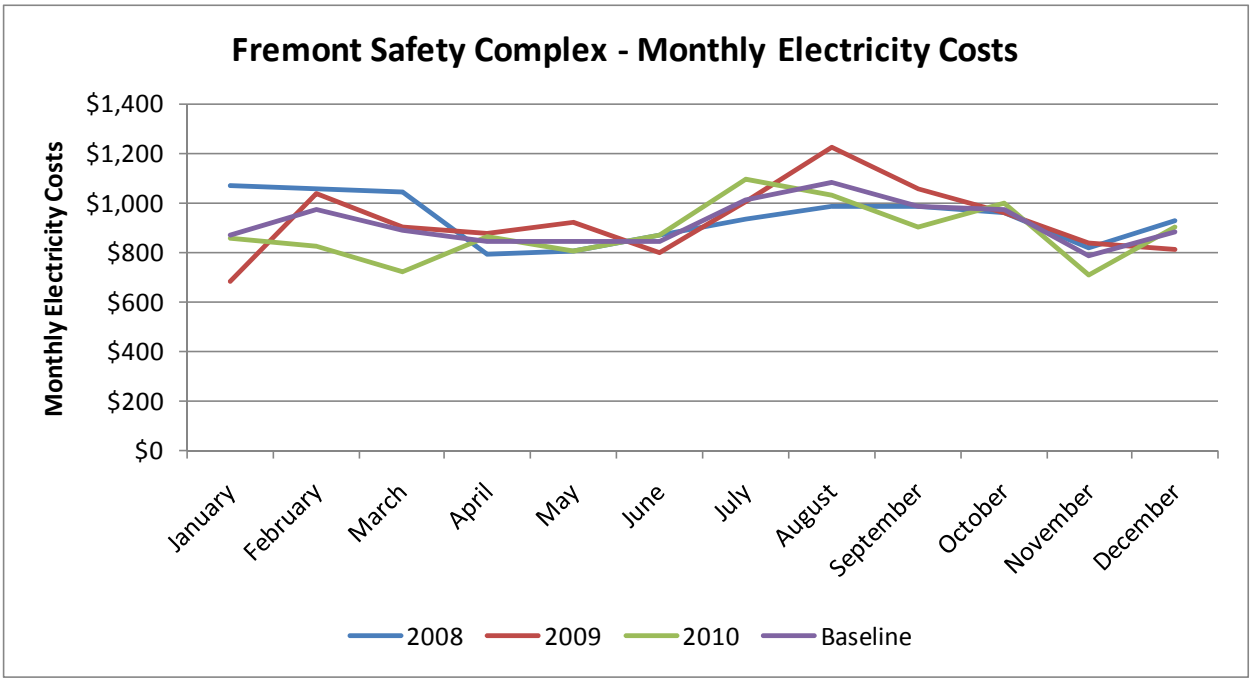


Figure 28: Electricity Costs

The Safety Complex uses electricity for lighting, plug loads, ventilation, and air conditioning.

Electricity consumption appears to be fairly stable throughout the year with a base load of approximately 5,000 kWh per month consisting of lighting, plug loads, and ventilation. The highest usage is July and August which coincide with the additional summer cooling load from

air conditioning, although in the past it seems that higher usage was in February due to various needs of the facility. Going forward it is assumed that the peak usage is in the summer months.

Table 15: Monthly Fuel Oil Usage[21]

Saftey Complex - Fuel Oil Usage (Gallons)				
Date	**2008**	**2009**	**2010**	**Baseline**
January	799	1,300	562	887
February	568	600	561	576
March	763	450	356	523
April	222	-	307	176
May	-	-	-	0
June	-	452	-	151
July	-	-	-	0
August	510	-	-	170
September	-	-	-	0
October	71	211	-	94
November	177	-	-	59
December	694	432	568	564
Total	**3,803**	**3,445**	**2,353**	**3,200**

Table 16: Monthly Fuel Oil Costs[22]

Saftey Complex- Fuel Oil Cost ($)				
Month	**2008**	**2009**	**2010**	**Baseline**
January	$1,754	$2,883	$1,269	$ 1,969
February	$1,255	$1,200	$1,275	$ 1,243
March	$1,674	$855	$843	$ 1,124
April	$487	$0	$755	$ 414
May	$0	$0	$0	$ -
June	$0	$904	$0	$ 301
July	$0	$0	$0	$ -
August	$893	$0	$0	$ 298
September	$0	$0	$0	$ -
October	$212	$421	$0	$ 211
November	$458	$0	$0	$ 153
December	$1,677	$684	$1,269	$ 1,210
Total	**$ 8,409**	**$ 6,946**	**$ 5,411**	**$ 6,922**

[21] Monthly usage estimated based on fuel oil deliveries, December 2010 usage estimated using similar months' usage averaged.
[22] Monthly costs estimated based on averaged fuel oil deliveries, December 2010 costs estimated using similar months' usage averaged.

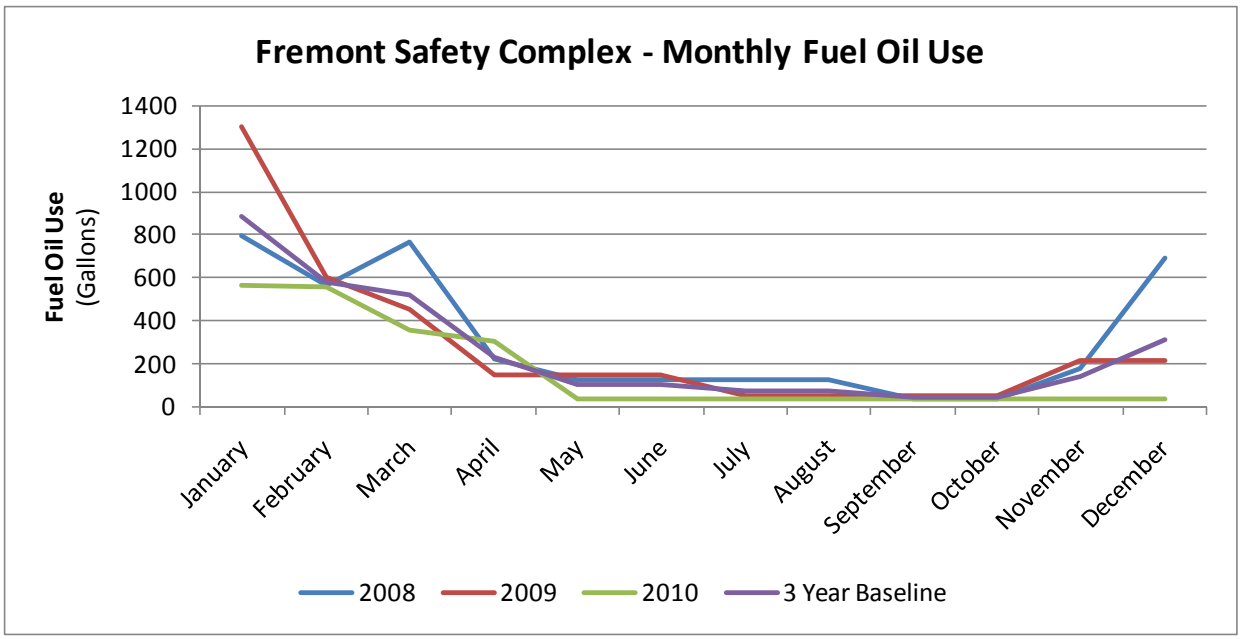


Figure 29: Fuel Oil Consumption

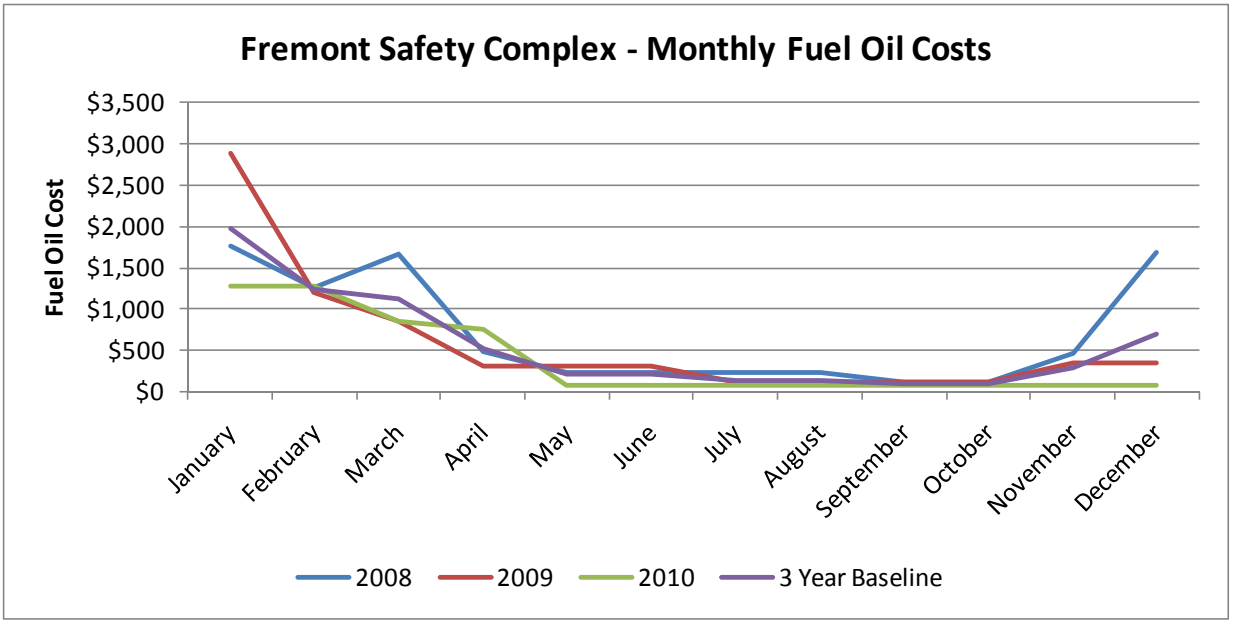


Figure 30: Fuel Oil Costs

Fuel oil is used primarily for space heating for the entire building and domestic water heating for the bathrooms and showers. The oil delivery information shows an average base annual fuel usage of approximately 50 gallons for the domestic water heating load. Peak months are in the winter months due to space heating requirements.

ENERGY EFFICIENCY MEASURES

The table below illustrates the 8 potential energy efficiency measures that have been targeted within this report for consideration at the Safety Complex. Additional energy efficiency measures that merit consideration are discussed at the end of this section.

Table 17: Safety Complex Detailed EEM Table[23]

ID	Energy Efficiency Measure Description	Electricity (kWh/yr)	Fuel Oil (gal/yr)	Savings ($/yr)	Installed Cost ($)	Simple Payback (Years)
Safety Complex						
Building Envelope Measures						
SC-B1	Weatherization & Air Sealing	1,480	380	$1,040	$6,000	5.8
HVAC Measures						
SC-H1	Existing Building Commissioning (HVAC System)	6,000	384	$1,711	$3,660	2.1
SC-H2	Thermostat Temperature Setback	1,175	98	$385	$1,200	3.1
Lighting Measures						
SC-L1	Lighting Controls (Occupancy Sensors)	493	0	$72	$0	0.0
Other Energy Efficiency Measures						
SC-O1	Computer Measures (Thin Clients, Flat Screens, Power Management Software)	3,797	0	$557	$154	0.3
SC-O2	Smart Power Strips	1,540	0	$226	$770	3.4
SC-O3	Vending Machine Sensors	1,250	0	$183	$135	0.7
Renewable Energy Systems						
SC-R1	Expansion of Solar Photovoltaic System	27,425	0	$4,026	$157,500	39.1
	Total Savings & Costs	**43,160**	**862**	**$8,201**	**$169,419**	**20.7**
	Savings as a Percentage of Current Usage	**58%**	**27%**	**46%**	**-**	**-**
	Total Baseline Usage & Costs	**74,896**	**3,200**	**$17,916**	**-**	**-**

[23] No rebates or incentives were included in the costs or calculated in the simple payback in this table.

SC-B1: Weatherization and Air Sealing

GDS visually inspected the attic of the Safety Complex and performed blower door testing on the offices side of the building (did not included garages) to determine the level of air leakage from the facility. Due to the leakiness of the building compared to an average commercial building of its size, GDS recommends visually inspecting and sealing penetrations from the attic to the conditioned spaces and the use of closed cell foam insulation (spray foam) is preferred. Above the acoustical tiles in the meeting room, hallways, and offices is an ideal application for a spray foam product.

The areas of highest air leakage appeared to be the attic floor, above the acoustical tiles of offices, and the wall to the garages. These areas, although insulated, did not have proper air sealing done and are recommended to be addressed by the Safety Complex. Windows and doorways to the outside and to the garages could utilize additional caulking and weather-stripping to reduce drafts in those locations.

Use caulking for small gaps around duct venting, plumbing and wiring penetrations from the attics to the conditioned spaces. For larger gaps around framing and vent pipes use high density foam.

Windows and doorways are common areas for air infiltration. Exterior doors should have weather stripping and door sweeps installed and replaced regularly about every 2-3 years of normal use. Access doors to unconditioned spaces such as attics should have a weather strip and or a door sweep to reduce conditioned air losses to the space. In addition, garages should have their overhear doors closed when possible to reduce excess air infiltration to the sides of the office space.

The energy savings for this measure are due primarily to the reduction in heating energy consumption and cooling usage. Energy savings were estimated as a result of energy modeling using eQuest™ building energy modeling software. The savings are based on the assumed infiltration reduction to 10 ACH_{50} for this building. Costs were estimated using PSNH contractor costs, prior similar projects, and GDS field experience. The savings are based on the assumed infiltration reduction of 17% (2,000 CFM_{50}). This measure results in a simple payback of approximately six years.

