Energy Audit

for the

New Hingham Elementary School

Chesterfield-Goshen Regional School District
Massachusetts

Massachusetts Department of Energy Resources

July 2009

Prepared by

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1. EXECUTIVE SUMMARY

An energy audit was performed on the New Hingham Elementary School located at 30 Smith Road in Chesterfield as part of the Energy Audit Program sponsored by the Massachusetts Department of Energy Resources (DOER). The audit consisted of a building evaluation aimed at 1) assessing the overall energy efficiency of the building and its on-site systems, 2) identifying potential areas of improvement in the building and systems based on a maximum of a 15 year payback period, and 3) where appropriate, proposing alternatives to the conventional systems.

Several Energy Conservation Measures (ECMs) have been identified for this property. The table on the following page summarizes these ECMs in terms of description, the initial investment required to implement these ECMs, their impact on energy and cost savings, and the simple payback in terms of years.

For the New Hingham Elementary School, the options have a combined savings of 4% on fuel and 15% on electricity. The total cost of upgrades is just under $16,000, with an average payback of 4.2 years.

A renewable energy assessment was also conducted for this site; an onsite solar photovoltaics system and a wind turbine are both recommended for further consideration.

Energy Conservation Measures Summary Table

New Hingham Elementary School			Annual Energy Savings				Annual Cost Savings			Simple Payback ECM Cost/ Savings (years)
			Electrical		Fuels	Energy	Electrical	Fuels	Total	
ECM#	Description	ECM Cost	kWh	kW	Oil Gal.	Total MMBTU	$	$	$	
BEs	Building Envelope	$3,172	0	0.0	348	48.3	$ -	$ 871	$ 871	3.6
OSs	Occupancy Sensors	$9,017	9,882	0.0	0	33.7	$ 1,383	$ -	$ 1,383	6.5
LUs	Lighting Upgrades	$439	4,303	3.0	0	14.7	$ 947	$ -	$ 947	0.5
MCs	Motor Controls	$268	733	0.0	27	6.3	$ 103	$ 69	$ 171	1.6
VSs	Variable Speed Drive	$2,977	2,666	0.0	0	9.1	$ 373	$ -	$ 373	8.0
	TOTAL	$15,873	17,583	3.0	376	112.2	$ 2,806	$ 940	$ 3,746	4.2

Total Building Energy Usage	116,790	0	10,368	1,836.7	$16,351	$ 25,920	$ 42,271
Savings Reduction (%)	15%	N/A	4%	6%	17%	4%	9%

2. INTRODUCTION

Through the Energy Audit Program (EAP) offered by the Commonwealth of Massachusetts, Department of Energy Resources (DOER), technical assistance is provided for all buildings owned and operated by cities, towns, regional school districts and wastewater districts to identify capital improvements to reduce energy costs. The technical assistance provided by DOER includes an initial benchmarking of buildings and structures included in the application. Based on the results of the benchmarking, a detailed energy audit may be performed as well as a variety of feasibility studies to evaluate the potential to incorporate renewable energy sources. This comprehensive assistance provides communities with the knowledge needed to reduce energy consumption and associated financial resources.

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 (ECIP), support performance contracting or justify a municipal bond funded improvement program. ECIP 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 building(s) and associated systems and equipment, including both process systems and building systems. The major areas covered in the audit included the building envelope, process systems, electrical systems, HVAC systems, lighting systems and operational and maintenance procedures. A major element of the audit also included 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.

CET's energy auditor Bill Lafley and Precision Decisions' licensed professional engineer Chris Vreeland performed the onsite audit, developed the recommendations and wrote the audit report. Personnel from the municipality provided site-specific information in advance of the audits as well as observations during the site walkthrough.

The recommendations within this report are based on one year of submitted usage data, a site review and preliminary evaluation. The energy savings and energy production figures are projected estimates based on conceptual project upgrades, information gathered at the site, and from the historical utility information provided. The actual savings may vary from these estimates due to a variety of factors. The figures used for the cost of recommended upgrades are 'opinions of probable cost' and are intended to be used for feasibility purposes only. The recommended measures should proceed to detailed design and further re-evaluation followed by competitive bidding per the Massachusetts Procurement Guidelines. The resulting responses to the bid should be used for budget approval purposes. For more information see: *Office of the Inspector General, Municipal, County, District, and Local Authority Procurement of Supplies, Services, and Real Property, Publication No. CR-1520-170-200-09/06-IGO.*

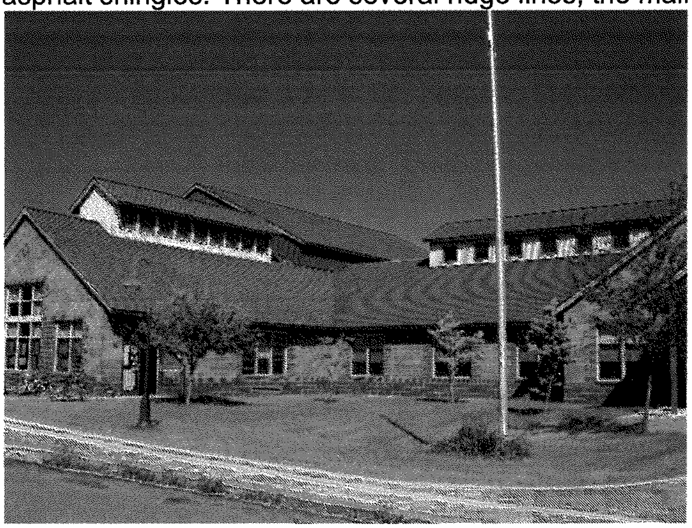
3. FACILITY DESCRIPTION

The New Hingham Elementary School in Chesterfield is a 32,865 square foot, 1-story building located at 30 Smith Road. The building was constructed in 1998 and serves the towns of Chesterfield and Goshen. Occupancy is year-round with approximately 225 (students and staff) present during the school year; a few dozen students and staff are present for the summer program.

The building has twelve classrooms, a library, gymnasium, cafeteria, kitchen, six offices, mechanical room, 13 restrooms and various other small classrooms and storage areas.

Building Envelope

The building is constructed of masonry block and brick and is on a slab on grade. The roof is pitched and constructed of wood trusses. The roof covering is asphalt shingles. There are several ridge lines; the main ridgeline runs northeast to southwest; several wings have ridgelines running southeast to northwest. There are several attributes that shade portions of the roof. All the roofs appear to be in good condition.



The walls have 2 inches of foam insulation. The flat attic floor is insulated with 8 to 9 inches of blown-in cellulose insulation. A wood cathedral ceiling in the cafeteria is insulated with 3 inches of foam insulation on the side facing the open attic and is assumed to be insulated with fiberglass batts on the enclosed slope area.

The windows in the building are double pane and in good condition.

