Readington Township Public Schools

Prepared For:
Readington Township
Board of Education

Energy Audit

FINAL

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

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Energy Audit Purpose & Scope

Purpose:

- The objectives of the energy audit are to evaluate each site's energy consumption, establish baselines for energy efficiency 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. 2010 – Dec. 2010

Buildings	Electric				Natural Gas			
	Account Number	Annual Consumption kWh	Annual Cost	$ / kWh	Account Number	Annual Consumption Therms	Annual Cost	$ / Therms
Readington Middle School	10 00 03 3653 90	610,800	$91,545.46	$0.150	66 901 280 08	35,947	$38,900.52	$1.082
	10 00 03 3654 32	4,857	$857.72	$0.177	65 702 226 00	17,050	$18,932.09	$1.110
	10 00 55 2571 49	514,080	$80,254.61	$0.156				
Holland Brook School	10 00 03 3655 72	1,533,760	$230,617.15	$0.150	66 654 222 08	79,095	$73,958.24	$0.935
Whitehouse School	10 00 57 0375 31	708,000	$109,178.25	$0.154	65 326 195 07	36,089	$38,914.64	$1.078
	10 00 03 3654 99	307,320	$47,646.48	$0.155				
Three Bridges School	10 00 03 5423 11	587,100	$89,566.14	$0.153	48 526 865 21	38,065	$36,491.67	$0.959
	10 00 03 5425 35	140,640	$21,466.74	$0.153				
TOTAL / AVERAGE		**4,406,557**	**$671,132.55**	**$0.152**	**TOTAL**	**206,246**	**$207,197.16**	**$1.005**

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

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.
- Due to inefficient HVAC design of the middle school, and elementary school s and older outdated HVAC units, it will be difficult for these buildings to achieve the energy star label. After implementing some energy conservation measures listed in this this report, the school's energy star score should improve.

Facility Name	Total Floor Area	Energy Star Score	Eligible to Apply for ENERGY STAR	Current Site Energy Intensity (kBtu/SF)	Current Source Energy Intensity (kBtu/SF)
Readington Middle School	121,536	56	NA	70.3	139.4
Holland Brook School	90,869	4	NA	141.2	254.3
Whitehouse School	73,333	28	NA	91.7	197.0
Three Bridges School	61,435	39	NA	93.3	183.3

Historic Energy Consumption (continued)

Portfolio Manager Sign - In

- An account has been created for Readington Township BOE 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 district'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: ***ReadingtonBOE***
- Password: ***DTReadingtonBOE***
- Email for account: ***dthornton@readington.k12.nj.us***

Facility Information

- **Building Name:** **Readington Middle School**

Address:	48 Readington Road Whitehouse Station, NJ 08889
Gross Floor Area:	121,536 sf
Year Built:	1960
Occupants:	Approximately 900 students and staff
Use:	The building is a school serving grades 6 through 8. It is operated M-F from 7 AM until 3:30 PM with lighter occupancy until 9 PM; Saturdays from 8 AM - 6 PM during the months of Dec-Mar and Sundays from 8 AM - 5 PM during the months of Dec-Mar; additionally, summer school is in session M-F from 7 AM - 4 PM during July and August.

- **Construction Features:**

Facade:	One story, brick, in good condition
Roof Type:	Flat, 2/3 is light-colored and 1/3 is dark, metal deck, membrane, in good condition
Windows:	Covering approximately 20% of façade, metal frame, operable, casement-type, shades or blinds on 90% of the windows, in mostly good condition (some are candidates for replacement); many are single pane
Exterior Doors:	Older sections are metal frame and the more newly renovated sections have more glass doors, in good condition (some attention to weather stripping is needed)

Facility Information

Major Mechanical Systems – Readington Middle School

Air Handlers / AC Systems / Ventilation Systems

This facility has 32 packaged rooftop units that are equipped with direct expansion (DX) coils for cooling and gas-fired furnaces or heat wheels for heating and serve various areas throughout the facility including classrooms and offices. Additionally, there are approximately 21 exhaust fans that serve areas including mechanical/boiler rooms, toilets, kitchen, gym and office spaces. The perimeter spaces are served by:

- 10 Trane unit ventilators (UV's) that are equipped with hot water coils (4) or electric coils (6) for heating and DX coils for cooling,
- 9 Nesbitt unit ventilators (UV's) that are equipped with hot water coils for heating and stand-alone window AC units for cooling,
- 5 Airedale Packaged Terminal AC units (PTAC) that are equipped with hot water coils for heating and DX coils for cooling and,
- Perimeter hot water baseboard for heating

Boilers

There are 3 Lochnivar natural gas fired hot water boilers each with a capacity of 750 MBH. These boilers operate in a lead / lag sequence and are served by three (3) ¼ HP primary pumps and two (2) 7 ½ HP secondary pumps that operate in a lead / lag sequence and supply hot water to the new addition of the school.

There are also 3 Patterson-Kelley MACH condensing boilers each with a capacity of 2000 MBH. These boilers operate in a lead / lag sequence and are served by three (3) 3 HP primary pumps and four (4) 5 HP secondary pumps and supply hot water to the original sections of the school.

Domestic Hot Water

There are four (4) A.O. Smith, natural gas fired domestic hot water heaters rated for approximately 240 MBH each.

Controls

The building's heating and cooling equipment are controlled by a Direct Digital Controls (DDC) Building Management System (BMS).

Facility Information

Building Name: Holland Brook School

Address:	52 Readington Road Whitehouse Station, NJ 08889
Gross Floor Area:	90,869 sf
Year Built:	1998
Occupants:	Approximately 400 students and staff
Use:	The building is a school, serving grades 4 and 5. It is operated M-F from 7 AM until 3:30 PM, with lighter usage until 9 PM. Saturdays from 8 AM - 6 PM Dec-Mar and Sundays 8 AM - 5 PM Dec-Mar; additionally summer school is in session from 7 AM – 4 PM M-F during July and August.

Construction Features:

Facade:	One story, brick/block, in excellent condition
Roof Type:	Flat, white, metal deck, membrane, in excellent condition
Windows:	Covering approximately 20% of façade, metal frame, in excellent condition
Exterior Doors:	Mixture of metal and glass, in excellent condition

Facility Information

Major Mechanical Systems – Holland Brook School

Air Handlers / AC Systems / Ventilation Systems

This facility has 21 packaged rooftop units that are equipped with direct expansion (DX) coils for cooling and hot water coils for heating and serve various areas throughout the facility including classrooms and offices. Additionally, there are approximately 22 exhaust fans that serve areas including mechanical/boiler rooms, toilets, kitchen, gym and office spaces.

Boilers

There are 2 Smith natural gas fired, cast iron type hot water boilers each with a capacity of 4180 MBH. These boilers are served by two (2) ¼ HP primary pumps and two (2) 15 HP secondary pumps that supply hot water throughout the school.

Domestic Hot Water

There is one (1) A.O. Smith, natural gas fired domestic hot water heater rated for approximately 300 MBH.

Controls

The building's heating and cooling equipment are controlled by a Direct Digital Controls (DDC) Building Management System (BMS).

Facility Information

Building Name: Three Bridges School

Address:	480 Main Street Three Bridges, NJ 08887
Gross Floor Area:	61,435 sf
Year Built:	1950; renovation 2005
Occupants:	Approximately 500 students and staff
Use:	The building is a school, serving grades Kindergarten through 3rd. It is operated M-F from 7 until 3:30, with lighter usage until 9 pm. Saturdays from 8-6 Dec-Mar and summer school is in session M-F 7-4 during July and August.

