Sample Public School

06-07 Gas Usage	60,914 Therms
06-07 Electric Usage	920,000 KWHs

	PROJECTED SAVINGS	PAYBACK
1. Refrigeration page 11	$900	<2 yrs
2. Lighting Retrofit page 12	$3,400	<7 yrs
3. Premium Motors & Adjustable Frequency Drive page 13	$3,400	<4 yrs
4. Boiler Room Atmospheric Combustion Air page 19	$800	<2 yrs
5. 1961 Gym HVAC & Energy Management page 20	$2,400	<5 yrs
6. 1927 Gym HVAC & Energy Management page 21	$1,200	<5 yrs
7. Test/Balance & Optimize Energy Management page 22	$6,100	<3 yrs
8. Steam/Hydronic Conversion & Front-End Boiler page 26	$14,000	<6 yrs
TOTAL	$32,200 per year	

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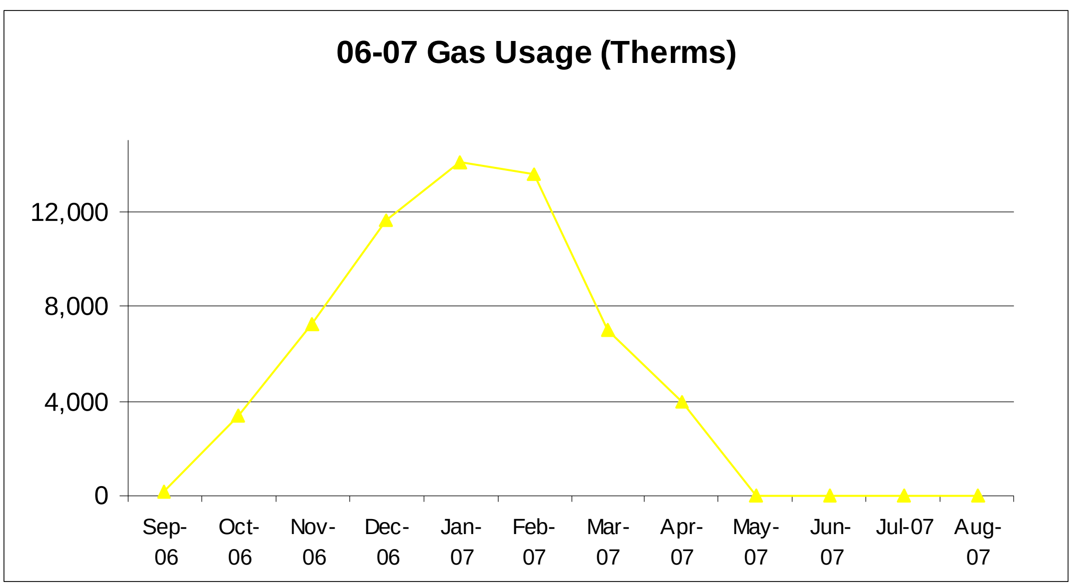
Natural Gas

Natural gas retail prices fluctuate with the monthly New York Mercantile Exchange, NYMEX, contract prices. Increased demand combined with the decreased domestic supply (US, Canada & Mexico) have combined to create a highly volatile natural gas energy market.

Dual fuel capability, (boiler operates on gas or oil), allows the school district to contract for "interruptible service" which reduces gas prices approximately $0.12 per Therm.
06-07 Interruptible Gas Savings = $7,300 per year

	Therms	Amount	Gas Cost*
August-07	0	$50	#DIV/0!
July-07	13	$60	$0.77
June-07	0	$50	#DIV/0!
May-07	0	$50	#DIV/0!
April-07	3,969	$3,305	$0.82
March-07	6,969	$6,411	$0.91
February-07	13,531	$12,641	$0.93
January-07	14,076	$13,117	$0.93
December-06	11,651	$11,388	$0.97
November-06	7,213	$6,492	$0.89
October-06	3,351	$1,844	$0.54
September-06	141	$160	$0.78
Annual	**60,914**	**$55,568**	**$0.90**



Electric

New electrical rates were implemented October 2007.

- ***Previously electric service charges were based upon KWH energy usage***
- ***Electrical services are now based upon KW power and KWH energy usage***

DEMAND METERING

KW Demand Charges reflect capital investment in the power plants, transmission lines, transformers, etc.

KWH Energy Charges reflect the operational costs associated with the fuel source, coal, natural gas, oil, etc.

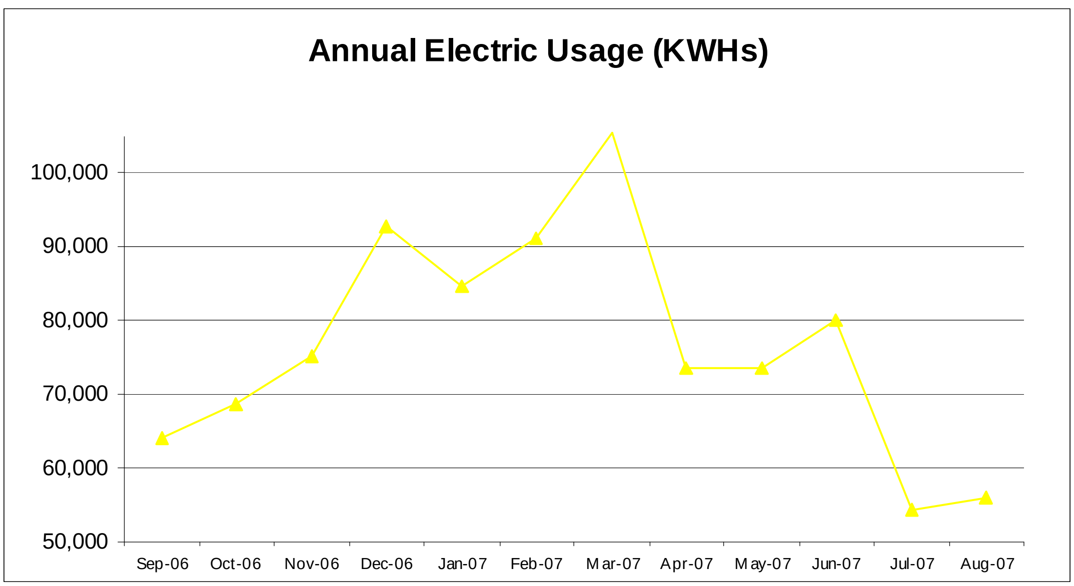
KILOWATT HOUR (KWH) ENERGY CHARGES
Energy usage is measured in kilowatt-hour, KWH.
(10) 100-watt light bulbs would consume 1000 watts of energy per hour, 1 KWH

