Monmouth Regional High School

Energy Audit

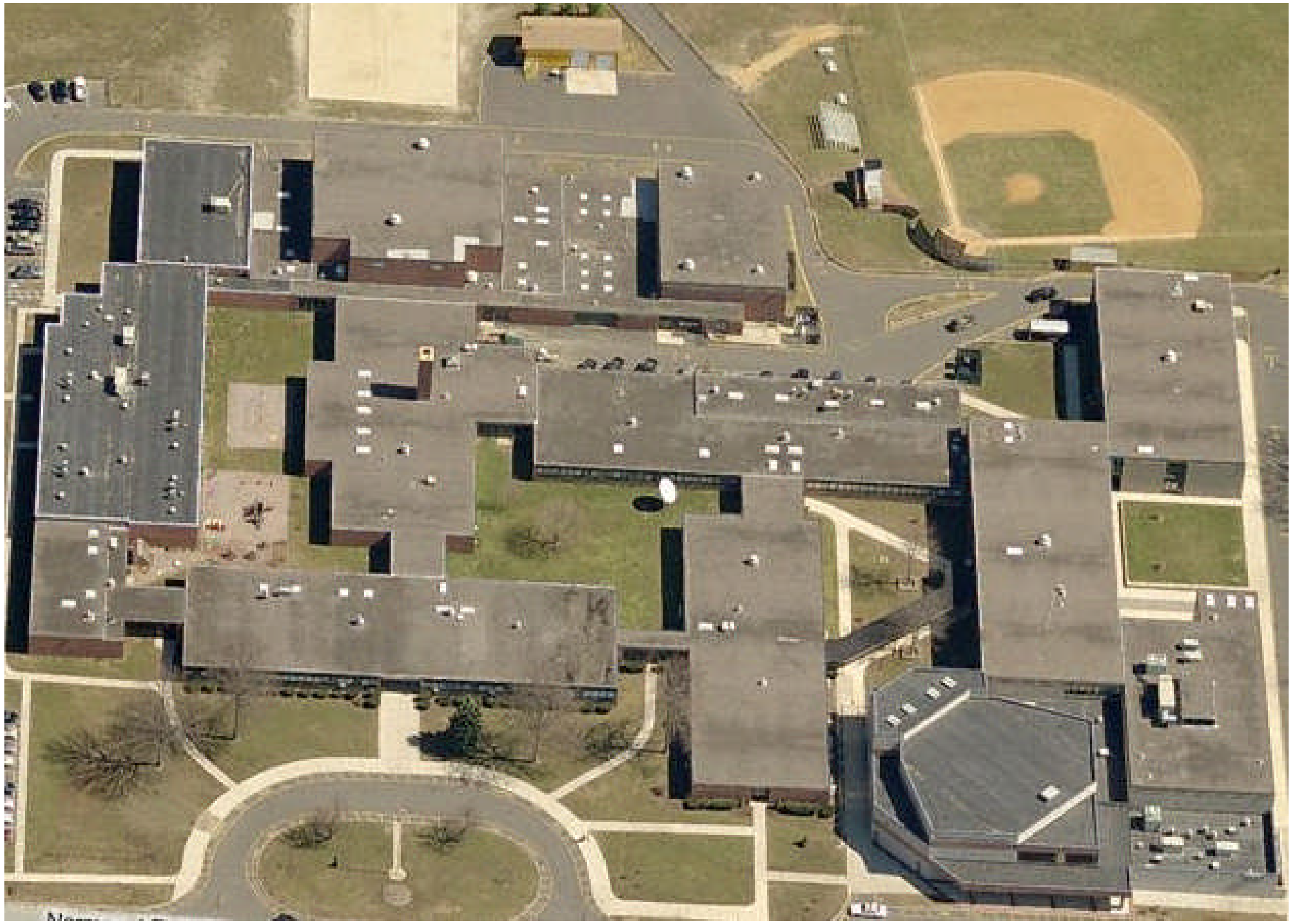
Prepared For:
Monmouth Regional High School

Contact:
Maria A. Parry, CPA, PSA
Business Administrator

Prepared By:
Dome - Tech, Inc.

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

September, 2009



Dome-Tech, Inc.

510 Thornall Street, Suite 170
Edison, NJ 08837
Phone: 732-590-0122
Fax: 732-590-0129

Dome-Tech, Inc.
www.dome-tech.com
510 Thornall Street, Suite 170
Edison, NJ 08837
Tel: 732.590.0122
Fax: 732.590.0129

MONMOUTH REGIONAL HIGH SCHOOL
ENERGY AUDIT REPORT
TABLE OF CONTENTS

Dome-Tech, Inc.

www.dome-tech.com

510 Thornall Street, Suite 170
Edison, NJ 08837

Tel: 732.590.0122
Fax: 732.590.0129

June 30, 2009

Maria Anne Parry, CPA, PSA
School Business Administrator/ Secretary to the Board
Monmouth Regional High School Board of Education
1 Norman J. Field Way
Tinton Falls, NJ 07724

**Re: EXECUTIVE SUMMARY FOR MONMOUTH REGIONAL HIGH SCHOOL
STATE OF NEW JERSEY LOCAL GOVERNMENT ENERGY AUDIT**

Dear Ms. Parry,

Dome-Tech was retained by Monmouth Regional High School 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 school's 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 energy conservation measures;
- Evaluating the economic viability of various renewable/distributed energy technologies;
- Performing a utility tariff analysis and assessing savings potential from energy procurement strategies; and
- Providing the method of analyses

Presently, Monmouth Regional High School has an annual expenditure of:

- Electricity: 1,888,650 kWh at a total cost of $306,473
- Natural Gas: 125,650 therms at a total cost of $254,495

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 ECM's 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, by cost, etc.

