Town of Harvard Energy Advisory Committee

Meeting Minutes 9/9/2020

Attendees: B. Smith, D. Fay, F. Hodgkins, E. Sachs-Leicher, Peter Kelly-Joseph
John Snell (MRPC Consultant)

Location: **This Meeting was held virtually in accordance with the Governor's Executive Order Suspending Certain Provisions of the Open Meeting Law, G.L.c.30A. S.20.; Zoom Meeting ID: 881 7096 3252**

	Meeting Discussion/Status
Admin	**1. The minutes of 8/26/2020 were approved 4-0 (Smith, Fay, Hodgkins, Sachs-Leicher)**
Schools	1. HES Existing Solar Panels ~6kW – Need a site that is feasible to accept the panels. - No update 2. Charging Station – The HES Building project scope includes the infrastructure but not the dual charging station. Brian is working with Horizon Solutions.- **Brian received a list of questions from Horizon for the HES project team.** 3. HES Solar ~245 kW Behind the Meter project earliest June 2021– Energy Power Purchase Agreement (PPA) proposal from Solect Energy. PILOT and Lease required. a. Interconnect Application – denied by National Grid **to Solect Energy**. The Ayer substation requires upgrade in 4-5 years. Solect requesting a written response from NGRID. Solect says to apply to DOER for an award incentive without an I/C approved. HEAC discussed other ways to push NGRID to make this a priority. b. **Meeting scheduled for 9/17 by NGRID to present list of upgrades to the entire system.** c. **David to report to the School Building Committee on 9/17.**
Town Energy Project Updates	1. GC Projects – 2019 Competitive Grants – awarded 9/3/19. a. Reporting – **Final grant report overdue to DOER.** b. Need ideas for GC2020 application – TBS Economizer, battery storage, sewer plant and DPW opportunities were mentioned. School Insulation – Brian discussed with RISE Eng and was referred to NGRID. Brian to create a separate list and assign owners. Brian review Police Station lighting (5 lights). **Determine opportunities based on Energy Review report discussed during this meeting.** c. Annual Town Building Energy Reviews **– Pete Jackson will attend Oct meeting for an Energy Review of the Library**
Subcommittees/ Initiatives	**1.** Community Resiliency Working group CRWG (Chair Peter Kelly-Joseph) a. Consultant KLA is to complete the Climate Action Plan (CAP) by September. Focus on Agriculture/Forestry- a survey of Agricultural lands was completed in mid-May. KLA working on a greenhouse gas inventory and will refer to the MEI energy use data. There is also an effort on outreach and education for the CAP; **KLA to issue a CAP Framework by 9/30/20.** b. MVP Phase 2 – Resilience / Agriculture Branding – outreach is in process and survey pending. c. MVP Phase 3 – Planning phase for Energy Module – this may involve a battery storage system. **2.** Energy Policy Subcommittee (Chair Paul Green)– They are reviewing examples of towns using bylaws for new construction prohibiting fossil fuel use. The

Town of Harvard Energy Advisory Committee

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	committee should establish an achievable emissions goal or similar as part of the initial effort. (80% reduction by 2050 MA goal or similar) Some towns are going beyond their legal right; Chris Ryan reported about other towns that are creating zoning provisions to encourage renewables and reduce GHG emissions. Paul will talk to Chris Ryan. – **No update** **3.** MRPC grant project review- John Snell has been contracted by MRPC on 6/29 under a DOER grant to perform Energy Analysis and Evaluation for the Town of Harvard to complete by Oct 2020. a. **Objective is to reach 20% energy reduction goal. Focus on top 3 building energy users – Schools and Library.** b. **Final Report Review - Overall John Snell reported that in order to make significant reductions in energy use, there needs to be significant investment. One example at Bromfield could be moving to smaller distributed heat pumps. Another example is that one rooftop unit is responsible for a large majority of the energy use at the Library – this could be replaced with a heat pump. The report details suggestions for a long-term plan to analyze and reduce energy use.** c. Integrate with Climate Action Plan. Recommend Town Energy Plan. **4.** Master Plan Status Residential Energy Conservation Forum – to be considered in the FY21 plans.
	Meeting adjourned 9:05 pm
Future Meetings	2020 Oct 14, Nov 11, Dec 9 HEAC Meeting Location/Time: Volunteer Government Room, Town Hall 8 pm. – Virtual until further notice

Green Communities Program Review Town of Harvard

September 8, 2020 Final Draft for Review

Prepared for:

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Executive Summary

The Massachusetts Green Communities Designation and Grant Program, administered by the Department of Energy Resources (DOER), supports cities and towns in improving their energy efficiency, with a goal of reducing municipal energy use by 20% in five years. Because the majority of communities that were designated at least five years ago have not yet met their energy reduction goal, DOER initiated this program review with a sample of eight communities around the state.

Since its designation as a Green Community in 2010, the Town of Harvard has actively participated in the program and received $533,393 in grants to implement many energy conservation measures (ECMs). In 2019, reported usage savings compared to the baseline year of 2009 was 7%.

MRPC's energy consultant John Snell met with municipal staff and reviewed energy data, Green Communities reporting documents, and current project plans to assess current energy efficiency efforts in Harvard and provide guidance to the town in working toward its energy reduction goal.

Following are four key findings:

- Three buildings, Bromfield School, Hildreth School, and the new Library represent 70% of Harvard's total municipal energy use.
- The original savings estimates in Harvard's original EAP for the Hildreth and Bromfield schools were optimistic. Achieving DOER's 20% energy savings target for Harvard will require a significant capital outlay by Harvard.
- High efficiency electric heating system replacement at the New Library and Bromfield School offer the most cost-effective solution to achieve DOER's 20% energy savings and Massachusetts Global Warming Solutions Act (GWSA) carbon reduction targets.
- Harvard's Community Resilience Working Group (CRWG) should include an energy component to its Climate Action Plan for the town (municipal and non-municipal) that aligns with the state's GWSA.

Commented [B1]: There is a current effort by a consultant to produce a Climate Action Plan. Is this the same thing? If not why is it part of the Community Resilience Working Group?

1. Introduction

Green Communities Designation and Grant Program

The Massachusetts Green Communities Designation and Grant Program, administered by the Department of Energy Resources (DOER), provides financial and technical support to cities and towns that develop a plan to reduce municipal energy use by 20% over five years and meet four other criteria established in the Green Communities Act. Since 2010, 240 of the 351 cities and towns across the Commonwealth have achieved designation status. Many communities have significantly improved their energy efficiency, including several that have reduced energy use by 20% or more, but very few of the communities that were designated at least five years ago have met their energy reduction goal.

About this Program Review

This report is intended to help Harvard assess its energy reduction activities to date and provide recommendations to advance progress toward the town's energy reduction goal. Our review consisted of three primary components:

1. **Data review –** We reviewed the town's Green Communities annual report and data tracked in the web-based tool MassEnergyInsight (MEI), and investigated any discrepancies that might result in an inaccurate measure of the town's baseline energy use or its progress towards the energy reduction goal.
2. **Priority building review –** Buildings are typically where cities and towns use most of their energy, and there are often a few buildings that together account for the majority of building energy use. With this in mind, this project focused on Harvard's three largest energy users, Bromfield High School, Hildreth Elementary School, and the New Library. These buildings represent 85% of the total energy use in Harvard's facilities. Through communications with municipal staff, review of building information and project records, and analysis of energy data, we worked to determine major drivers of energy use in each of these buildings, assess the success of energy conservation measures (ECMs) implemented to date, and identify opportunities for additional ECMs.
3. **Process review –** We considered the management of energy efficiency efforts in Harvard, including how the town fulfills Green Communities program requirements, tracks energy data, identifies new ECMs, and engages staff and stakeholders.