SC-H1: Existing Building Commissioning

Existing Building Commissioning is “a process that seeks to improve how building equipment and systems function together”.[24] GDS recommends performing existing building commissioning on the HVAC systems at the Safety Complex to assure equipment and systems optimally serve the needs of the Safety Complex. This recommendation is based on the 2009 Building Commissioning Report to the California Energy Commission by Evan Mills of the Lawrence Berkley National Laboratory which found that virtually all existing building (commissioning) projects were cost-effective with average payback of less than 2 years, which includes testing and balancing of HVAC systems, checking setpoints and adjusting gauges and sensors if they are out of alignment or have not been calibrated, checks for properly performing ventilation fans, and makes sure building operating schedules and temperature setpoints meet the needs of the occupants. In addition to the expected energy savings, improved occupant comfort is a benefit of performing existing building commissioning. The economic analysis of this EEM is based on factors derived in the aforementioned report. GDS has professional

[24] Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions, Evan Mills, Ph.D., LBNL, Report Prepared for: CEC and PIER; July 21, 2009.

relationships with several local commissioning providers and can provide their contact information if the Town of Fremont wishes to include them in an RFP for performing Existing Building Commission at the Safety Complex or any other Fremont municipally-owned building.

SC-H2: Thermostat Temperature Setback

During the site visit a check of the programmable thermostat schedules found the Safety Complex was maintained at 68°F. The heating temperature is usually set to turn down when the Safety Complex is unoccupied, however it was also discussed that the temperature in certain areas (holding rooms) cannot be lower than comfortable due to liability issues therefore the temperature is manually adjusted at times to compensate. It is recommended to be more aggressive with the temperature setback controls and reprogram the existing programmable thermostats to turn down the heating set point at least 5 degrees in the winter months and turn up the unoccupied temperature setpoint 5 degrees during the summer. The programmable thermostats allow a warm-up time to be established so that occupants are comfortable when they arrive in the morning. It is also recommended to install programmable thermostats in locations that currently have manual thermostats (garages and fire chief office). This low cost measure will provide electricity energy savings from the space heating and cooling systems and fuel oil savings from the space heating system, with a relatively short payback.

SC-L1: Lighting Controls (Occupancy Sensors)

The Safety Complex already has occupancy sensors installed in the majority of the facility. Although minimal savings are available, there are a few possible areas which were analyzed to determine potential additional energy savings. One noticeable example is the Squad Room which had its occupancy sensor disabled due to it inadvertently turning the lights off when the room was occupied. As a no-cost solution, it is recommended to reincorporate the occupancy sensor and adjust the time delay on the control to a more reasonable 20 or 30 minute delay, compared to the current 10-minute delay. Another alternative solution is to replace the occupancy sensor with a dual sensor control which has both passive infrared motion sensors ultrasonic technology. Another example is the Fire Department corridor, which had its occupancy sensor disabled because it trips involuntarily. The reason for this is assumed because it may be seeing occupants in other locations in the facility, such as the meeting room or other hallways. The no-cost solution is to re-adjust the sensor so it does not pick up false movements in the space, and the higher cost solution is to replace the sensor with one better fit for the size of the space it is installed in. The meeting room is used less than 1,000 hours per year according to metered data therefore the simple payback of installing an occupancy sensor there is over 20 years. This is not recommended unless the meeting room becomes more frequently used. Savings for the lighting controls measures were estimate using standard EPA estimates for occupancy sensor savings and base hours of use were calculated using metered data from the data loggers installed on-site. No-cost measures were recommended based on limiting any immediate financial impacts to the Town, therefore the payback for this measure is immediate, or 0 years in the EEM table.

SC-O1: Computer Energy Savings (Thin Clients, Flat Screens, Power Management Software)

This measure is a combination of a few computer related energy efficiency measures that are recommended for the Safety Complex. Thin clients, which may run on Linux operating systems and whose applications are usually stored in a central server, are effective energy efficient replacements for most of the standard desktop and tower type computers that the Safety Complex uses. All desktop computers are recommended to be replaced on failure or on the current replacement cycle. Flat screen LED backlit monitors are the next step in terms of energy

efficiency and monitor quality, as the standard LCD monitors are fluorescent backlit and these are also recommended to be replaced on failure or on the current replacement cycle. Energy usage calculations were based on estimated annual hours of usage, in idle mode, and sleep mode. Energy usage was based on actual measurements of similar computers and monitors using a Kill A Watt® meter to measure wattage consumption, and published manufacturer specifications. Costs were estimated as incremental compared to standard efficiency equipment. Additionally there are cost savings from installing thin clients instead of desktop computers, although these cost savings were not included in the payback calculations.

LED backlit monitors and thin clients' energy usage were researched and are recommended, however the highest energy savings would come from an alternative of replacing all desktop computers and monitors with laptops due to no additional computer monitors being required except in certain situations. The laptop replacements may only be useful if security concerns are mitigated by properly locking each laptop to the desk or floor, therefore this measure was analyzed but not recommended.

A third energy efficiency measure recommended to the Safety Complex is a power management software tool. This tool is able to be installed on each computer and can control power usage remotely, either to run a computer in low energy mode or shut it down completely when not in use. IT departments that require computers to be on for upgrades also utilize these types of software tools as they allow for computers to be awakened on demand. It is recommended that the Town of Fremont research various manufacturers of these devices further as costs differ dramatically. The type that can be installed once and does not require an annual fee is most likely the preferred path for the Safety Complex. Costs were estimated after researching a few manufacturers' prices.
Related software: PowerPro - http://www.powerpromanager.com/
PowerMinder - http://www.powerminder.com/
Power Manager - http://www.verismic.com/power_manager.html

Reference Appendix A for detailed lighting analysis tables.

SC-O2: Smart Power Strips
Private office and other computer plug loads at the Safety Complex include computers and the peripherals, printers, task lamps, computer monitors, fax machines, radio systems, and televisions. Plug loads consume electricity when no one is around. Even in "sleep" mode, plug loads may consume 2-10 watts out of necessity. GDS recommends an energy efficiency controls solution to automatically turn off plug loads during evenings and weekends. The recommendation is to install personal "smart power strips" or power strips with occupancy sensors. The Wattstopper® Isolé power strips are one option which schools have used to reduce their plug load electricity usage. At a conservative energy savings of 20% on 1,100 kWh per office workstation the simple payback for these types of devices is estimated at less than 4 years. The sensors should only be installed in private offices as the rest of the computer stations do not have many peripherals and they may be falsely tripped by other occupants walking through the spaces.

SC-O3: Vending Machine Sensors
GDS recommends installing a VendingMiser® on the cold drink vending machine in the Safety Complex garage. This low-cost energy efficiency measure has an occupancy sensor which reduces the power consumption of the vending machine and reach-in cooler when no one is around (power down the machine, monitors the room temperature, and repowers the cooling system). Simple payback for this sensor is less than one year.

ES-R1: Expansion of Solar Photovoltaic System

GDS examined the feasibility of expanding the existing 460W crystalline Solar Photovoltaic (PV) system at the Safety Complex into a 25 kW system. The renewable energy system currently provides approximately 500 kWh to the site, and was installed in January 2010. It is estimated that the new system would be able to provide approximately 27,000 kWh annually to the facility.

DOE's PVWATTS® software was used to calculate the expected annually kWh production for the additional PV panels based on the closest location (Concord, NH). The tilt angle of 45 degrees was used because of the existing roof to be used. The direction the panels would face would be Southeast (135°) as the roof slope faces that direction and was used as the expected orientation in the software.

The roof appeared to be in good condition, although it is recommended that the facility perform a structural engineering study to determine if the roof can handle the additional load from a 25 kW system. Crystalline module system can be affected by snow in this climate. At the estimated roof tilt angle of 45 degrees the estimated production lost due to snow cover is 2%[25].

Because of the ability to tie into the existing PV system, it is possible that this next step be installed in phases as funds allow, however the best case scenario would be to install the entire system after enough funding is procured by the Town of Fremont.

No incentives were included in the simple payback calculated in the EEM table. Reference Appendix G for detailed calculations and sensitivity analysis.

GDS included the NH PUC Solar Rebate Program grant and the Federal Tax Credit in the incentives for initial payback in the calculation in the appendix.

In addition a few different scenarios were analyzed. The first scenario used $150/MWh for one year of Class II Solar REC's from the NH PUC, and the annual national average cost of REC's of $15/MWh afterwards. The second scenario used only the conservative $15/MWh annual income from REC's and an average electricity rate increase to $0.20/kWh over the lifetime of the system. The third scenario utilized a combination of those first two scenarios to define a "best case" scenario. These provide much improved cost/benefit scenarios for the Town of Fremont.

Similar to the PV system for the Ellis School, for the Safety Complex there also are several additional vehicles available to finance a Solar PV system for the Town, including a Power Purchase Agreement, leasing the roof space, or leasing a solar system.

The Power Purchase Agreement (PPA) is an option that might work well for the Town of Fremont. Fremont would agree to pay a set amount for kWh produced from the Solar PV system and allow use of roof space. The PPA provider would own, install and maintain the system. The PPA provider would also take advantage of any tax credits and SREC's, etc.

Another option is to lease the roof space, allowing a connection to the grid for a PV system by a solar developer. The developer will then sell the power to the market and reap the tax credits and SREC's, etc. The Town of Fremont could also lease a solar system in which case the

[25] "Selecting a solar electric system for a commercial building rooftop," fact sheet by Focus on Energy, 2008; ratio of snowfall from NOAA used for NH versus WI

leasing company might be able to use the tax credits and the lease agreement would need to be arranged so that if the Solar PV developer were to be able to sell the REC's then the payment would be lower to account for this added value to the system.

For financing or lump sum payments directly from the Town of Fremont it would be possible to take advantage of all applicable incentives. This would need to be compared to the other options, as the Town would reap all associated benefits from incentives, however the Town would be required to maintain the system in question.

Additional EEM's for Consideration

A number of potential energy efficiency measures were identified during the site survey and in conversations with the Town of Fremont staff. Given the targeted scope of this project, 8 EEM's were identified for detailed evaluation. This section briefly discusses the additional potential measures that were identified but not fully evaluated. Time and budget permitting, the Town of Fremont may choose to evaluate these potential measures in further detail.

Short Payback Items:

1) Compact Fluorescent Bulbs: Replace any incandescent bulbs with Compact Fluorescent (CFL) bulbs. Although the incandescent bulbs were located in low usage areas including the attic and storage, it is recommended to replace these bulbs over time with CFL's as they reduce energy usage and last longer than incandescent bulbs.

2) Insulate Hot Water Piping: Install 1" insulation on all hot water piping in the boiler room (approximately 10' of vertical piping and 30' of horizontal piping) and above the ceiling in other locations of the facility where practical.

3) Tune HVAC System: GDS recommends having a reputable heating service professional perform an annual cleaning and tuning for oil fired heating appliances, which will conduct a combustion efficiency test and evaluation of the heating system, leaving behind a service tag with the results of the test. Proper maintenance will increase the life and overall efficiency of the heating system.

4) Low Flow Water Savings Devices: Install low flow faucet aerators, and low flush water closets or flapper-less toilets to save water consumption and domestic hot water energy usage.

Other Potential Energy Savings Opportunities:

1) Garage door seals: the large overhead garage doors for the fire engines are potential areas for air leakage. GDS analyzed the savings for these and the sally port garage doors, however because of the radiant slab floor heating in the space the paybacks are much longer than expected. This measure is worth considering in the future as energy bills increase, however does not appear to be cost effective at this time. One possible vendor of effective garage door seals is http://www.ritehite.com/

2) Relocate Police Department Thermostat: Although this would be addressed by commissioning, if it is not then it is recommended to relocate the thermostat that controls FCU-1 down the hall towards the Police Chief office. Currently supply air is being discharged near the thermostat which appears to be contributing to the inadequate heating and cooling of the Police Chief's office.

3) Remove Fire Chief Override Thermostat: Add electric baseboard in the Fire Chief office and remove the override thermostat. This will allow for temporary heating in the Fire Chiefs

office when FCU-1 is in setback mode instead of overriding the FCU-1 thermostat and heating the entire front office area.

5 ENERGY EFFICIENCY AND RENEWABLE ENERGY FINANCING

Several areas of energy efficiency and renewable energy system funding were researched in completing this report including: Local Utility Incentive Programs, State and Local Grant and Loan Programs, and Federal Tax Credits for Renewable Energy Systems

Each of the above opportunities is briefly described below. No incentives or rebates were included in the simple payback calculations as incentives are usually not guaranteed and require an application process.

Local Utility Incentive Programs

There are several utility programs that provide incentives for reduced energy use. For the Town of Fremont, GDS researched the available electricity (and fuel oil) incentives. As is typical with utility programs, there is no guarantee that funds will be available. These programs are designed to influence the energy related decisions made when a project is in the planning stages. Therefore the recommended first step in any renovation project is to reach out to the electric utility to determine if there are project energy savings opportunities, funding availability, and/or any new innovative technologies that could be incorporated into the project. Fuel oil distributors rarely provide incentives to reduce energy consumption.

Under **PSNH's Municipal Smart Start Program**, municipal customers may reduce energy consumption (and bills) by allowing the utility to install energy-saving measures at municipal facilities. Payment for services and products will be made over time with the savings obtained from lower energy costs. Under the Smart Start Program, PSNH pays all of the costs associated with the purchase and installation of approved measures. A monthly charge, calculated to be less than the monthly savings, is added to the municipal facility's monthly electric bill until all costs are repaid. Energy efficiency lighting has been provided for the Town of Fremont through this program and it is great to see the benefits of this program already working for the Town.
http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

PSNH Large Business Retrofit Program has incentives available for schools and the Ellis School is believed to fall under the large retrofit rebate program due to its peak monthly demand usage around and over 100 kW. Customers can lower their energy usage with rebates through this retrofit program for inefficient equipment including lighting controls and custom energy efficiency projects (with approval from PSNH). It is recommended to contact your PSNH account representative or PSNH directly to determine what is currently available to the Town through this program.
http://www.psnh.com/SaveEnergyMoney/Large-Power/Large-Business-Retrofit-Program.aspx

PSNH Small Business Energy Solutions has incentives available for municipal buildings and the Safety Complex falls under the 100 kW maximum for this program. Customers can lower their energy usage with rebates through this retrofit program for inefficient equipment including occupancy sensors and programmable thermostats and refrigeration controls. It is recommended to contact your PSNH account representative or PSNH directly to determine what is currently available to the Town through this program.
http://www.psnh.com/SaveEnergyMoney/For-Business/Small-Business-Energy-Solutions.aspx

PSNH New Equipment & Construction Program has incentives available for schools and municipal customers to lower their energy usage with enhanced rebates. It is recommended to contact your PSNH account representative or PSNH directly to determine what is currently

available, however it appears that the Town of Fremont has already taken advantage of much of the lighting rebates available through this program.
http://www.psnh.com/SaveEnergyMoney/Large-Power/New-Equipment---Construction-Program.aspx

State and Local Grant and Loan Programs

The programs available to local government entities include the New Hampshire Public Utilities Commission (NH PUC) Solar Rebate Program, New Generation Energy Community Lending Program, the Community Development Finance Authority (CDFA) Municipal Energy Reduction Fund loan program, and the New Hampshire EnergySmart Schools Program.

