

Detailed Energy Audit

Dover School District
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Dover, NH 03820-4181

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1 Executive Summary

1.1 INTRODUCTION

This report details the recommendations and conclusions of an energy audit at Dover Public School District located in Dover, NH. The Dover school district comprises of six different schools. The following Table represents the details about the schools.

Table 1

	Area Sq Ft	Number of Students	Number of Staff
High School (HS)	224,075	1,606	132
Middle School (MS)	175,020	1,142	83
Woodman Park School (WPS)	73,108	479	45
Home Street School (HES)	48,236	435	32
Garrison School (GES)	49,678	428	36
Alternative School (AS)	7,935	-	-

A summary of recommended Facility Improvement Measures is shown in Table 2. This table shows the energy savings and cost savings for each measure.

Section two to seven of this report includes a discussion of the building description and detailed discussions and analysis for the measures analyzed for all six schools.

1.2 IDENTIFIED FACILITY IMPROVEMENT MEASURES (FIMs)

The Identified Facility Improvement Measures for the Dover School District is listed in the Table 2 with the electrical and fuel savings and implementation costs associated with each measure. Woodman Park School is not a part of this detailed energy audit, due to the pending renovation of the facility. However, Siemens has included the study (Section 7) for future consideration.

As a result of the implementation of the recommended FIMs Dover Schools will reduce its current energy cost conservatively by \$ 213,865 or 26%. Please refer to Table 2 on the next page for a detailed summary.

Table 2: Summary of Recommended Facility Improvement Measures
Dover Public Schools, Dover, NH

Facility Improvement Measures	Schools	KW	KWh	Gas Therms	# 4 Oil Gallons	Water	Sewer	Cost Savings
Lighting	AS,HS,MS,HES,GES	1,906	509,592	-9,362	-601			\$53,078
Lighting Controls	HS,MS,HES,GES		82,647					\$8,370
EMS Optimization (Night Setback)	AS,HS,MS,HES,GES			37,694	5,814			\$51,238
EMS Optimization (DCV)	AS,HS,MS,HES,GES			23,084	1,457			\$28,530
Motor & Drives	HS,MS,HES,GES	28	209,602					\$21,418
Building Envelope Improvements	HS,MS,HES,GES			11,800	1,431			\$15,371
Replace electric gridle in kitchen with gas-fired equivalent	HS	324	19,505	-1,445				\$2,417
Dishwasher Replacement	HS			2,516		174,563	174,563	\$4,565
Steam kettle replacement	HS			755				\$899
Kitchen hood control	HS & MS		7,000	1,801				\$2,810
Classroom Ventilation Upgrades	HS			2,648				\$3,151
Water Conservation	HS,HES,GES			1,397	94	1,305,041	1,305,041	\$13,510
Vending Miser	HS,MS,HES,GES		32,038					\$3,248
Computer Power Management System	HS,MS,HES,GES		174,000					\$17,621
Replace electric Booster with gas-fired equivalent	MS,HES	644	45,249	-3,195				\$5,394
Boiler Replacement	HES				6,266			\$6,892
DHW Heater	HES			-3,467	3,792			\$46,20
Total		2,902	1,079,633	64,226	18,253	1,479,604	1,479,604	\$238,564

2 Dover High School



2.1 BUILDING DESCRIPTION

The school was originally built in 1966. A Vocational Center and other additions were added in 1970, 1989, 1991 and 2003 increasing the original building to a total of 224,075 square feet. The current occupancy of the high school is 1606 students and 132 staff members.

2.1.1 Lighting

Most of the lighting system at the High School comprises of 32 watt T8 fluorescent lamps with standard electronic ballasts. The main gymnasium is illuminated by 400 watt, metal halide fixtures. These fixtures were installed in a 15' x 30' grid pattern. A small number of exiting classrooms were equipped with occupancy sensors.

2.1.2 Mechanical System:



The heating system at the High School comprises of two individual boiler plants. Three Cleaver Brooks hot water boilers are utilized for space conditioning at the High School. Each of these boilers is rated with a capacity of 9,900 MBH. Although most of the time only one boiler is operated, the remaining two boilers are kept warm by circulating the hot water return constantly through the vessel, thus wasting energy. The heating hot water is circulated by two 15 HP hot water pumps.

These pumps are of standard efficiency and are connected to a variable frequency drive. The second boiler plant is located in the Vocational Center. These two Cleaver Brooks, cast-iron sectional boilers provide the heating hot water for the seven hot water heating zones in the facility. The boilers have an input capacity of 2,237 MBH each. Each of the zones has a ½ HP circulator pump. Both boiler plants distribute heating hot water to heating coils in air-handling units, unit ventilators and perimeter baseboard. All of the air-handling units have a draw-thru fan. Based on information provided by facility personnel, outside air dampers associated with the unit ventilators are not functioning properly and remain open 100%.

Domestic hot water for the High School is generated by the (3) Turbo Power gas heaters with the input capacity of 600 MBH each. Domestic hot water for the Vocational School is provided by (1) Polysield water heater with the input capacity of 300 MBH.

In addition, a single steam boiler located in the High School Mechanical Room provides steam needed to operate various kitchen equipment. The boiler is manufactured by Fulton and has an input capacity of 6,300 MBH. Low pressure steam provided is utilized for steam kettles as well as the booster heater for the dishwasher.

2.1.3 Energy Management System:

An existing Apogee Building Control system is utilized to provide scheduling and temperature controls for the building. The main front end for the school is located in the facilities office located near by the Cafeteria. A review of the current operating procedures showed that all of the equipment is operated 24/7. Siemens data logged the space temperatures and motor ampere for different area in the schools. Based on the report from the data loggers, it revealed that there is none or minimum night setback going on in the space.

The controls for the Vocational School class room unit ventilators are pneumatic controls.

2.2 BASELINE

Table 3 is a summary of the available data for the most recent 12-month electric billing history for the building. Figure 1 is a plot of the energy usage in kilowatt-hours. The total electrical usage was 1,650,007 kWh. The total electrical costs were \$184,816. The gross average electrical cost was \$0.11/kWh.

**Table 3: Electrical History
Dover High School**

Electrical Usage					
Read Date	Number of Days	KWH	KW Demand	Bill Amount	\$/kWh
03/08/05	29	136,174	448	\$14,511	\$0.11
02/07/05	31	152,091	422	\$16,570	\$0.11
01/07/05	31	162,702	441	\$17,615	\$0.11
12/07/04	32	152,091	433	\$16,657	\$0.11
11/05/04	30	149,733	421	\$16,357	\$0.11
10/06/04	28	155,038	433	\$16,900	\$0.11
09/08/04	30	101,983	400	\$12,075	\$0.12
08/09/04	32	79,582	208	\$9,237	\$0.12
07/08/04	30	111,415	412	\$13,483	\$0.12
06/08/04	29	145,606	412	\$16,614	\$0.11
05/10/04	33	152,091	448	\$17,486	\$0.11
04/07/04	30	151,501	430	\$17,312	\$0.11
Total	365	1,650,007	4,908	\$184,816	\$0.112
Rates:					
Demand Charge					
	Distribution Demand Charge			0.187 /KW	
	Transmission Demand Charge			1.11 /KW	
	Stranded cost recovery charge			5.38 /KW	
	Total Demand			6.68 /KW	
Electrical Energy Charge					
	Distribution Charge			0.01371 /KWh	
	Stranded cost recovery charge			0.019 /KWh	
	System Benefit Charge			0.003 /KWh	
	Consumption Tax Charge			0.00055 /KWh	
	Default Energy Rate			0.0649 /KWh	
	Total Charge			0.10116 /KWh	
Electrical Energy Charge (including Demand)				\$0.11 /KWh	

Figure 1 Electrical History, High School

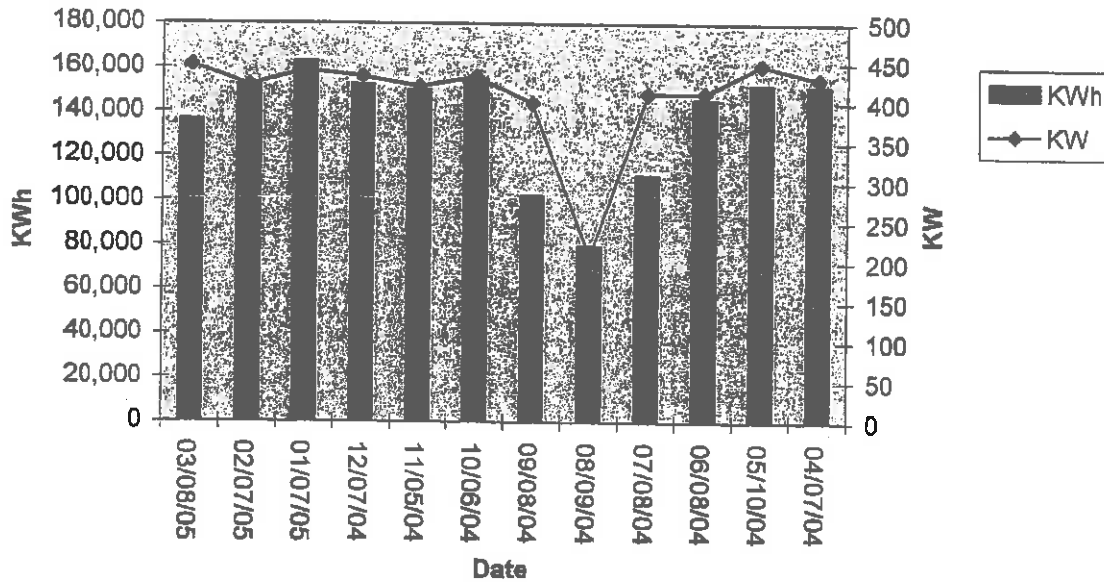


Table 4 is a summary of the available data for the most recent 12-month billing history for the Natural Gas. Total fuel delivered during past twelve months was 162,288 therms. Total fuel costs were \$193,539. The average unit cost is \$1.19 per therm.

**Table 4: Fuel History
Dover High School**

Natural Gas Usage

Date	Therms	Cost	\$/Therm
Mar-05	25,072	\$33,363	\$1.33
Feb-05	23,366	\$29,808	\$1.28
Jan-05	26,443	\$33,076	\$1.25
Dec-04	25,295	\$31,652	\$1.25
Nov-04	19,979	\$24,803	\$1.24
Oct-04	12,133	\$13,970	\$1.15
Sep-04	1,657	\$2,112	\$1.27
Aug-04	358	\$718	\$2.00
Jul-04	422	\$762	\$1.80
Jun-04	3,752	\$2,970	\$0.79
May-04	5,806	\$4,362	\$0.75
Apr-04	18,085	\$16,544	\$0.92
Total	162,288	\$193,539	\$1.19

2.3 FACILITY IMPROVEMENT MEASURES (FIMs)

Siemens identified the following feasible FIMs for the facility

Table 5: Summary of the Facility Improvement Measures, High School

		KW/Yr	KWh	Therms	Water	Sewer
1	Lighting	829	232,138	-4,662		
2	Lighting Controls		42,722			
3	EMS Optimization					
	Night Setback			25,917		
	Demand Control Ventilation			10,339		
4	Motor & Drives	16	12,299			
5	Building Envelope Improvements			,839		
6	Electric griddle Replacement	324	19,505	-1,445		
7	Dishwasher Replacement			2,516	174,563	174,563
8	Steam kettle replacement			755		
9	Kitchen hood control		5,725	1,129		
10	Classroom Ventilation Upgrades			2,648		
11	Water Conservation			1,315	842,193	842,193
12	Vending Miser		11,847			
13	Computer Power Management System		77,100			
		960	401,336	44,352	1,016,756	1,016,756

2.3.1 Lighting Retrofit

Siemens proposes to replace existing 32 watt T 8 fixtures and normal power electronic ballasts with 28 watt T8 lamps and high efficiency low power electronic ballasts. This retrofit allows schools to attain 28% savings over the existing system. In addition, the existing 400 watt metal halide fixtures in the gymnasium shall be replaced with new 6 lamp T5 fixtures.

Siemens also proposes to replace the existing 300w incandescent light fixtures in the auditorium with new recessed fixtures with (2) 32w amalgam compact fluorescent lamps, 10" silver alzak reflector and dimming ballasts. These fixtures will be installed in new 2x4 ceiling tiles which will replace the exiting tiles. These proposed lamps have a 20,000 hour lamp life, which compared to the existing incandescent life of 1000 hours, will significantly reduce the need for lamp replacement. The lumens per fixture will also be increased from 3,660 existing to 4,800 proposed. Siemens will install (3) new dimming control panels to allow the control of all of the lighting in the main auditorium as well as the A and B wing. Currently the A wing does not have any dimming capability. The dimming of all of the lighting will be located in one location (at the school's direction). The existing dimming switches will be converted to On/Off toggle switches.

Siemens will provide a single man Genie lift with a "super straddle" that will reach all of the lighting in the auditorium. This includes the straddle and the single man lift to attach to it. This lift can be used elsewhere in the facility for other tasks the school might have.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	829
Electrical Savings (kWh)	232,138
Gas Savings (Therms)	(4,662)
Total Energy Cost Savings	\$23,469

2.3.2 Lighting Controls

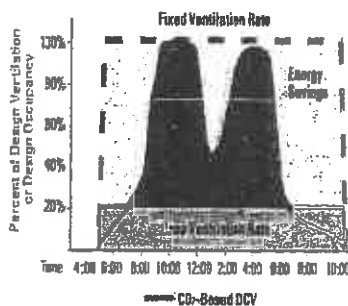
Although some of the classrooms are already equipped with occupancy sensors, Siemens identified more areas with sensor opportunities. The areas identified are the gymnasium, the cafeteria, the auditorium, the lecture hall, selected office areas and other class rooms. Please refer to the lighting savings spreadsheet for further details.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	
Electrical Savings (kWh)	42,722
Gas Savings (Therms)	
Total Energy Cost Savings	\$4,322

2.3.3 Siemens Direct Digital Control (DDC) System Optimization

The Air handling units at the Gymnasium, Auditorium and Cafeteria are currently controlled based on the space temperature. The total outside air requirement for these air handling units is 25,840 CFM. To meet ASHRAE 62.99, most HVAC systems are designed to supply ventilated air based on assumed, rather than actual occupancy. This often results in over-ventilation, wasting energy. The occupancy for the Gymnasium, Auditorium and Cafeteria is not constant and varies all around the year from very low occupancy to full occupancy. Siemens recommends that existing air handling units be modified to operate based on the need for fresh air based on actual occupancy or Carbon Dioxide Demand Control Ventilation (CO₂DCV).