KILOWATT (KW) DEMAND CHARGES
Demand is measured in kilowatts, KW, measures the power requirement (HP or KW) to operate the building.
(10) 100-watt light bulbs would demand 1000 watts of power, 1 KW

	October 2007	**January 2009**
Service Charge	$22 per Month	$26 per month
KW Demand	$4.45 per KW	$5.85 per KW
KWH Energy	$0.0670 per KWH	$0.0670 per KWH
Maximum Charge per KWH	$0.10 per KWH	$0.12 per KWH

	Electric KWH	Amount*
August-07	56,000	NA
July-07	54,400	NA
June-07	80,000	NA
May-07	73,600	NA
April-07	73,600	NA
March-07	105,600	NA
February-07	91,200	NA
January-07	84,800	NA
December-06	92,800	NA
November-06	75,200	NA
October-06	68,800	NA
September-06	64,000	NA
Annual	**920,000**	NA

Monthly electric amount was difficult to obtain due to the ongoing "water credit"



BUILDING OVERVIEW

The original 1927 facility has been expanded and upgraded through numerous additions. The 1994 addition/upgrade included variable air volume heat/ventilation/cool, HVAC, systems and a new energy management system, EMS.

NOTES:

i) Not all HVAC equipment is controlled by the EMS
ii) The auditorium is the only variable air volume system equipped with an adjustable frequency drive to control supply fan speed.
iii) The remaining variable air volume systems maintain supply duct static pressure with a bypass damper between the supply and return duct.

The energy management system controls occupied and unoccupied operational status for the air handlers and exhaust fans. The 3:30 pm shut-down of occupied mode versus 8 pm (maintenance staff and after school activities) reduces the annual electric bill $5,100 per year!

Occupied Hours 7 am – 3:30 pm

Steam boiler #1 and #2, 1985 vintage, are equipped with original dual fuel burners.

Natural Gas Input 1830 – 5312 MBTU
Fuel Oil Input 13 – 37.9 GPH

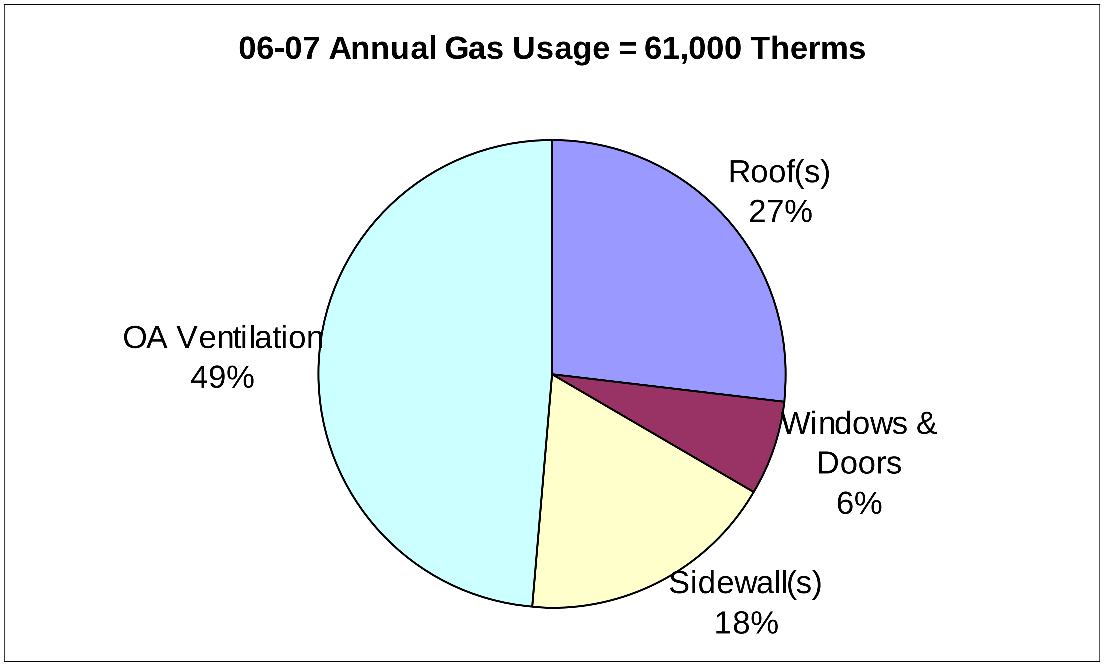
The 1994 upgrade included a steam/water converter for all the air handlers and unit ventilators except the gyms (1927 & 1961), cafeteria and a few classrooms. An outdoor reset schedule controls discharge water temperature from the steam/water converter based upon outdoor air temperature and return water temperature.