NH PUC C&I Solar Rebate Program, announced in November 2010, funded through the state's renewable portfolio standard alternative compliance payments, the program is designed to support non-residential solar photovoltaic (PV) and solar thermal installations. 25% of the installed cost is available up to $50,000 for a maximum 100 kW system. The 50 kW system recommended for the Ellis School provides the maximum rebates available per kW from this program. Solar thermal incentives are also available.
http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-CI.html

New Generation Energy Community Lending Program offers low interest loans for the installation of ENERGY STAR rated kitchen appliances via its Community Food Service Energy Efficiency Lending Program and low interest loans for Solar PV and Solar Thermal systems through its Solar Lending Program.
http://newgenerationenergy.org/?q=community-lending/community-lending-program

CDFA Municipal Energy Reduction Fund is available to help municipalities improve the energy efficiency of their municipal buildings, street lighting, water and sewer treatment facilities, and where appropriate, electrical distribution systems. The goal is to reduce energy usage and costs. The CDFA loan is targeted at local governments, although school districts are not eligible. The revolving loan fund is funded by the Greenhouse Gas Emissions Reduction Fund (RGGI) through the New Hampshire Public Utilities Commission.
http://www.nhcdfa.org/web/erp/merf/merf_overview.html

New Hampshire EnergySmart Schools Program offers free benchmarking services and a list of resources to assist with energy efficiency incentives. It appears that the Town of Fremont has already taken advantage of this program and is well versed in its benefits to the Town.
http://www.nhschoolbenchmarking.com/

Federal Tax Credits for Renewable Energy Systems

The Federal Tax Credits are not available directly to the Town of Fremont as it is a municipality, however it is believed that they are available to for-profit renewable energy system installation contractors and companies; this is not a guarantee however is worth further research by the Town.

Business Energy Investment Tax Credit (ITC) is a corporate tax credit available for 30% of the installed costs of solar, fuel cells, and small wind, and 10% for geothermal, microturbines, and CHP. This incentive, although not available directly to the Town, may be available for the installation contractor or Power Purchase Agreement (PPA) owner of a renewable energy system.
http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F

6 ENERGY PROCUREMENT

The Town of Fremont has two readily available electricity supply options. First, Fremont can continue to take services under PSNH's "bundled" Energy Service rate. Second, Fremont can contract with a competitive electric supplier (PSNH would continue to provide electricity delivery services). This would allow the Town of Fremont more pricing plan options and financial solutions that may yield energy cost savings potentially in excess of 10% per year. Several towns in New Hampshire have already switched their electricity supplier, including the Town of Bedford and the Town of Exeter. It may be beneficial for the Town Fremont to contact these and other municipalities to determine the benefits and to find out what related experiences they have had that may help the Town of Fremont move forward with this process. Given the potential benefits of procuring power from a competitive supplier, the Town of Fremont should consider soliciting pricing proposals from qualified competitive electricity suppliers so that it can be determined which option is most beneficial. See the table below for names and contact information for competitive suppliers currently registered to sell energy in PSNH's service territory. Appendix J provides a sample Request for Proposals (RFPs) recently used by another NH municipality for this purpose.

Table 18: Competitive Supplier Contact Information

Company Name	Address	Contact	Phone	Email	Website
ConEdison *Solutions*	2 Burlington Woods Burlington, Ma 22203	Sam Morgan	1-781-203-2707 or 1-800-316-8011	morgansa@conedsolutions.com	www.ConEdisonSolutions.com
Constellation NewEnergy, Inc.	800 Boylston St., 28th Floor Boston MA	Emily Neill	1-617-772-7500	Emily.Neill@constellation.com	www.newenergy.com
Glacial Energy of New England, Inc.	24 Route 6A, Suites 1, 2 and 3 Sandwich, MA		1-877-569-2841	customercare@glacialenergy.com	www.glacialenergy.com
Hess Corporation	14 May Lane Pelham, NH 03076	Mark Gilday	1-603-635-3297 or 1-800-437-7872	mgilday@hess.com	www.hessenergy.com
Integrys Energy Services, Inc.	1750 Elm St., Suite 800 Manchester, NH 03104	Jamie Cote	1-603-263-6902 or 1-888-288-0218	jjcote@integrysenergy.com	www.integrysenergy.com
NextEra Energy Services New Hampshire, LLC Trade Name: Gexa Energy	20 Greenway Plaza, Suite 600 Houston, TX 77046		1-866-960-4392	custserv@gexaenergy.com	www.gexaenergy.com
South Jersey Energy Company d/b/a Halifax American Energy Company	816 Elm St. Ste 364 Manchester, NH 03101		1-603-625-2244	sales@haecpower.com	www.southjerseyenergy.com
TransCanada Power Marketing Ltd.	110 Turnpike Road, Suite 203 Westborough, MA 01581-2863	Cheryl Popiak	1-877-634-2928	cheryl_popiak@transcanada.com	www.transcanada.com

Fremont should be aware that the solicitation of proposals from competitive suppliers may not result in competitive electricity pricing proposals that are acceptable or below the expected PSNH Energy Service prices. Care should be taken to assess all proposals received and to ensure that potential suppliers are financially sound, and will be good business partners for the Town.

The NH Public Utility Commission's toll-free Answer Center (800-528-2070) is available should the Town of Fremont have questions regarding competitive energy suppliers.

Appendix A

Lighting Analysis,

Lighting Data Logger Results, and

Sample Datasheets

(ES-L1 and SC-L1)

Ellis School - Lighting Controls - Daylight Harvesting Controls Proposed EEM's

Location	Weekly Hours of Use	Annual Hours of Use	Total # of Fixtures	# of Sensors Needed	Lamp Type to be Controlled (Sensor Type)	Annual kWh	Annual Cost	Sensor Labor Cost	Sensor Materials Cost	Total Cost	Savings Factor	kWh Savings	Annual Cost Savings	Simple Payback
Room 109	45	1,980	9	1	4-lamp T8 - 4' (32W)	2,053	$300	$200	$200	$400	30%	616	$92	**4.3**
									Totals	**$400**	**-**	**616**	**$92**	**4.3**

Note : Green Highlight Indicated Presence of an EEM Worthy Item (after analysis performed)

Note 2: Daylight effects estimated based on typical artificial light reduction for this type of space and a discussion with facility manager.

Safety Complex - Lighting Controls - Occupancy Sensors Proposed EEM's

Location	Annual Hours of Use	Total # of Fixtures	# of Sensors Needed	Lamp Type for Control	Annual kWh	Annual Cost	Sensor Labor Cost	Sensor Material Cost	Total Cost	Savings Factor	kWh Savings	Annual Cost Savings	Simple Payback
Squad Room	4,016	4	1	2-lamp T8 - 4' (30W)	867	$121	$0	$0	$0	30%	260	$36	**0.0**
Meeting Room	569	8	1	2-lamp T8 - 4' (30W)	246	$34	$100	$150	$250	30%	74	$10	**24.3**
Hallway - Fire Dept	1,795	8	1	2-lamp T8 - 4' (30W)	775	$113	$0	$0	$0	30%	233	$34	**0.0**
								Totals	**$0**	**-**	**493**	**$72**	**0.0**

Note : Green Highlight Indicated Presence of an EEM Worthy Item (after analysis performed)

Note 2: No cost for Squad Room measure as occupancy sensors are already installed,
however the delay time on the occupancy sensor needs to be adjusted to more than 15 minutes.

Note 3: No cost for Hallway measure as occupancy sensors are already installed,
however the occupancy sensor needs to be readjusted so that false "on" readings do not occur.

Lighting Data Logger Results

ON Time %

	School			Safety Complex			
	Total Hallways	Hallway 1	Hallway 2	Total	Hallway	Squad Rm (occ sensor not used)	Meeting Rm (no occ sensor)
Weekday	65%	68%	62%	23%	12%	51%	4%
Weekend/Holiday	11%	12%	11%	13%	5%	33%	1%

Average Hours	Total	Weeks	Total	Weeks
Weekday	3,425	44	1,380	51
Weekend/Holiday	391	8	342	1
Total	3,815	hallways	1,722	average

Plot Title: GDS-4 Ellis School: Hallway 1

Daily ON-time			Minutes	Hours	ON%	Weekend/Holiday
12/29/2010	12:00 AM	11:59 PM	484.48	8.1	33.6%	holiday week
12/30/2010	12:00 AM	11:59 PM	503.83	8.4	35.0%	holiday week
12/31/2010	12:00 AM	11:59 PM	100.72	1.7	7.0%	holiday week
1/1/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/2/2011	12:00 AM	11:59 PM	338.07	5.6	23.5%	weekend
1/3/2011	12:00 AM	11:59 PM	907.20	15.1	63.0%	
1/4/2011	12:00 AM	11:59 PM	928.87	15.5	64.5%	
1/5/2011	12:00 AM	11:59 PM	927.72	15.5	64.4%	
1/6/2011	12:00 AM	11:59 PM	923.42	15.4	64.1%	
1/7/2011	12:00 AM	11:59 PM	905.43	15.1	62.9%	
1/8/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/9/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/10/2011	12:00 AM	11:59 PM	923.02	15.4	64.1%	
1/11/2011	12:00 AM	11:59 PM	910.30	15.2	63.2%	
1/12/2011	12:00 AM	11:59 PM	250.97	4.2	17.4%	snow day
1/13/2011	12:00 AM	11:59 PM	1031.98	17.2	71.7%	
1/14/2011	12:00 AM	11:59 PM	1347.97	22.5	93.6%	
1/15/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/16/2011	12:00 AM	11:59 PM	89.33	1.5	6.2%	weekend

Overall ON-time						
Weekday	8806	min	147	hrs	67.9%	
Weekend/Holiday	1516	min	25	hrs	11.7%	

Plot Title: GDS-10 Ellis School: Hallway 2

Daily ON-time			Minutes	Hours	ON%	Weekend/Holiday
12/29/2010	12:00 AM	11:59 PM	426.32	7.1	29.6%	holiday week
12/30/2010	12:00 AM	11:59 PM	429.05	7.2	29.8%	holiday week
12/31/2010	12:00 AM	11:59 PM	146.33	2.4	10.2%	holiday week
1/1/2011	12:00 AM	11:59 PM	24.53	0.4	1.7%	weekend
1/2/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/3/2011	12:00 AM	11:59 PM	857.70	14.3	59.6%	
1/4/2011	12:00 AM	11:59 PM	853.58	14.2	59.3%	
1/5/2011	12:00 AM	11:59 PM	873.38	14.6	60.7%	
1/6/2011	12:00 AM	11:59 PM	898.57	15.0	62.4%	
1/7/2011	12:00 AM	11:59 PM	868.18	14.5	60.3%	
1/8/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/9/2011	12:00 AM	11:59 PM	124.28	2.1	8.6%	weekend
1/10/2011	12:00 AM	11:59 PM	876.58	14.6	60.9%	
1/11/2011	12:00 AM	11:59 PM	909.57	15.2	63.2%	
1/12/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	snow day
1/13/2011	12:00 AM	11:59 PM	898.20	15.0	62.4%	
1/14/2011	12:00 AM	11:59 PM	971.60	16.2	67.5%	
1/15/2011	12:00 AM	11:59 PM	65.30	1.1	4.5%	weekend
1/16/2011	12:00 AM	11:59 PM	196.93	3.3	13.7%	weekend

Overall ON-time					
Weekday	8007	min	133	hrs	61.8%
Weekend/Holiday	1413	min	24	hrs	10.9%

Plot Title: GDS-8 Safety Complex: Hallway

Daily ON-time			Minutes	Hours	ON%	Weekend/Holiday
12/29/2010	12:00 AM	11:59 PM	17.68	0.3	1.2%	holiday week
12/30/2010	12:00 AM	11:59 PM	10.38	0.2	0.7%	holiday week
12/31/2010	12:00 AM	11:59 PM	318.28	5.3	22.1%	holiday week
1/1/2011	12:00 AM	11:59 PM	55.33	0.9	3.8%	weekend
1/2/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/3/2011	12:00 AM	11:59 PM	332.88	5.5	23.1%	
1/4/2011	12:00 AM	11:59 PM	61.20	1.0	4.3%	
1/5/2011	12:00 AM	11:59 PM	169.32	2.8	11.8%	
1/6/2011	12:00 AM	11:59 PM	337.82	5.6	23.5%	
1/7/2011	12:00 AM	11:59 PM	211.75	3.5	14.7%	
1/8/2011	12:00 AM	11:59 PM	239.02	4.0	16.6%	weekend
1/9/2011	12:00 AM	11:59 PM	5.95	0.1	0.4%	weekend
1/10/2011	12:00 AM	11:59 PM	427.10	7.1	29.7%	
1/11/2011	12:00 AM	11:59 PM	64.93	1.1	4.5%	
1/12/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	
1/13/2011	12:00 AM	11:59 PM	147.78	2.5	10.3%	
1/14/2011	12:00 AM	11:59 PM	41.95	0.7	2.9%	
1/15/2011	12:00 AM	11:59 PM	48.82	0.8	3.4%	weekend
1/16/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend

Overall ON-time						
Weekday	1795	min	30	hrs	12.5%	
Weekend/Holiday	695	min	12	hrs	5.4%	