Lighting

The lighting in the building is shown in the table below:

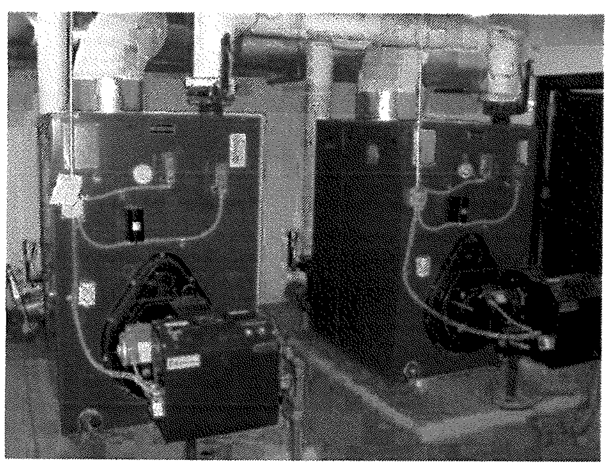
Area	Type	Length (feet)	Wattage	Control
Classrooms	T8 - 4 lamp	4	112	Manual
Gym	CFL - 5 lamp		55 watt each	3 light levels
Halls	T8 - 2 & 4 lamp	4	50 & 112	Manual
Offices	T8 - 3 lamp	4	85	Manual
Cafeteria	T8 - 4 lamp	4	112	Manual
Kindergarten/Preschool	T8 - 4 lamp	4	112	Manual
Restrooms	2 lamp - U tube	2 x 2	49	Manual

Heating and Cooling System

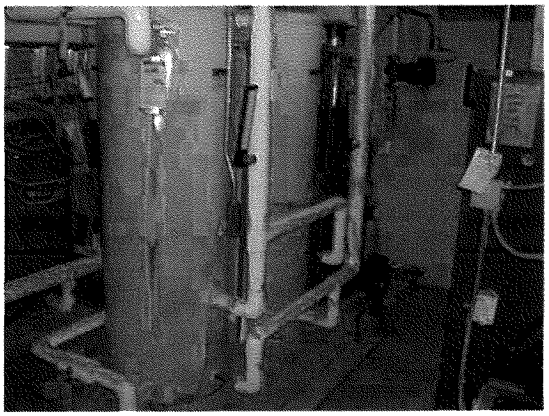
The building is heated and by a two pipe hydronic system with two oil-fired Burnham boilers each rated at 1.281 MMBTUH. Heat is distributed via radiators and unit ventilators.

The original supervisor control system was recently replaced; at the time of the audit, the programming was still being optimized.

Water is circulated with two 5 HP circulators.



Hot Water System



Potable water is received from an onsite well. The building fixtures are low flow/water efficient. Potable hot water is generated by one oil-fired 32 gallon water heater during the non-heating season and from an indirect zone off the boilers during the heating season. There is a 1/3 HP circulator on the hot water distribution; there is no timer for the circulator.

Computers, Appliances & Other Plug Loads

The site also has the following major plug loads:

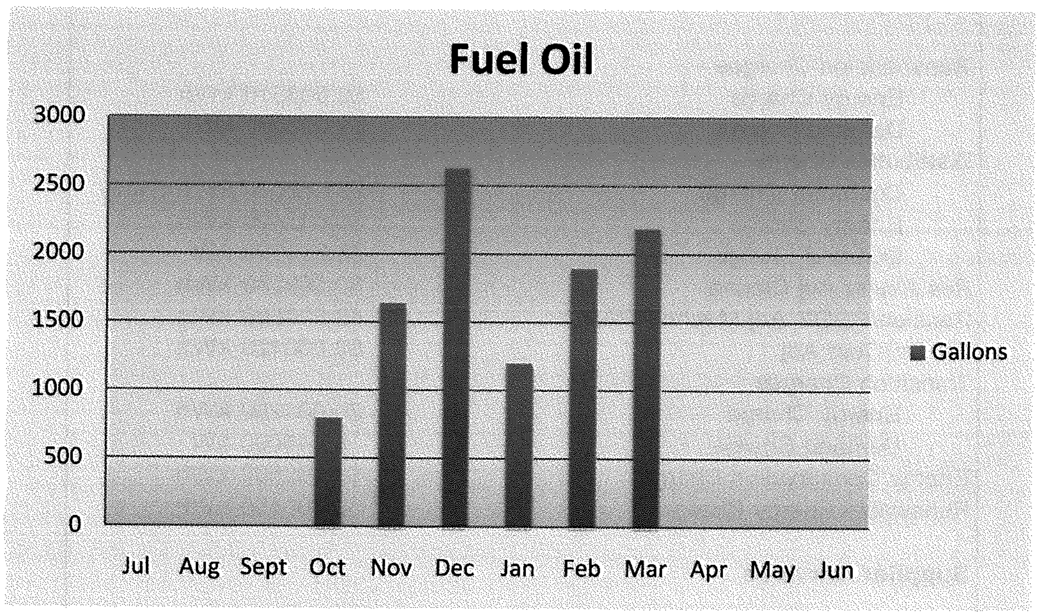
- 45 computer stations
- photo copiers
- 1 fax machine
- 1 refrigerator
- 1 microwave
- 1 toaster oven
- 1 water cooler
- 2 coffee makers

Energy Profiles

The site uses oil and electricity.

Fuel Oil

The New Hingham Elementary School used 10,368 gallons of #2 fuel in FY07.



A rate of $ 2.50 per gallon was used for savings estimates in this report.

Electrical

Electricity is provided by Western Massachusetts Electric Company (WMECO). Electricity is billed under the G0 rate. For the second quarter of 2009 these rates were as follows:

Delivery Services		
Transmission Charges		
Energy Charge	$0.009310	kWh
Demand Charge	$1.050000	kW
Distribution Charge		
Customer Charge	$31.82000	flat monthly
Energy Charge	$0.002400	kWh
Demand Charge	$8.030000	kW
Res Assist Adj Clause	$0.002030	kWh
Pension/PBOP Adj Mechn PPAM	$0.000850	kWh
Dflt Srv Cost Adj	$0.000120	kWh
Transition Charges		
Energy Charge	$0.004290	kWh
Demand Charge	$0.45000	kW
Energy Conservation Charge	$0.002500	kWh
Renewable Energy Charge	$0.000500	kWh
Supplier Services		
Generation Charge	0.12081	kWh

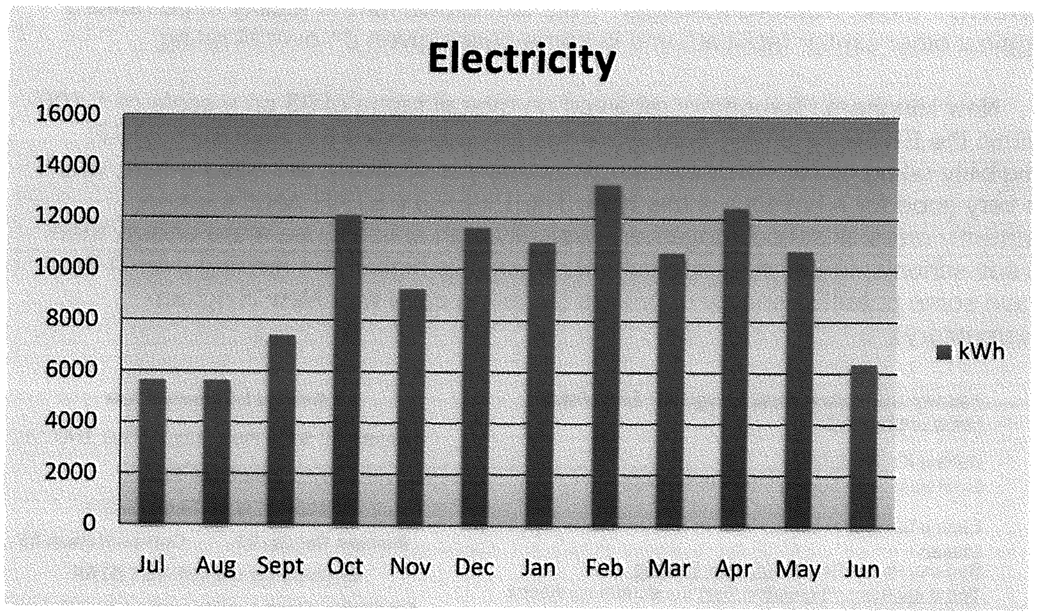
Total rate for Energy Usage (kWh)	$0.142810
Total rate for Energy Demand (kW)	$9.53000

This results in the following:

Average Monthly Usage	9,733 kWh	$1,389.97
Average Monthly Demand	42 kW	$400.26

A rate of $0.14 per kWh and $9.53 per kW is used for savings estimates in this report. The monthly demand varied from 23 kW to 49 kW. This variability is normal for this site.

