nationalgrid

Melrose Lincoln School

Prepared for

NATIONAL GRID

Prepared by

B2Q Associates, Inc.

Beverly, MA

Revision Date

September 10, 2008

Whole Building Program

5 Arrowhead Lane
Beverly, MA 01915

Opportunities Screening Final Report
Melrose Lincoln School
NGRID Whole Building Program

Walk Through Date: 6/11/08
Address: 80 W. Wyoming Ave., Melrose, MA

Facility Description

Building Description
The Lincoln School was originally built in 1896. The building was completely rebuilt in 1999, with the exception of the front façade and one wall which remains in the atrium. New lighting was installed throughout the building with the 1999 addition. The total floor area is 64,000ft2. Major HVAC equipment was replaced as part of the 1999 renovation.

The school has approximately 393 students enrolled with a capacity of approximately 425.

Utilities
Electricity is supplied by Trans Canada
Electric delivery company is National Grid
Gas supply and delivery company is National Grid (Keyspan)

HVAC
(1) Air Handling Unit (AHU) for Admin.
(1) Rooftop Unit (RTU) for Atrium.
(6) Heat Recovery Units (HRUs) serve cafeteria, library, gym, and classrooms.
See Appendix C for equipment list.

Fan coil units in classrooms.
Small hot water unit heaters in attic, kitchen and boiler room.

Heating
(2) Burnham hot water gas boilers, each 3353 kBtu/h output with IBR of 2916 kBtu/h, 3hp blower motor. Efficiency listed at 84.6% by service technician documentation.

Dual hot water/chilled water pumping loop with manual switchover.
(2) 20hp pumps with variable speed drive control, running at 34Hz and 15Hz on 99F outside air temperature day. 91% efficient, 480gpm, 90ft head.

200 kBtu/h natural gas domestic hot water heater, 100gal.

Cooling
Air cooled chiller on roof, nominal 60ton capacity at approximately 1.1kW/ton.
Most areas of the building are cooled with the exception of the gym.

Lighting
New lighting installed in 1999. New T5 high bay lighting recently installed in gym. There appears to be no additional opportunity for lighting fixture upgrades, however we suggest investigating lighting occupancy sensors.

Building Automation System (BAS or EMS)
Invensys building automation system controls all major units and fan coils in classrooms.

Other Equipment
Exhaust hood in kitchen
130 Computers

Schedules
Occupancy schedules are as follows:
- 7:30am to 2:30pm M – F
- Night events (about two times per month)
- Building is shutdown during summer break, except for custodial area

Equipment schedule:
- Custodian starts up units at 5:30am on weekdays, and sporadically for night events and other special uses.

Areas of interest:
- Gym: 8:00am to 6:00pm weekend use during winter, maximum capacity 580
- Cafeteria: maximum capacity 359
- Kitchen: hood runs 6:30am to 1:00pm M – F during school year

Contacts

Customer's Contacts			
Lenny Maclean	Custodian	339-203-0326	
Mike Lindstrom	Project Administrator	781-979-4440	mlindstrom@cityofmelrose.org
National Grid			
Anita Hagspiel	Principal Analyst/ Program Manager	781-907-1581	anita.hagspiel@us.ngrid.com
Denise Rouleau	Rouleau Consulting	978-281-0623	deniserouleau@comcast.net
NGRID's TA Consultants			
Richard Andelman	B2Q Associates, Inc.	978-263-9395	randelmanb2q@comcast.net
Joshua Doolittle	B2Q Associates, Inc.	978-846-1994	jdoolittleb2q@comcast.net

Utility Data and Benchmarking

The table below compares this building to two typical benchmarks – CBECS and EPA Portfolio Manager. CBECS is a database of buildings and their characteristics, and is commonly used to compare energy use in buildings and establish benchmarks. Portfolio Manager is a Web-based tool supported by the EPA which rates your building against similar buildings.