Plot Title: GDS-15 Safety Complex: Squad Room

Daily ON-time			Minutes	Hours	ON%	Weekend/Holiday
12/29/2010	12:00 AM	11:59 PM	681.45	11.4	47.3%	holiday week
12/30/2010	12:00 AM	11:59 PM	510.00	8.5	35.4%	holiday week
12/31/2010	12:00 AM	11:59 PM	411.40	6.9	28.6%	holiday week
1/1/2011	12:00 AM	11:59 PM	252.85	4.2	17.6%	weekend
1/2/2011	12:00 AM	11:59 PM	981.07	16.4	68.1%	weekend
1/3/2011	12:00 AM	11:59 PM	509.50	8.5	35.4%	
1/4/2011	12:00 AM	11:59 PM	997.97	16.6	69.3%	
1/5/2011	12:00 AM	11:59 PM	820.68	13.7	57.0%	
1/6/2011	12:00 AM	11:59 PM	857.77	14.3	59.6%	
1/7/2011	12:00 AM	11:59 PM	1055.00	17.6	73.3%	
1/8/2011	12:00 AM	11:59 PM	412.48	6.9	28.6%	weekend
1/9/2011	12:00 AM	11:59 PM	472.98	7.9	32.8%	weekend
1/10/2011	12:00 AM	11:59 PM	533.27	8.9	37.0%	
1/11/2011	12:00 AM	11:59 PM	424.25	7.1	29.5%	
1/12/2011	12:00 AM	11:59 PM	665.70	11.1	46.2%	
1/13/2011	12:00 AM	11:59 PM	995.78	16.6	69.2%	
1/14/2011	12:00 AM	11:59 PM	502.63	8.4	34.9%	
1/15/2011	12:00 AM	11:59 PM	230.50	3.8	16.0%	weekend
1/16/2011	12:00 AM	11:59 PM	275.20	4.6	19.1%	weekend

Overall ON-time

Weekday	7363	min	123	hrs	51.1%
Weekend/Holid	4228	min	70	hrs	32.6%

Plot Title: GDS-16 Safety Complex: Meeting Room

Daily ON-time			Minutes	Hours	ON%	Weekend/Holiday
12/29/2010	12:00 AM	11:59 PM	39.60	0.7	2.8%	holiday week
12/30/2010	12:00 AM	11:59 PM	2.47	0.0	0.2%	holiday week
12/31/2010	12:00 AM	11:59 PM	44.57	0.7	3.1%	holiday week
1/1/2011	12:00 AM	11:59 PM	1.33	0.0	0.1%	weekend
1/2/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/3/2011	12:00 AM	11:59 PM	212.27	3.5	14.7%	
1/4/2011	12:00 AM	11:59 PM	41.02	0.7	2.8%	
1/5/2011	12:00 AM	11:59 PM	19.10	0.3	1.3%	
1/6/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	
1/7/2011	12:00 AM	11:59 PM	2.35	0.0	0.2%	
1/8/2011	12:00 AM	11:59 PM	20.87	0.3	1.4%	weekend
1/9/2011	12:00 AM	11:59 PM	0.00	0.0	0.0%	weekend
1/10/2011	12:00 AM	11:59 PM	195.92	3.3	13.6%	
1/11/2011	12:00 AM	11:59 PM	29.15	0.5	2.0%	
1/12/2011	12:00 AM	11:59 PM	10.22	0.2	0.7%	
1/13/2011	12:00 AM	11:59 PM	1.88	0.0	0.1%	
1/14/2011	12:00 AM	11:59 PM	71.92	1.2	5.0%	
1/15/2011	12:00 AM	11:59 PM	46.28	0.8	3.2%	weekend
1/16/2011	12:00 AM	11:59 PM	5.43	0.1	0.4%	weekend

Overall ON-time					
Weekday	584	min	10	hrs	4.1%
Weekend/Holiday	161	min	3	hrs	1.2%

Appendix B

Computer Energy Savings Analysis

(ES-O1 and SC-O1)

School Thin Clients and LED Monitor Energy Savings

Estimated Wattages for Computers and Monitors

	ON	Idle	Sleep	OFF	Notes
Computer - Tower/Desktop	70	40	10	3	conservatively low as computers vary and power consumption is dramatically decreasing in general for PC's
Computer - Laptop	30	20	5	2	greater energy savings due to no monitor needed, however they may be only useful for teachers who may take school and work-related items home with them
Computer - Thin Client	20	10	5	2	conservatively high, including larger backend server requirements to run all of the additional thin client machines, some models are even lower
Monitor - CRT	50	8	na	5	based on actual measurement of 17" CRT 2005
Monitor - Flatscreen/LCD	35	5	na	2	msrmnt of 21" flatscrn '09 & 17" LCD (Simple Network Consulting article)
Monitor - Flatscreen/LED	20	5	na	2	based on published manufacturers specifications on Newegg.com website

Room-specific counts	Computers			Monitor		
	Desktop	Laptop	Thin Client	CRT	LCD	LED backlit
Computer Lab (Room 411)	1		24		25	
Room 501/502	10		17		27	
Others	9		35		44	estimated qty
Totals	20		76		96	

	ON	Idle	Sleep	OFF	Total	
Ave annual hours	1,000	200	3,780	3,780	8,760	assumed on, 5 hrs per day, 5 days per week, 40 weeks per year; 1 hr per day idle, remainder 50% sleep & 50% off
Desktops to Thin Clients & LCD's to LED's						
Current Computer Usage	2,935	314	2,198	803	6,250	
Proposed Computer Usage	1,920	192	1,814	726	4,652	
Computer Energy Savings	1,015	122	384	77	**1,598**	
Current Monitor Usage	3,360	96		1,452	4,908	
Proposed Monitor Usage	1,920	96		1,452	3,468	
Monitor Energy Savings	1,440	0	0	0	**1,440**	
Current Computer Cost	$ 439	$ 47	$ 329	$ 120	$ 935	
Proposed Computer Cost	$ 287	$ 29	$ 271	$ 109	$ 696	

Computer Cost Savings	$ 152	$ 18	$ 57	$ 11	**$ 239**
Current Monitor Cost	$ 502	$ 14	$ -	$ 217	$ 734
Proposed Monitor Cost	$ 287	$ 14	$ -	$ 217	$ 519
Monitor Cost Savings	$ 215	$ -	$ -	$ -	**$ 215**

Alternative EEM (100% laptops)

Current Total Usage	6,295	410	2,198	2,254	11,157
Proposed Total Usage	2,880	384	1,814	726	5,804
Energy Savings	3,415	26	384	1,528	**5,353**
Current Total Cost	$ 941	$ 61	$ 329	$ 337	$ 1,669
Proposed Total Cost	$ 431	$ 57	$ 271	$ 109	$ 868
Cost Savings	$ 511	$ 4	$ 57	$ 229	**$ 801**

Costs

	monitor	thin client	laptop
incremental cost	5	na	0
	480	0	0
payback	2	0	0

on replacement, which is when this measure is recommended, there are additional cost savings from purchasing thin clients versus desktop computers (approximately 300 per computer, this equates to $6,000 for 20 computers in savings)

laptops are similar cost as desktops

Safety Complex Thin Clients and LED Monitor Energy Savings

Estimated Wattages for Computers and Monitors

	ON	Idle	Sleep	OFF	Notes
Computer - Tower/Desktop	70	40	10	3	conservatively low as computers vary and power consumption is dramatically decreasing in general for PC's
Computer - Laptop	30	20	5	2	not recommended in safety complex due to potential security requirements unless precautions are taken
Computer - Thin Client	20	10	5	2	conservatively high, including larger backend server requirements to run all of the additional thin client machines, some models are even lower energy
Monitor - CRT	50	8	na	5	based on actual measurement of 17" CRT 2005
Monitor - Flatscreen/LCD	35	5	na	2	based on actual measurement of 21" flatscreen 2009 and reference of 17" LCD from Simple Network Consulting article
Monitor - Flatscreen/LED	20	5	na	2	based on published manufacturers specifications on Newegg.com website

Room-specific counts	Computers			Monitor		
	Desktop	Laptop	Thin Client	CRT	LCD	LED backlit
Totals	11			2	9	

	ON	Idle	Sleep	OFF	Total	
Ave annual hours	2,800	4,900	1,060	0	8,760	assumed on, 8 hrs per day, 7 days per week, 50 weeks per year; 14 hrs per day idle, remainder sleep (fire dept only)
Desktops to Thin Clients & LCD's to LED's						
Current Computer Usage	2,156	2,156	117	0	4,429	
Proposed Computer Usage	616	539	58	0	1,213	
Computer Energy Savings	1,540	1,617	58	0	**3,215**	
Current Monitor Usage	1,162	299	30	0	1,491	
Proposed Monitor Usage	616	270	23	0	909	
Monitor Energy Savings	546	29	6	0	**582**	
Current Computer Cost	$ 315	$ 315	$ 17	$ -	$ 648	
Proposed Computer Cost	$ 90	$ 79	$ 9	$ -	$ 178	
Computer Cost Savings	$ 225	$ 237	$ 9	$ -	**$ 470**	
Current Monitor Cost	$ 170	$ 44	$ 4	$ -	$ 218	
Proposed Monitor Cost	$ 90	$ 39	$ 3	$ -	$ 133	

Monitor Cost Savings	$ 80	$ 4	$ 1	$ -	**$ 85**

Alternative EEM (100% laptops)

Current Total Usage	3,318	2,455	146	0	5,919
Proposed Total Usage	756	882	48	0	1,686
Energy Savings	2,562	1,573	99	0	**4,233**
Current Total Cost	$ 485	$ 359	$ 21	$ -	$ 866
Proposed Total Cost	$ 111	$ 129	$ 7	$ -	$ 247
Cost Savings	$ 375	$ 230	$ 14	$ -	**$ 619**

Costs

	monitor	thin client	laptop
incremental cost	5	na	100
	55	0	1100
payback	0.65	0	1.8

on replacement, which is when this measure is recommended, there are additional cost savings from purchasing thin clients versus desktop computers (approximately 300 per computer, this equates to $3,300 for 11 computers in savings)

Computer Power Management Software Analysis

	School	Safety	
Computers	96	11	
Energy Savings	2404	459	kWh
Cost Savings	$ 359	$ 67	
Cost	$ 864	$ 99	
Payback	2.4	1.5	yrs

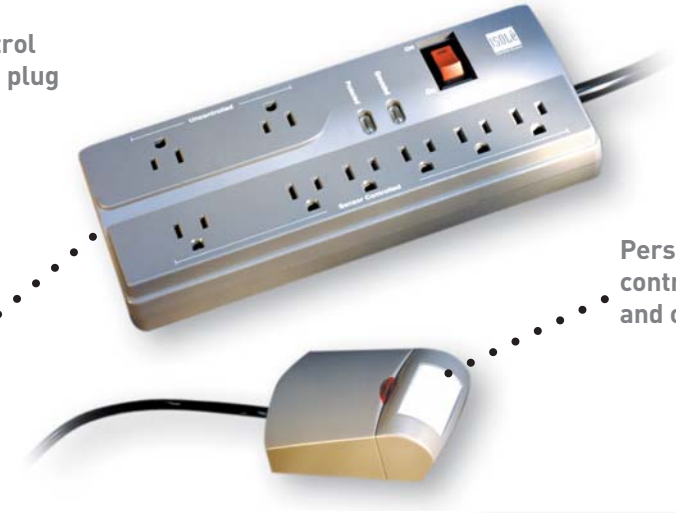
http://powerminder.com calculator

Appendix C

Smart Power Strips Sample Datasheets

(ES-O2 and SC-O2)

Isolé IDP-3050 Power Strip with Personal Sensor



PROJECT
LOCATION/TYPE

Product Overview

Description

The Isolé IDP-3050 is an energy-saving control system that provides maximum surge and noise suppression while keeping plug load equipment off when there is no occupancy. It consists of an eight-outlet power strip and a personal occupancy sensor.

Operation

The IDP-3050 turns plug load devices on and off based on occupancy. The personal sensor connects to the eight-outlet power strip with the attached cable. The power strip contains six outlets controlled by occupancy and two outlets that are uncontrolled. The IDP-3050 automatically turns all controlled devices on when the workspace is occupied, and off when the workspace has been unoccupied for the user-defined time delay. Uncontrolled devices remain on regardless of occupancy.

Surge Suppression

The power strip provides a high degree of surge suppression that protects connected equipment against threats like power surges, lightning strikes and voltage spikes. It features a resettable circuit breaker and two LEDs that indicate that the outlet is wired and grounded properly and the surge protection is functioning.

Application

The IDP-3050 is ideal for controlling task lighting and computer monitors. Additional devices for the controlled outlets include space heaters, fans and other equipment that can be turned off during unoccupied periods. Devices such as CPUs and fax machines should be plugged into the uncontrolled outlets. Applications include workstations, open office cubicles, offices and engineering stations.