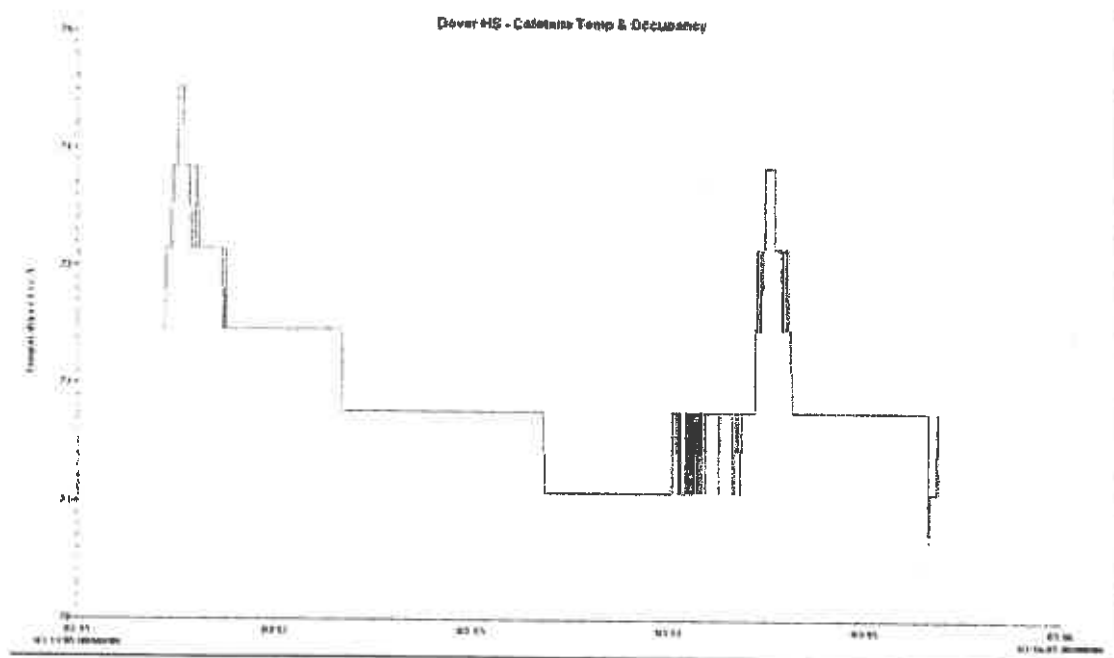


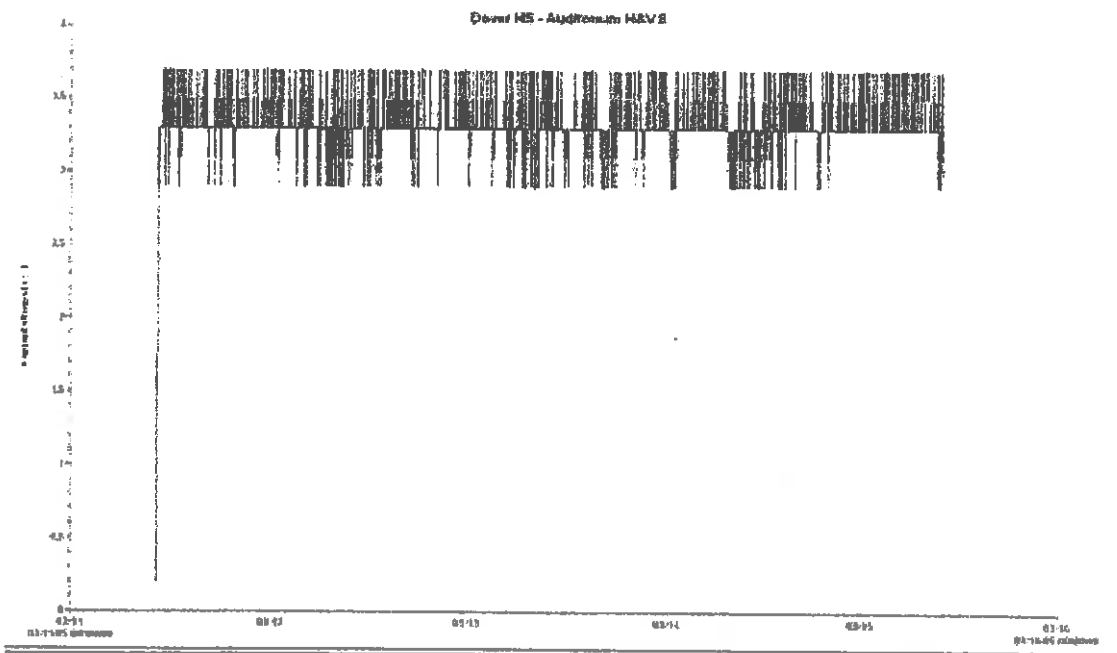
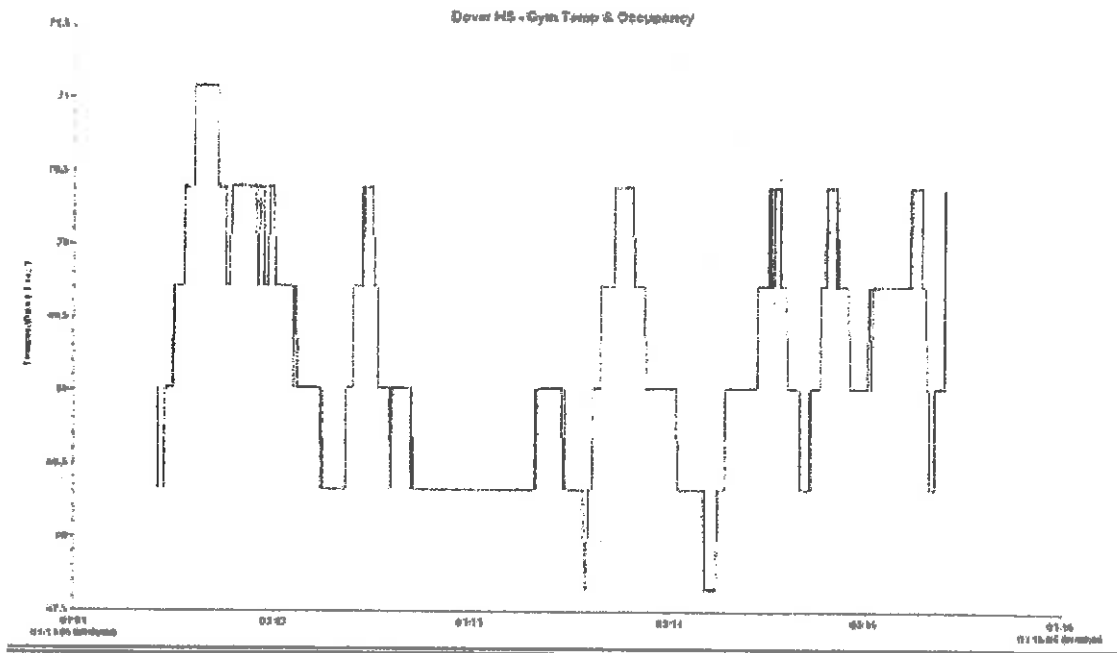
This can be determined by measuring the amount of carbon dioxide (CO₂) in the air within the space. The air handling systems will be controlled to provide enough outside air to maintain the CO₂ levels below 800 (adjustable) parts per million (ASHRAE Standard 62 recommends CO₂ levels to be below 1,000 ppm). This control will be achieved by installing CO₂ sensors within key areas of the building connected to the existing Siemens DDC. When the CO₂ level of any of the sensors reaches 800 ppm, the exhaust air dampers will be activated, otherwise they will remain off.

Figure1 provides the graphical representation of the energy savings potential for the CO₂ based control strategy. The area in the brown on the graph represents the typical occupancy of the space. The dashed line shows a scheduled ventilation strategy that is designed to provide for maximum occupancy throughout the day. The area in green shows the potential for the energy savings. The figure also shows the importance of providing base ventilation rate for non-occupant related contaminants.

Siemens is also recommending installing variable frequency drives (VFD) for the Cafeteria and Auditorium air handling units. EMS will modulate the speed on the drive and modulate the outside air damper based on the CO₂ level in the space. The control for the Gymnasium AHU will be outside air damper based on CO₂ level in the space.

An investigation of the current Siemens DDC system found that the current sequence of operation of the systems needs to be changed. Based on the report from the data logging of the space temperature from 3/11/05 to 3/15/05 for the Gymnasium and Cafeteria, we noticed that there is no night setback going on in these spaces. The temperature for gymnasium was maintained between 68 °F to 72 °F, while temperature for cafeteria was maintained between 71 °F to 75 °F. Siemens also data logged the ampere of Auditorium AHU-8 and noticed that The AHU was running continuously even during the unoccupied periods.





To improve the energy performance of the DDC system, Siemens proposes to implement the night setback strategy, re-commission the entire DDC system and making changes to reflect current needs. It is also recommended that energy efficient protocols be re-introduced and adhered to for future operation.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Therms)	36,255
Total Energy Cost Savings	\$43,144

2.3.4 Motor Replacement and Variable Frequency Drive Installation

Substantial energy savings can be obtained by replacing the standard efficiency motors located in the High School. Most of these motors appear to be original equipment, and are in fairly poor condition.

Siemens proposes to replace the motors in the following table with new premium efficiency units.

In addition, Siemens will also install a variable frequency drive (VFD) on the existing AHUs for Auditorium, Cafeteria and Kitchen in the building.

Dover High School Air Handling Units Motor Replacement		
		HP
AHU1	Gymnasium	1
AHU2	Gymnasium	1
AHU3	Gymnasium	1
AHU4	Gymnasium	1
AHU6	Kitchen	3
AHU7	Cafeteria	3
AHU8	Auditorium	3
AHU9	Auditorium	3
AHU10	Lecture Area	3
VFD Installation		
		HP
AHU6	Kitchen	3
AHU7	Cafeteria	3
AHU8	Auditorium	3
AHU9	Auditorium	3

Primary Hot Water Pumps

Motor Replacement

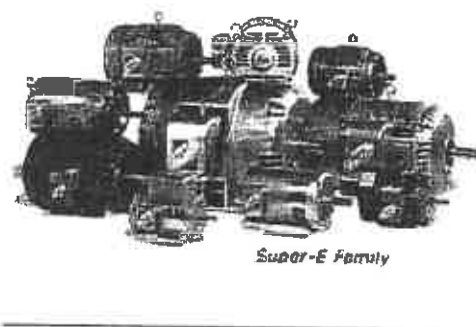
		HP
Primary	Hot Water Pumps	15

The control strategy for AHU units for the Cafeteria and Auditorium shall be Demand Control Ventilation. Fan speed will increase linearly with the increase in CO₂ levels when the space is occupied. The speed for the kitchen AHU will be control by the new kitchen hood control.

HV12 will receive a static pressure sensor. When a zone temperature set point is achieved, the zone damper shall close thus increasing static pressure. As the pressure increase the associated supply and return air fan will slow down and save energy.

The scope of work for this measure will be as follows:

- Measure the motor power consumption under full load conditions.
- Select the replacement motor to match the demand.
- Remove and dispose of the old standard efficiency motor, belts, and coupling inserts.
- Install the new motors on the existing HVAC units and pumps.
- Inspect all belt sheaves and replace belts as needed. The sheaves will be aligned to EASA standards with a straight edge.
- Measurement and verification of the post retrofit voltage, amperage, and RPM.



The post retrofit RPM is expected to increase slightly because of the new motor, but not to exceed 7 percent change.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	16
Electrical Savings (kWh)	12,299
Gas Savings (Therms)	
Total Energy Cost Savings	\$1,351

2.3.5 Building Envelope Improvements

Air leakage is defined as the "uncontrolled migration of conditioned air through the building envelope" caused by pressure differences due to wind, chimney (or stack) effect, and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Tests carried out by the National Research Council of Canada on High Rise Commercial and Residential Buildings, Schools, Supermarkets, and Houses have shown levels of 30 % to 50% of heat loss could be attributed to Air Leakage. Reports detailing this are available for perusal. Beyond representing potential for energy savings uncontrolled air leakage can affect thermal comfort of occupants, air quality through ingress of contaminants from outside and the imbalance of mechanical systems, and the structural integrity of the building envelope - through moisture migration. Control of air leakage involves the sealing of gaps, cracks and holes, using appropriate materials and systems, to create, if possible, a continuous plane of "air-tightness" to completely encompass the Building Envelope. Part of this process also incorporates the need to "decouple" floor - to - floor, and to "compartmentalize" components of the building in order to equalize pressure differences.

During the audit phase of this proposal Siemens performed a very detailed building envelope assessment utilizing a smoke puffer to identify location and severity of air leakage pathways.

As a result Siemens proposes the following improvements:

DOORS: (Newer brown aluminum doors are okay)

- Weather-strip 23 exterior doors- existing weather-stripping is missing or ineffective
- Weather-strip 1 set of oversized doors – 10' high
- Weather-strip 1 boiler room door
- Weather-strip 8- (12'x 12') overhead doors- **including bottoms**
- Weather-strip 6 overhead doors – **bottoms okay**
 - 4 - (10' x 10')
 - 1 - (16' x 10')
 - 1 – (30'x 20')

ROOF/WALL PERIMETER:

- Seal 720' of roof/wall perimeter x 1 line
- Seal 170' of roof/wall perimeter x 2 lines
- Total roof/wall perimeter sealing = 1,060'

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Gas Savings (Therms)	5,839
Total Energy Cost Savings	\$6,949

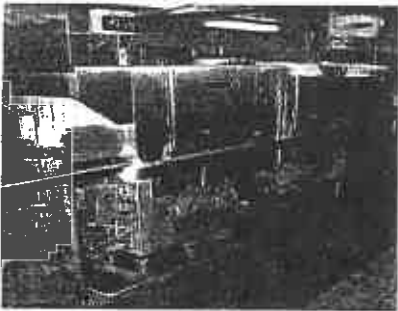
2.3.6 Electric Griddle Replacement

The existing griddle in the kitchen is electric and rated for 16.2 KW capacities. The existing operating hours for the one griddle is 6:30 AM to 12:30 PM; while other griddle is operate for 4 hours per month. Siemens is proposing to replace both griddles with a new gas-fired equivalent. As a result of the replacement, the current electrical demand is reduced by 32.4 kW. In addition a significant amount of electrical energy can be saved.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	324
Electrical Savings (kWh)	19,505
Gas Savings (Therms)	-1,445
Total Energy Cost Savings	\$2,934

2.3.7 Dishwasher Replacement



The main kitchen located in the High School serves 600 meals per day. There is a variety of food preparation and kitchen equipment including

- (1) Hobart CRS 103 dishwasher
- (2) Electric griddles
- (2) Steam kettles
- (1) Pizza oven
- Several walk-in refrigerators and freezers

Most of equipments appears to be original and was installed in 1967. The existing consumes about 300 gallons of hot water per hour. Newer dishwasher machines available today consume only 145 gallons of hot water per hour. The dishwasher uses 180°F hot water for the final rinse. The hot water from the DHW heater is boosted from 140°F to 180°F by a steam to hot water heat exchanger located underneath the dishwasher. In addition steam is utilized for steam kettles. The steam is generated by a single Fulton steam boiler located inside the High School MER.

Siemens proposes to replace the existing dishwasher with a new energy efficient equivalent. The new dishwasher shall be equipped with a gas-fired booster heater. The newer machine will consume 50 % less hot water compare to the exiting machine and will save a significant amount of hot water heating related energy.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Gas Savings (Therms)	2,516
Water Savings (Gallons)	174,563
Sewer Savings (Gallons)	174,563
Total Energy Cost Savings	\$4,566

2.3.8 Steam Kettle Replacement

Like most of the kitchen equipment, the existing steam kettles are original. Information provided by facility personnel revealed that only one of the two steam kettles is used. It is operated approximately 16 hours per week and has a capacity of 130 gallons. Based on the amount of meals prepared, the unit could be downsized.

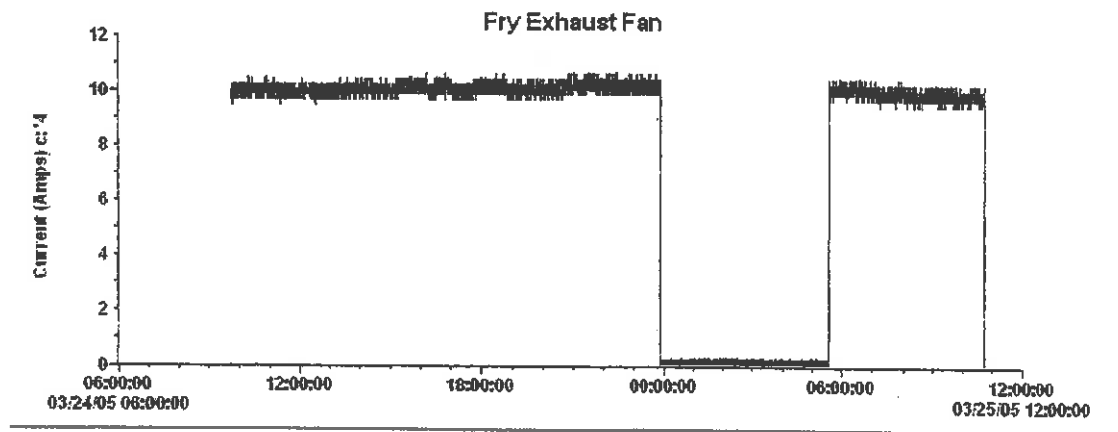
Siemens proposes to replace the existing steam kettles with one new, gas-fired kettle. This kettle shall have a capacity of 80 gallons. Replacing the dishwasher and steam kettles with a gas-fired equivalent will eliminate the need for operating the Fulton steam boiler. Besides the energy related savings, a significant amount of maintenance cost associated with the operation of a steam boiler (water treatment cost, steam traps etc.) can be saved as well.

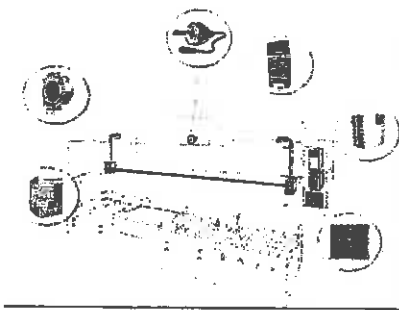
Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Gas Savings (Therms)	755
Total Energy Cost Savings	\$899

2.3.9 Kitchen Hood Control

The kitchen hood exhaust fans at the facility operate at 100% capacity all day long even during idle, non-cooking periods. At the time of our walkthrough Siemens data logged the amperage drawn by the exhaust fan for the fry hood and observed that fan was operating about 18 hours per day. However actual operating time for the kitchen is only 9 hours per day. Please refer to the graphics below.





Siemens proposes to install a new kitchen hood control system for the hoods and reduce the run time for the exhaust fans by changing the schedule on EMS. The controls are extremely simple to operate. In fact, the only noticeable difference in kitchens equipped with this control system is a blue keypad on the front of the hood. At the beginning of each day, the EMS will turn on the control—and that's it! The hood lights turn on and the fans reach a preset minimum speed of between 10 and 50 percent. When the cooking applications are active, the fan speed increases based on exhaust air temperature. During actual cooking, the speed increases to 100 percent until smoke and heat are removed. The control will also signal the EMS to modulate the speed of Kitchen AHU-6 supply fan drive based on exhaust air quantity.

In summary, Kitchen Hood Control will:

- **Reduced Energy Costs** - by reducing the exhaust and make-up fan speeds.
- **Optimize Kitchen Comfort** – by reducing the supply of hot and humid make-up air during idle cooking periods, utilize free cooling when outside air conditions permit and reduce hood noise in the kitchen by up to 90 percent when the fans slow down.
- **Improve Fire Safety** - by monitoring the exhaust air temperature and if it approaches the fusible link rating of the fire suppression system, an alarm can sound and/or the cooking appliances are shutdown.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	5,725
Gas Savings (Therms)	1,129
Total Energy Cost Savings	\$1,923

2.3.10 Classroom Ventilation Upgrades

Individual classroom unit ventilators provide heating, cooling and ventilation to each classroom. The source of outside air ventilation for these units comes from 14 outside air intakes located on the roof. A closer investigation of the existing system showed that most of these dampers have failed open and are no longer operable. As a result the unit ventilators have to condition 100% outside air during occupied and non-occupied periods. This is a tremendous waste of energy.