Construction Features:

Facade:	Two story, brick/block, in good condition
Roof Type:	Metal deck, membrane (on addition); older section is built-up, in good condition
Windows:	Metal frame, operable, double pane, in good condition
Exterior Doors:	Metal with < 85% glass, in good condition

Facility Information

Major Mechanical Systems – Three Bridges School

Air Handlers / AC Systems / Ventilation Systems

This facility has 12 packaged rooftop units that are equipped with direct expansion (DX) coils for cooling and gas-fired furnaces or heat wheels for heating that serve various areas throughout the facility including classrooms and offices. Additionally, there are approximately 10 exhaust fans that serve areas including mechanical/boiler rooms, toilets, kitchen, gym and office spaces. The perimeter spaces are served by:

- 4 Nesbitt unit ventilators (UV's) that are equipped with steam coils for heating and stand-alone window AC units for cooling,
- 16 Airedale Packaged Terminal AC units (PTAC) that are equipped with steam coils for heating and DX coils for cooling

Boilers

There are 2 Smith natural gas fired, cast iron type steam boilers each with a capacity of 3050 MBH. These boilers supply steam throughout the school.

Domestic Hot Water

There is one (1) Rheem, natural gas fired domestic hot water heater rated for approximately 75.5 MBH.

Controls

The building's heating and cooling equipment are controlled by a Direct Digital Controls (DDC) Building Management System (BMS).

Facility Information

Building Name: Whitehouse School

Address:	50 Whitehouse Avenue Whitehouse Station, NJ 08889
Gross Floor Area:	73,333 sf
Year Built:	1950
Occupants:	Approximately 500 students and staff
Use:	The building is a school, serving grades Kindergarten through 3rd. It is operated M-F from 7 until 3:30, with lighter use until 9 pm. Saturdays from 8-6 Dec-Mar and summer school is in session M-F 7-4 during July and August.

Construction Features:

Facade:	Two story, brick/block, in good condition
Roof Type:	Flat, 1/3 is white, 1/3 is light-colored, 1/3 is black, metal deck, membrane, in good condition
Windows:	Covering approximately 40-50% of façade, metal frame, operable, in good condition
Exterior Doors:	Metal frame, in excellent condition

Facility Information

Major Mechanical Systems – Whitehouse School

Air Handlers / AC Systems / Ventilation Systems

This facility has 11 packaged rooftop units that are equipped with direct expansion (DX) coils for cooling and gas-fired furnaces or heat wheels for heating and serve various areas throughout the facility including classrooms and offices. Additionally, there are approximately 13 exhaust fans that serve areas including mechanical/boiler rooms, toilets, kitchen, gym and office spaces. The perimeter spaces are served by:

- 16 Airedale Packaged Terminal AC units (PTAC) that are equipped with steam coils for heating and DX coils for cooling and,
- Perimeter steam radiators for heating

Boilers

There are 2 Smith natural gas fired, cast iron type steam boilers each with a capacity of 2163 MBH that supply steam throughout the original section of the school.

There are 2 Lochnivar natural gas fired hot water boilers each with a capacity of 1500 MBH that supply hot water throughout the newer section of the school.

Domestic Hot Water

There are two (2) A.O. Smith, natural gas fired domestic hot water heaters rated for approximately 150 MBH each. There is also one (1) older natural gas fired domestic hot water heater rated for approximately 75 MBH.

Controls

The building's heating and cooling equipment are controlled by a Direct Digital Controls (DDC) Building Management System (BMS).

Greenhouse Gas Emission Reduction

Implementation of all identified ECMs will yield:

- 1,571,730 kilowatt-hours of annual avoided electric usage.
- 13,705 therms of annual avoided natural gas usage.
- This equates to the following ***annual*** reductions:

- 625 tons of CO2;

  -OR-

- 108 Cars removed from road;

  -OR-

- 170 Acres of trees planted annually

The Energy Information Administration (EIA) estimates that power plants in the state of New Jersey emit 0.666lbs 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.

Energy Conservation Measure (ECM) #1: Boiler Operates 24/7 – Option 1 and 2

Holland Brook School		
Implementation Type	Option 1: CHP	Option 2: Solar HHW
Estimated Annual Energy Cost Savings:	$72,230	$20,670
Gross Estimated Implementation Costs:	$685,440	$998,870
NJ Smart Start Rebate:	$400	$1,200
Net Estimated Implementation Costs:	$685,040	$997, 670
Simple Payback (years)	9.5	48.3
Annual Avoided CO_2 Emissions (tons):	0	134

- The Holland Brook School HVAC system is equipped with duct mounted hot water reheat coils that require the boilers to remain in service all year.
- Dome-Tech recommends installing a Combined Heat and Power (CHP) system to provide heating hot water to the reheat coils, while simultaneously generating electricity to reduce the amount of utility provided electric power.
- The high initial cost of a CHP system may preclude this ECM from being justified by economics alone. However, reliability and educational opportunities warrant consideration of these projects as part of a long-term capital improvement plan.
- Solar thermal generation for heating hot water was also considered, however, the estimated simple payback period is far greater than CHP and is not recommended.

ECM #2: HHW Supply Temperature Reset

	Middle School	Whitehouse	Three Bridges	TOTAL
Estimated Annual Savings:	$1,440	$1,700	$1,220	**$4,360**
Gross Estimated Implementation Cost:	$1,820	$1,820	$1,930	**$5,570**
NJ Smart Start Rebate:	$0	$0	$0	**$0**
Net Estimated Implementation Cost:	$1,820	$1,820	$1,930	**$5,570**
Simple Payback (years):	1.3	1.1	1.6	**1.3**
Annual Avoided CO_2 Emissions (tons):	8	9	7	**24**

- The Middle School's Lochnivar boilers have a fixed heating hot water (HHW) temperature setpoint that is set at approximately 180˚F during the winter and is manually reset to approximately 160˚F during warmer weather. A hot water reset program will automatically reduce the temperature of the hot water leaving the boilers during low load conditions.
- Automatically resetting the hot water temperature setpoint reduces the load on the boilers and will also decrease the heat losses in the distribution piping, thus decreasing energy consumption.
- Dome-Tech recommends automatically resetting the hot water supply temperature setpoint based on the outdoor air temperature.

ECM #3: Demand Controlled Ventilation

	Middle School	Holland Brook	Whitehouse	Three Bridges	TOTAL
Estimated Annual Savings:	$2,950	$960	$3,690	$2,260	**$9,860**
Gross Estimated Implementation Cost:	$7,860	$3,040	$4,550	$3,040	**$18,490**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Cost:	$7,860	$3,040	$4,550	$3,040	**$18,490**
Simple Payback (years):	2.7	3.2	1.2	1.3	**1.9**
Annual Avoided CO_2 Emissions (tons):	7	2	10	7	**26**
Area Recommended:	Cafeteria, Library, Stage	Cafeteria, Library, Gym	Cafeteria, Gym	Cafeteria	

- 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). Since maximum design occupancy is rarely achieved, this results in excessive fresh air volumes which require costly and unnecessary conditioning.
- Demand-controlled ventilation (DCV) controls the amount of outside air being supplied based upon the CO_2 levels generated by building occupants. DCV should be added to any space that is ventilated by a large quantity of outdoor air, and where occupancy varies dramatically (cafeterias and libraries).
- Because CO_2 levels correlate directly with the number of people in an occupied zone, CO_2 sensors will be used to control the ventilation rate of outside air supplied to each zone. Reducing the amount of outdoor air supplied to a zone reduces the energy required to heat and cool that air, while space conditions are kept in compliance with building codes and standards such as the ASHRAE Indoor Air Quality Standard.