Green Communities Building Energy Analysis Tool

Accompanying this report is the Green Communities Building Energy Analysis Tool, an Excel-based tool that was developed to help communities track progress in reducing energy use in targeted facilities. Using data downloaded from MEI, the tool generates summary tables and graphs that display key information about the town's energy use. For each of the priority buildings considered in this review, the tool has a tab with basic building information, a table

tracking ECMs and other energy-related changes implemented each year alongside the annual energy use, and a graph of annual energy use and heating and cooling degree days (an indicator of the heating and cooling loads each year, based on historical weather data).

Tracking this information together can be valuable in understanding building energy use, changes over time, and the projected and actual impact of ECMs in relation to total building energy. It can also serve as a valuable repository of information, especially when new staff are hired. We encourage your community to continue to use this tool and take the following steps to update it after the completion of each fiscal year:

- Look up the heating and cooling degree days for the past year and enter them in the Program Years & Weather Data table on the Start Here tab
- Download updated data from MEI (including all years from your baseline through the most recently completed), paste over the existing data on the Data Input tab, and press the button to generate updated summary tables and graphs
- Copy updated energy use for each priority building from the All Building Data tab and paste onto the building-specific tab
- On each building-specific tab, make any appropriate changes or additions to basic information, planned or implemented ECMs (those supported by Green Communities grants as well as other funding sources), other changes (building stock, occupancy or operation, other major projects or new equipment), and observations, or recommendations
- If you would like to track details for other facilities, create additional building-specific tabs using the button on the Start Here tab Detailed instructions are provided on the tool's Start Here tab.

Please contact Lauren Mattison from the UMass Clean Energy Extension at ag.umass.edu/clean-energy or 413-545-8510 with any questions or feedback regarding the tool.

Commented [B2]: How does this integrate with the Green Community Annual Report update?

Commented [3R2]: Brian, the tool does not integrate with the Annual report update. If I understand the tool's purpose correctly, the spreadsheet file is designed to be a central depository of information that can be used (or not) to help flesh out the annual report update.

Commented [B4]: Is this data in MEI and if not is it different?

Commented [5R4]: No, this weather data is not in MEI. MEI uses daily average temperature to calculate normalized weather adjustments. The tool includes a link to US EPA's utility data website that has heating and cooling degree days.

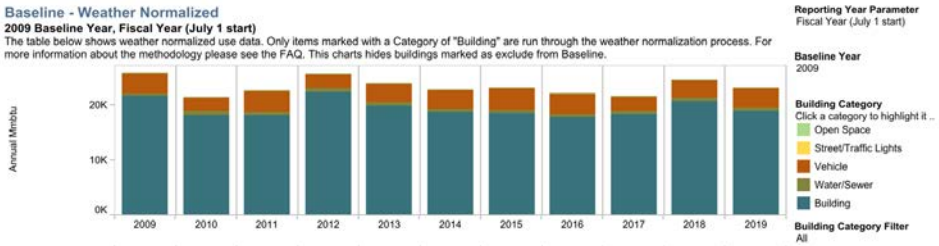
2. Overview of Municipal Energy Use

In 2008, Harvard established the Harvard Energy Advisory Committee (HEAC). In 2010, Harvard was one of the first communities to be designated a Green Community. The town selected fiscal year (FY)[1] 2009 as its baseline year. Total municipal energy use in 2009 was 24,738 MMBtu[2] or 25,890 MMBtu if the energy use is weather normalized[3]. Weather normalized energy use in 2019 was 23,179 MMBtu or 7% below the weather normalized 2009 baseline energy use. The target energy use reduction is 20%.

Please note that Figure 1 and the rest of the figures in this report do not include energy use for 2020. Energy use for 2020 is an outlier because most municipal buildings closed beginning in March 2020 due to the Coronavirus pandemic. Energy use for FY2021 will continue to be an outlier with decreased use due to building closures and increased use due to higher levels of and longer hours of ventilation.

Total Energy Use

As shown in Figure 1, buildings account for most of municipal energy use in Harvard. The other major area of energy use is vehicle fuel use.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Building	21,673	18,171	18,097	22,382	19,778	18,671	18,509	17,807	18,398	20,679	18,772
Open Space	2	2	2	1	2	5	0	0	0	0	0
Street/Traffic Lights	90	91	89	88	89	90	93	94	93	94	93
Vehicle	3,706	2,676	3,914	2,596	3,481	3,501	4,079	3,755	2,810	3,274	3,528
Water/Sewer	419	655	500	635	710	579	551	490	452	649	786
Grand Total	**25,890**	**21,595**	**22,602**	**25,704**	**24,060**	**22,846**	**23,233**	**22,145**	**21,753**	**24,696**	**23,179**

Figure 1. Harvard historic weather-normalized municipal energy use (MMBtu)
Energy Use 2009 - 2019

[1] For this report all years are fiscal year. Harvard's fiscal year runs from July to June
[2] MMBTU = Million British thermal units
[3] Mass Energy Insight adjusts building energy use up or down to account for weather conditions that are warmer or colder than normal. This is called weather normalization.

Energy Use Intensity

In addition to total energy use, the other significant measure of municipal facility energy use is energy use intensity (EUI). Energy use intensity data quantifies the energy efficiency of buildings in a similar manner to how miles per gallon (MPG) quantify fuel efficiency of vehicles. High EUI is bad. Low EUI is good.

Figure 2 includes the energy performance of a large subset of buildings from across the state collected from MassEnergyInsight. The buildings were categorized by building type and then the energy use intensity (EUI – kBtu/square foot) was recorded for each building. The graph in figure 2 shows the range of building performance for the best, average, and worst performing buildings by quartile. The vertical lines in the graph indicate the full range of EUIs for buildings in each category. The blue bars indicate the median EUI for buildings in each category.

For example, elementary schools in the MEI subset of buildings that we reviewed have an energy performance (EUI) that ranges from about 20 to 130 kBtu/square foot. The median EUI is about 61 kBtu/square foot. The top 25% performing elementary schools have an EUI between 20 and 55 kBtu/ square foot. The bottom 25% performing elementary schools have an EUI between 80 and 130 kBtu/square foot. The average 50% performing elementary schools have an EUI between 55 and 80 kBtu/square foot.

The red, green, and purple bars with arrows represent the building performance of selected Harvard buildings. Red bars represent the 2019 energy use intensity. Green bars represent the target EUIs proposed in Harvard's 2010 Energy Reduction Plan (EAP) submitted to DOER as part of the Green Community application process. The purple bar represents the forecasted EUI for the New Hildreth school building.

