ENERGY EFFICIENCY OPPORTUNITY

BENCHMARKING REPORT

R.J. Grey Junior High School

Prepared for

Acton-Boxborough Regional School District

16 Charter Road - Acton, MA 01720

Prepared by

ENERGY MANAGEMENT ASSOCIATES, INC.

March 2014

The Acton-Boxborough Regional School District is a participant in the NSTAR ENERGY STAR Benchmarking Initiative, a program designed to help customers assess the energy performance of their buildings, and identify opportunities for improvement. They chose to participate with the R.J. Grey Junior High School located at 16 Charter Road, Acton, MA 01720.

Estimated Energy Performance Rating:
37

The performance of this building was assessed using the Portfolio Manager benchmarking tool from ENERGY STAR. For the twelve months ending December 31, 2013, the building received an energy performance rating of 37. The rating represents the percentile ranking of this building compared to others of its type in the United States based on source energy consumption. While the facility has already made a number of improvements (not all of which are fully represented in this Score), the school has the potential of further increasing its ENERGY STAR rating with measures outlined in this report. Buildings that receive a rating of **75** or greater are eligible for an ENERGY STAR label. A Statement of Energy Performance, generated by Portfolio Manager, and an Action Plan, are included as the last two pages of this report.

To identify opportunities for improving energy performance, Steve Di Giacomo, PE, CEM, CPMP and Nick Hill, CEM, LEED AP of Energy Management Associates, Inc. (EMA) conducted site visits on February 12 and 19, 2014, followed by telephone and e-mail discussions with school and District staff, vendors and contractors.

We would like to recognize and thank Kate Crosby, the District's Energy Advisor, and Mr. Dave Cormier, HVAC Specialist, for their time, interest, invaluable assistance and detailed discussions regarding the building's operations, equipment controls, and schedules.

FACILTY DESCRIPTION

Building Description

The R.J. Grey Junior High School serves 930 seventh and eighth students, along with approximately 110 faculty and staff. Offices for the Acton-Boxborough Regional School District are also located at the facility. The school is a 143,280 square foot one-story structure that wraps around three courtyards. The original building was constructed in 1955, with additions in 1960 and 1986. In 2002, the gymnasium was expanded and connected to the rest of the building. At this time, E-Wing (Classrooms 201-311) and the Superintendent's office area were added and the mechanical and electrical systems were upgraded as well. A 102.5 kWDC solar photovoltaic system was completed in March 2010 by Nexamp Solar and produces approximately 120,000 kWh annually.

The exterior walls are primarily brick, with extensive glazed curtain walls. During the course of the 2002 insulation was added to the walls where feasible and the metal panel portions of the curtain wall were insulated. Much of the existing glazing had another layer of glazing installed, to create an insulated system. The roof was replaced in 2002. The flat parts are an EDPM membrane with rigid insulation underneath, while the other portions have asphalt shingles with insulation beneath.

The facade was air-sealed in 2013 through funding provided by the Massachusetts Green Communities Act. This work consisted of closing gaps at the top of perimeter curtain walls, extensive caulking, installing a thermal barrier in the Administrative Offices and air-sealing underneath the gymnasium floor. This work also included the disconnection of a ¾ HP fan and two dehumidifiers that were running beneath the gym.

The site also contains two modular units, the Snack Shack and the Facilities and Transportation building. Both are fed from the Junior High School's electrical system, but neither can be considered an intrinsic part of the School. The Snack Shack is used during athletic events and has no winter utilities. The 1200 square foot Facilities Building houses a staff of ten and is heated and cooled by an air-source heat pump with supplemental electric resistance baseboard heating.

Boiler Plant and Controls

The boiler plant consists of two (2) gas-fired, cast iron sectional HB Smith Series 28A boilers dating from 2002. Each has with an input rating of 4,517,000 BTU per hour. On June 26, 2013, Boiler #1 tested at 85.4% combustion efficiency and Boiler #2 tested at a combustion efficiency of 84.6%. They are outfitted with Power Flame modulating burners rated at a maximum of 4,718,000 BTU per hour input. This hydronic system feeds the unit ventilators, unit heaters and some of the rooftop unit heating coils. It has a primary-secondary loop. The primary loop has two (2) 1.5 HP pumps in parallel. The secondary loop has 20 HP pumps in parallel, each with a variable frequency drive (VFD). From our observations and discussion with facility staff, the drives do not appear to vary the pump speeds significantly.

A JACE energy management system controls the boilers and HVAC system. The system has a weekend and night setbacks and an outdoor air temperature (OAT) reset control. This is set such that boiler leaving water temperature varies between 180°F (when outdoor air temperatures are 20°F) and 120°F (at temperatures above 60°F).

HVAC Units

The HVAC units and the areas they serve are listed in the table below. Of the rooftop units, those serving the Auditorium, Cafeteria and Media Center/Superintendent's Office have air cooling capability. These units, along with RTU-5, which serves the School Offices, have direct-fired heating units. The other rooftop and air handling units are fitted with hot water coils and provide heating and ventilation only.

The Finance Offices on the building's east side have individual through-the-wall air conditioning units in addition to the heating and ventilation supplied by RTU-7. Most of these units were wrapped to reduce winter infiltration, but the wrapping was loose on two of the units. An infrared image from the interior showed surprisingly little infiltration through the wrapped units.

Ventilation

The building has 52 exhaust fans. With the exception of the four fans serving the kitchen and gymnasium, these fans total 39,750 CFM and 8 2/3 HP. Roughly half of the classroom fans are inoperable due to burned-out motors. The rest of the fans are running continuously, without control. The exhaust fans for AHU's 2 and 3 have recently been brought under control via the EMS. The kitchen exhaust fan is tied to MAU-1 and controlled by the EMS. The 5000 CFM, 5 HP exhaust fan within AHU-1 is not yet under control and runs continuously.

There are 58 unit ventilators (UV's) in the classrooms. These provide fresh air and contain a hot water heating coil, per the HVAC equipment schedule above. They were recently (2013/13) repaired and recommissioned. This work included testing and repairing damper operation, recalibrating temperature sensors and verifying fan operation. During this work, it was confirmed that the hot water valve cannot be controlled using the unit ventilator control module, which means that varying HW supply temperature is not an option.

The auditorium, served by RTU-3, is currently experiencing pressurization problems such that it is sometimes difficult to close the doors to the space. EMA has been told that holes in the exterior ductwork are

contributing to this problem. We experienced the pressurization but were unable to observe the ductwork due to rooftop snow conditions.

HVAC Equipment Schedule

Tag	Area Served	Total CFM	Outside Air CFM	Heating (MBH output)	Supply Fan HP	Equipment Operating Schedule	Notes
AHU-1	New Gym	5000	5000	280	3	Always on	
AHU-2	Old Gym	5000	5000	285	3	6AM-10PM, Mon-Sun	Rarely needed in summer
AHU-3	Old Gym	5000	5000	285	3		
AHU-4	Mech Room	1600	1600	140	1.5	When called for by thermostat (rarely)	
RTU-1	Choral	2700	1500	208	2	8AM-2:30PM, Mon-Fri, No summer use	
RTU-2	Band	3200	1650	248	2		
RTU-3	Auditorium	8000	6900	731	5	8AM-2:30PM Mon-Fri, Noon-10 PM S-S, 5 months/yr. No summer use	VFD and DCV installed 2012/13, each unit has 40 tons cooling.
RTU-4	Cafeteria	7500	6000	709	5	6AM-2PM Mon-Fri, Noon-10 PM S-S, 5 months/yr. Sun 12-4 PM, 3 months/yr. No summer use	
RTU-5	School Offices	6680	1150	275	7.5	4:30 AM – 5 PM, Mon-Fri, all year	
RTU-6	Media Center/ Superintendent	6200	1125	294	7.5	Always on	18 tons cooling. VFD and DCV installed 2012/13
RTU-7	Finance Dept.	3850	1125	101	3	Always on	VFD Installed 2013
RTU-8	Locker	2700	2700	276	2	When called for by thermostat (rarely)	
RTU-9	Computer Lab A&B	3000	1600	129	2	6AM-2:30 PM, Mon-Fri,	12.5 tons cooling, VAV, Control issues
AC	Computer Lab C	Unk.	Unk.	Unk.	Unk.	3 programmable thermostats, AC for summer use only	
MUA-1	Kitchen MAU	5150	5150	600	3	6AM-1:30 PM, Mon-Fri	
UV-2	Science & Tech Classrooms	1500	500	78.5	1/8	6AM-2:30 PM, Mon-Fri, 12-4PM Sun	20 units
UV-3	Other Classrooms	1500	375	68.7	1/8		38 units
HV-1	B Wing Corridor (506-629)	1600	1600	125	1.5	Not used	
HV-2	C Wing Corridor (601-613)	725	725	75	5	Not used	
HV-3	D Wing Corridor (401-409)	1650	1650	125	1.5	Not used	Not Operational

Domestic Hot Water (DHW)

The school has two parallel domestic hot water systems, one designed for 140°F water and the designated as a conventional domestic hot water system. The 140°F system serves the custodial (mop) sinks, the kitchen kettles, prep sinks, and pot washing sinks. The lower temperature system serves showers, the restroom sinks and the classroom sinks. There are two Turbopower 199 MBH direct-fired hot water boilers, each with 250 gallon integral storage tanks. (The third boiler is inoperable.) The 140°F system's boiler (boiler #3) delivered 145°F water and tested at a combustion efficiency of 83.4% on June 21, 2013. The tank temperature of the other system was 110°F, and the unit tested at a combustion efficiency of 85.0% Water temperature in the kitchen prep sink was measured at 120°F. The hot water supply and return pipes are well-insulated.