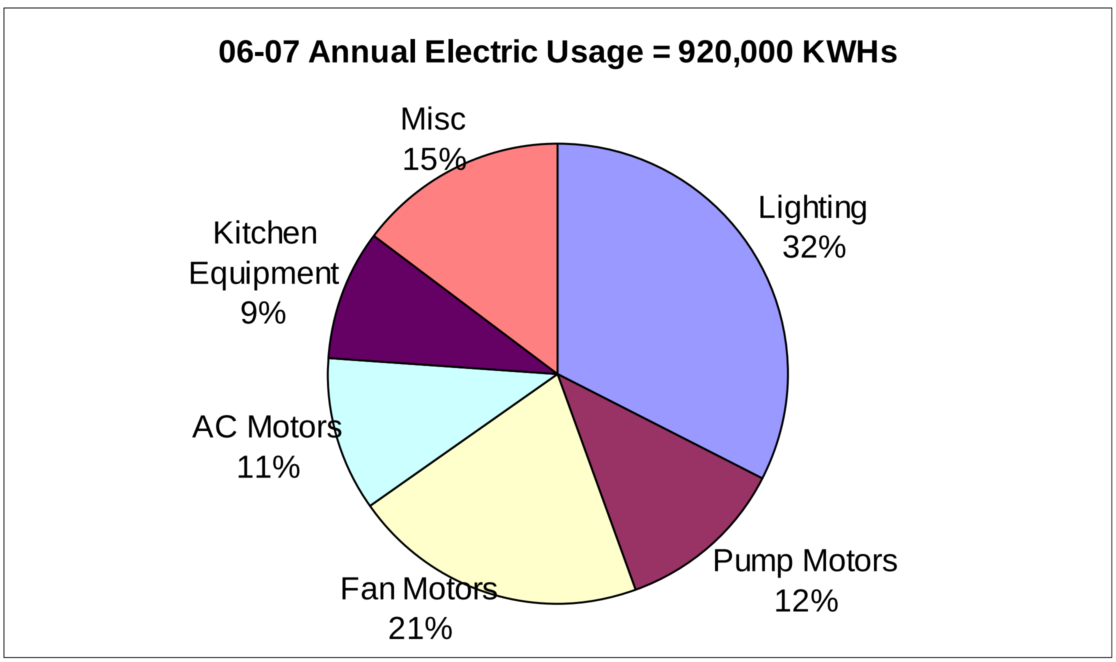
Air conditioning is provided to the auditorium, offices, media center and several computer labs. The remainder of the facility is not currently air conditioned.

Domestic hot water is provided by two (2) 1000 MBTU boilers and one (1) 1000 gallon storage tank.

The entire kitchen is equipped with electric appliances. (No gas appliances.)

With a few exceptions, lighting in the entire facility has been retrofit with energy efficient T8 fluorescent and compact fluorescent technology. The 1927 gym has mercury vapor lamps, the 1961 gym has metal halide lamps and several classrooms/hallways are still lit with F410T12 fluorescent lamps.


06-07 Annual Gas Usage = 61,000 Therms
Roof(s) 27%
Windows & Doors 6%
Sidewall(s) 18%
OA Ventilation 49%


06-07 Annual Electric Usage = 920,000 KWHs
Misc 15%
Lighting 32%
Kitchen Equipment 9%
AC Motors 11%
Fan Motors 21%
Pump Motors 12%

EQUIPMENT & OPERATIONAL ENERGY USAGE

AHU	Location	VAV System	Supply CFM	OA%	AC tons	Heat Coil	NOTES
B1	Auditorium	ASD	18,100	20%	40	water	
C1	2nd Floor In-fill	Bypass	9,900	25%	NA	water	
C2	Supt Offices	Bypass	2,800	15%	7.5	water	
C3	Media Center	Bypass	9,100	15%	25	water	
C4 Rtp	1st Floor In-fill	Bypass	10,000	25%	NA	water	
C5 Rtp	Cafeteria	na	8,000	25%	na	steam	Not controlled by EMS
RT1	Elem Offices	na	2,000	20%	5	water	
RT2	Elem Computer Lab	na	2,000	20%	5	water	
RT3	HS Offices	na	2,000	20%	5	water	
RT4	IBS Lab	na	2,000	20%	5	water	
RT5	PC Lab	na	2,000	20%	5	water	
RT6	Mac Lab	na	2,000	20%	5	water	
AH1	1961 Gym AHU	na	8,000	?%	na	steam	Not controlled by EMS
AH2	1961 Gym	na	8,000	?%	na	steam	Not controlled by EMS
AH3	1927 gym	na	5,000	?%	na	steam	Not controlled by EMS
AH4	1927 gym	na	5,000	?%	na	steam	Not controlled by EMS
Univen	Classrooms (35)	na	52,500	30%	na	both	Steam or hot water
Total			**148,400**		**103**		

AHU	Location	Supply hp	Return hp	KW	KWH	Hours	Motor Load
B1	Auditorium	15	5	16.2	22,769	2340	60%
C1	2nd Floor In-fill	10	2	9.7	22,769	2340	85%
C2	Supt Offices	3	na	2.4	5,692	2340	85%
C3	Media Center	10	na	8.1	18,974	2340	85%
C4 Rtp	1st Floor In-fill	10	3	10.5	24,667	2340	85%
C5 Rtp	Cafeteria	5	na	4.2	9,918	2340	100%
RT1	Elem Offices	1	na	0.9	2,054	2340	100%
RT2	Elem Computer Lab	1	na	0.9	2,054	2340	100%
RT3	HS Offices	1	na	0.9	2,054	2340	100%
RT4	IBS Lab	1	na	0.9	2,054	2340	100%
RT5	PC Lab	1	na	0.9	2,054	2340	100%
RT6	Mac Lab	1	na	0.9	2,054	2340	100%
AH1	1961 Gym AHU	7.5	na	6.6	15,403	2340	100%
AH2	1961 Gym	7.5	na	6.6	15,403	2340	100%
AH3	1927 gym	2	na	1.8	4,107	2340	100%
AH4	1927 gym	2	na	1.8	4,107	2340	100%
Univen	Classrooms (35)	8.75	na	7.7	17,970	2340	100%
Total		**87**	**10**	**81**	**174,102**		

