Energy Audit

Fairbank Center
40 Fairbank Road
Sudbury, MA 01776

Prepared for:
Massachusetts Department of Energy Resources
Energy Audit Program

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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, Fairbank Center, located at 40 Fairbank 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 18, 2009.

1.1 General Description of Building

The Fairbank Center in Sudbury, MA contains 28,076 interior square feet comprised of a senior center, school administrative offices, and recreation center. An 11,000 sf natatorium was added in 1987. This facility was originally constructed as a school in 1950. The single story building is now comprised of the original gymnasium, offices, multipurpose rooms, commercial kitchen, and the natatorium.

The facility received additions and interior space remodeling in 1987 and 1989.

Jim Kelly, Art Richard, and Tim Goulding, the aquatics director, served as the on-site representative for the energy audit.

1.2 ECM Table

FEC has identified 11 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: #	Proposed ECMs: Description	Proposed ECMs: Installed Cost	Effect on connected electrical load (kW)	Annual Energy Usage – Existing: KWh	Annual Energy Usage – Existing: MMBTU Primary Fuel	Annual Energy Usage – Existing: MMBTU Backup Fuel	Annual Energy Usage – Savings with ECM: KWh	Annual Energy Usage – Savings with ECM: MMBTU Primary Fuel	Annual Energy Usage – Savings with ECM: MMBTU Backup Fuel	Annual Energy Usage – % Reduction: KWh	Annual Energy Usage – % Reduction: MMBTU	Annual Reduction in Greenhouse Gas (CO_2) Emissions (Tons)	Annual Savings	Simple Payback (years)
1	Vending Machine Timer	$875	0.23	6,570			1,971			30.0%		0.84	$369	2.4
2	Replace Refrigerator	$1,950	0.41	4620			3,555			76.9%		1.51	$665	2.9
3	Replace Water Heater	$1,000	0.25	2,157			2,157			100.0%		0.91	$278	3.6
4	HVAC Pump VFDs	$5,600	0.91	16,785			4,096			24.4%		1.74	$766	7.3
5	DCV in Gym	$1,500	0.00		93			15			15.9%	0.78	$222	6.8
6	VFDs on Gym AHU	$5,600	1.20	8,206			5,391			65.7%		2.29	$1,008	5.6
7	Relocate A/C Unit	$800	1.70	3,500			1,700			48.6%		0.72	$318	2.5
8	Pool Lightning	$8,400	3.12	36720			15,912			43.3%		6.75	$2,976	2.8
9	Premium Efficiency Pump Motors	$2,000	0.57	47,314			4,997			10.6%		2.12	$935	2.1
10	Pool Pump VFDs	$8,000	0.85	64,902			7,405			11.4%		3.14	$1,385	5.8
11	Replace Rooftop Economizer	$140,000	1.49	130,646	6,402		13,065	2087		10.0%	32.6%	116.17	$33,754	4.1
	Total	$175,725	10.71	321420	6,402		60,249	2102.2		18.7%	32.8%	136.96	$42,674	4.1

1.3 Financial Summary

If these ECM’s are implemented, Fairbank Center can potentially save approximately $42,674 per year with an investment of $175,725.

1.4 Clean Tech

Based on this audit, and due to its location, Fairbank Center appears to be a good candidate for a potential solar hot water system. The Massachusetts Department of Energy Resources has approved a solar hot water feasibility study for this location.

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

Fairbank Center

The Fairbank Center in Sudbury, MA contains 28,076 interior square feet comprised of a senior center, school administrative offices, and recreation center and natatorium. This facility was originally constructed as a school in 1950. The single story building now contains the original gymnasium, offices, multipurpose rooms, a commercial kitchen, and a natatorium.

Sudbury School Department Administrative Offices:

Many of the classrooms of the Fairbanks School are now home to the Sudbury School Department's administrative offices. Their offices are open from 8:00 am to 5:00 pm Monday through Friday and during July and August their hours are 8:30 am to 3:00 pm Monday through Friday.

The original building is constructed of concrete block walls with gypsum wallboard interiors. The roof is a low-slope black single-ply EPDM membrane system supported by steel framing. Ceiling tiles are suspended throughout the building. The windows are older double-pane units. The floors are finished with tile or carpet.

The offices are air-conditioned with 14 window units that vary in size from 8,000 to 28,500 BTUs and with Energy Efficiency Ratios (EER) ranging from 7.1-10.8.