Because the domestic hot water system was designed to have a 140°F distribution service for certain uses, it is not recommended to drastically reduce the water temperature. However, we believe that the high-temperature system can be reduced from 145 degrees to 130 degrees without affecting operations. The sanitary code does not explicitly call for high temperatures in mop and pot-washing sinks, so facility staff should experiment by dropping the water temperature in 5 degree increments and noting any impacts.

Lighting & Lighting Controls

With the exception of the gymnasium, the lighting systems date from the 2002 renovation. All of the linear fluorescent lighting uses standard 2-, 3- and 4-foot T8 lamps and electronic ballasts. Most of the classroom and office lighting is provided by recessed 2'x4' three-lamp deep-cell parabolic fixtures with white louvers. These fixtures provide excellent glare control by diffusing and severely limiting the amount of light that reaches the work surface. Although most of the fixtures are in good condition, they are reaching the age when ballasts will need to be replaced with increasing frequency. The technical (shop) classrooms and cafeteria spaces are also lit by fixtures with standard lamps and T8 ballasts in pendant and semi-recessed fixtures. The media center has a vaulted open ceiling that is lit by pendant-hung indirect compact fluorescent fixtures. The lower ceiling areas surrounding this space have recessed and surface-mount fluorescent fixtures.

The corridors throughout the building have recessed compact fluorescent "can" fixtures. These are in a wide spacing pattern and provide night and/or emergency lighting in these spaces. The center dome and main corridors also have fluorescent strip fixtures recessed where the ceiling and walls intersect, for a cove-lighting effect. In the areas of the 300, 400 and 600 corridors with student lockers (C-, D- and E-Wings), the recessed can fixtures are supplemented by linear fluorescent "box" fixtures mounted in continuous rows atop the lockers. They direct their light upwards and towards the center of the corridor, with the goal of providing ambient lighting. The light level in these areas is very poor, between 8 and 15 footcandles when vacant.

The gymnasium lighting was converted from 400 Watt metal halide fixtures to 250 watt induction fixtures in 2013. Unfortunately, a few of the old light fixtures remain in place. Because of an issue with the fixture lens guards, individual occupancy sensors could not be installed on each fixture as originally planned. The lighting is currently controlled by three sets of contactors.

The auditorium house lighting is a combination of 500 Watt incandescent and linear T8 fluorescent fixtures. The house lights are fully dimmable and are controlled from a number of points, including a wall-switch by the doors at the rear of the space. The backstage areas have 4-foot T8 fluorescent fixtures.

Utility Rates

The rates used to determine costs and savings are $1.116 per therm, $0.0709 per kWh (delivery & supply) and $19.45 per kW on peak (this is a blend of the $17.96/kW winter and $21.89/kW NStar B3 summer demand rates).

Hours of Operation

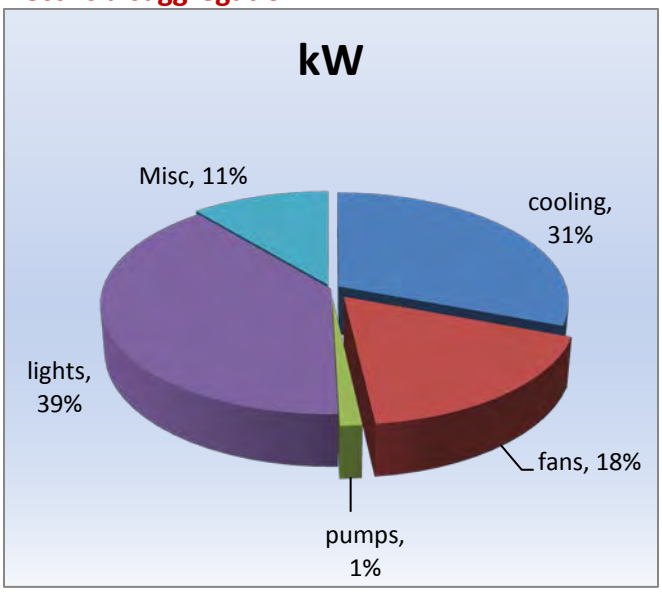
During the school year (late August through mid-June), classes are in session Monday through Friday, 7:30AM to 2:06PM. Students and staff typically start to arrive around 7AM. The building is in use for after-school activities until 3:30PM. The gymnasiums are in frequent use in the evening and weekends. Five classrooms are used for Continuing Education classes two hours per night, Monday through Thursday. On Sundays from noon to 4PM during the school year, all classrooms are used for a Chinese language program. For five months of the school year, community theater groups use the auditorium and cafeteria on weekends from noon to 10 PM. There are no regularly scheduled summer classes or activities, although the gym is used extensively. HVAC operation for special events, such as a school play, is programmed into the EMS as needed. The areas housing the offices of the School Administration, the Superintendent and the District Financial Staff are typically occupied on weekdays until 5PM, year-round.

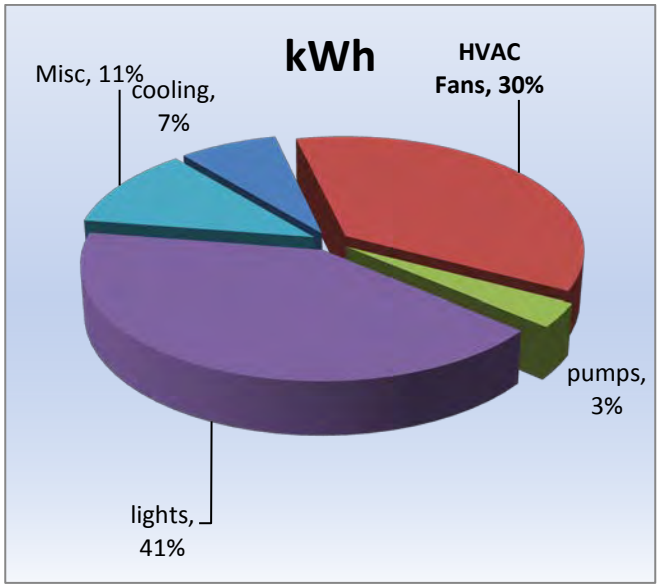
The equipment operating schedules are noted in the table above. Because the building is so spread out, with a great deal of exterior wall and glazed area, the staff has had to adjust schedules and temperature setbacks in order to maintain a comfortable winter environment.

Holidays and other scheduled days without classes for 2013-14

- August 30 - September 2 – Labor Day
- October 14 – Columbus Day
- November 5, 11, 27, 28 - Veteran's Day, Thanksgiving
- December 23 - 31 - Winter Vacation
- January 1, 20 – New Year's, MLK Day
- February 17 - 21 - February Vacation
- April 18 - 25 – Spring Vacation
- May 26 – Memorial Day