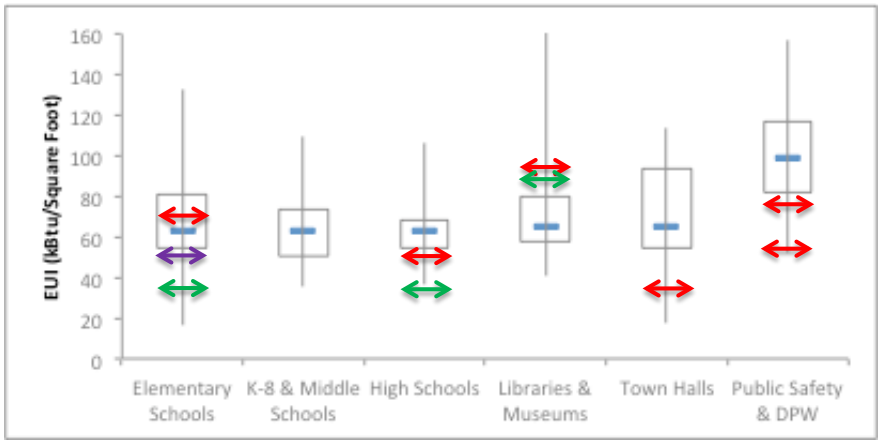


Figure 2. Harvard MA municipal facility energy use intensity – Target

Commented [6]: [DF: What plan is this? The green arrows for schools don't make any sense.]
JS: This is the 2010 EAP submitted by Harvard to DOER. DOER had a copy that they provided to me for this report.
JS: You are correct the green bars don't make sense. The savings forecasts for the proposed measures don't appear to have been grounded by a post construction EUI review. They appear to have been overly optimistic. As we learned in the detailed monitoring and retrocommissioning review in 2017 there are multiple conflicting issues in the school buildings that make it difficult to reduce energy use in the schools any further.

As Figure 2 shows, most of Harvard's facilities have lower energy use per square foot than other similar municipal buildings. Hildreth Elementary School's EUI (72) is slightly above average and the New Library's EUI (94) is in the bottom quartile energy performance of all municipal libraries. The upper public safety red line represents the Center Fire Station (78) and the lower public safety red line represents the Police/Ambulance Station (53) and the Highway Department building (55). As we will discuss later, the target EUIs in the EAP for Hildreth Elementary School and Bromfield High School were very aggressive.

3. Findings and Recommendations

Priority Buildings

In 2019, Bromfield School, Hildreth Elementary, and the New Library accounted for 85% of building energy use and 70% of Harvard's total municipal energy use. Our review focuses on these buildings because significant efficiency improvements will likely have to be made in each of them in order for Harvard to reach its 20% energy reduction goal.

We compiled information on each of these buildings in the Green Communities Building Energy Analysis Tool accompanying this report. This data, collected from Green Communities reports and communications with town and MA DOER staff, includes ECMs implemented and other changes to equipment or building use since the baseline year. We then reviewed energy billing data and noted how changes in energy use aligned with ECM implementation.

Many ECMs have been implemented in each building over the past ten years, but total sustained energy savings are still less than 20%. This section contains a summary and analysis of energy use in each school, followed by recommendations to reduce their energy use.

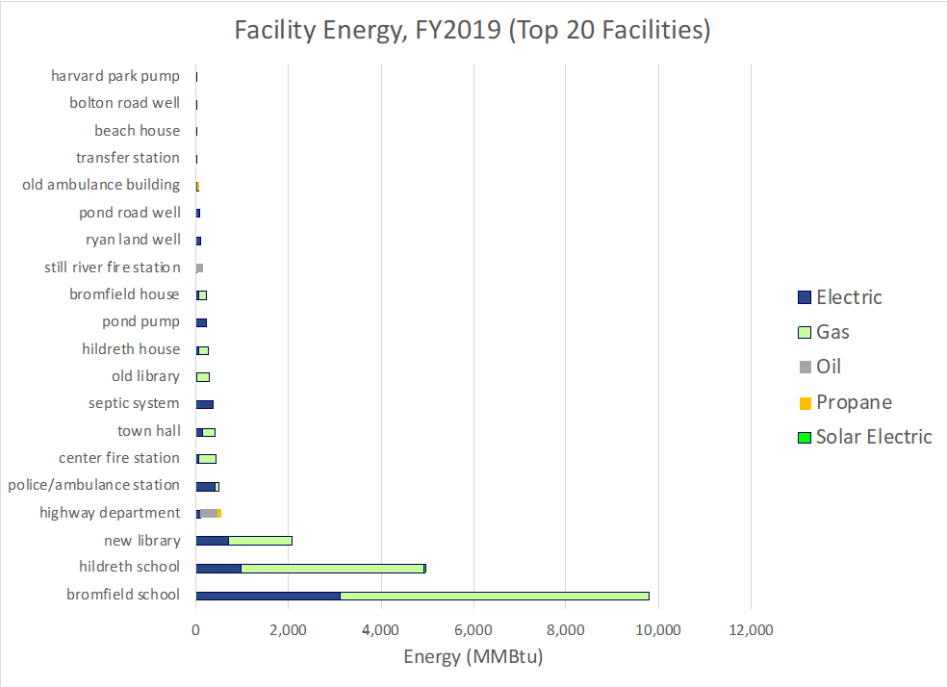


Figure 3 Harvard MA Building energy 2019

Commented [7]: DF: this should be FY2019 to avoid the one-off pandemic year]
JS: I added a note above regarding FY2020 being an anomaly. However, all the graphs that I use from CEE's spreadsheet and MEI include 2020 by default. I agree with your comment.

Bromfield School

Bromfield School accounted for 51% of the town's building energy use in 2019. The high school is for grades 6-12 and was built in 1962. The building is about 180,921 square feet and had a weather-normalized energy use intensity (EUI) of 49 kBtu/square foot in 2019. While this EUI is below the statewide median value of 61 kBtu/square foot for schools (based on all data in MEI), the target EUI proposed in Harvard's energy reduction plan is 34 kBtu/square foot.

Figure 4 shows the weather normalized energy use for Bromfield School. In 2019, Electricity use was 4% below the 2009 baseline and natural gas use was 11% below the 2009 baseline, for a net energy use decrease of 6% below the 2009 baseline. As the graph indicates, annual energy use at Bromfield School has fluctuated from a 27% decrease in 2011 to an 11% increase in 2012. The blue bar represents the target energy use proposed in Harvard's Energy Action Plan.

