SPOTSWOOD PUBLIC SCHOOLS

Energy Audit

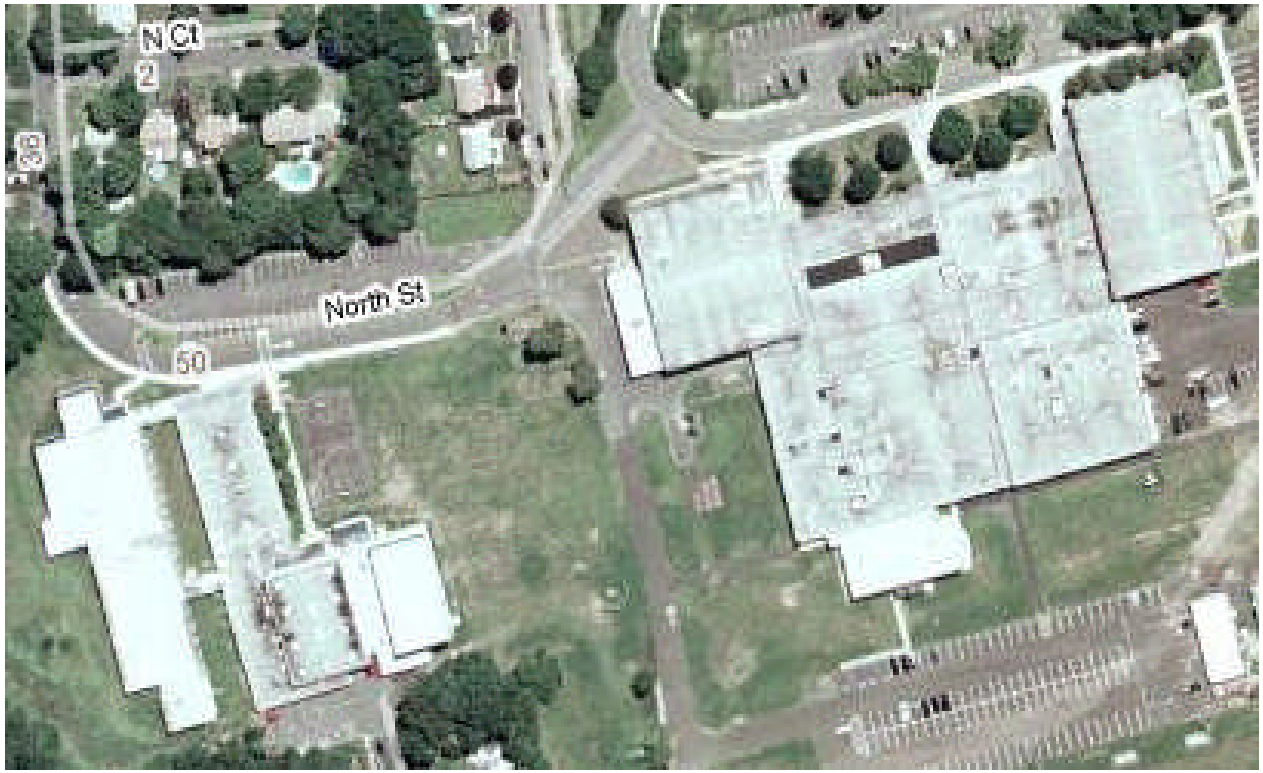
Prepared For:
Spotswood Board of Education

Tish Spinillo
Business Administrator

Prepared By:
Dome – Tech, Inc.

Prepared Under the Guidelines of the State of NJ Local Government Energy Audit Program

August, 2009



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SPOTSWOOD BOARD OF EDUCATION
ENERGY AUDIT REPORT
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September 1, 2009

Ms. Tish Spinillo, Board Administrator
School Business Administrator's Office
Spotswood Board of Education
105 Summerhill Road
Spotswood, NJ 08884

Re: EXECUTIVE SUMMARY FOR SPOTSWOOD BOARD OF EDUCATION
STATE OF NEW JERSEY LOCAL GOVERNMENT ENERGY AUDIT – FINAL REPORT

Dear Ms. Spinillo:

Dome-Tech was retained by Spotswood Board of Education, as a prequalified participant in the Local Government Energy Audit Program, to perform an energy audit. The objective of the energy audit was to evaluate the schools' energy consumption, establish baselines for energy efficiency and identify opportunities to reduce the amount of energy used and/or its cost.

The scope of the audit is standardized under the Program, and consisted of the following:

- Benchmarking historic energy consumption utilizing EPA Energy Star's Portfolio Manager
- Characterizing building use, occupancy, size, and construction
- Providing a detailed equipment list including estimated service life and efficiency
- Identifying and quantifying energy conservation measures (ECMs)
- Evaluating the economic viability of various renewable/distributed energy technologies
- Performing a utility tariff analysis and assessing savings potential from energy procurement strategies
- Providing the method of analyses

Based upon data received for the period Jan 2008 – Dec 2008, the Spotswood schools have an annual expenditure of:

- Electricity: 3,578,560 kWh at a total cost of $553,667
- Natural Gas: 91,784 therms at a total cost of $162,583

Please refer to Section 2 of this report for a detailed list of identified Energy Conservation Measures (ECMs), along with a summary of their preliminary economics (estimated project cost, estimated annual energy savings, applicable rebate(s), etc.) In this report, all identified ECMs are ranked and presented according to their simple payback; however, please note that the master ECM table can also be sorted by building, by measure type, etc.

If all identified ECMs were to be implemented, they would provide the following estimated benefits to Spotswood Board of Education:

- Total annual electrical savings: 1 614,590 kilowatt-hours; 44%
- Total annual natural gas savings: 31,500 therms of natural gas usage; 34%
- Total annual cost savings: $309,160; 43%
- Total annual CO_2 emissions reduction: 698 tons
- Total estimated implementation cost: $1,487,655
- Total average simple payback: 7.9 years

The projects that are recommended for implementation (at all facilities) include: installing a Building Management System (BMS), upgrading the lighting, installing programmable thermostats, installing vending machine power management devices, and implementing energy awareness programs.

The Spotswood schools data was entered into the US EPA ENERGY STAR's Portfolio Manager database program. The scores ranged from a low of 6 to a high of 30. Buildings with scores of 75 or higher may qualify for the ENERGY STAR Building Label. Please see report for individual school scores.

Distributed/Renewable Energy Systems were reviewed for the schools with the following conclusions:

- Dome-Tech considered three different types of wind turbine technologies that consisted of both building-mounted and traditional ground-mounted variety. Due to attractive payback and high potential for energy reduction, the 50 kilowatt ground mounted wind turbine project appears to be the most attractive option. Should the Spotswood BOE decide to pursue a wind turbine project, Dome-Tech recommends commissioning a more detailed study.
- A roof-mounted 976 kw dc photovoltaic system that could provide 50% of the high school's annual energy usage was assessed for implementation.
- CHP, Fuel Cells, and Micro-turbines were also researched, but are not recommended due to the lack of thermal requirements in the summertime.

Regarding the procurement of utilities, Dome-Tech understands that Spotswood BOE's four schools and administrative facilities are served by five electric accounts behind Jersey Central Power & Light, under various rate classes. Dome-Tech understands that Spotswood BOE has Basic Generation Service Fixed Price accounts that are currently not contracted with a retail energy supplier. The District is also served by seven natural gas accounts behind Public Service Electric & Gas Company. Now is an ideal time to seek longer-term rate stability through a fixed price arrangement through a retail supplier.

During the development of this audit, Dome-Tech was assisted by facility personnel, who were both knowledgeable and very helpful to our efforts. We would like to acknowledge and thank those individuals.