$/kWh	$/therm
$0.13	$1.54

Building Information			Performance Ratings					Operating Costs / SqFt		
Building Type	EPA Bldg Type	Area sqft	Occ W/ft2	UnOcc W/ft2	EPA Rank (1-100)	CBECS 2003 Avg Site kBtu /sqft	2007 % Above CBECS Avg	2007 Electric $/sqft	2007 Fuel $/sqft	Total $/sqft
School	School	64,000	2.42	*N/A*	50	101.6	-32%	$0.94	$0.69	$1.63

Weather Information			Electric and Fuel Use			Energy Use Indices			
Year	Heating Degree Days	Cooling Degree Days	Actual Electric kWh	Actual Fuel kBtu	Norm. Fuel kBtu	kWh/sqft	Norm. Fuel kBtu /sqft	Norm. Site Total kBtu /sqft	Norm. Source Total kBtu /sqft
2006	5,007	806	429,400	2,214,900	2,495,357	7	39	62	108
2007	5,662	907	460,600	2,871,100	2,860,451	7	45	69	119
30 yr avg	5,641	678							

Norm = Normalized values. Normalized based on 30 year average weather data. Degree days are base 65.

The terms in the table above are described on the next page.

This facility would need to reduce energy use by 19% to raise its EPA rank to 75 and become eligible to apply for Energy Star certification.

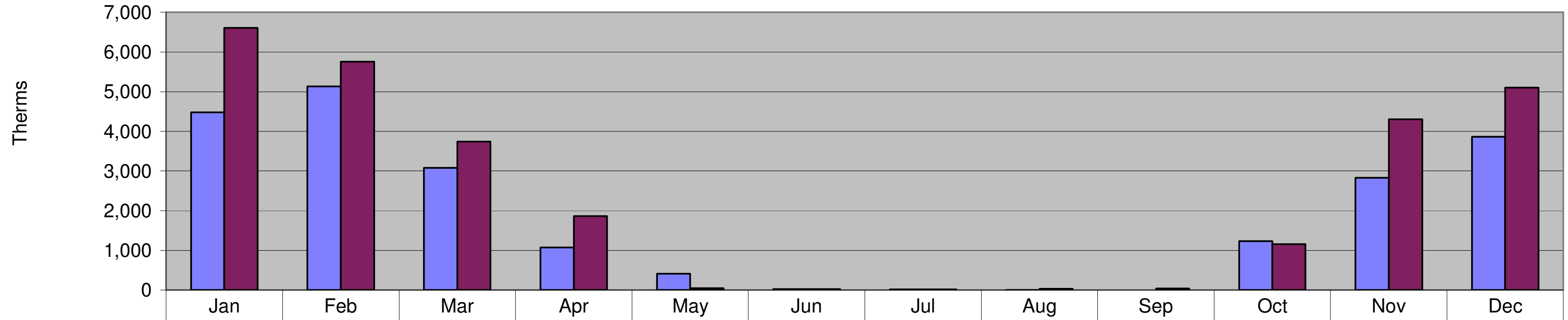
Note: 2006 data was used to calculate the EPA Portfolio Manager rank because of unusual building use in 2007.

The following terms are used in the table above:

- ***Building type:*** The type of building being examined.
- ***EPA Building Type:*** EPA Portfolio Manager has a limited number of building types used for benchmarking one building against another. The EPA building type indicates what type of building was chosen to compare this building against.
- ***Occ W/ft2:*** This is the occupied Watts per square foot (W/ft2), which is an indication of how much energy is being used while the building is occupied on a typical day.
- ***Unocc W/ft2:*** This is the unoccupied Watts per square foot, which is an indication of how much energy is being used while the building is unoccupied on a typical day. High levels of unoccupied W/ft2 indicate that equipment is running when there are few people in the building, and may indicate the opportunity to shutoff equipment.
- ***EPA Rank:*** This is the rank of the building in EPA's Portfolio Manager benchmarking tool. The scale is 1 to 100, with an average building ranking a 50. Buildings can apply for an Energy Star Award when they receive a rank of 75 or above.
- ***Site and Source:*** Shown in the table above are the total annual electric and fuel use, and approximate costs per square foot based on average electric and fuel rates. *Site* and *Source* benchmark indices are also shown. Site means how much energy is consumed at the site, while Source means how much energy is consumed back at the power plants used to generate the energy, which is then transmitted to the Site. The difference is in the conversion of kWh – for Site the conversion is 3.413 kBtu/kWh, while for Source it is 10.3 kBtu/kWh.
- ***Heating Degree Days:*** An indication of how cold the year was, with higher Heating Degree Days indicating a colder year.
- ***Cooling Degree Days:*** An indication of how warm the year was, with higher Cooling Degree Days indicating a warmer year.
- ***Actual Fuel kBtu:*** How much heating energy was used during the year, including gas, oil, propane, and other heating fuels. Measured in kBtu, which is 1000 Btu's, or 1/100 of a therm of natural gas.
- ***Norm. Fuel kBtu:*** The heating energy used during the year, normalized to 30 yr averages based on Heating Degree Days.
- ***kWh/sqft:*** The total electric energy use per year in kilowatt-hours divided by the gross square footage of the building.
- ***Norm Site Total kBtu/sqft:*** The total Site-based energy use of the building, including electricity use and normalized fuel use, divided by the gross square footage of the building.
- ***Norm Source Total kBtu/sqft:*** The total Source-based energy use of the building, including electricity use and normalized fuel use, divided by the gross square footage of the building.