Siemens proposes to replace all fresh air intake dampers with new motorized control dampers. The energy management system will maintain the minimum opening for the outside air dampers based on the space requirement. In addition, Siemens will replace 8 (40 year old) ceiling mounted unit ventilators on the third floor which will greatly improve classroom comfort and meets the intent of the recently passed warrant article.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Gas Savings (Therms)	2,648
Total Energy Cost Savings	\$3,152

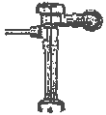
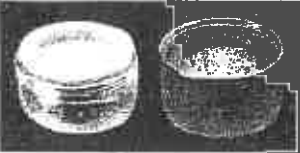
2.3.11 Water Conservation

An audit of the High School was performed to determine the performance and usage of water consuming devices. Siemens's audit team observed that domestic water was consumed by a variety of equipment including toilets, urinals and sinks.

Many of the existing water fixtures at the High School use two to three times more water than current plumbing codes require. In the case of toilets and urinals, more water is consumed than required. These toilets and urinals are a major contributor to water and sewer usage the facility.

Bathroom sinks were also observed to be consuming high levels of water. Some of these fixtures were found to have had the aerators removed resulting in increased water usage.

Based on the conditions identified during our audit, Siemens proposes to implement the following water conservation project at the facility:

- 
 - Replace 59 toilets. Siemens will replace the existing china with 1.6 gallons per flush china bowls and rebuild the flushometer valves with 1.6 gallons per flush diaphragm assemblies. The new toilet bowls will be installed to match the low flow flush valve kits. This will minimize having to double-flush to clear the bowl. Occupants will not suffer any reduction in performance.
- Install urinal retrofit kits for 24 urinals. Siemens will install flushometer retrofit kits. The retrofit kits will reduce the water usage to only one gallon per flush. These kits are manufactured specifically for urinal applications.
- 
 - Install 51 low-flow faucet aerators. These engineered aerators break the water into fine droplets and entrain air while maintaining wetting effectiveness. The new aerators will have a flow rate of 0.50 gallons per minute.
- Replace 29 basin cocks which are not able to accept the restrictors with the new basin cocks with the ability to accept the restrictors.
- Replace approximate 14 broken flanges with new ones.

Energy Unit and Cost Savings:

Water Savings (Gallons)	842,193
Sewer Savings (Gallons)	842,193
Gas Savings (Therms)	1,315
Total Cost Savings	\$9,144

2.3.12 Plugload Controllers



The occupancy at the high school varies greatly during a typical day, with student and staff entering and leaving frequently. Despite this variation in occupancy, the facility has many electrical devices that operate all of the time. In particular, vending machines (four cold drink machines and four snack machines) are located throughout the facility, offering snacks and beverages. A typical cold drink machine will consume nearly 5,000 kWh annually, at a utility cost of nearly \$450 per machine per year.

In order to minimize the unnecessary operation of electrical devices, Siemens proposes to install plug load controllers on all vending machines located throughout the facility.

On refrigerated cold drink machines, Siemens will install VendingMiser™ controllers. Utilizing a passive infrared (PIR) sensor, the device completely powers down a vending machine when the area surrounding it is unoccupied. Once powered down, the unit will monitor the room's temperature and use this information to automatically re-power the vending machine at one- to three-hour intervals, independent of occupancy, to ensure that the vended product stays cold.

The VendingMiser™ also monitors electrical current used by the vending machine. This ensures that the unit will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. The proposed controller is approved for use by the Coca Cola Company and the Pepsi Corporation for use on their machines.

The plug load controllers are easily installed and virtually transparent to inmates and staff. Unnecessary run hours and, therefore, energy consumption will be reduced with no interruption of normal school activities.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	11,847
Gas Savings (Therms)	
Total Energy Cost Savings	\$1,198

2.3.13 Install Computer Network Energy Manager System

PCs are voracious consumers of electricity, and their energy use is increasing as faster processors, more memory, and more power-hungry peripherals become commonplace. According to the Department of Energy and Lawrence Berkeley National Laboratories, the average PC can waste up to 400 kilowatt-hours of electricity a year simply by running at full power when no user is present.

The Surveyor Network Energy Manager is an easy-to-deploy software utility that addresses network energy waste and reduces operating costs without impacting PC users. Surveyor

measures, manages, and minimizes the energy consumed by the network's PC clients through one centralized interface. It provides IT departments with a powerful approach to automate energy-efficient "best practices" throughout their networks, while it adds new control and flexibility to traditional PC power management. Surveyor's ROI is demonstrable and rapid, with average per-PC savings of 200 kWh a year.

Siemens will work with Dover Public Schools to install and rapidly deploy the Surveyor software on the district's PC network. This 1-2 day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Siemens will also provide ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings.

Energy Unit and Cost Savings:

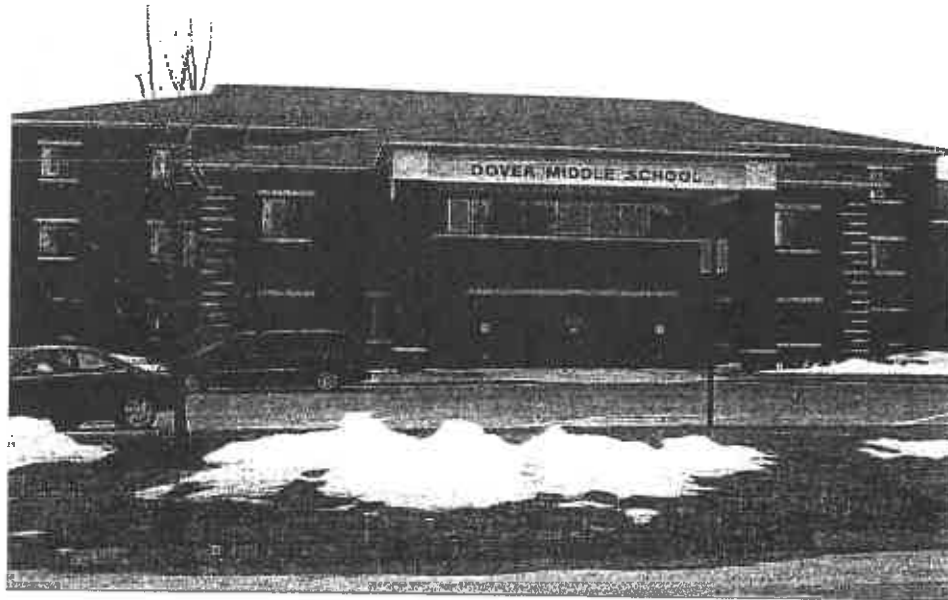
Electrical Savings (kWh)	77,100
Gas Savings (Therms)	
Total Energy Cost Savings	\$7,799

2.3.14 Install Air-Conditioning System for the Computer Class Room

Siemens will install split air conditioning system in computer Classroom 140 as a part of this energy conservation program. There will be no energy savings associated with this measure. Siemens will use capital funding provided by the School to implement this measure.

The new system will provide comfort for the students and staff member as well as increase the performance of computers by providing better temperature control in the space year around.

3 Dover Middle School



3.1 BUILDING DESCRIPTION

The three story school was originally built in 1998 and comprises of a brick faced façade with double pane, aluminum windows. A second wing was added in 2003 increasing the original building to a total of 175,020 square feet. Currently the facility is occupied by 1,142 students and 83 staff members.

3.1.1 Lighting

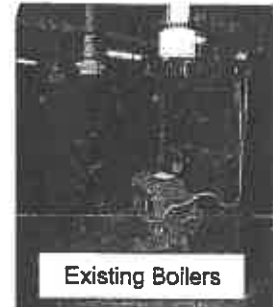


The existing lighting at the Middle School is comprised of 32 Watt T8 fluorescent lamps with normal electronic ballasts. The main gymnasium lighting is made up of 400 watts metal halide fixtures with spacing of 12' X 15'. Most of the classrooms are already equipped with occupancy sensors.

3.1.2 Mechanical System

Three Weil McLain model 1594 hot water boilers with the input capacity of 5,052 MBH provide the heating hot water needed for space conditioning of the Middle School. Hot water generated by the boilers is circulated by two 25 HP hot water pumps to heating coils and perimeter radiators. The pumps operate at constant speed.

The heating distribution system for the building consists of seven Air Handling Units, two energy heat recovery units, unit ventilators and perimeter radiators. There is no VFD control for the air handling units and energy recovery units except for the AHU 6 & 7.



Domestic hot water for the building is generated by the two A.O. Smith gas-fired hot water heaters with an input capacity of 800,000 Btu each. Domestic hot water produced by these units is stored in a single 400 gallon storage tank.

3.1.3 Energy Management System

An existing Apogee Building Control system is utilized to provide scheduling and temperature controls for the building. The main front end for the school is located in the High School. A review of the current operating procedures showed that all of the equipment is operated 24/7.

3.2 BASELINE

Table 6 is a summary of the available data for the most recent 12-month electric billing history for the building. Figure 2 is a plot of the energy usage in kilowatt-hours. The total electrical usage was 1,812,400 kWh. The total electrical costs were \$204,396. The gross average electrical cost was \$0.11/kWh.

**Table 6: Electrical History
Dover Middle School**

Electrical Usage					
Read Date	Number	KWH	KW	Bill Amount	\$/kWh
	of Days		Demand		
03/08/05	29	203,600	406	\$23,128	\$0.11
02/07/05	31	174,800	420	\$20,520	\$0.12
01/07/05	31	155,200	430	\$17,647	\$0.11
12/07/04	32	159,600	422	\$17,969	\$0.11
11/05/04	30	146,800	413	\$16,764	\$0.11
10/06/04	28	146,000	400	\$16,585	\$0.11
09/08/04	30	121,600	365	\$14,101	\$0.12
08/09/04	32	114,400	278	\$12,948	\$0.11
07/08/04	30	116,000	395	\$13,342	\$0.12
06/08/04	29	154,000	426	\$16,801	\$0.11
05/10/04	33	151,600	417	\$16,525	\$0.11
04/07/04	30	168,800	429	\$18,067	\$0.11
Total	365	1,812,400	4801	\$204,396	\$0.11
Rates:					
Demand Charge					
	Distribution Demand Charge		0.187 /KW		
	Transmission Demand Charge		1.11 /KW		
	Stranded cost recovery charge		5.38 /KW		
	Total Demand		6.68 /KW		
Electrical Energy Charge					
	Distribution Charge		0.01371 /KWh		
	Stranded cost recovery charge		0.019 /KWh		
	System Benefit Charge		0.003 /KWh		
	Consumption Tax Charge		0.00055 /KWh		
	Default Energy Rate		0.0649 /KWh		
	Total Charge		0.10116 /KWh		
Electrical Energy Charge (including Demand)				\$0.11 /KWh	

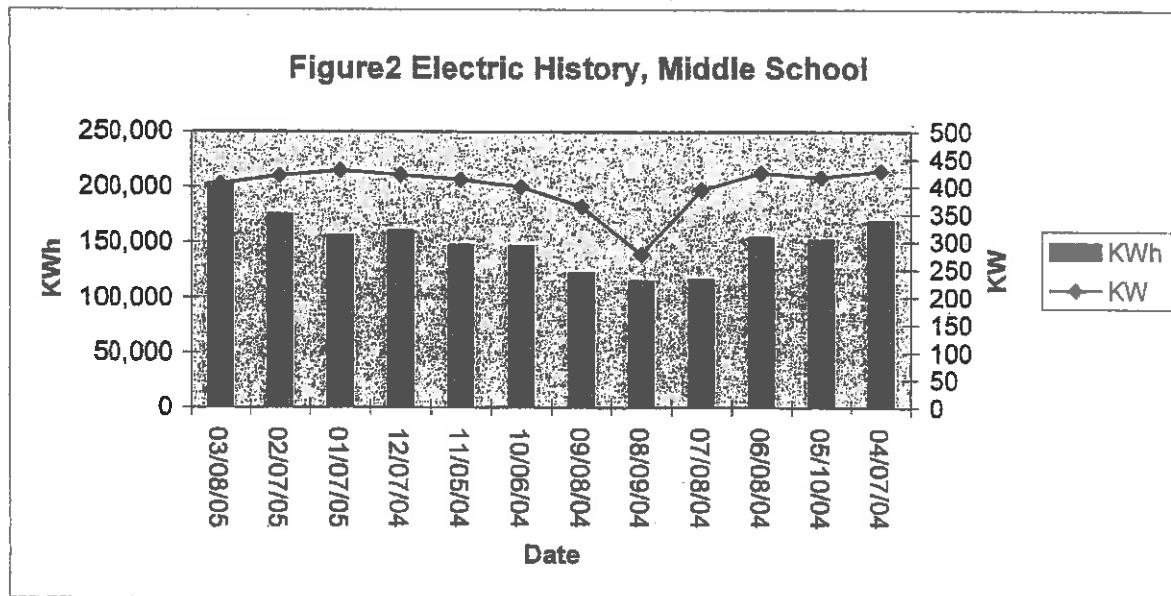


Table 7 is a summary of the available data for the most recent 12-month billing history for the Natural Gas. Total fuel delivered during past 344 days was 75,630 therms. Total fuel costs were \$193,539. The average unit cost is \$1.13 per therm.

**Table 7: Fuel History
Dover Middle School**

Natural Gas Usage				
Date	Days	Therms	Cost	\$/ Therm
Mar-04	30	6,091	\$1,531	\$0.25
Apr-04	31	2,573	\$455	\$0.18
May-04	30	932	\$203	\$0.22
Jun-04	14	62	\$91	\$1.47
Jul-04	29	241	\$322	\$1.33
Aug-04	32	293	\$378	\$1.29
Sep-04	30	1,511	\$1,699	\$1.12
Oct-04	27	5,320	\$6,148	\$1.16
Nov-04	31	8,826	\$11,110	\$1.26
Dec-04	33	14,245	\$17,894	\$1.26
Jan-05	28	18,559	\$23,413	\$1.26
Feb-05	29	16,977	\$22,133	\$1.30
Total	344	75,630	\$85,377	\$1.13
Adjusted Baseline for 365 Days				
			80,246.95	

3.3 FACILITY IMPROVEMENT MEASURES

Siemens identified the following feasible FIMs for the facility

Table 8: Summary of the Facility Improvement Measures, Middle School

		KW/Year	KWh	Therms
1	Lighting	548	146,930	(2,951)
2	Lighting Controls		23,865	
3	EMS Optimization			
	Night Setback			2,923
	Demand Control Ventilation			10,633
4	Motor & Drives		167,440	
5	Building Envelope Improvements			4,078
6	Replace Electric booster heater with gas-fired equivalent	378	30,799	(1,917)
7	Kitchen hood control		1,275	671
8	Water Conservation			
9	Vending Miser		8,974	
10	Computer Power Management System		65,700	
		926	444,984	13,437

3.3.1 Lighting Retrofit

Siemens proposes to replace existing 32 watt T 8 fixtures and normal power electronic ballasts with 28 watt T8 lamps and high efficiency low power electronic ballasts. This retrofit allows schools to attain 28% savings over the existing system. In addition, the existing 400 watt metal halide fixtures in the gymnasium shall be replaced with new 3 lamp T5 fixtures.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	548
Electrical Savings (kWh)	146,930
Fuel Savings (Therms)	(2951)
Total Energy Cost Savings	\$15,188

3.3.2 Lighting Controls

Although the classrooms are already equipped with occupancy sensors, Siemens identified more areas with sensor opportunities. The areas identified are the gymnasium, the cafeteria, the lecture hall and selected office areas. Please refer to the lighting savings spreadsheet for further details.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	23,865
Fuel Savings (Therms)	
Total Energy Cost Savings	\$2,414

3.3.3 Siemens Direct Digital Control (DDC) System Optimization

The Air handling units at the Gymnasium, Auditorium, Music hall, Cafeteria and class rooms are currently controlled based on the space temperature. The total outside air requirement for these air handling units is 54,200 CFM. To meet ASHRAE 62.99, most HVAC systems are designed to supply ventilated air based on assumed, rather than actual occupancy. This often results in over-ventilation, wasting energy. The occupancy for the Gymnasium, Auditorium and Cafeteria is not constant and varies all around the year from very low occupancy to full occupancy.

Siemens recommends that existing air handling units be modified to operate based on the need for fresh air based on actual occupancy or Carbon Dioxide Demand Control Ventilation (CO₂DCV).