Sincerely,

Bang Duong
Energy Engineer

SPOTSWOOD BOE

ECO/ECM Summary

	Energy Conservation Measures (ECM)	Building	Energy Savings kWh	Energy Savings Therms	Gross Installation Costs*	Like & Kind Replacement Costs*	Rebates/ Incentives	Net Implementation Costs	Total Annual Cost Savings*	Simple Pay Back*	Avoided CO2 Emissions (tons)	Return on Investment (ROI)	Lifecycle Cost Savings*
1	Vend Miser Controls	Appleby Elementary	1,180	0	$ 180	$ -	$ -	$ 180	$ 180	1.0	0.4	100%	*NA*
1	Vend Miser Controls	High School	5,890	0	$ 900	$ -	$ -	$ 900	$ 810	1.1	1.9	90%	*NA*
1	Vend Miser Controls	Memorial Middle School	3,530	0	$ 540	$ -	$ -	$ 540	$ 490	1.1	1.2	91%	*NA*
1	Vend Miser Controls	Schoenly Elementary	1,180	0	$ 180	$ -	$ -	$ 180	$ 160	1.1	0.4	89%	*NA*
2	Install Weatherstripping	Appleby Elementary	480	50	$ 700	$ -	$ -	$ 700	$ 180	3.8	0	26%	*NA*
2	Install Weatherstripping	High School	240	30	$ 350	$ -	$ -	$ 350	$ 90	3.8	0	26%	*NA*
2	Install Weatherstripping	Memorial Middle School	240	30	$ 350	$ -	$ -	$ 350	$ 90	3.8	0	26%	*NA*
3	Premium Efficient Motors Upgrade	Memorial Middle School	1,000		$ 1,800	$ -	$ 220	$ 1,580	$ 160	10.0	0.3	10%	*NA*
3	Premium Efficient Motors Upgrade	Appleby Elementary	6,230	0	$ 890	$ -	$ 320	$ 570	$ 950	0.6	2.1	167%	*NA*
4	Walk in Freezer Controls	High School	2,410	0	$ 2,340	$ -	$ -	$ 2,340	$ 370	6.3	1	16%	*NA*
5	Lighting Retrofit	Appleby Elementary	51,900	0	$ 46,100	$ -	$ 3,440	$ 42,700	$ 7,790	5.5	17	18%	*NA*
5	Lighting Retrofit	Memorial Middle School	35,300	0	$ 35,500	$ -	$ 3,430	$ 32,100	$ 5,300	6.1	12	17%	*NA*
5	Lighting Retrofit	High School	93,500	0	$ 96,300	$ -	$ 6,270	$ 90,000	$ 15,000	6.0	31	17%	*NA*
5	Lighting Retrofit	Schoenly Elementary	20,700	0	$ 30,200	$ -	$ 1,620	$ 28,600	$ 3,100	9.2	7	11%	*NA*
6	Heat Pump Replacement	Appleby Elementary	29,000	0	$ 581,300	$ 547,000	$ 2,100	$ 32,200	$ 4,400	7.3	10	14%	*$66,000*
7	VFD on Unit Ventilators	Schoenly Elementary	4,490	0	$ 5,840	$ -	$ -	$ 5,840	$ 620	9.4	1	11%	*NA*
7	VFD on Unit Ventilators	Memorial Middle School	6,120	0	$ 7,970	$ -	$ -	$ 7,970	$ 840	9.4	2	11%	*NA*
8	Install Timers on DHW	Memorial Middle School	240	0	$ 220	$ -	$ -	$ 220	$ 30	7.3	0.1	14%	*NA*
8	Install Timers on DHW	Schoenly Elementary	200	0	$ 215	$ -	$ -	$ 215	$ 30	7.2	0.1	14%	*NA*
8	Install Timers on DHW	Appleby Elementary	240	0	$ 220	$ -	$ -	$ 220	$ 40	5.5	0.1	18%	*NA*
8	Install Timers on DHW	High School		40	$ 2,900	$ -	$ -	$ 2,900	$ 100	29.0	0.2	3%	*NA*
9	Energy Star Kitchen Equip.. Upgrade	Memorial Middle School	3,250	0	$ 5,400	$ -	$ -	$ 5,400	$ 470	11.5	1	9%	*$7,050*
9	Energy Star Kitchen Equip.. Upgrade	Schoenly Elementary	1,200	0	$ 2,700	$ -	$ -	$ 2,700	$ 170	16.3	0	6%	*$2,550*
9	Energy Star Kitchen Equip.. Upgrade	High School	13,000	0	$ 32,900	$ -	$ -	$ 32,900	$ 1,800	18.1	4	5%	*$27,000*
9	Energy Star Kitchen Equip.. Upgrade	Appleby Elementary	1,620	0	$ 5,390	$ -	$ -	$ 5,390	$ 230	23.4	1	4%	*$3,450*
10	Install High Efficiency Cond. Boiler	Memorial Middle School	0	4,050	$ 159,720	$ 137,340	$ 1,750	$ 20,630	$ 6,200	3.3	24	30%	*$155,000*
11	RTU replacement	Schoenly Elementary	7,810	0	$ 41,700	$ 39,100	$ 2,100	$ 500	$ 1,100	0.5	3	220%	*$16,500*
11	RTU replacement	High School	74,100	0	$ 87,000	$ 60,000	$ 21,900	$ 5,100	$ 10,000	0.5	24	196%	*$150,000*
11	RTU replacement	Memorial Middle School	14,500	0	$ 94,400	$ 83,200	$ 9,000	$ 2,200	$ 2,000	1.1	5	91%	*$30,000*
12	Install BMS	High School	87,700	6,170	$ 69,400	$ -	$ -	$ 69,400	$ 26,500	2.6	65	38%	*NA*
12	Install BMS	Appleby Elementary	229,000	800	$ 36,800	$ -	$ -	$ 36,800	$ 36,800	1.0	80	100%	*NA*
12	Install BMS	Schoenly Elementary	106,100	3,640	$ 80,900	$ -	$ -	$ 80,900	$ 23,960	3.4	56	30%	*NA*
12	Install BMS	Memorial Middle School	100,100	3,090	$ 73,900	$ -	$ -	$ 73,900	$ 21,900	3.4	51	30%	*NA*
13	Temperature Set point Optimization (BMS)	Memorial Middle School	9,800		$ 73,900	$ -	$ -	$ 73,900	$ 6,700	11.0	3	9%	*NA*
13	Temperature Set point Optimization (BMS)	Appleby Elementary	158,000	0	$ 97,900	$ -	$ -	$ 97,900	$ 24,200	4.0	52	25%	*NA*
13	Temperature Set point Optimization (BMS)	Schoenly Elementary	34,800	0	$ 80,900	$ -	$ -	$ 80,900	$ 8,900	9.1	11	11%	*NA*
14	Time of Day Optimization (BMS)	High School	59480	4,290	$ 69,400	$ -		$ 69,400	$ 9,100	7.6	25	13%	*NA*
14	Time of Day Optimization (BMS)	Appleby Elementary	78,000	0	$ 97,900	$ -	$ -	$ 97,900	$ 12,000	8.2	26	12%	*NA*
14	Time of Day Optimization (BMS)	Memorial Middle School	0	730	$ 73,900	$ -	$ -	$ 73,900	$ 1,500	49.3	4	2%	*NA*
14	Time of Day Optimization (BMS)	Schoenly Elementary	12,560	2,000	$ 80,900	$ -	$ -	$ 80,900	$ 4,800	16.9	16	6%	*NA*
14	Programmable Thermostats	Appleby Elementary	106,000	0	$ 1,410	$ -	$ -	$ 1,410	$ 15,500	0.1	35	1099%	*NA*
14	Programmable Thermostats	High School	101,000	0	$ 2,440	$ -	$ -	$ 5,200	$ 9,100	0.6	33	175%	*NA*
14	Programmable Thermostats	Schoenly Elementary	34,500	0	$ 310	$ -	$ -	$ 310	$ 13,700	0.0	11	4419%	*NA*
14	Programmable Thermostats	Memorial Middle School	25,600	0	$ 560	$ -	$ -	$ 560	$ 8,200	0.1	8	1464%	*NA*
15	DCV Demand Control Ventilation (BMS)	Schoenly Elementary	24,600	1,640	$ 80,900	$ -	$ -	$ 80,900	$ 5,900	13.6	18	7%	*NA*
15	DCV Demand Control Ventilation (BMS)	Memorial Middle School	35,300	2,360	$ 73,900	$ -	$ -	$ 73,900	$ 8,500	8.7	25	12%	*NA*
15	DCV Demand Control Ventilation (BMS)	High School	28,200	1,880	$ 69,400	$ -	$ -	$ 69,400	$ 6,800	10.2	20	10%	*NA*
15	DCV Demand Control Ventilation (BMS)	Appleby Elementary	17,400	810	$ 97,900	$ -	$ -	$ 97,900	$ 4,400	22.3	11	4%	*NA*
Totals		All Schools	1,614,950	31,500	$ 2,403,625	$ 866,640	$52,150	$1,487,655	$309,160	7.9	698	8367%	$457,550

Energy Audit Purpose & Scope

Purpose:

- The objectives of the energy audit are to evaluate the site's energy consumption, establish baselines for energy consumption and identify opportunities to reduce the amount of energy used and/or its cost.

Scope:

I. Historic Energy Consumption: Benchmark energy use using Energy Star Portfolio Manager

II. Facility Description – characterize building usage, occupancy, size and construction.

III. Equipment Inventory – detailed equipment list including useful life and efficiency.

IV. Energy Conservation Measures: Identify and evaluate opportunities for cost savings and economic returns.

V. Renewable/Distributed Energy Measures: evaluate economic viability of various renewable/distributed energy technologies.

VI. Energy Purchasing and Procurement Strategies: perform utility tariff analysis and assess potential for savings from energy procurement strategies.

