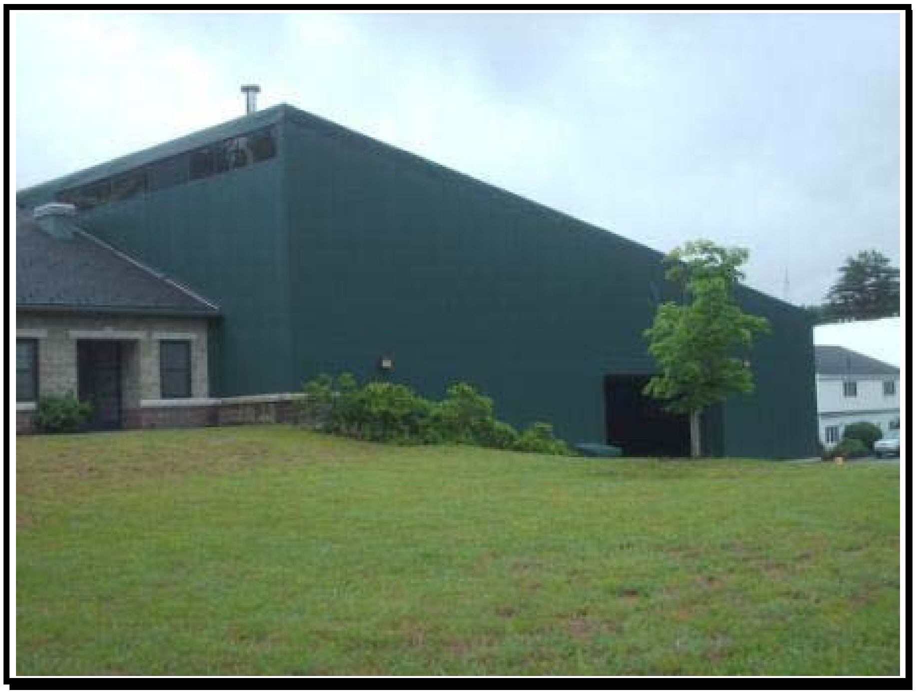
Energy Audit



Sudbury DPW and Highway Building
275 Old Lancaster Road
Sudbury, MA 01776

Prepared for:
Massachusetts Department of Energy Resources
Energy Audit Program

Prepared by:
Russell Friend PE
Facility Energy Consultants, LLC
800 Purchase Street, Suite 314
New Bedford, MA 02740

FEC Project No.: F09-016-05

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Executive Summary

The Massachusetts Department of Energy Resources contracted with Facility Energy Consultants, LLC, (FEC) to conduct an energy audit of the subject property, Sudbury Department of Public Works (DPW) and the Highway Building both located at 275 Old Lancaster Road, Sudbury, Massachusetts 01776. The audit consisted of a building evaluation aimed at 1) assessing the overall energy usage efficiency of the building and its on-site systems, 2) identifying potential energy areas of improvement in these systems based on a maximum of a 15 year payback period, and 3) where applicable, proposing “clean energy” alternatives to the current systems where future energy savings could be realized. Included as part of the audit was a review of the building’s construction features, its historical energy costs, discussions with the local utilities concerning the property’s energy usage, and discussions with the prime energy equipment suppliers/manufactures for the purpose of determining more efficient alternatives. The energy audit site visit was performed on June 20, 2009.

1.1 General Description of Building

The Sudbury DPW consists of a front office building of traditional masonry construction attached in the rear to a metal framed and sided high bay storage building. The building reportedly contains 28,000 interior square feet and was constructed around 2004.

Since the relatively recent construction, no significant energy improvements were reported or observed.

The Highway Building is a block and steel structure with both high bay vehicle maintenance spaces and living quarters for crews. The reported square footage of this building is 4,000. No significant energy improvements were reported or observed.

Mr. Art Richard served as the on-site representative for the energy audit.

1.2 ECM Table

FEC has identified 6 Energy Conservation Measures (ECMs) for this property. The following table summarizes these ECMs in terms of description, the initial investment required to implement these ECMs and their impact on energy and cost savings.