Heating is by hot water radiators connected to the central hot water loop.

Lighting has been upgraded to T8 florescent bulbs and electronic ballasts.

Sudbury Senior Center

The Senior Center accounts for 4,439 of the interior square feet. The building is a 1989 addition to the Fairbanks Center. The single story building is comprised of a lobby area, bathrooms for men and women, two large multipurpose rooms, one with an attached kitchenette, and staff offices. It also has shared use with the recreation center of a commercial kitchen.

The building is regularly occupied from 8:30 am to 4:00 pm Monday through Friday with some evening and weekend use.

This is a red concrete block building with interior metal stud framing. The roof is a 4/12 pitch truss construction with three tab asphalt shingles, and the gable end is finished with clapboard siding. There is attic access above the offices. There are three inches of composite rigid insulation on the roof for an estimated R-value of 19 and three and one half inches of fiberglass insulation in the sidewalls for an estimated R-value of 12. The windows are double-pane insulated units with tilt out elements in each unit. The main entrance incorporates a double pane insulated glass vestibule area.

The interior areas of the building are primarily finished with drywall and vinyl tile or carpet. Suspended acoustic ceiling tiles are utilized in the offices and restrooms. The other areas have cathedral ceilings. Two of the rooms have a 144 square foot fiberglass skylight incorporated into the roof system. Interior blinds are fitted to the window units.

Energy efficient T8 florescent bulbs with electronic ballasts supply the center's primary lighting. Exterior lighting is provided by metal halide pole lamps and building mounted flood lights.

Heating is provided to radiators located throughout the space which are supplied by the facility's central hot water boiler system

Air-conditioning is provided to the senior center with two rooftop units. Each is paired to a Trane air handler with economizers located in the attic.

Sudbury Community Recreation Center

The community recreation center underwent significant remodeling in 1987 to the southern end of the building. Some existing classrooms were converted to locker rooms and restrooms; also, a natatorium was added. The natatorium added 11,000 sqft. to the facility

Recreation center spaces include the original commercial kitchen which is shared with the senior center as well as classroom spaces that have been converted into community rooms. These spaces are all of the original school construction with flat roofs.

The commercial kitchen serves multiple functions. It is used by the Senior Center and the Recreation Center for special functions as well as serves as the community food bank. The kitchen is supplied with multiple appliances including a walk-in refrigerator, a residential gas range, and other remaining kitchen appliances. Heating appliances have minimum use. An 80 gallon electric water heater serves the kitchen.

The exception to the flat roof is the 4/12 pitch roof/cathedral ceiling over the gymnasium which is also part of the recreation center. This is covered with three tab asphalt shingles and appears to have minimal insulation. The small gymnasium with a stage at one end measures 74' by 40'. Heating and fresh air are supplied through a dedicated roof top air handler. The specifics of this unit were not able to be determined while on-site, but it is assumed to be a supplied heat from the hot water system and appears to require a five HP fan motor. It is assumed that it is thermostatically controlled through a flow regulator on the hot water loop.

Heating to the rest of the Recreation Center spaces is provided by hot water radiant heaters supplied by the building's central hot water system.

Fairbanks Center's Common Heating and Domestic Hot Water:

Hot water for heating is provided by two natural gas-fired, Patterson Kelly-Thermific near condensing boilers. Each is rated for an output capacity of 2,000 MBH. The hot water is distributed by two 5-horse power pump motors that distribute hot water to radiators in the recreation center, senior center and school administrative wing.

Two natural gas-fired 90-gallon water heaters made by Maxim supply the domestic hot water for all the pool related showers and restroom facilities. These are each rated at 399,000-BTUH input capacity. According to the building personnel, the hot water heaters typically meet the shower demand with an occasional comment from patrons during times of high demand about cool shower water.

Fairbanks Center's Pool:

A natatorium was added to the facility in 1987. The pool was a design-build project by Stanmar.

The facility is operated somewhat independently of the town and is open to members seven days a week for a total of approximately 97 hours per week.

The natatorium itself is constructed of concrete block walls with double-paned, metal framed fixed windows. The roof is supported by large curved wooden laminated beams which support a roof decking and a ballasted membrane roof.

The internal temperature of the facility is maintained at 78 to 80 degrees F, set back at night to 75 to 76 degrees F.