The FY07 electric usage at New Hingham Elementary School was 116,790 kWh.



The electrical usage is variable throughout the year, with significant variations corresponding with school vacation periods.

The facility data for the New Hingham Elementary School was input into the ENERGY STAR Portfolio Manager. This tool allows for the facility to be ranked against other similar facilities, and in some cases given an overall rating.

New Hingham Elementary received an overall rating of 95 on a scale of 1-100 within the ENERGY STAR Portfolio Manager, well above the ENERGY STAR eligibility rating of 75. The site energy intensity is 48.2kBtu per square foot, which is very good for a building of this type. The ENERGY STAR benchmarking currently rates all schools together. Typically high schools use more energy than grade schools; therefore grade schools often rate high in the ranking even if they have some potential energy upgrades (as is the case with New Hingham Elementary).

Facility Summary: **New Hingham Elementary**
How do I use this page?

Building ID: 1803747
Level of Access: Building Data Administrator

Electric Distribution Utility: Western Massachusetts Elec Co (change)
Regional Power Grid: NPCC New England
Select my Power Generation Plant to calculate my electric emissions rate
Electric Emissions Rate (kgCO2e/MBtu): 124.3 (what is this?)

Generate a Statement of Energy Performance for uses other than applying for the ENERGY STAR.

General Information Edit

Address: 30 Smith Road , Chesterfield, MA 01012

Year Built: 1998

Property Type: Single Facility

Baseline Rating: 95 **Current Rating:** 95

Eligibility for the ENERGY STAR

Not Eligible: Current period ending over 120 days

Facility Performance Set Baseline Period | Set Energy Performance Target

Select View: Summary: Energy Use — Create View | Edit View

12 Months Ending	Current Rating (1-100)	Current Site Energy Intensity (kBtu/Sq. Ft.)	Current Source Energy Intensity (kBtu/Sq. Ft.)	Change from Baseline: Energy Use Intensity (kBtu/Sq. Ft.)	Change from Baseline: Adjusted Energy Use Intensity (kBtu/Sq. Ft.)	Energy Use Alerts
June 2008 (Current)	95	48.2	72.9	0.0	0.0	Data > 120 days old
Select Date						
Change						

REFRESH VIEW

4. ENERGY CONSERVATION MEASURES

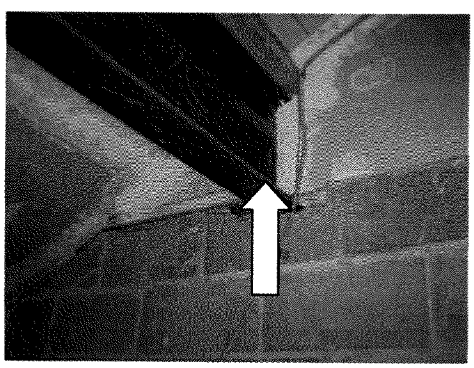
For the New Hingham Elementary the following energy conservation measures were evaluated:

Building envelope improvements
Occupancy sensors for lighting
Other lighting upgrades
Motor controls and VFDs for pumps

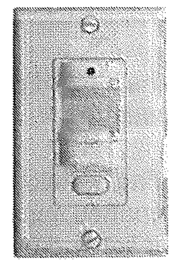
For each ECM detailed below, there is a corresponding appendix that further details the quantitative assumptions, projections and opinions of cost for the measure. The name of each appendix corresponds with each ECM section (i.e. ECM LU1 would be found in Appendix LU).

ECM BE1 – Air Sealing

Above the suspended ceiling in the cafeteria and hallways there are several penetrations around pipes and metal beams that allow heated air to escape through the ceiling above. These penetrations should be sealed with fire-rated material in order to stop this heat loss. The reduction in summer cooling was not factored into the analysis due to the level of A/C usage. The estimated energy savings is 348 gallons of oil resulting in an annual savings of $871. The estimated cost of the measure is $3,172 yielding a simple payback of 3.6 years. This upgrade is recommended at this time.



ECM OS1 to OS5 – Install Occupancy Sensors



Certain lights are on continuously while the building is occupied and potentially when it is unoccupied. Installing occupancy sensors would turn the lights out for the number of hours that there is no activity in offices and hallways. It is estimated that by using occupancy controls, the lights would be off an additional 4 to 8 hours per day. The estimated energy savings is 9,882 kWh per year resulting in an annual savings of $1,383. The estimated cost of the measure is $9,017 yielding a simple payback of 6.5 years. This upgrade is recommended at this time.

ECM LU1 – Delamping

The classrooms and many other areas have excellent daylighting opportunities because of the copious amounts of window area. Light measurements taken during the audit showed that removing some lamps from fixtures and keeping the window shades in a higher position provided adequate levels of light. For the classrooms it is recommended that one lamp be removed from each fixture in the row of lights nearest the window. In the kindergarten hallway the upper lamp should be removed from each fixture. Approximately half of the lamps in the conference and teacher rooms should also be removed. In some rooms the delamping will likely require window shades to be kept in a higher position to let in more natural light.

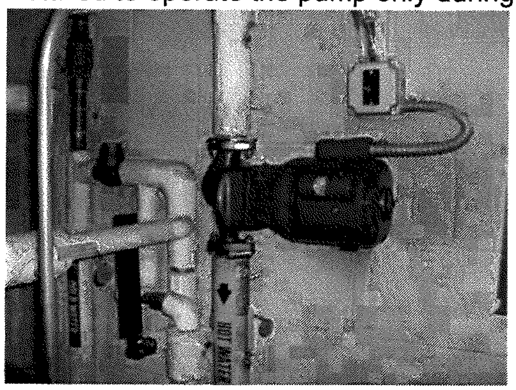
Included in the cost of this ECM is the purchase of a light meter so staff can monitor light levels and make adjustments as necessary. Ideally the lamp removal would be performed during the annual bulb check and replacement, thereby minimizing the labor. The estimated energy savings is 3,863 kWh per year resulting in an annual savings of $835. The estimated cost of the measure is $293 yielding a simple payback of 0.4 years. This upgrade is recommended at this time.

ECM LU2 – Upgrade Lighting

There are eight incandescent floodlights in the library that should be replaced with compact fluorescent floodlights. The estimated energy savings is 440 kWh per year resulting in an annual savings of $112. The estimated cost of the measure is $146 yielding a simple payback of 1.3 years. This upgrade is recommended at this time.