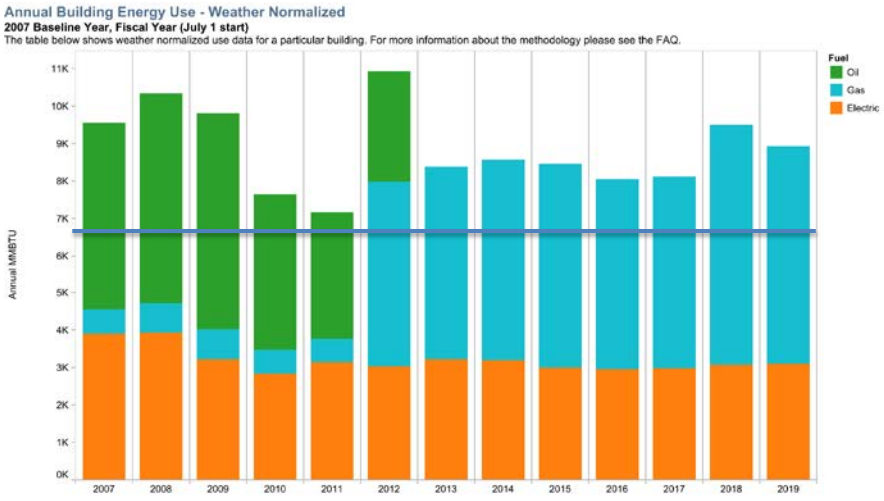


Figure 4. Bromfield School weather-normalized energy use (MMBtu) 2007 – 2019

Table 1 summarizes energy conservation measure (ECM) estimated energy savings in MMBtu and completion dates for energy projects installed in the high school.

Projected Savings	FY 2009	FY 2010	FY 2016	FY 2017	Total
ECM electricity savings	464	611	249	161	1,486
ECM fossil fuel savings		1,955		350	2,305
ECM Total Savings	464	2,567	249	511	3,790
EAP Target Savings					3,031

Table 1. Bromfield School projected energy measure savings (MMBtu)

Measures completed in 2009 and 2016 included lighting upgrades with an 8% target savings. Measures completed in 2010 included boiler and rooftop unit variable speed drives, converting the building management system from pneumatic controls to digital controls, and building management system commissioning with a 34% target savings. Measures completed in 2017 included energy monitoring and retrocommissioning with a 6% target savings.

Electricity and Oil energy savings from the measures installed in 2009 and 2010 were dramatic. Harvard almost achieved the facility's target savings with these measures. However, energy use rose dramatically when the school converted to natural gas in February 2012. Energy use stabilized in 2013 above the previous best performance standard set in 2011. Energy savings from lighting measures installed in 2016 appear to have been offset by other sources of electricity use. And, energy use increased significantly after the energy monitoring and retrocommissioning was completed in 2017.

So how do we explain the dramatic increase in energy use in 2012 and to a lesser extent in 2018? As a general rule, gas burners operate slightly less efficiently than oil burners. This could account for the general increase in thermal energy use post 2011. But, it doesn't account for the dramatic increase in thermal energy use in 2012. Gas use in 2012 was for only 3 months of the heating season and during this period the school consumed almost as much natural gas as the full heating season the following year. This was a very warm winter and weather-normalization may be overcorrecting for the warm weather. In addition, HEAC members believe that there may have been some broken equipment or other burner adjustments that required attention.

Commented [B8]: My experience is that gas burners are more efficient than oil. Is this correct?

Commented [9R8]: High efficiency (condensing) gas boilers are more efficient than oil boilers. Boilers with non-condensing gas burners are less efficient by a couple percent than oil burners.

Commented [B10]: Actual non-normalized energy use in FY12 was the lowest. We think this was because of a warm winter or broken equipment and that is why we think the normalized is so high.

Commented [11R10]: I will add this to the text

The important lesson learned from the post retrocommissioning work in 2017 is that some (or even a lot) of a facility's energy management equipment may be turned off or broken. DOER now provides META grant assistance for communities to confirm building operation and help specify a cost-effective retrocommissioning program. Please refer to Peregrine Energy's Winter 2017 snapshot report and associated engineer's logs for more detail about Bromfield School's operation. These reports provide important insights into the school's operation in 2017.

Highlights from Peregrine's reports include that many of the 20+ ventilation heat recovery units were turned off or not working, corridor lights were left on 24/7, data server rooms were over cooled, and the building control system was outdated. We understand that many of the HRUs were turned off because they had failed and were replaced in 2018. This might help explain the high energy use in FY2018. The monitoring report identified several electricity saving measures, and some were implemented. However, thermal energy-related building control adjustments and repairs identified in the reports appear to have increased gas use.

Commented [B12]: Are you referring to the controls that were not replaced when the BAS system was updated to DDC controls?

Commented [13R12]: I believe that Kaj's comments about the controls was broader than just the remaining pneumatic controls. The software was 8 or more years old when he reviewed the control system. 8 years is a long time between control software updates.

Another consideration that has been identified in other schools is that use of the buildings for other athletic and other community programs has increased outside of school hours and throughout the year. This can be quantified by interviewing school administrative staff and the school's facility manager.

To put energy use in context with heating and cooling loads, the graph in Figure 5. shows the heating and cooling degree days for each year. These values, based on historic weather data, are indicators of how cold or warm the outside air was in a given year. For example, a higher heating degree day value indicates a colder year, so more energy will likely be used for heating. See more information in the Building Energy Analysis Tool.

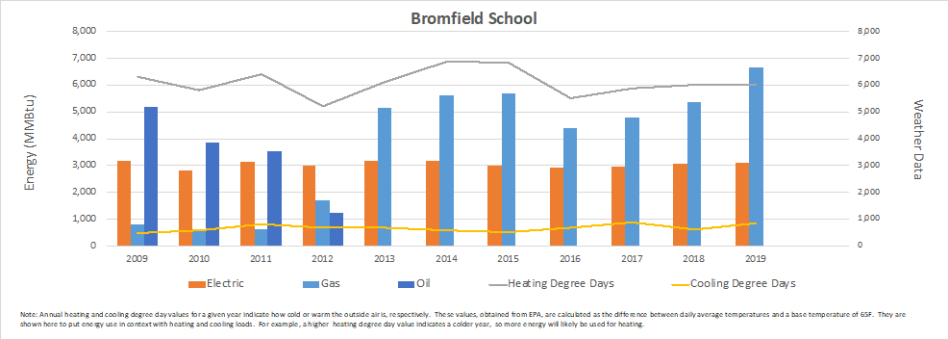


Figure 5. Bromfield School Energy Use and Degree Days 2009 – 2019

Hildreth School

Hildreth School accounted for 23% of the town's building energy use in 2019. The school is for grades K-5 and was built in 1962. The building is about 68,732 square feet and had an energy use intensity (EUI) of 70 kBtu/square foot in 2019. This EUI is above the statewide median value of 61 kBtu/square foot for schools (based on all data in MEI), the target EUI proposed in Harvard's energy reduction plan is 37 kBtu/square foot.

Figure 6 shows the weather-normalized energy use for Hildreth School. In 2019, Electric use was 28% below the 2009 baseline and natural gas was 1% above, for a total decrease of about 7% below the 2009 baseline. As the graph indicates, annual energy use at Hildreth School has fluctuated from an 11% decrease in 2011 to an 15% increase in 2018. The blue bar represents the target energy use proposed in Harvard's Energy Action Plan.