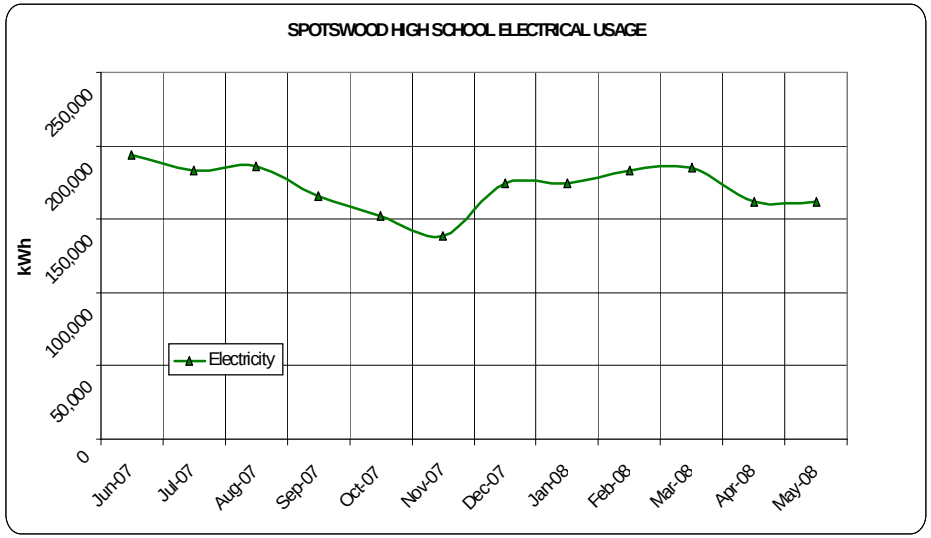
VII. Method of Analysis: Appendices

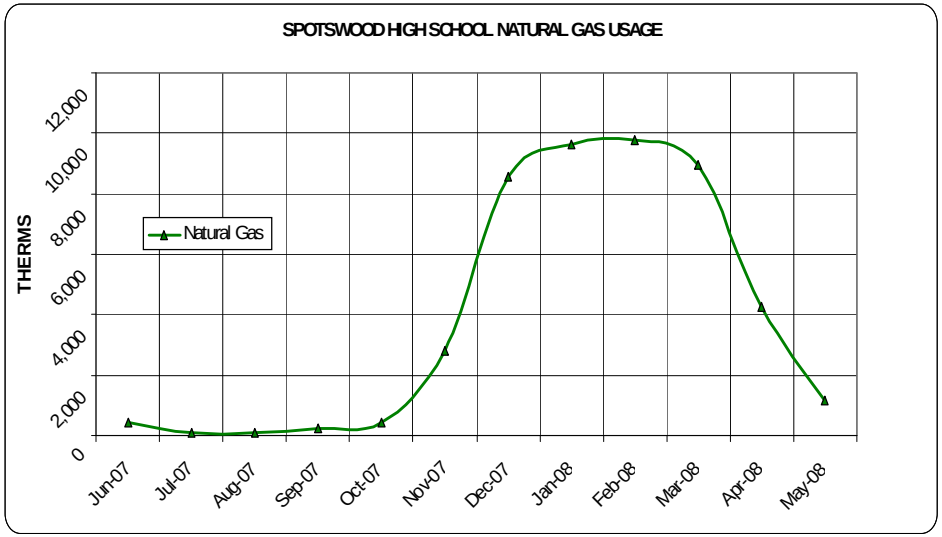
Historic Energy Consumption

Utility Usage and Costs Summary

Time-period: Jan. 2008 – Dec. 2008

SCHOOLS	Electric			Natural Gas			ENERGY STAR SCORE
	Annual Consumption	Annual Cost	$ / kWh	Annual Consumption	Annual Cost	$ / Therm	
APPLEBY	745,440	$114,171	$0.15	361	$766	$2.12	30
MEMORIAL	452,960	$70,208	$0.15	25,887	$45,593	$1.76	20
SCHOENLY	320,960	$49,487	$0.15	19,119	$34,083	$1.78	6
SPOTSWOOD HS	2,059,200	$319,801	$0.16	46,417	$82,141	$1.77	17
TOTALS	**3,578,560**	**$553,667**	**$0.15**	**91,784**	**$162,583**	**$1.86**	**18**





Please see Appendix for full utility data and consumption profiles for all Schools.

Historic Energy Consumption

ENERGY STAR SCORES

- Energy Star Score is calculated to establish a facility-specific energy intensity baseline.
- Energy Star can be used to compare energy consumption to other similar facilities and to gauge the success of energy conservation and cost containment efforts.
- Buildings with an Energy Star rating/score of 75, or above, are eligible to apply for an official Energy Star Building label.

Facility Name	Energy Star Score	Eligible to Apply for ENERGY STAR	Current Site Energy Intensity (kBtu/SF)	Current Source Energy Intensity (kBtu/SF)
Schoenly Elementary School	6	NA	138.3	213.8
Appleby Elementary School	30	NA	51.6	169.3
Memorial Middle School	20	NA	103.8	162.5
Spotswood High School	17	NA	112.2	226.4

Historic Energy Consumption (continued)

Portfolio Manager Sign - In

- An account has been created for Spotswood Schools in Portfolio Manager. You will have received an email to notify you of the generation of this account and shared access with Dome-Tech. Please use this to read your facility information. Please feel free to alter this information when the report is finalized. We would ask that you leave the sign-in information alone until then. Your college's information is currently shared as read only.
- When the report is finalized the shared access will be changed so that you can use / edit the information and change as you wish.
- Website link to sign-in: https://www.energystar.gov/istar/pmpam/index.cfm?fuseaction=login.Login

- Username: SpotswoodBOE
- Password: DTSpotswoodBOE
- Email for account: tspinillo@spotswood.K12.nj.us

Facility Information

Building Name: Schoenly Elementary

Address:	80 Kane Avenue, Spotswood, NJ
Gross Floor Area:	35,942 sq ft.
Year Built:	1958
Grades:	Pre-K through 1
# Students/ # Staff:	236/37

Construction Features:

Facade:	Concrete masonry with brick; in good condition
Roof Type:	Pitched, white, metal deck; tar with river rock; in good condition (installed in 2004)
Windows:	Metal frame, operable, dual pane with shades; in good condition
Exterior Doors:	Metal with glass, in good condition

Major Mechanical Systems

Air Handlers / AC Systems / Ventilation Systems

- Fifteen (15) Exhaust Fans - (12 Greenheck; 3 Universal)
- Fifteen (15) Lennox - Packaged Roof Top Units
- Two (2) Lennox - Split System Roof Top Unit's

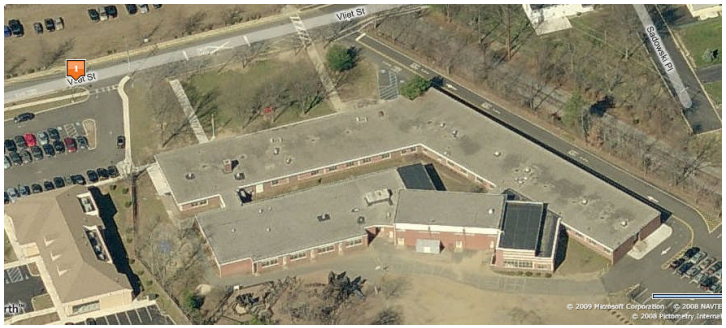
Boilers/ Heating Systems

- Four (4) Marley Eng. Products Unit Heaters
- Nine (9) McQuay Classroom Unit Heaters

Facility Information

Building Name: Appleby Elementary

Address:	23 Vliet Street, Spotswood, NJ
Gross Floor Area:	52,160 sq ft.
Year Built:	1953
Grades:	2-5
# Students/ # Staff:	461/61



Construction Features:

Facade:	Brick; in good condition
Roof Type:	Pitched, black, metal deck, rubber membrane; in good condition
Windows:	Covering 30-40% of façade, metal frame, operable dual pane with shades
Exterior Doors:	Metal doors, three are new (1995), three to be repaired this summer, remaining seventeen require attention

Major Mechanical Systems

Air Handlers / AC Systems / Ventilation Systems

- Sixty-three (63) Water Furnace Ground Source Heat Pumps
- One (1) Carrier - Air Handling Unit
- Two (2) Circulating pumps for ground source heat pumps
- Seventeen (17) exhaust fans (Loren cook, Greenheck, Marathon)
- One (1) AAON Roof Top Unit

Boilers/ Heating Systems

- Sixty-three (63) Water Furnace Ground Source Heat Pumps
- Twelve (12) McQuay Unit Ventilators

Facility Information

- **Building Name:** **Memorial Middle School**

Address:	115 Summerhill Road, Spotswood, NJ
Gross Floor Area:	65,839 sq ft.
Year Built:	1967 (originally); 2004 (renovated)
Grades:	6-8
# Students/ # Staff:	340/41

- **Construction Features:**

Facade:	Concrete masonry with brick
Roof Type:	Pitched, white, metal deck, tar with river rock, in good condition
Windows:	Covering 40% of façade, metal frame, operable, single pane with shades, in good condition
Exterior Doors:	Seventeen are new; three are original, metal

Facility Information

- **Building Name:** **Memorial Middle School**

- **Major Mechanical Systems**

Air Handlers / AC Systems / Ventilation Systems

- Six (6) Packaged Rooftop AC Units with indirect gas fired heating (AAON)
- Thirteen (13) packaged split system AC units (Lennox -1; ICP -12)
- Twenty (20) Exhaust Fans (some Penn; some unidentified)

Boilers/ Heating Systems

- One (1) Cleaver Brooks Gas fired Domestic Hot Water Heater
- Nine (9) Fan Coil Units (5-Mitsubishi; 4 unidentified)
- Two (2) Aerco Hot Water Boilers
- Four (4) Hot Water Pumps (B & G, Taco, AO Smith)

Controls

- One (1) DeVilbiss Air Compressor

Facility Information

Building Name: Spotswood High School

Address:	105 Summerhill Road, Spotswood, NJ
Gross Floor Area:	148,460 sq ft.
Year Built:	1976
Grades:	9-12
# Students/ # Staff:	750/120

Construction Features:

Facade:	Concrete masonry with brick
Roof Type:	Mostly flat, pitched over the new wing, gym, cafeteria, white, gravel, metal deck, slag, tar with gravel, 20 years old
Windows:	Covering 10-15% of façade, all original except for new wing; aluminum, operable, single pane in original, dual pane in new wing with shades, wear and tear evident in old wing; in good condition in new wing
Exterior Doors:	Approximately 25, two are 2 years old, metal frame with insulated glass door, in good condition

Major Mechanical Systems

Air Handlers / AC Systems / Ventilation Systems

- Twenty-four (24) Roof Top AC Units with indirect gas fired heating (Carrier, AAON)
- Nineteen (19) exhaust fans (ILG, Dayton, unidentified)
- Two (2) roof top exhaust fans

Boilers/ Heating Systems

- Twenty-four (24) Roof Top AC Units with indirect gas fired heating (Carrier, AAON)

Greenhouse Gas Emission Reduction

Implementation of all the ECOs will yield:

- 1,581,050 kilowatt-hours of annual avoided electric usage.
- 31,590 therms of annual avoided gas usage.
- This equates to the following ***annual*** reductions:

- 387 tons of CO2;

  -OR-

- 100 Cars removed from road;

  -OR-

- 258 Acres of trees planted annually

The Energy Information Administration (EIA) estimates that power plants in the state of Connecticut emit 0.694 lbs CO2 per kWh generated.