Electric disaggregation

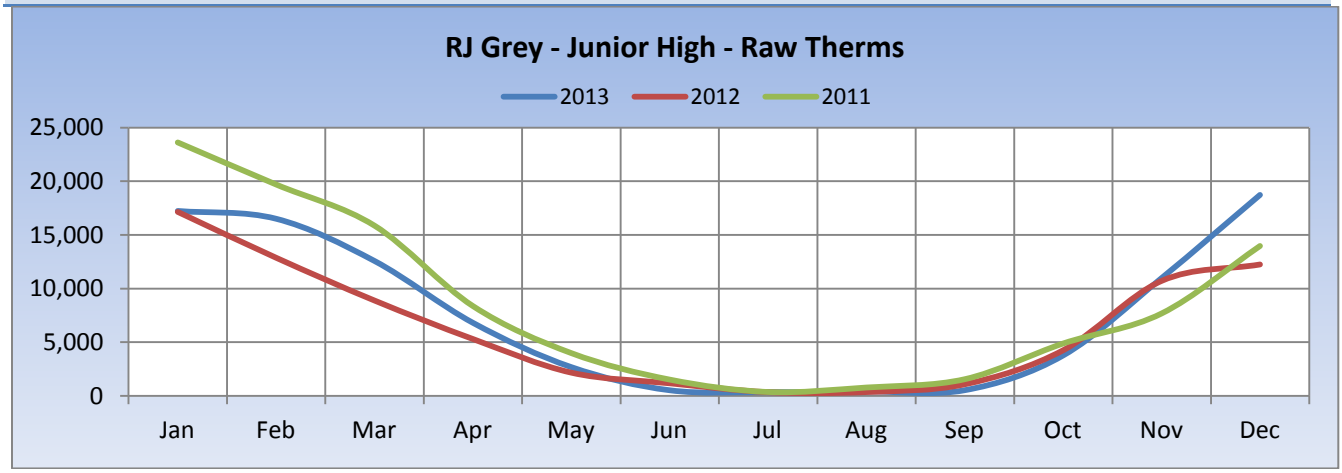




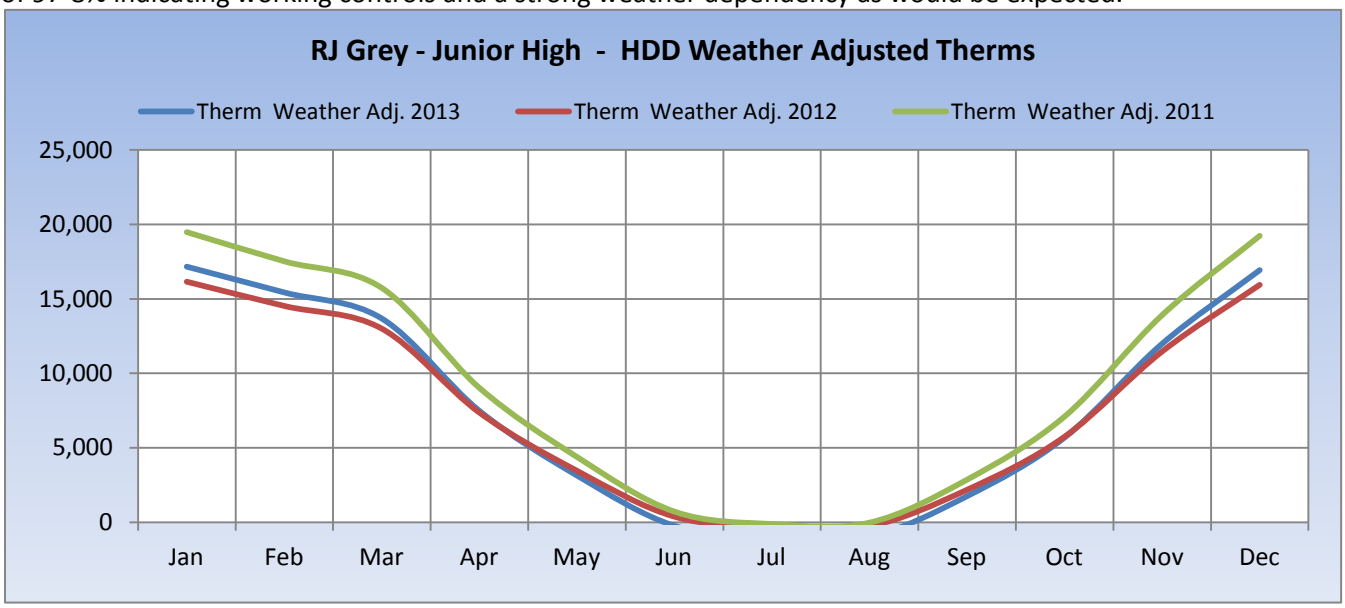
Energy Usage, Patterns and Trends

Natural Gas Energy Use - Therms Degree Day Weather Normalized to Most Recent Year

	HDD/day	Days in Period	Weather Adjusted 2013 therms	Weather Adjusted 2012 therms	Weather Adjusted 2011 therms	Raw 2013 therms	Raw 2012 therms	Raw 2011 therms
Jan	36.85	31	17,164	16,156	19,473	17,224	17,141	23,621
Feb	36.70	28	15,432	14,528	17,512	16,495	12,865	19,701
Mar	29.84	31	13,679	13,002	15,723	12,560	8,879	15,867
Apr	17.85	30	7,474	7,368	9,014	6,798	5,295	8,379
May	8.61	31	3,135	3,461	4,377	2,667	2,159	3,996
Jun	1.78	30	-249	378	703	510	1,167	1,529
Jul	0.18	31	-1,055	-331	-132	338	340	373
Aug	0.35	31	-967	-251	-37	398	350	792
Sep	5.93	30	1,746	2,184	2,850	517	1,077	1,566
Oct	14.13	30	5,687	5,751	7,092	3,760	4,248	4,894
Nov	26.44	31	11,988	11,473	13,904	10,967	10,710	7,689
Dec	36.39	31	16,931	15,946	19,223	18,718	12,240	13,976
Total		365	90,963	89,665	109,703	90,952	76,471	102,383

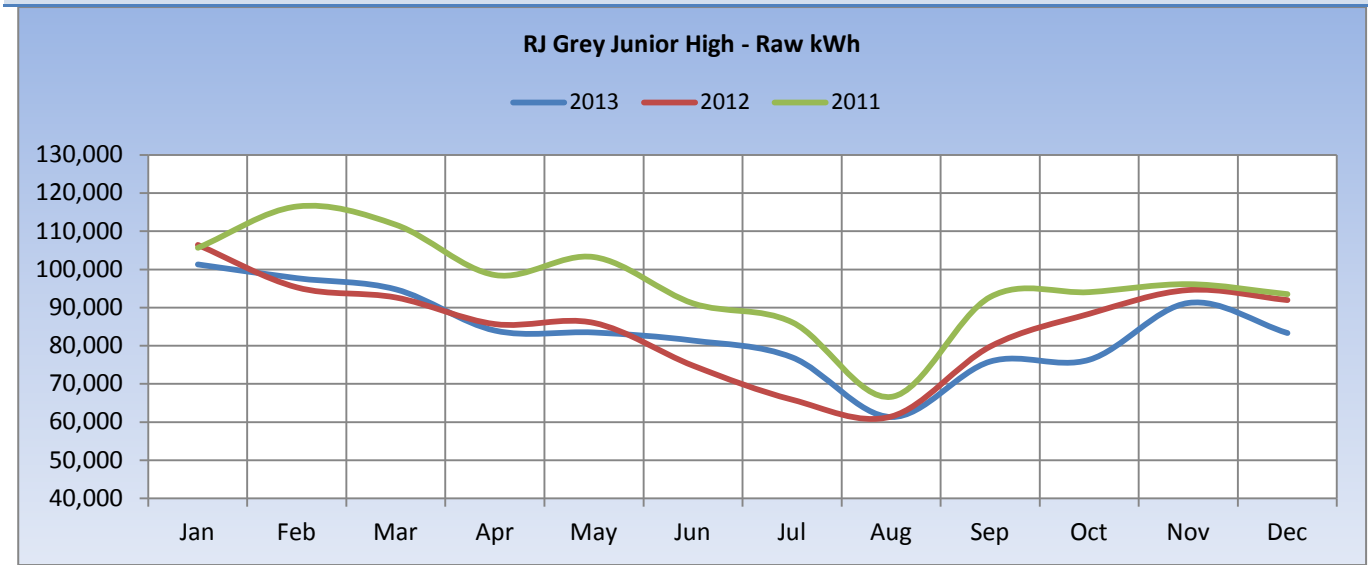


Usage is up 19% over the previous winter due to previously mild winter; after adjusting for heating degree days usage is actually up only 1.5%. A longer view shows gas usage trending upward. Statistical models have R^2 values of 97-8% indicating working controls and a strong weather dependency as would be expected.