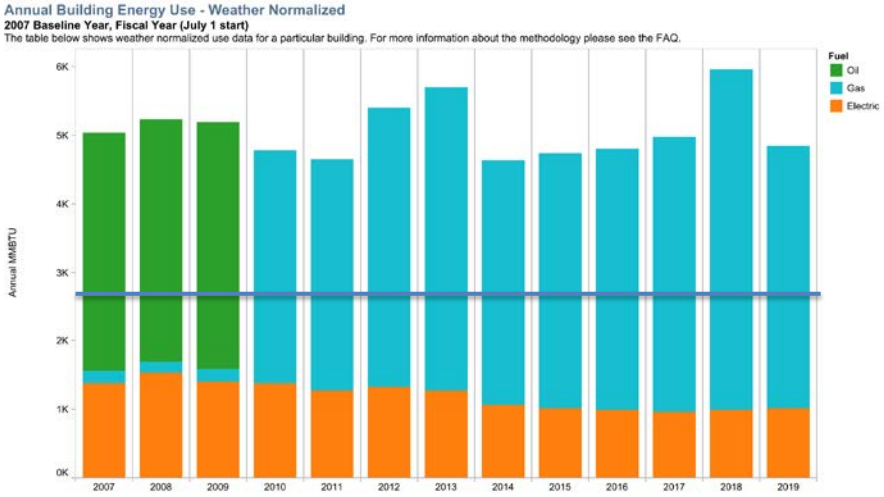


Figure 6. Hildreth School weather-normalized energy use (MMBtu) 2007 – 2019

Table 2 summarizes the dates and energy conservation measure (ECM) estimated energy savings in MMBtu for the projects that Harvard has installed in the elementary school.

Projected Savings	FY 2010	FY 2011	FY 2013	FY 2017	Total
ECM electricity savings	1,181	122	23	61	1,387
ECM fossil fuel savings			843	133	976
ECM Total Savings	1,181		866	194	2,241
EAP Target Savings					2,499

Table 2. Hildreth School projected measure energy savings (MMBtu)

Measures completed in 2010 included lighting upgrades, two new burners, a boiler, and conversion from oil to gas with a 25% target savings[4]. Measures completed in 2011 included new boiler hot water variable speed drives and controls with a 3% target savings. Measures completed in 2013 included demand control ventilation, building management system upgrades & retrocommissioning with a 15% target savings. Measures completed in 2017 included energy monitoring and retrocommissioning with a 4% target savings.

Electricity and fuel savings from the measures installed in 2010 and 2011 were about 11% instead of the projected 25% savings. Similar to Bromfield, the replacement gas burners may have been less efficient than the oil burners that they replaced. It is difficult to determine what was supposed to generate about 22% fuel savings. A cast iron boiler was replaced with another cast iron boiler with about the same potential energy performance. Electricity savings were about the same as projected for the lighting measures that were installed.

It's unclear why the energy use increased in 2012 and 2013 by 16% and then 23% from 2011. The measures installed in 2013 reduced the high energy use in 2013 back down by about 17% in 2014.

Energy use increased 20% from 2017 to 2018 after Peregrine's energy monitoring and retrocommissioning report. The engineer's log for the school included a litany of HVAC system problems such as 35 uncontrolled unit ventilators, exhaust fans running when the school was closed, air leaks in the pneumatic control system, valves that weren't able to allow proper performance and benefit of the variable speed drives, and four heating ventilation units malfunctioning.

2018 was also about the time that discussions about constructing a new school became more serious and any energy efficiency investments were put on hold. The New Hildreth school is scheduled to open in 2021. The project design engineers prepared an energy analysis that suggests the new school will have an EUI of about 47. This includes a 20% cushion to account for potential building operation variables. It is also higher than the original EAP target EUI of 37. However, it's important to note that the original EAP target energy savings provided by the heating system and retrocommissioning contractors appear to have been inflated and unrealistic.

Commented [B14]: I understand your point but is it more accurate to say that the target energy savings have not been realized. This may be because the estimates were inflated or other factors?

To put energy use in context with heating and cooling loads, the graph in Figure 7 shows the heating and cooling degree days for each year. These values, based on historic weather data, are indicators of how cold or warm the outside air was in a given year. For example, a higher heating degree day value indicates a colder year, so more energy will likely be used for heating. See more information in the Building Energy Analysis Tool.

[4] It's unclear why the savings listed in the database DOER provided for these measures are all electricity savings and no thermal savings.

Figure 7 breaks out the energy use by fuel type and shares the heating and cooling degree day trends. The data in this graph is not weather-normalized.

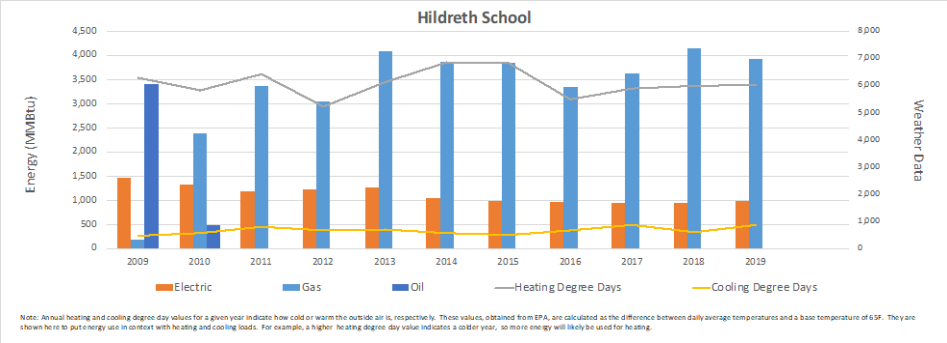


Figure 7. Hildreth School Energy Use and Degree Days 2009 – 2019

New Public Library

The New Public Library accounted for 11% of the town's building energy use in 2019. The library moved to the original Bromfield School (constructed in 1878) that was renovated and expanded in 2007. The building is about 22,199 square feet and had an energy use intensity (EUI) of 94 kBtu/sq. ft. in 2019. This EUI is above the median value of 62 kBtu/square foot for other library buildings. The target EUI proposed in Harvard's energy reduction plan is 88 kBtu/sq. ft.

Figure 8 shows the weather-normalized energy use (MMBtu) for the New Library from 2007 to 2020. In 2019, Electricity use was 11% below the 2009 baseline and natural gas was 2% below, for a net decrease of about 5% below the 2009 baseline. As the graph indicates, annual energy use at the library has fluctuated from an 20% decrease in 2015 to the current 5% decrease in 2019. The blue bar represents the target energy use proposed in Harvard's Energy Action Plan. In addition, The Library had made significant energy reductions prior to 2009.

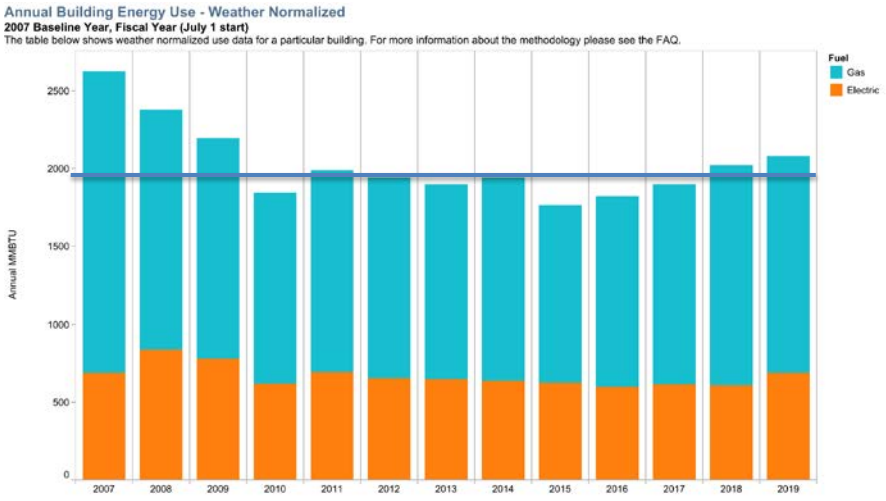


Figure 8. New Library Energy Use (MMBtu) 2007 – 2019

Table 3 summarizes the dates and energy conservation measure (ECM) estimated energy savings in MMBtu for the projects that Harvard has installed in the library.