Pool climate control is provided by a gas-fired rooftop mounted make-up air unit with an economizer. The heating unit consists of two Reznor units each rated at 600,000 BTUH. The unit is designed to capture the energy from exhausted warm, moist air being exhausted and transfer it to the fresh air being drawn into the building. This unit is designed to condense water vapor out of the exhausted air and return the energy to the incoming fresh air, thus heat recovery is designed to be from both the sensible and latent heat of the exhausted air. The design flow through the unit is 14,000 scfm and is provided for by a 20 HP intake fan motor and a 15 HP exhaust fan motor.

Lighting is provided to the natatorium by 24 400-watt metal halide lamps suspended from the ceiling.

The natatorium includes two pools. One pool is a dive pool with a surface area that measures 25 by 40 feet and a volume of approximately 82,000 gallons. This pool is heated to between 84 and 85 degrees F by its own gas-fired pool heater rated at 511,000 BTUH.

The main lap pool is 76' by 56' and holds 165,000 gallons. This pool is heated to between 82 and 82.5 degrees F by its own gas-fired pool heater rated at 800,000 BTUH.

Pool water is required to be circulated through a sand filter at the rate between 425 and 450 gallons per minute by code enforced by the Board of Health. The sand filter is rated at 424 gallons per minute. Circulation is accomplished with duel 10 hp lead and stand-by circulation pumps. This circulation loop also directs part of its flow through the pool heater before being re-injected into the loop prior to returning to the pool. All of the pumps and heating equipment are located in a pool maintenance room adjacent to the natatorium. Pool chemicals are also applied to the pool water in this room.

The locker rooms include gang showers with hot water supplied by the facility's central system.

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	$ 0.187/kWh	$39,859
Gas	NGRID	$1.70/therms	$108,520
#2 Oil			
Water & Sewer		Not Available	Not Available
Propane Gas		NA	NA
TOTALS			**$ 148,374**

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)
39,076	$ 148,374	$3.90	183

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 Fairbank facilities are difficult to benchmark as the building serves a wide variety of functions and it has a swimming pool. Swimming pools are energy intensive and are not accommodated for in the Energy Star benchmarking tool.

Energy Star has compiled a database of some facility types sufficient to allow energy use comparisons.

The energy use metric (energy intensity) of KBTU/SF/yr was used as a general guide to determine the efficiency of this facility. The Fairbank facility's total energy intensity is 183 KBTU/SF/YR with an energy cost of $3.90 per square foot. Both of these figures are very high and inflated as a result of the indoor pool. Based on this and the potential for energy savings with indoor pools, 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. These results are displayed for illustrative purposes, but due to the way that the bills are split between the two facilities and the pool demand, little can be learned from this benchmarking exercise beyond confirmation of significant energy consumption at the facility.

4.3 Statement of Energy Performance for Fairbanks Center

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)	27	27	0	N/A	65
Source (kBtu/ft2)	89	89	0	N/A	136
Energy Cost					
$/year	$ 39,859.00	$ 39,859.00	N/A	N/A	$ 97,253.57
$/ft2/year	$ 1.47	$ 1.47	N/A	N/A	$ 3.59
Greenhouse Gas Emissions					
$MtCO_2e$/year	90	90	0	N/A	220
$kgCO_2e$/ft2/year	3	3	0	N/A	7

4.4 Statement of Energy Performance for Fairbanks Center Pool

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)	582	582	0	N/A	65
Source (kBtu/ft2)	610	610	0	N/A	136
Energy Cost					
$/year	$ 108,519.00	$ 108,519.00	N/A	N/A	$ 12,116.49
$/ft2/year	$ 9.87	$ 9.87	N/A	N/A	$ 1.10
Greenhouse Gas Emissions					
$MtCO_2e$/year	341	341	0	N/A	38
$kgCO_2e$/ft2/year	31	31	0	N/A	3