Features

Power Strip

- Eight outlets; six controlled, two uncontrolled
- Surge and noise suppression protects desktop equipment
- Ground protected for safety; will not operate without a grounded outlet
- Two LEDs to indicate: 1) correct wiring and grounding; 2) surge protection is functioning
- Installation requires no hardwiring
- Flat offset plug for wire management
- One uncontrolled outlet and one controlled outlet are wall-transformer-enabled
- Plugs into a standard three-prong outlet

Personal Sensor

- Uses latest passive infrared (PIR) technology to detect occupancy
- User-adjustable time delay of 30 seconds to 30 minutes
- Multi-level Fresnel lens for superior occupancy detection
- 120° coverage, up to 300 square feet
- ASIC technology reduces components and enhances reliability
- Instantaneous response time

Specifications

Power Strip:

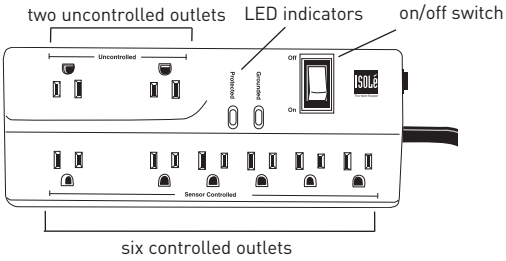
- Electrical rating: 120VAC, 12A, 50/60 Hz
- 12A dry contact relay
- Six-foot black cord
- Transformer provides power to sensor
- Mounts with screws or double-sided tape
- UL 1449 3rd Edition rating: 600V
- Circuit: High-energy, multistage hybrid
- Noise filtration: 0-25db (94.38%)
- Joule rating: 740 joules
- Maximum surge amperage: 48,000 Amps
- Protection modes: 500V L-N, 600V L-G, 600V N-G
- Response time: instantaneous
- Let-through voltage: 140V
- Initial clamping voltage: 200V
- UL and cUL listed
- Five year warranty

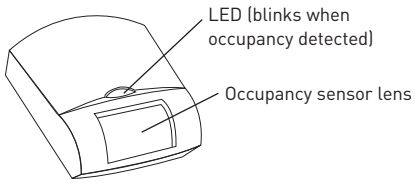
Personal Sensor:

- Nine-foot connector cable
- Supply voltage: 12 VDC
- UL and cUL listed
- Five year warranty

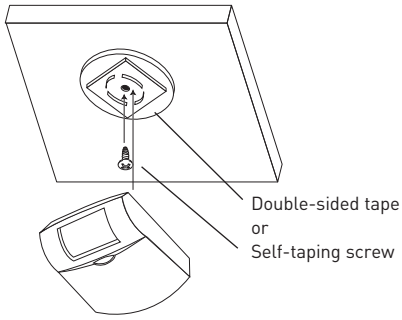
Controls & Mounting

Product Controls





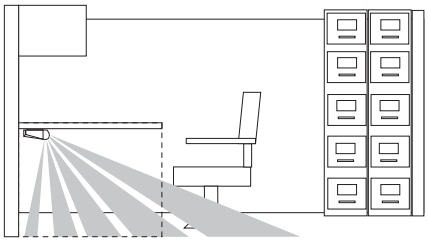
Personal Sensor Mounting



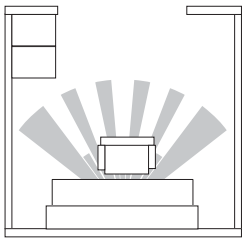
Sensor mounts under desk or binder bin with double-sided tape or self-taping screw

Coverage

Side Coverage Pattern



Overhead Coverage Pattern



Ordering Information

Catalog No.	Description
☐ IDP-3050-A	Eight-outlet power strip with personal sensor
☐ DI-110	Auto-on personal sensor
☐ CK1-1	20' extension cable w/single 1-1 connector (for single sensor and power strip)
☐ CK1-2	Two 10' extension cables w/duplex 1-2 connector (for multiple sensors and/or power strips)

Products are dark grey

Appendix D

Vending Machine and Reach-in Cooler Sensors Sample Datasheets

(ES-O3 and SC-O3)

VendingMiser®

ENERGY MANAGEMENT SYSTEM
For Refrigerated Vending Machines

Improve the profitability of your existing cold drink machines. Vending Miser® puts you on a cost-effective refresher course for energy savings and conservation.

VendingMiser cuts energy costs down to size

VendingMiser incorporates its innovative energy-saving technology into a small, plug-and-play powerhouse that installs in minutes either on the wall or on the vending machine. It's that easy.

With VendingMiser there's no need to have new machines to achieve maximum energy savings resulting in a reduction in operating costs and greenhouse gas emissions. When equipped with the VendingMiser, refrigerated beverage vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR® qualified machines.

Power play

Compatible with all types of cold drink vending machines, the VendingMiser uses a Passive Infrared Sensor (PIR) to power down the machine when the area surrounding it is vacant. Then it monitors the room's temperature and automatically re-powers the cooling system at one- to three-hour intervals, independent of sales, to ensure that the product stays cold.

This Miser runs the bank

For a series of up to four machines, VendingMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

Refresher course

VendingMiser's microcontroller will never power down the machine while the compressor is running, eliminating compressor short-cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down. This reduces the wear and tear on your machines, extending the lifespan and prolonging your profitability. Maintenance savings is generated through reduced running time of vendor components – estimated at $40 - $80 per year, per machine. The VendingMiser has been tested and accepted for use by major bottlers.

VendingMiser reduces energy consumption an average of 46%—typically $150 per machine.

Vending Miser offers...

- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Early return on investment
- Environmental benefits

VendingMiser can also control other cooled product vending machines, such as refrigerated candy machines.

VendingMiser Technical Specifications

Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Vending Machines: Any machine, except those containing perishable goods such as dairy products

Inactivity Timeouts
Occupancy Timeout: 15 minutes
Auto Re-power: One to three hours, dynamically adjusted, based on ambient temperature

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lbs. (includes power cable)

Regulatory Approvals
Safety: UL/C-UL Listed
Information Technology Equipment (ITE) 9T79

Other energy-saving products offered by USA Technologies include VM2IQ™, CoolerMiser™, SnackMiser™ and PlugMiser™.

GSA Schedule Contract GS-35F-0031R

ENERGY STAR PARTNER

USA TECHNOLOGIES

For more information about VendingMiser by USA Technologies: 888.521.6982 www.usatech.com

Frequently Asked Questions

Will VendingMiser® keep my drinks cold?
Absolutely - VendingMiser® has been tested and accepted for use by both major bottlers.

Is the VendingMiser® easy to install?
Yes! VendingMiser® is a simple external plug-and-play product. The VendingMiser® can be installed on the wall with simple hand tools or it can be attached to the vending machine without tools using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is VendingMiser® safe for all machines?
Yes! VendingMiser® is compatible with all types of cold drink vending machines. In fact, by reducing run time of the machines, VendingMiser® reduces maintenance costs.

Has VendingMiser® been field tested?
Tens of thousands of VendingMisers® are operational in the field. Typical energy savings have been independently documented to be between 35% and 45%. Measurement and verification test results as well as testimonials are available on the website.

Are there any locations not appropriate for VendingMiser®?
VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings. Our VM2IQ is more appropriate for this type of location and will typically save up to 35% energy use.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)

COMPATIBILITY

Vending Machines:	Any machine, except those containing perishable goods such as dairy products.

INACTIVITY TIMEOUTS

Occupancy Timeout:	15 minutes
Auto Repower:	One to three hours, dynamically adjusted, based on ambient temperature

DIMENSIONS

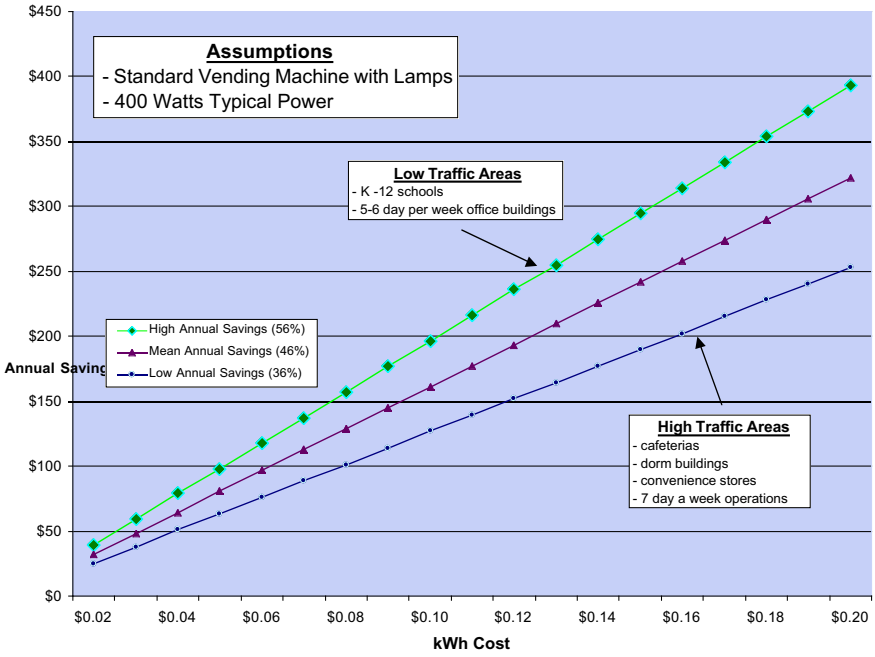
Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

UL LISTED c UL LISTED

Typical Saving Generated with VendingMiser®



VendingMiser® Products

VM150	VendingMiser® with PIR Sensor
VM151	VendingMiser® only
VM160	Weatherproof VendingMiser® with PIR Sensor
VM161	Weatherproof VendingMiser® only
VM170	Easy-Install VendingMiser® with PIR Sensor
VM171	Easy-Install VendingMiser® only
VM180	Weatherproof Easy-Install VendingMiser w/PIR sensor
VM181	Weatherproof Easy-Install VendingMiser only

CoolerMiser™

ENERGY MANAGEMENT SYSTEM
For Glass-Front Coolers

Start a cooling trend that saves you money and conserves energy.

CoolerMiser™ refreshes profits, reduces costs.

With CoolerMiser, achieve maximum energy savings resulting in a reduction in both operating costs and greenhouse gas emissions. CoolerMiser incorporates its innovative energy-saving technology into a small, plug-and-play powerhouse that installs in minutes.

Power sense

Compatible with all glass-front coolers that contain non-perishable goods, CoolerMiser's Passive Infrared Sensor (PIR) powers down the machine when the surrounding area is vacant. Then it monitors the room's temperature and periodically re-powers the cooling system to ensure that the product stays cold.

CoolerMiser analyzes the cooler's performance on a cycle-by-cycle basis, constantly responding to changes in load, sales and environment. It then modifies its behavior accordingly, ensuring proper operation and temperature controls.

This Miser runs the bank

For a bank of coolers, CoolerMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

CoolerMiser's electrical current sensor will never power down the machine while the compressor is running, eliminating compressor short cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down. This reduces the wear and tear on your machines, extending the lifespan and prolonging your profitability.

According to current customer results, CoolerMiser can save an average of $100 per year, per cooler in energy costs. In addition, one CoolerMiser reduces greenhouse gas emissions by 1,600 lbs. of CO2 and 2,740 grams of NOx each year, based on occupancy and the Energy Information Administration's national average of greenhouse gas emissions and electricity generation.

CoolerMiser offers...

- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Environmental benefits
- Early return on investment
- Can control single-, double- and triple-door coolers

CoolerMiser Technical Specifications

Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Slide Coolers: Any cooler, except those containing perishable goods, which do not exceed 12 AMP nameplate rating

Inactivity Timeouts
Occupancy Timeout: 15 minutes
Auto Re-power: One to seven hours, dynamically adjusted, based on cooler performance and ambient temperature

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lbs. (includes power cable)

Other energy-saving products offered by USA Technologies include VendingMiser®, VM2IQ™, SnackMiser™ and PlugMiser™.

GSA Schedule Contract GS-35F-0031R

ENERGY STAR PARTNER

USA TECHNOLOGIES

Optimum Energy Products Ltd. Toll Free 877-766-5412 Main 403-256-3636 Fax 403-256-3431

Frequently Asked Questions

Will CoolerMiser™ keep my drinks cold?
Absolutely - CoolerMiser™ has been extensively tested in countless field and laboratory environments and does not compromise the for-sale products.

Is the CoolerMiser™ easy to install?
Yes! CoolerMiser™ is a simple external plug-and-play product. The CoolerMiser™ can be installed on the wall with simple hand tools or it can be attached without tools to the cooler using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is CoolerMiser™ safe for all machines?
Yes! CoolerMiser™ is compatible with all types of coolers. CoolerMiser™ analyzes the cooler it controls and then modifies its behavior to match the cooler's requirements. In fact, by reducing run time of the machines, CoolerMiser™ reduces the cooler's maintenance costs.

Are there any locations not appropriate for CoolerMiser™?
CoolerMiser's savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)

COMPATIBILITY

Slide Coolers:	Any cooler, except those containing perishable goods, which do not exceed 12 Amp nameplate rating.

INACTIVITY TIMEOUTS

Occupancy Timeout:	15 minutes
Auto Repower:	One to seven hours, dynamically adjusted, based on cooler performance and ambient temperature

DIMENSIONS

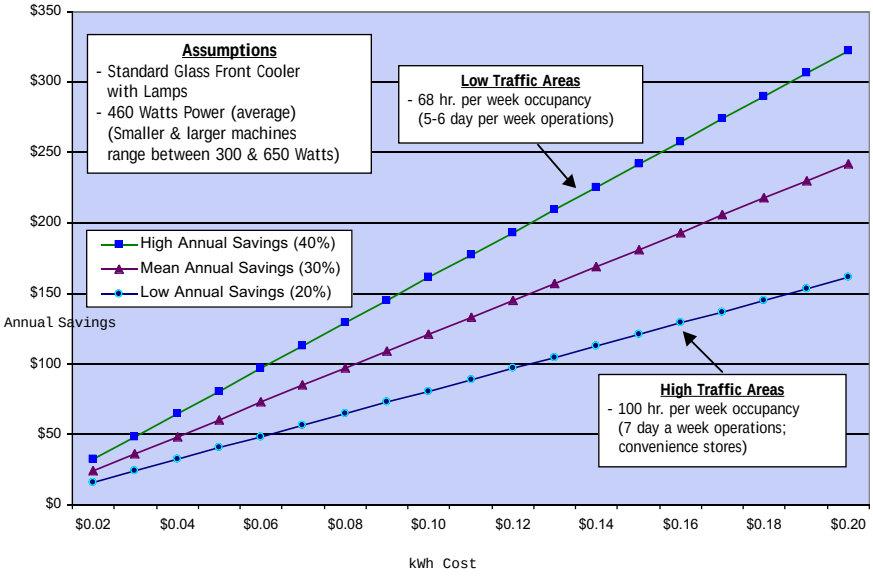
Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

UL LISTED c UL LISTED

Typical Saving Generated with CoolerMiser™



CoolerMiser™ Products

CM150	CoolerMiser with PIR Sensor
CM151	CoolerMiser only
CM170	Easy-Install CoolerMiser with PIR Sensor
CM171	Easy-Install CoolerMiser only

For more information about the CoolerMiser™
Contact Optimum Energy Products Toll Free 877-766-5412 or visit www.VendingMiserStore.com

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Appendix E

Geothermal System Analysis

(ES-R1)

Fremont School - high level geothermal savings potential

AC	Cooling Load currently 30 tons for library and media center		
Heat	Based annual fuel usage of -	14,000	gallons/yr

	138500	Btu/gallon — ASHRAE 1993 fundamentals #2
	2500	annual heating hours — AHRI chart for Southern NH (whole USA chart)
	85%	Assumed oil system efficiency
	55	Resulting budgetary estimate earth couple size (n tons)
$	87,000	Each 30 ton well (assumed 10% discharge for 80 hours per year)
	60	ton system
$	174,000	Well system cost
$	300,000	Inside equipment cost is based on $5,000 per ton installed (very rough for a retrofit project) Also assumed the most cost effective water air system
$	474,000	total estimated cost
$	33,040.00	annual costs for oil
$	9,900	annual cost for AC (at 9 EER)
$	4,050	annual cost for Geothermal cooling
$	20,725	annual cost for Geothermal heating
$	18,165	annual savings
	26	Simple payback
	11	Sensitivity analysis if the price of oil is $3.50/gallon and electricity is $0.15
	16	Sensitivity analysis if the price of oil is $3.50/gallon and electricity is $0.20