Proposed ECMs			Effect on connected electrical load (kW)	Annual Energy Usage								Annual Reduction in Greenhouse Gas (CO_2) Emissions (Tons)	Annual Savings
				Existing			Savings with ECM			% Reduction			
					MMBTU			MMBTU					
#	Description	Installed Cost		KWh	Primary Fuel	Backup Fuel	KWh	Primary Fuel	Backup Fuel	KWh	MMBTU		
1	Lighting DPW Office Building	$12,000	-0.486	27300			13260			48.6%		5.62	$2,652
2	Low Velocity Fans for Destratification	$22,000	0.96	0	900		-1056	270		-100.0%	30.0%	13.86	$2,515
3	Lighting DPW Highway Building	$3,000	-0.486	6825			3315			48.6%		1.41	$663
4	Replace Refrigerator	$650	-0.598	1,100			658			59.8%		0.28	$115
5	Clean Radiant Heat Reflectors	$1,000			992			45			4.5%	2.39	$788
6	Control Air Leakage	$800			992			38.416			3.9%	2.04	$672
	Total:	**$39,450**	**-0.61**	**203840**	**2742.1**	**0**	**16177**	**353.416**	**0**	**7.9%**	**12.9%**	**25.59**	**$7,405**

1.3 Financial Summary

If these ECMs are implemented, the Sudbury DPW can potentially save approximately $7,405 per year with an investment of $39,450.

1.4 Clean Tech

There currently does not appear to be clean technology opportunities available at the Sudbury DPW.

2 Introduction

Through the Energy Audit Program (EAP) offered by the Commonwealth of Massachusetts, Department of Energy Resources (DOER), technical assistance is provided to cities, towns, regional school districts and wastewater districts to identify capital improvements to reduce energy costs.

The purpose of this audit report is to provide the program participant with a list of energy conservation projects, their costs and estimated energy savings. This information may be used to support a future application to DOER's Energy Conservation Improvement Program, support performance contracting or justify a municipal bond funded improvement program. EAP is a state funded grant program that provides funds for energy conserving capital improvements.

The approach taken in this audit included a thorough walk-through of the buildings and associated systems and equipment, including both process systems and building systems. The major areas covered in the audit included the building envelope, electrical systems, HVAC systems, lighting systems and operational and maintenance procedures. Another element of the audit is an initial interview and ongoing consultation with operational and maintenance personnel as well as building occupants. This approach is critical to the quality of the audit process, since the input of building personnel is invaluable to the effort to obtain accurate information required for the audit

Facility Energy Consultants, LLC, (FEC) is pleased to submit this Energy Audit for the subject property. Our services have been performed in accordance with the scope of services and terms and conditions in FEC's contract with the Massachusetts Department of Energy Resources dated January 26. 2009.

The conclusions, recommendations, and financial implications presented in this report are based on a brief review of available drawings, interviews with key personnel who have a working knowledge of this property, our site observations, and our experience on similar projects. Observations were made by a trained professional or professionals but there may be energy conservation opportunities at the facility that were not readily accessible, not visible or which were inadvertently overlooked. Additional energy conservation measures may develop with time that were not evident at the time of this audit.

Recommendations presented in this report are conceptual in nature and are not intended to serve as a scope of work for implementation. Additional assessment and preparation of construction drawings may be required in order to develop a formal scope of work and to develop actual implementation budgets.

Opinions of probable capital costs are intended only to provide an order of magnitude or scale of the recommendations and were prepared, without developing a formal scope of work. The Opinions of Probable Costs were based on a combination of sources including published sources of cost data such as R.S. Means, discussions with the site contact(s) and others identified in this report and our experience with other projects. Actual costs will be dependant upon many factors that are beyond FEC's control including but not limited to the quality of the type and design of the remedy/replacement, quality of the materials and installation, manufacturer and type of equipment or system selected, field conditions, the extent of work performed at any one time, whether items are purchased individually or under a master purchase contract, and other factors. Additionally, bids for work can vary widely (e.g., 50-percent to 200-percent of the mean bid). If any of the opinions of probable capital costs presented herein are considered critical in making decisions about the Subject Property, FEC recommends that formal scopes of work be developed and quotations be obtained from contractors or suppliers, prior to making a final decision on the property.

3 Facility Description

The Sudbury DPW consists of a front office building of traditional masonry construction attached in the rear to a metal framed and sided high bay storage building. The building reportedly contains 28,000 interior square feet and was constructed around 2004.

The front office section of the DPW Building is constructed of masonry with a light steel framed pitched roof with asphalt shingles supported by light steel framing. It houses some town offices and meeting rooms and is typically occupied from 7 am to 4 pm weekdays with occasional evening meetings. The rear portion of the building is high bay space designed to store town equipment. It is a steel framed structure with insulated steel panel walls and roof.

Double-clad metal framed windows are used in the front office building.

This front office space is heated and cooled by six split systems each serving independent spaces controlled by a central thermostat. All six gas furnaces and air handlers are located in the attic space. The furnace units are all gas-fired and rated at 125,000 MBH. Each of the air handlers is coupled to a condensing unit mounted on a small piece of flat roofing between the front office and rear high bay sections of the building. Each of the condensing units is rated at between three and six tons of cooling.