Electric and gas utility data for this facility are shown below:

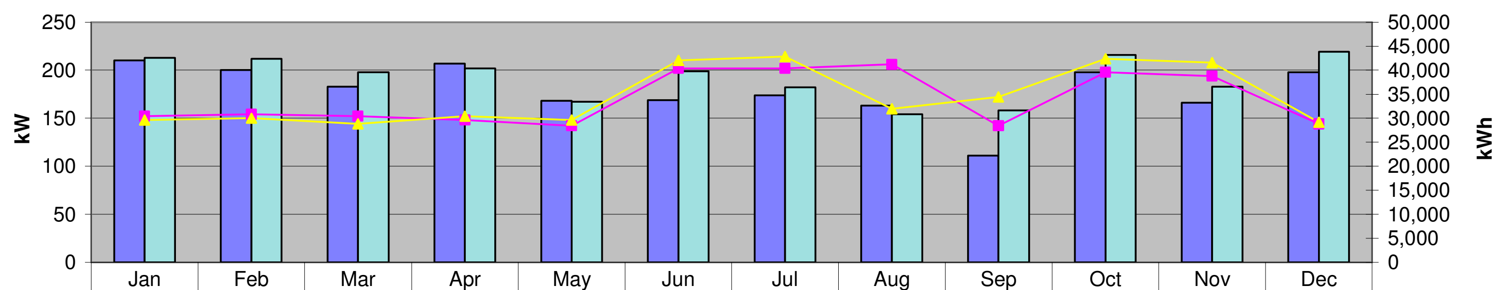
Gas Use
Previous and Current Year-to-Date



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gas Use 2006 (therms)	4,477	5,132	3,079	1,074	414	28	19	3	0	1,232	2,827	3,864
Gas Use 2007 (therms)	6,610	5,757	3,746	1,865	49	28	22	31	42	1,156	4,304	5,101

Month

Electric Use and Demand
Previous Year and Current Year-to-Date



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electricity Use 2006 (kWh)	42,000	40,000	36,600	41,400	33,600	33,800	34,800	32,600	22,200	39,600	33,200	39,600
Electricity Use 2007 (kWh)	42,600	42,400	39,600	40,400	33,400	39,800	36,400	30,800	31,600	43,200	36,600	43,800
Electric Demand 2006 (kW)	152	154	152	148	142	202	202	206	142	198	194	144
Electric Demand 2007 (kW)	148	150	144	152	148	210	214	160	172	212	208	146