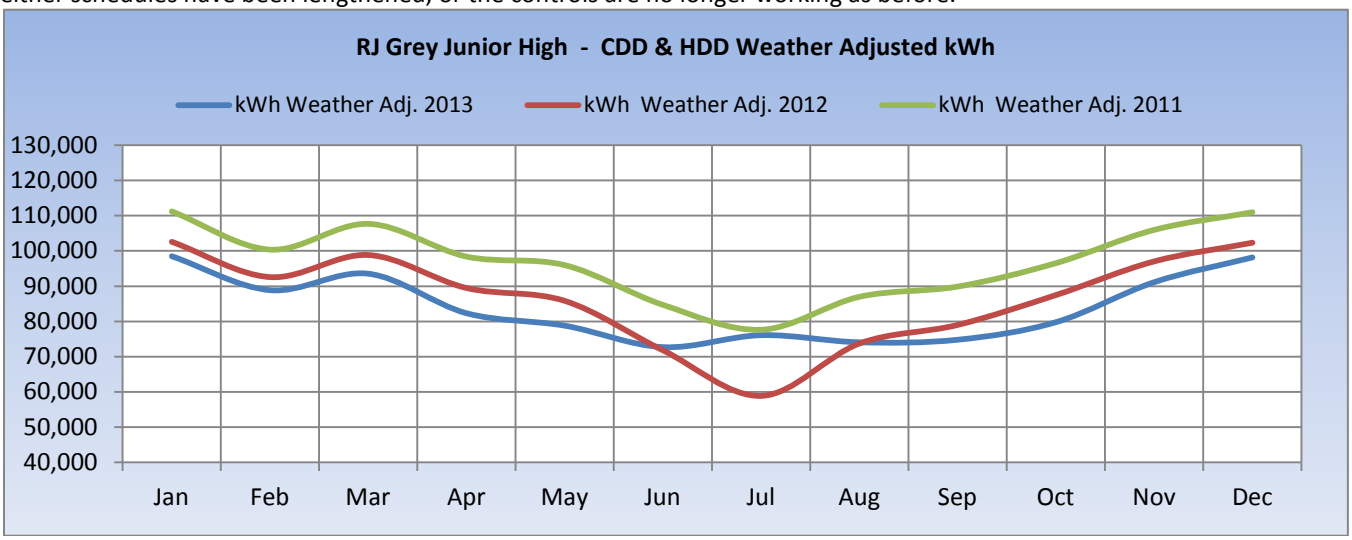


Electric Energy Use – kWh Degree Day Weather Normalized to Most Recent Year

	HDD/day	CDD/day	Weather Adjusted 2013 kWh	Weather Adjusted 2012 kWh	Weather Adjusted 2011 kWh	Raw 2013 kWh	Raw 2012 kWh	Raw 2011 kWh
Jan	36.85	0.00	98,488	102,605	111,205	101,306	106,425	105,650
Feb	36.70	0.00	88,856	92,599	100,371	97,698	95,291	116,475
Mar	29.84	0.00	93,528	98,870	107,685	94,758	92,636	111,678
Apr	17.85	0.00	82,310	89,504	98,390	83,958	85,671	98,509
May	8.61	0.74	78,774	85,855	95,958	83,459	85,977	103,216
Jun	1.78	4.20	72,687	71,828	84,689	81,337	74,766	91,074
Jul	0.18	10.45	76,080	58,910	77,631	76,929	65,857	86,127
Aug	0.35	4.06	74,055	73,775	86,992	61,287	61,445	66,575
Sep	5.93	1.93	74,788	79,039	89,888	75,850	79,799	92,770
Oct	14.13	0.03	79,778	87,515	96,539	76,316	88,372	94,030
Nov	26.44	0.00	91,123	97,058	105,977	91,204	94,599	96,119
Dec	36.39	0.00	98,157	102,356	110,970	83,312	91,960	93,496
			1,008,625	**1,039,914**	**1,166,297**	**1,007,414**	**1,022,798**	**1,155,719**



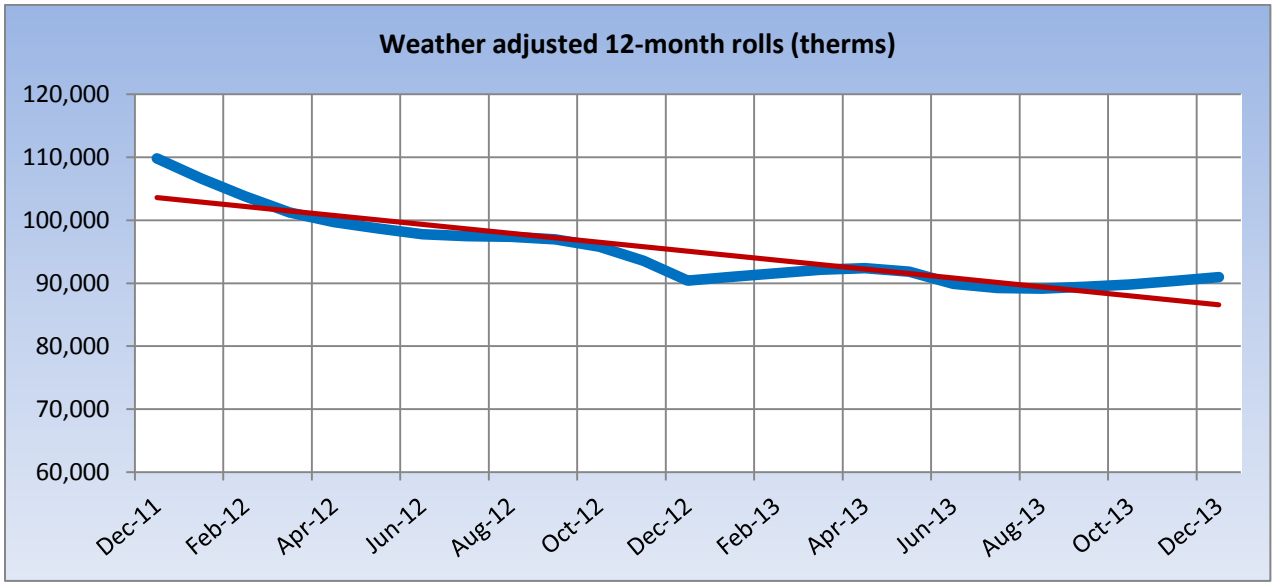
Electricity usage is down 2% over the previous year, even after normalizing for weather. In the past year R-squared (the correlation of the data to the model) has dropped from 95% in the preceding years to 63%. This indicates that either schedules have been lengthened, or the controls are no longer working as before.



HISTORICAL TRENDS

12-month Rolling Average of Gas Use –

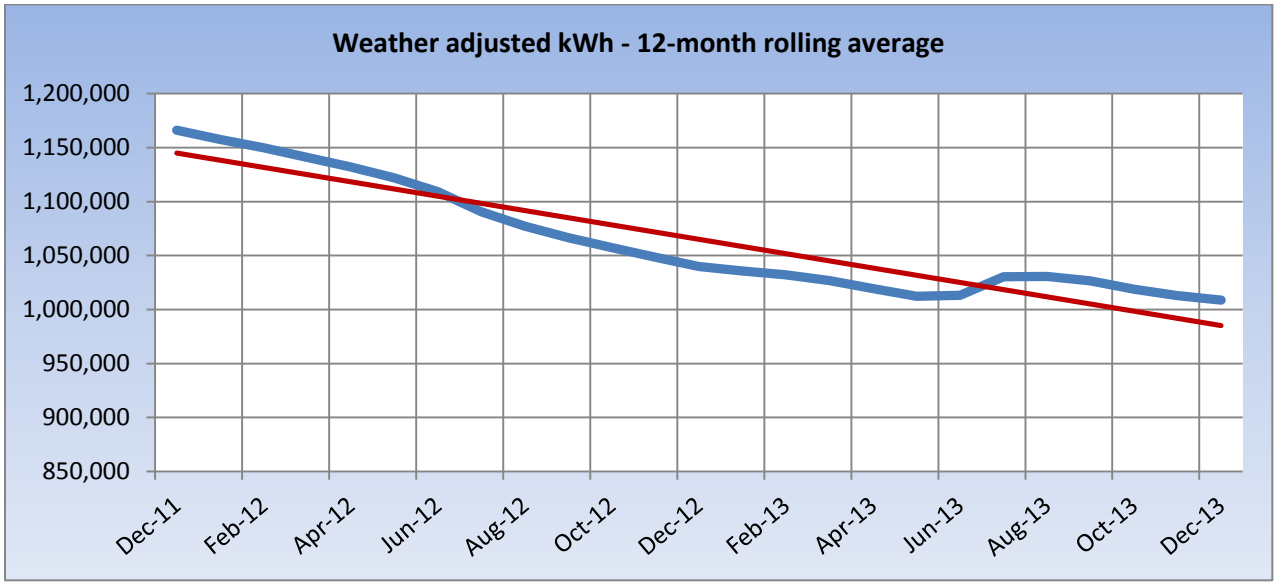
When adjusted for weather variations, the gas usage data shows a welcome downward trend.



Energy Use - Electric kWh

12-month Rolling Average of Electrical Use –

Once again, we see a nice downward trend in usage, showing the cumulative effect of efficiency efforts.