If all identified ECM's were to be implemented, they would provide the following estimated benefits to Monmouth Regional High School Board of Education:

- Total annual electrical savings: 123,465 kilowatt-hours; 6.5%

- Total annual natural gas savings: 14,840 therms of natural gas usage; 11.8%
- Total annual energy cost savings: $43,460; 7.7%
- Total annual CO_2 emissions reduction: 123 tons
- Total estimated implementation cost: $242,960
- Total average simple payback: 7.1 yrs

Those projects that are highly recommended for implementation include: installing vending misers on vending machines, replacing the domestic hot water heater, implementing demand controlled ventilation in the theater and gymnasium areas, converting the dishwasher hot water booster from electric to natural gas, implementing an automatic boiler temperature reset strategy, installing a heat recovery system in the photography labs, implementing an energy education program, and installing a solar application.

Monmouth Regional High School attained an ENERGY STAR rating of 19 when data was entered into the US EPA ENERGY STAR Portfolio Manager database. Buildings with ratings of 75 or higher may qualify for the ENERGY STAR Building Label.

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

- A Ground Source Heat Pump (GSHP) installation is not recommended as an immediate retrofit project. 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.
- 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 Monmouth Regional High School decide to pursue a wind turbine project, Dome-Tech recommends commissioning a more detailed study.
- A roof-mounted 220 kw dc photovoltaic system that could provide 12% of the school's annual energy usage was assessed and is recommended 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 Monmouth Regional High School is served by two electric accounts behind Jersey Central Power & Light, one served under rate class General Service Secondary (GGS) and one for outdoor street lighting under rate class (SWV-01S). The district should consider shopping for electric generation service for its BGS-FP accounts. The district is also served by one natural gas account behind New Jersey Natural Gas. 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,

Reed Berinato
Senior Energy Engineer

MONMOUTH HIGH SCHOOL ECM MEASURE SUMMARY TABLE

Prepared by Dome-Tech, Inc.

ECO/ECM Summary

	Energy Conservation Measures (ECM)	Areas	Energy Savings		Gross Installation Costs*	Rebate / Incentives	Net Implementation Costs	Annual Energy Cost Savings*	Annual Operating Cost Savings*	Total Annual Cost Savings*	Simple Pay Back*	CO2	Return on Investment (ROI)	Lifetime*
			kWh	Therms										
1	VendingMisers		10,400	0	$1,800		$1,800	1,700		$1,700	1.1	3	94%	NA
2	Replace Domestic Hot Water Heater		0	3,800	$14,200		$14,200	7,500		$7,500	1.9	22	53%	$112,500
3	Theatre Demand Control Vent (DCV)	Theater	4,700	7,300	$29,900		$29,900	15,000		$15,000	2.0	44	50%	NA
4	Dishwasher Heater Fuel Conversion	Kitchen	19,500	-700	$12,000		$12,000	1,700		$1,700	7.2	2	14%	NA
5	Automatic Boiler Temperature Reset		0	940	$21,000		$21,000	1,800		$1,800	11.4	6	9%	NA
6	Gymnasium Demand Control Vent (DCV)	Gym	0	3,500	$26,900		$26,900	2,200		$2,200	12.1	21	8%	NA
7	Photography Lab Heat Recovery	Photo lab	880	0	$28,000		$28,000	1,700		$1,700	16.7	0	6%	NA
	LIGHTING	ALL	73,120		$114,600	$5,440	$109,160	11,860	$14,800	$26,660	4.1	24	24%	NA
	TOTALS		**123,465**	**14,840**	**$248,400**	**$5,440**	**$242,960**	**$43,460**	**$14,800**	**$58,260**	**7.1**	**123**	**32%**	**$112,500**

Cars	212.54
Trees	33.51

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.