Exhaust Fans	Location	Motor hp	Exhaust CFM	KW	KWH	Hours
EF1	Toilet		90			
EF2	Toilet		90			
EF3	Toilet		90			
EF4	Toilet		90			
EF5	Storage		165			
EF6	Locker		165			
EF7	Storage		310			
EF8	Kiln		740			
EF9	Dark Room		310			
EF10	?		165			
EF11	Elevator Equip		310			
EF12	Projector Storage		1360			
EF13	?		165			
Total		**2.5**	**4050**	**2**	**5,455**	2340

Power Roof Ventilators	Location	Motor hp	Exhaust CFM	KW	KWH	Hours
A1	Elem Toilets		1525			
B1	B166		365			
B2	Concession		365			
B3	2nd FL Toilets		1070			
B4	B179-180, Toilets		1320			
C1	Weight Rm		1510			
C2	Wood Shop		595			
C3	C 1st Floor		750			
C4	C 2nd Floor		850			
C5	C120-122, Toilet		525			
C6	C108-laundry		365			
Kitchen	Dishwasher		500			
Kitchen	Exhaust Hood		4000			
Total		**5.5**	**13740**	**5**	**12,001**	2340

Pumps	Location	Motor hp		KW	KWH	Hours
A1/A2	Elem Wing Heat	7.5		6	37,300	6000
B1/B2	B1 AHU (Auditorium)	0.25		0	1,243	6000
B3/B4	1st Fl Reheat	1		1	4,973	6000
B4/B5	2nd Fl Reheat	0.5		0	2,487	6000
C1/C2	2nd Fl Reheat	0.5		0	2,487	6000
C3/C4	2nd Fl Univents	1		1	4,973	6000
C5/C6	C1 AHU (2nd fl)	0.25		0	1,243	6000
C7/C8	Media Reheat	0.75		1	3,730	6000
C9/C10	2nd Fl Reheat	0.75		1	3,730	6000
C11/C12	1st Fl Reheat	0.5		0	2,487	6000
C13/C14	C4 AHU (1st Fl)	0.25		0	1,243	6000
C15/C16	1st Fl Reheat	0.75		1	3,730	6000
C17/C18	Boiler Comb Air	0.25		0	1,243	6000
C19/C20	Primary Heat	7.5		6	37,300	6000
Total		**22**		**18**	**108,170**	

Kitchen Equipment	Qty	KW	KW	KWH	Hours	Load
Dishwasher Booster	1	15	15	6000	400	100%
Convection Ovens	4	11	44	14080	800	40%
Broiler Ovens	2	25	50	16000	800	40%
Steam Kettle	1	15	15	3600	600	40%
Flat Top	1	21	21	5040	600	40%
Water Heater	1	18	18	7200	400	100%
TOTAL			**163**	**51920**		

Refrigeration	Qty	KW	KW	KWH	Hours	Load
3-Door Freezer, 1985	1	1.5	1.5	6570	8760	50%
WI Cooler, 2007	1	2.5	2.5	10950	8760	50%
WI Freezer	1	1.5	1.5	6570	8760	50%
4-Door Freezer, 1970	1	2	2	8760	8760	50%
TOTAL			**8**	**32850**		

Lighting System	Qty	Watts	KW	KWH	Hours
2-lamp F32T8	160	58	9.28	19,488	2100
3-lamp F32T8	800	87	69.6	146,160	2100
2-lamp CFL	30	45	1.35	2,835	2100
1-lamp Metal Halide	10	290	2.9	8,990	3100
1-lamp Metal Halide	32	460	14.72	45,632	3100
1-lamp Mercury Vapor	15	450	6.75	20,925	3100
2-lamp F40T12	190	78	14.82	31,122	2100
4-lamp F40T12	30	156	4.68	9,828	2100
Exterior Wallpack	20	210	4.2	17,640	4200
TOTAL			**128**	**302,620**	

RECOMMENDATIONS

1. Refrigeration

Projected Annual Savings = $900 per year

Payback < 2 years

a. Replace the 1980s vintage 3-door freezer with a 1-door freezer
b. Remove the 1970s vintage 4-door freezer
c. Install shelving in walk-in freezer. (Currently almost empty!)

Assumptions:
3-door = 1.5 KW
4-door = 2 KW
1-door = 1 KW

Annual Savings = (2+1.5-1)*12*365
= 10,950 KWH & 2.5 KW **= $868 per year**

Estimated Investment	$1500
Estimated Rebate	$??
Payback	< 2 years

2. Lighting Retrofit

Projected Annual Savings = $3,400 per year

Payback < 7 years

a. Retrofit existing 2-lamp F40T12 fixtures with T8F32 lamps and reduced light output, RLO ballasts
b. Replace 4-lamp F40T12 (8 foot fixtures) with new 8 foot 4-lamp F32T8 fixtures
c. Replace 400 watt metal halide fixtures with high output 4-lamp F54T5 fixtures
d. Replace 400 watt mercury vapor fixtures with 4-lamp F32T8 fixtures

Assumptions:
See enclosed spreadsheet(s)

Projected Annual Savings* = 14.6 KW & 39,201 KWH = $3,406 per year

Estimated Investment (material & labor)	$22,300
Estimated Rebate	$??
Payback	6.5 years