ECM #4: Time of Day Optimization

	Middle School	Holland Brook	Whitehouse	Three Bridges	TOTAL
Estimated Annual Savings:	$220	$3,200	$275	$220	**$3,915**
Gross Estimated Implementation Cost:	$4,500	$2,645	$1,320	$1,320	**$9,785**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Cost:	$4,500	$2,645	$1,320	$1,320	**$9,785**
Simple Payback (years):	20.5	0.8	4.8	6.0	**2.5**
Annual Avoided CO_2 Emissions (tons):	0	11	1	1	**13**

- A review of the Building Management System (BMS) time of day schedules revealed an opportunity to reduce HVAC operating hours and costs.
- For example, many of the Holland Brook HVAC units currently operate from 5:00 am to 9:30 pm Monday through Friday; however, the classrooms are not occupied through that entire period of time. Optimizing the schedules to better reflect actual building occupancy hours (i.e. 6:00 am to 6:00 pm) will reduce heating and cooling conditioning costs, electrical motor costs and have no impact on the indoor air quality during the school days.
- These savings can easily be achieved by adjusting the BMS time of day schedules.

ECM #5: Lighting Upgrades

	Middle School	Holland Brook	Whitehouse	Three Bridges	Totals
Estimated Annual Savings:	$25,800	$21,030	$16,310	$13,695	**$76,835**
Gross Estimated Implementation Cost:	$86,370	$64,350	$41,360	$40,155	**$232,235**
NJ Smart Start Rebate:	$4,900	$8,050	$4,440	$2,345	**$19,735**
Net Estimated Implementation Cost:	$81,470	$56,300	$36,920	$37,810	**$212,500**
Simple Payback (years):	3.2	2.7	2.3	2.8	**2.8**
Annual Avoided CO_2 Emissions (tons):	57	46	35	30	**168**

- Although most of the current light fixtures have higher efficiency T-8 fluorescent lamps and ballasts, improving lamp efficiency will further reduce lighting energy costs while maintaining the minimum lighting output as per state codes. Several of the gyms have older HID lighting technology and should be retrofitted with High Output T5 or T8 fluorescent fixtures.
- 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: Upgrade Door Weather Stripping

Middle School	
Estimated Annual Savings:	**$820**
Gross Estimated Implementation Cost:	**$3,380**
NJ Smart Start Rebate:	**$0**
Net Estimated Implementation Cost:	**$3,380**
Simple Payback (years):	**4.1**
Annual Avoided CO_2 Emissions (tons):	**4**

Close up of exterior door seal at the Middle School

- Missing or degraded weather stripping should be replaced on doors at the following facilities:

Facility	Exterior Doors Qty:
Middle School	6

ECM #7: Replace Electric Kitchen Equipment with Natural Gas Fired Booster Heaters

	Middle School	Holland Brook	Whitehouse	Three Bridges	Totals
Estimated Annual Savings:	$1,930	$1,290	$1,290	$1,320	**$5,830**
Gross Estimated Implementation Cost:	$10,210	$10,210	$10,210	$10,210	**$40,840**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Cost:	$10,210	$10,210	$10,210	$10,210	**$40,840**
Simple Payback (years):	5.3	7.9	7.9	7.7	**7.0**
Annual Avoided CO_2 Emissions (tons):	2	1	1	1	**5**

- Each school's kitchen is equipped with electric hot water booster heaters for dishwashing.
- The school's electric cost is over $ 0.15 per kilowatt hour. The equivalent natural gas cost for a 95% efficient natural gas hot water heater is $ 4.63 per therm. The actual price for natural gas is approximately $ 1.11 per therm (almost 260% less than electric heat).
- Replacing the electric heaters with natural gas units will provide approximately $5,800 in annual savings and will reduce electric demand.

ECM #8: Install VFD Controls On Hot Water Pumps

	Middle School	Holland Brook	Whitehouse	Three Bridges	TOTAL
Estimated Annual Savings:	$1,050	$3,430	$610	$470	**$5,560**
Gross Estimated Implementation Cost:	$8,360	$40,300	$6,550	$6,550	**$61,760**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Cost:	$8,360	$40,300	$6,550	$6,550	**$61,760**
Simple Payback (years):	8.0	11.7	10.7	13.9	**11.1**
Annual Avoided CO_2 Emissions (tons):	2	8	1	1	**12**

- The hot water distribution pumps serve a variable volume system and are currently equipped with system bypass valves that modulate to maintain a differential pressure setpoint. However, the Holland Brook School currently utilizes a constant volume, primary loop pumping system and may have a mix of both 2-way and 3-way hot water control valves. Additionally, the Middle School's old Gym HV units are currently equipped with 3-way hot water control valves to regulate the discharge air temperature.
- Dome-Tech recommends replacing all 3-way control valves to 2-way valves in order to convert to a variable volume pumping system. To take full advantage of the 2-way valves, Dome-Tech recommends reconfiguring the hot water piping in the Holland Brook boiler room to utilize a primary / secondary pumping configuration. This will then allow for utilizing Variable Frequency Drives (VFDs) on the secondary hot water pumps.
- Dome-Tech recommends installing VFDs on the hot water distribution pumps and isolating the bypass valves to reduce pumping energy consumption. The VFDs will modulate the hot water pump speed to maintain the differential pressure setpoint.

ECM #9: Replace Window AC Units

	Middle School	Three Bridges	TOTAL
Estimated Annual Savings:	$190	$160	**$350**
Gross Estimated Implementation Cost:	$3,150	$1,130	**$4,280**
NJ Smart Start Rebate:	$0	$0	**$0**
Net Estimated Implementation Cost:	$3,150	$1,130	**$4,280**
Simple Payback (years):	16.6	7.1	**12.2**
Annual Avoided CO_2 Emissions (tons):	0	0	**0**

Middle School Window AC Unit

- Window air conditioning units that are installed at the Middle and Three Bridges Schools provide localized air conditioning for several classrooms. The units are in good/fair physical condition, however they are inefficient compared to today's standards.
- Dome-Tech recommends replacing these units with new, higher efficiency units.
- New 10.5 SEER (Seasonal Energy Efficiency Rating) units are estimated to be 8% - 30% more efficient at full/part loads than the existing equipment.

Three Bridges School Window AC Unit

ECM #10: Boiler Combustion Controls Upgrade

Combustion Controls

Whitehouse Elementary School	
Estimated Annual Energy Cost Savings:	$1,130
Gross Estimated Implementation Costs:	$15,100
NJ Smart Start Rebate:	$0
Net Estimated Implementation Costs:	$15,100
Simple Payback (years)	13.4
Annual Avoided CO_2 Emissions (tons):	6

- The Whitehouse Elementary School boilers utilize mechanical linkage fuel-air controls. This configuration is typically reliable and cost effective. A jack shaft is rotated by an actuator. The forced draft fan flow control damper and the fuel valves are mechanically linked to the jack shaft. The fuel valves are characterized, over the burner firing range, to achieve the proper fuel to air ratio. These systems are mechanically controlled and prone to back-lash and hysteresis, reducing the operating efficiency. The estimated turndown ratio with this configuration is 3 to 1.
- Upgrading the boilers to utilize "linkageless" controls will provide significant annual fuel cost savings. "Linkageless" controls independently adjust the fuel and air control devices to maintain the desired fuel to air ratio. This type of control system provides extremely accurate control, improves the operating efficiency, reduces boiler emissions and provides energy savings.
- The annual fuel savings from a "linkageless" control system is estimated at 3% of the annual fuel usage (1,083 therms per year).
- Other added benefits to this upgrade include Flue Gas Recirculation control capability and improved turndown up to 6 to 1.