The Environmental Protection Agency (EPA) estimates that one car emits 11,560 lbs CO2 per year.

The EPA estimates that reducing CO2 emissions by 7,333 pounds is equivalent to planting an acre of trees.

Notes and Assumptions

- Project cost estimates were based upon industry accepted published cost data, rough order of magnitude cost estimates from contractors, and regional prevailing wage rates. The cost estimates presented in this report should be used to select projects for investment grade development. The cost estimates presented in this report should not be used for budget development or acquisition requests. Estimated Service Life is from ASHRAE standards.
- Incentives/Equipment Rebates when available are listed in the ECM, if amount is $0 then there is not a rebate currently available for this ECM.
- The following utility prices provided were used within this study:
  - Electricity Cost ($/kWh): $ 0.15
  - Natural Gas Cost ($/therm): $ 1.88
- The average CO2 emission rate from power plants serving the facilities within this report was obtained from the Environmental Protection Agency's (EPA) eGRID2007 report. It is stated that power plants within the state of NJ emit 1.096 lbs of CO2 per kWh generated. The EPA estimates that burning one therm of natural gas emits 11.708 lbs CO2.
- The EPA estimates that one car emits 11,560 lbs CO2 per year.
- The EPA estimates that reducing CO2 emissions by 7,333 pounds is equivalent to planting an acre of trees.

Energy Conservation Measures ECM #1: Vending Machine Power Management

- Dome-Tech recommends installing a VendMiser vending machine power management device on all vending machines.
- The device uses a passive infrared sensor to power down the machine when the area surrounding it is vacant. Then it monitors the room's temperature and automatically re-powers the cooling system at one- to three-hour intervals, independent of sales, to ensure that the product stays cold.
- The microcontroller will never power down the machine while the compressor is running, eliminating compressor short-cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down (reduces compressor wear and tear).

Note: There is no rebate program for this measure

ECM #1: Vending Machine Power Management (continued)

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$810	$490	$160	$180	**$1,640**
Estimated Gross Implementation Costs:	$900	$540	$180	$180	**$1,800**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$900	$540	$180	$180	**$1,800**
Estimated Simple Payback (years):	1.1	1.1	1.1	1.0	**1.1**
Annual Avoided CO_2 Emissions (tons):	1.9	1.2	0.4	0.4	**3**

ECM #2: Weather-stripping Exterior Doors

	High School	Memorial MS	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$90	$90	$200	**$380**
Estimated Gross Implementation Costs:	$350	$350	$700	**$1,400**
NJ Smart Start Rebate:	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$350	$350	$700	**$1,400**
Estimated Simple Payback (years):	3.9	3.9	3.5	**3.7**
Annual Avoided CO_2 Emissions (tons):	0.5	0.2	0.2	**0.9**

Infiltration Area

Picture: Appleby School

- Many of the perimeter doors have poor weather stripping that allow infiltration to enter conditioned areas causing an unnecessary increase in the heating, cooling and dehumidification load.
- Dome-Tech recommends replacing all old weather stripping on perimeter doors that do not have vestibules. Also the threshold in the high school should be reinforced.
- Energy savings will be realized by the reduction of hot and cold outside air that the building's HVAC equipment must condition to room temperature.

Note: There is no rebate program for this measure

ECM #3: Premium Efficiency Motors

	APPLEBY	MEMORIAL MS	TOTALS
Estimated Annual Energy Cost Savings:	$950	$160	**$1,110**
Estimated Gross Marginal Costs:	$890	$1,800	**$2,690**
NJ Smart Start Rebate:	$320	$220	**$540**
Net Estimated Marginal Costs:	$570	$1,580	**$2,150**
Estimated Simple Payback (years):	0.6	9.9	**1.9**
Annual Avoided CO2 Emissions (tons):	2.1	0.3	**2.4**

- Most of the existing motors serving the AHU's and pumps are standard efficiency motors. See the appendix for a detailed list of motors surveyed for this ECO.

Typical Efficiencies for Standard & Premium Motors
(1800 RPM Open Drip-Proof Motors)

LOCATION	HP	EXISTING	PROPOSED
APPLEBY BOILER MER	40	*89.5%*	94.1%
APPLEBY BOILER MER	40	*89.5%*	94.1%

- Dome-Tech recommends replacing select regularly operated standard efficiency motors (pumps and large AHU's) with new premium efficiency motors. For all other motors, when the motor starts to fail it is recommended that they are replaced with new premium efficiency motors. The new motors would reduce the electrical consumption of the buildings' motors by approximately $1,110/year.

ECM #4 - Walk-In Cooler Controllers

	High School
Estimated Annual Energy Cost Savings:	$370
Gross Estimated Implementation Cost:	$2,340
NJ Smart Start Rebate:	$0
Net Estimated Implementation Cost:	$2,340
Simple Payback (years):	6.3
Annual Avoided CO2 Emissions (tons):	1.0

- Typically the walk-in cooler evaporator fans run continuously. However, full airflow is only required 50% of the runtime.
- In the most common applications (those that use single-phase power), motors for the fans are typically shaded-pole or permanent-split-capacitor types, both of which are very inefficient.
- Inexpensive controllers are currently available that slow these fans when full-speed operation is unnecessary.
- Reducing the operating speed reduces the energy consumption of the fan. In addition, the motor produces less heat at slower speeds, which means that the compressor has less heat to remove from the refrigerated compartment.

Note: There is no rebate program for this measure

ECM #5: Lighting Upgrade

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$15,000	$5,300	$3,100	$7,800	**$31,200**
Estimated Gross Implementation Costs:	$96,300	$35,500	$30,200	$46,100	**$208,100**
NJ Smart Start Rebate:	$6,270	$3,430	$1,620	$3,440	**$14,760**
Net Estimated Implementation Costs:	$90,030	$32,070	$28,580	$42,660	**$193,340**
Estimated Simple Payback (years):	6.0	6.1	9.2	5.5	**6.2**
Annual Avoided CO_2 Emissions (tons):	31	12	7	17	**67**

- Although most of the current light fixtures have higher efficiency T-8 fluorescent lamps and ballasts, improved light fixture designs will further reduce lighting energy costs by reducing the total number of lamps and fixtures while maintaining the minimum lighting output as per state codes.

- Many areas were observed to have lights on regardless of occupancy. Installing occupancy sensors in these areas will automatically turn lights on/off according to actual occupancy by sensing the presence of people in the room. Occupancy sensors will reduce lighting energy costs by approximately 30%*.

*Source: Turner, Wayne, Energy Management Handbook, 1999.

ECM #6: Replacement of Heat Pump

	Appleby
Estimated Annual Energy Cost Savings:	$4,400
Gross Estimated Implementation Cost:	$581,300
Estimated Like and Kind Replacement Cost:	$547,000
Estimated Gross Marginal Implementation Costs:	$34,300
NJ Smart Start Rebate:	$2,100
Net Estimated Implemtation Costs:	$32,200
Estimated Simple Payback (years):	7.3
Annual Avoided CO_2 Emissions (tons):	11

Appleby School

- The existing heat pumps are between 15-30 years old and are at the end of their estimated equipment service life (EESL) per ASHRAE standards. (The EESL for heat pump is 15 years.)
- Replacing these Heat Pump's with new, higher efficiency units will significantly reduce annual energy and maintenance costs.
- New Jersey SmartStart offers rebates that usually pay for the incremental cost to upgrade to higher efficient units.
- New Jersey SmartStart offers rebates that usually pay for the incremental cost to upgrade to higher efficient units.

*Energy Efficiency Ratios: EER is the rating of cooling output (Btu) divided by the electrical energy input (watts). The higher the EER, the more efficient the unit.

*Savings do not include maintenance savings.

Energy Efficiency Ratios*

Unit Capacity (tons)	Existing SEER	Proposed SEER	# of Units	$/Ton Rebate	Total Rebate
2-10	10	19	65	$81	$27,800

ECM #7: Univent – VFD's on Blower Fans

	Memorial MS	Schoenly	TOTALS
Estimated Annual Energy Savings:	$840	$620	**$1,460**
Gross Estimated Implementation Cost:	$7,970	$5,800	**$13,800**
NJ Smart Start Rebate:	$0	$0	**$0**
Net Estimated Implementation Cost:	$7,970	$5,800	**$13,800**
Simple Payback (years):	9.5	9.4	**9.5**
Annual Avoided CO2 Emissions (tons):	2	1	**3**

- Currently, twenty-six (26) unit ventilators are equipped with single speed fan motors.

- Installation of fractional horsepower variable speed drives on unit ventilators and packaged terminal air conditioning units will reduce fan power energy.