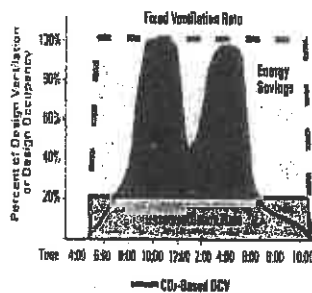


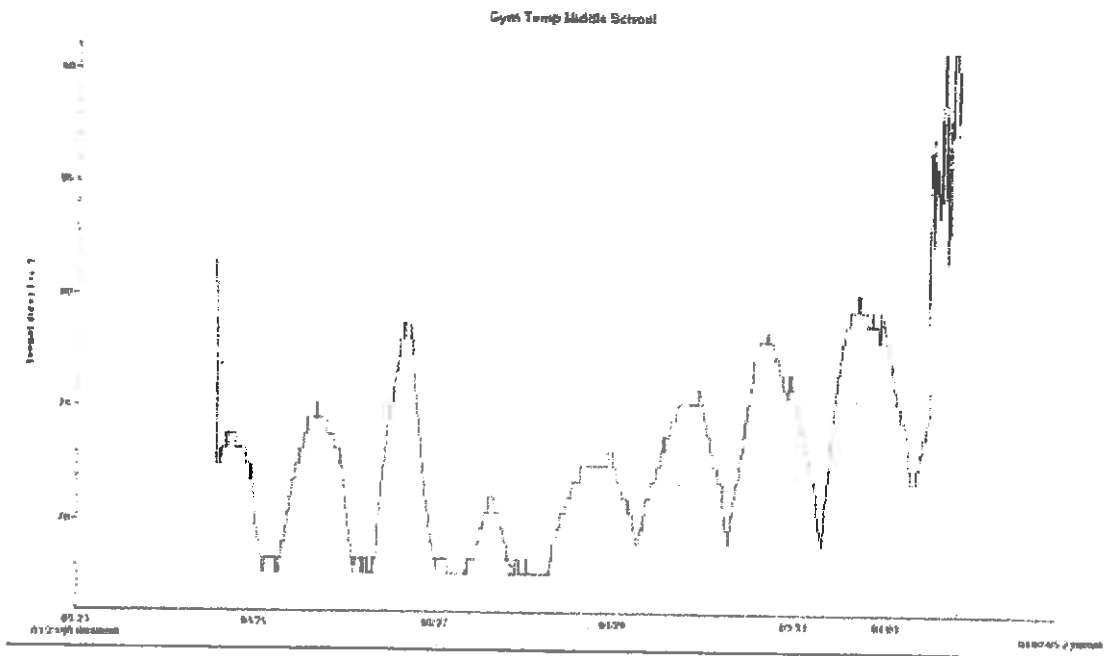
Figure 1

This can be determined by measuring the amount of carbon dioxide (CO₂) in the air within the space. The air handling systems will be controlled to provide enough outside air to maintain the CO₂ levels below 800 (adjustable) parts per million (ASHRAE Standard 62 recommends CO₂ levels to be below 1,000 ppm). This control will be achieved by installing CO₂ sensors within key areas of the building connected to the existing Siemens DDC. When the CO₂ level of any of the sensors reaches 800 ppm, the exhaust air dampers will be activated, otherwise they will remain off.

Figure1 provides the graphical representation of the energy savings potential for the CO₂ based control strategy. The area in the brown on the graph represents the typical occupancy of the space. The dashed line shows a scheduled ventilation strategy that is designed to provide for maximum occupancy throughout the day. The area in green shows the potential for the energy savings. The figure also shows the importance of providing base ventilation rate for non-occupant related contaminants.

Siemens is also recommending installing variable frequency drives (VFD) for the Gymnasium, Auditorium, Music hall, Cafeteria and Class rooms air handling units. EMS will modulate the speed on the drive and modulate the outside air damper based on the CO₂ level in the space.

An investigation of the current Siemens DDC system found that the current sequence of operation of the systems needs to be changed. Based on the data logging report of the space temperature from 3/11/05 to 3/15/05 for the Gymnasium, we noticed that there is a very little night setback going on in the Middle School. The temperature for gymnasium was maintained between 68 °F to 79 °F.



To improve the better energy performance of the DDC system, Siemens proposes to implement night setback strategy, re-commission the entire DDC system and making changes to reflect current needs. We also recommend that energy efficient protocols be re-introduced and adhered to for future operation.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Therms)	13,556
Total Energy Cost Savings	\$15,318

3.3.4 Motor Replacement and Variable Frequency Drive Installation

Most of the air handlers (AHUs) at the middle school have no speed control for the motors. Supply and return fans for the AHUs operates at the constant speed. Siemens will install a variable frequency drive (VFD) on the AHUs listed in the following table.

Dover Middle School Air Handling Units VFD Installation		
ID	Area Handled	HP
AHU 1	Music Rooms	15
AHU 2	Gym Wing Core	5
AHU 3	Gym	15
AHU4	Tech Ed Areas	5
AHU5	Dining Kitchen	20
AHU R 1	Music Rooms	5
AHU R 3	Gym	5
AHU R 4	Tech Ed Areas	3
AHU R 5	Dining Kitchen	5
ERU 1 SF	Class Wing Left	40
ERU 1 RF	Class Wing Left	25
ERU 2 SF	Class Wing Right	40
ERU 2 RF	Class Wing Right	25

The control strategy for all AHU units (except AHU2 and 4) shall be Demand Control Ventilation. Fan speed will increase linearly with the increase in CO₂ levels when the space is occupied. The control strategy for all AHU units shall be CO₂ except for AHU 2 and 4. Fan speed will increase linearly with the increase in CO₂ levels when the space is occupied. The speed control for the AHU 2 and 4 will respond to a static pressure sensor set point. When a zone temperature set point is satisfied, the zone damper shall close thus increasing static pressure. As the pressure increase the associated supply and return air fan will slow down and save energy.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	167,440
Fuel Savings (Therms)	
Total Energy Cost Savings	\$16,938

3.3.5 Building Envelope Improvements

Air leakage is defined as the "uncontrolled migration of conditioned air through the building envelope" caused by pressure differences due to wind, chimney (or stack) effect, and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Tests carried out by the National Research Council of Canada on High Rise Commercial and Residential Buildings, Schools, Supermarkets, and Houses have shown levels of 30 % to 50% of heat loss could be attributed to Air Leakage. Reports detailing this are available for perusal. Beyond representing potential for energy savings uncontrolled air leakage can affect thermal comfort of occupants,

air quality through ingress of contaminants from outside and the imbalance of mechanical systems, and the structural integrity of the building envelope - through moisture migration. Control of air leakage involves the sealing of gaps, cracks and holes, using appropriate materials and systems, to create, if possible, a continuous plane of "air-tightness" to completely encompass the Building Envelope. Part of this process also incorporates the need to "decouple" floor - to - floor, and to "compartmentalize" components of the building in order to equalize pressure differences. During the audit phase of this proposal Siemens performed a very detailed building envelope assessment utilizing a smoke puffer to identify location and severity of air leakage pathways.

As a result Siemens proposes the following improvements:

DOORS:

- Weather-strip 34 exterior doors- existing weather-stripping is missing or ineffective
- Weather-strip 2 boiler room doors

ROOF/WALL PERIMETER:

- Seal 900' of roof/wall perimeter x 2lines = 1,800' total – severe air gaps

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Therms)	4,078
Total Energy Cost Savings	\$4,608

3.3.6 Install new Gas Booster Heater for the Dishwasher Machine

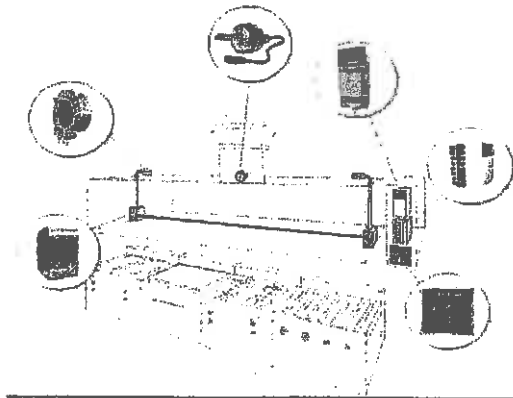
The existing hot water booster heater for the dishwasher at the Middle is electric. Domestic hot water needed for the final rinse cycle is boosted from 140°F to 180°F. The booster heater is rated at 54 kW. Electric boosters heaters are expensive to operate, when cost of electricity and demand is high. Based on the current electrical energy and demand costs, operating an electric booster results in a total energy cost of \$ 5,157 per year.

To avoid higher operating cost Siemens proposes to replace the existing electric booster heater with an gas-fired equivalent. The proposed booster heater will consume 1,917 therms of natural gas.

Energy Unit and Cost Savings:

Electrical Savings (kW)	378
Electrical Savings (kWh)	30,799
Fuel Savings (Therms)	(1,917)
Total Energy Cost Savings	\$3,473

3.3.7 Kitchen Hood Control



The kitchen hood exhaust fans at the Middle School operate at 100% capacity all day long even during idle, non-cooking periods. The operating time for the kitchen is 9 hours per day.

Siemens proposes to install a new kitchen hood control system for the existing hoods. The controls are extremely simple to operate. In fact, the only noticeable difference in kitchens equipped with the controls is a blue keypad on the front of the hood. At the beginning of each day, the EMS will turn on the control—and that's it! The hood lights turn on and the fan reaches a preset minimum speed of between 10

and 50 percent. When the cooking applications are active, the fan speed increases based on exhaust air temperature. During actual cooking, the speed increases to 100 percent until smoke and heat are removed. The control will also send signal to kitchen AHU to modulate the speed on the supply fan drive based on exhaust air quantity.

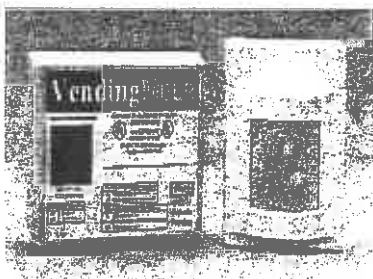
In summary, Kitchen Hood Control will:

- **Reduced Energy Costs** - by reducing the exhaust and make-up fan speeds.
- **Optimize Kitchen Comfort** – by reducing the supply of hot and humid make-up air during idle cooking periods, utilize free cooling when outside air conditions permit and reduce hood noise in the kitchen by up to 90 percent when the fans slow down.
- **Improve Fire Safety** - by monitoring the exhaust air temperature and if it approaches the fusible link rating of the fire suppression system, an alarm can sound and/or the cooking appliances are shutdown.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	1,275
Gas Savings (Therms)	671
Total Energy Cost Savings	\$888

3.3.8 Plug Load Controllers



The occupancy at the Middle school varies greatly during a typical day, with student and staff entering and leaving frequently. Despite this variation in occupancy, the facility has a many electrical devices that operate all of the time. In particular, vending machines (four cold drink machines and four snack machines) those are located throughout the facility, offering snacks and beverages. A typical cold drink machine will consume nearly 5,000 kWh annually, resulting in a utility cost of nearly \$450 per machine per year.

In order to minimize the unnecessary operation of electrical devices, Siemens proposes to install plug load controllers on all vending machines located throughout the facility.

On refrigerated cold drink machines, Siemens will install VendingMiser™ controllers. Utilizing a passive infrared (PIR) sensor, the device completely powers down a vending machine when the area surrounding it is unoccupied. Once powered down, the unit will monitor the room's temperature and use this information to automatically re-power the vending machine at one- to three-hour intervals, independent of occupancy, to ensure that the vended product stays cold.

The VendingMiser™ also monitors electrical current used by the vending machine. This ensures that the unit will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. The proposed controller is approved for use by the Coca Cola Company and the Pepsi Corporation for use on their machines.

The plug load controllers are easily installed and virtually transparent to inmates and staff. Unnecessary run hours and, therefore, energy consumption will be reduced with no interruption of normal school activities.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	8,974
Natural Savings (Therms)	
Total Energy Cost Savings	\$908

3.3.9 Install Computer Network Energy Manager System

PCs are voracious consumers of electricity, and their energy use is increasing as faster processors, more memory, and more power-hungry peripherals become commonplace. According to the Department of Energy and Lawrence Berkeley National Laboratories, the average PC can waste up to 400 kilowatt-hours of electricity a year simply by running at full power when no user is present.

Siemens will work with Dover Public Schools to install and rapidly deploy the Surveyor Network Energy Manager software on the district's PC network (about 500 computers for Middle School). This 1-2 day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Siemens will also provide ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	65,700
Fuel Savings (Therms)	
Total Energy Cost Savings	\$6,646

4 Alternative School

The school was built in 2002. The school encompasses 7,935 square feet.

4.1 BUILDING DESCRIPTION

4.1.1 Lighting

Most of the lighting system at the Alternative School comprises of 32 watt T8 fluorescent lamps with standard electronic ballasts.

4.1.2 Mechanical System

The heating and cooling for the alternative school is provided by two roof top units. The primary fuel for the heating is natural gas. In addition one electric heater located by the entrance door provides the heating to the entrance area of the building.

Two roof top units are controlled by the thermostat. The existing thermostat has no capabilities to do night setback. Temperature is maintained at 72°F all the time.

4.2 BASELINE

Alt School does not have its own Electric bill. Their costs are contained within the Dover High School billing.

Table 9 is a summary of the available data for the most recent 12-month billing history for the Natural Gas. Total fuel delivered during past twelve months was 7,911 therms. Total fuel costs were \$10,324. The average unit cost is \$1.31 per therm.

**Table 9: Fuel History
Dover High School**

Natural Gas Usage			
Date	Therms	Cost	\$/ Therm
Mar-05	1,138	\$1,516	\$1.33
Feb-05	1,520	\$1,956	\$1.29
Jan-05	1,531	\$1,953	\$1.28
Dec-04	1,130	\$1,449	\$1.28
Nov-04	722	\$903	\$1.25
Oct-04	241	\$309	\$1.28
Sep-04	17	\$40	\$2.38
Aug-04	0	\$19	
Jul-04	0	\$19	
Jun-04	210	\$260	\$1.24
May-04	299	\$403	\$1.35
Apr-04	1,103	\$1,498	\$1.36
Total	7,911	\$10,324	\$1.31

4.3 FACILITY IMPROVEMENT MEASURES

Siemens identified the following feasible FIMs for the facility

Table 10: Summary of the Facility Improvement Measures, High School

		KW	KWh	Therms	Water	Sewer
1	Lighting Retrofit	29	7,657	-154		
2	EMS Optimization Night Setback			1,355		
		29	7,657	1,201	0	0

4.3.1 Lighting Retrofit

Siemens proposes to replace existing 32 watt T 8 fixtures and normal power electronic ballasts with 28 watt T8 lamps and high efficiency low power electronic ballasts. This retrofit allows schools to attain 28% savings over the existing system

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	29
Electrical Savings (kWh)	7,657
Gas Savings (Therms)	(154)
Total Energy Cost Savings	\$764

4.3.2 Install Programmable Thermostat

Roof top units at the Alternative School are controlled by (2) wall mounted thermostats. Neither thermostat has night setback capability.

Siemens proposes to install a programmable thermostat for existing roof top units.

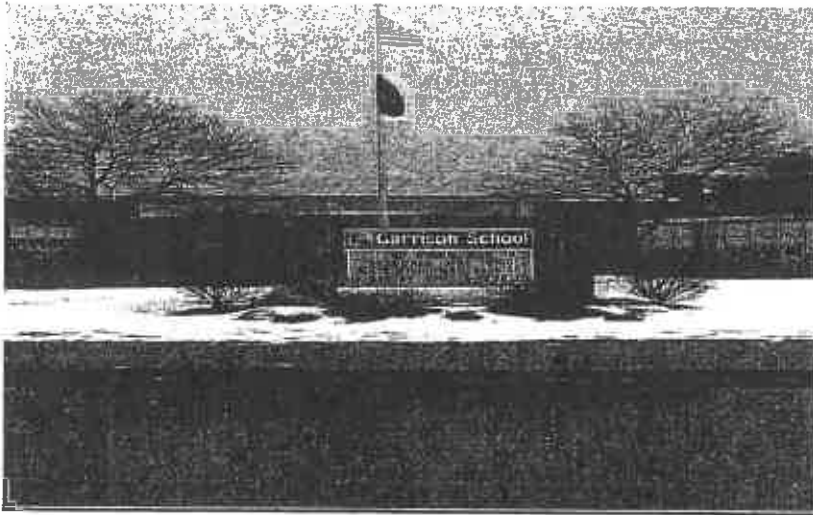
The new thermostat will have following energy control functions:

- Thermostat will store and repeat multiple daily settings, which can be manually overridden without affecting the rest of the daily or weekly program.
- New thermostat will store six or more temperature settings a day.
- New thermostat will adjust heating or air conditioning turn-on times as the outside temperature changes.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Gas Savings (Therms)	1,355
Total Energy Cost Savings	\$1,775

5 Garrison School



5.1 BUILDING DESCRIPTION

The Single story school was originally built in 1962 with additions in 1967, 1969, 1999 and 2003. The school encompasses 49,678 square feet of learning space. The building envelope is comprised of a brick faced façade with single pane, aluminum windows. Currently the facility is occupied by 428 students and 36 staff members.

5.1.1 Lighting

The existing lighting at the Garrison School is comprised of 32 Watt T8 fluorescent lamps with normal electronic ballasts. The main gymnasium lighting is made up of 400 watts metal halide fixtures with spacing of 20' X 20'. Some of the classrooms are already equipped with occupancy sensors.

5.1.2 Mechanical System

Two HB Smith 28A series and one Weil McLain model 1094 hot water boilers with the combined input capacity of 11,607 MBH provide the heating hot water needed for space conditioning of the facility. Two 7 ½ HP hot water pumps are utilized to pump the heating hot water to heating coils and perimeter baseboard. The pumps operate at constant speed. The HB Smith boilers were installed in December 2004, while the Weil McLain boiler is more than 10 yrs old. The primary fuel for the heating is natural gas. Garrison School switched over to the natural gas in December 2004, before that, the primary heating fuel was # 4 oil.

The heating distribution system for the building includes air-handling units for the gymnasium and cafeteria, unit ventilators for the class rooms and perimeter radiators. There is no VFD control for the air handling units.

Domestic hot water for the building is generated by the two A.O. Smith gas-fired hot water heaters with an input capacity of 199,000 Btu each with 81 gallons of storage capacity each.

5.1.3 Energy Management System

An existing Apogee Building Control system is utilized to provide scheduling and temperature controls for the building. The main front end for the school is located in the High School. A review of the current operating procedures showed that all of the equipment is operated 24/7. The controls for the class room unit ventilators are pneumatic controls.