Electric wall units serve entrance vestibules. Lighting is typically by T8 florescent bulbs with electronic ballasts.

The high bay space is metal framed with metal walls and roof. The roof slopes just one direction. Insulated, roll up type overhead doors are located at either end of the building allowing vehicles to drive through. This space is primarily heated with direct gas-fired forced air units mounted to the ceiling. Each of these is rated at 648 MBH. Two smaller units are located near the doors for positive pressure of the space when the doors are open. Each of the units is rated at 300 MBH. According to the facility personnel, attempts are being made to use just the smaller units to heat the building to a working temperature around 60 degrees. Six ceiling fans have been installed to de-stratify the space during periods of high heating demand. Lighting is provided by twenty-four 400 watt metal halide lamps.

A vehicle wash stall is located at the north end of the building. A 395,000 BTUH water heater as well as a water recycling system are both part of the equipment associated with this stall.

The Highway Building contains both high bay vehicle maintenance spaces and living quarters for crews. Multiple construction types are part of this building. The living quarters has a block first floor with a traditionally stick-framed second floor. The attached high bay spaces are typically steel framed with insulated steel walls and roofs. The reported square footage of this building is 4,000.

The high bay maintenance space includes typical vehicle service equipment including air compressors for tools, vehicle lifts, and high bay roll-up doors. These spaces are primarily heated with multiple natural gas-fired radiant tube heaters each rated for 100,000 BTUH.
Domestic hot water is located by the kitchen and bathroom sinks, the dishwasher, and the showers. It is provided by a 30 gallon natural gas-fired water heater.

The employee service rooms in this facility include a dining area, a small kitchen, locker rooms with showers and a small bunk house on the second floor. Appliances include a dishwasher, an electric range, clothes dryer, water cooler, and refrigerator.

A ducted furnace provides heat to the space. A/C is provided by a small window unit. Lighting is primarily by T12 florescent lighting. A programmable thermostat is located within the space.

4 Energy Usage Analysis and Benchmarking

4.1 Usage Analysis

The following table summarizes the basic energy rates and FY08 energy cost expenditure data that formed the basis for many of the calculations in this report.

Utility	Provider	Rates	FY08 Expenditures
Electric	NSTAR	$ 0.175/kWh	$35,659.00
Gas	NGRID	$1.74/therm	$47,661.00
#2 Oil		NA	NA
Water & Sewer		NA	NA
Propane Gas		NA	NA
TOTALS			**$ 83,320.00**

The following table lists the building's area and its total energy and cost indices. The total energy index is a measure of energy intensity, or annual energy usage per square foot of building area. Similarly, the energy cost index is a measure of annual energy costs per square foot of building area.

Heated Area (SF)	Total Annual Cost Of Energy ($)	Energy Cost Index $/SF-Year	Total Energy Index (KBTU/SF-YR)
32,000	$ 83,320.00	$2.54	107

4.2 Benchmarking in Energy Star

Benchmarking has been employed in order to make determinations of the relative energy efficiency of this facility. FEC, in cooperation with the Massachusetts Department of Energy Resources, is using the Portfolio Manager tool developed by the Federal EPA. The Portfolio Manager tool allows the input of historic utility data of a facility to be compared to normalized data of a large database of buildings of its peers.

The energy use metric (energy intensity) of KBTU/SF/yr was used as a general guide to determine the efficiency of this facility. The Sudbury DPW's energy intensity is 107 KBTU/SF/YR with an energy cost of $2.54 per square foot. Both of these figures are high. Based on this, it was determined that this facility should be audited for potential energy savings measures.

The results generated by Portfolio Manager related to this facility are displayed below in section 4.3.

4.3 Statement of Energy Performance

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 06/30/2008)	**Baseline** (Ending Date 06/30/2008)	**Rating of 75**	**Target**	**National Average**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft2)	107	107	0	N/A	77
Source (kBtu/ft2)	162	162	0	N/A	150
Energy Cost					
$/year	$ 81,329.00	$ 81,329.00	N/A	N/A	$ 58,357.40
$/ft2/year	$ 2.54	$ 2.54	N/A	N/A	$ 1.82
Greenhouse Gas Emissions					
$MtCO_2e$/year	232	232	0	N/A	166
$kgCO_2e/ft^2$/year	7	7	0	N/A	5

5 Energy Conservation Measures

5.1 ECM Summary

FEC has identified 6 Energy Conservation Measures (ECMs) for this property. The following table summarizes these ECMs in terms of description, the initial investment required to implement these ECMs and their impact on energy and cost savings.