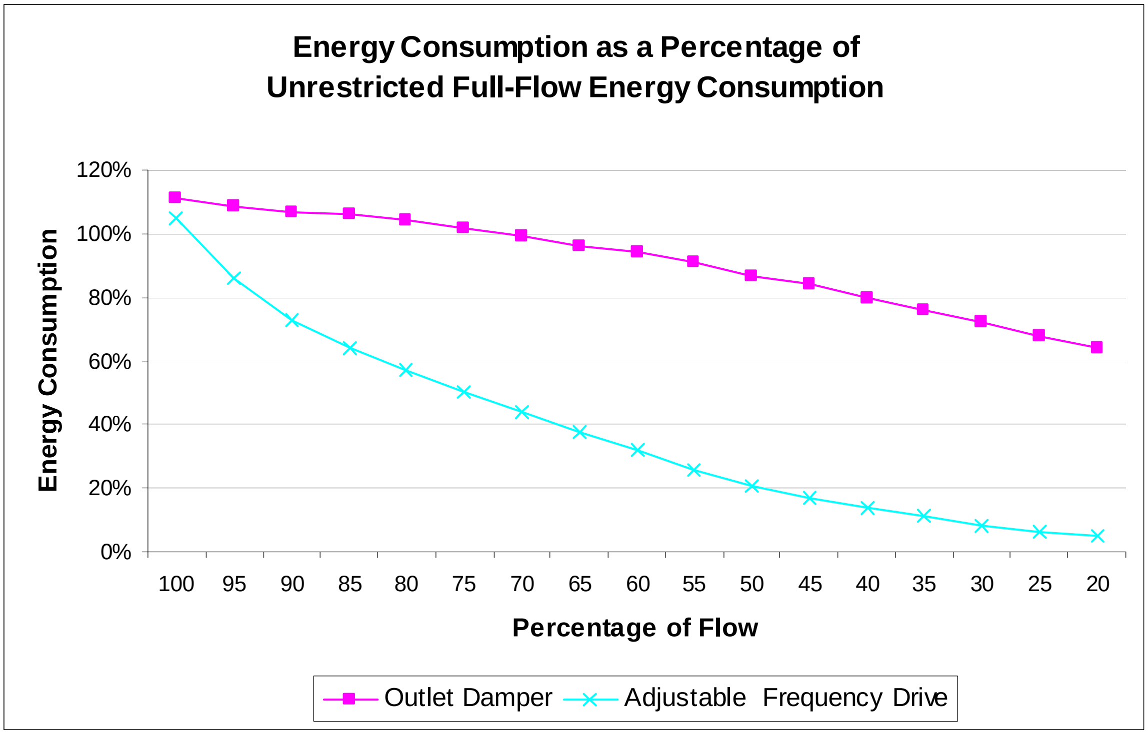
*Projected savings does not include existing annual maintenance costs (eliminate bulb/ballast replacement for first 5 years after retrofit) nor does it include reduction in air conditioning costs by reducing internal heat gain.

3. Premium Motors & Adjustable Frequency Drives, AFD

Projected Annual Savings = $3,400 per year

Payback <4 years

Installing adjustable frequency drive(s) will significantly reduce energy usage. Applications include supply fan and pump motors.



Install high efficiency motors and adjustable frequency drives on the following equipment:

i) Pumps A1 & C18.
Elementary wing heating and primary heating

ii) Air Handling Units C1, C2, C3 & C4.
2nd Floor In-fill, Supt Offices, Media Center & 1st Floor In-fill

NOTE: Installation of adjustable frequency drives on the variable air volume air handlers will require removal of the bypass damper between the supply and return ducts!

.

Projected Annual Savings = 49,717 KWH = $3,442 per year

Projected Payback = 4 years

Install Premium Motor(s)

$4.45	per KW
$0.067	per KWH

Old Motor(s) **New Motor(s)**

Equip ID	Motor Size	Motor Efficiency	Motor Size	Motor Efficiency	Operating Hours	KW Savings	KWH Savings
A1 Pump	7.5	86.5%	7.5	91.0%	6000	0.32	1919
C19 Pump	7.5	86.5%	7.5	91.0%	6000	0.32	1919
C1 Fan	10	87.0%	10	91.7%	2340	0.44	1028
C2 Fan	3	85.0%	3	89.5%	2340	0.13	310
C3 Fan	10	87.0%	10	91.7%	2340	0.44	1028
C4 Fan	10	87.0%	10	91.7%	2340	0.44	1028
	TOTAL SAVINGS		**48**			**2.09**	**7233**

Annual Savings Amount **$596**

Motor Investment	**$4,800**	**(Motor @ $100 per hp)**
AFD Rebate	**??**	
Motor Rebate	**??**	
Net Investment	**$4,800**	
Payback Years	**8.1**	

Install Adjustable Frequency Drives

$4.45	per KW
$0.067	per KWH

Equip ID	Motor Size	Motor Efficiency	Operating Hours	KWH Savings
A1 Pump	7.5	91.0%	6000	9868
C19 Pump	7.5	91.0%	6000	9868
C1 Fan	10	91.7%	2340	6878
C2 Fan	3	89.5%	2340	2114
C3 Fan	10	91.7%	2340	6878
C4 Fan	10	91.7%	2340	6878
TOTAL	**48**			**42484**

Annual Savings Amount	**$2,846**	
Motor Investment	**$9,600**	**(AFD @ $200 per hp)**
AFD Rebate	**??**	
Motor Rebate	**??**	
Net Investment	**$9,600**	
Payback Years	**3.4**	