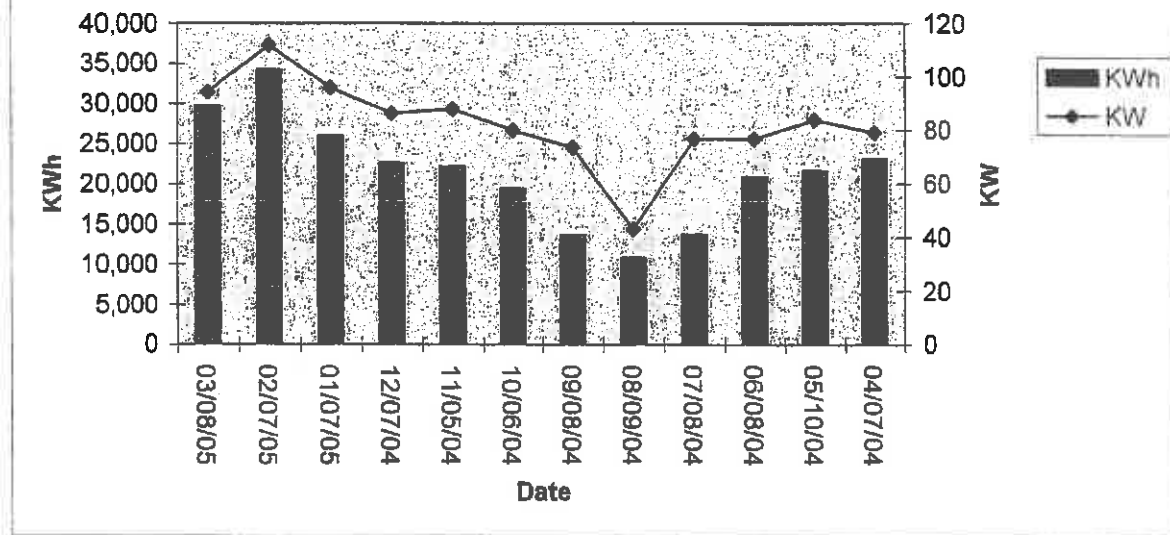
5.2 BASELINE

Table 11 is a summary of the available data for the most recent 12-month electric billing history for the building. Figure 3 is a plot of the energy usage in kilowatt-hours. The total electrical usage was 257,360 kWh. The total electrical costs were \$31,634. The gross average electrical cost was \$0.12/kWh.

**Table 11: Electrical History
Garrison School**

Electrical Usage					
	Number		KW		
Read Date	of Days	KWH	Demand	Bill Amount	\$/kWh
03/08/05	29	29,600	94.4	\$3,690	\$0.12
02/07/05	31	34,240	112	\$4,288	\$0.13
01/07/05	31	25,920	96	\$3,150	\$0.12
12/07/04	32	22,560	86.4	\$2,765	\$0.12
11/05/04	30	22,080	88	\$2,731	\$0.12
10/06/04	28	19,360	80	\$2,417	\$0.12
09/08/04	30	13,600	73.6	\$1,822	\$0.13
08/09/04	32	10,800	43.2	\$1,338	\$0.12
07/08/04	30	13,680	76.8	\$1,794	\$0.13
06/08/04	29	20,880	76.8	\$2,437	\$0.12
05/10/04	33	21,600	84	\$2,554	\$0.12
04/07/04	30	23,040	79.2	\$2,648	\$0.11
Total		257,360	990	\$31,634	\$0.123
Rates					
Demand Charge					
	KW Distribution Charge			5.4 /KW	
	Stranded cost recovery charge			2.01 /KW	
	Total Demand			7.41 /KW	
Electrical Energy Charge					
	Distribution Charge			0.0014633 /KWh	
	Transmission Charge			0.00298 /KWh	
	Stranded cost recovery charge			0.02891 /KWh	
	System Benefit Charge			0.003 /KWh	
	Consumption Tax Charge			0.00055 /KWh	
	Default Energy Rate			0.0649 /KWh	
	Total Charge			0.1018033 /KWh	
Electrical Energy Charge (including Demand)				0.12 /KWh	

Figure 3 Electrical History, Garrison School



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Table 12 is a summary of the available data for the 2-month billing history for the # 4 fuel oil.. Total fuel delivered during 2003-2004 was 21,501 gallons which is equivalent to 31,176 therms. Total fuel costs were \$20,404. The average unit cost is \$0.95 per gallon.

**Table 12: Fuel History
Garrison School**

# 4 Oil Usage					
Date	HDD	Gals	Equivalent Therms	Cost	\$/ Gals
Jun-04	86	286	415	\$272	\$0.95
May-04	251	836	1,212	\$793	\$0.95
Apr-04	533	1,775	2,574	\$1,684	\$0.95
Mar-04	888	2,957	4,288	\$2,806	\$0.95
Feb-04	995	3,313	4,804	\$3,144	\$0.95
Jan-04	1,449	4,825	6,996	\$4,579	\$0.95
Dec-03	995	3,313	4,804	\$3,144	\$0.95
Nov-03	670	2,231	3,235	\$2,117	\$0.95
Oct-03	478	1,592	2,308	\$1,510	\$0.95
Sep-03	97	323	468	\$307	\$0.95
Aug-03	11	37	54	\$35	\$0.95
Jul-03	4	13	19	\$13	\$1.00
Total	6,457	21,501	31,176	\$20,404	\$0.95

5.3 FACILITY IMPROVEMENT MEASURES

Siemens identified the following feasible FIMs for the facility

Table 13: Summary of the Facility Improvement Measures, Garrison School

		KW	KWh	Therms	Water	Sewer
1	Lighting	306	79,462	-1,596		
2	Lighting Controls		10,765			
3	EMS Optimization					
	Night Setback			7,499		
	Demand Control Ventilation			2,112		
4	Motor & Drives	4	13,780			
5	Building Envelope Improvements			1,882		
6	Water Conservation			82	203,362	203,362
7	Vending Miser		4,487			
8	Computer Power Management System		16,200			
		310	124,694	9,980	203,362	203,362

5.3.1 Lighting Retrofit

Siemens proposes to replace existing 32 watt T 8 fixtures and normal power electronic ballasts with 28 watt T8 lamps and high efficiency low power electronic ballasts. This retrofit allows schools to attain 28% savings over the existing system. Siemens will install new fixtures in all class rooms with 2 x 4 lay in ceiling. The fixtures will be 2 lamp recessed troffers with low power electronic ballasts and 28 watt lamps. In addition, the existing 400 watt metal halide fixtures in the gymnasium shall be replaced with new 4 lamp T5 fixtures.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	306
Electrical Savings (kWh)	79,462
Fuel Savings (Therms)	(1596)
Total Energy Cost Savings	\$8,457

5.3.2 Lighting Controls

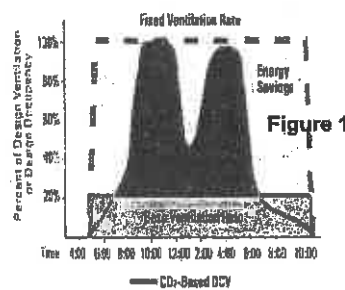
Although the classrooms are already equipped with occupancy sensors, Siemens identified more areas with sensor opportunities. The areas identified are the gymnasium, the cafeteria, the lecture hall, other class rooms and selected office areas. Please refer to the lighting savings spreadsheet for further details.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	10,765
Fuel Savings (Therms)	
Total Energy Cost Savings	\$1,096

5.3.3 Siemens Direct Digital Control (DDC) System Optimization

The Air handling units at the Gymnasium and Cafeteria are currently controlled based on the space temperature. The total outside air requirement for these air handling units is 5,250 CFM. To meet ASHRAE 62.99, most HVAC systems are designed to supply ventilated air based on assumed, rather than actual occupancy. This often results in over-ventilation, wasting energy. The occupancy for the Gymnasium and Cafeteria is not constant and varies all around the year from very low occupancy to full occupancy.



Siemens recommends that existing air handling units be modified to operate based on the need for fresh air based on actual occupancy or Carbon Dioxide Demand Control Ventilation (CO₂DCV). This can be determined by measuring the amount of carbon dioxide (CO₂) in the air within the space. The air handling systems will be controlled to provide enough outside air to maintain the CO₂ levels below 800 (adjustable) parts per million (ASHRAE Standard 62 recommends CO₂ levels to be below 1,000 ppm). This control will be achieved by installing CO₂ sensors within key areas of the building

connected to the existing Siemens DDC. When the CO₂ level of any of the sensors reaches 800 ppm, the exhaust air dampers will be activated, otherwise they will remain off.

Figure1 provides the graphical representation of the energy savings potential for the CO₂ based control strategy. The area in the brown on the graph represents the typical occupancy of the space. The dashed line shows a scheduled ventilation strategy that is designed to provide for maximum occupancy throughout the day. The area in green shows the potential for the energy savings. The figure also shows the importance of providing base ventilation rate for non-occupant related contaminants.

Siemens is also recommending installing variable frequency drives (VFD) for the Gymnasium and Cafeteria air handling units. EMS will modulate the speed on the drive and modulate the outside air damper based on the CO₂ level in the space.

An investigation of the current Siemens DDC system found that the current sequence of operation of the systems needs to be changed.

To improve the better energy performance of the DDC system, Siemens proposes to implement night setback strategy, re-commission the entire DDC system and making changes to reflect current needs. We also recommend that energy efficient protocols be re-introduced and adhered to for future operation.

Siemens also proposes to convert pneumatic control to DDC controls for the unit ventilators in the class rooms.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Therms)	9,611
Total Energy Cost Savings	\$11,437

5.3.4 Motor Replacement and Variable Frequency Drive Installation

Substantial energy savings can be obtained by replacing the standard efficiency motors located in the Garrison School. Most of these motors appear to be original equipment, and are in fairly poor condition.

Siemens proposes to replace the motors in the following table with new premium efficiency units.

In addition, Siemens will also install a variable frequency drive (VFD) on the existing AHUs for Gymnasium and Cafeteria.

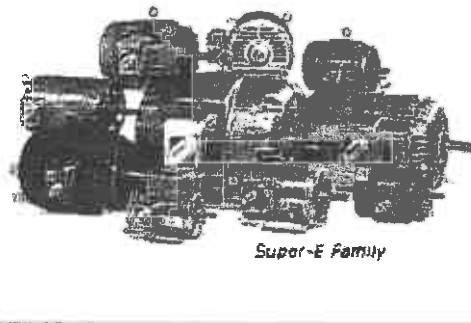
Garrison School Air Handling Units Motor Replacement		
ID	Area Handled	HP
AHU	Gym	3
AHU	Cafeteria	3
Garrison School Air Handling Units VFD Installation		
ID	Area Handled	HP
AHU	Gym	3
AHU	Cafeteria	3
Pump	Hot Water Pump	7.5

The control strategy for all AHU units shall be Demand Control Ventilation. Fan speed will increase linearly with the increase in CO₂ levels when the space is occupied.

The control for the hot water pump will be via differential pressure. The downstream control valves shall close thus increasing differential pressure between the supply and return. As the pressure increase the Hot Water Pump will slow down and save energy.

The scope of work for this measure will be as follows:

- Measure the motor power consumption under full load conditions.
- Select the replacement motor to match the demand.
- Remove and dispose of the old standard efficiency motor, belts, and coupling inserts.
- Install the new motors on the existing HVAC units and pumps.
- Inspect all belt sheaves and replace belts as needed. The sheaves will be aligned to EASA standards with a straight edge.
- Measurement and verification of the post retrofit voltage, amperage, and RPM.



The post retrofit RPM is expected to increase slightly because of the new motor, but not to exceed 7 percent change.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	4
Electrical Savings (kWh)	13,780
Fuel Savings (Therms)	
Total Energy Cost Savings	\$1,429

5.3.5 Building Envelope Improvements

Air leakage is defined as the "uncontrolled migration of conditioned air through the building envelope" caused by pressure differences due to wind, chimney (or stack) effect, and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Tests carried out by the National Research Council of Canada on High Rise Commercial and Residential Buildings, Schools, Supermarkets, and Houses have shown levels of 30 % to 50% of heat loss could be attributed to Air Leakage. Reports detailing this are available for perusal. Beyond representing potential for energy savings uncontrolled air leakage can affect thermal comfort of occupants, air quality through ingress of contaminants from outside and the imbalance of mechanical systems, and the structural integrity of the building envelope - through moisture migration. Control of air leakage involves the sealing of gaps, cracks and holes, using appropriate materials and systems, to create, if possible, a continuous plane of "air-tightness" to completely encompass the Building Envelope. Part of this process also incorporates the need to "decouple" floor - to - floor, and to "compartmentalize" components of the building in order to equalize pressure differences.

During the audit phase of this proposal Siemens performed a very detailed building envelope assessment utilizing a smoke puffer to identify location and severity of air leakage pathways.

As a result Siemens proposes the following improvements:

DOORS:

- Weather-strip 21 exterior doors- existing weather-stripping is missing or ineffective
- Weather-strip 2 boiler room doors

ROOF/WALLPERIMETER:

- Seal 570' of roof/wall perimeter – air leakage occurring

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Therms)	1,882
Total Energy Cost Savings	\$2,240

5.3.6 Water Conservation

An audit of Garrison School was performed to determine the performance and usage of water consuming devices. Siemens's audit team observed that domestic water was consumed by a variety of equipment including toilets, urinals and sinks.

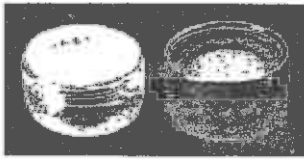
Many of the existing water fixtures at Garrison School use two to three times more water than current plumbing codes require. In the case of toilets and urinals, more water is consumed than required. These toilets and urinals are a major contributor to water and sewer usage the facility.

Bathroom sinks were also observed to be consuming high levels of water. Some of these fixtures were found to have had the aerators removed resulting in increased water usage.

Based on the conditions identified during our audit, Siemens proposes to implement the following water conservation project at the facility:

- Replace 19 toilets. Siemens will replace the existing china with 1.6 gallons per flush china bowls and rebuild the flushometer valves with 1.6 gallons per flush diaphragm assemblies. The new toilet bowls will be installed to match the low flow flush valve kits. This will minimize having to double-flush to clear the bowl. Occupants will not suffer any reduction in performance.
- Install urinal retrofit kits for 11 urinals. Siemens will install flushometer retrofit kits. The retrofit kits will reduce the water usage to only one gallon per flush. These kits are manufactured specifically for urinal applications.





- Install 49 low-flow faucet aerators. These engineered aerators break the water into fine droplets and entrain air while maintaining wetting effectiveness. The new aerators will have a flow rate of 0.50 gallons per minute.

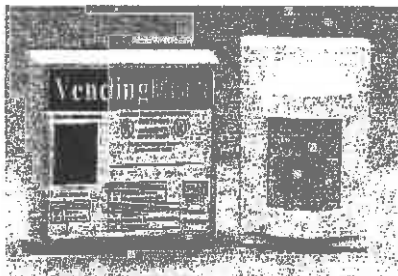
- Replace 6 basin cocks which are not able to accept the restrictors with the new basin cocks with the ability to accept the restrictors.
- Replace approximate 8 broken flanges with new ones.

Energy Unit and Cost Savings:

Water Savings (Gallons)	203,361
Sewer Savings (Gallons)	203,361
Gas Savings (Therms)	82
Total Cost Savings	\$1,928

5.3.7 Plug Load Controllers

The occupancy at the Garrison School varies greatly during a typical day, with student and staff entering and leaving frequently. Despite this variation in occupancy, the facility has a many electrical devices that operate all of the time. In particular, vending machines (four cold drink machines and four snack machines) those are located throughout the facility, offering snacks and beverages. A typical cold drink machine will consume nearly 5,000 kWh annually, resulting in a utility cost of nearly \$450 per machine per year.



In order to minimize the unnecessary operation of electrical devices, Siemens proposes to install plug load controllers on all vending machines located throughout the facility.

On refrigerated cold drink machines, Siemens will install VendingMiser™ controllers. Utilizing a passive infrared (PIR) sensor, the device completely powers down a vending machine when the area surrounding it is unoccupied. Once powered down, the unit will monitor the room's temperature and use this information to automatically re-power the vending machine at one- to three-hour intervals, independent of occupancy, to ensure that the vended product stays cold.

The VendingMiser™ also monitors electrical current used by the vending machine. This ensures that the unit will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. The proposed controller is approved for use by the Coca Cola Company and the Pepsi Corporation for use on their machines.

The plug load controllers are easily installed and virtually transparent to inmates and staff. Unnecessary run hours and, therefore, energy consumption will be reduced with no interruption of normal school activities.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	4,487
Natural Savings (Therms)	
Total Energy Cost Savings	\$457

5.3.8 Install Computer Network Energy Manager System

PCs are voracious consumers of electricity, and their energy use is increasing as faster processors, more memory, and more power-hungry peripherals become commonplace. According to the Department of Energy and Lawrence Berkeley National Laboratories, the average PC can waste up to 400 kilowatt-hours of electricity a year simply by running at full power when no user is present.

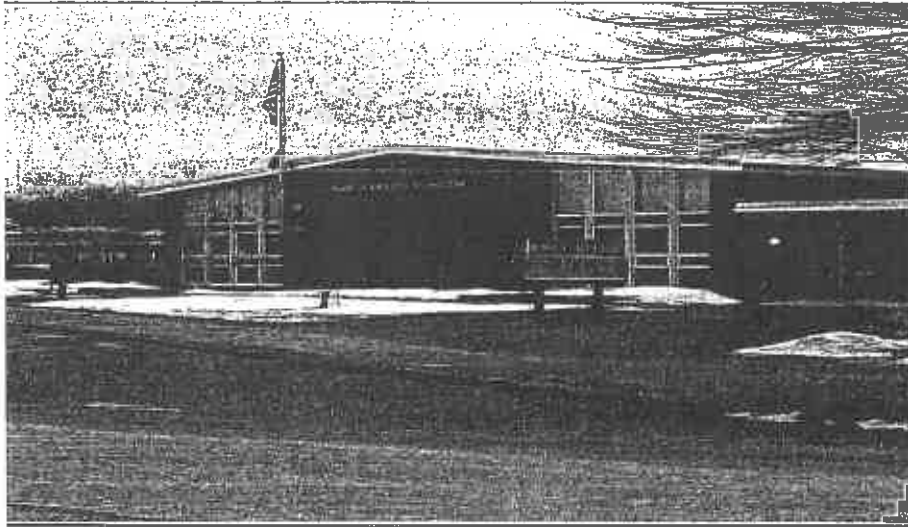
The Surveyor Network Energy Manager is an easy-to-deploy software utility that addresses network energy waste and reduces operating costs without impacting PC users. Surveyor measures, manages, and minimizes the energy consumed by the network's PC clients through one centralized interface. It provides IT departments with a powerful approach to automate energy-efficient "best practices" throughout their networks, while it adds new control and flexibility to traditional PC power management. Surveyor's ROI is demonstrable and rapid, with average per-PC savings of 200 kWh a year.