Proposed ECMs			Effect on connected electrical load (kW)	Annual Energy Usage								Annual Reduction in Greenhouse Gas (CO_2) Emissions (Tons)	Annual Savings
#	Description	Installed Cost		Existing			Savings with ECM			% Reduction			
				KWh	MMBTU		KWh	MMBTU					
					Primary Fuel	Backup Fuel		Primary Fuel	Backup Fuel	KWh	MMBTU		
1	Lighting DPW Office Building	$12,000	-0.486	27300			13260			48.6%		5.62	$2,652
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If these ECMs are implemented, the Sudbury DPW can potentially save approximately $7,405 per year with an investment of $39,450.

5.2 ECM Discussion

FEC has identified 6 Recommended Energy Conservation Measures (ECMs) for this property. The following paragraphs describe each of these ECMs along with the initial annual energy savings and payback period for each ECM.

5.2.1 Lighting Upgrades - DPW Office

DPW Office Building High Bay Lighting

The metal equipment storage high bay space attached to the DPW Office Building is currently lit with twenty-four (24) 400-watt metal halide units. We estimate that the lights are on at least 2,500-hours per year.

Recommendation: It is recommended to replace the metal halide units with energy efficient T5 high-bay florescent fixtures.

Cost to implement	$ 12,000.00	Est. annual cost savings	$2,652.00	Payback period	4.5 years

5.2.2 Install Large Diameter Fans in High-Bay Area

DPW High Bay Space

The high-bay building is used to store and maintain vehicles and equipment. Primary heating of the space is by two ceiling-suspended natural gas heaters. Typically, these spaces tend to stratify heat and that the high, unoccupied space stays much warmer than the working height of the space.

FEC's visit to the space was during summer months and the observers were unable to determine the level of wintertime heat stratification. Prior to implementing this ECM, the assumption that the roof is 20 degrees warmer than the floor should be confirmed with the doors closed.

Six, 56-inch diameter ceiling fans were installed in this space during initial construction to provide the function of destratifying the heat in the building. Based on FEC's experience, these fans can improve the air flow throughout the space but are not capable of adequately keeping uniform air temperatures at all levels.

There are some various options for improving the destratification of the heat to the level of the workers.

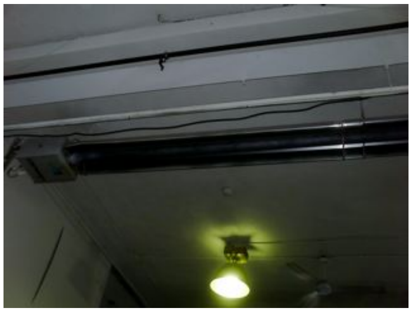
One option is to use radiant heaters. Gas-fired radiant heaters are often used in large spaces for local comfort by directing the heat on the occupants while the overall temperature of the space remains low (such as those used in the DPW Highway Building). Due to the very high ceilings in this space, these may be difficult to install at a useful height without compromising the overhead space.

Large diameter, slow moving, energy efficient ceiling-mounted fans could help eliminate the stratification and increase indoor air comfort. Mixing of the air would save energy consumption as the hot upper air would mix with the colder air reducing the amount of heating required to maintain comfortable temperatures in the floor level occupied zone.

Recommendation: It is recommended that two large-volume, low velocity fans be installed in the main high bay storage room. For this space, the fans were sized to be 20 feet in diameter. Fans should be capable of maintaining comfort levels while reducing energy use by pulling the heat down that normally would rise near the ceiling of the space.

Cost to implement	$22,000.00	Est. annual cost savings	$2,515.0	Payback period	8.7 years

5.2.3 Lighting Upgrades - DPW Highway



Highway Building Radiant Heater and Lighting

One maintenance bay is currently lit with six (24) 400-watt metal halide units. We estimate that the lights are on at least 2,500-hours per year.

Recommendation: It is recommended to replace the metal halide units with energy efficient T5 high-bay florescent fixtures.

Cost to implement	$ 3,000.00	Est. annual cost savings	$663.00	Payback period	4.5 years

5.2.4 Replace Refrigerator

We observed a top freezer refrigerator in the break room. A model number for this Amana 22 refrigerator could not be found. It is assumed that the date of manufacture was sometime around the late eighties and its consumption was compared to other refrigerators of similar size from that era.

Recommendation: It is recommended that the older refrigerator be replaced with Energy Star rated refrigerator.