ECM #11: Replace Boilers with High Efficiency Modulating Condensing Boilers

- The Holland Brook School is equipped with two 79% efficient natural gas fired hot water boilers. The Three Bridges School is equipped with two 61% efficient natural gas fired steam boilers with approximately 70% of the steam output converted to heating hot water.
- For the most part, these boilers are old and are at or nearing the end of their equipment service life (ASHRAE states the service life of similar equipment to be 25 years).
- The ages, sizes, types and configurations of the boilers do not lend themselves to efficient operation. Generally, as boilers approach the end of their service life, their efficiency degrades and they 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.
- For the Holland Brook School, Dome-Tech recommends replacing the two older cast-iron boilers with three smaller, 95% efficient condensing boilers each rated for 50% of the load or approximately 1800 MBH each.
- For the Three Bridges School, Dome-Tech recommends the following:
  - Replace one of the large 61% efficient steam boilers with three smaller, 82% efficient boilers each rated for 50% of the steam load or approximately 360 MBH each.
  - Remove the steam to hot water converter and replace the second large 61% efficient steam boiler with three smaller, 95% efficient condensing boilers each rated for 50% of the heating hot water load or approximately 700 MBH each.

Picture: Cast Iron Sectional Boiler at the Holland Brook School

Picture: Old Cast Iron Sectional Steam Boiler at the Three Bridges School

NOTE: The presented economics should be used for planning purposes only. If the District decides to proceed with any boiler replacement project, these economics should be refined with an investment grade analysis.

ECM #11: Replace Boilers w/ High Efficiency Modulating Condensing Boilers (continued)

- If the existing boilers were replaced by high efficiency, modulating or modular condensing boilers, savings will be realized in three ways.
  - The new boiler efficiencies are significantly greater than the existing boilers.
  - Modulating boilers, usually 1,000 MBH or smaller, employ multiple burners to meet the heating load. Each burner operates independently, eliminating the "all on/all off" operation of single burner boilers. As building load increases only those burners necessary to meet the load are fired. This allows each burner to run at optimal efficiency. Modular boilers operate under the same principal but for larger installations. In this case multiple boilers are used rather than multiple burners. Modular boilers usually are employed in 1000, 2000 or 3000 MBH sizes.
  - Condensing boilers recover energy from the exhaust gas resulting in higher efficiencies of 90% and above.
- When a boiler is both a modulating/modular type and a condensing type, extremely high efficiencies can be realized.
- The high first cost of a new boiler system may preclude this ECM from being justified by economics alone. However, reliability issues warrant consideration of these projects as part of a long-term capital improvement plan. The ECM table details the economics at each site.

	Holland Brook	Three Bridges	Totals
Estimated Annual Savings:	$9,175	$10,170	**$19,345**
Gross Estimated Implementation Cost:	$203,410	$131,650	**$335,060**
NJ Smart Start Rebate:	$5,400	$5,750	**$11,150**
Net Estimated Implementation Cost:	$198,010	$125,900	**$323,910**
Simple Payback (years):	21.6	12.4	**16.7**
Annual Avoided CO_2 Emissions (tons):	57	62	**119**

ECM #12: Replace Existing Domestic Hot Water Heater & Optimize the Setpoint

Whitehouse	
Estimated Annual Savings:	**$240**
Gross Estimated Implementation Cost:	**$5,220**
NJ Smart Start Rebate:	**$0**
Net Estimated Implementation Cost:	**$5,220**
Simple Payback (years):	**21.8**
Annual Avoided CO_2 Emissions (tons):	**1**

- There is one gas-fired domestic hot water (DHW) heater with a hot water setpoint currently set at 155 degrees.

- Dome-Tech recommends replacing this unit with a modern natural gas-fired domestic hot water heater and reducing the setpoint to 120 degrees. These changes will result in cost savings due to the improved operating efficiency and reduced heating load.

ECM #13: Install Solar Domestic Hot Water Heating Panels

	Holland Brook	Middle School	Whitehouse	Three Bridges	Totals
Estimated Annual Savings:	$734	$1,342	$881	$783	**$3,741**
Gross Estimated Implementation Cost:	$38,098	$59,264	$38,098	$38,098	**$173,559**
NJ Smart Start Rebate:	$0	$0	$0	$0	**$0**
Net Estimated Implementation Cost:	$38,098	$59,264	$38,098	$38,098	**$173,559**
Simple Payback (years):	48.63	41.39	40.63	45.66	**43.89**
Annual Avoided CO_2 Emissions (tons):	21	21	21	21	**84**

- These facilities currently utilize gas-fired domestic hot water heaters.
- Installing a Solar Thermal Heating system for domestic water heating purposes will reduce the load on existing gas-fired domestic hot water heaters.
- The high initial cost of a solar domestic hot water system may preclude this ECM from being justified by economics alone. However, reliability and educational opportunities warrant consideration of these projects as part of a long-term capital improvement plan.

ECM #14: Replace Existing Roof Top Units (RTUs)

Middle School	
Estimated Annual Savings:	**$130**
Gross Estimated Implementation Cost:	**$38,470**
NJ Smart Start Rebate:	**$400**
Avoided Cost (Like and Kind Replacement): [1]	**$32,530**
Net Estimated Implementation Cost:	**$5,540**
Simple Payback (years):*(Incremental and without Avoided Costs)*	**42.6**
Annual Avoided CO_2 Emissions (tons):	**0**

[1] The cost incurs if replacing existing equipment with equivalent standard efficiency equipment, pro-rated by equipment life and ASHRAE expected service life .

- There are two antiquated Lennox DX roof-top units (RTUs) at the Middle School that are still in use. These units have exceeded their expected service life and should be considered for replacement.
- Dome-Tech recommends replacing these units with modern, high efficiency RTUs. New units with approximately 15.5 SEER (Seasonal Energy Efficiency Rating) are more efficient at full/part loads than the existing equipment.
- As the existing RTU's airflow and cooling capacities could not be identified, the incremental energy savings shown above were based on 5 ton replacement units and the SEER difference between a standard efficiency unit (13 SEER) versus a high efficiency unit (15.5 SEER). These energy savings do not reflect the total energy savings between the existing equipment and the replacement equipment.
- Similarly, the implementation cost reflects the incremental cost difference between the standard efficiency unit versus a high efficiency unit and does not reflect the total installed cost.

ECM #15: Install Occupancy Sensor Controls on Stand-Alone Unit Ventilators

Middle School	
Estimated Annual Savings:	**$20**
Gross Estimated Implementation Cost:	**$1,950**
NJ Smart Start Rebate:	**$0**
Net Estimated Implementation Cost:	**$1,950**
Simple Payback (years):	**97.5**
Annual Avoided CO_2 Emissions (tons):	**0**

Middle School Trane Unit Ventilator

- The Middle School has six Trane unit ventilators that provide heating and cooling to their respective classrooms. These units are programmed with a time of day schedule at the building automation system.
- Dome-Tech recommends installing occupancy sensors to place the unit ventilators in an unoccupied mode when the classrooms are unoccupied during normal school hours. This would be similar to the configuration that is installed for the Airedale units.