Note: There is no rebate program for this measure

ECM #8: Install Timers on Hot Water Heaters

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$100	$30	$30	$40	**$200**
Estimated Gross Implementation Costs:	$2,900	$220	$215	$220	**$3,555**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$2,900	$220	$215	$220	**$3,555**
Estimated Simple Payback (years):	29.0	7.3	7.2	5.5	**17.8**
Annual Avoided CO_2 Emissions (tons):	0	0	0	0	**0**

- The two buildings creates domestic hot water from 3 electric hot water heaters (one per mechanical room). The hot water heaters are rated for a total of 140 gallons and 14.5 kilowatts of heating.
- Although hot water heaters/storage tanks are insulated, there is significant standby heat loss during off hours. The heating elements turn on throughout unoccupied hours to maintain the desired set point temperature.
- Placing timers on the units will turn the units off during unoccupied hours and turn them back on two hours prior to occupation. This setback schedule eliminates energy used to make up the standby heat loss.
- The boiler in the administration wing in the high school is heated a boiler year round, moving to an instantaneous tankless heat will eliminate standby heat loss.

Dome-Tech does not recommend this ECM for the High School since the payback periods is longer than 25 years

Note: There is no rebate program for this measure

ECM #9: Replace Kitchen Equipment with Energy Star Rated Equipment

- Most of the kitchen equipment (reach-in coolers/freezers, food warmers, dishwashers) in the Spotswood is older and less efficient than newer higher efficiency equipment. (ASHRAE states the service life of similar equipment to be 15 years).
- Replacing the electric equipment with higher efficiency Energy Star labeled equipment will provide at least $2,690 in annual savings.
- Improvements in kitchen equipment include lower idle rates, better insulation which reduces the amount of standby losses through sides and top, and premium efficient fan motors.


Dishwasher


Food Warmer


Electric Convection Oven


Freezer Refrigerator

ECM #9: Replace Electric Kitchen Equipment with Energy Star (continued)

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$1,820	$470	$170	$230	**$2,690**
Estimated Gross Implementation Costs:	$32,900	$5,400	$2,700	$5,390	**$46,390**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$32,900	$5,400	$2,700	$5,390	**$46,390**
Estimated Simple Payback (years):	18.1	11.5	15.9	23.4	**17.2**
Annual Avoided CO_2 Emissions (tons):	4	1	0	1	**6**

Note: There is no rebate program for this measure

ECM #10: High Efficiency Boilers

- Memorial Middle School has one (1) 750 MBH Cleaver Brooks fire-tube hot water boiler.
- The boiler is at the end of the equipment service life (ASHRAE states the service life of similar equipment to be 25 years).
- The boiler's age, size, type and configuration of the boilers do not lend themselves to efficient operation. Generally, as boilers approach the end of their service life, the efficiency degrades and the boiler must consume more fuel in order to produce the same rated output. In addition, there is a direct correlation between risk of equipment failure (tube breaks & meltdown, shell cracks, furnace surface area failure) and equipment age.
- If the existing boilers were replaced high efficiency condensing boilers, savings will be incurred in two ways. Firstly, in modular boiler applications, multiple smaller boilers are installed to meet the overall building load. Each boiler operates independently, eliminating the "all on/all off" operation of single burner boilers. As building load increases only those units necessary to meet the load are fired. This allows each unit to run optimal efficiency. Secondly, condensing boilers extract more heat from natural gas thus allowing efficiencies of 90% and above.
- The high first cost of a new boiler system preclude this ECO from being justified by economics alone. However, reliability issues warrant consideration of this project as part of a long-term capital improvement plan. Installation of a new boiler would allow boiler runtimes to be equally distributed and would allow for reliable backup capacity should one boiler fail or require repairs.

ECM #10: High Efficiency Boilers

➢High efficiency boilers should be considered when the existing boilers near the end of their useful equipment lives.

	Memorial MS
Estimated Annual Energy Cost Savings:	$6,300
Gross Estimated Implementation Cost:	$159,720
Estimated Like and Kind Replacement Cost:	$137,340
Estimated Gross Marginal Implementation Costs:	$22,380
NJ Smart Start Rebate:	$1,750
Net Estimated Implemtation Costs:	$20,630
Estimated Simple Payback (years):	3.3
Annual Avoided CO_2 Emissions (tons):	24

ECM #11: Replacement of RTU's

	High School	Memorial MS	Schoenly	TOTALS
Estimated Annual Energy Cost Savings:	$10,200	$2,000	$1,100	**$13,300**
Gross Estimated Implementation Cost:	$87,000	$94,400	$41,700	**$223,100**
Estimated Like and Kind Replacement Cost:	$60,000	$83,200	$39,100	**$182,300**
Estimated Gross Marginal Implementation Costs:	$27,000	$11,200	$2,600	**$40,800**
NJ Smart Start Rebate:	$21,900	$9,000	$2,100	**$33,000**
Net Estimated Marginal Costs:	$5,100	$2,200	$500	**$7,800**
Estimated Simple Payback (years):	0.5	1.1	0.5	0.6
Annual Avoided CO_2 Emissions (tons):	11	4	6	21

*Savings do not include maintenance savings.

- The existing rooftop units (RTUs) are between 15-30 years old and are at the end of their estimated equipment service life (EESL) per ASHRAE standards. (The EESL for package rooftop units is 15 years.)
- Replacing these RTU's with new, higher efficiency units will significantly reduce annual energy and maintenance costs.
- New Jersey SmartStart offers rebates that usually pay for the incremental cost to upgrade to higher efficient units.
- New Jersey SmartStart offers rebates that usually pay for the incremental cost to upgrade to higher efficient units.

*Energy Efficiency Ratios: EER is the rating of cooling output (Btu) divided by the electrical energy input (watts). The higher the EER, the more efficient the unit.

Energy Efficiency Ratios*

Unit Capacity (tons)	Existing SEER	Proposed SEER	# of Units	$/Ton Rebate	Total Rebate
3-30	9	13	47	$81	$36,600

ECM #12: Building Management System

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$26,500	$21,900	$23,900	$36,800	**$109,100**
Estimated Gross Implementation Costs:	$69,400	$73,900	$80,900	$97,900	**$322,100**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implemtation Costs:	$69,400	$73,900	$80,900	$97,900	**$322,100**
Estimated Simple Payback (years):	2.6	3.4	3.4	2.7	**3.0**
Annual Avoided CO_2 Emissions (tons):	65	51	56	80	**252**

- An energy management system (EMS) is a computer system designed specifically for the automated control and monitoring of the heating, ventilation, lighting, and needs of a single facility or group of buildings such as university campuses, office buildings or factories. The system can also be used for data collection and used to produce trend analysis and annual consumption forecasts.

- Aside from a few stand-alone equipment controllers, three schools (High School, Memorial Middle School and Schoenly School) are not equipped with a centralized energy management system, and much of the HVAC is operated manually.

- The Dome-Tech Group recommends installing a Energy Management System with the following capabilities (the following calculations below are included under the Building Management System energy savings):

  - **Setpoint Optimization**
  - **Time of Day Optimization**
  - **Demand Control Ventilation**

Note: There is no rebate program for this measure

ECM #12: Building Management System

- Demand Control Ventilation - Building codes require that a minimum amount of fresh air be provided to ensure adequate air quality. To comply, ventilation systems often operate at a fixed rate based on an assumed occupancy (e.g., 20 cfm per person multiplied by the maximum design occupancy). The result is excessive fresh air volumes which require costly (and unnecessary) conditioning. DCV modulates the amount of outside air based upon the CO2 levels generated by building occupants. Demand ventilation should be added to any return air system where space occupancy varies dramatically. By installing CO2 sensors and controlling the CO2 level at acceptable levels, the outside air flow is kept to the absolute minimum while space conditions are kept in compliance with building codes and standards such as the ASHRAE Indoor Air Quality Standard. Implementing the demand ventilation control would normally incur annual energy savings of over $2,500

- Optimize and Standardize the Space Temperature Set points - A review of the building management systems revealed room and supply temperature set point inconsistencies'. Dome-Tech recommends that standard summer/winter setpoints be implemented as follows:

  - *74 °F cooling – 72 °F heating*
  - *Ensure there are no deviations between the zone temperature set points* ***(prevents one zone heating, next zone cooling)***

- Optimize Time of Day Schedules - Optimizing the schedules to better reflect actual building occupancy will reduce heating and cooling costs.

- Univent – VFD's on Blower Fans - Installation of fractional horsepower variable speed drives on unit ventilators and packaged terminal air conditioning units will reduce fan power energy.

ECM #13: Optimize and Standardize the Space Temperature Setpoints – Option A: BMS

	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$6,700	$8,900	$24,200	**$39,800**
Estimated Gross Implementation Costs:	$73,900	$80,900	$97,900	**$252,700**
NJ Smart Start Rebate:	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$73,900	$26,900	$97,900	**$198,700**
Estimated Simple Payback (years):	11.0	3.0	4.0	**5.0**
Annual Avoided CO_2 Emissions (tons):	3	11	52	**66**

- A review of the building management systems revealed room and supply temperature setpoint inconsistencies.