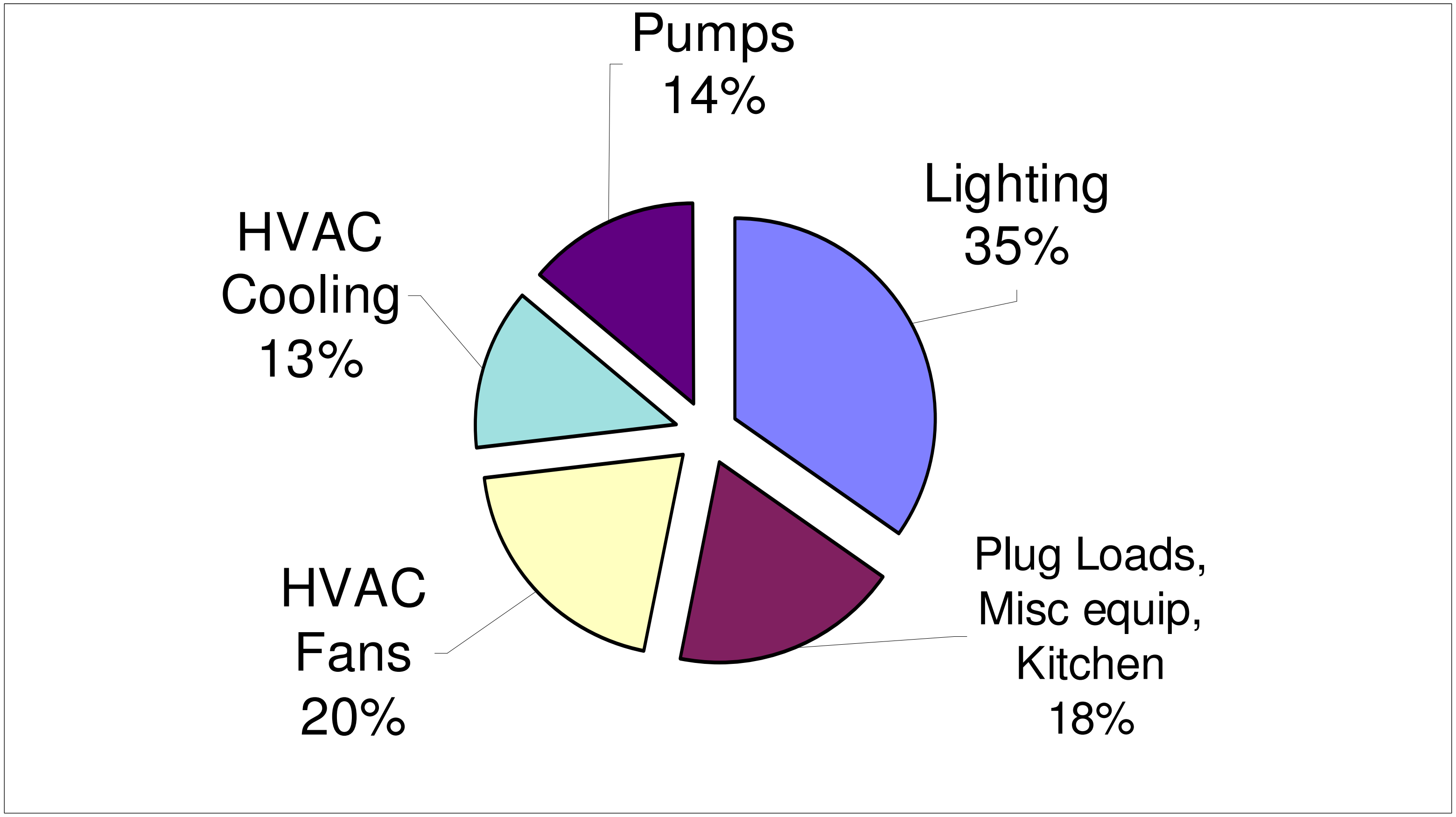
Benchmarking Notes:

- Gas use in 2007 follows typical heating patterns.

- Electricity use generally tracks from 2006 to 2007, although there was a 30% increase in use during the month of September in 2007. This may be due to unusual building use, however it may also indicate that equipment was running unnecessarily. It should also be noted that peak demand dropped in August 2007 by approximately 22%. This indicates that large equipment, such as the chiller, was turned off or used at lower capacity in this month.

Electricity End-Use Reconciliation Estimate

The chart below estimates the percentage of annual electricity use by each of the resources listed.



Note: 2006 data was used to produce this graph, because of unusual building use in 2007.

Energy Efficiency Measures for Further Study

The energy efficiency measures (EEMs) recommended for further study are summarized on the next page. This is based on initial discussions and observations, and each will require further detailed study of the systems to ensure that they are compatible with the technologies suggested. Costs and savings estimates for each measure are shown as initial estimates, with further refinement needed through detailed study of the facility. As the opportunities listed here are studied in more detail, additional opportunities may emerge.

These initial cost and savings estimates are expected to be within 15% of the final numbers, which will be determined after a detailed study of the facility.

Important Note(s):

1. These amounts do ***not*** include gas company rebates, which could impact both economics and design recommendations.
2. Since a "menu" of choices is supplied for this report, there is deliberately overlap in costs and savings estimates. This means that there is overlap in the savings estimates if all measures were to be done together. It also means that there are likely economies of scale to be realized by doing multiple projects, and that cost estimates could be lowered.
3. Additional recommendations and explanations are included in the text following the EEM table. Not all recommendations are included in the EEM table because some measures may need more detailed study or are otherwise outside the scope of this preliminary study.