ECM #16: Replace Existing Motors with Premium Efficiency Motors at End of Life

Three Bridges	
Estimated Annual Savings:	**$20**
Gross Estimated Implementation Cost:	**$2,730**
NJ Smart Start Rebate:	**$110**
Net Estimated Implementation Cost:	**$2,620**
Simple Payback (years):	**131.0**
Annual Avoided CO_2 Emissions (tons):	**0**

- The two existing 5 HP motors serving hot water pumps at the school are standard efficiency motors. Standard efficiency motors consume more power than their equivalent premium efficiency motors. Premium efficiency motors should be installed at the end of life.
- Dome-Tech recommends replacing the recommended regularly operated standard efficiency motors with new premium efficiency motors at their end of life (EOL).

ECM #17: Upgrade Windows

Middle School	
Estimated Annual Savings:	**$5,720**
Gross Estimated Implementation Cost:	**$1,945,770**
NJ Smart Start Rebate:	**$0**
Net Estimated Implementation Cost:	**$1,945,770**
Simple Payback (years):	**340.2**
Annual Avoided CO_2 Emissions (tons):	**25**

NOTE: The presented economics should be used for planning purposes only. If the District decides to proceed with the window replacement project, these economics should be refined with an investment grade analysis.

- A survey of the Middle School revealed a mixture of types and sizes of windows and functionality and condition varied throughout the buildings. However, a large quantity of the windows are of the single pane type.

- A window and door replacement project would result in an improvement in heat retention. In addition, increased aesthetic value and occupant comfort would accompany a window and door project. It should be noted however, that even an optimized window project can rarely be justified solely on economic payback.

- Because the economics alone are not sufficient to justify implementation, occupant comfort and aesthetics should be the overriding considerations in deciding whether to move forward with this project.

ECM # 18: Creation of a Behavioral-Based Energy Management Program

Estimated Annual Savings:	$10,000 - $15,000*
Gross Estimated Implementation Cost:	$1500 per school
Expected Rebate / Energy Efficiency Credit:	None
Net Estimated Implementation Costs:	$1500 per school
Simple Payback (yrs):	Varies
Annual Avoided CO_2 Emissions (tons):	Varies
Cost per Ton CO_2 Reduction ($/ton):	Varies

- The Readington School District has no observed energy awareness program or behavioral-based energy management program in place.

- 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.

ECM # 18: Creation of a Behavioral-Based Energy Management Program (cont.)

- There are a few options by which the Readington School District can implement a behavioral-based energy management program, as follows:

  1. The District could retain a consultant to develop an energy awareness program or to guide the District in the implementation of a relatively inexpensive program available online.
  2. The District can implement a program on its own, using current/existing personnel. There are several resources and options available to assist the District with a self-administered program; these are presented and discussed below.
  3. The District may consider hiring an individual, on a full-time or a part-time basis, to act as the District's "energy representative", or "energy manager". The purpose of hiring an individual would be to drive energy usage and cost reductions through an increased focus by staff and students on changing and/or improving everyday behaviors that can have an impact on consumption.

- Dome-Tech understands that numerous k-12 school districts in New Jersey have implemented this type of program (#3, above). While Dome-Tech does not typically recommend hiring additional personnel to achieve energy savings, this type of program appears to be worthy of additional investigation and potentially implementation. It may be especially worthwhile in a District where existing resources are not available to accept an incremental role in becoming the "energy manager", in addition to their existing responsibilities.

ECM # 18: Creation of a Behavioral-Based Energy Management Program (cont.)

- Dome-Tech recommends that the District bring in a representative from a neighboring school district, in order to learn more about the implementation process, as well as their experience and results. For reference purposes, Dome-Tech will also provide a recently-released RFP from a New Jersey k-12 District that is currently seeking these services.

- Should the District choose to implement a program on its own (a self-administered program), several resources are available for free or a nominal fee. A number of these are listed below.

1. NJCEP – TEACH Program (currently unavailable but the possibility exists that it will be reinstated) – includes an engaging, in-school education about energy efficiency for all faculty, staff and students. Participating schools receive a comprehensive Green Schools curriculum and energy monitoring instruments for student use www.njcleanenergy.com/commercial-industrial/programs/teach

2. The New Jersey Sustainable Schools Network is a consortium of schools, a wide variety of organizations, and concerned individuals who are committed to promoting education and school practices for a sustainable future in all schools in New Jersey.
   - Within this program is the program entitled “Doing Our Share”, The School Campaign to Reduce Greenhouse Gas Emissions, which offers a greenhouse gas calculator, sample resolutions for School Boards, and a GHG Manual http://www.globallearningnj.org/ssn.htm

ECM # 18: Creation of a Behavioral-Based Energy Management Program (cont.)

3. The New Jersey Green Schools Program offers a host of resources and links including a Road Map. The program trains students to use a diagnostic toolkit that assesses energy usage at their school. www.ase.org/programs/green-schools-program

4. The United States Department of Energy, Energy Education and Workforce Development, offers K-12 Lesson Plans and Activities, as well as information on student competitions and Energy Smart Schools www.energy.gov/kids

5. The United States Environmental Protection Agency, Energy Star program has numerous resources for raising the awareness of school kids www.energystar.gov/kids

6. NEED, The National Energy Education Development Project, has a mission to design and deliver objective multi-sided energy education programs for low to moderate costs. They offer a curriculum packet, kits, and guides.

7. The Energy Hog, is a free computer game that teaches students how to beat the Energy Hog, http://energyhog.org

Operations & Maintenance

Dome-Tech observed the following O&M issues:

Middle School:

- Books, shelves, desks, etc. are blocking the airflow across the perimeter baseboard heaters.
- One of the domestic hot water heaters by the Lochnivar boilers continually trips offline.

Three Bridges:

- The condensate return pump short - cycles excessively. Recommend repairing.

- **Further Considerations**:
  - The Readington School District should consider consolidating summer school sessions at Readington Middle School and Holland Brook School so that only one of those buildings needs to be utilized (conditioned). The schools are in close enough proximity that it would not produce a hardship for those attending.
  - The Readington School District should also consider compressing or curtailing the time that the schools are open on weekends or consolidating these activities among the schools. A study of actual usage may prove useful in determining actual need. This activity could also be performed for extra-curricular activities and meetings that are held during the week at the various schools.

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.

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.

Whitehouse Station 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 Whitehouse Station area is 4.6 meters per second. Ideal wind speeds for a successful project should average over 6 meters per second.

For Readington Township BOE, 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	***Readington Middle School***		
	Building Integrated	Ground Mount 5 kW	Ground Mount 50 kW
Gross Installation Cost Estimate	$130,000	$62,400	$250,000
NJJ SSB Rebate	$45,278	$35,994	$95,720
Net Installation Cost Estimate	$84,722	$26,406	$154,280
Annual Energy Savings	$2,278	$1,811	$16,912
Simple Payback	37.2 yrs.	14.6 yrs.	9.1 yrs.
System Capacity	20 kW	10 kW	50 kW
Annual Avoided Energy Use	14,149 kWh	11,248 kWh	105,041 kWh
Annual CO2 Emmisions, Therms	5	4	37
% of Annual Electric Use*	1.3%	1.0%	9.3%
Readington Middle School: 1129737 kWh/Year.			