- Note: Implementation cost estimates include entire energy management system and will provide savings beyond this particular ECM

Note: There is no rebate program for this measure

ECM #13: Optimize and Standardize the Space Temperature Setpoints - Option B: Prog T Stat

	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$6,700	$8,900	$24,200	**$39,800**
Estimated Gross Implementation Costs:	$560	$310	$1,410	**$2,280**
NJ Smart Start Rebate:	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$560	$310	$1,410	**$2,280**
Estimated Simple Payback (years):	0.1	0.0	0.1	**0.1**
Annual Avoided CO_2 Emissions (tons):	3	11	52	**66**

- A review of the facilities showed that the HVAC systems were controlled by non-programmable thermostats.
- Dome-Tech recommends replacing the non-programmable thermostats with programmable thermostats.
- Installing programmable thermostats will provide scheduled temperature control to prevent overheating and cooling when the building is unoccupied.

Note: There is no rebate program for this measure

ECM #14: Optimize Time of Day Schedules – Option A: BMS

Please see Appendix for Time of Day Schedules

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$9,100	$1,500	$4,800	$11,900	**$27,300**
Estimated Gross Implementation Costs:	$69,400	$73,900	$80,900	$97,900	**$322,100**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$69,400	$73,900	$80,900	$97,900	**$322,100**
Estimated Simple Payback (years):	7.6	49.3	16.9	8.2	**11.8**
Annual Avoided CO_2 Emissions (tons):	25	23	16	26	**90**

- A review of the schedules in building management system (BMS) revealed an opportunity to optimize the time of day schedules.
- Optimizing the schedules to better reflect actual building occupancy will reduce heating and cooling costs.
- For example, programming the units to come on one hour later and turn off one hour sooner will reduce HVAC costs.
- Note: Implementation cost estimates include entire energy management system and will provide savings beyond this particular ECM

Dome-Tech does not recommend this ECM for Memorial Middle school since the payback periods is longer than 25 years but if it is incorporated with the other BMS measures the total payback for the middle school will be reduced to 11 years.

Note: There is no rebate program for this measure

ECM #14: Optimize Time of Day Schedules – Option B: Prog T Stat

	Spotswood HS	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$9,100	$1,500	$4,800	$11,900	**$27,300**
Estimated Gross Implementation Costs:	$2,440	$560	$310	$1,410	**$4,720**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implemtation Costs:	$2,440	$560	$310	$1,410	**$4,720**
Estimated Simple Payback (years):	0.3	0.4	0.1	0.1	**0.2**
Annual Avoided CO_2 Emissions (tons):	25	4	16	26	**71**

- A review of the facilities showed that the HVAC systems were controlled by non-programmable thermostats.
- Dome-Tech recommends replacing the non-programmable thermostats with programmable thermostats.
- Installing programmable thermostats will provide scheduled temperature control to prevent overheating and cooling when the building is unoccupied.

Note: There is no rebate program for this measure

ECM #15: Demand Control Ventilation

	High School	Memorial MS	Schoenly	Appleby	TOTALS
Estimated Annual Energy Cost Savings:	$ 5,940	$ 8,540	$ 6,800	$ 4,400	**$25,680**
Estimated Gross Implementation Costs:	$69,400	$73,900	$80,900	$97,900	**$322,100**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Costs:	$69,400	$73,900	$80,900	$97,900	**$322,100**
Estimated Simple Payback (years):	11.7	8.7	11.9	22.3	**12.5**
Annual Avoided CO_2 Emissions (tons):	20	25	18	11	**74**

- Building codes require that a minimum amount of fresh air be provided to ensure adequate air quality. To comply, ventilation systems often operate at a fixed rate based on an assumed occupancy (e.g., 20 cfm per person multiplied by the maximum design occupancy). The result is excessive fresh air volumes which require costly (and unnecessary) conditioning.

- Demand-controlled ventilation controls the amount of outside air based upon the CO_2 levels generated by building occupants. Demand ventilation should be added to any return air system where space occupancy varies dramatically – High School Gym, Middle School Cafeteria and Music Room, Appleby All Purpose Room, Schoenly All Purpose Room
- By installing CO_2 sensors and controlling the CO_2 level at less than 1000 PPM, the outside air flow is kept to the absolute minimum while space conditions are kept in compliance with building codes and standards such as the ASHRAE Indoor Air Quality Standard.

- Note: Implementation cost estimates include entire energy management system and will provide savings beyond this particular ECM

Note: There is no rebate program for this measure

ECM #16: Creation of an Energy Awareness & Education Program

- The Spotswood schools currently have little or no observed program in place. Only the High School displayed posters encouraging conservation. This effort could be enhanced and spread throughout the four schools to increase participation.
- Educational institutions are where our nation's youth spend a significant portion of their time. As such, educators can have a potentially large impact on promoting an energy conscious and conservation-minded society that starts at their school, leading to energy cost reductions, environmental benefits, and national energy independence.
- In addition, schools can receive recognition for their efforts and possible media coverage, which can contribute to enhanced school spirit, and individual feelings of accomplishment and connection.

Estimated Annual Savings:	2-3%*
Gross Estimated Implementation Cost:	$1500 each
Expected Rebate / Energy Efficiency Credit:	None
Net Estimated Implementation Costs:	$1,500
Simple Payback (yrs): (with and w/o rebate)	Varies
Annual Avoided CO2 Emissions (tons):	Varies
Cost per Ton CO2 Reduction ($/ton):	Varies

Renewable/Distributed Energy Measures

Distributed Generation & Renewable Energy

- Distributed Generation (on-site generation) generates electricity from many small energy sources. These sources can be renewable (solar/wind/geothermal) or can be small scale power generation technologies (CHP, fuel cells, microturbines)
- Renewable energy is energy generated from natural resources (sunlight, wind, and underground geothermal heat) which are naturally replenished
- Photovoltaics (solar) are particularly popular in Germany and Spain and growing in popularity in the U.S.
- Wind power is growing as well, mostly in Europe and the U.S.
- Geothermal applications are used widely in western U.S. (most prominent in the Yellowstone basin and in northern California)

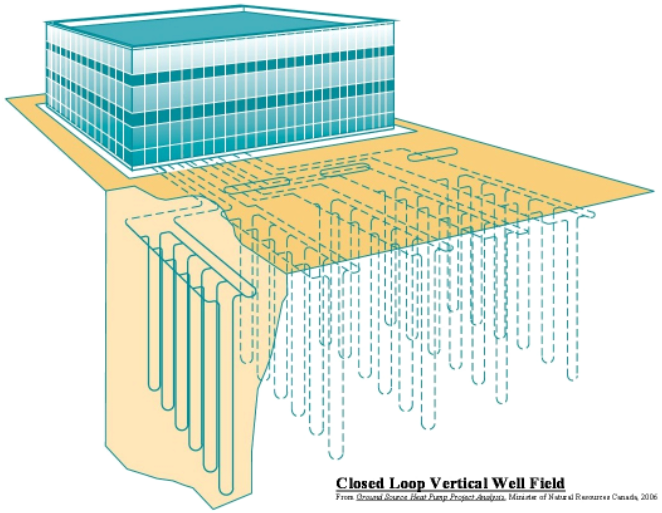
Renewable Energy Technologies: Geothermal

Geothermal ground source heat pump (GSHP) systems are HVAC systems that use the earth's relatively constant temperature to provide heating or cooling to a system. In doing so, GSHP systems move 3 to 5 times more energy between the building and the ground than is actually consumed by the system components. In comparison, this represents a 30% decrease in energy consumption when compared to conventional HVAC systems that required chillers or refrigeration coils for cooling and boilers or electric resistance coils for heating.

A GSHP system consists of three major components: the heat pump, the well field, and the heating/cooling distribution system.

Heat Pump

The heat pump is the driving force behind a GSHP system. A typical heat pump is an "air-to-water" unit, meaning the fluid carries heat to and from the earth (via the earth connection) is a water or water/antifreeze mixture, and the HVAC distribution system in the building distributes hot or cold air. Heat pumps are self-contained in a single enclosure and consist of a refrigerant compressor, earth heat sink heat exchanger, and an air distribution system (fan, refrigerant-to-air heat exchanger, and condensate removal). Heat pumps range in size between 1 to 30 tons. For larger facilities (such as schools and office buildings), several heat pump units are required.



Closed Loop Vertical Well Field

From Ground Source Heat Pump Project Analysis, Minister of Natural Resources Canada, 2006

Well Field

The well field provides the heat exchanging mechanism between the GSHP system water side and the earth. Well fields are either open or closed system. Open systems directly draw from an adjacent water source such as a lake or aquifer. Closed systems are typically polyurethane tubing buried in horizontal trenches or boreholes. The system selected for this analysis is a closed loop, horizontal well field. Wells are typically 250 to 500 feet deep each, and provide 1 ton of cooling for every 250 linear feet. Wells are spaced at 15 to 20 feet on center, and larger systems can have a significant footprint. In addition, the well boring portion of the project is capital intensive and usually accounts for over 50% of the total GSHP system cost. Once installed, and well field has a estimated equipment service life of over 50 years.

Heating/Cooling Distribution System

The heating/cooling distribution system consists of the ductwork used to supply conditioned air the building. As previously stated, larger facilities often require multiple heat pumps connected to a common building loop. Buildings equipped with GSHP's may also require make-up air units to provide fresh air to the spaces, as well as an auxiliary heat source (such as a boiler or steam heat exchanger) to supplement heating during high heating degree days.