Heating Sensitivity		Cooling Sensitivity	
49000	27633.57	13200	5400

Equation: source AEE CEM exam review materials

kW	12	3.517
Ton	EER	COP

Existing cooling

kW	12	kW_{load} =	73
55	9		

Geothermal cooling

kW	12	kW_{load} =	30
55	22		

Geothermal Heating

kW	3.517	kW_{load} =	55
55	3.5		

Appendix F

Biomass Heating System RETScreen® Outputs and Analysis

(ES-R2)

RETScreen Energy Model - Heating project

Heating project

		Base case	Proposed case		Incremental initial costs
Heated floor area for building	ft²	60,800			
Energy efficiency measures			0%		$ -
Heating load for building	(Btu/h)/ft²	8	8		
Domestic hot water heating base demand	%	0%	0%		
Total heating	MWh	279	279		
Base load heating system					
Technology		Oil	Biomass system		
Capacity	million Btu/h	0.5	1.0	205.6%	$ 350,000
Heating delivered	MWh	278.6	278.6	100.0%	
Fuel type		Diesel (#2 oil) - gal	Biomass		
Seasonal efficiency	%	50%	50%		
Fuel consumption - annual	gal	13,809	102	t	
Fuel rate	$/gal	2.360	52.000	$/t	
Fuel cost	$	32,589	5,280		
Peak load heating system					
Technology			Wood Chip		
Suggested capacity	million Btu/h		0.0		
Capacity	million Btu/h		0.0	0.0%	
Fuel type			Biomass		
Seasonal efficiency	%		50%		
Fuel consumption - annual	t		0		
Heating delivered	MWh		0.0	0.0%	
Fuel rate	$/t		52.000		
Fuel cost	$		0		

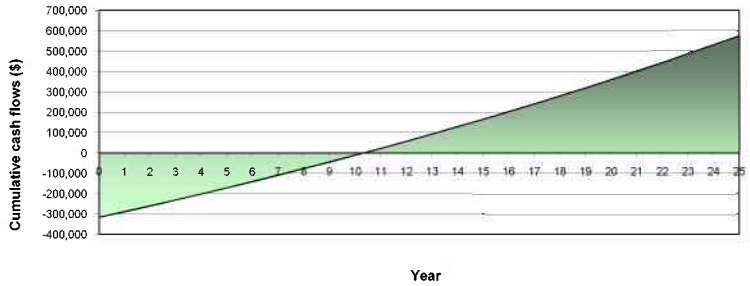
Emission Analysis

GHG emission					
Base case	tCO2	140			
Proposed case	tCO2	4			
Gross annual GHG emission reduction	tCO2	136			
GHG credits transaction fee	%	0.0%			
Net annual GHG emission reduction	tCO2	136	is equivalent to	27.6	Cars & light trucks not used
GHG reduction income					
GHG reduction credit rate	$/tCO2	0.00			

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	25	
Debt ratio	%	0%	
Initial costs			
Heating system	$	350,000	100.0%
Other	$	0	0.0%
Total initial costs	$	350,000	100.0%
Incentives and grants	$	35,000	10.0%
Annual costs and debt payments			
O&M (savings) costs	$	0	
Fuel cost - proposed case	$	5,280	
Other	$	0	
Total annual costs	$	5,280	
Annual savings and income			
Fuel cost - base case	$	32,589	
Other	$	0	
Total annual savings and income	$	32,589	
Financial viability			
Pre-tax IRR - assets	%	9.3%	
Simple payback	yr	11.5	
Equity payback	yr	10.3	

Cumulative cash flows graph



Fremont School Biomass (Woodchip) Analysis

System size based on 14,000 gallon per year and 2500 hours of heating per year (AHRI)

	14,000	Oil used per yr (gallons)
	138,500	Heat content of oil (Btu/gallon)
	2,500	Annual full load heating hours (hr/yr)
	775,600	Heating system input system size (Btuh)
	80%	Heating system efficiency

Bio mass system

$	300,000	Wood chip boiler installed
$	50,000	Stack
	853,160.0	System nameplate size based on 70% efficiency and 50% moisture content of wood
	1.0	Size used on analysis based on typically available units (MMBtu)

RETScreen results

	13,707	Annual fuel savings (Gallons/yr)
	1,898,419,500	Energy savings (Btu/yr)
	1,898,420	Energy savings (kBtu/yr)
	8.6	50% moisture content heat value per ton (MMBtu/ton)
$	11,479	Annual cost for wood (@ $52/ton woodchips)
$	33,040	Annual oil cost
$	21,561	Annual savings
	16.23	Simple payback

Appendix G

Solar Photovoltaic System Analysis and PVWATTS® Outputs

(ES-R3 and SC-R1)

Crystalline System Details

Item	Values	Reference Source and Comments
Module DC Capacity (kW)	50	Rooftop PV capacity based on total usable roof area (20,000 ft ^{2}) and layout of refrigeration compressors, exhausts, chimneys, and skylights, as well as the "sweet spot" for maximum available rebates.
Rack	Fixed, Tilt-up	
Compass Direction	180	south facing
Tilt Angle	20	Tilt angle recommended to be 20 degrees due to wind loading issues
Non-Snow Shading (%)	5%	Estimate, based on similar measurements from other NH buildings
Estimate of Snow Covering (%)	4%	Estimate for New Hampshire calculated by using the product of WI Focus on Energy fact sheet and the ratio of snowfall (inches) for Concord, NH and Milwaukee, WI respectively (sources = *Selecting a Solar Electric System for a Commercial Building Rooftop Fact Sheet* , Wisconsin Focus on Energy, 2008 has 3% listed for Milwaukee, WI based on a 20 degree tilt system; NOAA snowfall data for Concord, NH and Milwaukee, WI http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/snowfall.html)
Total Inverter capacity (kW)	50 kW/208 Volts	50 kW Generic Inverter
Installation Price Estimate	$315,000	Approximately $6,300/kW (source = Advanced Solar Electric System Training Business Programs Integration, Presentation, Niels Wolter, Wisconsin Energy Conservation Corp.; med/large systems GDS estimate; Solarbuzz trends and dicussion with local installars for budget number)

Production Estimate

Item	Values	Reference Source and Comments
PV Watts Calculated Production (kWh/yr)	61,947	Assuming 0.80 derate factor (source = Advanced Solar Electric System Training Business Programs Integration, Presentation, Niels Wolter, Wisconsin Energy Conservation Corp.)
PV Watts city used	Concord, NH	Closest PVWatts location to Fremont, NH
Estimated Production (kWh/yr)	**56,372**	Includes shading and snow-covering effects as described above

Detailed System Cost Data

Cost Of	Values	Reference Source and Comments
Module Unit Cost ($/W)	$3.40	$3.40/W -- Solarbuzz Module October retail price index (http://www.solarbuzz.com/Moduleprices.htm)
Modules	$170,000	
Inverter Unit Cost ($/W)	$0.80	$0.80/W -- GDS estimate based on current retail cost data and RS Means Electrical Cost Data
Inverter	$40,000	
Racking	$42,000	Estimate based on additional 20% of material costs (source = *Selecting a Solar Electric System for a Commercial Building Rooftop Fact Sheet,* Wisconsin Focus on Energy, 2008)
Charge controller and batteries	n/a	Grid tied
Balance of System	n/a	n/a
Labor	$63,000	Estimate based on total installed price minus the materials costs
Shipping	n/a	n/a
Tax	n/a	No sales tax in NH
Total	**$315,000**	n/a

Manufacturer Make & Model Data

Item	Values	Additional Notes / Details
Panel Manufacturer & Model	SunTech	STP210-18/Ud
Inverter Manufacturer & Model	generic	50 kW Solar Inverter

Rebates & Incentives

Item	Values	Additional Notes / Details
Federal Tax Credit (Business Energy Investment Tax Credit)	$94,500	30% solar project cost (can only be taken advantage of by a for-profit business such as the installation contractor) http://dsireusa.org/solar/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=0
NH PUC C&I (RGGI) Grant	$50,000	25% of total project, $50,000 maximum cap. If funds are available and application is accepted; "first come, first serve." http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-CI.html
System cost	$170,500	After rebates and grants have been applied
CDFA Municipal Energy Reduction Fund (loan)	$0	$5,000 to $400,000 available per local government, no loan included, low interest loan (2.5 to 4%, depending on length of loan, 3-10 years) http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NH38F&re=1&ee=0
Remaining capital cost after loan	$170,500	After grant has been applied (no rebates or loan assumed)
Remaining capital cost payback	**20.2 Yrs**	Payback based on $0.15/kWh rate

Renewable Energy & Carbon Offset Credits

Item	Values	Additional Notes / Details
Renewable Energy Credits (REC's)	$0	Class II Solar REC's: require additional meter to be installed and an independent contractor to certify the REC's. Prices not available at the moment, but assumed to be less than the Alternative Compliance Payments as set by the NH RPS (2010 Class II ACP is $160.01). http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$846	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Carbon Offset Credits (COC's)	$349	908.9lbs/MWh (source = Table 14.1 p 104 CRM manual), at $15/metric ton (source = Bloomberg.com, referenced 9/3/2010) **Note:** Not included in savings - replaced by more valuable REC's
Payback after REC's	18.3 Yrs	$0.15/kWh
ROI after REC's	5.5%	

Crystalline System Sensitivity Analysis

Item	Values	Additional Notes / Details
Renewable Energy Credits (REC's)	$8,456	First year only, estimated $150/MWh Class II Solar REC's http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$846	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Simple Payback	17.5	$0.15/kWh
Renewable Energy Credits (REC's)	$0	No Class II Solar REC's http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$846	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Simple Payback	14.1	Price of electricity increases to an average of $0.20/kWh
Renewable Energy Credits (REC's)	$8,456	First year only, estimated $150/MWh Class II Solar REC's http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$846	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Simple Payback	13.4	Price of electricity increases to an average of $0.20/kWh

AC Energy & Cost Savings

Cautions for Interpreting the Results

Town of Fremont - Ellis School

Station Identification	
City:	Concord
State:	New Hampshire
Latitude:	43.20° N
Longitude:	71.50° W
Elevation:	105 m
PV System Specifications	
DC Rating:	50.0 kW
DC to AC Derate Factor:	0.800
AC Rating:	40.0 kW
Array Type:	Fixed Tilt
Array Tilt:	20.0°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	15.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	2.96	3798	569.70
2	3.83	4496	674.40
3	4.55	5768	865.20
4	5.28	6128	919.20
5	5.85	6725	1008.75
6	6.07	6594	989.10
7	6.11	6806	1020.90
8	5.68	6340	951.00
9	4.73	5214	782.10
10	3.54	4201	630.15
11	2.59	3049	457.35
12	2.26	2830	424.50
Year	4.46	61947	9292.05

Output Hourly Performance Data

About the Hourly Performance Data

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.1 for another US location or an International location
Run PVWATTS v.2 (US only)

Please send questions and comments regarding PVWATTS to Webmaster

Crystalline System Details

Item	Values	Reference Source and Comments
Module DC Capacity (kW)	25	Rooftop PV capacity based on total south(east)-facing usable roof area (6,000 ft^2) and layout of
Rack	Fixed, Flat	
Compass Direction	135	Southeast facing slope
Tilt Angle	45	Fixed tilt, flat panels on existing roof
Non-Snow Shading (%)	5%	Estimate, based on similar measurements from other NH buildings
Estimate of Snow Covering (%)	2%	Estimate for New Hampshire calculated by using the product of WI Focus on Energy fact sheet and the ratio of snowfall (inches) for Concord, NH and Milwaukee, WI respectively (sources = *Selecting a Solar Electric System for a Commercial Building Rooftop Fact Sheet* , Wisconsin Focus on Energy, 2008 has 1% listed for Milwaukee, WI based on a 45 degree system; NOAA snowfall data for Concord, NH and Milwaukee, WI http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/snowfall.html)
Total Inverter capacity (kW)	25 kW/208 Volts	25 kW Generic Inverter
Installation Price Estimate	$157,500	Approximately $6,300/kW (source = Advanced Solar Electric System Training Business Programs Integration, Presentation, Niels Wolter, Wisconsin Energy Conservation Corp.; med/large systems GDS estimate; Solarbuzz trends and dicussion with local installars for budget number)

Production Estimate

Item	Values	Reference Source and Comments
PV Watts Calculated Production (kWh/yr)	29,489	Assuming 0.80 derate factor (source = Advanced Solar Electric System Training Business Programs Integration, Presentation, Niels Wolter, Wisconsin Energy Conservation Corp.)
PV Watts city used	Concord, NH	Closest PVWatts location to Somersworth, NH
Estimated Production (kWh/yr)	**27,425**	Includes shading and snow-covering effects as described above

Detailed System Cost Data

Cost Of	Values	Reference Source and Comments
Module Unit Cost ($/W)	$3.40	$3.40/W -- Solarbuzz Module October retail price index (http://www.solarbuzz.com/Moduleprices.htm)
Modules	$85,000	
Inverter Unit Cost ($/W)	$0.80	$0.80/W -- GDS estimate based on current retail cost data and RS Means Electrical Cost Data
Inverter	$20,000	
Racking/Mounting	$21,000	Estimate based on additional 20% of material costs (source = *Selecting a Solar Electric System for a Commercial Building Rooftop Fact Sheet,* Wisconsin Focus on Energy, 2008)
Charge controller and batteries	n/a	Grid tied
Balance of System	n/a	n/a
Labor	$31,500	Estimate based on total installed price minus the materials costs
Shipping	n/a	n/a
Tax	n/a	No sales tax in NH
Total	**$157,500**	n/a

Manufacturer Make & Model Data

Item	Values	Additional Notes / Details
Panel Manufacturer & Model	SunTech	STP210-18/Ud
Inverter Manufacturer & Model	generic	50 kW Solar Inverter