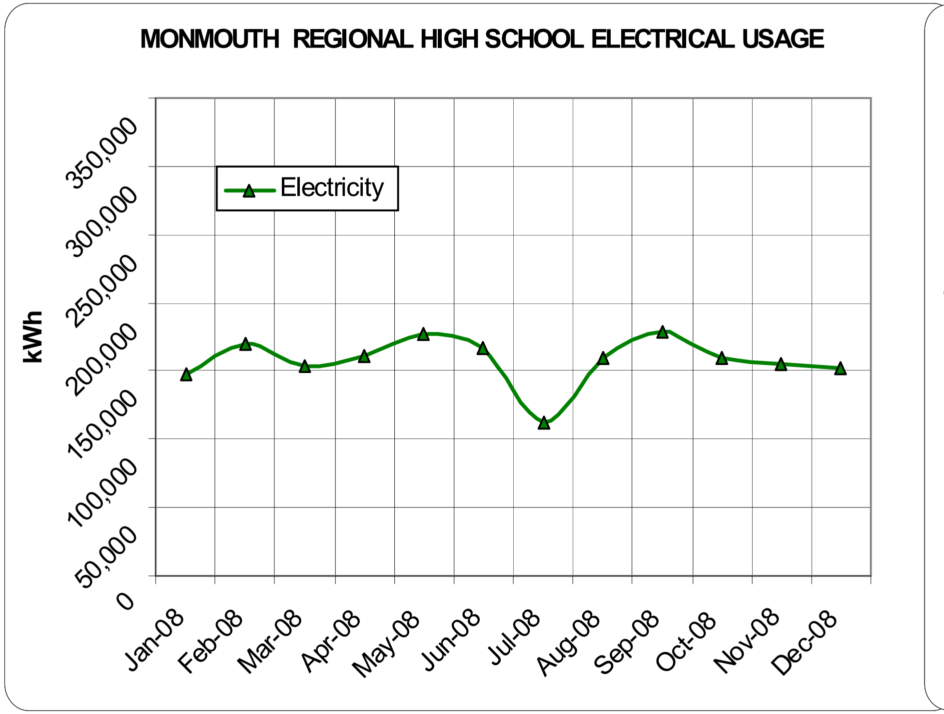
VI. Energy Purchasing and Procurement Strategies: perform utility tariff analysis and assess potential for savings from energy procurement strategies.

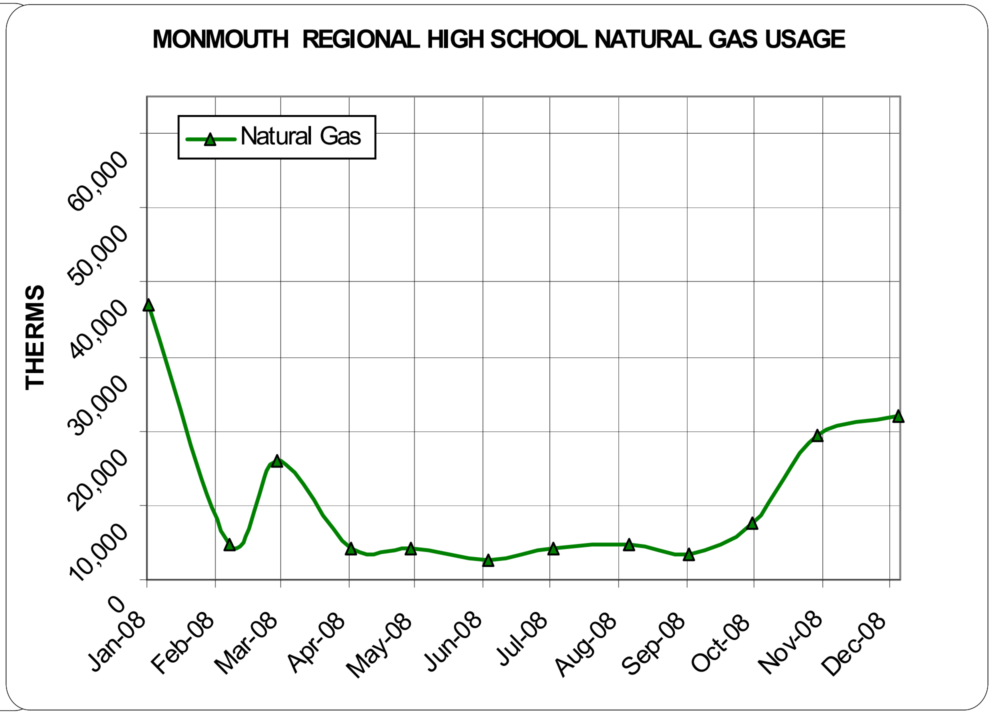
VII. Method of Analysis: Appendices

Historic Energy Consumption

Utility Usage and Costs Summary **Time-period: Jan. 2008 – Dec. 2008**

SCHOOL	Electric			Natural Gas		
	Annual Consumption	Annual Cost	$ / kWh	Annual Consumption	Annual Cost	$ / therms
Monmouth Regional High School	1,888,659.00	$306,472.76	$0.16	125,653.00	$254,494.72	$2.03





Please see Appendix for full utility data and consumption profiles for the School

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 of 75, or above, are eligible to apply for an official Energy Star Building label.

Summary Energy Performance Report

Facilities included: Monmouth Regional HS Group

Facility Name	Facility Address	Year ending 12/2008 Facility Floorspace	Year ending 12/2008 Rating	Year ending 12/2008 Average Site Energy Intensity (kBtu/Sq. Ft.)	Year ending 12/2008 Average Weather Normalized Source Energy Intensity (kBtu/Sq. Ft.)	Year ending 12/2008 Site Electric Use (kWh)	Year ending 12/2008 Site Natural Gas Use (Therms)
Monmouth Regional High School	One Norman J. Field Way Tinton Falls, NJ 07724	202441	19	93.9	160.7	1,888,659	125,653

Historic Energy Consumption (continued)

Summary Energy Performance Report

Facilities included: Monmouth Regional HS Group

Number of facilities: 1

	Year ending 12/2008
Total Floorspace (sq. ft.)	192,441
Average Rating	19
Number of Facilities with a Rating	1
Number of Non-ratable Facilities*	0
Total Site Energy Use (kBtu)	19,009,390
Total Weather Normalized Source Energy Use (kBtu)	32,528,879
Average Weather Normalized Source Energy Intensity (kBtu/Sq. Ft.)	160.7
Average Site Energy Intensity (kBtu/Sq. Ft.)	93.9
Total Site Electric Use (kWh)	1,888,659
Total Site Natural Gas Use (Therms)	125,653
Average Actual Annual Source Energy Intensity (kBtu/Sq. Ft.)	171.3

*Non-ratable buildings are defined as buildings that currently are ineligible to receive the ENERGY STAR rating due to its operating characterisitcs and/or building type.