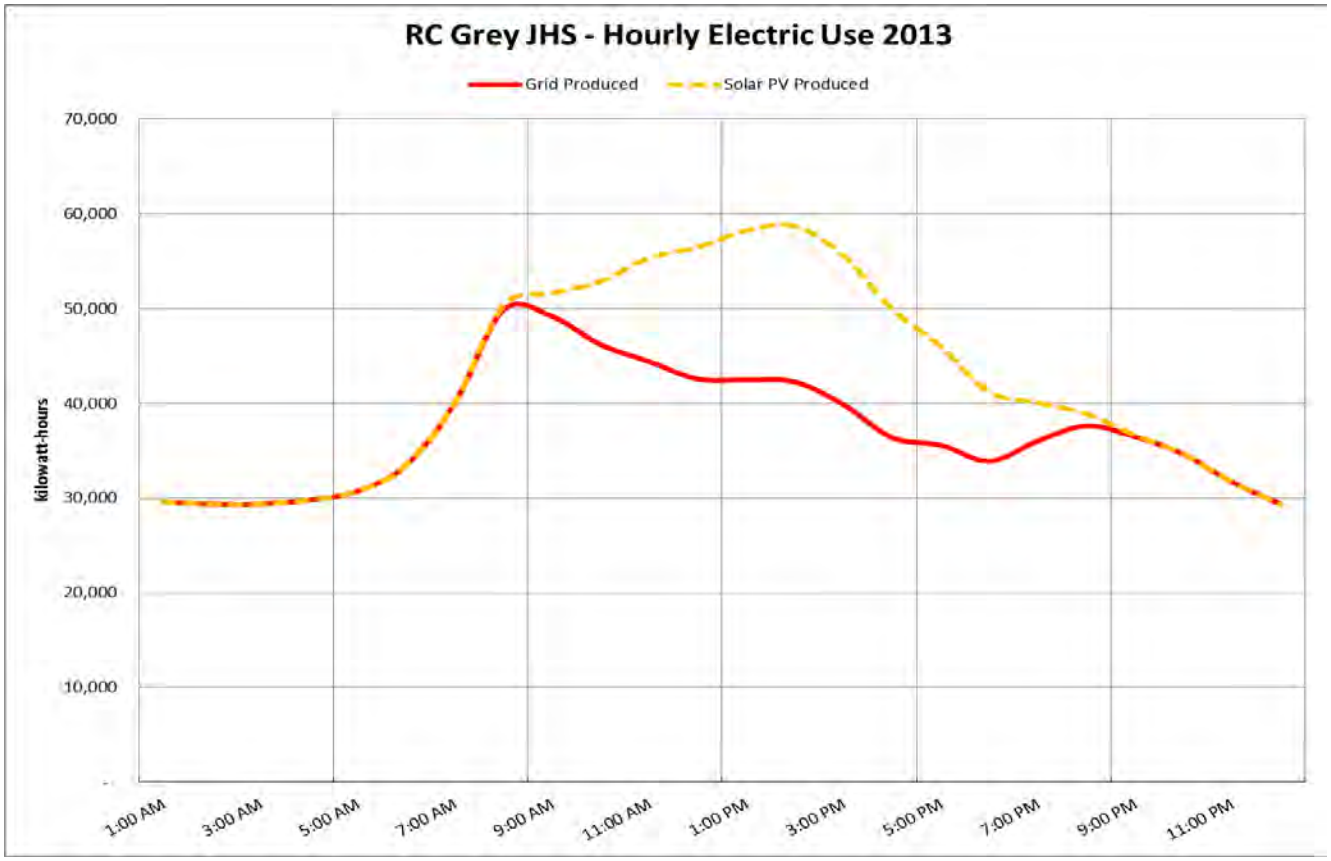
ELECTRIC DISTRIBUTION

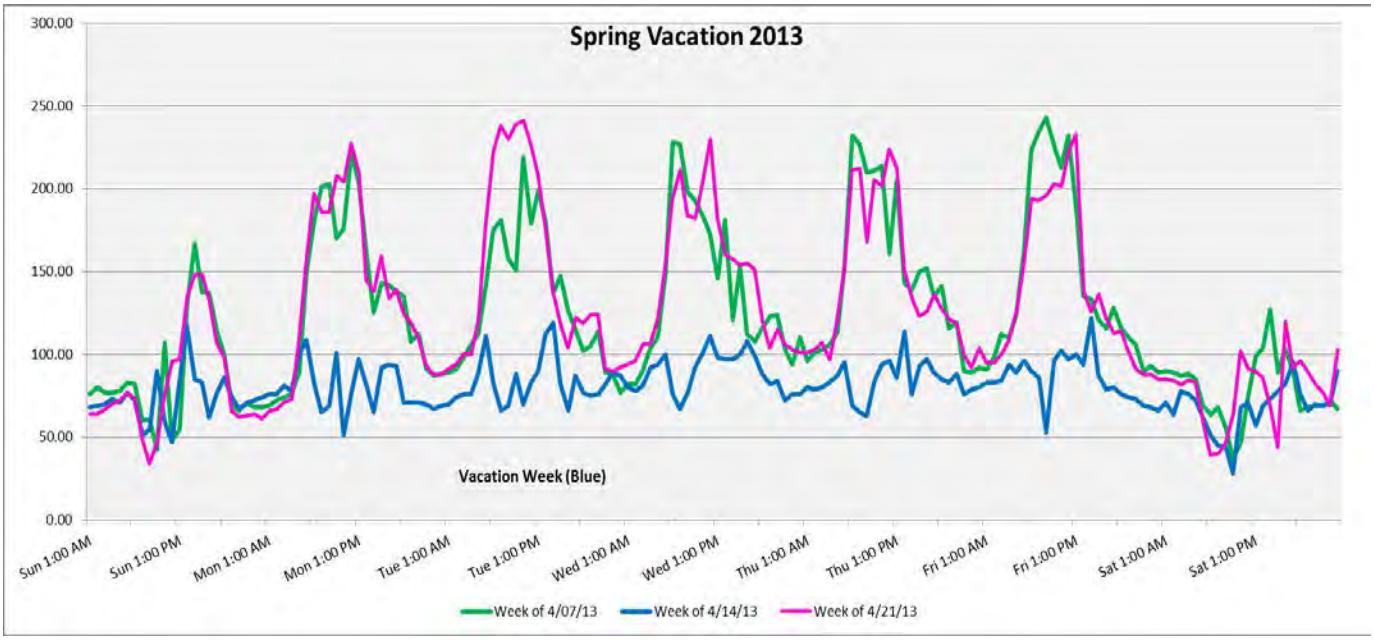
	Average 3AM kW	Peak kW
January 2013	74	321
February	80.0	266
March	68	277
April	60	250
May	44	294
June	43	254
July	42	247
August	21	266
September	41	279
October	42	247
November	55	246
December	63	247
January 2014	68	263

As expected the winter increase in early morning demand (kW) demonstrates the impact of the both hot water heating system pumps and the modular unit's electric heat. The modular unit is responsible for 21kW of the winter demand. It's exciting to see the demand reduction between January 2013 and January 2014, despite the record cold during January 2014. We believe this is a result of the energy efficiency work undertaken by the ABRSD during 2013.

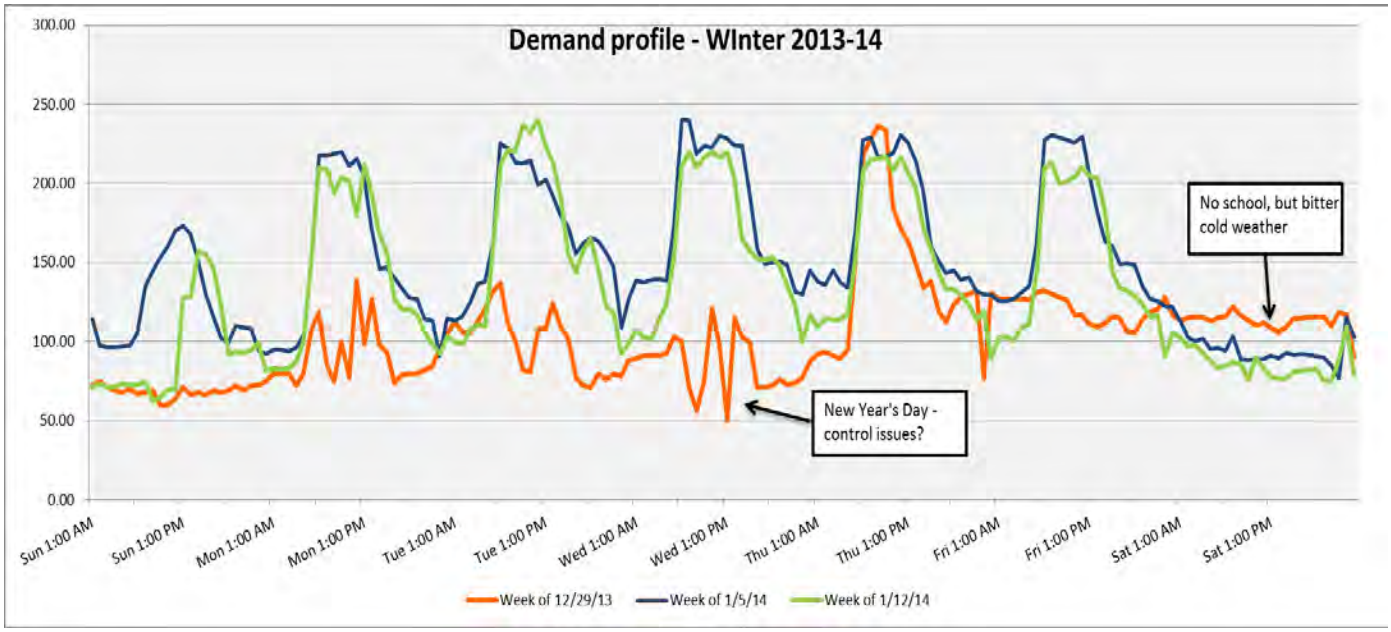
DEMAND KW PROFILES

The electricity production from the solar panels atop the school makes a significant dent in the afternoon peak demand. The chart below shows the average hourly electricity usage. Notice how the electricity usage from the grid drops off in the afternoon as the solar production ramps up.





The demand profiles show that equipment is turned off in the evenings and on Saturdays. Notice the shutoff during the spring (above) and winter (below) breaks. There is still equipment cycling on and off, however. Also notice the impact of record low temperatures just after New Year's 2014. The orange line shows continued high electric demand, over 100 kW, through the weekend.



Benchmarks

The following benchmarking data represents the actual billing data for the twelve months ending December 31, 2013.

Occupied kW	Unoccupied kW	Site Equiv. Therms	kWh/sf	Occ. watt/sf	Unocc. watt/sf	Therm-Equiv. per sf	Site kBTU/sf	Source kBTU/sf	EPA National Ranking
321	81	90,952	7.03	2.24	0.56	0.63	87.5	135.9	37

Unoccupied watts / sf can be reduced by reducing the nighttime fan, pump and electric heating loads. The current energy usage is equivalent to 779 metric tons equivalent of (MTCDE) of carbon dioxide emissions (CO_2e), or 11.98 pounds of CO_2e per square foot.

If the measures recommended in this report are implemented (except EEM9a, 9b - boilers) the anticipated energy metrics for the building will be as follows. If the base measures (no boilers) in this report are funded, then annual metric tons of CO_2e will drop to 653 MTCDE, or 10.04 pounds of CO_2e per SF per year.