Install Adjustable Frequency Drive

Primary & Elementary Heating Pumps, A1 & C19

7.5	hp	$0.067 /KWH
91%	NEMA Eff	

Percentage of Flow	**Motor**	**AFD**		**Hours per Year**	**Exist KWH**	**Proposed KWH**	**Savings KWH**
100	100%	105%		1000	6148	6456	-307
90	94%	73%		1500	8669	6732	1937
80	89%	57%		1500	8208	5257	2951
70	83%	44%		1000	5103	2705	2398
60	79%	32%		1000	4857	1967	2890
			TOTAL	**6000**	**32986**	**23118**	**9868**

TOTAL KWH SAVINGS **9868**

TOTAL KWH$ SAVINGS **$661**

AFD Investment	**$1,500**	**(AFD @ $200 per hp)**
AFD Rebate	**??**	
Motor Rebate	**??**	
Net Investment	**$1,500**	
Payback Years	**2.3**	

Install Adjustable Frequency Drive

Air Handlers C1, C3 & C4

10	hp
91.7%	NEMA Eff
$0.067	/KWH

Percentage of Flow	Motor	AFD		Hours per Year	Exist KWH	Proposed KWH	Savings KWH
100	100%	105%		292	2375	2494	-119
80	89%	57%		878	6357	4071	2286
60	79%	32%		878	5643	2286	3357
40	71%	14%		292	1687	333	1354
			TOTAL	**2340**	**16062**	**9184**	**6878**

TOTAL KWH SAVINGS **6878**

TOTAL KWH$ SAVINGS **$461**

AFD Investment	**$2,000**	**(AFD @ $200 per hp)**
AFD Rebate	**??**	
Motor Rebate	**??**	
Net Investment	**$2,000**	
Payback Years	**4.3**	

Install Adjustable Frequency Drive
Air Handlers C2

				3	hp		$0.067	/KWH
				89.5%	NEMA Eff			

Percentage of Flow	Motor	AFD		Hours per Year	Exist KWH	Proposed KWH	Savings KWH
100	100%	105%		292	730	767	-37
80	89%	57%		878	1954	1251	703
60	79%	32%		878	1734	703	1032
40	71%	14%		292	518	102	416
			TOTAL	**2340**	**4937**	**2823**	**2114**

TOTAL KWH SAVINGS **2114**

TOTAL KWH$ SAVINGS **$142**

AFD Investment	**$600**	**(AFD @ $200 per hp)**
AFD Rebate	**??**	
Motor Rebate	**??**	
Net Investment	**$600**	
Payback Years	**4.2**	

4. Boiler Room Atmospheric Combustion Air

Projected Annual Savings = $800 per year

Payback < 1 years

The boiler room air handler provides an excessive 3000 CFM fresh outdoor air to the boiler room for combustion air. Operation of is relayed with the boiler. A hot water coil tempers the outdoor air but the coil failed last winter so the pump has been shut-off. The excessively oversized air handler pressurizes the boiler room with cold fresh air.

- *The boiler room is pressurized.*
- *Boiler room temperature was near 45 degrees on the day of my visit.*
- *The office and hallway were an uncomfortable 50 degrees.*

Consequently the boiler room and nearby office/hallway is extremely uncomfortable.

a. Modify the existing atmospheric combustion air duct located on the wall with a motorized damper.
   Air In = Air Out
   2 foot diameter chimney = approximately 6 square feet
b. Relay damper operation with boiler and/or water heater operation
c. Install manual switch on air handler and operate only during spring/fall when boiler room overheats..

Assumptions:
Fan = ½ hp
3000 hours per winter
3000 CFM
2500 HDD

Fan Savings	= 0.5*0.746/80%*3000	
	= 1,399 KWH	**= $94 per year**
OA Heat Savings	= 3000*1.08*8*2500/(80%*100000)	
	= 810 Therms	**= $729 per year**

5. 1961 Gymnasium HVAC & Energy Management

Projected Annual Savings = $2,400 per year

Payback < 5 years

The gymnasium is heated with steam fin coil radiators around the perimeter and two (2) air handlers. Additions have eliminated the originally exposed exterior walls.

- *The two (2) exhaust fans are controlled by the energy management system*
- *But the air handlers are controlled manually with an on/off switch. Outdoor air %, mixed air temperature and discharge air temperature is unknown.*
- *Control of the steam fin-coil is unknown.*
- *The heating system, fin-coil and air handlers, is substantially oversized!*

Consequently the gym overheats and operates at a negative pressure.

HVAC & Energy Management Upgrade

- Utilize the fin-coils to provide primary heating
- Utilize one (1) air handler to provide fresh outdoor air during occupied mode
- Utilize secondary air handler to provide economizer cooling as needed

a. Eliminate 50% of the steam fin-coil radiators. Repair traps, actuators, sensors, etc.
b. Upgrade the two (2) air handlers with new actuators, mixed air and discharge air sensors.
c. Control operation of the fin-coil radiators, exhaust fans and air handlers with the energy management system.
d. Relay the exhaust fan operation with each air handler.
e. Test-n-balance exhaust ventilation with air handler outdoor air ventilation.
f. Program the energy management system to optimize and stage operation of the air handlers.
    - Optimize mixed air temperature and discharge air temperature to provide fresh air and "free cooling" as required
    - Minimize/eliminate use of steam coil in the air handlers

Assumptions:
Eliminate overheating during the winter.
4500 HDD
Supply fan = 7.5 hp
Exhaust fan = 1 hp

Exhaust fan = 2500 CFM	Existing	Proposed
AH1 & Exhaust Fan	60 hours per week	60 hours per week
AH2 & Exhaust Fan	60 hours per week	< 10 hours per week

Fan Savings = (7.5+1)*0.746/88%*50*52
= 18,735 KWH **= $1,255 per year**

OA Heat Savings = 2500*1.08*60/168*24*4500/(80%*100000)
= 1302 Therms **= $1,172 per year**

6. 1927 Gymnasium HVAC & Energy Management

Projected Annual Savings = $1,200 per year

Payback < 5 years

The gymnasium is heated two (2) air handlers.