Energy Efficiency Measure Table

Utility Rates		
Elec Rate	$0.13	*$/kWh*
Gas Rate	$1.54	*$/therm*

Results		
Total Cost	*$48,926*	
Total Savings	*$15,170*	
Simple Payback	*3.2*	*yrs*

Climate Impact Table	*lbs of Pollutants Reduced*	*Equiv trees planted*	*Equiv gallons of gasoline*
CO2 Reduction	*127,680*	*64*	*6,384*
SO2 Reduction	*182*		
NOx Reduction	*141*		

EEM	**Savings Estimate (kWh)**	**Savings Estimate (therms)**	**Savings Estimate ($)**	**Cost Estimate ($)**	**Potential Incentive ($)**	**Net Cost ($)**	**Simple Payback (yrs)**	**Action Items**
1. No/Low Cost Measures								
Computer Power Management	6,500	0	$845	$500	$0	$500	0.6	Utilize internal IT staff
Schedules, Setpoints, O&M	724	287	$536	$500	$0	$500	0.9	Utilize facilities staff
2. Retrocommissioning	12,882	1,436	$3,885	$13,800	$0	$13,800	3.6	Arrange for EMS/HVAC specialist to review existing control systems
3. DCV Cafeteria, Gym	15,695	3,076	$6,778	$17,449	$1,200	$16,249	2.4	Arrange for DCV specialist to review
4. Kitchen Hood Controls	570	666	$1,099	$7,500	$0	$7,500	6.8	Arrange for Kitchen Hood specialist to review
5. VSD on Gym, Caf RTUs	15,585	0	$2,026	$17,177	$6,800	$10,377	5.1	Arrange for EMS/HVAC specialist to install
6. Lighting Occupancy Sensors	Arrange For Lighting Specialist To Review							
Total	51,955	5,465	$15,170	$56,926	$8,000	$48,926	3.2	
% of Total Existing Amount	11%	19%	15%					

Additional Information on Energy Efficiency Measures

1. *No/low cost measures*: National Grid is providing guidance on a number of no and low cost measures which can be implemented. Please review the Notebook provided by National Grid. Reviewing these measures and educating personnel can provide immediate energy savings and improve comfort throughout the buildings. In addition, the following no/low cost measures are recommended:

    a. Computer Power Management: Power Management features are standard in Windows and Macintosh operating systems, and can place monitors and computers into a low-power "sleep mode" after a period of inactivity. Touching the mouse or keyboard "wakes" the computer and monitor almost instantly. There are many ways to activate sleep features across entire networks of computers, including free solutions that utilize open source software and/or tools that you may already have at your disposal. Alternatively, a number of commercial software packages offer more feature-rich solutions for a fee, and may deliver more energy savings.

       To maximize power savings, set computers to enter system standby or hibernate after 30 minutes or less of inactivity, and set monitors to enter sleep mode after 15 minutes or less of inactivity. The lower the time settings, the more energy you save. On laptops, be sure to activate these settings in the AC as well as DC (battery) power profiles. See the Energy Star website for more information at: http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_management

    b. Schedule, Setpoints and O&M Measures: All spaces should have their schedules and temperature setpoints for occupied and unoccupied periods reviewed and tightened in the BAS. See Appendix A for more detailed information about energy use patterns and electric loads.

       Check all copiers, personal appliances, printers, etc. and ensure they are set to power down to their standby or energy saving modes when not in use. There appears to be a large number of personal appliances in the building which should be shut off when not in use, and/or consolidated with central cafeteria equipment.

       Create a preventative maintenance (PM) program, to systematically check and manage the following items:

Adjust Belts	Fix Refrigerant Leaks
Clean Condenser Coils	Maintain Cabinet Integrity
Clean Evaporator Coils	Maintain Outside Air Dampers
Clean Filters	Check Airflow
Check Refrigerant Charges	Maintain Fans
Maintain Condenser Fans and Motors	Seal Ducts

Incorporating a quality PM vendor will keep equipment running smoothly and efficiently, and identify potential problems early on.