Siemens will work with Dover Public Schools to install and rapidly deploy the Surveyor software on the district's PC network (about 500 computers for Middle School). This 1-2 day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Siemens will also provide ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	16,200
Fuel Savings (Therms)	
Total Energy Cost Savings	\$1,649

6 Horne Street School



6.1 BUILDING DESCRIPTION

The Single story school was originally built in 1957 with additions in 1993, 1999 and 2002. The school encompasses 48,236 square feet. The building envelope is comprised of a brick faced façade with single pane, aluminum windows. Currently the facility is occupied by 435 students and 32 staff members.

6.1.1 Lighting

Most of the lighting system at the Horne Street School comprises of 32 watt T8 fluorescent lamps with standard electronic ballasts. The main gymnasium is illuminated by 400 watt, metal halide fixtures. These fixtures were installed in a 20' x 20' grid pattern. A small number of existing classrooms were equipped with occupancy sensors.

6.1.2 Mechanical System

One H.B Smith model 1194 hot water boilers with an input capacity of 25 GPH of # 4 oil (3,625 MBH) provides the heating hot water needed for the space conditioning of the school. Based on a heating load calculation, it appears that this boiler is oversized. Hot water generated by the boiler is circulated by one 7.5 HP and two 1 HP hot water pumps to



heating coils and perimeter radiators. The pumps operate at constant speed. The 7.5 HP pump is equipped with standard efficiency motor. As part of the detailed energy audit Siemens performed a combustion efficiency test on the existing boiler using a Bacharach combustion analyzer.

Please refer to the table below for the results of this test.

O ₂	9.4 %
CO ₂	6.5 %
Ambient Temp	77°F
Stack Temp	829°F
Efficiency	63.1 %

Heating hot water from the boiler is distributed to heating coils in the cafeteria and gymnasium air-handling units, classroom unit ventilators and perimeter radiation. The fans associated with the air-handling units are of standard efficiency and operate at a constant volume. Currently no provision has been made for variable frequency drive operation of these fan motors.

Domestic hot water for the building is generated by the three tankless coils inserted into same H.B Smith boiler. The temperature of the domestic hot water is maintained by the mixing valve station located in the boiler room.

6.1.3 Energy Management System

An existing Apogee Building Control system is utilized to provide scheduling and temperature controls for the building. The main front end for the school is located in the High School. A review of the current operating procedures showed that all of the equipment is operated 24/7.

The controls for the class room unit ventilators are pneumatic controls.

6.2 BASELINE

Table 14 is a summary of the available data for the most recent 12-month electric billing history for the building. Figure 4 is a plot of the energy usage in kilowatt-hours. The total electrical usage was 268,520 kWh. The total electrical costs were \$33,489. The gross average electrical cost was \$0.12/kWh.

Table 1: Electrical History
Horne Street School

Electrical Usage					
Read Date	Number of Days	KWH	KW Demand	Bill Amount	\$/kWh
1/18/2005	31	25,800	116.8	\$3,293	\$0.13
12/18/2004	31	27,760	115.2	\$3,465	\$0.12
11/17/2004	29	25,880	110.4	\$3,253	\$0.13
10/19/2004	32	25,120	108.8	\$3,170	\$0.13
9/17/2004	30	17,440	96.8	\$2,351	\$0.13
8/18/2004	30	9,560	41.2	\$1,207	\$0.13
7/19/2004	32	8,880	57.2	\$1,222	\$0.14
6/17/2004	30	20,880	106.8	\$2,656	\$0.13
5/18/2004	33	24,000	105.6	\$2,926	\$0.12
4/15/2004	29	26,160	112.8	\$3,172	\$0.12
3/17/2004	29	24,800	114	\$3,059	\$0.12
2/17/2004	32	32,240	112.8	\$3,715	\$0.12
Total	368	268,520	1,198	\$33,489	\$0.12
Rates					
Demand Charge					
	KW Distribution Charge			5.4 /KW	
	Stranded cost recovery charge			2.01 /KW	
	Total Demand			7.41 /KW	
Electrical Energy Charge					
	Distribution Charge			0.0014633 /KWh	
	Transmission Charge			0.00298 /KWh	
	Stranded cost recovery charge			0.02891 /KWh	
	System Benefit Charge			0.003 /KWh	
	Consumption Tax Charge			0.00055 /KWh	
	Default Energy Rate			0.0649 /KWh	
	Total Charge			0.1018033 /KWh	
Electrical Energy Charge (including Demand)				0.12 /KWh	

Figure 4 Electrical History, Horne Street School

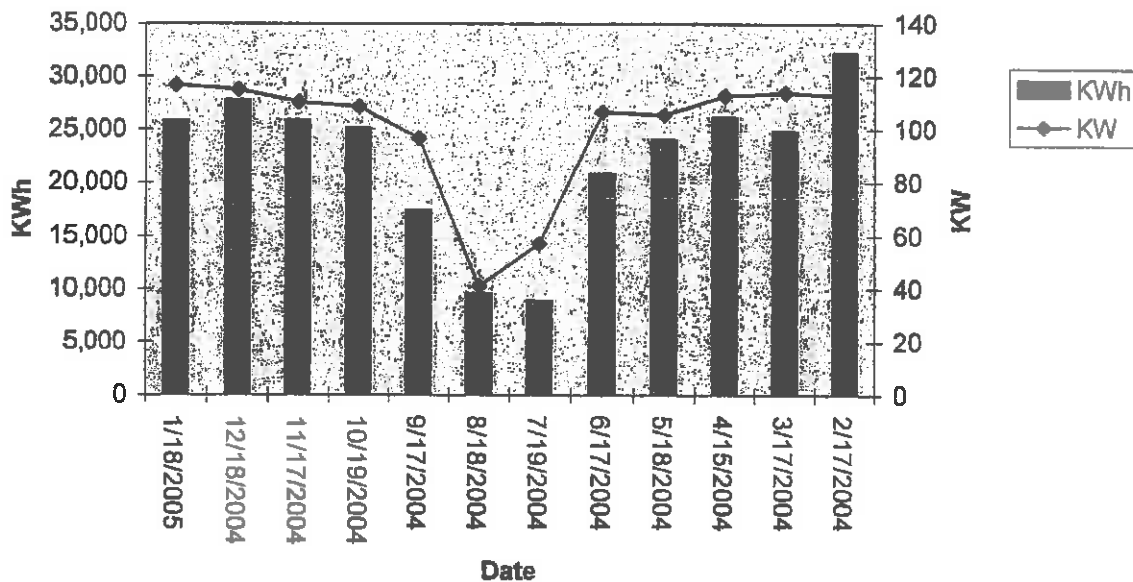


Table 15 is a summary of the available data for the most recent 12-month billing history for the # 4 fuel oil. Total fuel delivered during 2004-2005 was 26,500 gallons. Total fuel costs were \$29,280. The average unit cost is \$1.10 per gallon. The total fuel consumption for year 2003-2004 was 28,000 gallons.

**Table 15: Fuel History
Horne Street School**

# 4 Oil Usage			
Date	Gals	Cost	\$/ Gals
Mar-04	3,000	\$2,917	\$0.97
May-04	3,000	\$2,917	\$0.97
Sep-04	2,000	\$2,328	\$1.16
Nov-04	2,500	\$2,904	\$1.16
Dec-04	3,000	\$3,457	\$1.15
Jan-05	3,000	\$3,457	\$1.15
Feb-05	5,000	\$5,634	\$1.13
Mar-05	5,000	\$5,667	\$1.13
Total	26,500	\$29,280	\$1.10

6.3 FACILITY IMPROVEMENT MEASURES

Siemens identified the following feasible FIMs for the facility

Table 16: Summary of the Facility Improvement Measures, Horne Street School

		KW	KWh	Gallon	Therms	Water	Sewer
1	Lighting	194.7	43,404	-601			
	Lighting Controls		5,295				
2	EMS Optimization						
	Night Setback			5,814			
	Demand Control Ventilation			1,457			
3	Motor & Drives	8	16,082				
4	Building Envelope Improvements			1,431			
5	Replace Electric booster heater with gas-fired equivalent	266	14,449		-1,278		
6	Boiler Replacement			6,266			
7	DHW Heater			3,792	-3,467		
8	Water Conservation			94		259,487	259,487
9	Vending Miser		6,731				
10	Computer Power Management System		15,000				
		469	100,962	18,252	-4,745	259,487	259,487

6.3.1 Lighting Retrofit

Siemens proposes to replace existing 32 watt T 8 fixtures and normal power electronic ballasts with 28 watt T8 lamps and high efficiency low power electronic ballasts. This retrofit allows the facility to attain 28% savings over the existing system. In addition, the existing 400 watt metal halide fixtures in the gymnasium shall be replaced with new 4 lamp T5 fixtures.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	195
Electrical Savings (kWh)	43,404
Fuel Savings (Gallons)	(601)
Total Energy Cost Savings	\$5,200

6.3.2 Lighting Controls

Although some of the classrooms are already equipped with occupancy sensors, Siemens identified more areas with sensor opportunities. The areas identified are the gymnasium, the cafeteria, the other class rooms and selected office areas. Please refer to the lighting savings spreadsheet for further details.

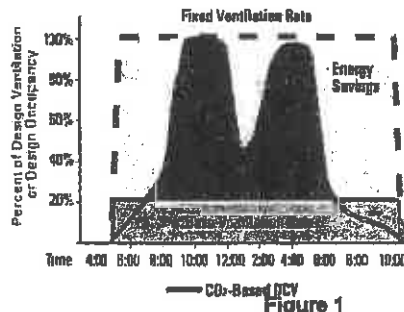
Energy Unit and Cost Savings:

Electrical Savings (kWh)	5,295
Fuel Savings (Gallons)	
Total Energy Cost Savings	\$539

6.3.3 Siemens Direct Digital Control (DDC) System Optimization

The Air handling units at the gymnasium and the cafeteria s are currently controlled based on the space temperature. The total outside air requirement for these air handling units is 5,250 CFM. To meet ASHRAE 62.99, most HVAC systems are designed to supply ventilated air based on assumed, rather than actual occupancy. This often results in over-ventilation, thus wasting energy due to conditioning more outside air than needed. The occupancy for the Gymnasium, Auditorium and Cafeteria is not constant and varies all around the year from very low occupancy to full occupancy.

Siemens recommends that existing air handling units be modified to operate based on the need for fresh air based on actual occupancy or Carbon Dioxide Demand Control Ventilation (CO₂DCV).



This can be determined by measuring the amount of carbon dioxide (CO₂) in the air within the space. The air handling systems will be controlled to provide enough outside air to maintain the CO₂ levels below 800 (adjustable) parts per million (ASHRAE Standard 62 recommends CO₂ levels to be below 1,000 ppm). This control will be achieved by installing CO₂ sensors within key areas of the building connected to the existing Siemens DDC. When the CO₂ level of any of

the sensors reaches 800 ppm, the exhaust air dampers will be activated, otherwise they will remain off.

Figure1 provides the graphical representation of the energy savings potential for the CO₂ based control strategy. The area in the brown on the graph represents the typical occupancy of the space. The dashed line shows a scheduled ventilation strategy that is designed to provide for maximum occupancy throughout the day. The area in green shows the potential for the energy savings. The figure also shows the importance of providing base ventilation rate for non-occupant related contaminants.

Siemens is also recommending installing variable frequency drives (VFD) for the Gymnasium and Cafeteria air handling units. EMS will modulate the speed on the drive and modulate the outside air damper based on the CO₂ level in the space.

An investigation of the current Siemens DDC system found that the current sequence of operation of the systems needs to be changed.

To improve the better energy performance of the DDC system, Siemens proposes to implement night setback strategy, re-commission the entire DDC system and making changes to reflect current needs. We also recommend that energy efficient protocols be re-introduced and adhered to for future operation.

Siemens also proposes to covert pneumatic control to DDC controls for the unit ventilators in the class rooms.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	7,271
Total Energy Cost Savings	\$7,998

6.3.4 Motor Replacement and Variable Frequency Drive Installation

Substantial energy savings can be obtained by replacing the standard efficiency motors located at the Horne Street School. Most of these motors appear to be original equipment, and are in fairly poor condition.

Siemens proposes to replace the motors in the following table with new premium efficiency equivalent.

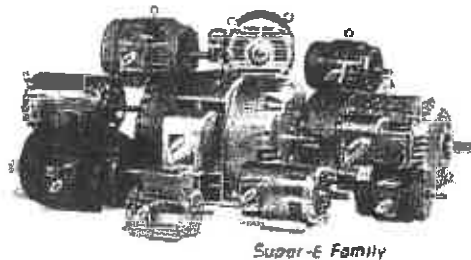
In addition, Siemens will also install a variable frequency drive (VFD) on the existing AHUs for gymnasium and cafeteria.

Horne Street School Air Handling Units Motor Replacement		
ID	Area Handled	HP
AHU	Gym	3
AHU	Cafeteria	3
Pump	Hot water Pump	7.5
Horne Street School Air Handling Units VFD Installation		
ID	Area Handled	HP
AHU	Gym	3
AHU	Cafeteria	3
Pump	Hot water Pump	7.5

The control strategy for all AHU units shall be Demand Control Ventilation. Fan speed will increase linearly with the increase in CO₂ levels when the space is occupied.

The scope of work for this measure will be as follows:

- Measure the motor power consumption under full load conditions.
- Select the replacement motor to match the demand.
- Remove and dispose of the old standard efficiency motor, belts, and coupling inserts.
- Install the new motors on the existing HVAC units and pumps.
- Inspect all belt sheaves and replace belts as needed. The sheaves will be aligned to EASA standards with a straight edge.
- Measurement and verification of the post retrofit voltage, amperage, and RPM.



The post retrofit RPM is expected to increase slightly because of the new motor, but not to exceed 7 percent change.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	8
Electrical Savings (kWh)	16,082
Fuel Savings (Gallons)	
Total Energy Cost Savings	\$1,700

6.3.5 Building Envelope Improvements

Air leakage is defined as the "uncontrolled migration of conditioned air through the building envelope" caused by pressure differences due to wind, chimney (or stack) effect, and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Tests carried out by the National Research Council of Canada on High Rise Commercial and Residential Buildings, Schools, Supermarkets, and Houses have shown levels of 30 % to 50% of heat loss could be attributed to Air Leakage. Reports detailing this are available for perusal. Beyond representing potential for energy savings uncontrolled air leakage can affect thermal comfort of occupants, air quality through ingress of contaminants from outside and the imbalance of mechanical systems, and the structural integrity of the building envelope - through moisture migration. Control of air leakage involves the sealing of gaps, cracks and holes, using appropriate materials and systems, to create, if possible, a continuous plane of "air-tightness" to completely encompass the Building Envelope. Part of this process also incorporates the need to "decouple" floor - to - floor, and to "compartmentalize" components of the building in order to equalize pressure differences.

During the audit phase of this proposal Siemens performed a very detailed building envelope assessment utilizing a smoke puffer to identify location and severity of air leakage pathways.

As a result Siemens proposes the following improvements:

DOORS:

- Weather-strip 12 exterior doors- existing weather-stripping is missing or ineffective
- Weather-strip 10 aluminum exterior doors (fuzz and 7' sweeps)
- Weather-strip 1 boiler room door

ROOF/WALL PERIMETER:

- Seal 535' of roof/wall perimeter with 2 component foam x 1 line
- Seal 190' of open concept roof/wall perimeter with a combination of foam and caulking

WINDOWS:

- Single pane window systems – operable are not leaky enough to justify doing anything with

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	1,431
Total Energy Cost Savings	\$1,574

6.3.6 Install new Gas Booster for the Dishwasher Machine

The existing hot water booster for the dishwasher at the Horne Street is electric. Domestic hot water needed for the final rinse cycle is boosted from 140°F to 180°F. The booster is rated at 38kW. Electric boosters are expensive to operate, when cost of electricity and demand is high. Based on the current electrical energy and demand costs, operating an electric booster heater will result in a total energy cost of \$ 3,416 per year.