Occupied kW	Unoccupied kW	Therms	kWh/sf	Occ. watt/sf	Unocc. watt/sf	Therm-per sf	Site kBTU/sf	Source kBTU/sf	EPA National Ranking
279	61	68,306	5.34	1.95	0.41	0.53	75.8	111.60	60

If a single boiler is installed the ranking increases to a **65** and MTCDE decreases to 614

If two boilers are installed the ranking increases further, and total MTCDE decreases to 584

Note - until recently AHU-2 and AHU-3 ran continuously (24x365). The score will climb 6 points due to this revision; accordingly, a score of **73** is possible.

ENERGY STAR® Benchmarking Initiative

EEM #	Measure Description	Q	Est'd Savings kWh	Est'd Savings therms	Est'd Svgs per Yr	Cost	Simple PB (Years)
	Low Cost / No Cost Energy Efficiency Opportunities						
1	Computer Power Management	225	11,250	0	$798	$3,263	4.1
2	Controls for cold beverage dispensing machines - Vending Misers	1	800	0	$57	$180	3.2
3	High Efficiency Spray Valves for pots & pans	1	0	130	$145	$100	0.7
	Energy Efficiency Opportunities Requiring Capital Outlay						
4	Reprogram 20 hp VFDs for Secondary HW building heating Loop based on 25 deg F differential temperature difference between building supply & return.	1	19,408	-166	$1,192	$1,500	1.3
5	Tie AHU-1 and 26 classroom exhaust fans into BAS / EMS and program off-times. Currently they operate 24x365	1	11,383	8,423	$10,208	$40,000	3.9
6	Convert AHU-1-2-3 from CAV to VAV with CO2 override	3	15,824	0	$1,123	$7,500	6.7
7	Modular Offices - air sealing / winterization	1	7,500	0	$532	$2,000	3.8
8	Modular Offices - install Wife Programmable Thermostat to capture zone setback and 13 Holidays	1	7,117	0	$505	$1,500	3.0
9a	*Install two (2) 3000 MBH Condensing boilers*	*2*	*0*	*12,923*	*$11,537*	*$150,000*	*10.4*
9b	replace one of the existing boilers w/ 3000 MBH condensing boiler	1	0	7,323	$8,172	$89,756	11.0
10	Lighting Upgrades to Corridors	16.1	77,590	0	$9,365	$51,079	5.5
11	Lighting Upgrades to Auditorium	8.6	17,400	0	$3,285	$13,088	4.0
12	Lighting Upgrades to Gymnasium	1.1	16,200	0	$1,414	$6,103	4.3
13	Lighting Upgrades to Classrooms & Offices	15.8	58,100	0	$6,207	$34,107	5.5
	TOTALS FOR ALL MEASURES excluding 9a		**242,572**	**15,710**	**$43,002**	**$250,174**	**5.8**
			24%	**17%**			
	TOTALS FOR ALL MEASURES excluding 9a & 9b		**242,572**	**8,387**	**$34,829**	**$160,418**	**4.6**
			24%	**9%**			

NSTAR Electric, National Grid Gas and Energy Management Associates, Inc. (EMA) neither has control of, nor assumes control of the actual building processes, equipment operation or climatic conditions. Additionally, EMA does not expressly or implicitly warrant or represent that EMA's energy and cost estimates of the building or equipment operation will be the actual operation energy and cost. Incentive rebates are estimates, and should be finalized by issuance of a commitment letter for customer measure prior to proceeding with retrofits.

RECOMMENDATIONS

LOW COST/NO COST ENERGY EFFICIENCY OPPORTUNITIES

EEM-1 Control Power Management

Computer energy use can be controlled through a combination of automatic power management features and manual shut down by users. Organizations can use a standardized setting so that all monitors go into sleep mode after 10 minutes of inactivity. Power management can also be enabled for computer hard drives, but may require some investigation and testing before full implementation. Savings calculations in this report are based on 50 kWh saved per PC**.** There are no costs to implement the power management, other than in-house efforts. Insist on 80% or greater energy efficient power supplies and visit www.80plus.org. Additional information is available on the ENERGY STAR website at www.energystar.gov/powermanagement. Some firms have found that some software is disabled by antivirus programs; it has been reported that NightWatchman® does not have this issue: http://www.1e.com/softwareproducts/nightwatchman/index.aspx.

► ***Action Steps:*** *Work with School or Town IT staff to adjust power management settings.*

EEM-2 Install Controls on Vending Snack and Beverage Machines

We include this measure, even though this building may not have a cold-beverage vending machine in case it may apply to other buildings. Vending machines and refrigerated beverage coolers typically consume energy 24 hours per day, in the form of lights and refrigeration. Energy savings can be achieved by installing an occupancy-based controller that will turn the lights off and reduce the compressor runtime when the area is unoccupied. Savings calculations for this are based on 800 kWh savings per cold beverage machine. NSTAR offers rebate-incentive of $115 for each cold beverage vending machine, and $45 for a snack machine vending-miser. To qualify for the rebate, a vending machine sensor must be installed on a unit located indoors and scheduled to remain in NSTAR's territory for a minimum of three years. A single unit can be used to control a bank of vending machines for additional savings at no additional cost; however circuit breaker capacity should be verified first. The most popular controllers are the Energy Miser series from USA Technologies (www.usatech.com/energy_management).

► **Action Steps:** *Purchase Vending Miser directly or work with an NSTAR Preferred Provider to install the device. The Utility Program Manager or Preferred Provider for the facility is able to provide assistance with obtaining financial incentives***.**

EEM-3 High Efficiency Spray valves for kitchen pot washing

Kitchen pots, pans and dishes can be cleaned more efficiently with high efficiency nozzles, which deliver the same pot-washing effectiveness while using less hot water. They save approximately 0.5 therm per hour of use.

► ***Action Steps*****:** *A spray valve can cost around $100, and there is a Mass Save incentive of $100.*

ENERGY EFFICIENCY OPPORTUNITIES REQUIRING CAPITAL OUTLAY

EEM-4 Reprogram Heating Loop VFDs

The 20 HP variable frequency drives (VFD's) on the secondary hot water heating loop are not functioning properly (one is inoperable) and are not varying the hot water flow due to abandoned 2-way modulating valves, and are thus not contributing any energy savings. We recommend that the operable VFD be re-programmed to vary the hot water flow based on a 25°F differential between the building supply and return temperatures.

EEM-5 Tie 26 Classroom Exhaust Fans and AHU-1 into EMS

Currently, 26 classrooms exhaust fans run continuously. These classroom exhaust fans, along with AHU-1 and its associated exhaust fan should be tied into the EMS. Turning off these units each evening will provide significant ventilation and fan motor savings. Because the classroom fans are so small, we propose to control those fans by ganged circuits, rather than by individual fan unit. This is much more cost-effective and does not affect savings much. Until recently AHU-2 and AHU-3 fan systems ran continuously.

► ***Action Item:*** *Obtain turnkey quote from qualified control vendors, and work with NSTAR Electric and National Grid custom incentives*

EEM-6 Convert AHU's 1, 2 and 3 from CAV to VAV

Constant volume ventilation systems (CAV), like AHU's 1, 2 and 3 in the gym spaces, provide the same airflow regardless of heating or ventilation requirements. Installing a VFD and converting these units to variable air volume (VAV) systems will produce significant electric fan motor savings. Airflow can automatically be reduced when space heating loads, and increase as the loads increase. In this case, it is "pure" temperature-dependent VAV operation because no VAV boxes and no minimum static pressure set points are required. There are large fan power savings according to the Affinity (cubic[1]) law, i.e. at 50% flow you will save ~85% power, less VFD & motor losses. EMA recommends maintaining no less than 25% (15 Hz) fan speed. Each of these three air handling units has a 3 HP supply fan motor. The airflow should vary in order to achieve space temperature set-point only after the unit is delivering maximum required heating output. The EMS contractor should become familiar with the operation of the RTU to ensure that all components control in a manner consistent with the above energy strategy, and economizer controls.

[1] *The cubic relationship is valid when we take into account power necessary to overcome inertia in order to initiate flow*

► ***Action Item:*** *Obtain turnkey quote from a controls vendor, and work with NSTAR to obtain electric incentives.*

EEM-7 Air-Seal Modular Office Unit

Although the modular office unit is considered to be temporary, "temporary" structures tend to stay in use far longer than originally intended. Inefficiencies in the buildings are long-lasting and, because of the electric heat, costly. As the infrared photos in the Appendix indicate, the modular office unit is suffering from air leakage and is not well insulated. Although increasing the building's overall insulation is not an economical option, air sealing is cost-effective. This will plug the major channels where infiltration occurs, such as at the soffits and can address large gaps in the wall insulation.

► ***Action Item:*** *Obtain turnkey quote from qualified control vendors, and work with NSTAR Electric and custom incentives*

EEM-8 Install Wi-Fi Programmable Thermostat for Modular Office Unit

Although the modular unit currently has a programmable thermostat for its air-source heat pump, the electric resistance heat remains on manual control. An internet-managed and/or wireless control system offers far more power than a standard programmable thermostat. Look for a model that can control both the electric baseboard heat and the 2-stage heat pump (heat and AC). Two separate units will probably be needed, although but the controls can be grouped so that programming can be done for multiple units. This way school schedules – including holidays and special events - can easily be programmed far in advance. Most controls of this type can be installed in place of existing thermostats and connected to the school's internet connection either wirelessly or via a cable. A minimal amount of programming may also be required. Savings come from additional perimeter heat savings (zone setback) and holiday programming.