ECM MC1 – Timer on Hot Water Circulator Pump

There is a circulator pump on the domestic hot water system that serves the bathrooms, kitchen and janitorial sinks. The circulator pump operates off of a thermostat, but operates during non-occupied times to maintain hot water to these services. A 7-day, programmable timer can be installed to operate the pump only during occupied hours.



The yearly estimated energy savings is 733 kWh and 27 gallons of oil resulting in an annual savings of $171. The estimated cost of the measure is $268 yielding a simple payback of 1.6 years. This upgrade is recommended at this time.

ECM VS1 – Variable Speed Drive

The existing circulator pump on the hydronic system is operated continuously at full speed whenever the outdoor air temperature is below a certain range (approximately 55 F) and when any zone is heating. Installing a variable speed drive (VFD) on one of the circulator pumps and operating off of differential pressure will allow for reduced pump speed and reduced flow, matching the required flow as various zones open for heat.

The economics of this project will not justify VFDs for both pumps. One VFD should be installed and the pump sequencing will have to run that pump 95% of the time; the other pump should be exercised for 1-2 hours per week. The VFD should be installed in a location that will allow the output feeds to the motors to be swapped, such that the other pump can be put on the VFD (i.e. switch once ever 3-4 years). The estimated energy savings is 2,666 kWh per year resulting in an annual savings of $373. The estimated cost of the measure is $2,977, resulting in a simple payback of 8 years. This measure is recommended at this time.

5. OPERATIONAL ANALYSIS

The quality of the maintenance and operation of the energy systems for a building 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 site. These actions, which have been divided into specific and general recommendations, will help improve energy conservation and support the measures identified in this report.

Specific Recommendations

- It is recommended that an annual preventative maintenance contract be developed for the HVAC systems at the site.
- Turn off the pilot light for each of the burners on the stove for the summer and long vacation periods.
- Install check valves on hot water lines in kitchen rinse sink and janitorial sinks to prevent thermo-siphoning when faucets are left on (required by code).
- Separate the occupancy air schedule from the temperature schedule on supervisor controller to allow for building preheating without running occupancy air.

General Recommendations

The following general recommendations and tasks should be continued or implemented (where applicable):

Building Envelope

1. Verify that caulking and weather stripping are functional and effective.
2. Patch and seal holes in the building envelope.
3. Repair cracked windowpanes.
4. Remove window air conditioners prior to the heating season.
5. Verify that automatic door closing mechanisms are functional.
6. Interior vestibule doors should remain closed.
7. Storm windows are closed in the fall and throughout heating season.
8. Screens are removed on south facing windows during heating season.
9. Maintain gutters: manage roof runoff and perimeter surface water.

Heating and Cooling

10. The pilot lights on furnaces are turned off in the summer.
11. The burners are clean and fuel/air ratios are optimized.
12. Heat exchange surfaces of furnaces are clean and free of scale.
13. Utilize existing programmable thermostats: reduce the set point of the overnight setback from 62 F to 55 F, and extend hours as needed to

reach occupied set point at start of workday; keep unoccupied areas at reduced temperature settings.
14. Set points are seasonally adjusted.
15. Control valves and dampers are fully functional.
16. Pneumatic control systems are checked for air leaks, and corrected if needed.
17. Equipment is inspected for worn or damaged parts.
18. Ductwork is sealed.
19. Hot air registers and return air ductwork are clean and unobstructed.
20. Air dampers are operating correctly.
21. Heating is uniform throughout the designated areas.
22. Air filters are clean and replaced as needed.

Domestic Hot Water

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

Lighting

26. Turn off lights in rooms when there is enough natural lighting.
27. Use single (compact fluorescent) desk lamps in offices and turn off overhead lights if applicable.
28. Over-lit areas are managed by bi-level switching or photocell controls.
29. Only energy efficient replacement lamps are used and in-stock.
30. Lighting fixture reflective surfaces and translucent covers are clean.
31. Walls are clean and bright.
32. Timers and/or photocells are operating correctly on exterior lighting.

Miscellaneous

33. Use energy saver settings – sleep, standby, hibernate or off – for all computers and monitors.
34. Use energy saver modes on copiers, fax machines, etc.
35. Turn off/shutdown all office equipment at night.
36. Refrigerator and freezer doors should close and seal correctly.
37. Reduce number of refrigerators (remove smaller personal refrigerators and replace with a single larger unit for the building).
38. Set refrigerator(s) on energy saver mode and/or adjust to medium temperature setting.
39. Set freezer(s) on lowest energy (highest temp) mode when not in use.
40. Use kitchen/bathroom exhaust fans only when needed.
41. Conduct all recommended equipment-specific preventive maintenance tasks.
42. Verify that peak demand on the building/equipment has not changed significantly since the original building commissioning or the most recent retro-commissioning.
43. Replacement equipment (pumps, compressors, etc): not over/undersized for the particular application.
44. Replacement equipment should be energy conserving and/or high premium devices (compare life cycle costs, not first costs).

6. CLEAN ENERGY 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 Photovoltaics

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

The Massachusetts Technology Collaborative (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

1 Web site: www.commonwealthsolar.org

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 for 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. Third-Party Financing for municipal PV systems is just taking hold in Massachusetts. At this time, the sites of primary interest are buildings with large flat roofs that can accommodate at least 100 kW of solar.

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, radiant floor 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 with full year hot water usage (summer locker room and/or kitchen usage), fire stations, and public housing facilities. On a periodic basis, the DOER accepts grant applications for solar hot water systems. 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.

Wind

The Massachusetts Renewable Energy Trust (MRET) Commonwealth Wind Incentive Program will provide an overarching framework to expand investments for wind energy installations in Massachusetts and help the Commonwealth meet its goal of 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 soon be available. 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 approximately 2 MW range where the project sponsor and primary beneficiary is a private company or organization, a municipality, or a government agency
- *Micro-scale* projects up to 10 kW serving residential, small commercial or small institutional buildings

Wood Pellet Fueled Heating

On a periodic basis 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.

District Energy

A district energy system consists of a central plant that produces steam, hot water or chilled water to provide space heating, domestic hot water heating, and air conditioning. Modern systems typically rely on hot water distribution rather than steam. The district energy is delivered through a network of pre-insulated buried pipes to a clustered community of commercial, industrial and residential customers. As a result, individual buildings don't need their own boilers, furnaces and cooling systems. Applications for towns can include a cluster (2 or more) of town buildings, school buildings located proximate to each other. The development of small district energy systems serving public buildings can provide an anchor for the expansion of the system into town centers to serve privately owned buildings. Using biomass as a fuel source for the district system enables the rapid displacement of fossil fuels used for building heating and appreciable reductions in town greenhouse gas emissions. Funding is available for towns that can demonstrate good district energy applications to perform feasibility studies of district energy systems that primarily serve town buildings.

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

Clean Energy Assessment

The New Hingham Elementary School was assessed for solar, hydroelectric, biomass, and wind.

Solar Hot Water and Photovoltaics

The first criterion for a good solar site is to have a relatively large roof area with excellent unshaded solar access. There are several attributes that shade portions of the roof including: roof monitors, clerestories, HVAC vents, a chimney and a cupola. The balance of the roof area can be considered for solar energy (see highlighted areas in photo below).

Although these areas could accommodate a small solar hot water system, the limited and seasonal hot water usage at the site makes it a poor candidate for solar hot water.