5 Energy Conservation Measures

5.1 ECM Summary

FEC has identified 11 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	Simple Payback (years)
#	Description	Installed Cost		Existing			Savings with ECM			% Reduction				
				KWh	MMBTU		KWh	MMBTU						
					Primary Fuel	Backup Fuel		Primary Fuel	Backup Fuel	KWh	MMBTU			
1	Vending Machine Timer	$875	0.23	6,570			1,971			30.0%		0.84	$369	2.4
2	Replace Refrigerator	$1,950	0.41	4620			3,555			76.9%		1.51	$665	2.9
3	Replace Water Heater	$1,000	0.25	2,157			2,157			100.0%		0.91	$278	3.6
4	HVAC Pump VFDs	$5,600	0.91	16,785			4,096			24.4%		1.74	$766	7.3
5	DCV in Gym	$1,500	0.00		93			15			15.9%	0.78	$222	6.8
6	VFDs on Gym AHU	$5,600	1.20	8,206			5,391			65.7%		2.29	$1,008	5.6
7	Relocate A/C Unit	$800	1.70	3,500			1,700			48.6%		0.72	$318	2.5
8	Pool Lightning	$8,400	3.12	36720			15,912			43.3%		6.75	$2,976	2.8
9	Premium Efficiency Pump Motors	$2,000	0.57	47,314			4,997			10.6%		2.12	$935	2.1
10	Pool Pump VFDs	$8,000	0.85	64,902			7,405			11.4%		3.14	$1,385	5.8
11	Replace Rooftop Economizer	$140,000	1.49	130,646	6,402		13,065	2087		10.0%	32.6%	116.17	$33,754	4.1
	Total	$175,725	10.71	321420	6,402		60,249	2102.2	0	18.7%	32.8%	136.96	$42,674	4.1

If these ECMs are implemented, the Fairbank Center can potentially save approximately $42,674 per year with an investment of $175,725.

5.2 ECM Discussion

FEC has identified 11 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 Install Timer on the Vending Machine

One of the five Vending Machines

Vending machines that refrigerate non-perishable items can be turned off when the building is not occupied by using timers. The timer would turn off the unit and its compressor during unoccupied times and would turn on in the early morning with ample cooling time to chill the contents in time for dispensing during the work day.

Recommendation: It is recommended that a vending machine timer be installed on the vending machine.

Cost to implement	$875.00	Est. annual cost savings	$369.00	Payback period	2.4 years

5.2.2 Replace Refrigerators

Refrigerator

Three older refrigerators were identified that have high energy consumption.

An 18.7 cu.ft Whirlpool model # EB19MKXL consumes 1839 kWh/yr.

A 20.3 cu.ft GE model # FF20DSAR consumes 1083 kWh/yr.

A 14.2 cu.ft GE model # TBF14DA consumes 1700 kWh/yr.

Recommendation: It is recommended that the old refrigerators be replaced with an Energy Star rated refrigerator.

Cost to implement	$1,950.00	Est. annual cost savings	$665.00	Payback period	2.9 years

5.2.3 Replace Electric Water Heater

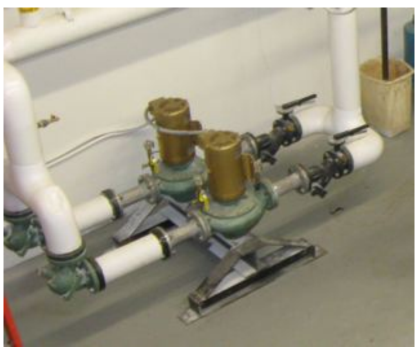
There is an 80 gallon electric water heater located in the commercial kitchen. Electric heating is expensive. Natural gas-fired units are less expensive to operate than electric water heaters.

Recommendation: It is recommended to replace the existing water heater with a natural gas equivalent. A natural gas line is available nearby serving the range. The gas-fired unit will require a vent. If the unit cannot be vented naturally through the roof, a powered vent unit may be required.

Existing electric water heater

Cost to implement	$1000.00	Est. annual cost savings	$ 278.00	Payback period	3.6 years

5.2.4 Install VFDs on Heating Circulating Pump Motors



Heating hot water circulation throughout the facility is by two 5-horsepower motors. The pumping efficiency can be improved by installing variable frequency drives on the motors and pumps.

Recommendation: Installation of variable frequency drives for the heating water circulating pump motors.

Hot Water Circulating Pumps

Cost to implement	$5,600.00	Est. annual cost savings	$766.00.00	Payback period	7.3 years

5.2.5 Install Demand Controlled Ventilation on the Gym Air Handling Unit.

Gym Air Handler

Air handlers with heating coil sections are used in the gym to provide heat and the required outside fresh air. Currently, these air handlers are designed to provide outside air sufficient to meet fresh air demand at maximum space design occupancy. Most often, the maximum design occupancy is not occurring in this space.