Rebates & Incentives

Item	Values	Additional Notes / Details
Federal Tax Credit (Business Energy Investment Tax Credit)	$47,250	30% solar project cost (can only be taken advantage of by a for-profit business such as the installation contractor) http://dsireusa.org/solar/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=0
NH PUC C&I (RGGI) Grant	$39,375	25% of total project, $50,000 maximum cap. If funds are available and application is accepted; "first come, first serve." http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-CI.html
System cost	$70,875	After rebates and grants have been applied
CDFA Municipal Energy Reduction Fund (loan)	$0	$5,000 to $400,000 available per local government, no loan included, low interest loan (2.5 to 4%, depending on length of loan, 3-10 years) http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NH38F&re=1&ee=0
Remaining capital cost after loan	$70,875	After grant has been applied (no rebates or loan assumed)
Remaining capital cost payback	**17.7 Yrs**	Payback based on $0.146/kWh rate

Renewable Energy & Carbon Offset Credits

Item	Values	Additional Notes / Details
Renewable Energy Credits (REC's)	$0	Class II Solar REC's: require additional meter to be installed and an independent contractor to certify the REC's. Prices not available at the moment, but assumed to be less than the Alternative Compliance Payments as set by the NH RPS (2010 Class II ACP is $160.01). http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$411	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Carbon Offset Credits (COC's)	$170	908.9lbs/MWh (source = Table 14.1 p 104 CRM manual), at $15/metric ton (source = Bloomberg.com, referenced 9/3/2010) **Note:** Not included in savings - replaced by more valuable REC's
Payback after REC's	16.1 Yrs	$0.146/kWh
ROI after REC's	6.2%	

Crystalline System Sensitivity Analysis

Item	Values	Additional Notes / Details
Renewable Energy Credits (REC's)	$4,114	First year only, estimated $150/MWh Class II Solar REC's http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$411	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Simple Payback	15.2	$0.146/kWh
Renewable Energy Credits (REC's)	$0	No Class II Solar REC's http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$411	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Simple Payback	12.0	Price of electricity increases to an average of $0.20/kWh
Renewable Energy Credits (REC's)	$4,114	First year only, estimated $150/MWh Class II Solar REC's http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm
	$411	Annual credit of $0.015 per kWh (source = 2005 NREL Emerging Markets for Renewable Energy Certificates report)
Simple Payback	11.4	Price of electricity increases to an average of $0.20/kWh

AC Energy & Cost Savings

Cautions for Interpreting the Results

Town of Fremont - Safety Complex

Station Identification	
City:	Concord
State:	New Hampshire
Latitude:	43.20° N
Longitude:	71.50° W
Elevation:	105 m
PV System Specifications	
DC Rating:	25.0 kW
DC to AC Derate Factor:	0.800
AC Rating:	20.0 kW
Array Type:	Fixed Tilt
Array Tilt:	45.0°
Array Azimuth:	135.0°
Energy Specifications	
Cost of Electricity:	14.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.22	2060	288.40
2	3.98	2311	323.54
3	4.41	2761	386.54
4	4.91	2829	396.06
5	5.36	3060	428.40
6	5.47	2949	412.86
7	5.42	2983	417.62
8	5.16	2850	399.00
9	4.49	2441	341.74
10	3.55	2093	293.02
11	2.68	1574	220.36
12	2.49	1577	220.78
Year	4.26	29489	4128.46

Output Hourly Performance Data

About the Hourly Performance Data

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.1 for another US location or an International location
Run PVWATTS v.2 (US only)

Please send questions and comments regarding PVWATTS to Webmaster

Appendix H

Solar Thermal Air Heating System Sample Datasheets

SolarDuct™ Modular Rooftop Air Heating System

1 SolarDuct™ System
2 Air Handling Units (AHU)
3 Hot Air Ducts

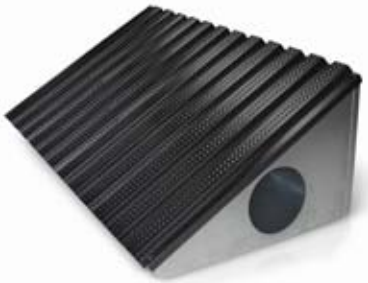
SolarDuct™ is based on the highly efficient and award-winning SolarWall® system. The technology has been specifically engineered for roof settings and for applications in which a traditional wall mounted system is not feasible.

Like the original SolarWall technology, SolarDuct is a solar heating system that heats ventilation air before it enters the air handling units. The patented system uses an all-metal collector panel and is suitable for commercial, industrial, and institutional facilities. Perforations in the panels allow the heat that normally collects on a dark surface to be uniformly drawn through the SolarDuct panel and then ducted into the conventional HVAC system.

The SolarDuct system is optimized to meet site conditions in terms of orientation towards the sun and proximity to rooftop air handling units. The modular arrays are sized according to the energy requirements of the building.

Features & Advantages

- Heats ventilation air using the highest performing and lowest cost solar collector on the market
- Collector efficiency up to 75%
- Easy to install modular rooftop units
- Optimized to meet site conditions
- Internally ballasted or fastened system which is quick to assemble and simple to integrate into existing air intake system
- Individual units are 6' by 4' and each produces 1000 watts of thermal energy
- Typical array length is 48 feet long (8 units) and will deliver up to 2000 cfm of heated ventilation air and 8kW of heating
- Substantial CO_2 displacement



SolarWall®

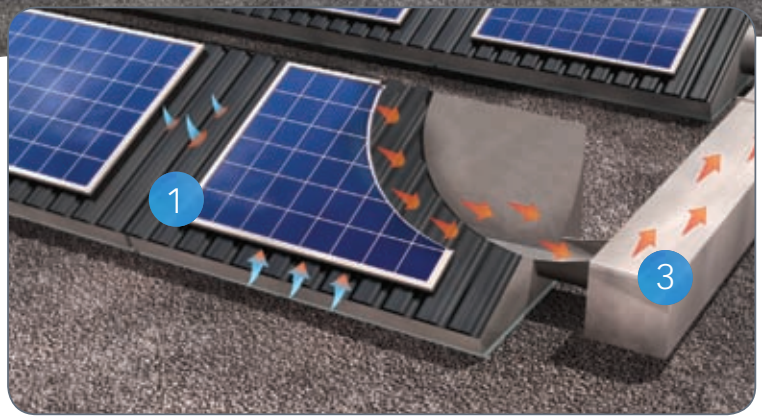
by **Conserval Engineering Inc.**

www.solarwall.com

SolarDuct™ PV/T

Modular Rooftop Air Heating System with PV

1 SolarDuct PV/T™ System
2 Air Handling Units (AHU)
3 Hot Air Ducts



The SolarDuct™ product can also be used for PV/thermal cogeneration systems. With a SolarDuct PV/T system, the all-metal SolarWall® panels draw the heat away from the PV modules. This heat energy is then ducted to the nearest rooftop air handling unit and then into the building's conventional HVAC system where it offsets the heating load.

The removal of the heat from the back of the PV modules also enhances the electrical operating efficiency of the PV by up to 10%.

SolarDuct™ PV/T Performance

- Improves PV system return on investment
- Generates both electricity and heat energy
- Total operating efficiency above 50%
- Cools the PV cells to reduce heat related drop in output.
- Can be configured for any PV module
- SolarWall air heating panels serve as the racking system needed to mount the PV modules
- Angled at an ideal orientation for maximum solar gain
- Offsets heating & electricity costs
- Huge reduction in CO_2 emissions

Canada
Conserval Engineering Inc.
200 Wildcat Road, Toronto, ON M3J 2N5
P: 416.661.7057 | F: 416.661.7146 | E: info@solarwall.com

U.S.A.
Conserval Systems Inc.
4242 Ridge Lea Road, Suite 28, Buffalo, NY 14226
P: 716.835.4903 | F: 716.835.4904 | E: info@solarwall.com

Europe
SolarWall Europe
66 Avenue des Champs Elysees 75008 Paris France
P: +33(0)6 34 66 85 74 | E: info@solarwall.eu

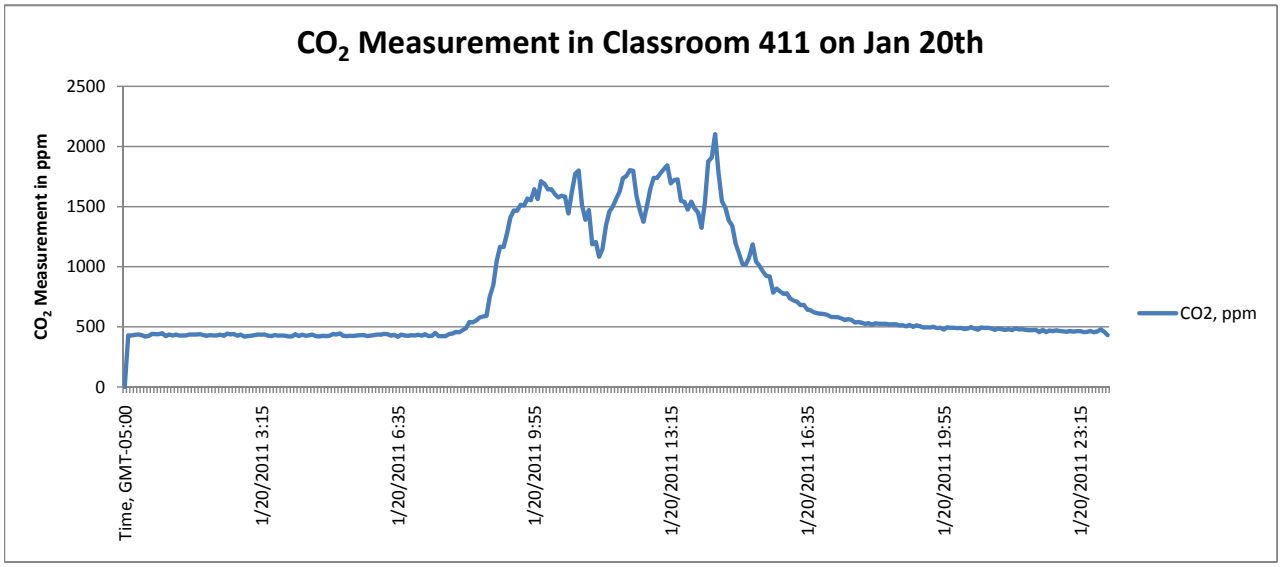
SolarWall®

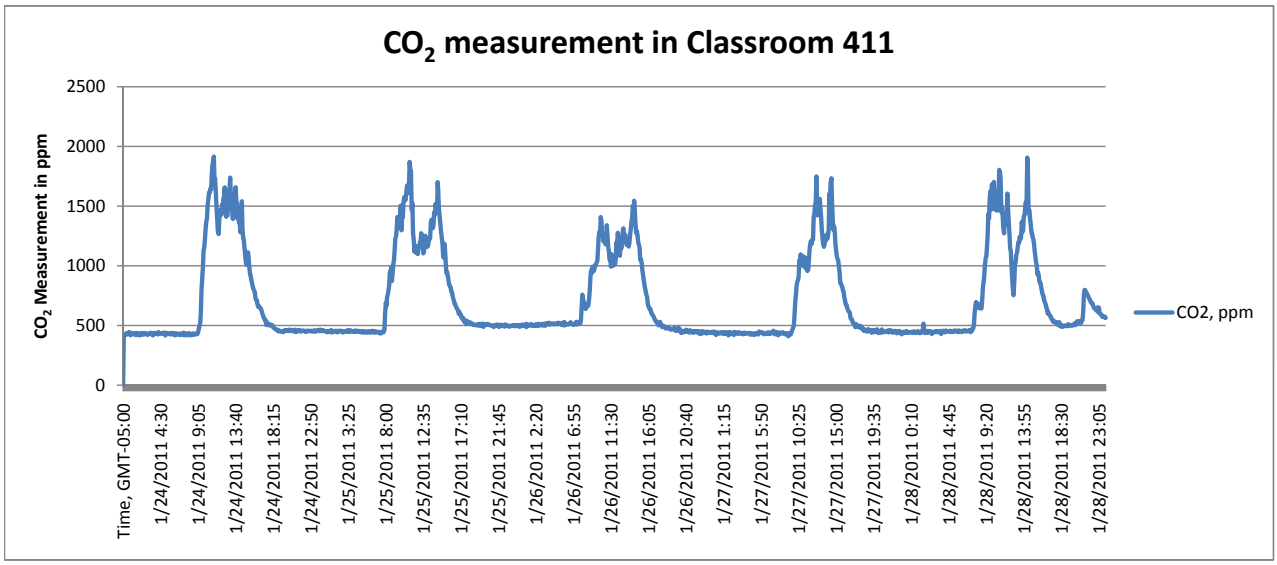
by **Conserval Engineering Inc.**

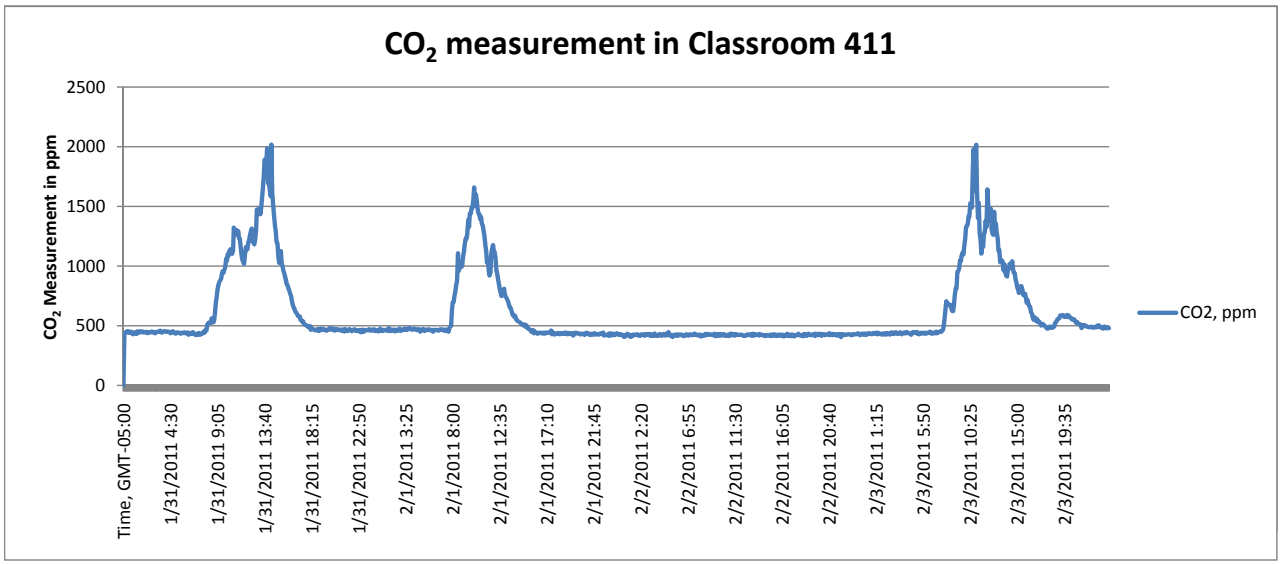
www.solarwall.com

Appendix I

CO_2 Data Logger Results


CO2 Measurement in Classroom 411 on Jan 20th
CO2 Measurement in ppm
2500
2000
1500
1000
500
0
Time, GMT-05:00
1/20/2011 3:15
1/20/2011 6:35
1/20/2011 9:55
1/20/2011 13:15
1/20/2011 16:35
1/20/2011 19:55
1/20/2011 23:15
CO2, ppm