Wind Turbine Pros & Cons

Pros	Cons
➢Annual reduction in energy spend and use can be potentially reduced by almost $17,000 (9% reduction). ➢Typical equipment life span is 15-30 years. ➢Reduction of annual greenhouse gas emissions by 126 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 the long payback periods and potential zoning related issues, wind turbine projects do not appear to be a viable option. However, should the District decide to pursue a wind turbine project, Dome-Tech recommends commissioning a more detailed study.

Renewable Energy Technologies: Wind

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

Wind Turbine Economics	***Holland Brook School***		
	Building Integrated	Ground Mount 5 kW	Ground Mount 50 kW
Gross Installation Cost Estimate	$130,000	$62,400	$250,000
NJJ SSB Rebate	$45,278	$35,994	$95,720
Net Installation Cost Estimate	$84,722	$26,406	$154,280
Annual Energy Savings	$2,122	$1,687	$15,756
Simple Payback	39.9 yrs.	15.7 yrs.	9.8 yrs.
System Capacity	20 kW	10 kW	50 kW
Annual Avoided Energy Use	14,149 kWh	11,248 kWh	105,041 kWh
Annual CO2 Emmisions, Therms	5	4	37
% of Annual Electric Use*	0.9%	0.7%	6.8%
Readington Holland Brook School: 1533760 kWh/Year.			

Wind Turbine Economics	***Three Bridges School***		
	Building Integrated	Ground Mount 5 kW	Ground Mount 50 kW
Gross Installation Cost Estimate	$130,000	$62,400	$250,000
NJJ SSB Rebate	$45,278	$35,994	$95,720
Net Installation Cost Estimate	$84,722	$26,406	$154,280
Annual Energy Savings	$2,165	$1,721	$16,071
Simple Payback	39.1 yrs.	15.3 yrs.	9.6 yrs.
System Capacity	20 kW	10 kW	50 kW
Annual Avoided Energy Use	14,149 kWh	11,248 kWh	105,041 kWh
Annual CO2 Emmisions, Therms	5	4	37
% of Annual Electric Use*	1.9%	1.5%	14.4%
Readington Three Bridges School: 727740 kWh/Year.			

Wind Turbine Economics	***Whitehouse School***		
	Building Integrated	Ground Mount 5 kW	Ground Mount 50 kW
Gross Installation Cost Estimate	$130,000	$62,400	$250,000
NJJ SSB Rebate	$45,278	$35,994	$95,720
Net Installation Cost Estimate	$84,722	$26,406	$154,280
Annual Energy Savings	$2,193	$1,743	$16,281
Simple Payback	38.6 yrs.	15.1 yrs.	9.5 yrs.
System Capacity	20 kW	10 kW	50 kW
Annual Avoided Energy Use	14,149 kWh	11,248 kWh	105,041 kWh
Annual CO2 Emmisions, Therms	5	4	37
% of Annual Electric Use*	1.4%	1.1%	10.3%
Readington Whitehouse School: 1015320 kWh/Year.			

Renewable Energy Technologies: Solar Photovoltaic

Solar Photovoltaic

- Sunlight can be converted into electricity using photovoltaics (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.

Renewable Energy Technologies: Solar Photovoltaic

Solar Photovoltaic Systems

MIDDLE SCHOOL - ROOF SYSTEM	
System Capacity, kw-dc (maximum utilization of roof space)	803 kw dc
Annual Electric Generation, kwhrs of AC electricity produced	846,569 kwh
Total Annual Facility Electric Use, kwhrs	1,129,737 kwh
% of Total Annual Usage	75%
All-In Cost of Electric Year 1	$0.150 / kwh
Annual Electric Cost Savings	$126,985
Estimated SREC Value (Year 1):	$599 / SREC
Estimated Year 1 SREC Revenue:	$507,036
Equivalent Annual CO2 Emission Reduction (tons per year)[1]	464 tons/yr
Equivalent Cars Removed From Road Annually[2]	80
Equivalent Acres of Trees Planted Annually[3]	127
System Installed Cost	$4,417,582
Simple Payback	8.1
IRR (25 Years)	10%
1. Estimated CO2 Emissions Rate: 0.66 lbs/kWh	
2. EPA Estimate: 11,560 lbs CO2 per car	
3. EPA Estimate: 7,333 lbs CO2 per acre of trees planted	

Renewable Energy Technologies: Solar Photovoltaic

Solar Photovoltaic Systems

HOLLAND BROOK SCHOOL - ROOF SYSTEM	
System Capacity, kw-dc (maximum utilization of roof space)	812 kw dc
Annual Electric Generation, kwhrs of AC electricity produced	856,276 kwh
Total Annual Facility Electric Use, kwhrs	1,533,760 kwh
% of Total Annual Usage	56%
All-In Cost of Electric Year 1	$0.150 / kwh
Annual Electric Cost Savings	$128,441
Estimated SREC Value (Year 1):	$599 / SREC
Estimated Year 1 SREC Revenue:	$512,849
Equivalent Annual CO2 Emission Reduction (tons per year)[1]	469 tons/yr
Equivalent Cars Removed From Road Annually[2]	81
Equivalent Acres of Trees Planted Annually[3]	128
System Installed Cost	$4,468,233
Simple Payback	8.1
IRR (25 Years)	10%
1. Estimated CO2 Emissions Rate: 0.66 lbs/kWh	
2. EPA Estimate: 11,560 lbs CO2 per car	
3. EPA Estimate: 7,333 lbs CO2 per acre of trees planted	

Renewable Energy Technologies: Solar Photovoltaic

Solar Photovoltaic Systems

THREE BRIDGES SCHOOL - ROOF SYSTEM	
System Capacity, kw-dc (maximum utilization of roof space)	394 kw dc
Annual Electric Generation, kwhrs of AC electricity produced	415,447 kwh
Total Annual Facility Electric Use, kwhrs	727,740 kwh
% of Total Annual Usage	57%
All-In Cost of Electric Year 1	$0.153 / kwh
Annual Electric Cost Savings	$63,563
Estimated SREC Value (Year 1):	$599 / SREC
Estimated Year 1 SREC Revenue:	$248,824
Equivalent Annual CO2 Emission Reduction (tons per year)[1]	228 tons/yr
Equivalent Cars Removed From Road Annually[2]	39
Equivalent Acres of Trees Planted Annually[3]	62
System Installed Cost	$2,167,894
Simple Payback	8.0
IRR (25 Years)	10%
1. Estimated CO2 Emissions Rate: 0.66 lbs/kWh	
2. EPA Estimate: 11,560 lbs CO2 per car	
3. EPA Estimate: 7,333 lbs CO2 per acre of trees planted	

Renewable Energy Technologies: Solar Photovoltaic

Solar Photovoltaic Systems

WHITEHOUSE SCHOOL - ROOF SYSTEM	
System Capacity, kw-dc (maximum utilization of roof space)	483 kw dc
Annual Electric Generation, kwhrs of AC electricity produced	508,718 kwh
Total Annual Facility Electric Use, kwhrs	1,015,320 kwh
% of Total Annual Usage	50%
All-In Cost of Electric Year 1	$0.155 / kwh
Annual Electric Cost Savings	$78,851
Estimated SREC Value (Year 1):	$599 / SREC
Estimated Year 1 SREC Revenue:	$304,687
Equivalent Annual CO2 Emission Reduction (tons per year)[1]	279 tons/yr
Equivalent Cars Removed From Road Annually[2]	48
Equivalent Acres of Trees Planted Annually[3]	76
System Installed Cost	$2,654,603
Simple Payback	8.0
IRR (25 Years)	10%
1. Estimated CO2 Emissions Rate: 0.66 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 Readington Township BOE would place your facilities 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.
- A CHP system is recommended for Readington Township Board of Education Holland Brook School due to the high reheat load requirements in the summertime. Please reference ECM #1.