Recommendation:
It is recommended to retrofit the Gym AHU with a CO_2 sensor and related controls to adjust the occupied mode ventilation in response to actual occupancy. The sensor shall monitor CO_2 gas concentration to reflect room occupancy. The OA dampers and Relief Air fan shall sequence in response to changes in occupancy. Work will require integrating CO_2 controls with the existing pneumatic controls at the gym AHUs. This ECM will reduce heating energy required to condition unnecessary ventilation.

Cost to implement	$1,500.00	Est. annual cost savings	$222.00	Payback period	6.8 years

5.2.6 Install VFD Fan Speed Control on Gym Air Handling Unit

Gym Air Handler

Air handlers with heating coil sections are used in the gym to provide heat and the required outside fresh air. The fan motors run at full speed to provide a constant volume of air to the space

Recommendation:
It is recommended to install a Variable Frequency Drive (VFD) to control fan speed in response to demand by ventilation and/or temperature controls. In periods of low demand for air flow, the supply fans shall slow to match demand. Work will require electrical, mechanical and automatic controls contractors to implement. This ECM will reduce electric energy for fan operation.

Cost to implement	$5,600.00	Est. annual cost savings	$1,008.00	Payback period	5.6 years

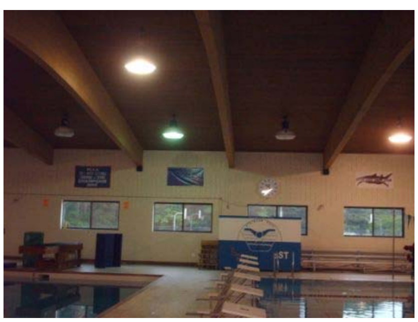
5.2.7 Relocate A/C Unit

A/C Unit

This A/C unit vents to the vestibule leading outside. The vestibule is small and does not allow the heat to escape. Furthermore, some of the heat is reintroduced into the cooled space whenever this door is opened. This A/C unit would be more efficient if it were installed though an exterior wall. If an exterior wall is not available, an alternative suitable location would be the wall between the cooled space and the pool.

Cost to implement	$800.00	Est. annual cost savings	$318.00	Payback period	2.5 years

5.2.8 Upgrade Pool Lighting



Pool Lighting

The pool is lit with 24 240 watt metal halide fixtures. Savings could be realized if these units could be converted to T5 type lighting. Sudbury building officials are aware of this potential energy saving measure but expressed concern over installing metal fixtures in the pool environment as they could corrode.

Recommendation: Convert the fixtures to T5 fixtures designed for wet environment use. The fixture cost is higher than standard fixtures but replacement is still justified on energy savings. FEC does not recommend specific models or brands of energy saving products, but we are aware of a product called the Monsoon Series of light fixtures. This is a T5 fixture designed for wet conditions. The unit is manufactures by The Light Edge, Inc. Their local rep is located in Peabody, MA and they can be contacted via the web at: www.lymlightsales.com

Cost to implement	$8,400.00	Est. annual cost savings	$2,976.00	Payback period	2.8 years

5.2.9 Upgrade to Premium Efficient Pool Pump Motors

Pool Pumps

The duel 10 HP pool pump motors are rated at a NEMA efficiency of 84%. These are not high efficiency motors.

Recommendation: Since one of the 10 HP motors runs continuously, it is recommended that both of the pumps be replaced with high efficiency pump motors. 10 HP motors are available with NEMA efficiencies of 91.7%.

Cost to implement	$2,000.00	Est. annual cost savings	$935.00	Payback period	2.1 years

5.2.10 Install VFDs on Pool Pump Motors

Pool Pumps

The pool pump motors run continuously. Their application is to pump the pool water through the heater and the sand filter. A minimum flow rate is required to maintain the pool. Most VFDs run at reduced speeds as demand decreases. Based on the pool flow demand of 424 gallons per minute, it is not possible for the pumps to shed very much speed. However, the pool facilities manager states that when the filter is clean, the pumps can cycle through 500 gallons a minute. Pump speed will only be able to be reduced by a few percent, however, since the pump runs continuously and can be expected to run at the marginally reduced speed during most of its operation it has been determined that there could be significant electric savings by running it in this mode.

Recommendation: It is recommended that the pool pumps be fitted with Variable Frequency Drives (VFDs). The drive controls should be based on the pressure drop across the sand filter that corresponds with the minimum flow required.

