



Manasquan Board of Education

Local Government Energy Audit

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Dome-Tech, Inc.



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- **Dome-Tech, Inc., A UTC Company, offers energy and engineering consulting services to optimize building performance, reduce energy expenses and improve building sustainability.**





NJ Local Government Energy Audit (LGEA) Program Information

- Five companies approved for the work
- Standardized application, scope of work and RFP process
- All five firms receive the RFP
- 100% reimbursed (formerly 75% reimbursement with a requirement to implement)
- Pricing ranges from \$0.08/SF to \$0.12/SF. Smaller districts are higher on range



NJ LGEA Scope of Work

1. Historic Energy Consumption: Benchmark energy use using Energy Star Portfolio Manager
2. Facility Description: Characterize building usage, occupancy, size and construction
3. Equipment Inventory: Detailed equipment list including useful life and efficiency
4. Energy Conservation Measures: Identify and evaluate opportunities for cost savings and economic returns.
5. Renewable/Distributed Energy Measures: Evaluate economic viability of various renewable/distributed energy technologies
6. Energy Purchasing and Procurement Strategies: Perform utility tariff analysis and assess potential for savings from energy procurement strategies
7. Method of Analysis: Appendices



NJ LGEA Summary of Findings

	Energy Conservation Measures (ECM)	Buildings	Energy Savings			Total Annual Cost Savings*	Net Implementation Costs Pay Back (Net) Yrs
			kWh	kW	therms		
1	HVAC Time of Day Optimization	Elementary School	61,100		0	\$ 8,430	0.6
2a*	UV Time of Day Optimization	High School	25,000		0	\$ 3,450	1.5
3	Vending Machine Power Management	High School	13,000		0	\$ 1,790	1.5
3	Vending Machine Power Management	Elementary School	3,240		0	\$ 450	1.5
4	Computer Power Management	High School	11,400		0	\$ 1,570	6.1
4	Computer Power Management	Elementary School	8,630		0	\$ 1,190	6.1
5	Lighting Upgrade	High School	67,600		0	\$ 9,330	7.6
6	Lighting Upgrade	Elementary School	70,600		0	\$ 9,740	9.1
7	Walk-In Controllers	Elementary School	630		0	\$ 90	13.6
7	Walk-In Controllers	High School	630		0	\$ 90	13.6
8	Occupancy Sensors	Elementary School	21,300		0	\$ 2,940	15.4
8	Occupancy Sensors	High School	11,800		0	\$ 1,640	17.2
9	Premium Efficiency Motors	Elementary School	930		0	\$ 130	16.5
10	Dishwasher Booster Pump Fuel Switch	High School	4,150		-170	\$ 380	19.6
10	Dishwasher Booster Pump Fuel Switch	Elementary School	2,640		-110	\$ 350	21.2
11	Boiler Replacement	High School	0		5,600	\$ 6,500	7.5
Totals			302,650	0	5,320	\$ 48,070	6.9



Greenhouse Gas Emission Reduction

Implementation of all identified ECMs will yield:

- 302,650 kilowatt-hours of annual avoided electric usage.
- 5,320 therms of annual avoided natural gas usage.
- This equates to the following **annual** reductions:

- 131 tons of CO₂;

- -OR-

- 23 Cars removed from road;

- -OR-

- 36 Acres of trees planted annually



The Energy Information Administration (EIA) estimates that power plants in the state of New Jersey emit 0.666 lbs CO₂ per kWh generated.



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



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



ECM #1: HVAC Unit Time of Day Schedules

HVAC Unit Time of Day Schedules	Elementary School
Estimated Annual Savings:	\$8,430
Gross Estimated Implementation Cost:	\$4,790
NJ Smart Start Rebate:	\$0
Net Estimated Implementation Cost:	\$4,790
Net Simple Payback (years):	0.6
Annual Avoided CO ₂ Emissions (tons):	20.2

- Investigation of the BAS's existing equipment operating schedules revealed that while operating schedules do exist, they are very general and do not closely reflect actual operation.