Renewable Energy Technologies: Geothermal

The project economics and GSHP pro's and cons are presented in the following tables:

GSHP Economics*

	GSHP	DX Roof Top
Gross Installation Cost Estimate	$4,389,000	$2,194,500
NJJ SSB Rebate	$231,990	$49,533
Net Installation Cost Estimate	$4,157,010	$2,144,967
Annual Energy Cost	$259,764	$381,723
Annual Electric Use, kWh	1,659,565	1,501,554
Annual Natural Gas Use, Therms	0	82,281
Annual CO2 Emmisions, Therms	581	1,007

*Based upon Spotswood High School HVAC Systems & Energy Profile

Simple Payback on Net Install Cost GSHP

Net Installation Cost Estimate	$4,157,010
Annual Energy Savings	$ 121,959
Simple Payback (years)	34.5

Simple Payback on Incremental Cost of GSHP

Net Installation Cost Estimate	$2,916,981
Annual Energy Savings	$ 121,959
Simple Payback	23.9

GSHP Pros & Cons

Pros	Cons
➢Annual HVAC energy reduction of over 50% and energy spend by over $122,00. ➢Well fields installations typically last over 50 years. ➢Reduction of annual greenhouse gas emissions by 581 tons per year. ➢Potential for removal of boiler and chiller / low efficiency DX refrigeration system. ➢Potential for reduced maintenance costs if the GSHP system replaces a cooling tower or other equipment.	➢Payback period is longer than expected life of heat pump equipment (exclusive of well field). ➢Ground conditions are not always conducive to a well field installation. Conditions unknown until drilling is complete. ➢The well field requires a significant amount of real estate. In this case, well over an acre of land may be required depending on depth of well field.

A GSHP installation is not recommended as an immediate retrofit project for the schools without geothermal. However, a detailed life cycle analysis of a GSHP system versus a traditional HVAC system is recommended once the existing equipment exceeds the estimated equipment service life.

Renewable Energy Technologies: Wind

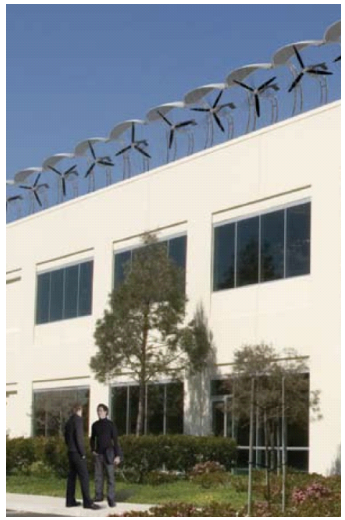
Wind turbines generate electricity by harnessing a wind stream's kinetic energy as it spins the turbine airfoils. As with most renewable energy sources, wind energy is subject to intermittent performance due to the unpredictability of wind resources.

Spotswood Wind Speed

As previously stated, wind speed is critical to the successful wind turbine installation. According to average wind data from NASA's Surface Meteorology and Solar Energy records, the average annual wind speed for the Spotswood area is 4.6 meters per second. Ideal wind speeds for a successful project should average over 6 meters per second.

For the Spotswood schools, Dome-Tech considered three (3) types of wind turbine technologies; building integrated wind turbines (1 kW each) and traditional ground mounted wind turbines (5 kW & 50 kW).

Building Integrated Wind Turbines
Model: AeroVironment AVX1000
Height: 8.5'
Rotor Diameter: 6'
Weight: 130 lbs.
Cut-In Wind Speed: 2.2 m/s
Maximum Generating Capacity: 1 kW



5 kW Ground Mount
Model: WES5 Tulipo
Height: 40'
Rotor Diameter: 16'
Weight: 1,900 lbs.
Cut-In Wind Speed: 3.0 m/s
Maximum Generating Capacity: 5.2 kW

50 kW Ground Mount
Model: Entegrity EW50
Height: 102'
Rotor Diameter: 50'
Weight: 21,000 lbs.
Cut-In Wind Speed: 4.0 m/s
Maximum Generating Capacity: 50 kW

Renewable Energy Technologies: Wind

The project economics and wind turbine pros and cons are presented in the following tables:

Wind Turbine Economics

	Building Integrated	Ground Mount 5 kW	Ground Mount 50 kW
Gross Installation Cost Estimate	$130,000	$62,400	$250,000
NJJ SSB Rebate	$54,029	$49,239	$120,036
Net Installation Cost Estimate	$75,971	$13,161	$129,964
Annual Energy Savings	$3,465	$2,462	$24,588
Simple Payback	21.9 yrs.	5.3 yrs.	5.3 yrs.
System Capacity	20 kW	10 kW	50 kW
Annual Avoided Energy Use	21,658 kWh	15,387 kWh	153,672 kWh
Annual CO2 Emmisions, Therms	8	5	54
% of Annual Electric Use*	1.1%	0.7%	7.5%

Spotswood High School: 2,059,200 kWh/Year.

Wind Turbine Pros & Cons

Pros	Cons
➢Annual reduction in energy spend and use can be potentially reduced by almost $24,600 (7.5% reduction). ➢Typical equipment life span is 15-30 years. ➢Reduction of annual greenhouse gas emissions by 54 tons per year. ➢A wind turbine project could be incorporated into science and other curriculums to raise student awareness of energy alternatives. ➢High visible “green” project.	➢Payback period is significant (over 10 years). ➢Average area wind speed is not ideal and impacts performance. ➢Prone to lighting strikes. ➢Bird collisions are likely, but may be reduced with avian guard (building integrate only). ➢Zoning may be an issue. Check with local zoning regulations. ➢Wind turbines do create noise, although below 50 dB (a typical car ride is over 80 dB).

Due to attractive payback and high potential for energy reduction, the 50 kilowatt ground mounted wind turbine project appears to be the most attractive option. Should the Spotswood BOE decide to pursue a wind turbine project, Dome-Tech recommends commissioning a more detailed study.

Solar Photovoltaic

- Sunlight can be converted into electricity using photovoltaic's (PV).
- A solar cell or photovoltaic cell is a device that converts sunlight directly into electricity.
- Photons in sunlight hit the solar panel and are absorbed by semiconducting materials, such as silicon. Electrons are knocked loose from their atoms, allowing them to flow through the material to produce electricity.
- Solar cells are often electrically connected and encapsulated as a module, in series, creating an additive voltage. The modules are connected in an array. The power output of an array is measured in watts or kilowatts, and typical energy needs are measured in kilowatt-hours.
- Can be recommended in this application for placement on additional schools.

Solar Photovoltaic Systems – High School

System Capacity, kw-dc (maximum utilization of roof space)	976 kw dc
Annual Electric Generation, kwhrs of AC electricity produced	1,028,927 kwh
Total Annual Facility Electric Use, kwhrs	2,059,200 kwh
% of Total Annual Usage	50%
All-In Cost of Electric Year 1	$0.155 / kwh
Annual Electric Cost Savings	$159,484
Estimated SREC Value (Year 1):	$640 / SREC
Estimated Year 1 SREC Revenue:	$658,174
Equivalent Annual CO2 Emission Reduction (tons per year)[1]	564 tons/yr
Equivalent Cars Removed From Road Annually[2]	98
Equivalent Acres of Trees Planted Annually[3]	154
System Installed Cost (does not include value of tax credits)	$6,833,484
Simple Payback (includes tax incentives)	9.9
IRR (25 Years)	7%

1. Estimated CO2 Emissions Rate: 1.096 lbs/kWh
2. EPA Estimate: 11,560 lbs CO2 per car
3. EPA Estimate: 7,333 lbs CO2 per acre of trees planted

Solar Photo Voltaic System

- Non-Financial Benefits of Solar PV
- The implementation of solar PV projects at Spotswood Schools places the district at the forefront of renewable energy utilization. This allows the district the opportunity to not only gain experience with this energy technology, but also to win recognition as an environmentally sensitive, socially conscience institution. Additionally, these projects could be incorporated into science education and additional curriculums to raise awareness of current energy alternatives to the younger generations.

Renewable Energy Technologies: CHP/Cogeneration

- CHP (combined heat and power) or cogeneration is the use of a heat engine to simultaneously generate both electricity and useful heat.
- Fuel Cells are electrochemical conversion devices that operate by catalysis, separation the protons and the electrons of the reactant fuel, and forcing the electrons to travel through a circuit to produce electricity. The catalyst is typically a platinum group metal or alloy. Another catalytic process takes the electrons back in, combining them with the protons and oxidant, producing waste products (usually water and carbon dioxide).
- Microturbines are rotary engines that extract energy from a flow of combustion gas. They can be used with absorption chillers to provide cooling through waste heat rather than electricity. Microturbines are best suited for facilities with year-round thermal and/or cooling loads.
- Not recommended for Spotswood Schools due to the lack of thermal requirements in the summertime.

Energy Procurement - Electricity

- **Accounts and Rate Class:** Spotswood BOE's four schools and administrative facilities are served by 5 electric accounts behind Jersey Central Power & Light under various rate classes.

- **Electric Consumption and Cost:** Total energy consumption over the one year period was approximately 3,578,000 kWh costing about $553,000. The district paid between $.14 and $.18 per kWh.