Cost to implement	$8,000.00	Est. annual cost savings	$1,385.00	Payback period	5.8 years

5.2.11 Replace Pool Rooftop Packaged Economizer Unit

Internal space of pool rooftop unit

The pool rooftop heating unit is designed to remove latent and sensible heat from the warm moist air being exhausted and transfer it to the conditioned outside air taking its place. The unit appears to use pressure provided from the intake and exhaust fans to force the intake and return air through an air to air heat exchanger. Water condensed out of the exhausted air is captured in the unit. According to the equipments design specifications, the unit was capable of 73% heat exchange efficiency at design conditions.

Upon inspection of the unit and with discussions with the building operators, it is clear that the original damper controls are not functioning and allowing the supply and return air streams to enter and exit the unit without passing through the heat exchanger. The unit itself is in fair condition.

One option would be to have the units control sequence and damper actuators fixed so the unit can operate as intended.

Another option would be to replace the unit with a new rooftop pool economizer.

Recommendation: Due to its age, it is recommended that the unit be replaced. The energy savings from both electricity from fan motor control as well as thermal efficiency from the economizer would be significant with a new unit.

Cost to implement	$140,000.00	Est. annual cost savings	$33,754.00	Payback period	4.1 years

5.3 Other ECMs Considered

The asphalt shingles on the sloped roof portion of the facility which cover the gymnasium and Senior Center are nearing the end of their life. The Insulation in these areas is likely less than two inches thick which correlates to a low R-Value. Energy efficiency alone falls far short of justifying a roof replacement, but insulation should be added at the time roof replacement is required due to the end of its useful life.

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. Interior vestibule doors are closed.

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. Usage demands on the building/equipment have not changed significantly since the original building commissioning or the most recent retro-commissioning.
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

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

Hot water heating demanded by the pool and showers associated with the pool use is substantial. Furthermore, the roof of the pool has a clear view of the southern sky and is ballasted. As the roof is nearing replacement, it will be possible to replace the roof with a membrane that does not require ballast. The structural load capacity relieved from the removal of the ballast could potentially be used to support a solar array. Based on this audit, and due to its location, Fairbank Center appears to be a good candidate for a potential solar hot water system. The Massachusetts Department of Energy Resources has approved a solar hot water feasibility study for this location.

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 Fairbank Centers
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 designation 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 Fairbank Center

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.

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

7.1 Recommended Clean Energy Projects for Fairbank Center

Based on this audit, and due to its location, Fairbank Center appears to be a good candidate for a potential solar hot water system. The Massachusetts Department of Energy Resources has approved a solar hot water feasibility study for this location.

8 Other Considerations

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

No other recommendations have been identified.

9 Appendices

Vending Machine Timer

Step 1	Obtain total cost of installing timers on all vending machines												
		Number of machines	5								$175	$	
Step 2	Transfer the following information from the Survey:												
	a	Annual hours machines are required to be on:									8,760		
	b	Number of machines:									5		
	c	Watts per machine:									150	Watts	
	d	Cost of electricity:									0.1870	$/kWh	
		Run time with timers									70%		
Step 3	Calculate existing energy consumption :												
		2a		2b		2c							
		8,760	x	5	x	150	/	1,000	=		6,570	kWh/yr	
Step 4	Calculate energy consumption with timers:												
				2b		2c		3					
		6,132	x	5	x	150	/	1,000	=		4,599	kWh/yr	
Step 5	Calculate annual energy savings:												
						3		4					
						6,570	-	4,599	=		1,971	kWh/yr	
Step 6	Calculate annual cost savings:												
						5		2d					
						1971	x	0.1870	=		$369	$/yr	
Step 7	Calculate payback period:												
						1		6					
	entered					875	/	369	=		2.4	yrs	
	calculated												

Replace Refrigerator

Efficiency Units

Step 1	Obtain total cost of replacing older refrigerators with high-efficiency units:							
		cost per unit:	$650				$1,950	$
Step 2	Transfer the following information from the Survey:							
4-13	**a**	Total number of units					3	
5-9	**c**	Cost of electricity:					0.187	$/kWh
Step 3	Obtain the following value from Table 1:							
Table 1	Approximate annual energy use of each old refrigerator:						1,540	kWh/yr
Step 4	Calculate annual energy savings per refrigerator:							
			3					
			1,540	-	355	=	1,185	kWh/yr
Step 5	Estimate annual energy savings:							
			2a		4			
			3	x	1185.00	=	3,555	kWh/yr
Step 6	Calculate annual cost savings:							
			5		2c			
			3,555	x	0.19	=	$665	$/yr
Step 7	Calculate payback period:							
			1		6			
			1,950	/	665	=	2.9	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