Cost to implement	$650	Est. annual cost savings	$115	Payback period	5.7 years

5.2.5 Clean Radiant Heat Reflectors

Dirty Radiant Heater Reflector

Radiant overhead gas heaters are used in the maintenance bay spaces of the DPW Highway Building's maintenance areas. These heaters are ideal for heating these types of spaces efficiently. Heat is transferred by radiation to any surface that is directly exposed to it. This allows a comfortable apparent temperature for workers without heating the entire space to a comfortable temperature. Employees are able to be comfortable even though the wall thermostat not exposed to the heaters may only read 50 or 55 degrees F.

Most of the radiant heat emitted from the units is emitted directly from the radiant tube itself. Some of the radiant heat is emitted from the heaters by the reflector above the radiant tube. These reflectors were observed to be very dirty. The ability of these reflectors to perform their function is significantly reduced.

Recommendation: It is recommended that these reflectors be thoroughly cleaned. The units may need to be taken down for ease of cleaning.

Cost to implement	$1,000.00	Est. annual cost savings	$787.00	Payback period	1.3 years

5.2.6 Control Air Leakage

FEC noticed multiple locations in the maintenance area of the Highway Building where wall penetrations were not sealed allowing for infiltration.

Recommendation: It is recommended that the maintenance areas of the Highway Building be thoroughly inspected around wall penetrations for drafts and sealed with caulk and/or insulation.

Cost to implement	$800.00	Est. annual cost savings	$672.00	Payback period	1.2 years

5.3 Other ECMs Considered

5.3.1 DPW Office Building

Each of the following were considered as potential ECMs but were not included either due to long payback periods or difficulty in establishing actual energy demanded.

According to on-site personnel, the office space had been experiencing the smell of vehicle fumes in the office space. Apparently the high bay space was operating at a higher pressure than the office space and causing air transfer from the high bay space to the offices. Steps have been taken to fix the problem by turning off the large high-bay heaters and sealing the wall between the spaces. The situation has improved.

Electric space heaters rated at 3 kW each were observed in vestibules at either end of the main hall. Electric heat is expensive. It is recommended that these be turned off as the vestibules appear to get little use.

A Smart Wash pressure washer system is tied to a 395,000 BTUH hot water heater for use in the building's vehicle wash station. Water heating for car washing is expensive and its use should be minimized. An analysis of monthly natural gas consumption suggests that very little is used in the summertime. From this, we are making the assumption that the water heater for the vehicle wash bay gets little use. It is apparent, however that the wash bay itself is used regularly. The pressure washer uses a 15 HP motor. The use of this equipment should be scheduled as to avoid coinciding with high building demand times to avoid unnecessary demand charges.

5.3.2 DPW Highway Building

Translucent panels were observed in the roof of the maintenance area of the Highway Building. These translucent panels have the advantage of introducing light into the space and can allow for adequate lighting levels even when the lights are turned off. This advantage is offset by the heat loss through the uninsulated spaces created by the translucent panels. The panels that serve the High way Building are very dirty so that very little daylight is able to enter through them. It is recommended that the translucent panel be cleaned or replaced so that daylight can be used in the space or the space under the panel be insulated so that heat is not lost through the uninsulated space.

Lighting in the break area and living quarters is T12 type florescent lighting with magnetic ballasts. Typically, an ECM would be to replace these lights with the higher efficiencyT8 bulbs with electronic ballasts. Most of these lights were off during our visit so it was assumed that these lights are not on for very many hours annually. Based on this, the simple payback of replacing these lights with T8s was not justified. If it is determined that lighting is some of the spaces is on for extended periods of the day, replacement may be prudent.

The window A/C unit observed is rated at 8000 BTU with an EER ratio of 9.5. Higher efficiency units are available but replacement was not a justified ECM.

6 Operational and Maintenance Analysis

The quality of the maintenance and operation of the facility's energy systems has a direct effect on its overall energy efficiency. Energy efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property. These actions, which have been divided into specific and general recommendations, will insure that the energy conservation measures identified in this report will remain effective. The following general recommendations should be continued or implemented.

Building Envelope

1. Caulking and weather stripping is functional and effective.
2. Holes are patched in the building envelope.
3. Cracked or fogged windowpanes are repaired.
4. Automatic door closing mechanisms are functional.
5. Overhead doors are left closed except when vehicles are being moved in and out.

Heating and Cooling

6. Temperature settings are reduced in unoccupied areas and set points are seasonally adjusted.
7. Control valves and dampers are fully functional.
8. Equipment is inspected for worn or damaged parts.
9. Hot air registers and return air ductwork are clean and unobstructed.
10. Air dampers are operating correctly.
11. Heating is uniform throughout the designated areas.
12. Evaporator and condenser coils in AC equipment are clean.
13. Air filters are clean and replaced as needed.