ECM #2a: Controls Upgrade

UV Time of Day Controls

Unit Ventilator Time of Day Controls	High School
Estimated Annual Savings:	\$3,450
Gross Estimated Implementation Cost:	\$5,290
NJ Smart Start Rebate:	\$0
Net Estimated Implementation Cost:	\$5,290
Net Simple Payback (years):	1.5
Annual Avoided CO ₂ Emissions (tons):	8.3



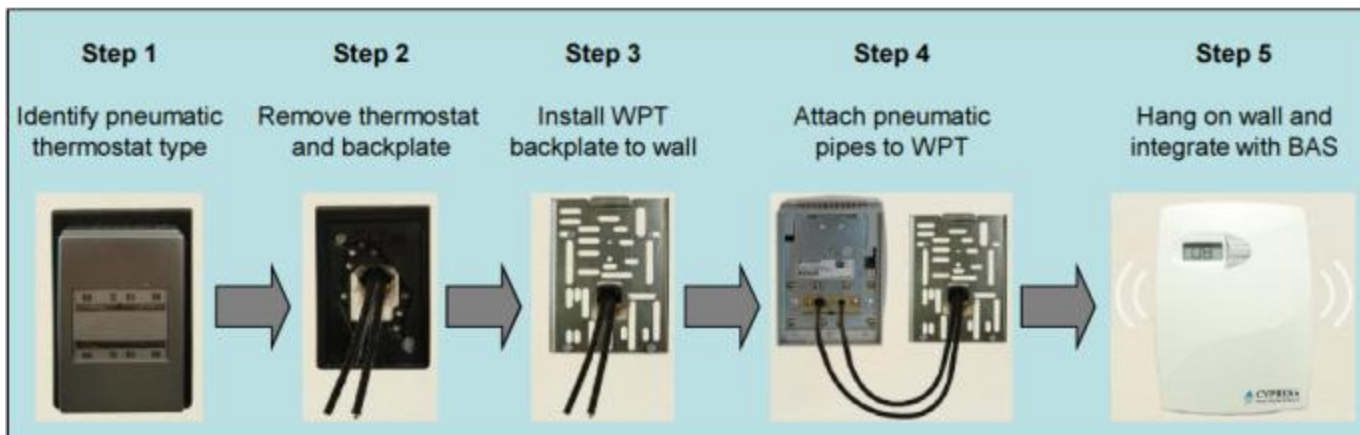
Typical Classroom Unit Ventilator

- All classrooms at the Manasquan High School are conditioned via unit ventilators (UV). While most rooms have only one (1) UV, some larger rooms are equipped with two (2). There are approximately forty-three (43) UVs in total.
- These units previously were operated via Barber Coleman electronic controls, but the equipment is no longer supported/operable. Currently, all UVs are operated manually. Consequently, the forty-three (43) UVs in the High School currently remain on 24/7.
- Dome-Tech recommends installing new digital 7-Day time clocks to control operation of the unit ventilators during building unoccupied hours. The cost above represents material and labor costs associated with installing the new time clocks.



ECM #2a: Controls Upgrade UV Time of Day Controls (continued)

- An alternate approach that the school district should consider is replacing the unit ventilators that are pneumatically controlled with wireless pneumatic thermostats.
- This option will allow for optimum control of all the units from the a BMS; however, the implementation cost is significantly larger than the installation of local time clocks.
- This retrofit is not possible on the unit ventilators that have disabled electronic controls. Time clock as previously mentioned will need to be installed for those units.





ECM #2b: Controls Upgrade

Building Management System Replacement

Building Automation System Replacement	High School
Estimated Annual Savings:	3,450
Gross Estimated Implementation Cost:	\$596,000
NJ Smart Start Rebate:	\$0
Net Estimated Implementation Cost:	\$596,000
Net Simple Payback (years):	>50
Annual Avoided CO ₂ Emissions (tons):	8.3

- This measure option is not justifiable on simple payback alone, but recommended for consideration as a full systems integration solution. Additional Retro Commissioning savings, which have not been accounted for in this analysis, would be realized with this implementation.