- ***Action Item*** *Obtain turnkey quotes from qualified vendors. Work with Mass Save prescriptive or custom incentives.*

EEM-9b Install 3000 MBH Condensing Boiler

We recommend adding a 3000 MBH high efficiency condensing boiler in order to provide energy savings and system redundancy, i.e., one boiler cannot handle design conditions. The new boiler would serve as the lead boiler while one of the older boilers would be needed on colder days. The condensing boiler can provide seasonal efficiencies of 86% and with low return water temperatures upwards of 93% efficiency.

- ***Action Item:*** *Firm-up sizing requirements and obtain turnkey quotes from qualified vendors. Work with Mass Save prescriptive or custom incentives*

EEM-10 Energy Efficient Lighting: Corridors

The corridor lighting consists of compact fluorescent downlights – most of which also serve as night and emergency lighting, fluorescent strip fixtures mounted in coves at the top of walls and in the dome, and locker-mounted fixtures in the C, D and E wings that shine upward and illuminate the ceilings. We recommend converting the recessed downlights ("cans") to LEDs with a retrofit or replacement fixtures. The fluorescent cove lighting can be replaced with LED strips which are optimized to project their light upward and outward along the ceiling. The locker-mounted fixtures provide very poor ambient lighting. They should be replaced with a new layout of recessed fixtures down the center of the corridor. Initial calculations show that 2-lamp T8 "volumetric" fixtures on a 10-foot spacing will increase light levels by 50 percent. Relocating the fixtures to the center of the corridors is contingent upon there being enough space above the ceiling to mount fixtures and run circuits. We also recommend installing occupancy sensors in the corridors to shut-off the non-emergency fixtures during low-vacancy periods. The fixtures in the main lobby dome area should also have a photocell control installed, in order to take advantage of the ample daylight in the space.

- ***Action Items***: *Work with NSTAR's vendors to develop custom lighting solutions*

EEM-11 Energy Efficient Lighting: Auditorium

The Auditorium's 500 Watt incandescent house lights also provide general illumination for the space. EMA was told that full theatrical dimming is not required for the Junior High School. We recommend that the incandescent house lights be replaced with an LED fixture. Some experimentation may be necessary in order to find the best replacement. If absolutely necessary, some of the incandescent fixtures can be left "as-is", with full dimming, but separated from the general ambient lighting circuit. The fluorescent backstage and house lighting fixtures should also be retrofitted with 28 Watt T8 lamps and low-power electronic ballasts. Currently, it's difficult to just turn a small portion of the lighting. The lighting controls should also be modified and split out so that not all house lights come up at once. This will reduce the phenomenon of having the lights left on behind the locked auditorium doors.

- ***Action Items***: *Work with NSTAR's vendors to develop custom lighting solutions*

EEM-12 Energy Efficient Lighting: Gymnasium

When the gymnasium lighting was converted from metal halide to induction lighting, certain work could not be installed due to field conditions. We recommend that the remaining six metal halide fixtures be converted to induction. Although the induction fixtures cannot be directly fitted with individual occupancy sensors, due to their protective cages, occupancy sensors should be installed to control the lights. Occupancy sensors can be installed on their ceiling and used to control groups of fixtures.

- ***Action Items***: *Work with NSTAR's vendors to develop custom lighting solutions*

EEM-13 Energy Efficient Lighting: Classrooms and Offices

The classroom and office fixtures are generally in good condition. We recommend retrofitting the fixtures with low-power electronic ballasts and 28 Watt T8 lamps. Because the original fixtures are beginning to reach an age where ballast failures will become more frequent, this work could also provide an offset to future maintenance expenses. We also evaluated using a retrofit kit to produce a more even, "volumetric" lighting effect, but the economics were less favorable. LED (light-emitting diode) lighting technology has a payback in excess of ten years, after incentives.

- ***Action Items***: *Work with NSTAR's vendors to develop custom lighting solutions*

NEXT STEPS

The ENERGY STAR Benchmarking Initiative provides ongoing support as customers work toward implementing the recommended improvements. EMA will review the recommendations in this report with the appropriate contact at the facility, and help them develop an action plan. For recommendations that are eligible for NSTAR incentive funding, the NSTAR Program Manager for this facility can provide assistance with locating implementation contractors and obtaining financial incentives. For the remaining measures, EMA will provide implementation support.

Please call one of the following contacts with any questions:

NSTAR Electric
Program Manager
Steve Grattan
781.441.8243
steven.grattan@nstar.com

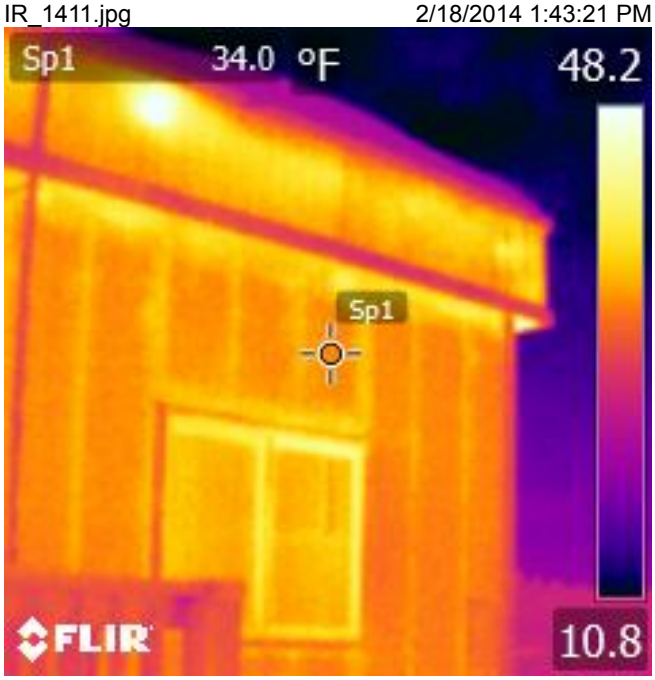
NSTAR Electric
Account Executive – Strategic Accounts
Mark Rooney
339.987.7826
mark.rooney@nstar.com

EMA – Energy Management Assoc., Inc.
Principal Commissioning &Energy Engineer
Steve Di Giacomo, PE, CEM, CPMP
508.533.1128
steve@EMA-Boston.com

National Grid Gas
Technical Support Energy Efficiency Consultant
Jose' Veiga, CBCP, CEP
781.907.2254
jose.veiga@nationalgrid.com

Appendix

IR_1411.jpg 2/18/2014 1:43:21 PM



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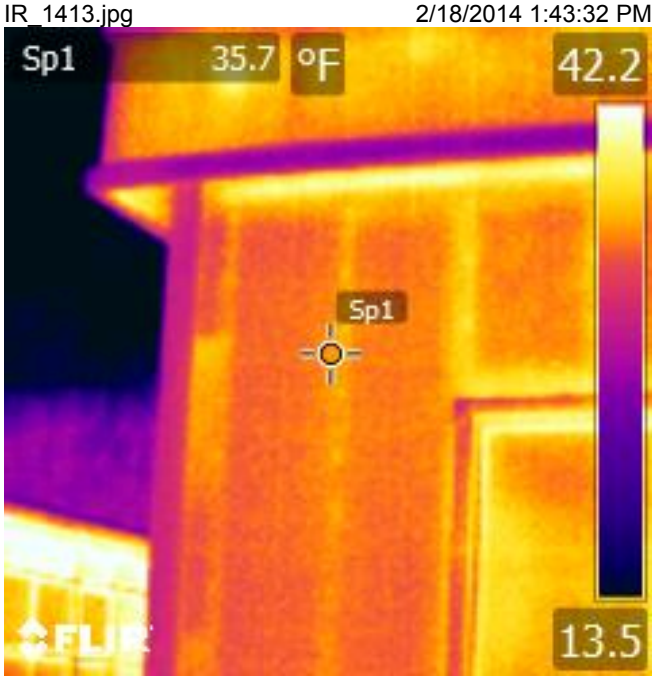

Above: Exterior views of Southwest (left) and Northeast (right) facades. Notice thermal transmission via wall studs and heat loss through soffit.