- *The one (1) exhaust fans and the two (2) air handlers are controlled manually with an on/off switch. Outdoor air %, mixed air temperature and discharge air temperature is unknown.*

Consequently the gym overheats and operates at a negative pressure.

HVAC & Energy Management Upgrade

- o Utilize one (1) air handler to provide heating and fresh outdoor air during occupied mode
- o Utilize secondary air handler to provide economizer cooling as needed

a. Upgrade the two (2) air handlers with new actuators, mixed air and discharge air sensors.
b. Install a new two-speed exhaust fan
c. Control operation of the exhaust fan and two (2) air handlers with the energy management system.
d. Relay the exhaust fan operation with each air handler. (Low speed = one air handler, High speed = both air handlers.)
e. Test-n-balance exhaust ventilation with air handler outdoor air ventilation.
f. Program the energy management system to optimize and stage operation of the air handlers.
    - ▪ Optimize mixed air temperature and discharge air temperature to provide fresh air and "free cooling" as required
    - ▪ Minimize use of steam coil in the air handlers

Assumptions:

Eliminate overheating during the winter.

6500 HDD (exposed sidewalls)

Supply fan = 3 hp

Exhaust fan = 0.5 hp

Exhaust fan = 1000/2000 CFM	Existing	Proposed
AH1 & Exhaust Fan	60 hours per week	60 hours per week
AH2 & Exhaust Fan	60 hours per week	< 10 hours per week

Fan Savings	= (3+0.5)*0.746/88%*50*52	
	= 7,714 KWH	**= $501 per year**
OA Heat Savings	= 1000*1.08*60/168*24*6500/(80%*100000)	
	= 752 Therms	**= $677 per year**

7. Test-n-Balance HVAC & Optimization Energy Management System

Projected Annual Savings = $6,100 per year

Payback < 3 years

A variable air volume system has several components and control strategies:

i) Room sensor controls VAV box

Temperature satisfied	=	*VAV damper closes to minimum airflow*
Heating required	=	*VAV damper opens to maximum airflow & reheat coil actuator opens (heating)*
Cooling required	=	*VAV damper opens to maximum airflow & reheat coil actuator closes*

ii) Static pressure controls fan speed

VAV damper @ minimum	=	*Increase static pressure*
Increase static pressure	=	*Reduce fan speed & reduce airflow*
	=	*Reduce fan horsepower*
	=	*Reduce heating and/or cooling*

iii) Mixed air sensor controls outdoor air damper

Mixed air temperature sensor	=	*% Return air + % Outdoor air*
Minimum % outdoor air	=	*Minimum OA damper*

iv) Discharge air sensor controls heat coil actuator

Discharge air temperature	=	*Mixed air + % actuator heat coil*

v) Optimization Program reduces excessive heating and/or outdoor air ventilation

Warm room (cooling)	=	*Reduce mixed air temperature*
		Reduce discharge air temperature
Remaining rooms	=	*Utilize reheat coils as needed*

Note: Discharge air and mixed air temperature should track each other.
Minimum discharge air temperature eliminates excessive reheat of remaining rooms.

It appears the existing Energy Management System is NOT programmed for optimization of mixed air and discharge air temperatures.

AHU	Area	Mixed Air, MA	Discharge Air, DA	Zone Temperature
B1	Auditorium	42.5 degrees	60 degrees	73.4 degrees
C1	2nd Fl In-fill	67.1 degrees	80.3 degrees	71.3 degrees
C2	Supt Office	50 degrees	58 degrees	76 degrees
C3	Media Center	45 degrees	49 degrees*4	72.4 degrees
C4	1st Fl In-fill	44.8 degrees	52.5 degrees*4	71.6 degrees

Outdoor Air Temperature = 23 degrees

B1 Auditorium:

AHU	Area	Mixed Air, MA	Discharge Air, DA	Zone Temperature
B1	Auditorium	42.5 degrees	60 degrees	73.4 degrees

Outdoor Air Temperature = 23 degrees

Based upon zone temperature @ 73.4 degrees and DA temperature @ 60 degrees, the Auditorium requires neither heating nor cooling. But the MA temperature @ 42.5 degrees is terribly amiss!

MA @ 42.5 degree = 60% OA @ 23 degrees + 40% RA @ 73 degrees

WHY is the energy management system requesting 60% OA! This excessive OA would satisfy fresh air requirements for 600 occupants! Minimum OA @ 20% would still be excessive. Except for major events, occupancy is normally less than 40 students!

C1 2nd Fl In-fill Classrooms:

AHU	Area	Mixed Air, MA	Discharge Air, DA	Zone Temperature
C1	2nd Fl In-fill	67.1 degrees	80.3 degrees	71.3 degrees

Outdoor Air Temperature = 23 degrees

The zone temperature sensor @ 71.3 degrees cannot be correct!
All C1 classrooms were overheating (80+ degrees) on the day of my visit!

Based upon DA temperature @ 80.3 degrees the face-n-bypass heat coil is malfunctioning.

Apparently the outdoor air actuator and/or MA sensor are also malfunctioning.
The energy management system stated OA @ 100% open but by it is actually open < 25%.

MA @ 67.1 degree = 25% OA @ 23 degrees + 75% RA @ 80+ degrees

NOTE: Room C216:
Room C216 was 89 degrees. (Whew that is hot!)
Apparently the VAV reheat coil actuator is stuck open.

C2 Superintendent Offices:

AHU	Area	Mixed Air, MA	Discharge Air, DA	Zone Temperature
C2	Supt Office	50 degrees	58 degrees	76 degrees

Outdoor Air Temperature = 23 degrees

Based upon zone temperature @ 76 degrees and DA temperature @ 58 degrees, the offices require a slight cooling. But the MA temperature @ 50 degrees is terribly amiss!