ECM #3: Vending Machine Power Management

Vending Machine Power Management	High School	Elementary School	TOTAL
Estimated Annual Savings:	\$1,790	\$450	\$2,240
Gross Estimated Implementation Cost:	\$2,720	\$680	\$3,400
NJ Smart Start Rebate:	\$0	\$0	\$0
Net Estimated Implementation Cost:	\$2,720	\$680	\$3,400
Net Simple Payback (years):	1.5	1.5	1.5
Annual Avoided CO ₂ Emissions (tons):	4.3	1.1	5.4



- Dome-Tech recommends installing vending machine power management devices on all soda and snack vending machines throughout the district.

	Soda Vending
High School	4
Elementary School	1
Total	5





ECM #4: Computer Power Management System

Computer Power Management System	High School	Elementary School	TOTAL
Estimated Annual Savings:	\$1,570	\$1,190	\$2,760
Gross Estimated Implementation Cost:	\$9,600	\$7,280	\$16,880
NJ Smart Start Rebate:	\$0	\$0	\$0
Net Estimated Implementation Cost:	\$9,600	\$7,280	\$16,880
Net Simple Payback (years):	6.1	6.1	6.1
Annual Avoided CO ₂ Emissions (tons):	3.8	2.9	6.7



Typical Computer Lab

	# of Computers per School
High School	384
Elementary School	291
Total	650

- According to staff, the power/ operating hours of the District's computers are each controlled independently; staff manually turn on and off all computers daily. Approximately 650 computers are utilized throughout the district.
- Installing a computer power management system will allow IT administrators to reduce per-PC operating cost by reducing energy consumption via shutdown, standby and hibernate for PC's and sleep for monitors.



ECM #5: Lighting Upgrade – High School



Lighting Upgrade: High School	High School
Estimated Annual Savings:	\$9,300
Gross Estimated Implementation Cost:	\$81,100
NJ Smart Start Rebate:	\$10,100
Net Estimated Implementation Cost:	\$71,000
Gross/Net Simple Payback (years):	8.7/7.6
Annual Avoided CO ₂ Emissions (tons):	22.3



- The High School underwent a full lighting upgrade 10 years ago, but additional opportunities exist.
- The interior spaces of the school currently does not have lighting controls in place.



ECM #6: Lighting Upgrade – Elem. School



Lighting Upgrade: Elem. School	Elementary School
Estimated Annual Savings:	\$9,750
Gross Estimated Implementation Cost:	\$102,000
NJ Smart Start Rebate:	\$13,200
Net Estimated Implementation Cost:	\$88,800
Gross/Net Simple Payback (years):	10.5/9.1
Annual Avoided CO ₂ Emissions (tons):	23.3



- The Elementary School underwent a full lighting upgrade 10 years ago, but additional opportunities exist.
- The interior spaces of the school currently does not have lighting controls in place.



ECM #8: Lighting Occupancy Sensors

Lighting Occupancy Sensors	High School	Elementary School	TOTAL
Estimated Annual Savings:	\$1,640	\$2,940	\$4,580
Gross Estimated Implementation Cost:	\$30,900	\$50,300	\$81,200
NJ Smart Start Rebate:	\$2,660	\$5,100	\$7,760
Net Estimated Implementation Cost:	\$28,200	\$45,200	\$73,400
Gross/Net Simple Payback (years):	17.1/15.4	18.8/17.2	17.7/16.0
Annual Avoided CO ₂ Emissions (tons):	3.9	7.0	10.9

- Both schools use manual toggle switches to control the building lighting.
- Energy savings will be realized from the implementation of occupancy sensors in classrooms, cafeterias, media centers, gyms, faculty lounges, conference rooms, copy rooms, offices and other areas with variable occupancy and minimum load of 165W per space.



ECM #11: Boiler Upgrade at End of Life

Boiler Upgrade	High School
Estimated Annual Savings:	\$6,500
Gross Estimated Implementation Cost:	\$532,280
NJ Smart Start Rebate:	\$10,000
Avoided Cost :	\$472,818
Net Estimated Implementation Cost:	\$49,462
Simple Payback with and without Avoided Cost & Rebate (years):	7.6 / 81.8
Annual Avoided CO ₂ Emissions (tons):	32.8

- Due to long payback, this project is not recommended for the High School at this time.
- This is the alternative to “replacement in kind” and should be studied when boilers are at “end of life”



5,862 MBH Boilers in the High School



2,163 MBH Boilers in the High School



Renewable Energy Technologies: Wind

Manasquan Wind Speed

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 Manasquan area is between 5.3– 6.6 meters per second.