Domestic Hot Water

14. Domestic hot water heater temperature is set to the minimum temperature required.
15. All hot water piping is insulated and not leaking.
16. Tank-type water heaters are flushed as required.

Lighting

17. Only energy efficient replacement lamps are used and in-stock.
18. Lighting fixture reflective surfaces and translucent covers are clean.
19. Walls are clean and bright.
20. Timers and/or photocells are operating correctly on exterior lighting.

Miscellaneous

21. Refrigerator and freezer doors close and seal correctly.
22. Office/computer equipment is either in the “sleep” or off mode when not used.
23. All other recommended equipment specific preventive maintenance actions are conducted,
24. Compressed air system is continuously checked for leaks
25. All equipment replacements are not over/undersized for the particular application, and
26. All equipment replacements should be with energy conserving and/or high efficiency devices.

7 Clean Technology Opportunities

The Commonwealth of Massachusetts is dedicated to promoting clean energy as an alternative to traditional sources of energy. As such, the DOER and other agencies have developed a number of programs to promote the use of clean energy sources by potentially providing technical assistance and/or financial incentives based on project feasibility. A brief discussion of the various programs is provided below, along with specific projects that may be appropriate for the respective technologies.

Solar Energy

Through the Commonwealth Solar Program[1], rebates are offered to encourage the installation of solar photovoltaic (PV) power by homeowners, businesses and municipalities. The rebate program is designed to help defray the costs that are associated with the installation of eligible systems from 20% - 60%. Rebate applications have been available since January 23, 2008. Incentives are greater for projects on public buildings and those that incorporate products manufactured in Massachusetts. The rebates are available for systems that will be directly owned by the applicant, as well as those financed through a third-party ownership model that takes advantage of federal and state tax credits. A total of $68 million is available over the next four years. The following table provides the initial rebate levels:

Non-Residential Rebates for Incremental Capacity ($/Watt)				
Incremental Capacity	**First:** **1 to 25 kW**	**Next:** **> 25 to 100 kW**	**Next:** **> 100 kW to 200 kW**	**Next:** **> 200 kW to 500 kW**
Base Incentive	$3.15	$3.00	$2.00	$1.40
PLUS: Additions to Base Incentives				
Massachusetts Manufactured System	$0.15	$0.15	$0.15	$0.15
Public Building	$1.00	$1.00	$1.00	$1.00

Third-Party PV Financing Resources

MTC and DOER encourage applicants to explore various options for financing their PV project. One such option is known as Third-Party Financing. With Third-Party Financing, the PV system is owned and operated by an entity that is separate from the building owner or the PV installer. The Third-Party Financing entity has sufficient financial capital to pay for the entire installation and to maintain and operate the system over its lifetime. In return, the building owner, or “host” site, signs a long term contract agreeing to purchase all the power produced by the PV system.

Third-Party Financing is a way to install a large PV array with little or no up-front capital expense from the building owner or “host” site. This type of financing may be most applicable to entities such as non-profits or public buildings. The Third-Party PV Owner can utilize the substantial tax incentives available for PV projects, along with rebates and other incentives, plus the sale of the electricity from the PV array to finance the PV project.

Solar Hot Water

The State supports the use of solar hot water systems and the payback periods are generally attractive for buildings with high water usage. Systems are generally composed of solar thermal collectors, a fluid system to move the heat from the collector to its point of usage, and a reservoir or tank for heat storage and subsequent use. The systems may be used to heat water for home or business use, for swimming pools, underfloor heating or as an energy input for space heating and cooling and industrial applications. Attractive applications for town buildings and facilities may include municipal pools, schools especially with summer locker room or kitchen usage, fire stations, and public housing facilities. On a periodic basis, the DOER accepts grant applications for solar hot water systems.

[1] Web site: www.commonwealthsolar.org

Solar at Sudbury DPW
Solar PV at Sudbury DPW is not recommended. Even given available incentive programs, a solar photovoltaic system will not achieve a justified simple payback.

The current domestic hot water demand is relatively low. Summertime hot water demand for the vehicle wash station is low. For these reasons, a solar hot water feasibility study is not recommended for this facility.