2. *Building Automation System (BAS) Retrocommissioning (RCx):* RCx is the process of systematically going through the building to determine whether equipment is functioning correctly, and then recommending and implementing no or low cost measures which can be implemented to improve energy efficiency and reduce maintenance costs. During the site visit, we sampled equipment and found that, in general, there is opportunity for adjusting equipment operations and improving energy efficiency. Below is a list of items which can be addressed, many at no or low cost.

   a. All spaces in the building need to have their schedules and temperature setpoints reviewed, to tighten the occupied and unoccupied periods and setpoints. Examples are mentioned below:

      i. The first floor Corridor 153 fan coil unit was set at 60°F on the BAS and the space temperature was 77°F.

      ii. Several of the fan coil units in the first floor classrooms had cooling set points far below optimal. These units were struggling to meet the set points.

      iii. All second floor units displayed 100% operation on the BAS and were struggling to meet the set points. This is normal for a peak design day, such as the day of our walkthrough, however, the cooling system was not operating at 100%. See section b (below) for more information.

      iv. All third floor units had cooling set points far below optimal and displayed 100% operation on the BAS. These units were struggling to meet the set points.

   b. The pump which was running was at 34 Hz, or 56% of its maximum speed, yet most of the building was starved for cooling. This pump should have been running near its maximum of 100%. This could imply there is a problem with the differential pressure setpoint.

   c. Building sequences of operation as listed in the building plans seemed incorrect in several places. Example: The sequence for RTU4 (gym) discusses cooling, but no cooling is specified for this unit. The actual current building sequence of operations should be documented by the BAS vendor to create a clear reference guide as to how the building is actually operated.

   d. The heat recovery and rooftop units should be checked for proper operation of dampers, economizer cycle, and the response of return and ventilation dampers to changes in occupancy and temperature. Since the building plans do not seem to match the existing BAS, implementation of intended control functions should be checked.

   e. Optimal start/stop is an algorithm which optimizes the start and stop time of equipment, so that units are automatically turned on to bring space temperatures to their setpoints only at the time needed, rather than starting or stopping on a fixed schedule. Optimal start/stop strategies should be implemented into the Building Automation System (BAS).

f. As part of the RCx process, building facility staff should be trained on the use of the Building Automation system to utilize the system to its maximum potential. This is extremely important, as it will help staff monitor and diagnose equipment, as well as optimize the runtime of equipment and the overall energy use of the building.

g. One immediate RCx measure is to perform a walk-through during unoccupied periods to audit equipment which is operating even though it should be turned off during these periods.

h. Upgrade BAS software to the latest version.

i. Take advantage of "trending" BAS points over time to view how equipment behaves over several weeks. Often examining a point (temperature, humidity, etc) requires seeing how that information behaves over a period of time. By setting up trends on all the equipment in the building, at any point in time facility staff can review how that equipment has been behaving over the past several weeks, and determine if there is now a problem.

3. *Demand-controlled ventilation (DCV) in the Cafeteria and Gym:* DCV is a control strategy that adjusts the quantity of outdoor ventilation air supplied to a zone based on the number of occupants and the ventilation rate required to provide adequate indoor air quality. Designers often design HVAC systems for the maximum number of occupants in a space, however these spaces are rarely used to full capacity. Often for spaces such as these, they are only occupied to 10 or 20% of their capacity for the majority of the time.

   For areas with highly fluctuating occupancy characteristics, a significant amount of heating (and cooling) energy can be saved by applying the right amount of ventilation air to satisfy the ventilation requirements at any given time of day. Typically CO2 sensors are used to indicate the occupancy levels, and the amount of ventilation air required. This measure is very effective when implemented in conjunction with Variable Speed Drives on the units serving these areas.

   Note: DCV is listed on the sequence of operations in the building plans for the Cafeteria, but there did not appear to be evidence that this unit has DCV control enabled.

4. *Kitchen hood controls*: Add controls, variable speed drives, and smoke sensors to kitchen hoods and kitchen make up air systems to reduce runtime and conditioning of makeup and outside air. One possible product to use is Melink hood fan controls. We were not able to inspect the fan motor during our walkthrough and a more detailed investigation is warranted to revise savings and cost estimates.

5. *VSD on Gym and Cafeteria RTUs:* This measure is to add Variable Speed Drives (VSDs) to the Supply and Exhaust fan motors on two of the Rooftop Units. These VSDs modulate the speed of the motor to meet variations in building loads. Just as a car is not driven at maximum speed on the roadways at all times, there is no reason to run a fan at

full speed at all times. It should speed up and slow down to meet the needs of the building. This measure is very effective when implemented in conjunction with the DCV strategy.

6. *Lighting Occupancy Sensors:* Occupancy sensors can reduce unnecessary energy use by performing the duties of turning lights in an area on and off when they sense someone entering or leaving an area. Areas that are good candidates for occupancy sensors are those that are used infrequently or unpredictably, such as classrooms, private offices, conference rooms, storage rooms, and bathrooms. The Lincoln School has several of these types of areas.