Retail Energy Purchasing: Recommendations

Electric

- For the period studied, Readington Township BOE was utilizing ACES as a Third Party Supplier for the supply of electricity at floating rate between $0.78 - $0.10/kWh.

Natural Gas

- For the period studied, the Readington Township BOE was utilizing ACES as a Third Party Supplier for the supply of natural gas.

Retail Energy Purchasing: Recommendations and Resources

- **Electric**
  - Based on current and recent market conditions, and actual bid processes run by Dome-Tech clients, we have seen customers with BGS-FP accounts save approximately 10-15% in projected energy costs by switching to retail energy supplier. It is important to note that actual rates and potential savings will be dependent on several factors, including market conditions, account usage characteristics/load profile (load factor), volume, and contract term.
- **Natural Gas**
  - Based on current and recent market conditions, and actual bid processes run by Dome-Tech clients, we have seen many customers entering into longer-term contracts for fixed natural gas rates. These rates vary substantially based on load type, volume, and term.
- **Energy Purchasing Co-Operatives**
  - Many public entities participate in various energy aggregation buying groups. Sometimes, an entity will have multiple options to choose from. These might include purchasing through a County co-operative, or purchasing through a trade-type association like ACES. Co-operative purchasing may not necessarily get you the lowest rates; however, there is often substantial volume, and it can represent a good alternative for entities with limited energy consumption who can have a difficult time getting energy suppliers to respond to them on a direct, singular basis.
- To determine whether a savings opportunity currently exists for your entity, or for guidance on how to get started, you may contact Dome-Tech to discuss. There is also additional information provided below.

Utility Tariff and Rate Review: Electricity

- **Accounts and Rate Class:** Readington Township BOE has four facilities with eight electric accounts with service behind Jersey Central Power & Light Company under rate classes General Service Secondary 3 Phase.

- **Electric Consumption and Cost:** Based on the one-year period studied, the total annual electric expenditure for the BOE is about $671,000 and the total annual consumption is about 4,406,000 kilowatt-hours (kWh).

- **Average/Effective Rate per kWh:** For the one year period studied, the BOE's average monthly cost per kilowatt-hour ranged from 14.99 ¢/kWh to 17.66 ¢/kWh, inclusive of utility delivery charges. The BOE's overall, average cost per kilowatt-hour during this period was 15.23 ¢/kWh.

  - Note that these average electric rates are "all–inclusive"; that is, they include all supply service (generation and commodity-related) charges, as well as all delivery service charges. The supply service charges typically represent the majority (60-80%) of the total monthly bill. It is the supply portion of your bill that is deregulated, which is discussed on subsequent slides in this section.

Utility Tariff and Rate Review: Natural Gas

- **Accounts and Rate Class:** Readington Township BOE has four facilities with four natural gas accounts with service behind Public Service Electric and Gas Company and one with Elizabethtown Gas under rate classes Large Volume Service (LVG) and DCQ Firm Transportation (at Three Bridges School).

- **Natural Gas Consumption and Cost:** Based on the one-year period studied, the total annual natural gas expenditure for the BOE is about $207,000 and the total annual consumption is about 206,000 therms (th). Natural gas is used predominantly throughout the winter period for heating purposes.

- **Average/Effective Rate per Therm:** For the one year period studied, the BOE's overall, average cost per therm during this period was $1.005 per therm.
  - Note that these average natural gas rates are "all–inclusive"; that is, they include all supply service (interstate transportation and commodity-related) charges, as well as all delivery service charges. The supply service charges typically represent the majority (60-80%) of the total monthly bill. It is the supply portion of your bill that is deregulated, which is discussed on subsequent slides in this section.

Utility Deregulation in New Jersey: Background and Retail Energy Purchasing

- In August 2003, per the Electric Discount and Energy Competition Act [N.J.S.A 48:3-49], the State of New Jersey deregulated its electric marketplace thus making it possible for customers to shop for a third-party (someone other than the utility) supplier of retail electricity.
- Per this process, every single electric account for every customer in New Jersey 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 of accounts was based on rate class. The largest electric accounts in the State (those served under a Primary or a Transmission-level rate class) were moved into BGS-CIEP pricing. All other accounts (the vast majority of accounts in the State of New Jersey, including residential) were placed in the BGS-FP category, receiving default electric supply service from the utility.
- The New Jersey Board of Public Utilities (NJBPU) has continued to move new large energy users from the BGS-FP category into the BGS-CIEP category by lowering the demand (kW) threshold for electric accounts receiving Secondary service. Several years ago, this threshold started at 1,500kW; now, it has come down to 1,000 kW. So, if an account's "peak load share" (as assigned by the utility) is less than 1,000 kW, then that facility/account is in the BGS-FP category. If you are unsure, you may contact Dome-tech for assistance.

Utility Deregulation in New Jersey: Background and Retail Energy Purchasing (cont.)

- There are at least 3 important differentiating factors to note about each rate category:
  1. The rate structure for BGS-FP accounts and for BGS-CIEP accounts varies.
  2. The "do-nothing" option (ie, what happens when you don't shop for retail energy) varies.
  3. The decision about whether, and why, to shop for a retail provider varies.

- **Secondary (small to medium) Electric Accounts**:
  - BGS-FP rate schedules for all utilities are set, and re-set, each year. Per the results of our State's BGS Auction process, held each February, new utility default rates go into effect every year on June 1st. The BGS-FP rates become each customer's default rates, and they dictate a customer's "Price to Compare" (benchmark) for shopping purposes. To learn more about the BGS Auction process, please go to www.bgs-auction.com.
  - A customer's decision about whether to buy energy from a retail energy supplier is, therefore, dependent upon whether a supplier can offer rates that are lower than the utility's (default) Price to Compare. In 2009, and for the first time in several years, many BGS-FP customers have "switched" from the utility to a retail energy supplier because there have been savings. This may be the same case in 2010.

- **Primary (large) Electric Accounts:**
  - The BGS-CIEP category is quite different. There are two main features to note about BGS-CIEP accounts that do not switch to a retail supplier for service. The first is that they pay an hourly market rate for energy; the second is that these accounts also pay a "retail margin adder" of $0.0053/kWh. For these large accounts, this retail adder can amount to tens of thousands of dollars. The adder is eliminated when a customer switches to a retail supplier for service.
  - For BGS-CIEP accounts, the retail adder makes a customer's decision about *whether* to switch relatively simple. However, the process of setting forth a buying strategy can be complex, which is why many public entities seek professional assistance when shopping for energy.
  - For more information concerning hourly electric market prices for our region, please refer to www.pjm.com.

Utility Deregulation in New Jersey: Background and Retail Energy Purchasing (cont.)

- **Natural Gas Accounts:**

  - The natural gas market in New Jersey is also deregulated. Unlike the electric market, there are no "penalties", or "adders", for not shopping for natural gas. Most customers that remain with the utility for natural gas service pay rates that are market-based and that fluctuate on a monthly basis. While natural gas is a commodity that is exceptionally volatile and that is traded minute-by-minute during open trading sessions, market rates are "settled" each month, 3 business days prior to the subsequent month (this is called the "prompt month"). Customers that do not shop for a natural gas supplier will typically pay this monthly settlement rate to the utility, plus other costs that are necessary to bring gas from Louisiana up to New Jersey and ultimately to your facility.