Historic Energy Consumption (continued)

Portfolio Manager Sign - In

- An account has been created for Monmouth Regional High School 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:	MonmouthHS
➢Password:	DTMonmouthHS
➢Email for account:	mparry@monmouthregional.net

Facility Information

➢ **Building:** **Monmouth Regional HS**

Address:	One Norman J. Field Way Tinton Falls, New Jersey 07724
Gross Floor Area:	192,441 sf
Year Built:	1960/Additions in 1964 & 1998
Grades:	9-12
# Students/ # Staff:	1141/200

➢ **Construction Features:**

Facade:	Concrete masonry units with exterior brick; predominantly un-insulated
Roof Type:	Flat, slab on deck with ISO board insulation; rubber membrane Roof is new – installed within the last two years
Windows:	Cover 25% of façade; awning-type aluminum frame w/ interior shades Administration section has newly installed windows; remaining windows are scheduled for replacement during summer 2009
Exterior Doors:	Metal (some fully glazed; others partially (40%)); good condition; weather-stripping needs replacement in particular locations

Facility Information

➢ Major Mechanical Systems

Air Handlers / AC Systems / Ventilation Systems:

- Various different types of HVAC systems serve Monmouth Regional HS. The majority of cooling systems were installed during or after the 1997/1998 renovation. Major system types can be summarized as follows:
  - *Split System with Indoor DX Air Handler and Rooftop Condensing Unit*
  - *Rooftop Split DX*
  - *Packaged DX Rooftop*
  - *Floor Mounted Split DX*
  - *Mini Split (Ceiling Cassette)*
  - *Hot Water Heating & Ventilating Unit*
  - *Gas fired Make-Up Air Unit*

Boilers/ Heating Systems

- There is a central boiler plant within the school that has expanded its service organically as the school has expanded over the years. The central plant consists of two Burnham gas fired 357 HP (12,000MBH) hot water boilers. The boilers are original 1960 equipment, and appear to be in good condition. The hot water is distributed by several base mounted, end suction hot water pumps.

Facility Information

Major Mechanical Systems (continued)

Boilers/ Heating Systems (continued)

- Heating systems throughout the school vary, but consist primarily of hot water baseboard, convectors & cabinet unit heaters. Most roof mounted equipment incorporates the use of hot water for heating.

Controls:

- During the 1997/1998 renovation, a Siemens building automation system was installed to monitor & control the new equipment. Along with the new equipment, the BMS was tied into several older systems, including the central boiler plant, mainly for monitoring purposes.
- The capabilities of the control system include scheduling equipment operation, controlling economizer cycles, temperature control & monitoring.

Equipment Inventory:

- An extensive equipment inventory can be found within the appendix of this report. The inventory includes HVAC as well as kitchen equipment.

Greenhouse Gas Emission Reduction

Implementation of all the ECMs will yield:

- 123,465 kilowatt-hours of annual avoided electric usage.
- 14,840 therms of annual avoided natural gas usage.
- This equates to the following ***annual*** reductions:

- 123 tons of CO_2;

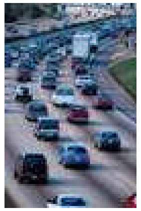
-OR-

- 212 Cars removed from road;

-OR-

- 33.5 Acres of trees planted annually

The Energy Information Administration (EIA) estimates that power plants in the state of Connecticut emit 0.694 lbs CO_2 per kWh generated.



The Environmental Protection Agency (EPA) estimates that one car emits 11,560 lbs CO_2 per year.

The EPA estimates that reducing CO_2 emissions by 7,333 pounds is equivalent to planting an acre of trees.

Energy Conservation Measures ECM #1: Vending Machine Power Management

Estimated Annual Energy Cost Savings:	$1,660
Estimated Gross Implementation Costs:	$1,800
NJ Smart Start Rebate:	$0
Net Estimated Implemtation Costs:	$1,800
Estimated Simple Payback:	1.1
Annual Avoided CO_2 Emissions (tons):	3

- Dome-Tech recommends installing a Vend Miser vending machine power management device on all nine (9) 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).

ECM #2: Replace Domestic Hot Water Heater

Existing Domestic Hot Water Heater

Estimated Annual Energy Cost Savings:	$7,500
Estimated Gross Implementation Costs:	$14,200
NJ Smart Start Rebate:	$0
Net Estimated Implementation Costs:	$14,200
Estimated Simple Payback:	1.9
Annual Avoided CO_2 Emissions (tons):	22

Example High Efficiency Model

- **Existing System**:
  - The existing domestic hot water system consists of a 400MBH A.O. Smith indirect, natural gas fired water heater with stand alone storage tanks. This unit was installed during the 1997 expansion, but appears to suffer from premature corrosion possibly due to flue gas condensation during cold months. The efficiency of the current burner is estimated to be between 75%-85%.