- **Hourly Energy Pricing and Retail Energy Shopping:**
  - In August 2003, the State of New Jersey deregulated its retail electric marketplace, and per this process, every electric account for every owner was placed into one of two categories: BGS-FP or BGS-CIEP. BGS-FP stands for Basic Generation Service-Fixed Price; BGS-CIEP stands for Basic Generation Service-Commercial and Industrial Energy Pricing.
  - At its first pass, this categorization was based on rate class. The largest electric accounts in the State (those on a Primary or a Transmission-level rate class) were moved into BGS-CIEP pricing. All other accounts (most in NJ) remained on default service, or BGS-FP.
  - Each June, the NJBPU continues to move new large energy users into BGS-CIEP by lowering the demand threshold for electric accounts receiving Secondary service

Energy Procurement - Electricity

- The default billing structure under the CIEP category includes two important features:
  1. Hourly Pricing. The facility is charged for energy generation supply based on the real-time PJM market price; this is an hourly price, and is passed directly through the utility. The kilowatt-hours consumed in each and every hour are charged at that hour's market price for energy. Over the course of a year, the effective monthly cost per kWh will fluctuate and will be unpredictable. In the summer months, Spotswood's supply costs have reached as high as 18.0¢ per kWh; in the shoulder months, Spotswood's supply costs have ranged from 14.0 ¢ - 15.0¢ per kWh. In this scenario, the customer is fully exposed to the performance of the market.
  2. Retail Margin Adder. Customers that do not switch to a retail energy supplier for service are charged a 'retail margin adder' of $0.0053 per kWh.

- Dome-Tech understands that Spotswood BOE has Basic Generation Service Fixed Price accounts that are currently not contracted with a retail energy supplier. Dependent upon the District's desire to achieve budget certainty and to avoid potentially wild price swings resulting from extreme market conditions, Dome-Tech would propose to assist the District with the development of a longer-term energy purchasing strategy, inclusive of conducting its competitive electric procurement processes and providing ongoing advisory services.

Energy Procurement – Natural Gas

- Spotswood BOE is served by 7 natural gas accounts behind Public Service Electric & Gas Company.

- Natural gas is used predominantly for heating purposes; total annual consumption is approximately 9,000 decatherms costing about $162,000.

- Spotswood utilizes Hess Corporation, a retail energy supplier for natural gas (commodity) service with a fixed rate of $1.42 per therm.

- Natural gas futures prices at the time of this report are at about $0.41 per therm for May 2009, and are below $0.60 per therm for the winter of 2009/2010. These are levels that have not been seen in more than 4 years. If Spotswood seeks longer-term rate stability, now is an ideal time to entertain it.

Energy Procurement – Natural Gas

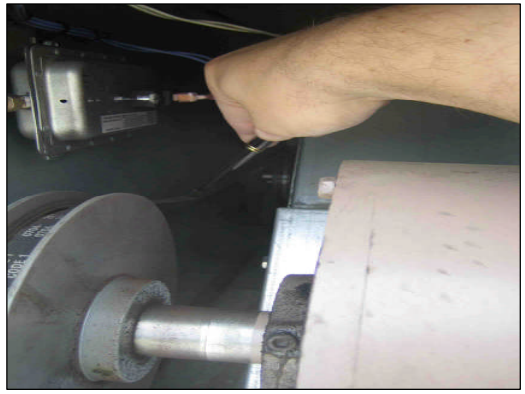
Henry Hub Natural Gas - 12 Month Strip

Operations & Maintenance

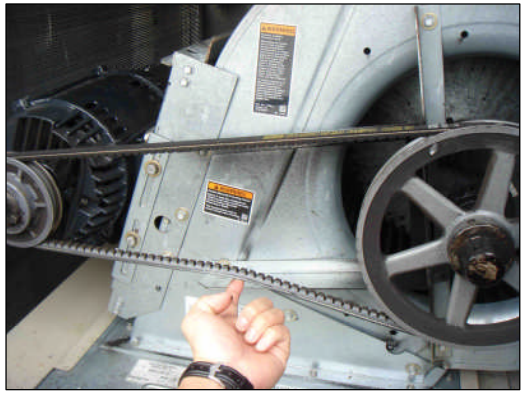
High School, Memorial Middle School, Schoenly School

- Issue: Loose Fan Belts for roof top unit supply fans
- Impact: Pressurization issues, improper ventilation, noise hazard, wasteful energy spending and premature motor failure
- Recommendation: Planned maintenance, functional checks and inspections on exhaust fans and rooftop units
  - High School: RTU – 7, 7A, 10A
  - Memorial Middle School: RTU – 1
  - Schoenly School: RTU 12
    - *There is little or no expected O&M savings from this measure*

Memorial Middle School – RTU 1



Spotswood High School – RTU 7



Schoenly School – RTU 12

Operations & Maintenance

Spotswood High School

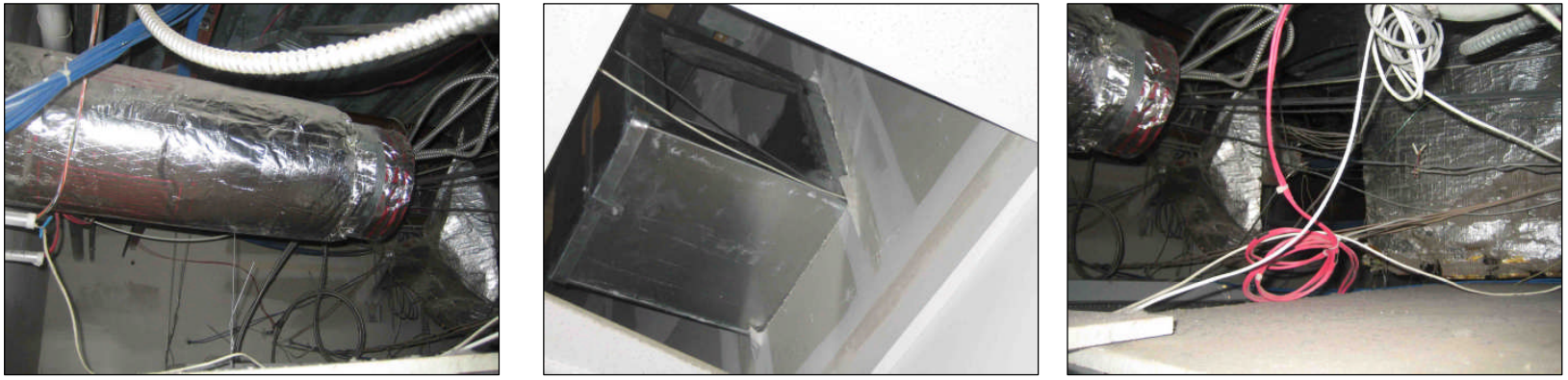
- Issue: Dome-Tech performed a sample installation and functional checks on three VAV Boxes in the new administration wing. Two of the three sample VAV boxes do not respond when called to heat or cool. Also damper does not stroke leading to improper flow rates into each room.
- Impact: Leads to inefficient performance, poor air quality, improper pressurization and ventilation and thermal comfort
- Recommendation: Verify controls and Air balance
  - High School: Rooms H124, H111
    - *There is little or no expected O&M savings from this measure*

Spotswood High School – Admin

Operations & Maintenance

Spotswood High School

- Issue: Improper Air Balance and Ventilation. Air is loud in corridor, the return grills are open above to the drop ceiling and the return air does not properly exhaust
- Impact: Leads to inefficient performance, noise hazards, poor air quality, improper pressurization and ventilation and thermal comfort
- Recommendation: Needs air rebalance and redesign and duct return air to roof top units and/or outside air.
  - *There is little or no expected O&M savings from this measure*



Spotswood High School – Pictures depicting exhaust/return air ending in plenum space

Operations & Maintenance

Memorial Middle School & Appleby School

- Issue: RTU Split System out of commission, Fan on condenser unit freezes and does not run; Heat Pumps out of commission
- Impact: Refrigerant lines overheating. Leads poor air quality, improper pressurization and ventilation and thermal comfort
- Recommendation: Replace RTU Split System
  - Memorial Middle School Electric Room: RTU 4
  - Appleby School Electric Room: Heat Pump 1,3
    - *There is little or no expected O&M savings from this measure due to original design specifications*

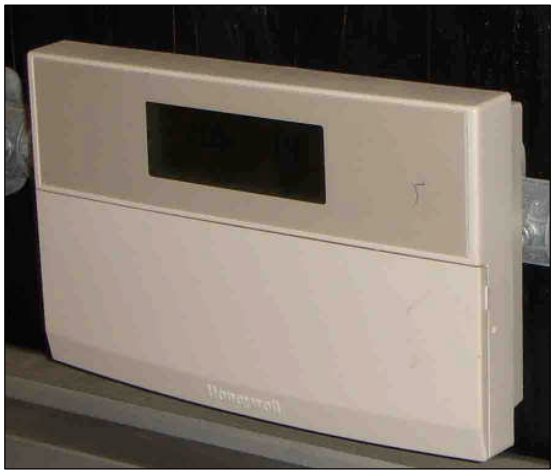
Memorial Middle School – RTU 4

Appleby School – Electric Room

Operations & Maintenance

Appleby School

- Issue: Broken programmable thermostats
- Impact: Leads poor air quality, improper pressurization and ventilation and thermal comfort, improper run time and wasteful energy spending
- Recommendation: Replace Thermostat
  - Appleby School: Room 111B
    - *Replacing the thermostats can save approximately $200 per year*



Appleby School – 111B

Next Steps

- **The following projects should be considered for further study and implementation:**
  - Install BMS systems – all facilities
  - Lighting upgrades – all facilities
  - Install Programmable Thermostats – all facilities
  - Vending machine power management – all facilities
  - RTU Replacement – All facilities
  - Heat Pump Replacement – Appleby School
  - Boiler Replacement - Memorial Middle School
  - Air Testing and Balancing – High School
  - Energy Awareness Program – All facilities
  - Energy Procurement (Electricity & Gas)
  - Retro-Commissioning Opportunities