  - For additional information about natural gas trading and current market futures rates for various commodities, you can refer to www.nymex.com.

  - A customer's decision about whether to buy natural gas from a retail supplier is typically dependent upon whether a customer seeks budget certainty and/or longer-term rate stability. Customers can secure longer-term fixed prices by enlisting a retail natural gas supplier. Many larger natural gas customers also seek the assistance of a professional consultant to assist in their procurement process.

Retail Energy Purchasing:

- To learn more about energy deregulation, visit the New Jersey Board of Public Utilities website: www.bpu.state.nj.us
- For more information about the retail energy supply companies that are licensed and registered to serve customers in New Jersey, visit the following website for more information: http://www.bpu.state.nj.us/bpu/commercial/shopping.html
- Provided below is a list of NJ BPU-licensed retail energy suppliers:

Company	Electricity	Natural Gas	Website
Hess	X	X	hess.com
Sprague	X	X	sprageenergy.com
UGI	X	X	ugienergyservices.com
South Jersey Energy	X	X	southjerseyenergy.com
Direct	X	X	directenergy.com
Global	X	X	globalp.com
Liberty	X		libertpowercorp.com
Reliant	X		reliant.com
First Energy	X		fes.com
ConEd Solutions	X		conedsolutions.com
Constellation	X		newenergy.com
Glacial	X		glacialenergy.com
Integrys	X		integrysenergy.com
Suez	X		suezenergyresources.com
Sempra	X		semprasolutions.com
Woodruff		X	woodruffenergy.com
Mx Energy		X	mxenergy.com
Hudson		X	hudsonenergyservices.com
Great Eastern		X	greateasterngas.com

**Note: Not every Supplier serves customers in all utility territories within New Jersey.*

Historical Energy Futures Settlement Prices

- Below please find graphs that show the last several years' worth of market settlement prices for both natural gas and electricity. Each of these graphs shows the average closing prices of a rolling 12-month period of energy futures prices. The graphs are representative of the commodity, alone; they do not include any of the additional components (capacity, transmission, ancillary services, etc.) that comprise a retail energy price. They are meant to provide an indication of the level of pricing that a particular customer might expect to see, but the graphs do not account for the specific load profile of any individual energy user.

Henry Hub 12 month strip

PJM West 12 month strip

Potential Project Funding Sources

Through the NJ Clean Energy program, the New Jersey Board of Public Utilities currently offers a variety of subsidies or rebates for many of the project types outlined in this report. More detailed information can be found at: www.njcleanenergy.com

NJ Smart Start Buildings – Equipment Rebates noted in ECMs where available.
Equipment Rebates - Water Heaters, Lighting, Lighting Controls/Sensors, Chillers, Boilers, Heat pumps, Air conditioners, Energy Mgmt. Systems/Building Controls, Motors, Motor-ASDs/VSDs, Custom/Others http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings

Pay for Performance Program – Performance-Based Incentives for installations.
Provides up to 50% of total project costs. ***Based on findings in this study, up to $450,000 in incentives for project implementation could be provided under this program.*** A minimum reduction target of 15% compared to baseline must be achieved. Energy modeling of building and systems and energy reduction plan is required (incentives provided to pay for part of study costs.)

Energy Savings Improvement Program (ESIP) Public entities can contract with energy services companies (ESCOs)in up to 20-year lease purchases enabling public entities to implement energy conservation measures to their facilities and pay for the costs using the value of energy savings that result from the improvements. www.nj.gov/dca/lgs/lfns/09lfns/2009-11.doc

Potential Project Funding Sources (continued)

Clean Energy Solutions Capital Investment Loan/Grant

The EDA offers up to $5 million in interest-free loans and grants to promote the concept of "going green" in New Jersey. Under this program, scoring criteria based on the project's environmental and economic development impact determines the percentage split of loan and grant awarded. Funding can be used to purchase fixed assets, including real estate and equipment, for an end-use energy efficiency project, combined heat and power (CHP or cogen) production facility, or new state-of-the-art efficient electric generation facility, including Class I and Class II renewable Energy. http://www.njeda.com/web/Aspx_pg/Templates/Npic_Text.aspx?Doc_Id=1078&menuid=1360&topid=722&levelid=6&midid=1357

Clean Renewable Energy Bonds (CREBs) – For Renewable Energy Projects

Federal Loan Program for Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal

http://www.irs.gov/irb/2007-14_IRB/ar17.html

Renewable funding for PV & wind, plus federal credits currently available:
http://www.njcleanenergy.com/renewable-energy/programs/renewable-energy-incentive-program/applications-and-e-forms-renewable-ener

Potential Project Funding Sources (continued)

Direct Install Program – NJ Clean Energy makes the investment in energy efficiency upgrades by initially covering 60% of the cost to install the recommended energy efficiency measures. If eligible, the entity will pay ONLY 40% of the total cost to install the energy efficiency measures. There is a $50,000 incentive cap on each project. The 100 kW peak demand threshold has been waived for local government entities who receive and utilize their Energy Efficiency and Conservation Block Grant in conjunction with Direct Install. **http://www.njcleanenergy.com/commercial-industrial/programs/direct-install**

We encourage you to contact the program directly for further information on this particular program for all Schools

Steps to Participate for Buildings

1. CONTACT THE PARTICIPATING CONTRACTOR IN YOUR AREA
   Identify the contractor assigned and trained to provide Direct Install services in the county where your project is located. Using the contact information provided, call or email the Participating Contractor to discuss your project. The contractor will schedule an Energy Assessment and work with you to complete the Program Application and Participation Agreement. If you're unable to contact the Participating Contractor or have questions, you may contact us at 866-NJSMART or send an e-mail to DirectInstall@trcsolutions.com..

2. REVIEW RESULTS
   After the Energy Assessment, the contractor will review results with you, including what measures qualify and your share of the project cost.

3. DECIDE TO MOVE FORWARD
   You will sign a Scope of Work document to proceed with implementation of qualifying measures.

4. ARRANGE INSTALLATION
   You and the Participating Contractor will set a convenient start date for the installation.

5. CONFIRM INSTALLATION
   Once the Participating Contractor completes the installation, you accept the work by signing a Project Completion Form. A program representative will approve the project as complete.

6. COMPLETE TRANSACTION
   You pay the Participating Contractor your share of the project cost and the program pays its share.

Next Steps

- **The following projects should be considered for implementation:**

  - Reset controls and temperature setpoints
  - Demand Control Ventilation
  - Time of Day Optimization
  - Install Weatherstripping on exterior doors
  - Lighting upgrades
  - Replace inefficient equipment
  - Start Energy Awareness Program
  - Install CHP system at the Holland Brook School
  - Continue to compare opportunities to reduce energy costs through energy cooperatives other than ACES
  - Solar Photovoltaics Systems

  Note that additional "Phase 2" engineering may be required to further develop these projects, to bring them to bidding and implementation.

- **Consider applying for Pay-For-Performance Program**

Notes and Assumptions

Dome-Tech, Inc.

- 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.
- Some ECM's proposed in this report are mutually exclusive (e.g. replacing boilers or controls). ECM savings are not cumulative.
- Interactive effects between ECM's have not been accounted for in all cases.
- 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 0.66 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.*
- The following utility prices provided were used within this study:

School	Electric $/Kwh	Natural Gas $ / therm
Readington Middle School	$0.150	$1.110
Holland Brook School	$0.150	$0.935
Whitehouse School	$0.155	$1.078
Three Bridges School	$0.153	$0.959
AVERAGE	**$0.152**	**$1.005**