Next Steps

- Immediately implement no/low cost measures
- Determine objectives and level of interest to proceed with detailed study
- Contact NGRID and local gas utility to review opportunities and begin detailed audit of opportunities
- Detailed report reviewed
- Implementation of recommended measures

Please feel free to contact me if you have any questions.

Sincerely,

Richard Andelman, PE, CEM, CBCP

Joshua Doolittle

Appendix A – Statement of Energy Performance

Statement of Energy Performance
FACILITY SUMMARY REPORT
Melrose Lincoln School

For 12-month Period Ending: December 31, 2007
Date Generated: September 08, 2008

This document was generated using EPA's Portfolio Manager system. All information shown is based on data provided by the Portfolio Manager account holder. Depending on the use of the SEP Facility Summary, building owners or managers may want to have a professional engineer (PE) verify that the underlying data is accurate. Blank space has been left intentionally on the SEP Facility Summary for a PE stamp.

80 W. Wyoming Ave
Melrose, MA 01930

Year Built: 1999
Gross Floor Area: **(ft^2)** 64,000

Facility Space Use Summary

K-12 School

Space Name	Gross Floor Area (ft^2)	Number of Students	Number of PCs	Weekly operating hours	Cooking Facility	% Cooled	% Heated	Months	Ventilated
Lincoln School	64,000	393	130	50	N	100	90	10	Y

Energy Performance Comparison

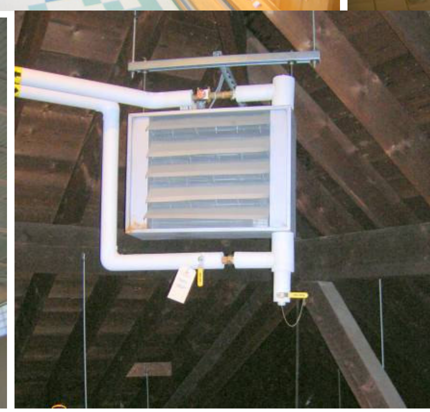
Results	Current (12/31/2007)	Baseline (12/31/2006)	Delta	Target	Industry Average	ENERGY STAR
Energy Performance Rating	**38**	**50**	**-12**	**75**	**50**	**75**
Energy Intensity (kBtu/ft^2)						
Site	69	58	12	51	63	51
Source	129	113	16	95	118	95
Energy Cost						
$/year	67701	56758	10944	49913	61889	49913
$/ft2/year	1.06	0.89	0.17	0.78	0.97	0.78
CO_2 Emissions (tons/year)	376	336	40	277	344	277

More than 50% of your building is defined as K-12 School. Please note that your rating accounts for all of the spaces listed. If you cannot see a rating, you will be compared to the national average of K-12 School.

EPA
United States
Environmental Protection
Agency

Appendix B – Images

Air cooled chiller, classroom fan coil unit, atrium, kitchen hood, rooftop unit, gymnasium, hot water unit heater

Appendix C – Equipment

RTU	CFM	OA CFM	TSP inWG	%OA	Serves	SF Nom HP	SF BHP	Cool (mbh)	Heat (mbh)	Fan kW
1	6,400	700	3.36	11%	Atrium	7.5	5.2	182.5	201.3	3.9
AHU	**CFM**	**OA CFM**	**TSP inWG**	**%OA**	**Serves**	**SF Nom HP**	**SF BHP**	**Cool (mbh)**	**Heat (mbh)**	**Fan kW**
1	5,900	1,320	2.47	22%	Admin/ Computer room	5	3.5	194.7	351.9	2.6
HRU	**CFM**	**OA CFM**	**TSP inWG**	**%OA**	**Serves**	**SF Nom HP**	**SF BHP**	**Cool (mbh)**	**Heat (mbh)**	**Fan kW**
2	7,200	5,745	4.06	80%	Cafeteria	10	7.1	400	460.7	5.3
3	3,440	3,440	3.72	100%	Classrooms	5	3.1	199.7	246.2	2.3
4	7,800	5,760	3.00	74%	Gym	10	5.7	--	583.7	4.2
5	3,070	3,070	3.67	100%	Classrooms	5	2.7	179.9	219.7	2.0
7	2,800	1,800	2.96	64%	Library	3	2.0	106	151.8	1.5
8	2,400	2,400	1.75	100%	Classroom	3	1.0	139.3	218.6	0.8