To avoid higher operating cost Siemens proposes to replace the existing electric booster heater with a gas-fired equivalent. The proposed booster heater will consume 1,278 therms of natural gas.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	266
Electrical Savings (kWh)	14,449
Fuel Savings (Gallons)	(1278)
Total Energy Cost Savings	\$1,921

6.3.7 New Heating Boiler

The existing H.B. Smith hot water boiler appears to be original and has reached the end of its useful life. With an input rating of 3,625 MBH, this boiler is oversized compared to the actual conditioned space. Based on an evaluation of the existing heating load, the actual heating requirement is only 2,500 MBH. A combustion efficiency test performed during the detailed energy audit revealed a current combustion efficiency of 63%. As a result of the poor physical condition and the combustion efficiency test, Siemens proposes to replace this boiler with (2) new 1,500 MBH hot water boilers. Each boiler is sized to satisfy 2/3 of the required heating load, providing the school with partial redundancy. The new boilers shall be equipped with a dual-fuel burner capable of burning either # 4 oil or natural gas.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	6,266
Total Energy Cost Savings	\$6,892

6.3.8 DHW Boiler Installation

In addition a new gas-fired domestic hot water heater shall be installed to meet all of the buildings domestic hot water needs. By installing new separate DHW heater, there will be no need to operate heating boiler during the summer time. The new DHW heater will be condensing boiler with seasonal efficiency of more than 90%.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	3,792
Fuel Savings (Therms)	(3467)
Total Energy Cost Savings	\$46

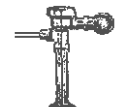
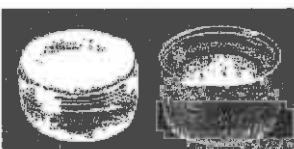
6.3.9 Water Conservation

An audit of the Horne Street School was performed to determine the performance and usage of water consuming devices. Siemens's audit team observed that domestic water was consumed by a variety of equipment including toilets, urinals and sinks.

Many of the existing water fixtures at the Horne Street School use two to three times more water than current plumbing codes require. In the case of toilets and urinals, more water is consumed than required. These toilets and urinals are a major contributor to water and sewer usage the facility.

Bathroom sinks were also observed to be consuming high levels of water. Some of these fixtures were found to have had the aerators removed resulting in increased water usage.

Based on the conditions identified during our audit, Siemens proposes to implement the following water conservation project at the facility:

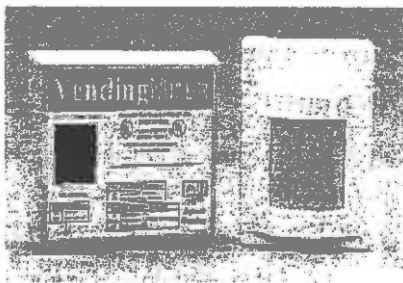
- 
 - Replace 4 toilets. Siemens will replace the existing china with 1.6 gallons per flush china bowls and rebuild the flushometer valves with 1.6 gallons per flush diaphragm assemblies. The new toilet bowls will be installed to match the low flow flush valve kits. This will minimize having to double-flush to clear the bowl. Occupants will not suffer any reduction in performance.
- Install urinal retrofit kits for 3 urinals. Siemens will install flushometer retrofit kits. The retrofit kits will reduce the water usage to only one gallon per flush. These kits are manufactured specifically for urinal applications.
- 
 - Install 21 low-flow faucet aerators. These engineered aerators break the water into fine droplets and entrain air while maintaining wetting effectiveness. The new aerators will have a flow rate of 0.50 gallons per minute.
- Replace approximate 1 broken flange with new one.

Energy Unit and Cost Savings:

Water Savings (Gallons)	259,487
Sewer Savings (Gallons)	259,487
Fuel Savings (Gallons)	94
Total Cost Savings	\$2,439

6.3.10 Plug Load Controllers

The occupancy at the Horne Street School varies greatly during a typical day, with student and staff entering and leaving frequently. Despite this variation in occupancy, the facility has a many electrical devices that operate all of the time. In particular, vending machines (four cold drink machines and four snack machines) those are located throughout the facility, offering snacks and beverages. A typical cold drink machine will consume nearly 5,000 kWh annually, resulting in a utility cost of nearly \$450 per machine per year.



In order to minimize the unnecessary operation of electrical devices, Siemens proposes to install plug load controllers on all vending machines located throughout the facility.

On refrigerated cold drink machines, Siemens will install VendingMiser™ controllers. Utilizing a passive infrared (PIR) sensor, the device completely powers down a vending machine when the area surrounding it is unoccupied. Once powered down, the unit will monitor the room's temperature and use this information to automatically re-power the vending machine at one- to three-hour intervals, independent of occupancy, to ensure that the vended product stays cold.

The VendingMiser™ also monitors electrical current used by the vending machine. This ensures that the unit will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. The proposed controller is approved for use by the Coca Cola Company and the Pepsi Corporation for use on their machines.

The plug load controllers are easily installed and virtually transparent to inmates and staff. Unnecessary run hours and, therefore, energy consumption will be reduced with no interruption of normal school activities.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	6,731
Fuel Savings (Gallons)	
Total Energy Cost Savings	\$685

6.3.11 Install Computer Network Energy Manager System

PCs are voracious consumers of electricity, and their energy use is increasing as faster processors, more memory, and more power-hungry peripherals become commonplace. According to the Department of Energy and Lawrence Berkeley National Laboratories, the average PC can waste up to 400 kilowatt-hours of electricity a year simply by running at full power when no user is present.

The Surveyor Network Energy Manager is an easy-to-deploy software utility that addresses network energy waste and reduces operating costs without impacting PC users. Surveyor measures, manages, and minimizes the energy consumed by the network's PC clients through one centralized interface. It provides IT departments with a powerful approach to automate energy-efficient "best practices" throughout their networks, while it adds new control and flexibility to traditional PC power management. Surveyor's ROI is demonstrable and rapid, with average per-PC savings of 200 kWh a year.

Siemens will work with Dover Public Schools to install and rapidly deploy the Surveyor software on the district's PC network. This 1-2 day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Siemens will also provide ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	15,000
Fuel Savings (Gallons)	
Total Energy Cost Savings	\$1,527

7 Woodman Park School



7.1 BUILDING DESCRIPTION

The three story school was originally built in 1950 with additions in 1999. The school encompasses 73,108 square feet. The building envelope is comprised of a brick faced façade with single pane, aluminum windows. Currently the facility is occupied by 479 students and 45 staff members.

7.1.1 Lighting

The existing lighting at Woodman Park School is comprised of 32 Watt T8 fluorescent lamps with normal power electronic ballasts. The main gymnasium lighting is made up of 400 Watt metal halide high bay fixtures. The 28 fixture layout of this gym has 12 lights over the court and 16 lights over the viewing area. Some of the class rooms are equipped with occupancy sensors.

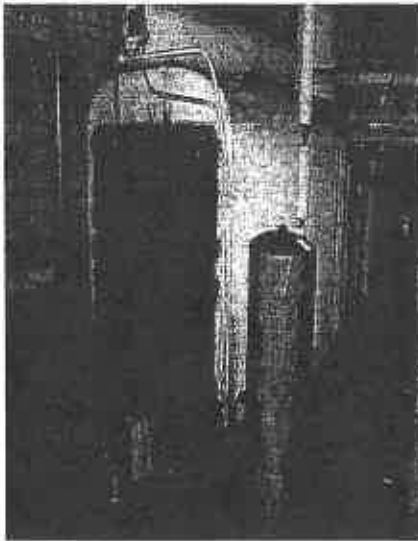
7.1.2 Mechanical System

Two Weil McLain cast iron steam boilers with the out capacity of 9,900 MBH each provides the steam needed for space conditioning. The primary heating fuel for the

facility is # 4 fuel oil. According to facility personnel, new boilers were installed 10 years ago, while the existing burners that are more than 20 years old were re-used on the new boilers. At the time of walk through, Siemens performed a combustion performance test on Boiler 1. The following results of this test are shown below:

O₂: 7.5%
CO₂: 7.6%
Ambient Temperature: 81°F
Stack Temperature: 551°F
Efficiency: 75.6%

The heating distribution system for the building is consisting of steam unit ventilators for the class rooms, air-handling units for the gymnasium and cafeteria; perimeter radiators, steam traps and condensate return system. According to facility personnel, the last steam traps maintenance at Woodman Park School was completed 10 years ago.



The domestic hot water (DHW) system comprises of one HB Smith hot water boiler and five Amtrol DHW makers. The primary fuel for the DHW is natural gas. The hot water generated by the HB Smith boiler is circulated through the Amtrol DHW makers. Two of the DHW makers are generating the 140°F hot water for the dish washer, while the other three generate 120°F hot water for the bathrooms and other areas of the school. This existing DHW boiler is more than 50 yrs old. The existing DHW system is very inefficient system with high stand by losses through the boiler and DHW makers. The existing DHW boiler is also oversized for the building. The overall efficiency for the system is very low as there is efficiency loss to generate the hot water by the boiler and again by using the same hot water to generate DHW by the DHW makers.

The heating boilers are connected to a direct digital control system (DDC) with the balance of the building consisting of pneumatic control actuators.

7.2 BASELINE

Table 17 is a summary of the available data for the most recent 12-month billing history for the building. The total annual energy consumption was extrapolated as noted in the table. Figure 5 is a plot of the energy usage in kilowatt-hours. The total electrical usage was 279,600 kWh. The total electrical costs were \$33,249. The gross average electrical cost was \$0.12/kWh.

Table 17: Electrical History
Woodman Park School

Electrical Usage					
Read Date	Number	KWH	KW	Bill Amount	\$/kWh
	of Days		Demand		
2/24/2005	28	27,200	92	\$3,431	\$0.13
1/27/2005	29	25,600	84	\$3,031	\$0.12
12/29/2004	29	24,200	82	\$2,886	\$0.12
11/30/2004	34	25,600	94	\$3,106	\$0.12
10/27/2004	29	24,200	94	\$2,974	\$0.12
9/28/2004	28	21,000	94	\$2,664	\$0.13
8/31/2004	34	14,000	64	\$1,789	\$0.13
7/28/2004	30	14,500	56	\$1,724	\$0.12
6/28/2004	33	25,400	80	\$2,864	\$0.11
5/26/2004	28	24,000	82	\$2,754	\$0.11
4/28/2004	30	26,000	84	\$2,947	\$0.11
3/29/2004	33	27,800	80	\$3,079	\$0.11
Total	365	279,600	986	\$33,249	\$0.12
Rates					
Demand Charge					
	KW Distribution Charge			5.4 /KW	
	Stranded cost recovery charge			2.01 /KW	
	Total Demand			7.41 /KW	
Electrical Energy Charge					
	Distribution Charge			0.0014633 /KWh	
	Transmission Charge			0.00298 /KWh	
	Stranded cost recovery charge			0.02891 /KWh	
	System Benefit Charge			0.003 /KWh	
	Consumption Tax Charge			0.00055 /KWh	
	Default Energy Rate			0.0649 /KWh	
	Total Charge			0.1018033 /KWh	
Electrical Energy Charge (including Demand)				0.12 /KWh	

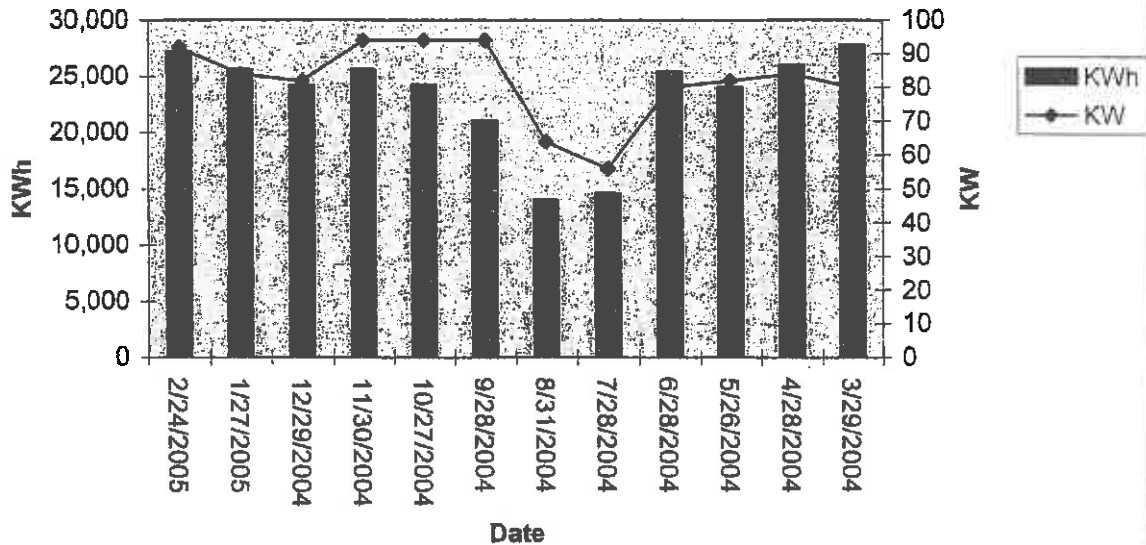
Figure 5: Electrical History, Woodman Park School

Table 18 is a summary of the available data for the most recent 12-month billing history for the # 4 oil. Total fuel delivered during past twelve months was 44,001 gallons. Total fuel costs were \$49,547. The average unit cost is \$1.13 per gallon.

Table 18: Fuel History
Woodman Park School

4 Oil Usage

Date	Gals	Cost	\$ / Gals
Mar-04	4,500	\$4,272	\$0.95
May-04	3,000	\$2,917	\$0.97
Sep-04	2,000	\$2,328	\$1.16
Nov-04	2,500	\$2,904	\$1.16
Nov-04	5,000	\$5,667	\$1.13
Dec-04	5,000	\$5,667	\$1.13
Jan-05	3,000	\$3,457	\$1.15
Jan-05	3,000	\$3,457	\$1.15
Feb-05	6,000	\$6,760	\$1.13
Feb-05	5,000	\$5,667	\$1.13
Mar-05	2,006	\$2,588	\$1.29
Mar-05	2,995	\$3,864	\$1.29
Total	44,001	\$49,547	\$1.13

Table 19 represents the natural gas consumption for the school for past twelve months. . Total fuel consumption during past twelve months was 2,782 therms. Total fuel costs were \$2,701. The average unit cost is \$0.97 per therm.

**Table 19: Fuel History
Woodman Park School**

Natural Gas Usage			
Date	Therms	Cost	\$/Therm
Apr-05	352	\$386	\$1.10
Mar-05	311	\$327	\$1.05
Feb-05	258	\$265	\$1.03
Jan-05	321	\$320	\$1.00
Dec-04	305	\$306	\$1.00
Nov-04	267	\$292	\$1.09
Oct-04	256	\$298	\$1.16
Sep-04	150	\$185	\$1.24
Aug-04	45	\$70	\$1.55
Jul-04	67	\$92	\$1.38
Jun-04	215	\$78	\$0.36
May-04	235	\$83	\$0.35
Total	2,782	\$2,701	\$0.97

7.3 FACILITY IMPROVEMENT MEASURES

Siemens identified the following feasible FIMs for the facility

Table 20: Summary of the Facility Improvement Measures, Woodman Park School

		KW	KWh	Gallon	Therms	Water	Sewer
1	Lighting	257	62,099	(860)			
2	Lighting Controls		8,117				
3	EMS Optimization						
	Night Setback			8,889			
	Demand Control Ventilation			1,125			
4	Motor & Drives	4	4,900				
5	Building Envelope Improvements			1,115			
6	Replace Electric booster heater with gas-fired equivalent	315	8,555		(639)		
7	Burner Replacement			3,923			
8	DHW Boiler Replacement				1,918		
9	Steam Trap Replacement			4,585			
10	Pipe Insulation and repair leaks			1,042			
11	Water Conservation				202	398,655	398,655
12	Vending Miser		6,731				
13	Computer Power Management System		18,600				
	Total	576	109,001	19,819	1,481	398,655	398,655

7.3.1 Lighting Retrofit

Siemens proposes to replace existing 32 watt T 8 fixtures and normal power electronic ballasts with 28 watt T8 lamps and high efficiency low power electronic ballasts. This retrofit allows the facility to attain 28% savings over the existing system. In addition, the existing 400 watt metal halide fixtures in the gymnasium shall be replaced with new 4 lamp T5 fixtures.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	257
Electrical Savings (kWh)	62,099
Fuel Savings (Gallons)	(860)
Total Energy Cost Savings	\$7,256

7.3.2 Lighting Controls

Although some of the classrooms are already equipped with occupancy sensors, Siemens identified more areas with sensor opportunities. The areas identified are the gymnasium, the cafeteria, the other class rooms and selected office areas. Please refer to the lighting savings spreadsheet for further details.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	8,117
Fuel Savings (Gallons)	
Total Energy Cost Savings	\$826

7.3.3 Energy Management System

The Air handling units at the Gymnasium and Cafeteria are currently controlled based on the space temperature. The total outside air requirement for these air handling units is 25,840 CFM. To meet ASHRAE 62.99, most HVAC systems are designed to supply ventilated air based on assumed, rather than actual occupancy. This often results in over-ventilation, wasting energy. The occupancy for the Gymnasium, Auditorium and Cafeteria are not constant and varies all around the year from very low occupancy to full occupancy.

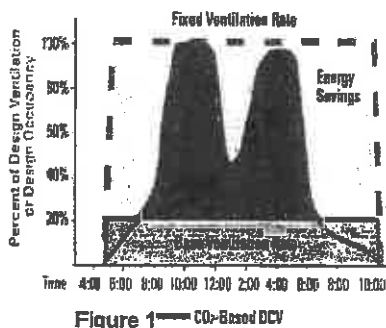


Figure 1 — CO₂-Based DCV

Siemens recommends that existing air handling units be modified to operate based on the need for fresh air based on actual occupancy or Carbon Dioxide Demand Control Ventilation (CO₂DCV).

This can be determined by measuring the amount of carbon dioxide (CO₂) in the air within the space. The air handling systems will be controlled to provide enough outside air to maintain the CO₂ levels below 800 (adjustable) parts per million (ASHRAE Standard 62

recommends CO₂ levels to be below 1,000 ppm). This control will be achieved by installing CO₂ sensors within key areas of the building connected to the existing Siemens DDC. When the CO₂ level of any of the sensors reaches 800 ppm, the exhaust air dampers will be activated, otherwise they will remain off.