Projected Savings (MMBtu)	FY 2014	FY 2016	FY 2017	Total
ECM electricity savings	33	7	33	73
ECM fossil fuel savings			58	58
ECM Total Savings	33	7	91	131
EAP Target Savings				244

Table 3. New Library projected measure energy savings (MMBtu)

Harvard's EAP target savings were for a retrocommissioning measure that was scheduled to be installed in 2013. Measures completed in 2014 included boiler hot water and air handler unit variable speed drives with a 2% target savings. The Measures completed in 2016 included LED interior lighting upgrades with a .3% target savings. Measures completed in 2017 included energy monitoring and retrocommissioning with a 4% target savings.

Electricity and fuel savings from the variable speed drives installed in 2014 reduced total energy use by about 7% in 2015 compared to 2013. However, total energy use increased each of the next 3 years. Energy savings proposed for the 2017 energy monitoring and retrocommissioning work did not materialize and annual energy use continue to increase through 2019.

According to Peregrine, the Library's mechanical systems were in good condition. The new Tridium building management system was in good condition and appeared to be properly setup. Peregrine recommended three improvements: (1) tighten scheduling; (2) lower unoccupied heating setpoints to 55F and (3) turn off the second heating hot water pump. HEAC will reach out to the library to see if these measures were implemented.

Commented [B15]: I think we should find out from Pete Jackson and the HVAC control vendor.

Figure 9 breaks out the energy use by fuel type and shares the heating and cooling degree day trends. The data in this graph is not weather-normalized.

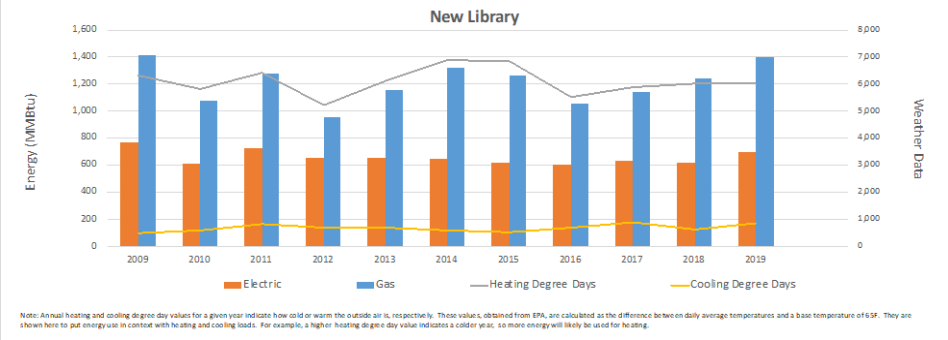


Figure 9. New Public Library Energy Use and Degree Days 2009 – 2019

Town Hall and Police/Ambulance Station

As part of our program review, we noticed that Harvard has a couple success stories in the form of significant energy use reductions in two of its smaller buildings.

Town Hall

Harvard renovated its historic Town Hall and reduced the facility's energy use significantly. According to HEAC member David Fay: We renovated the building at a cost of a couple of million dollars. The electric use went up because of better lighting but the energy use went down because the walls were insulated, and the building was tightened up.

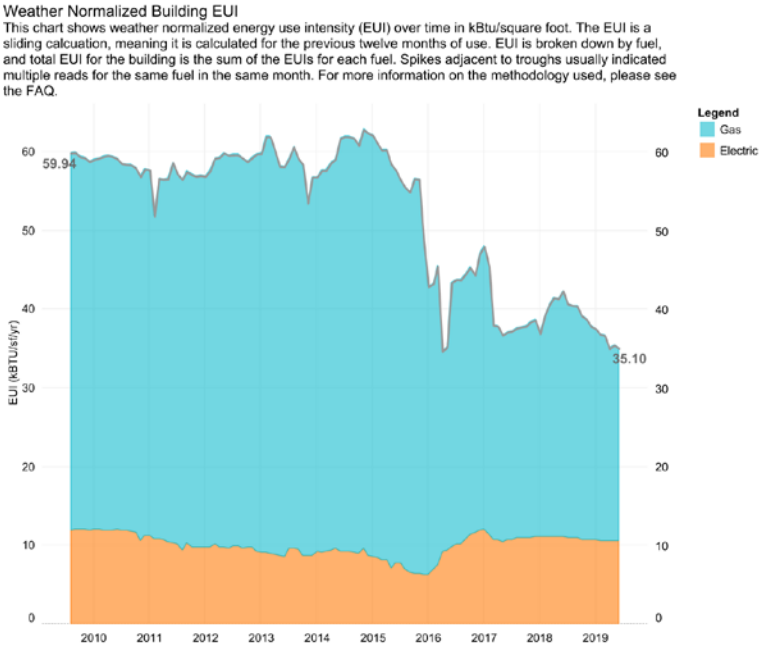


Figure 10. Town Hall rolling 12-month energy use intensity (kBtu/square foot/year)

Police/Ambulance Station

Energy savings at the Police/Ambulance Station were more unusual but also has an answer. According to HEAC member David Fay: The National Grid gas meter stopped working and National Grid refused to believe it was broken and wouldn't replace it for almost a year. The reduction in electricity is most likely due to moving the dispatch center to another location. In addition, Harvard replaced boilers, added insulation, and fixed issues with the fan coil units.

Commented [B16]: Also, the Police/Ambulance station: replace boilers, later added insulation and fixed issue with the fan coil units.

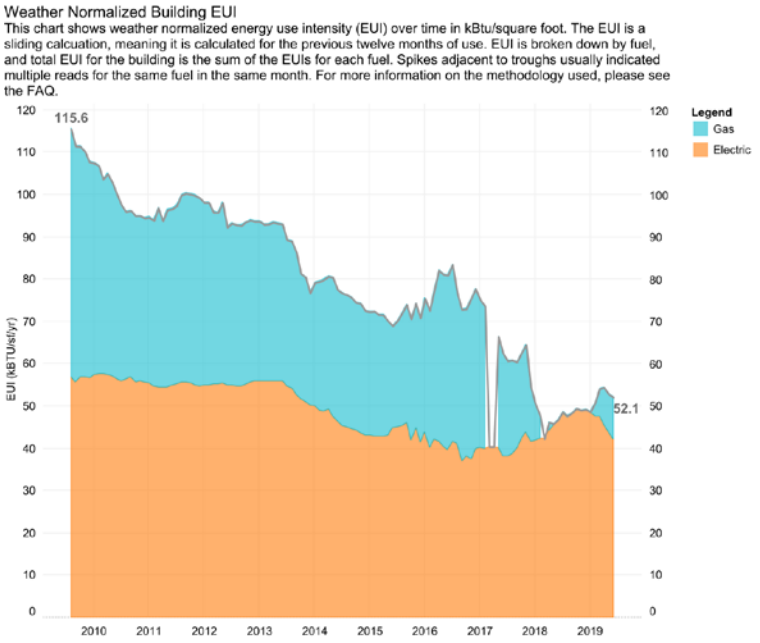


Figure 11. Police/Ambulance Station rolling 12-month energy use intensity (kBtu/square foot/year)

Recommendations

Following are recommendations to improve energy efficiency in Harvard's facilities. While these recommendations are targeted to the specific facilities based on information we collected during this program review note that we have not performed the site visits or detailed analysis required to confirm their actual feasibility and cost effectiveness.