MA @ 50 degree = 50% OA @ 23 degrees + 50% RA @ 76 degrees

WHY is the energy management system requesting 50% OA! This excessive OA would satisfy fresh air requirements for 80 occupants! Minimum OA @ 15% would satisfy occupancy of 30.

C3 Media Center

AHU	Area	Mixed Air, MA	Discharge Air, DA	Zone Temperature
C3	Media Center	45 degrees	49 degrees*4	72.4 degrees

Outdoor Air Temperature = 23 degrees

Which sensor is requesting DA temperature @ 49 degrees to provide excessive cooling?

Based upon zone temperature @ 72.4 degrees, the Media Center requires neither heating nor cooling. But the MA temperature @ 44.8 degrees and DA @ 52.5 degrees is wrong!

MA @ 45 degree = 55% OA @ 23 degrees + 45% RA @ 72 degrees

WHY is the energy management system requesting 55% OA! This excessive OA would satisfy fresh air requirements for 300 occupants! Minimum OA @ 15% would satisfy occupancy of 100.

1st Fl Fill-in Classrooms

AHU	Area	Mixed Air, MA	Discharge Air, DA	Zone Temperature
C4	1st Fl In-fill	44.8 degrees	52.5 degrees*4	71.6 degrees

Outdoor Air Temperature = 23 degrees

Which sensor is requesting DA temperature @ 52.5 degrees to provide excessive cooling?

Based upon zone temperature @ 71.6 degrees, the classrooms require neither heating nor cooling. But the MA temperature @ 44.8 degrees and DA @ 52.5 degrees is wrong!

MA @ 45 degree = 55% OA @ 23 degrees + 45% RA @ 72 degrees

WHY is the energy management system requesting 55% OA! This excessive OA would satisfy fresh air requirements for 300 occupants! Minimum OA @ 25% would satisfy occupancy of 170.

Test – n – Balance & Optimization

a. Repair all sensors and actuators.
   - You cannot control what you cannot measure!
b. Test/balance exhaust systems and minimum outdoor air
   - Exhaust air = minimum outdoor air requirement
c. Install CO2 sensor in Auditorium and reduce minimum OA from 25% to 5%
   - Low occupancy = minimal outdoor air requirement
d. Program the energy management system to optimize operation.
   - Optimize mixed air temperature and discharge air temperature to provide fresh air and "free cooling" as required
   - Minimize reheat

Assumptions:
Reduce excessive outdoor air ventilation from @ 50% - 60% in the winter to the original specification @ 15% - 25% OA
12000 CFM OA

Reducing OA will reduce simultaneous cooling/heating and reduce supply airflow requirements 20%+ and provide a 30% reduction in fan motor requirement.
16 hp reduced fan motor, 40 hours/week
4500 HDD

CO2 sensor will reduce minimum OA for Auditorium from 20% to <5%
3000 CFM OA
Cumulative Cooling Load = 2.0 ton-hour per CFM
AC = 1.2 KW per ton

Fan Savings	= 16*0.746/88%*40*52	
	= 28,212 KWH	**= $1,890 per year**
AC Savings	= 3000*2*1.2	
	= 7,200 KWH	**= $482 per year**
OA ReHeat Savings	= 12,000*1.08*40/168*24*4500/(80%*100000)	
	= 4,166 Therms	**= $3,749 per year**

8. Steam to Hydronic Conversion & High Efficiency Boiler System

- **Center Point rebates**

  Steam/hydronic conversion = 25% equipment costs
  High Efficiency = $2000 per MMBTU = $6000

Projected Annual Savings = $14,000 per year

Payback <6 years

Hydronic condensing boiler system efficiency increases up to 95% efficiency at partial load. *As discharge water temperature drops below 160 degrees, condensing of flue gases occurs and boiler efficiency dramatically improves, up to 95%.*

i) ***Replace one (1) steam boiler with a high efficiency dual-fuel boiler system***
  - ***Utilize the 3000MBTU boiler as the primary front-end heat source.***

ii) ***Convert the remaining 1985 boiler from steam to hot water.***
  - ***The second boiler is only required during extreme weather morning warm-up.***

iii) ***Convert the air handler(s) for the gym(s), cafeteria and several classroom unit ventilators from steam coils to water coils. NOTE: The gym steam coils are significantly oversized, so conversion to hot water will be easily accomplished.***

iv) ***Complete the hydronic conversion the remaining steam and condensate return distribution system.***

3000 MBTU Fulton Vantage Boiler, Oil & Gas, Up to 99% efficiency $40,000
http://www.ryancompanyinc.com/fulton.htm

Install trim package, pumps and three-way mixing valve on 1985 Burnham boiler
Replace condensate return piping with adequately sized return pipes and pumps
Control upgrades, electrical and misc $50,000

High Efficiency
Front-End Boiler

			Heat		TOTAL
06-07 Annual Gas Usage			**61,000**		**61,000**
Normalized Amount			**$54,900**		**$54,900**

	Mild Weather	Cold Weather	*Severe Weather*	*Seasonal Efficiency*	Total Savings
Percentage Annual HDD	*40%*	*40%*	*20%*	-	-
Heating Therms	24,400	24,400	*12,200*		
DHW Therms	0	0	*0*		
Existing Boiler System Efficiency	55%	70%	*70%*	*64%*	
Proposed System Efficiency	94%	90%	*70%*	*88%*	
Annual Heat Savings (Therms)	**10,123**	**5,422**	**0**		**15,546**
-					-
-					-
Annual Therm Savings					**15,546**

Annual Savings	**$13,991**