CO2 measurement in Classroom 411
CO2 Measurement in ppm
2500
2000
1500
1000
500
0
Time, GMT-05:00
1/24/2011 4:30
1/24/2011 9:05
1/24/2011 13:40
1/24/2011 18:15
1/24/2011 22:50
1/25/2011 3:25
1/25/2011 8:00
1/25/2011 12:35
1/25/2011 17:10
1/25/2011 21:45
1/26/2011 2:20
1/26/2011 6:55
1/26/2011 11:30
1/26/2011 16:05
1/26/2011 20:40
1/27/2011 1:15
1/27/2011 5:50
1/27/2011 10:25
1/27/2011 15:00
1/27/2011 19:35
1/28/2011 0:10
1/28/2011 4:45
1/28/2011 9:20
1/28/2011 13:55
1/28/2011 18:30
1/28/2011 23:05
CO2, ppm


CO2 measurement in Classroom 411
CO2 Measurement in ppm
2500
2000
1500
1000
500
0
Time, GMT-05:00
1/31/2011 4:30
1/31/2011 9:05
1/31/2011 13:40
1/31/2011 18:15
1/31/2011 22:50
2/1/2011 3:25
2/1/2011 8:00
2/1/2011 12:35
2/1/2011 17:10
2/1/2011 21:45
2/2/2011 2:20
2/2/2011 6:55
2/2/2011 11:30
2/2/2011 16:05
2/2/2011 20:40
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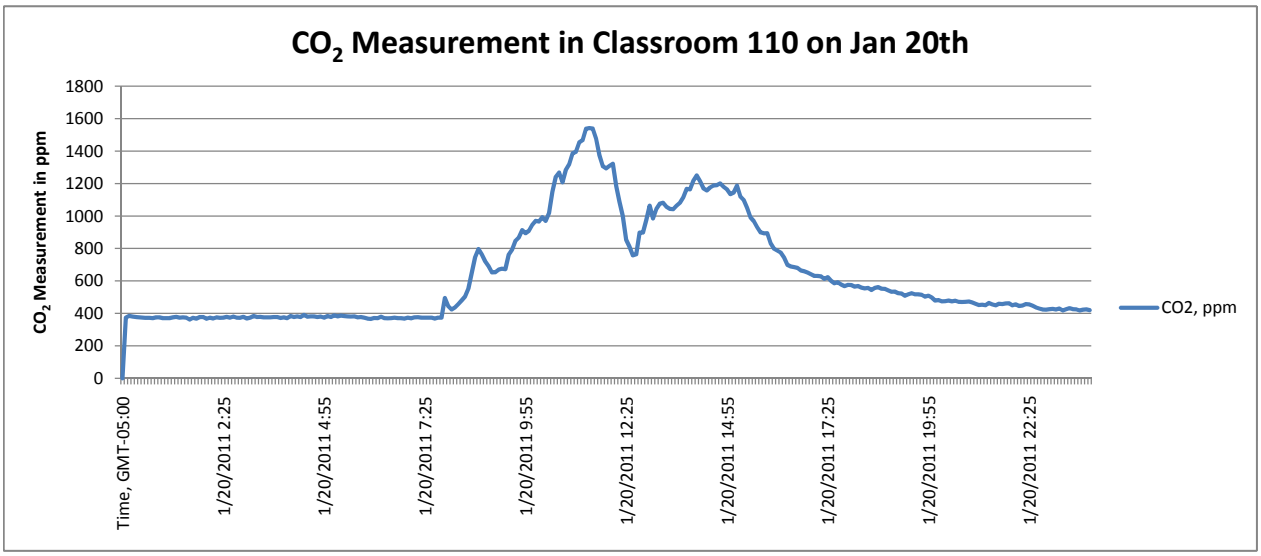
2/3/2011 15:00
2/3/2011 19:35
CO2, ppm


CO2 Measurement in Classroom 110 on Jan 20th
CO2 Measurement in ppm
1800
1600
1400
1200
1000
800
600
400
200
0
Time, GMT-05:00
1/20/2011 2:25
1/20/2011 4:55
1/20/2011 7:25
1/20/2011 9:55
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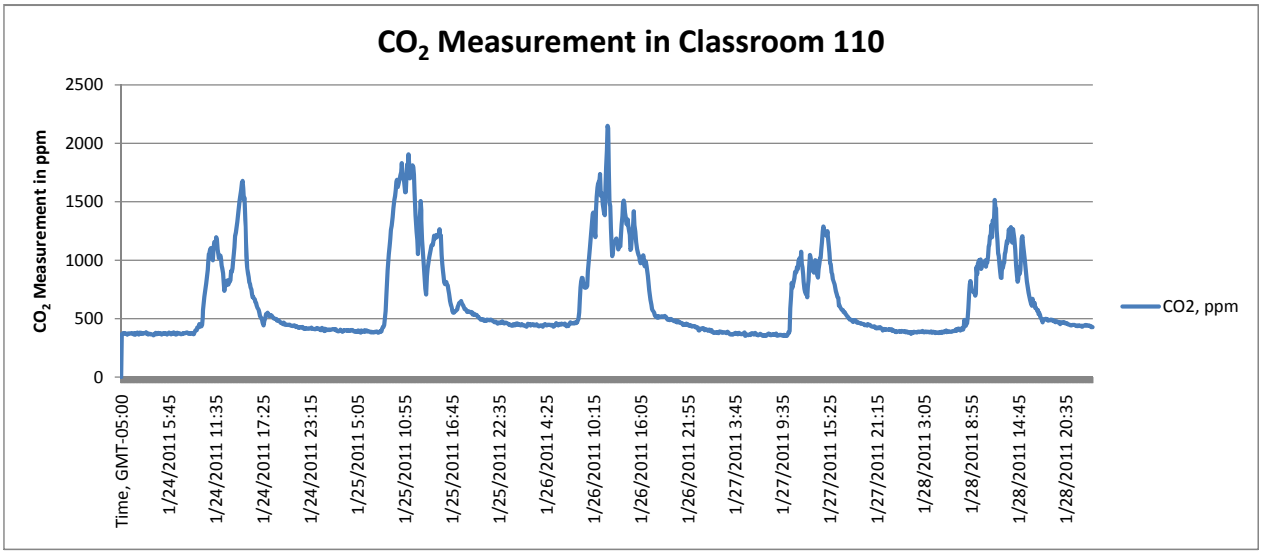
1/20/2011 19:55
1/20/2011 22:25
CO2, ppm


CO2 Measurement in Classroom 110
CO2 Measurement in ppm
2500
2000
1500
1000
500
0
Time, GMT-05:00
1/24/2011 5:45
1/24/2011 11:35
1/24/2011 17:25
1/24/2011 23:15
1/25/2011 5:05
1/25/2011 10:55
1/25/2011 16:45
1/25/2011 22:35
1/26/2011 4:25
1/26/2011 10:15
1/26/2011 16:05
1/26/2011 21:55
1/27/2011 3:45
1/27/2011 9:35
1/27/2011 15:25
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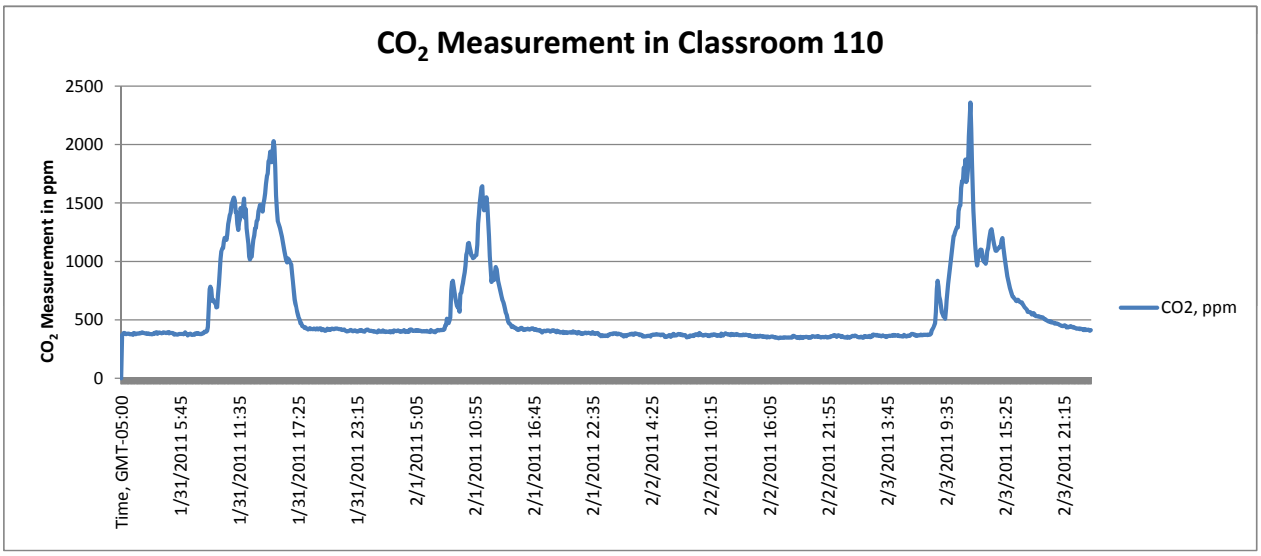
1/28/2011 14:45
1/28/2011 20:35
CO2, ppm


CO2 Measurement in Classroom 110
CO2 Measurement in ppm
2500
2000
1500
1000
500
0
Time, GMT-05:00
1/31/2011 5:45
1/31/2011 11:35
1/31/2011 17:25
1/31/2011 23:15
2/1/2011 5:05
2/1/2011 10:55
2/1/2011 16:45
2/1/2011 22:35
2/2/2011 4:25
2/2/2011 10:15
2/2/2011 16:05
2/2/2011 21:55
2/3/2011 3:45
2/3/2011 9:35
2/3/2011 15:25
2/3/2011 21:15
CO2, ppm

Appendix J

Sample Procurement Request for Proposals

Town of Bedford, New Hampshire

REQUEST FOR PROPOSAL

The Town of Bedford, New Hampshire seeks proposals for: Aggregated Electricity Supply

The Town of Bedford is seeking fixed price quotes for its electricity supply.

Background:

PSNH currently supplies electricity to the Town of Bedford for all municipal meters. Bedford's municipal electricity uses include municipal buildings, recreational facilities, transfer station, wastewater pumping, street lighting and other uses. The Town of Bedford seeks a fixed cost supply contract for all municipal meters.

- Although the Town of Bedford prefers to purchase its electricity supply from a single vendor, vendors may submit an alternative proposal for a fixed supply contract for a limited group of municipal meters selected by the vendor, provided that the vendor also provides information concerning the total projected electricity supply costs for the Town of Bedford, including those meters that the vendor proposes to supply, together with those meters that would continue to be served by PSNH.

Additional Considerations:

- Ease of integration of monthly electricity consumption data provided by vendor with Peregrine Energy Group http://www.peregrinegroup.com/) reporting tools made available to the Town of Bedford through participation in the Energy Technical Assistance & Planning program (http://www.etapnhc.org/node/111) coordinated by the NH Office of Energy & Planning and Southern NH Planning Commission.

- Electronic billing capability with electricity consumption specified for each municipal meter.

- Electronic bill payment capability.

Scope of work:

Pricing shall be FIXED for the duration of the periods requested:

1. 12 months – March 1, 2011 to March 1, 2012

2. 22 months – March 1, 2011 to December 31, 2012

The Town of Bedford is not interested in index or variable rate pricing.

The proposal shall include information relative to:

- Billing and payment terms;
- Electronic billing and electronic bill payment options;
- Integration with Peregrine Energy Group reporting tools;
- Copy of sample or proposed contract;
- Information relative to NHPUC Aggregator Registration;
- History of other municipalities serviced by aggregator; and
- Information on percentage of renewable energy from supplier.

Upon request, The Town of Bedford will provide vendor with copies of PSNH bills or will allow vendor access via PSNH Profiler for use in furnishing a competitive bid.

Submission Information:

Propsals must comply with the following submission procedures:

1. Sealed proposals shall be submitted marked “Aggregated Electricity Supply” on the outside of the envelope, addressed to:

Proposals will be accepted until 4:00 p.m. on January 14, 2011. Proposals received after this time will be returned unopened. Faxed or emailed proposals will not be accepted.

After review of all proposals, the Town of Bedford will sign an agreement by no later than February 15, 2011, if the proposal is in the best interest of the Town.

2. AUTHORIZATION: The proposal must be signed in ink by an authorized signer, or by an agent of the vendor legally qualified and acceptable to the vendor, and contain the printed names, titles, and business and post office address of both parties, if applicable.

3. WITHDRAWAL OF PROPOSALS: A vendor will be permitted to withdraw its proposal unopened after it has been deposited if such request is received in writing prior to the time specified for opening of the proposals.

4. DISQUALIFICATIONS OF PROPOSERS: A vendor may be disqualified and the vendor's proposal rejected for either of the following reasons: 1) evidence of collusion among vendors or 2) failure to supply complete information as requested by this Request for Proposals.

RESERVATION OF RIGHTS: The Town of Bedford reserves the right to reject any or all proposals, to waive technical or legal deficiencies, and to accept any proposal that it deems to be in the best interest of Town.

6. SEPARABILITY – The Town of Bedford will accept only full packages for all requested elements. Proposals submitted without all scope of work items included shall be disqualified.