- **Recommended Solution**:
  - At the end of the current unit's service life, the hot water heater should be replaced with a high efficiency model. For the purpose of these calculations, a condensing unit was assumed to be the replacement. The cost of flue replacement has been incorporated.

ECM #3: Demand Control Ventilation (DCV)

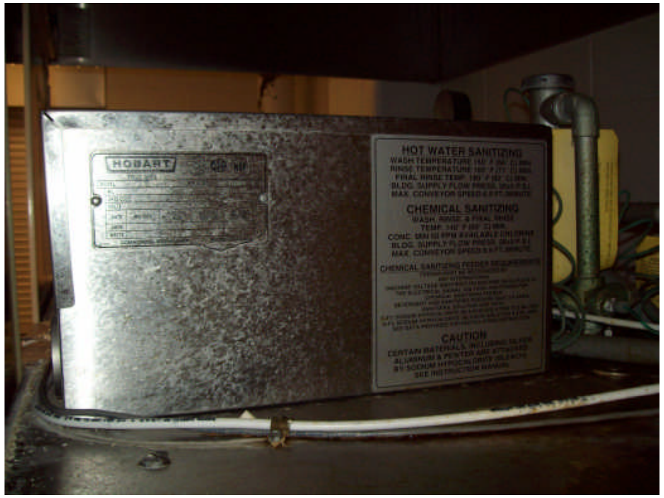
	Gymnasium	Theater	TOTAL
Estimated Annual Energy Cost Savings:	$2,200	$15,000	**$17,200**
Estimated Gross Implementation Costs:	$26,900	$29,900	**$56,800**
NJ Smart Start Rebate:	$0	$0	**$0**
Net Estimated Implementation Costs:	$26,900	$29,900	**$56,800**
Estimated Simple Payback:	12.2	2.0	**3.3**
Annual Avoided CO_2 Emissions (tons):	20.8	42.7	**63.5**

- 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 outdoor air which requires costly (and unnecessary) conditioning.

- Demand controlled ventilation (DCV) controls the amount of outside air based on the CO_2 levels generated by building occupants. DCV should be added to any return air system where space occupancy varies dramatically. In the case of Monmouth HS, the large gymnasium & theatre are candidates for DCV.

- By installing CO_2 sensors and controlling the CO_2 level rise in the space at less than 700 ppm, the outside air flow is kept to a minimum while space conditions are kept in compliance with building codes and standards such as *ASHRAE Std 62 Ventilation for Acceptable Indoor Air Quality.*

ECM #4: Replace Dishwasher Electric Hot Water Booster with a Gas Fired Unit



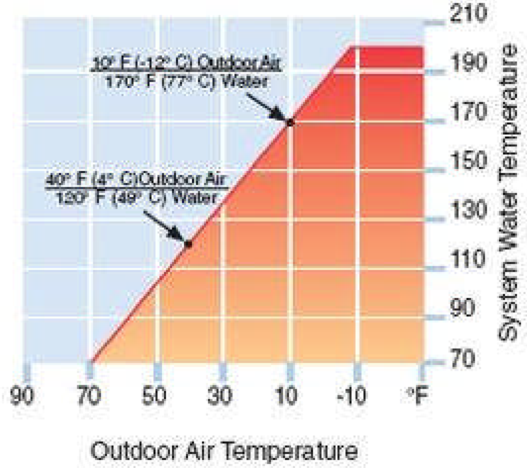
Electric hot water booster heater

Estimated Annual Energy Cost Savings:	$1,700
Estimated Gross Implementation Costs:	$12,000
NJ Smart Start Rebate:	$0
Net Estimated Implementation Costs:	$12,000
Estimated Simple Payback:	7.2
Annual Avoided CO_2 Emissions (tons):	2

- The school's kitchen is equipped with an electric hot water booster to raise water temperatures for dishwashing.
- With an average electric cost of $0.16 per kilowatt hour, the equivalent natural gas cost for a 95% efficient natural gas hot water heater is nearly $4.00 per therm. The actual price for natural gas is approximately $1.96 per therm, half the cost of running an electric unit.
- Replacing the electric heaters with natural gas units will provide at least $1,400 in annual savings and will reduce electric demand by 25 kW.

ECM #5: Automatic Boiler Temperature Reset

Estimated Annual Energy Cost Savings:	$1,800
Estimated Gross Implementation Costs:	$21,000
NJ Smart Start Rebate:	$0
Net Estimated Implementation Costs:	$21,000
Estimated Simple Payback:	11.4
Annual Avoided CO_2 Emissions (tons):	6



- The existing heating hot water system currently incorporates fixed hot water supply temperature controls. However, the boiler operator adjusts (resets) the supply water temperature seasonally based on outdoor air temperature. This seasonal adjustment accounts for a substantial savings compared to a system that is not adjusted seasonally.