Replace Water Heater

Current Usage	Stand-by				Consumption	**Total:**
Stand-by heat loss	1	deg/hr				
Volume	80.00					
Electric ($/therm)	5.48				35.20	
Boiler Efficiency	100%				100%	
ccf of fuel used/yr	38.40				35.20	
Current Cost	$ 210.45				$ 192.90	$ 403.36
Consumption						
Number of occupants	30			**Capital Cost**		
Set point	105			Installed cost per unit		$ 1,000.00
Incoming water temp.	50			Number units required		1
Total BTU required/day	9644.25			Total installed cost		$ 1,000.00
Usage/day/occcupant	0.7					
Days used per year	350		Current fuel cost			$ 403.36
			Proposed fuel cost			$ 125.13
			Annual Cost Savings			$ 278.23
Gas($/therm)	$1.70					
Boiler efficiency	0.80		**Annual Energy Savings**			
Annual gas cost	$ 125.13		**Capital Cost**			$ 1,000.00
			Simple Payback			3.6

HVAC Pump VFDs

Pump Motors

Step 1 Obtain total cost of installing VFDs on pump motors

Number of motors	2	$5,600	$

Step 2 Transfer the following information from the Survey:

a	Annual hours pumps operate:	4,500	
b	Percent of rated Speed:	80%	
c	Total running HP:	5	HP
d	Cost of electricity:	0.187	$/kWh
	Run time with at reduced speed	50%	

Step 3 Calculate existing energy consumption :

2a				2c					
4,500	x	1.00	x	5.0	x	0.746	=	16,785	kWh/yr

Step 4 Calculate energy savings with VFDs:

		2b		2c		3			
2,250	x	0.49	x	5.0	x	0.746	=	4,096	kWh/yr

Step 6 Calculate annual cost savings:

4096	x	0.187	=	$766	$/yr

Step 7 Calculate payback period:

1		6			
5,600	/	766	=	7.3	yrs

entered
calculated

Install Demand Controlled Ventilation in the Gym			
Cost to install CO2 sensors in each ventilation unit =		$	1,500.00
Total number of ventilation units =			1
Total cost to install DCV in the Gymnsium =		**$**	**1,500.00**
Cost of energy modeled without DCV (from hourly analysis) =		$	1,394.00
Cost of energy modeled with DCV (from hourly analysis) =		$	1,172.00
Annual Cost of energy saved		**$**	**222.00**
Cost of energy	($/therm)	$	1.50
Energy Saved	therms		148.00
Simple Payback (yrs)			**6.8**

VFDs on Gym AHU

Step 1	Obtain total cost of installing VFDs on fan motors										
		Number of motors	1							$5,600	$
Step 2	Transfer the following information from the Survey:										
	a	Annual hours fans operate:								2,200	
	b	Percent of rated Speed:								70%	
	c	Total running HP:								5	HP (ave)
	d	Cost of electricity:								0.187	$/kWh
		Run time with at reduced speed								50%	
Step 3	Calculate existing energy consumption :										
		2a				2c					
		2,200	x	1.00	x	5.0	x	0.746	=	8,206	kWh/yr
Step 4	Calculate energy savings with VFDs:										
				2b		2c		3			
		2,200	x	0.66	x	5.0	x	0.746	=	5,391	kWh/yr
Step 6	Calculate annual cost savings:										
						5391	x	0.187	=	$1,008	$/yr
Step 7	Calculate payback period:										
						1		6			
	entered calculated					5,600	/	1008	=	5.6	yrs