Bromfield School

Bromfield will continue to be a challenge for the town to reduce energy use down to the level necessary in order to meet DOER Green Community's 20% energy savings target. It is the largest building that the town owns and has already been operating at or below energy use performance standards for similar buildings. Bromfield is one of only a few high schools with heat recovery unit (HRU) ventilation systems and CO2 sensor controls. This might help explain why the school's energy use is below average.

Ventilation usually accounts for about 50% of the total heating energy use in school buildings. For example, Lincoln's Hartwell Elementary School is a similar 1950's, 60's, 70's school building with slab on grade, brick and concrete block walls with no insulation, single and some double pane glass, and minimal roof insulation. At .5 ACH ventilation accounts for about 33% of the total heating load. This is a reasonable estimate for a building with little or no mechanical ventilation running, and primarily natural air leakage. At 1.0 ACH, ventilation accounts for about 50% of the total heating load. At 2.0 ACH, ventilation accounts for about 66% of the total heating load.

Please refer to ASHRAE's recommendations for commercial building/school ventilation, filtration, and operation guidance to minimize air quality risks associated with bioaerosols. It's very good[5].

Short of constructing a new school, the most aggressive area that Harvard can begin to investigate is strategic replacement of the central gas-fired heating system with distributed high efficiency heat pump systems. This has been done effectively in the Plainfield NH School District[6]. MA DOER offers technical assistance through its META grant program to assess high performance fuel conversions like would be appropriate for Bromfield School.

In addition, Harvard should continue to hire a third-party energy engineer every two years to review the building management system for the school's facility manager and the building controls contractor. The energy engineer should continue to maintain the schools engineer log and develop specifications for associated software updates and HVAC equipment repairs.

Hildreth School

Of the three buildings that we assessed; Hildreth School offers the most promising opportunity for significant savings next year. The town is scheduled to open a new replacement school in 2021. DOER will require Harvard to recalibrate building's profile to include the increased square footage and incorporating the administrative services currently housed in the Bromfield House.

[5] https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf
https://www.ashrae.org/file%20library/technical%20resources/covid-19/guidance-for-the-re-opening-of-schools.pdf

[6] http://www.energysmiths.com/resources/documents/PlainfieldSchoolDER.pdf

Commented [17]: [DF: The observation about the ventilation system is very interesting and news to us. Where did you get that information? Another possibility is that the square footage of the building is incorrect. Is there any way we could get DOER to verify the measurement?]

JS: This is from personal energy analysis of individual schools. I should have clarified that ventilation is 50% of typical school heating loads and slightly less for total school energy use.

Regarding the square footage, this came up in 2017 and I believe after some research we decided to stick with the square footage listed in MEI. Please feel free to suggest another square footage.

Commented [B18]: We should find out what is the air exchange in Bromfield?

Commented [19R18]: Confirming actual air exchange in large buildings is really difficult and expensive. It either requires introducing tracer gases and recording the tracer gas decay rate, adding large fans and pressurizing the building, or estimating the mechanical and natural ventilation rate based on engineering best practices. None of these techniques are full proof.

As mentioned earlier, the new school building design engineers prepared an energy analysis that suggests the new school will have an EUI of about 47. This includes a 20% cushion to account for potential building operation variables. The proposed EUI of 47 is higher than the EAP's target EUI of 37 but the building's performance could approach the target EUI with good building operation and close attention to the facility's energy use.

Harvard can prepare for the school's opening by documenting the proposed energy performance and utility cost projections prepared by the project's design team. The town can then request hourly demand data from its utility provider or download hourly demand data from the building's energy management system provider (or other sources?) New school building utility cost savings are very sensitive to demand load management practices and it will be important to assess the interaction between outdoor weather conditions, equipment operation, and the investor-owned utility demand rate tariffs.

New Public Library

Any further improvements in the building envelope beyond what was installed in 2007 will be challenging. Similar to Bromfield School, the Library will need to focus on the transition to high efficiency heat pumps as the existing RTU and AHU equipment ages out. As Figure 12 indicates, RTU1 accounts for about 71,000 kWh per year or 39% of the library's total electricity use of about 180,000 kWh and would be the most important HVAC component to replace. In addition, gas consumption associated with hot water delivered to RTU1 will decrease as well.

Appendix A Monthly Electricity Use Grouped by Major Categories

The following chart summarize monthly electricity use between January 1, 2016, and December 31, 2016 grouped by major categories and sub-categories. The charts include all the electrical circuits that are being monitored at the Library. Energy use for individual months are color coded by sub-category. Months with higher electricity use are highlighted in red and months with lower electricity use are highlighted in green.

HVAC

Description	Category	Sub Category	January kWh	February kWh	March kWh	April kWh	May kWh	June kWh	July kWh	August kWh	September kWh	October kWh	November kWh	December kWh	Total kWh
Rooftop RTU 1	HVAC	Rooftop Unit	3,132	3,336	3,459	3,494	5,945	8,723	11,783	11,700	8,361	4,311	3,263	3,231	70,738
Fan Coil Unit 2	HVAC	Fan Coil Unit	627	506	471	385	352	393	714	711	757	801	548	351	6,617
Fan Coil Unit 1	HVAC	Fan Coil Unit	250	210	235	205	193	189	179	207	192	174	176	199	2,410
ACCU 2	HVAC	ACCU	79	74	79	76	87	435	1,119	1,076	501	83	0	0	3,608
ACCU 3	HVAC	ACCU	2	2	0	3	37	110	121	146	92	22	0	0	536
PAC unit	HVAC	Packaged AC Unit	266	249	264	260	346	468	830	973	643	322	257	267	5,146
Boiler Pump 2	HVAC	Heating Pump	519	416	411	314	29	96	46	39	50	167	336	271	2,693
Boiler Pump 1	HVAC	Heating Pump	519	478	290	171	183	28	29	34	120	148	165	715	2,881
Boiler make up fan	HVAC	Make Up Air Fan	366	309	233	219	165	46	31	33	109	133	258	327	2,227
Boiler 2	HVAC	Boiler	211	114	62	94	44	26	16	15	27	69	74	98	849
Boiler 1	HVAC	Boiler	10	100	111	4	4	4	4	4	4	4	50	145	445
Boiler shutdown relay	HVAC	Boiler Relay	7	7	7	7	7	7	7	7	7	7	7	7	87
Vestibule heater	HVAC	Cabinet Heater	146	131	25	9	0	0	1	1	0	0	1	121	434
CUH	HVAC	Cabinet Heater	31	27	14	8	1	0	0	0	7	25	29	45	187
Electrical room unit heater	HVAC	Electric Unit Heater	16	15	16	16	16	16	16	16	16	16	16	16	193
Building automation	HVAC	BMS	84	77	87	85	88	85	88	88	85	85	80	76	1,010
Ground floor bath exhaust	HVAC	Bath Exhaust	43	46	45	42	43	41	44	44	48	42	39	44	519
DHW Heater	HVAC	DHW heater	89	90	107	78	95	75	67	75	77	122	361	388	1,623
DHW recirculation pump	HVAC	DHW recirc	11	11	11	11	2	0	0	0	0	5	40	43	135
		Total	6,409	6,196	5,927	5,482	7,637	10,741	15,097	15,170	11,098	6,535	5,701	6,343	102,336