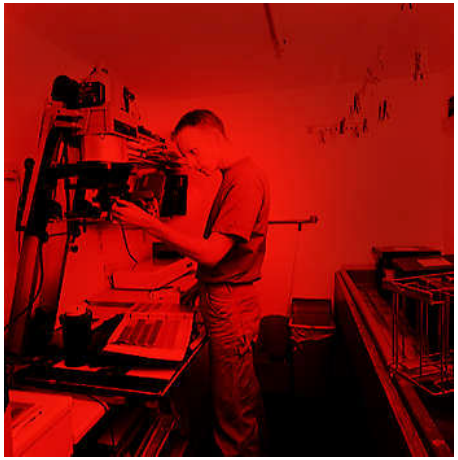
- Dome-Tech’s recommended action is Boiler controls be installed to adjust supply water temperature automatically and incrementally based on outdoor air temperature. Although the manual adjustments currently performed on the system account for a large portion of the savings potential associated with temperature reset, an automatic system will gain even more savings & take the responsibility off of the boiler operator.

ECM #6: Photography Lab Heat Recovery

Estimated Annual Energy Cost Savings:	$1,700
Estimated Gross Implementation Costs:	$28,000
NJ Smart Start Rebate:	$0
Net Estimated Implementation Costs:	$28,000
Estimated Simple Payback:	16.7
Annual Avoided CO_2 Emissions (tons):	0

- Approximately 2000 cfm of conditioned air is constantly being exhausted from the photography lab area. This air is replaced with outside air that needs to be conditioned.

- Heat recovery can be accomplished by installing a run-around glycol loop from the exhaust location to the air intake for the photography area. Fortunately, these two areas (exhaust & intake) are directly adjacent to one another on the roof, thus making this installation feasible.



ECM #7: Lighting Upgrade

Estimated Annual Energy Cost Savings:	$11,860
Gross Estimated Implementation Cost:	$114,580
NJ Smart Start Rebate:	$5,440
Net Estimated Implementation Costs:	$109,140
Simple Payback (yrs): (with rebate)	9.2
Annual Avoided CO_2 Emissions (tons):	24

- 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.
- Most of the current lights in the gymnasiums are high intensity discharge lamps, which can be replaced with high output, higher efficiency fluorescent fixtures that are specifically designed for high ceiling applications. Lighting energy will be reduced by nearly 50% in applicable gymnasiums.
- Many classrooms, break rooms and restrooms 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 #8: Creation of an Energy Awareness & Education Program

Estimated Annual Savings:	2-3%*
Gross Estimated Implementation Cost:	$1500
Expected Rebate / Energy Efficiency Credit:	None
Net Estimated Implementation Costs:	$1500
Simple Payback (yrs): (with and w/o rebate)	Varies
Annual Avoided CO_2 Emissions (tons):	Varies
Cost per Ton CO_2 Reduction ($/ton):	Varies

- Monmouth High School currently has no observed 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.

* Estimated Annual Savings are based on the robustness of the program implemented, maintenance, and annual energy costs.

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
- Photovoltaic (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)

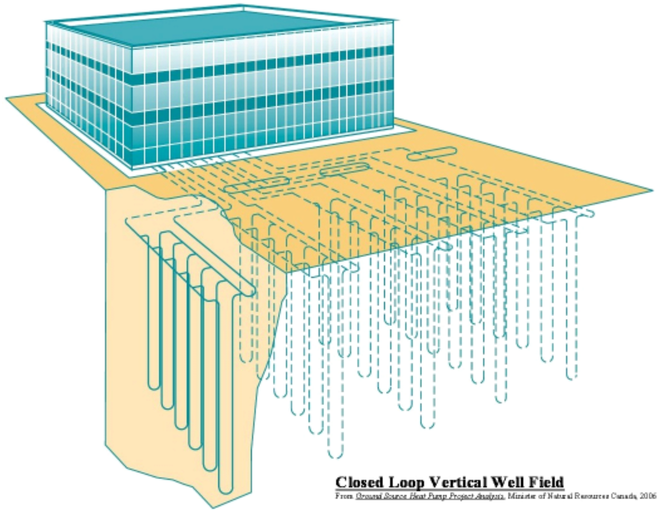
Renewable Energy Technologies: Geothermal

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	$3,381,000	$1,690,500
NJJ SSB Rebate	$178,710	$38,157
Net Installation Cost Estimate	$3,202,290	$1,652,343
Annual Energy Cost	$245,095	$343,364
Annual Electric Use, kWh	1,531,844	1,003,184
Annual Natural Gas Use, Therms	0	116,840
Annual CO2 Emmisions, Tons	536	1,035

*Based upon Monmouth County Regional High School HVAC Systems & Energy Profile

Simple Payback on Net Install Cost GSHP

Net Installation Cost Estimate	$3,202,290
Annual Energy Savings	$98,269
Simple Payback	32.6

Simple Payback on Incremental Cost of GSHP

Net Installation Cost Estimate	$1,549,947
Annual Energy Savings	$98,269
Simple Payback	15.8

GSHP Pros & Cons

Pros	Cons
➢Annual HVAC energy cost reduction of over $98,000. ➢Well fields installations typically last over 50 years. ➢Reduction of annual greenhouse gas emissions by ~500 tons per year. ➢Potential for removal of boiler and low efficiency DX refrigeration system. ➢Potential for reduced maintenance costs if the GSHP system replaces boiler 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 test bores are sampled. ➢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. 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. Due to the aging boilers and consistent age of the cooling systems (circa 1997), a geothermal heat pump system may be a viable replacement strategy.