Wind

The Massachusetts Renewable Energy Trust's (MRET) Commonwealth Wind initiative will provide an overarching framework to expand investments for wind energy installations in Massachusetts and help the Commonwealth meet Governor Deval Patrick's 2000 MW by 2020 wind goals as well as the Renewable Portfolio Standard (RPS). MRET will formally launch Commonwealth Wind during the summer of 2009 and additional details on the program will be available then. The three types of projects listed below would qualify for technical and/or financial assistance:

- Commercial scale projects that primarily serve wholesale markets
- Community-scale projects in the 100 kW to approximately2 MW range where the project sponsor and primary beneficiary is a private company or organization, a municipality, or a government agency, and
- Small-scale projects under 100 kW serving residential, small commercial, or institutional buildings.

Wind at Sudbury DPW
Based on the wind map of Massachusetts provided by the U.S. Department of Energy, Sudbury is located in a Class 1 or 2 wind region. A Class 1 wind is defined as wind power rated at 0-200 watts/square meter at a height of 50 feet. Class 2 wind is defined as wind power rated at 200 to 300 watts/square meter. These are the lowest wind power designations and regions with a Class 1 and 2 designations are typically not recommended for wind energy projects. A Massachusetts wind resource map can be found at the following web site: http://www.windpoweringamerica.gov/maps_template.asp?stateab=ma

Wood Pellet Fueled Heating

On a periodic basis, the DOER accepts grant applications for wood pellet fueled heating systems[2], which burn pellets made from renewable sources of energy such as compacted sawdust, wood chips, bark and agricultural crop waste. Funding is available to cities, towns, regional school districts, as well as water and wastewater districts. A maximum of $50,000 per project is available for installation; however, applicants may propose greater grant requests, which will be considered based on the merits of the project and available funding. A total of $525,000 is available for this program. The grantee is responsible for repaying 30% of the funds granted within one year of the completed installation.

Wood Pellet Heating for Sudbury DPW

Biofuels are typically attractive alternatives as a heating fuel in locations where wood pellets are available in bulk, the heating demand is sufficient to justify the investment, and when heating fuels with a greater cost than natural gas are the only alternatives. Sudbury does not meet this profile and biofuel heating is not recommended as a cost effective alternative.

7.1 Recommended Clean Energy Projects for Sudbury DPW

Based on this audit, and due to its location, Sudbury DPW does not currently exhibit a building profile that would lend itself to implementation of these clean technologies.

[2] http://www.mass.gov/Eoca/docs/doer/pub_info/doer_pellet_guidebook.pdf

8 Other Considerations

In addition to the actions recommended in Section 6 of this report, the following recommendations should also be considered.

Air compressors are used to run controls and power tools in both the office building and the highway building. Compressed air leaks are a major source of energy inefficiency. While no significant leaks were observed, there are many potential sources for air leaks. Observed leaks should be repaired as soon as possible.

9 Appendices

ECM Calculations

Lighting DPW Office Building

400w Metal Halide to T5 4 Lamp 54w 4' Electronic Ballast

Location: Cafeteria and Library

	Fixture	Cost / Fixture Installed	Number of Fixtures	Watts / Fixture	Hours / Year of Illumination	KWH / Year	Cost / KWH	Total Energy Cost / Year	Annual KWH Saved	**Total Cost to Implement**	**Annual Cost Saving**	**Years to Payback**
Existing												
	400w Metal Halide		24	455	2500	27300	$0.20	$5,460				
Recommended												
	T5 4 Lamp 54w 4' Electronic Ballast	$500	24	234	2500	14040	$0.200	$2,808	13260	**$12,000**	**$2,652**	**4.5**

Low Velocity Fans for Destratification

	Space 1			
Square footage of high-bay area	18000		sqft	
Ceiling Height	30		feet	
Recommended fan size	20		feet	
Annual heating hours	1100		hrs	
Electric consumption	960		W	
Annual electric consumption	1056		kWh	
Temperature at the ceiling height	80		deg F	
Average outside temperature	30		deg F	
Thermostat set point	55		deg F	
Average temperature before destratification	65		deg F	
Destratification effectiveness over exisiting	60%			
Current difference in average temp of building versus outside	35			
Difference in average building temp vrs outside with destratificatior	10			
Percent energy reduction with destratification	0.171428571			
Current annual heating consumption	9000			
Annual consumption with destratifiaction	7457.142857			
Annual energy cost savings	$ 2,700.00			
Installation cost	$ 22,000.00			
Electric rate $ 0.18 /kWh				
Heating fuel rate $ 1.75 /therm				
Total Installation cost	$ 22,000.00			
Annual cost of ECM	$ (184.80)			
Annual savings of ECM	$ 2,700.00			
Total annual cost savings	$ 2,515.20			
Individual space simple payback	8.7			
	Electric kWh	**Heating fuel**	**(therms)**	
Annual energy savings	**-1056**	**2700**		
Annual energy cost savings	**$**	**2,515.20**		
Simple Payback	**$**	**8.7**	**years**	