The highlighted roof areas could accommodate a solar photovoltaics system of approximately 50-80 kW. A 70 kW system is estimated to produce approximately 73,000 kWh per year, which is equivalent to approximately 75% of the annual projected electrical usage at the school after conservation measures are performed.

This project is probably too small to be considered for third party ownership at this time; however, future minimum requirements may decrease below 100 kW. A 70 kW solar photovoltaics system is estimated to cost $490,000 with a potential rebate of up to $294,250 -- roughly 60% of the project cost. The remaining $192,000 would have to be raised through other grants or appropriated from town funds. At $0.14 per kWh the project would have a 19 year payback.

Goshen currently has nearly $4,000 in Clean Energy Choice Funds (Chesterfield has $0); this money might be able to be used for New Hingham Elementary since it is a regional school.

Some trees adjacent to the building would need to be pruned and maintained, or removed, since they will grow tall enough to shade some of the array areas.

The roof structure is fairly new, but was built prior to the current building code. It is possible that it may be below the code requirements for the 7th edition of the MA building code, which requires upgrades to the structure when this amount of load is added to the building. A structural evaluation would need to be performed to confirm the additional load capacity of this building; this critical initial task should precede detailed design for a PV project.

Hydroelectric

Since there is no river or stream located at this site, it cannot be considered for hydroelectric.

Biomass

The level of fuel usage at the site is too small for a wood chip boiler. A pellet boiler could be configured to work with the existing distribution system; however, there is limited space for the additional boiler and no space for pellet storage. If additional space becomes available or an addition was planned for the building, a system could be configured.

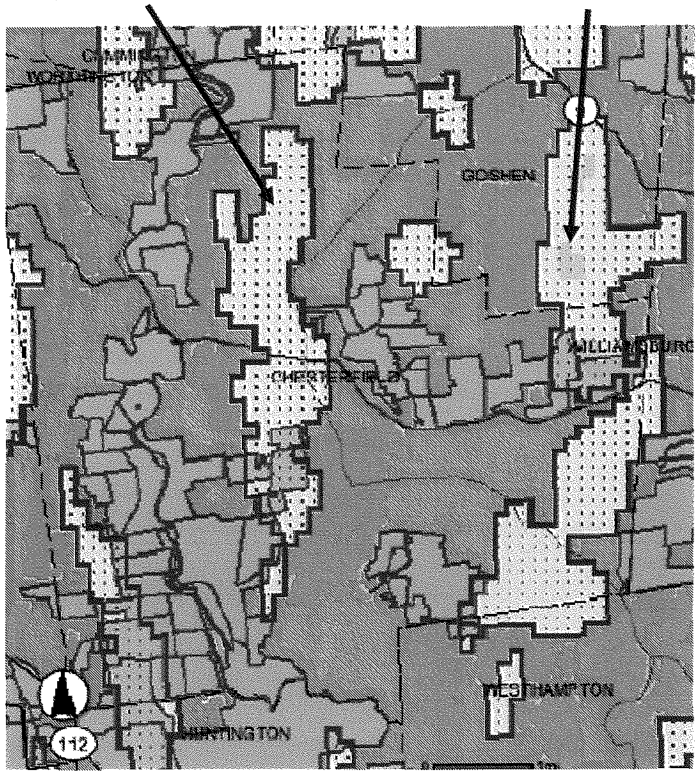
Currently, pellet prices are $250-$300 per ton. At these prices a pellet boiler would cost only a small faction less to operate compared to heating with oil. Pellet prices should moderate over the next year or two; the pellet boiler option should be reevaluated at that time.

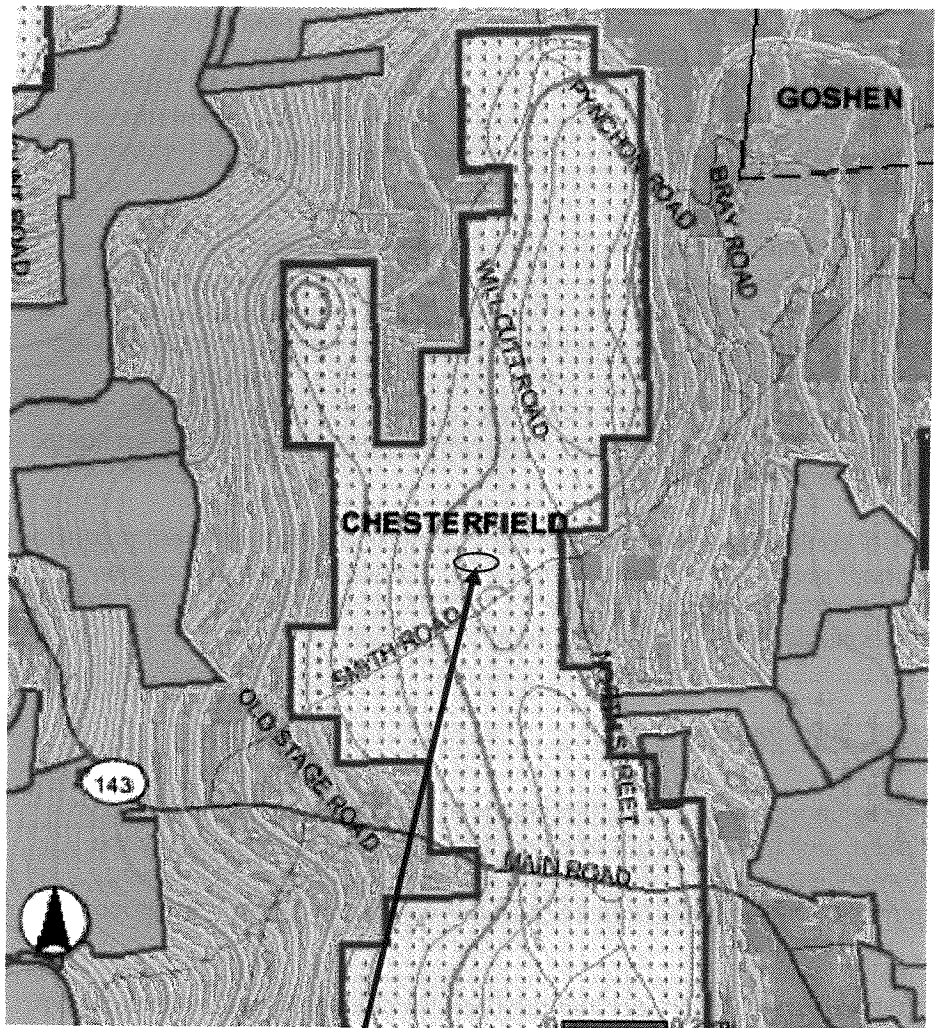
7. WIND

Much of the Town of Chesterfield is at a high elevation with fairly windy ridges and plateaus. Many of the areas, although windy, have marginal wind resources in terms of potential wind generation. According to wind resource maps, New Hingham Elementary School is in a marginal to fair wind zone (light pink area). A site inspection of the area behind the school provided supporting observations (tree flagging) that were indicative of zone 2 or zone 3 winds. Based on the wind resource maps the average wind speeds are in the 6 to 6.5 meters per second (m/s) range at a height of 70 meters (230 feet).