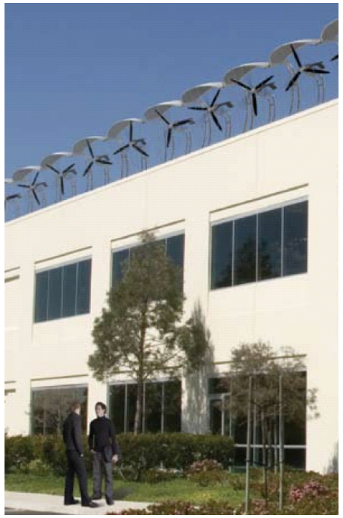
Renewable Energy Technologies: Wind

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.

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

For Monmouth High School, 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	$45,278	$35,994	$95,720
Net Installation Cost Estimate	$84,722	$26,406	$154,280
Annual Energy Savings	$2,264	$1,800	$16,806
Simple Payback	37.4 yrs.	14.7 yrs.	9.2 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, Tons	5	4	37
% of Annual Electric Use*	0.7%	0.6%	5.5%

Monmouth County Regional HS: 1892800 kWh/Year.

Wind Turbine Pros & Cons

Pros	Cons
➢Annual reduction in energy spend and use can be potentially reduced by almost $17,000 (5.5% reduction). ➢Typical equipment life span is 15-30 years. ➢Reduction of annual greenhouse gas emissions by 4-37 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 (9+ 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 Monmouth HS decide to pursue a wind turbine project, Dome-Tech recommends commissioning a more detailed study.

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.
- Can be recommended in this application for placement on additional area schools.

Solar Photovoltaic Systems

System Capacity, kw-dc (partial utilization of roof space)	220 kw dc
Annual Electric Generation, kwhrs of AC electricity produced	231,880 kwh
Total Annual Facility Electric Use, kwhrs	1,892,800 kwh
% of Total Annual Usage	12%
All-In Cost of Electric Year 1	$0.160 / kwh
Annual Electric Cost Savings	$37,101
Estimated SREC Value (Year 1):	$640 / SREC
Estimated Year 1 SREC Revenue:	$148,327
Equivalent Annual CO2 Emission Reduction (tons per year)[1]	80 tons/yr
Equivalent Cars Removed From Road Annually[2]	14
Equivalent Acres of Trees Planted Annually[3]	22
System Installed Cost (does not include value of tax credits)	$1,540,000
Simple Payback (includes tax incentives)	10.3
IRR (25 Years)	6%

1. Estimated CO2 Emissions Rate: 0.694 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

➢ Non-Financial Benefits of Solar PV

➢ The implementation of these solar PV projects places Monmouth Regional High School at the forefront of renewable energy utilization. This allows the school and 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

Dome-Tech, Inc.

- 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 Monmouth High School due to the lack of thermal requirements in the summertime.

Dome-Tech, Inc.

Energy Procurement – Electricity

Accounts and Rate Class:

- Monmouth Regional High School ("the District") is served by 2 electric accounts behind Jersey Central Power and Light Company. One account is served under rate class General Service Secondary (GSS) and one account serves outdoor street lighting under rate class (SWV-01S).

Electric Consumption and Cost:

- Total energy consumption over the one year period January 2008 – December 2008 was approximately 1,892,800 kWh costing $306,472. The District paid between $0.14 and $0.18 per kWh for the GSS account and $0.27 per kWh for the street lighting account, per month, on average, inclusive of utility delivery charges.

Basic Generation Service 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.
- The NJBPU has continued to move new large energy users into BGS-CIEP by lowering the demand (kW) threshold for electric accounts receiving Secondary service

Energy Procurement – Electricity & Natural Gas

Dome-Tech, Inc.

ELECTRICITY

- All of the District's electric accounts fall into the BGS-FP category.

- Until recently, the least-cost option for FP accounts has been to remain with the utility for default electric service. This may not continue to be the case because market pricing has fallen to a point that enables retail suppliers to beat the BGS-FP rates.

- The district should consider shopping for retail electric generation service for its BGS-FP account. Based on actual bid results from processes conducted in August 2009, it is possible that the District could potentially save approximately 15-20% versus the utility default (BGS) supply rate. Note that this is not inclusive of utility delivery charges.

NATURAL GAS

- The District is served by 1 natural gas account behind New Jersey Natural Gas.