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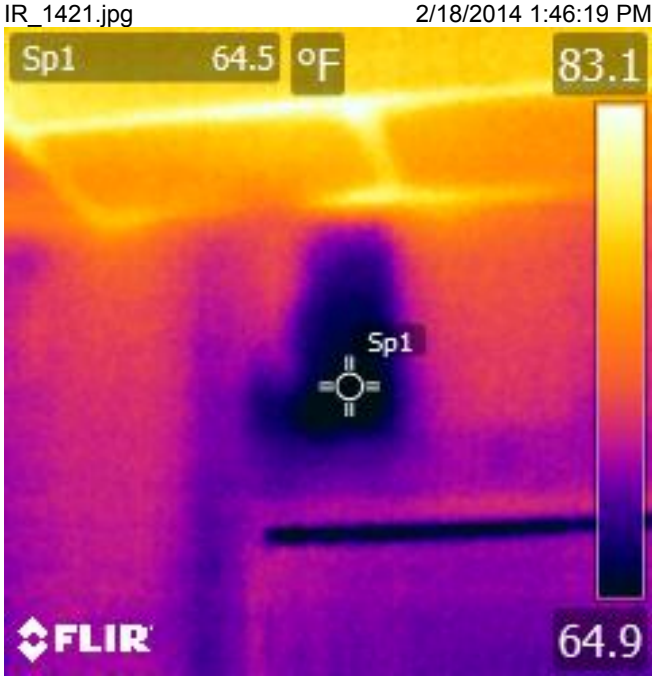

Southwest side: Deterioration and gaps in exterior wall insulation, as viewed from inside

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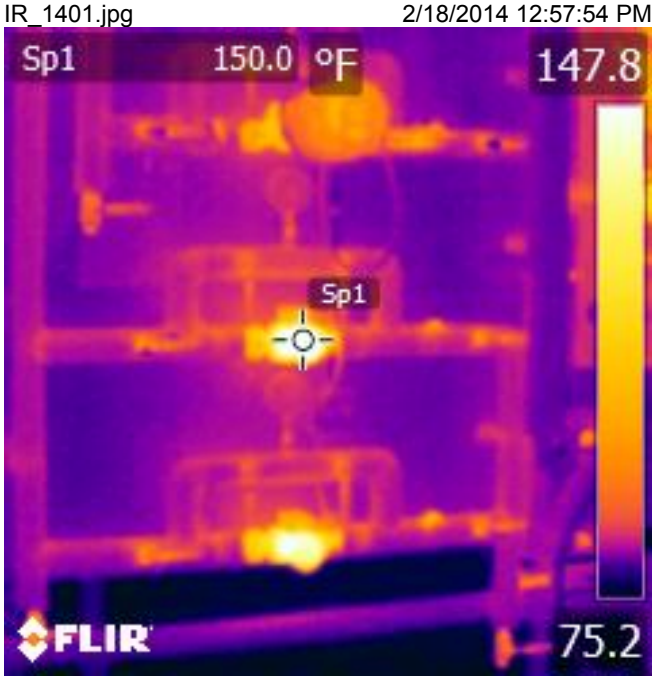

Domestic hot water pumping/ distribution board. High-temp HW circulator is at 150 degrees

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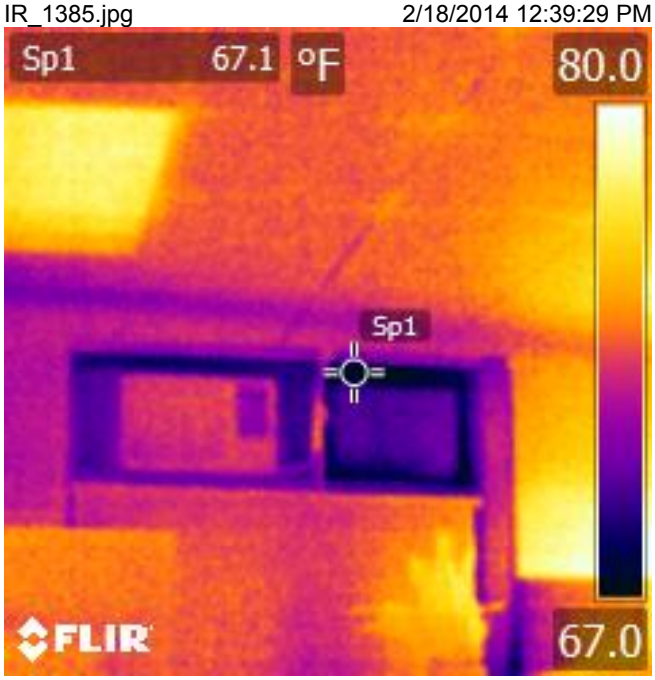
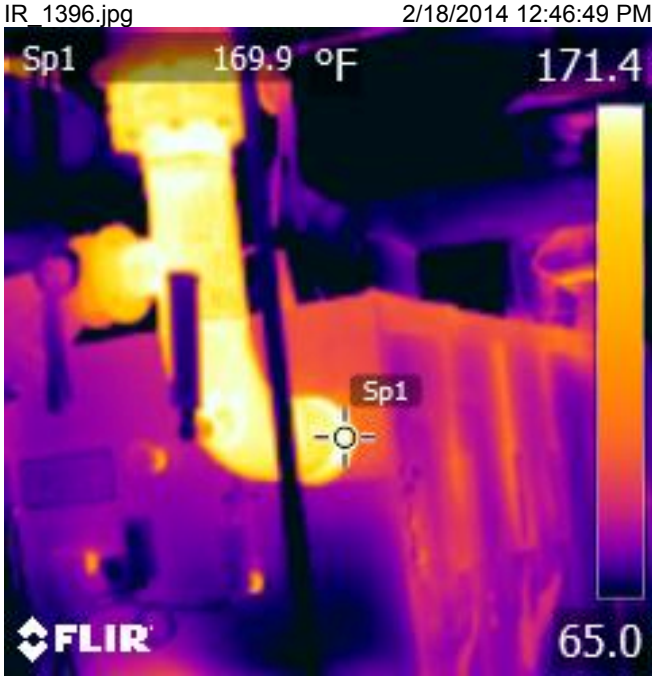


East side administrative offices. Surprisingly little cold air infiltration from window-mount AC unit. Less than a 5 degree difference between unit and wall temperatures

IR_1396.jpg 2/18/2014 12:46:49 PM



Boiler, showing that with the exception of the flue, pipes are well insulated. Notice that boiler sections are visible as warm vertical stripes.

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Water temperature at kitchen sink - 127 degrees!

ENERGY STAR® Statement of Energy Performance

37

ENERGY STAR® Score[1]

Acton RJ Grey Junior High

Primary Property Function: K-12 School
Gross Floor Area (ft²): 143,280
Built: 1955

For Year Ending: December 31, 2013
Date Generated: February 25, 2014

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Acton RJ Grey Junior High 16 Charter Rd Acton, Massachusetts 01720	_____ , (____)____-_____	____ _____ , (____)____-_____ _____

Property ID: 3960141

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
87.5 kBtu/ft²

Source EUI
135.9 kBtu/ft²

Annual Energy by Fuel	
Electric - Grid (kBtu)	3,031,480 (24%)
Natural Gas (kBtu)	9,095,200 (73%)
Electric - Solar (kBtu)	405,813 (3%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	78.5
National Median Source EUI (kBtu/ft²)	122
% Diff from National Median Source EUI	11%
Annual Emissions	
Greenhouse Gas Emissions (MtCO2e/year)	779

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: _____Date: _____

Licensed Professional

____ _____
,
(____)____-_____
_____

Professional Engineer Stamp
(if applicable)

ENERGY STAR® Statement of Energy Performance

60

ENERGY STAR® Score[1]

Acton RJ Grey Junior High

Primary Property Function: K-12 School
Gross Floor Area (ft²): 143,280
Built: 1955

For Year Ending: December 31, 2013
Date Generated: March 13, 2014

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Acton RJ Grey Junior High 16 Charter Rd Acton, Massachusetts 01720	_____ , (____)____-_____	____ _____ , (____)____-_____ _____

Property ID: 3960141

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
75.8 kBtu/ft²

Source EUI
111.6 kBtu/ft²

Annual Energy by Fuel	
Electric - Solar (kBtu)	405,813 (4%)
Natural Gas (kBtu)	8,256,500 (76%)
Electric - Grid (kBtu)	2,203,824 (20%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	82.9
National Median Source EUI (kBtu/ft²)	122
% Diff from National Median Source EUI	-9%
Annual Emissions	
Greenhouse Gas Emissions (MtCO2e/year)	653

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: _____Date: _____

Licensed Professional

____ _____
,
(____)____-_____
_____

Professional Engineer Stamp
(if applicable)

ENERGY STAR® Statement of Energy Performance

65

ENERGY STAR® Score[1]

Acton RJ Grey Junior High

Primary Property Function: K-12 School
Gross Floor Area (ft²): 143,280
Built: 1955

For Year Ending: December 31, 2013
Date Generated: March 13, 2014

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Acton RJ Grey Junior High 16 Charter Rd Acton, Massachusetts 01720	_____ , (____)____-_____	____ _____ , (____)____-_____ _____

Property ID: 3960141

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
70.7 kBtu/ft²

Source EUI
106.3 kBtu/ft²

Annual Energy by Fuel	
Electric - Solar (kBtu)	405,813 (4%)
Natural Gas (kBtu)	7,524,200 (74%)
Electric - Grid (kBtu)	2,203,824 (22%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	81.2
National Median Source EUI (kBtu/ft²)	122
% Diff from National Median Source EUI	-13%
Annual Emissions	
Greenhouse Gas Emissions (MtCO2e/year)	614

Signature & Stamp of Verifying Professional

I _____ (Name) verify that the above information is true and correct to the best of my knowledge.

Signature: _____Date: _____

Licensed Professional

____ _____
,
(____)____-_____
_____

Professional Engineer Stamp
(if applicable)