This modeling is stated to be only an indication of average wind speed. The elevation of the site is approximately 1,380 feet, which is a little low for wind speeds of this magnitude in western Massachusetts; however, the surrounding topography is lower which triggers the modeling used for the wind resource maps to project the increased wind speeds. The average wind speed should be confirmed with a full year of anemometer readings at 70 to 100% of planned hub height.

Marginal-Fair Wind (light pink) Good Wind (dark pink)





New Hingham Elementary School

If a wind turbine were to be sized to supply just the one building (the Elementary School), then only a small wind turbine of approximately 60 kW would be needed (based on post conservation usage). *NOTE: All the assumptions for sizing and energy production for the wind turbine assume that the school is not going to also pursue a solar PV system as recommended in Section 6.*

From 2005 through 2007, several dozen small wind turbines (mostly 10 kW) were installed at various locations throughout the state; most of these were partially funded through the MTC SRI Rebate program. In early 2008, MTC conducted a study of the performance of 19 of the small wind turbines to track actual performance in comparison to the modeling used to estimate performance. Some very disappointing results were revealed, with average outputs at less than half of what was projected. As a result, the SRI program was halted until early 2009.

To summarize the findings, the results were attributed to poor siting methods in some instances, and to equipment issues in others. The disparity was not quantified in every instance, but is probably due to the small size and relatively low elevation of these installations since this discrepancy is not demonstrated in the larger (and higher) wind projects. The full study and a follow-up summary can be found on MTC's website.

Based on these findings modeling for small wind turbines was revised. The project economics of the smaller wind turbines are quite poor unless the site has very high winds. Larger wind turbines (100 kW to 2 MW+) have notably better project economics due to the fact that they are typically installed on taller towers and they benefit from an economy of scale. Based on these findings we recommend considering a wind turbine with a capacity of 100kW or larger. Furthermore, the Commonwealth Wind Community Scale Rebate Program starts at a minimum size of 100 kW.

The school could also upgrade the heating system to air source heat pumps or geothermal heat pumps. This would reduce or eliminate the oil usage at the school, but increase the electrical usage by 100,000 to 140,000 kWh. This would increase the potential wind turbine size to up to 200 kW.

Net Metering Law Changes

There have been some major changes involving the *net metering* laws for Massachusetts, which were significantly improved in July 2008 as part of the Green Communities Act. *This act covers a wide range of changes to energy policies in the Commonwealth; only a few of the pertinent changes are discussed here.*

The maximum size of a project that qualifies for net metering was raised from 60 kW to 2 MW. There are three classes of net metering facilities designated in the new bill: less than 60 kW, 60 kW - 1 MW, and 1 MW - 2 MW. Each category has several implications, most notably how they deal with excess monthly generation and how it is *credited.*

Under the previous provisions, the power generated by a turbine over 60 kW that is not used on site (i.e. the excess power) was *sold* back to a third party (often the utility, but could be another entity) at the wholesale market rate. This is, on average, only 1/2 to 2/3 of the final price paid by a customer for electrical usage when including delivery charges (transmission, transition, etc). The new change allows for a municipal entity to have up to 2 MW *per unit* and still net meter. This allows excess power to be made during windy times and *credited*; that power can then be tapped for use during non-windy periods.

In addition, the net metering law used to have a monthly limit; it now allows for carrying the *net metering credit* forward. This is especially good for wind turbine projects which tend to produce more in the winter and less in the summer.

The last major change in the bill is that a municipal net metering credit can be reallocated. This last provision was not very detailed within the energy bill. This leaves much of the defining and interpreting up to the Department of Public Utilities which has only recently been finalizing the provisions of the bill.

If reallocation is allowed, the approach would be to *neighborhood* together municipal properties to utilize the power from one larger wind turbine. This could include other municipal buildings within Chesterfield. The fact that the school is a regional school and not owned outright by the Town of Chesterfield would require additional administrative and accounting provisions. The total number of sites and their energy usage would need to be evaluated to determine the additional wind turbine capacity.

100 kW Wind Turbine

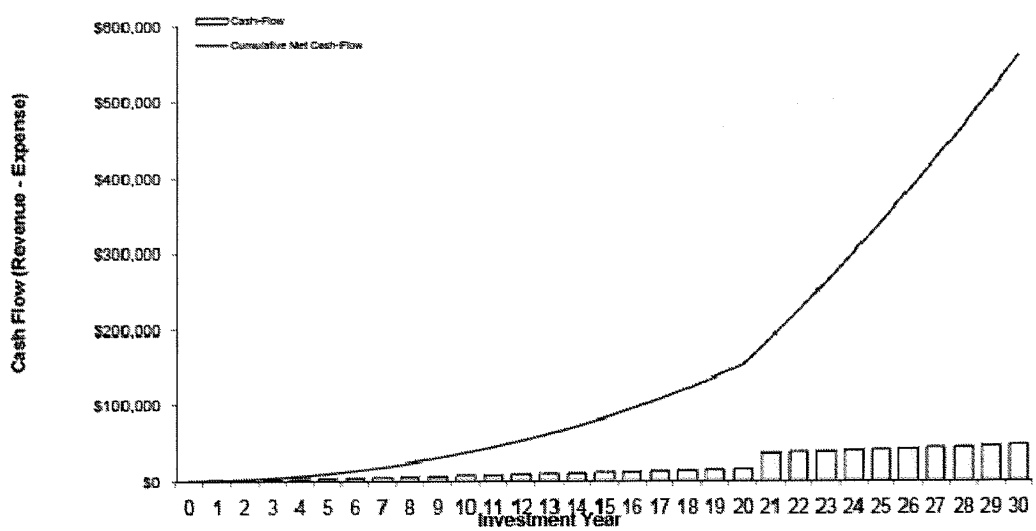
A 100 kW wind turbine was considered for a preliminary analysis. It was assumed that this would have a hub height of at least 160 feet, based on the terrain and vegetative cover on adjacent lots (which is assumed will not be cleared). A 100 kW turbine with a hub height at 160 feet would reach to just under 200 feet. For installations of 200 feet or above, a light is required by the FAA. The highest elevation spot is behind the school. If a 160 tower were erected near the property line, the fall zone might exceed the property limits; therefore, easements from the abutters would likely be required. For a turbine this size it is generally recommended to be at least 300 feet from a residence, and ideally 1,000 feet or more; based on the current neighboring buildings this should not be an issue. There are other setbacks that would also need to be addressed.

The preliminary analysis yielded an annual production estimate of 161,000 kWh. The economic model for a single 100 kW wind turbine was run with a total project cost (including feasibility, anemometer readings, design, and construction) of $550,000. It is assumed that $50,000 would be obtained from MTC in support of the monitoring and feasibility study and another $225,000 would be obtained from MTC in support of construction. These figures were deduced from the first round funding of the Community Scale Wind Program (the deadline for first round applications closed in June). The balance of $275,000 is assumed to be funded by a municipal bond with a term of 20 years at 3% interest. Future rounds of the

MRET Wind Program may have different funding levels; the program may change or even be discontinued over time.

The Green Communities Act and the Federal Stimulus Package from October 2008 both had provision for municipal bonds for energy projects (CREBs) at lower interest rates. Even at the 3% interest rate, the financial analysis projects that the wind turbine will provide positive cash flow in its very first year! The first few years have moderate cash flow, with increasing levels over a 20 year period. The project returns significant revenue to the District after the 20 year bond is paid off (net annual cash flow of over $35,000). See Appendix WT.