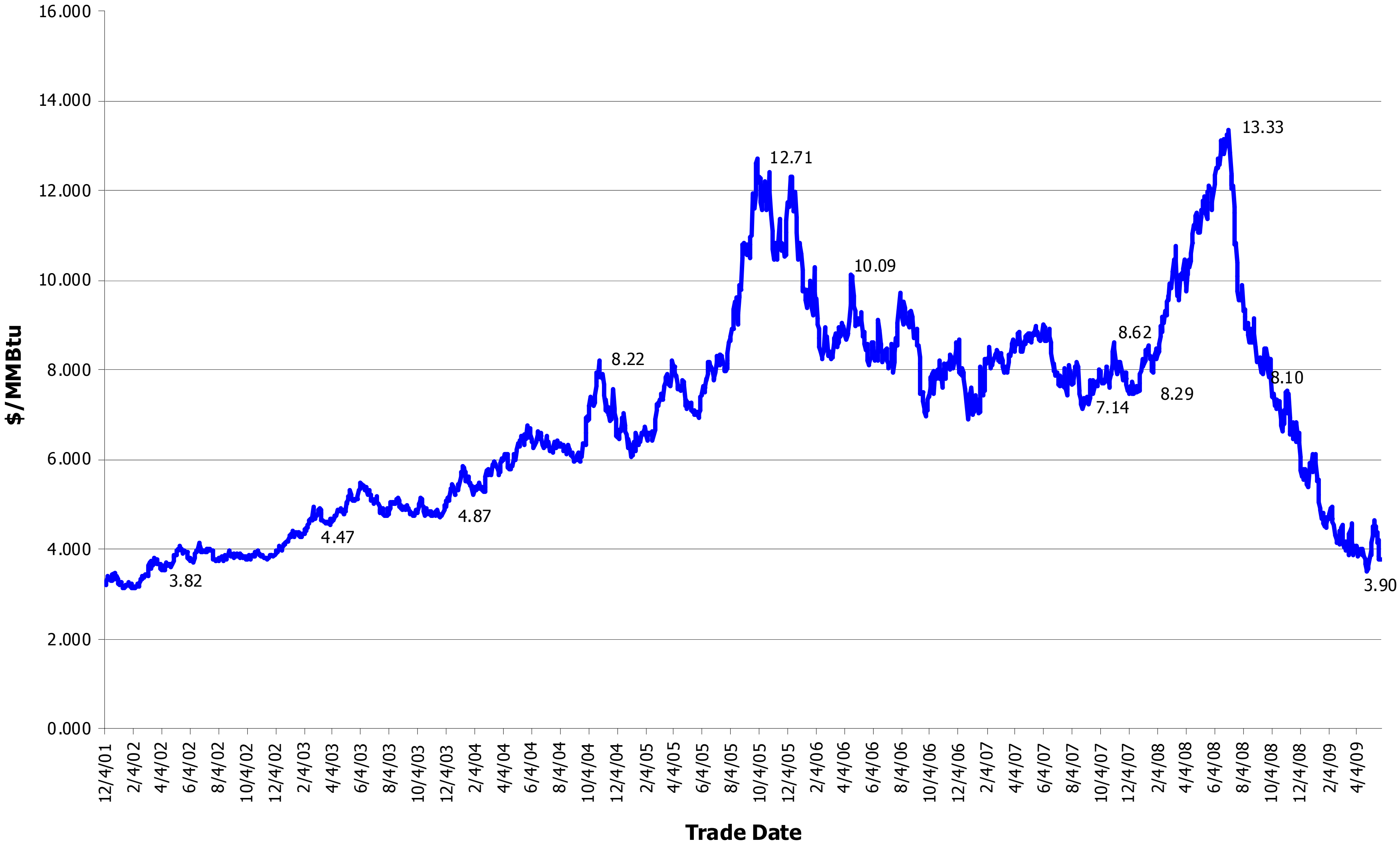
- Natural gas is used predominantly for heating purposes; total annual consumption for the period studied was approximately 12,900 decatherms costing about $254,000. The District paid $1.96 per therm, per month, on average, inclusive of utility delivery charges.

- The District is currently contracted with South Jersey Energy, a retail energy supplier for natural gas (commodity) service, with a floating rate that has cost between $1.028 and $1.289 per therm.

- Natural gas commodity futures prices at the time of this report are at about $0.39 per therm for July 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 6 years (see graph below). If the District seeks longer-term rate stability, now is an ideal time to entertain it through a fixed-price arrangement with a retail supplier.

Energy Procurement – Natural Gas

Henry Hub Natural Gas - 12 Month Strip



Dome-Tech, Inc.

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.

- The following utility prices provided were used within this study:
  - Electricity Cost ($/kWh): $ 0.16
  - Natural gas Cost ($/therm): $ 2.03

- The average CO_2 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 0.694 lbs of CO_2 per kWh generated.

- The EPA estimates that burning one therm of natural gas emits 11.708 lbs CO_2.

- The EPA estimates that one car emits 11,560 lbs CO_2 per year.

- The EPA estimates that reducing CO_2 emissions by 7,333 pounds is equivalent to planting an acre of trees.

Good Practices, Operations & Maintenance

- Good Practices
  - Monmouth Regional High School's Boiler Operator/Facilities Manager is exceptionally knowledgeable about the school's operation, history & future plans. Dome-Tech places a high value on tenured individuals who take ownership in building operations as it leads to expedited corrective action when things go wrong & ultimately saves energy & operational cost.
  - Boilers are manually started & shut down to minimize excess boiler firing & reduce energy consumption.
  - Boiler supply water temperature is reset manually to reduce excessive hot water temperatures & save energy.
- Operations & Maintenance Suggestions
  - Dome Tech recommends increasing the frequency which air filters are replaced within HVAC equipment. This will increase indoor air quality as well as decrease pressure drop through the filters, thus reducing energy consumption. Because filter types dictate minimum replacement schedules, it is recommended that filters be checked on a monthly basis, and replaced when necessary.

Next Steps

The following projects should be considered for implementation (further study may be required):

- Install Vending Misers on Vending Machines
- Replace the Domestic Hot Water Heater
- Install Demand Control Ventilation in the Theater and Gymnasium areas
  - *Gymnasium DCV should be installed at the end of current equipment's life.*
- Convert Electric Dishwasher Hot Water Booster to a Natural Gas Unit
- Install Heat Recovery System in Photography Labs
- Energy Education Program
- Solar Photovoltaic System
- Energy Procurement