Relocate A/C Unit

Step 1	Obtain total cost of replocating existing unit:										
						cost/unit:	$800		$800		
Step 2	Transfer the following information from the Survey:										
4-55	**a**	Power requirement of existing units:							450	W.h	
4-56	**b**	Cooling capacity of existing units:							18,000	Btu	
4-54	**c**	Number of existing units:							1		
5-9	**d**	Cost of electricity:							0.1870	$/kWh	
Step 3	Obtain the following value from Table 1:										
Table 1	Annual cooling hours (do not multiply by 1000):								1		
Step 4	Calculate existing energy efficiency rating (EER):										
					2b		2a				
					18,000	/	3,500	=	5.1		
Step 5	Calculate existing energy use per air conditioner:										
			3		2b		4				
			1.00	x	18,000	/	5	=	3,500	kWh/yr	
Step 6	Calculate new energy use per air conditioner:										
			3		2b						
			1.00	x	18,000	/	10	=	1,800	kWh/yr	
Step 7	Estimate annual energy savings:										
			5		6		2c				
			3,500	-	1,800	x	1	=	1,700	kWh/yr	
Step 8	Calculate annual cost savings:										
					7		2d				
					1,700	x	0.187	=	318	$/yr	
Step 9	Calculate payback period:										
					1		8				
					$800	/	$318	=	2.5	yrs	

Pool Lightning 240w Metal Halide to T5 3 Lamp 54w 4' Electronic Balas

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 Pool											
240w Metal Halide		24	300	5100	36720	$0.187	$6,867				
Recommended Pool											
w 4' Electronic Balast	$350	24	170	5100	20808	$0.187	$3,891	15912	**$8,400**	**$2,976**	**2.8**

Premium Efficiency Pump Motors

Step 1	Obtain total cost of installing high efficiency pump motors											
		Number of motor	2								$2,000	$
Step 2	Transfer the following information from the Survey:											
4-84	**a**	Annual hours pumps operate:									8,700	
4-80	**b**	Average percent of rated speed with VFDs:									90.0%	
4-81	**c**	Total running HP:									10	HP
5-9	**d**	Cost of electricity:									0.187	$/kWh
		Run time with at reduced speed									80%	
Step 3	Calculate energy consumption with VFDs :											
		2a				2c						
		8,700	x	0.73	x	10.0	x	0.746		=	47,314	kWh/yr
Step 4	Calculate energy savings with High Efficiency Motors:											
				2b		2c		3				
		8,700	x	0.08	x	10.0	x	0.746		=	4,997	kWh/yr
Step 6	Calculate annual cost savings:											
						4,997	x	0.187		=	$935	$/yr
Step 7	Calculate payback period:											
						1		6				
	entered					2,000	/	935		=	2.1	yrs
	calculated											

Pool Pump VFDs

Pump Motors

Step 1 Obtain total cost of installing VFDs on pump motors

Number of motors 2 cost plus controls $8,000 $

Step 2 Transfer the following information from the Survey:

a	Annual hours pumps operate:	8,700	
b	Percent of rated Speed:	95%	
c	Total running HP:	10	HP
d	Cost of electricity:	0.187	$/kWh
	Run time with at reduced speed	80%	

Step 3 Calculate existing energy consumption :

2a				2c					
8,700	x	1.00	x	10.0	x	0.746	=	64,902	kWh/yr

Step 4 Calculate energy savings with VFDs:

		1-2b^3		2c		3			
6,960	x	0.14	x	10.0	x	0.746	=	7,405	kWh/yr

Step 6 Calculate annual cost savings:

7405 x 0.187 = $1,385 $/yr

Step 7 Calculate payback period:

1		6			
8,000	/	1385	=	5.8	yrs

entered

calculated

Replace Rooftop Economizer

Assumptions:							
Total Annual Consumption (2008 natural gas)=	64,020		therms				
Summertime consumption = Hot water demand	1500		therms				
HVAC load for facility except pool @ 40 kbtu/sf =	11230		therms				
Rooftop unit electric demand w/20 and 15 HP blower motors= 35 HP =	130,646		kWh/yr				
			mo/yr				
Annual Hot Water Demand (therms)=	1,500	*	12	=	18000		
Total non-pool HVAC consumption (therms)=	11230	+	18000	=	29230		
Total Pool HVAC consumption (therms)=	64,020	-	29230	=	34,790		
From the existing design specs call for 73% recovery at design No controls are not working and all dampers are in full open position. Energy recovery is estimated at less than 10%							
New energy recovery units: Derate of typical recovery due to incomplete latent heat recovery at non-design conditions = 60%	60%	*	34,790	=	20874	therms/yr	
					$1.50	therm	
				=	$31,311		
Electrical savings with fan motor controls ~10%	13064.6		kWh				
Electrical energy savings	$ 2,443						
Capital Cost:	**$ 140,000**						
Annual Savings:	**$ 33,754**						
Simple Payback:	**4.1**						