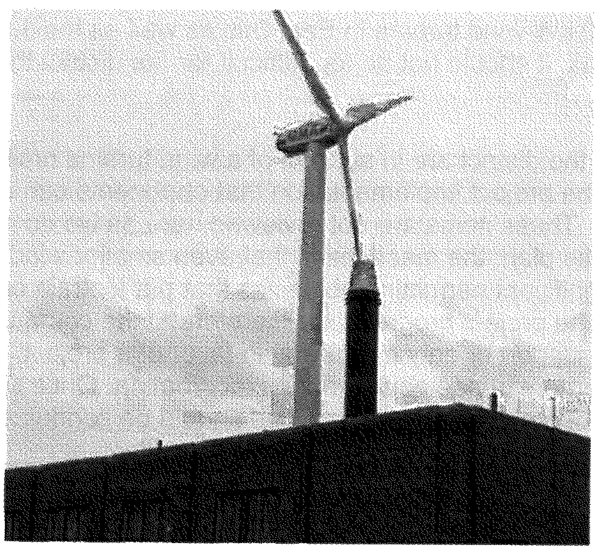
A larger project (such as 200 kW) would have similar economics with somewhat proportionally higher overall values.



NOTE: These financial models include estimates for operating and maintenance costs, as well as a 3% annual increase in energy costs.

One concern with a financial model at this time is the escalation in price over the next 3 to 5+years (which is the amount of time it will likely take to execute a project). Wind turbine prices have increased nearly 50% over the past four years. A variety of factors may result in future price volatility: energy prices have moderated, many wind projects have been scuttled, there has been an extension of federal tax credits, and there is continued interest in clean technology worldwide. A *carbon cap and trade system* would also likely spur further demand for wind turbines. While the cost of electricity has (and may continue to) increased, it is not necessarily going to match the increases in the project costs; this will potentially result in less favorable project economics. Therefore, financial modeling with the most up-to-date estimated costs should be performed repeatedly throughout the project development.

It should also be noted that the financials were run for an average wind speed of 6.5 meters per second. At 6 meters per second the estimated output drops from 161,000 kWh per year to 137,000 kWh per year; this still yield a project with attractive financials; however, net positive cash flow is not realized for 9 years. At a wind speed of 5.5 meters per second the project is no longer attractive. The sensitivity of the project financials to wind speed is typical of wind projects and underscores the importance wind siting, tower height and making accurate and comprehensive wind readings at the site.



Next Steps for Wind

There are several items to consider as to whether or not the district should further pursue a wind turbine project.

A preliminary economic analysis was provided in this report; this should be reviewed by the district school board. It is likely that they will conclude that this project is in the best economic interest of the district; however the capital cost is significant and incurring debt of this magnitude requires careful consideration. Most of the conservation projects have good economic returns as well and should be considered in unison with, or prior to, the investment in a wind turbine.

There are other details for a wind project which can potentially thwart the development of the project: noise, zoning, perceived aviary issues, visual impact, etc. These issues become qualitative at times and are hard to definitively address with formal studies, or with technical or even financial solutions. They will often be determined by community sentiment towards wind turbines. It is advisable to gage the sentiment towards wind early in the process so as not to waste time and money on the development of a project that townspeople are against. Given the recent installation of a 650 kW wind turbine in East Otis as well as the 1.5 MW wind turbine at Jiminy Peak, it should not be too difficult for the district to ascertain the local opinion.

Even if both towns in the district are in support of a wind turbine project, there are several steps during the project implementation that opponents can use to delay or halt the process. These items are not reviewed here as we do not wish to arm opponents with a battle plan; the message is that even smaller wind turbine projects have met with significant permitting obstacles that put a strain on the level of community support as the project progresses. Therefore, if the communities involved are fairly split in support or only marginally in favor of a project, a prolonged project development phase could prove exacerbating. Once some initial discussions have occurred, a straw poll of some kind should be conducted to gage the level and fortitude of community support for a wind project.

Appendix BE

Building Envelope Upgrade

Chesterfield-Goshen

New Hingham Elementary School

July-09

Area	ECM#	Description	Base Case Annual Usage Gallons	Base Case Efficiency	Base Case Net Energy MBTU	Base Case Annual Cost	Proposed Annual Usage Gallons	Proposed Efficiency	Proposed Net Energy MBTU	Proposed Annual Cost	Annual Savings MBTU	Annual Savings Gallons	Annual Savings $	Total Est. Cost	Simple Payback
	BE1	Airsealing	10368	77.0%	1107	$25,920	10020	77.0%	1070	$25,049	48	348	$871	$3,172	3.6
Total	BEs	Building Envelope	10,368							25,049	48	348	$871	$3,172	3.6
Fuel Type:	Oil														
Cost:	$2.50														

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr or sq ft)	Labor rate	Subtotal	Engineering 12%	Conting 10%	Total	Source
BE1		Airsealing	ea	1	$0	$200	32	$75	$2,600	$312	$260	$3,172	Est

Appendix OS

Occupancy Sensors - Lighting

Chesterfield-Goshen

New Hingham Elementary School

July-09

Area	ECM#	Description	Base Case Annual Hours	Base Case Fixture Quantity	Base Case Fixture Wattage	Base Case Annual Usage kWh	Proposed Annual Usage (Hours	Proposed Fixture Quantity	Proposed Fixture Wattage	Proposed Annual Usage kWh	Annual Savings kW	Annual Savings kWh	Annual Savings $	Total Est. Cost	Simple Payback
	OS1	Classrooms	2,000	117	112	26,208	1,500	117	112	19,656	0	6,552	917	3,744	4.1
	OS2	Library	2,000	1	1,368	2,736	1,500	1	1,368	2,052		684	96	454	4.7
	OS3	Halls	2,000	34	49	3,332	1,000	34	49	1,666		1,666	233	2,550	10.9
	OS4	Restrooms	2,000	13	49	1,274	1,000	13	49	637		637	89	1,475	16.5
	OS5	Other	2,000	7	49	686	1,000	7	49	343		343	48	794	16.5
Total	OSs	Occupancy Sensors				34,236					0	9,882	1,383	9,017	6.5

Power Cost: Electric $0.14 kWh; $9.53 kW

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr)	Labor rate	Subtotal	Engineering 12%		Conting 10%	Total	Source
OS1	Occ Sens	Classrooms	ea	33	$58	$0	0.5	$70	$3,069	$368		$307	$3,744	Est
OS2	Occ Sens	Library	ea	4	$58	$0	0.5	$70	$372	$45		$37	$454	Est
OS3	Occ Sens	Halls	ea	11	$120	$0	1	$70	$2,090	$251		$209	$2,550	Est
OS4	Occ Sens	Restrooms	ea	13	$58	$0	0.5	$70	$1,209	$145		$121	$1,475	Est
OS5	Occ Sens	Other	ea	7	$58	$0	0.5	$70	$651	$78		$65	$794	Est

Appendix LU

Lighting Upgrade

Chesterfield-Goshen

New Hingham Elementary School

July-09

Area	ECM#	Description	Base Case: Annual Hours	Base Case: Fixture Quantity	Base Case: Fixture Wattage	Base Case: Annual Usage kWh	Proposed: Annual Usage Hours	Proposed: Fixture Quantity	Proposed: Fixture Wattage	Proposed: Annual Usage kWh	Annual Savings: kW	Annual Savings: kWh	Annual Savings: $	Total Est. Cost	Simple Payback
	LU1	Delamping	1,500	103	25	3,863	1,500	103	0	0	3	3,863	835	$293	0.4
	LU2	Incandescent to CFL	1,000	8	75	600	1,000	8	20	160	0	440	112	$146	1.3
Total	LUs	Lighting Upgrades	0	0	0	4,463	0	0	0	0	3	4,303	947	$439	0.5
Power Cost:	Electric $0.14 kWh		$9.53 kW												

Fixture Quantity is number of lamps removed from classrooms, hall, etc.