Figure1 provides the graphical representation of the energy savings potential for the CO₂ based control strategy. The area in the brown on the graph represents the typical occupancy of the space. The dashed line shows a scheduled ventilation strategy that is designed to provide for maximum occupancy throughout the day. The area in green shows the potential for the energy savings. The figure also shows the importance of providing base ventilation rate for non-occupant related contaminants.

Siemens is also recommending installing variable frequency drives (VFD) for the Cafeteria and Auditorium air handling units. EMS will modulate the speed on the drive and modulate the outside air damper based on the CO₂ level in the space. The control for the Gymnasium AHU will be outside air damper based on CO₂ level in the space.

The control for the unit ventilators in the class rooms is pneumatic control. The pneumatic control for the class room unit ventilators is original. At the time of facility walkthrough, we noticed that there was none or minimum night setback going on in the facility. Siemens is proposing to install new DDC controls for all unit ventilators and implement the high setback strategy

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	10,014
Total Energy Cost Savings	\$11,315

7.3.4 Motor Replacement and Variable Frequency Drive Installation

Substantial energy savings can be obtained by replacing the standard efficiency motors located in the Woodman Park School. Most of these motors appear to be original equipment, and are in fairly poor condition.

Siemens proposes to replace the motors in the following table with new premium efficiency units.

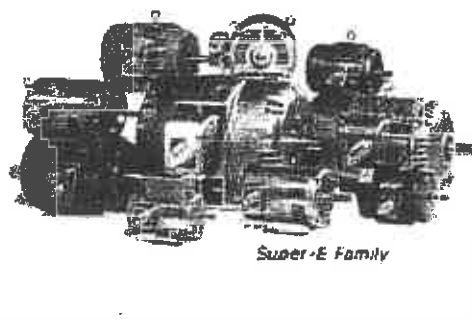
In addition, Siemens will also install a variable frequency drive (VFD) on the existing AHUs Cafeteria and Gymnasium in the building.

Woodman Park School Air Handling Units Motor Replacement		
		HP
AHU1	Gymnasium	3
AHU2	Cafeteria	3
VFD Installation		
AHU1	Gymnasium	3
AHU2	Cafeteria	3

The control strategy for all AHU units shall be Demand Control Ventilation. Fan speed will increase linearly with the increase in CO₂ levels when the space is occupied.

The scope of work for this measure will be as follows:

- Measure the motor power consumption under full load conditions.
- Select the replacement motor to match the demand.
- Remove and dispose of the old standard efficiency motor, belts, and coupling inserts.
- Install the new motors on the existing HVAC units and pumps.
- Inspect all belt sheaves and replace belts as needed. The sheaves will be aligned to EASA standards with a straight edge.
- Measurement and verification of the post retrofit voltage, amperage, and RPM.



The post retrofit RPM is expected to increase slightly because of the new motor, but not to exceed 7 percent change.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	4
Electrical Savings (kWh)	4,900
Fuel Savings (Gallons)	
Total Energy Cost Savings	\$525

7.3.5 Building Envelope Improvements

Air leakage is defined as the "uncontrolled migration of conditioned air through the building envelope" caused by pressure differences due to wind, chimney (or stack) effect, and mechanical systems. It has been shown to represent the single largest source of heat loss or gain through the building envelopes of nearly all types of buildings. Tests carried out by the National Research Council of Canada on High Rise Commercial and Residential Buildings, Schools, Supermarkets, and Houses have shown levels of 30 % to 50% of heat loss could be attributed to Air Leakage. Reports detailing this are available for perusal. Beyond representing potential for energy savings uncontrolled air leakage can affect thermal comfort of occupants, air quality through ingress of contaminants from outside and the imbalance of mechanical systems, and the structural integrity of the building envelope - through moisture migration. Control of air leakage involves the sealing of gaps, cracks and holes, using appropriate materials and systems, to create, if possible, a continuous plane of "air-tightness" to completely encompass the Building Envelope. Part of this process also incorporates the need to "decouple" floor - to - floor, and to "compartmentalize" components of the building in order to equalize pressure differences.

During the audit phase of this proposal Siemens performed a very detailed building envelope assessment utilizing a smoke puffer to identify location and severity of air leakage pathways.

As a result Siemens proposes the following improvements:

DOORS:

- Weather-strip 24 exterior doors- existing weather-stripping is missing or ineffective
- Weather-strip 7 aluminum exterior doors (fuzz and 7' sweeps)
- Weather-strip 1 boiler room door

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	1,115
Total Energy Cost Savings	\$1,260

7.3.6 Install new Gas Booster for the Dishwasher

The existing hot water booster for dishwasher at the Woodman Park is electric. This booster boosts the hot water temperature from 140°F to 180°F for the final rinse. The capacity of this electric booster is 45 KW. Electric booster is expensive to operate, when cost of electricity and demand is high. Currently School is paying 10 cents per KWh for the electricity and \$ 7.41 per KW for Electric Demand. The approximate operating cost for the electric booster is \$856 for the KWh and \$2,334 for the KW demand.

To avoid higher operating cost for the Electric booster, Siemens is proposing to install natural gas fired booster for the Dishwasher Machine. By replacing electric booster with natural gas, substantial savings will be achieved by eliminating the cost of electric demand. The new gas booster will consume 639 therms of natural gas.

Energy Unit and Cost Savings:

Electrical Demand Savings (kW)	315
Electrical Savings (kWh)	8,555
Fuel Savings (Therms)	(639)
Total Energy Cost Savings	\$2,585

7.3.7 Burner Replacement

The existing burners for the boilers at Woodman Park School are more than twenty years old. The existing burners have surpassed the end of their useful life and will require more maintenance in the future.

Siemens proposes to install new burners for the existing boilers. The new burners will be dual fuel burners and capable of burning both natural gas and # 4 fuel oil.

Following is the Scope of work for the burner replacement.

- Disconnect and remove (2) existing Industrial Combustion Burners from existing Weil McLain H-1594 steam heating boilers
- Furnish and install (2) new Industrial Combustion dual-fuel burners, size # MMG - 42
- Connect new dual-fuel burners to existing #4 oil distribution system
- Complete electrical tie-ins for new dual-fuel burners
- Connect controls for new dual-fuel burners to new proposed Energy Management System .
- Start-Up of new dual-fuel burners

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	3,923
Total Energy Cost Savings	\$4,433

7.3.8 DHW System Replacement

The existing DHW system at the Woodman Park is very in efficient system. The existing DHW boiler is more than 50 yrs old and is oversized. Siemens proposes to install new DHW boiler for the School. The new DHW boiler will be a condensing type boiler with combustion efficiency of more than 92%. The new system will be instantaneous and will produce DHW when it is required. The instantaneous system will eliminate standby losses for the system. Siemens is also proposing to install a mixing station for the DHW. The new mixing system will maintain the different temperature for the different requirements for the DHW in the school.

Following is the Scope of work for the new DHW system.

- Disconnect, and abandon in place (1) existing HB Smith DHW boiler and breeching.
- Furnish and install (1) condensing, gas fired DHW boiler.
- Connect natural gas supply to gas train
- Tie-in cold water supply into new DHW boiler
- Install new hot water mixing valve station.
- Connect new hot water supply from new DHW boiler to new mixing valve station.
- Insulate all new piping
- Complete electrical tie-ins for new DHW boiler
- Furnish and install new DHW boiler breeching and direct vent to outside.

- Connect controls for new DHW boiler to new proposed Energy Management System
- Start-Up of new DHW boiler

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Therms)	1,918
Total Energy Cost Savings	\$1,861

7.3.9 Steam Trap Replacement

The existing steam system at Woodman Park School comprises of steam and condensate main piping, steam and condensate distribution piping, strainers, steam control valves, terminal equipment (steam coils, radiators, etc.), condensate pumps, and steam traps. The function of the steam trap is to vent air and drain condensate that is formed in the steam distribution system to prevent live steam from exiting when condensate in the lines is vented. Condensate is trapped and removed via various styles of steam traps (float and thermostatic, thermodynamic, thermostatic, and bucket types), each having a specific function and range of applications. These traps require constant maintenance to assure proper operation.

Mechanical steam traps can lose steam in two different ways. The first unavoidable loss occurs during the normal cycling of steam traps. This loss typically amounts to 1% of the trap capacity. The second loss is from failed and malfunctioning traps. Since traditional steam traps are mechanical, they are susceptible to failures resulting in the trap "blowing" steam. The traps are also susceptible to a variety of malfunctions that lead to the traps "leaking." Majority of the steam traps at the Woodman Park are either failed or not working properly. Majority of the steam traps at the Woodman Park are either failed or not working properly.

Under this measure, all failed steam traps will be rebuilt or replaced. Siemens proposes to Replace/Retrofit Existing Steam Traps with a Long Term Solution – The SteamLoc® Tubular Outlet Technology & Velan Bi-Metallic Steam Traps. Installation of SteamLoc® Tubular Outlet Technology is recommended for most steam trap applications. The remaining ±5% of the traps will be replaced with high performance hybrid traps or Velan bi-metallic mechanical steam traps that are designed to perform reliably. The SteamLoc® Tubular Outlet Technology will eliminate water hammer caused by mechanical steam traps. The primary problems which are caused mechanical steam traps, will be eliminated once the SteamLoc® Tubular Outlet Technology system in conjunction with approximately 5% high performance mechanical steam traps are installed. Some of the steam traps in the Gym areas will require a lift to replace steam traps.

The Primary Advantages of the SteamLoc® Tubular Outlet Technology are as follows:

1. Reduce current and long term energy costs
2. + 10 Year performance warranty

3. No moving parts
4. Protect condensate receiver pumps from failure
5. Reduce or eliminate water hammer noise
6. Improve heat exchanger efficiency and performance
7. Reduced chemical treatment cost (lower amine requirements)

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	4,585
Total Energy Cost Savings	\$5,181

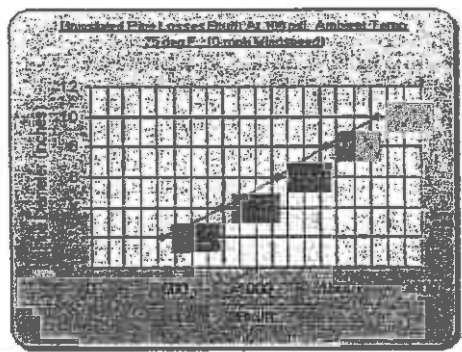
7.3.10 Pipe Insulation and Steam Leaks Repair

The majority of the piping at the Woodman Park School is insulated. However some of the steam piping, condensate piping, valves and fittings are bare and requires insulation.

Uninsulated steam distribution and condensate return lines are a constant source of wasted energy. Following table shows typical heat loss from uninsulated steam distribution lines. Insulation can typically reduce energy losses by 90% and help ensure proper steam pressure at plant equipment. Any surface over 120°F should be insulated, including steam and condensate return piping, and fittings.

Heat Loss per 100 feet of Uninsulated Steam Line				
Distribution Line Diameter (inches)	Heat Loss per 100 feet of Uninsulated Steam Line (MMBtu/yr)			
	Steam Pressure (psig)			
	15	150	300	600
1	140	285	375	495
2	235	480	630	840
4	415	850	1,120	1,500
8	740	1,540	2,030	2,725
12	1,055	2,200	2,910	3,920

Based on horizontal steel pipe, 75°F ambient air, no wind velocity, and 8,760 operating hr/yr.



Insulation frequently becomes damaged or is removed and never replaced during steam system repair. Damaged or wet insulation should be repaired or immediately replaced to avoid compromising the insulating value. Eliminate sources of moisture prior to insulation replacement. Causes of wet insulation include leaking valves, external pipe leaks, tube leaks, or leaks from adjacent equipment. After steam lines

are insulated, changes in heat flows can influence other parts of the steam system.

In addition to the financial savings that can be achieved by ensuring steam pipes are correctly insulated and maintained, will reducing atmospheric pollutants such as CO₂. The reduction in pollutants will be achieved by burning less fuel oil or gas. Poorly maintained insulation adversely impacts life cycle costs of steam installations by increased fuel costs.

Siemens proposes to replace missing or damaged insulation on the steam distribution piping system throughout the facility (Approximately 160 feet of piping). The steam distribution system includes piping, valves, and fittings.

During the walkthrough, we noticed one steam leak through steam system. Steam leaks usually develop around valve packing and stems, pressure regulators, and pipe joints. Even a small leak signifies a significant loss of steam produced annually. Steam leaks contribute to direct heat loss in the steam distribution system. Steam will cause an increase in boiler load and makeup water consumption, as the steam lost has to be compensated by an addition of steam in the system to meet the needs. To eliminate the steam leaks, Siemens is recommending repairing specific leak.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	
Fuel Savings (Gallons)	1,042
Total Energy Cost Savings	\$1,177

7.3.11 Water Conservation

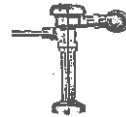
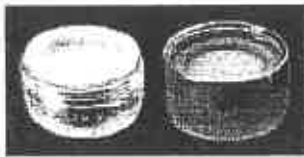
An audit of the Woodman Park School was performed to determine the performance and usage of water consuming devices. Siemens's audit team observed that domestic water was consumed by a variety of equipment including toilets, urinals and sinks.

Many of the existing water fixtures at the Woodman Park School use two to three times more water than current plumbing codes require. In the case of toilets and urinals, more water is consumed than required. These toilets and urinals are a major contributor to water and sewer usage the facility.

Bathroom sinks were also observed to be consuming high levels of water. Some of these fixtures were found to have had the aerators removed resulting in increased water usage.

Based on the conditions identified during our audit, Siemens proposes to implement the following water conservation project at the facility:

- Replace 38 toilets. Siemens will replace the existing china with 1.6 gallons per flush china bowls and rebuild the flushometer valves with 1.6 gallons per flush diaphragm assemblies. The new toilet bowls will be installed to match the low flow flush valve kits. This will minimize having to double-flush to clear the bowl. Occupants will not suffer any reduction in performance.
- Install urinal retrofit kits for 12 urinals. Siemens will install flushometer retrofit kits. The retrofit kits will reduce the water usage to only one gallon per flush. These kits are manufactured specifically for urinal applications.
- Install 29 low-flow faucet aerators. These engineered aerators break the water into fine droplets and entrain air while maintaining wetting effectiveness. The new aerators will have a flow rate of 0.50 gallons per minute.
- Replace 13 basin cocks which are not able to accept the restrictors with the new basin cocks with the ability to accept the restrictors.
- Replace approximate 10 broken flanges with new ones.

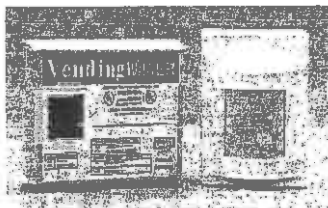


Energy Unit and Cost Savings:

Water Savings (Gallons)	398,655
Sewer Savings (Gallons)	398,655
Gas Savings (Therms)	202
Total Cost Savings	\$3,783

7.3.12 Plug Load Controllers

The occupancy at the Woodman Park School varies greatly during a typical day, with student and staff entering and leaving frequently. Despite this variation in occupancy, the facility has a many electrical devices that operate all of the time. In particular, vending machines (four cold drink machines and four snack machines) those are located throughout the facility, offering snacks and beverages. A typical cold drink machine will consume nearly 5,000 kWh annually, resulting in a utility cost of nearly \$450 per machine per year.



In order to minimize the unnecessary operation of electrical devices, Siemens proposes to install plug load controllers on all vending machines located throughout the facility. On refrigerated cold drink machines, Siemens will install VendingMiser™ controllers. Utilizing a passive infrared (PIR) sensor, the device completely powers down a vending

machine when the area surrounding it is unoccupied. Once powered down, the unit will monitor the room's temperature and use this information to automatically re-power the vending machine at one- to three-hour intervals, independent of occupancy, to ensure that the vended product stays cold. The VendingMiser™ also monitors electrical current used by the vending machine which insures that the unit will never power down a vending machine while the compressor is running, so a high head pressure start never occurs. In addition, the current sensor ensures that every time the vending machine is powered up, the cooling cycle is run to completion before again powering down the vending machine. The proposed controller is approved for use by the Coca Cola Company and the Pepsi Corporation for use on their machines.

The plug load controllers are easily installed and virtually transparent to inmates and staff. Unnecessary run hours and, therefore, energy consumption will be reduced with no interruption of normal school activities.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	6,731
Fuel Savings (Therms)	
Total Energy Cost Savings	\$685

7.3.13 Install Computer Network Energy Manager System

PCs are voracious consumers of electricity, and their energy use is increasing as faster processors, more memory, and more power-hungry peripherals become commonplace. According to the Department of Energy and Lawrence Berkeley National Laboratories, the average PC can waste up to 400 kilowatt-hours of electricity a year simply by running at full power when no user is present.

The Surveyor Network Energy Manager is an easy-to-use software utility that addresses network energy waste and reduces operating costs without impacting PC users. Surveyor measures, manages, and minimizes the energy consumed by the network's PC clients through one centralized interface. It provides IT departments with a powerful approach to automate energy-efficient "best practices" throughout their networks. Surveyor's ROI is demonstrable and rapid, with average per-PC savings of 200 kWh/yr.

Siemens will work with Dover Public Schools to install and rapidly deploy the Surveyor software on the district's PC network (about 500 computers for Woodman Park School). This 1-2 day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Siemens will also provide ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings.

Energy Unit and Cost Savings:

Electrical Savings (kWh)	18,600
Fuel Savings (Therms)	
Total Energy Cost Savings	\$1,894