Ideal wind speeds for a successful project should average over 6 meters per second.

Building Integrated Wind Turbines



5 kW Ground Mount

Height: 40'



50 kW Ground Mount

Height: 102'



"Building Your Greener World"



Renewable Energy Technologies: Wind

Wind Turbine Economics

	Building Integrated	Ground Mount 5 kW	Ground Mount 50 kW
Gross Installation Cost Estimate	\$325,000	\$312,000	\$250,000
Number of Units	50	10	1
Annual Energy Savings	\$7,473	\$10,619	\$21,210
Simple Payback	43.5 yrs.	29.4 yrs.	11.8 yrs.
System Capacity	50 kW	52 kW	50 kW
Annual Avoided Energy Use	54,144 kWh	76,937 kWh	153,672 kWh
Annual CO2 Emmissions, tons	19	27	54
% of Annual Electric Use*	2.1%	2.9%	5.9%

Manasquan Board of Education: 2,613,355 kWh/ Year.

Wind Turbine Pros & Cons

Pros	Cons
<ul style="list-style-type: none"> ➤ Annual reduction in energy spend and use can be potentially reduced across the district by approximately \$21,210 (5.9% reduction). ➤ Typical equipment life span is 15-30 years. ➤ Reduction of annual greenhouse gas emissions by 54 tons per year. ➤ A wind turbine project could be incorporated into science and other curriculums to raise student awareness of energy alternatives. ➤ High visible “green” project. 	<ul style="list-style-type: none"> ➤ Payback period is significant (approximately 11.8 years). ➤ Average area wind speed is not ideal and impacts performance. ➤ Prone to lightning 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).



Renewable Energy Technologies: Solar Photovoltaic – Roof Mounted Layout



Manasquan High School Proposed PV Layout



Manasquan Elementary School Proposed PV Layout



Renewable Energy Technologies: Solar Photovoltaic – Roof Mounted Economics

	High School	Elementary School	Total
Site Energy Use (kWh):	1,370,008	1,243,347	2,613,355
Location to Install Panels:	roof	roof	roof
Assumptions			
System Capacity, kw-dc (maximum utilization of roof space)	219 kw dc	273 kw dc	492 kw dc
Annual Electric Generation, kWhrs of AC electricity produced	230,469 kwh	287,898 kwh	518,367 kwh
Total Annual Facility Electric Use, kWhrs	1,370,008 kwh	1,243,347 kwh	2,613,355 kwh
% of Total Annual Usage	17%	23%	20%
All-In Cost of Electric Year 1	\$0.138 / kwh	\$0.138 / kwh	\$0.138 / kwh
Annual Electric Cost Savings	\$31,809	\$39,598	\$71,407
Estimated SREC Value (Year 1):	\$150 / SREC	\$150 / SREC	\$150 / SREC
Estimated Year 1 SREC Revenue:	\$34,570	\$43,185	\$77,755
Financial Results			
System Installed Cost	\$983,975	\$1,229,166	\$2,213,141
Simple Payback	15.3	15.3	15.3
IRR (25 Years)	3.3%	3.2%	3.3%
Net Present Value (25 yrs, 4% discount rate)	(\$66,742)	(\$86,070)	(\$152,812)
Environmental Impact			
Equivalent Annual CO2 Emission Reduction (tons per year) ¹	76 tons/yr	95 tons/yr	171 tons/yr
Equivalent Cars Removed From Road Annually ²	13	16	30
Equivalent Acres of Trees Planted Annually ³	21	26	47

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



Next Steps

- **The following projects should be considered for implementation:**
 - UV Time of Day Optimization
 - HVAC Time of Day Optimization
 - Vending Machine Power Management
 - Computer Power Management
 - Lighting Upgrade
 - Walk-in Cooler Controls
 - Lighting Occupancy Sensors

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



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.
- Some ECM's proposed in this report are mutually exclusive. 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
Manasquan High School	\$0.138	\$1.161
Manasquan Elementary School	\$0.138	\$1.139



Thank You!



Dome-Tech, Inc.