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr)	Labor rate	Subtotal	Engineering 12%		Conting 10%	Total	Source
LU1	Delamping	Light meter	ea	1	$0	$100	2	$70	$240	$29		$24	$293	Est
LU2	Upgrade	CFLs for library	ea	8	$15	$0	0	$70	$120	$14		$12	$146	Est

Appendix MC

Motor Controls

Chesterfield-Goshen

New Hingham Elementary School

July-09

			Base Case				Proposed				Annual Savings			Total Est.	Simple
Area	ECM#	Description	Elec Use	Heat Loss	System	Annual Cost	Elec Use	Heat Loss	System	Annual Cost				Cost	Payback
			kWh	MMBTU	Efficiency		kWh	MMBTU	Efficiency		Gallons	kWh	$		
	MC1	Circulator Pump Timer	1099.38	4.4	77%	$257	366	1.5	77.0%	$86	27	733	$171	$268	1.6
Total	MCs	Motor Controls	1,099	4		$257	366	1		$86	27	733	$171	$268	1.6
Fuel Type:	Oil	Electric													
Cost:	$2.50	$0.14													

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr)	Labor rate	Subtotal	Engineering	Conting	Total	Source
										12%	10%		
MC1	Timer	Circulator Pump Timer	ea	1	$80	$0	2	$70	$220	$26	$22	$268	Est

Appendix VS

Variable Speed Drive

Chesterfield-Goshen

New Hingham Elementary School

July-09

			Base Case				Proposed				Annual Savings			Total Est.	Simple
Area	ECM#	Description	Annual Hours	Motor BHP	Motor Qty	Annual Usage kWh	Motor RPM	Average Speed	Drive Loss	Annual Usage kWh	kW	kWh	$	Cost	Payback
	VS1	Variable Speed Drive	5,280	4	1	16,740	890	840	0.0%	14,074	0.00	2,666	$373	$2,977	8.0
Total	VSs	Variable Speed Drive				16,740					0.00	2,666	$373	$2,977	8.0
Power Cost:	Electric $0.14 kWh		$9.53 kW												

BHP = Belt HP (~85% of nameplate)

Opinion of Cost

Measure	Item	Detail	UOM	Qty	Equip (ea)	Matl (lot)	Labor (hr)	Labor rate	Subtotal	Engineering 12%		Conting 10%	Total	Source
VS1	VFD	Variable Speed Drive	ea	1	$1,300	$300	12	$70	$2,440	$293		$244	$2,977	Est

Summary Assumptions

Power Output (kWh/year)	161,880
Average Cost of Electricity ($/kWh)	$0.13
Nominal Electricity Escalation Rate (%/year)	3.00%
Total Installed Cost	$275,000
Downpayment (%)	0.00%
Debt Term (years)	20
Interest Rate (%/year)	3.00%
Marginal Effective Tax Rate (%/year)	0.00%
Variable Cost ($/kWh)	$0.02
Nominal Variable Cost Escalation Rate (%/year)	2.00%
Rated Power (kW)	100
Fixed Cost ($/kWh)	$0.00
Nominal Fixed Cost Escalation Rate (%/year)	2.00%

30-Year Nominal Cash-Flow (All units are expressed as dollars unless otherwise noted)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Revenue														
Power Output (kWh/year) (A)		161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880
Avoided Cost of Electricity ($/kWh) (B)		$0.134	$0.138	$0.142	$0.146	$0.151	$0.155	$0.160	$0.165	$0.170	$0.175	$0.180	$0.185	$0.191
Total Revenue (A*B)		$21,676	$22,326	$22,996	$23,686	$24,396	$25,128	$25,882	$26,658	$27,458	$28,282	$29,130	$30,004	$30,904
Expenses														
Initial Capital Expenditure (Downpayment)	$0													
Amount Financed	$275,000													
Total Debt Payment		$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484
Before-Tax Debt Interest Payment		$8,250	$7,943	$7,627	$7,301	$6,966	$6,620	$6,264	$5,897	$5,520	$5,131	$4,730	$4,318	$3,893
Debt Principal Payment (C)		$10,234	$10,541	$10,858	$11,183	$11,519	$11,864	$12,220	$12,587	$12,965	$13,353	$13,754	$14,167	$14,592
After-Tax Debt Interest Payment (D)		$8,250	$7,943	$7,627	$7,301	$6,966	$6,620	$6,264	$5,897	$5,520	$5,131	$4,730	$4,318	$3,893
Variable Costs (E)		$2,477	$2,526	$2,577	$2,628	$2,681	$2,735	$2,789	$2,845	$2,902	$2,960	$3,019	$3,080	$3,141
Fixed Costs (F)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Expenses (C+D+E+F)		$20,961	$21,011	$21,061	$21,113	$21,165	$21,219	$21,274	$21,329	$21,386	$21,444	$21,503	$21,564	$21,625
Net Cash-Flow	$0	$715	$1,315	$1,935	$2,573	$3,231	$3,909	$4,608	$5,329	$6,072	$6,838	$7,627	$8,440	$9,279
Cumulative Net Cash-Flow	$0	$715	$2,030	$3,965	$6,538	$9,769	$13,678	$18,286	$23,615	$29,687	$36,525	$44,152	$52,592	$61,871

Appendix WT

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880	161,880
$0.197	$0.203	$0.209	$0.215	$0.221	$0.228	$0.235	$0.242	$0.249	$0.257	$0.264	$0.272	$0.280	$0.289	$0.297	$0.306	$0.316
$31,832	$32,786	$33,770	$34,783	$35,827	$36,901	$38,008	$39,149	$40,323	$41,533	$42,779	$44,062	$45,384	$46,746	$48,148	$49,592	$51,080
$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$18,484	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$3,455	$3,004	$2,540	$2,061	$1,569	$1,061	$538	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$15,029	$15,480	$15,945	$16,423	$16,916	$17,423	$17,946	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$3,455	$3,004	$2,540	$2,061	$1,569	$1,061	$538	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$3,204	$3,268	$3,333	$3,400	$3,468	$3,537	$3,608	$3,680	$3,754	$3,829	$3,906	$3,984	$4,063	$4,145	$4,228	$4,312	$4,398
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$21,688	$21,752	$21,818	$21,884	$21,952	$22,022	$22,092	$3,680	$3,754	$3,829	$3,906	$3,984	$4,063	$4,145	$4,228	$4,312	$4,398
$10,143	$11,034	$11,952	$12,899	$13,874	$14,880	$15,916	$35,468	$36,569	$37,704	$38,873	$40,079	$41,321	$42,601	$43,920	$45,280	$46,682
$72,014	$83,048	$95,001	$107,899	$121,774	$136,653	$152,569	$188,038	$224,607	$262,311	$301,184	$341,263	$382,584	$425,185	$469,105	$514,385	$561,067