Lighting DPW Highway Building

400w Metal Halide to T5 4 Lamp 54w 4' Electronic Ballast

Location: Cafeteria and Library

	Fixture	Cost / Fixture Installed	Number of Fixtures	Watts / Fixture	Hours / Year of Illumination	KWH / Year	Cost / KWH	Total Energy Cost / Year	Annual KWH Saved	**Total Cost to Implement**	**Annual Cost Saving**	**Years to Payback**
Existing												
	400w Metal Halide		6	455	2500	6825	$0.20	$1,365				
Recommended												
	T5 4 Lamp 54w 4' Electronic Ballast	$500	6	234	2500	3510	$0.200	$702	3315	**$3,000**	**$663**	**4.5**

Replace Refrigerator

Step 1	Obtain total cost of replacing older refrigerators with high-efficiency units:					
	cost per unit:	$650			$650	$
Step 2	Transfer the following information from the Survey:					
4-13	**a** Total number of units				1	
5-9	**c** Cost of electricity:				0.175	$/kWh
Step 3	Obtain the following value from Table 1:					
Table 1	Approximate annual energy use of each old refrigerator:				1,100	kWh/yr
Step 4	Calculate annual energy savings per refrigerator:					
		3				
		1,100	-	442	= 658	kWh/yr
Step 5	Estimate annual energy savings:					
		2a		4		
		1	x	658.00	= 658	kWh/yr
Step 6	Calculate annual cost savings:					
		5		2c		
		658	x	0.18	= $115	$/yr
Step 7	Calculate payback period:					
		1		6		
		650	/	115	= 5.6	yrs

Size	Unit Cost	Make	Model	Energy Savings
15.0 CF	716	Whirlpool	ET5WSEXS	442
18.0 CF	776	Whirlpool	ET8FTEXS	486

Table 1: Energy Use of Existing Refrigerators

Entered
Calculated

Age	**Energy Use**	
1970s	1400	kWh/yr
Early 1980s	1100	kWh/yr
Late 1980s	800	kWh/yr

Clean Radiant Heat Reflectors

Step 1	Obtain cost to clean alterations, etc.							
							1,000	$
Step 2	Transfer the following information from the Survey:							
5-14	**a**	Annual heating fuel consumption:				Gas:	9,000	therm/yr
						Oil:		gal/yr
						Prop		gal/yr
4-49	**b**	Combustion efficiency of existing plant:					0.70	
5-9	**c**	Cost of heating fuel:				Gas:	1.75	$/therm
						Oil:	#REF!	$/gal
						Prop		$/gal
Step 3	Estimate efficiency improvement (as a decimal fraction):							
					2b			
			.75	-	0.70	=	0.05	
Step 4	Estimate annual energy savings:							
			3		2a			
		Gas:	0.05	x	9,000	=	450	
		Oil:	0.05	x	0.00	=	0	
		Propane:	0.05	x	0.00	=	0	$/yr
Step 5	Calculate annual cost savings:							
			4		2c			
		Gas:	450	x	1.75	=	788	
		Oil:	0.00	x	#REF!	=	#REF!	
		Propane:	0.00	x	0.00	=	0	$/yr
Step 6	Calculate payback period:							
			1		5			
		Gas:	1,000	/	787.50	=	1.3	yrs
		Oil:	1,000	/	#REF!	=	#REF!	yrs
		Propane:	1,000	/	0.00	=	0	yrs

Control Air Leakage

Step 1	Obtain total cost of air sealing:									
			cost		$800				$800	$
Step 2	Transfer the following information from the Survey:									
4-8	**a**	Heating degree-day zone:							3.43	DDZ
4-17	**b**	Total volume of buildings in development:							56,000	cu. ft.
5-9	**c**	Cost of heating fuel:			Gas:				1.75	$/therm
					Oil:				N/A	$/gal
					Electric:				0.156	$/kWh
					Propane:				NA	$/gal
Step 3	Obtain the following savings factors from Table 1:									
Table 1	Infiltration savings factor:								0.002	
Step 4	Estimate annual energy savings:									
		2a		2b		3				
		3.43	x	56,000	x	0.002	=		384	/yr
Step 5	Calculate annual energy cost savings:									
				4		2c				
				384	x	1.75	=		$672	$/yr
Step 6	Calculate payback period:									
				1		5				
				$800	/	$672	=		1.2	yrs

Table 1: Infiltration Savings Factors

Fuel	**Savings Factor**
Gas	0.0026
Oil	0.0019
Electric	0.053
Propane	0.0028

Entered
Calculated