Figure 12. Peregrine Winter 2017 – Snapshot Appendix A HVAC energy use

In addition, the domestic hot water system should be decoupled from the central boilers and replaced with a high efficiency electric system (or distributed systems). The existing DHW

equipment includes high quality components and may not need to be replaced in the near future.

Process Review

The Town of Harvard has actively participated in the Green Communities program and received $533,393 in grants, as well as Mass Save incentives, to make many upgrades to town facilities. HEAC has worked closely with town staff to prioritize the buildings that use most energy and actions that can be taken. Town management's focus is on energy efficiency investments with cost paybacks less than 10 years.

Commented [B20]: Not sure about the 10years; I am sure they want lower paybacks, but less than 10 is correct.

Energy solutions designed to address the town's Green Community 20% energy use reduction target and state greenhouse gas emission reductions will require more aggressive capital-intensive investments. HEAC, town management, and town residents need to agree on a long-term strategy and scale of investment to meet these energy and environmental aspirations.

Recommendations

We recommend that Harvard institutionalize energy efficiency and carbon emission reduction targets in town and school policies. The town's Green Community and residential energy initiatives are very active and well managed, but this is partially dependent on the commitment of individuals on the energy advisory committee. There may be additional energy savings opportunities in decisions made by town staff. We recommend these steps to institutionalize efficient practices throughout the town and schools:

- Integrate HEAC's community energy efficiency and renewable energy goals with the Planning Board's Community Resilience Working Group goals and recommendations. This is an excellent opportunity for HEAC to shift and align the town's economic-centric view of energy efficiency and renewable energy investments to longer term climate and greenhouse gas related goals.
- Present a community-wide Energy Action Plan to the Selectmen for their review and town meeting approval. HEAC can build off its successful 100% renewable energy community aggregation campaign and offer a blueprint for the town to meet the state's 80% by 2050 carbon emission reduction target. Concord has been working on this and I understand that individuals in Acton are working on a similar effort.
- Inform town staff about the town's energy reduction goal, the benefits of energy efficiency and Green Communities program participation. Encourage them to consider and discuss ways that they could contribute to improving efficiency and reducing operating costs.
- Develop energy efficient purchasing policies requiring that town and school staff consider efficiency in selection of all new energy-consuming equipment, including IT equipment, appliances, commercial kitchen equipment, HVAC equipment, and vehicles that are exempt from Green Communities Criterion 4. Guidance is available at energystar.gov/purchasing

Commented [B21]: GC Criterion 4 requires an energy efficient vehicle policy which we have.

- Include energy efficiency and Green Communities program management in relevant job descriptions to ensure that future hires continue this work.
- Engage the school community in energy efficiency efforts. Students and teachers can be valuable allies in improving energy efficiency in schools, and some Massachusetts schools have successfully reduced energy use through behavior-based programs. We recommend educating the school community about the Green Communities program and the town's energy reduction goal. The Massachusetts Department of Environmental Protection's Green Team program offers support for energy and environmental programs in schools, detailed at thegreenteam.org. CLC may also offer support for such programs.
- Leverage additional funding sources. Harvard has already earned substantial funding for energy efficiency projects from a few sources. These programs may offer additional support:
- Mass Save Equipment and Systems Performance Optimization Program – This new Mass Save program supports a variety of tuning, monitoring and retrocommissioning measures. See masssave.com/en/learn/business/espo/
- Massachusetts Clean Energy Center – MassCEC provides incentives toward installation of renewable energy systems, such as solar hot water. See masscec.com/get-clean-energy/government-and-non-profit
- Massachusetts Executive Office of Energy and Environmental Affairs – The Municipal Vulnerability Preparedness program provides support for cities and towns to plan for climate change resiliency and implement priority projects. See mass.gov/municipal-vulnerability-preparedness-mvp-program
- Track energy use and ECMs. We recommend using the Building Energy Analysis Tool provided with this report to review energy use for major facilities annually. Any unusual increases in energy use or large ECMs that did not appear to result in savings should be investigated, and if no explanation is found, retrocommissioning should be considered to ensure that equipment is operating properly.

Data Tracking

We found a few potential errors in the data for the three major buildings that we reviewed and have provided a spreadsheet that identifies these potential errors.

Recommendations

- Correct the errors in MEI that we identified.

Contacts

This document was prepared by staff at the Montachusett Regional Planning Commission (MRPC) on behalf of the Town of Harvard. MA DOER, The Town of Harvard, and Harvard Public Schools staff and committees provided all supporting information. Inquiries should be addressed to:

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Appendix A – Bromfield School Engineer's Log

Harvard Bromfield HS Cxing Comments

Comment No.	Comment Date	Reference	Comments	Recommendation	1/27/16 Comment	11/1/16 Comments
1	01/27/16	CO2 control	CO2 setpoints are not user accessible	Bring setpoint forward to graphic	Follow-up service from BCM	This applies to HV-1, -2 (gym) and 4, -5 (common areas). 4 and 5 complete. 1 and 2 are follow-ups
2	01/27/16	HV-1, -2	Space setpoint 74F	Change to 68F	Complete	
3	01/27/16	HV-1, -2, -4, -5	Economizer low limit is set at 65F	Change to 50F	Complete	
4	01/27/16	HV-1, -2, -4, -5	CO2 control opens OAD 50% upon exceeding setpoint.	Update CO2 control: use PID logic to increment damper if CO2 exceeds setpoint. Disable CO2 control and revert to min OAD position if CO2 readings <300, >2,000 PPM	Follow-up programming by BCM	Needs follow-up
5	01/27/16	HV-1, -2	Space temp 3-5F off between the two units in open gym	Consider averaging results from both sensors (including CO2) and setting up both H&V's to run I the same mode off a common command	Mark ok'd update - BCM to program	Complete
6	01/27/16	HV-1, -2	CO2 reading of 586 (HV-2) and 820 (HV-1). This is the same space	Recalibrate sensors	Follow-up service by BCM	Suggest adding CO2 averaging of both sensors so both H&V's operate in same mode. Follow-up w/ comment #4
7	01/27/16	HV-1, -2, -4, -5	Sequence calls for 70% fan speed unless HW valve is 100% open, then 100% speed. Single zone systems w/ VFD are usually controlled off space temp and CO2	Consider updating sequence to follow a fan reset speed off zone temp. Suggest a 50% speed min.	Follow-up service by BCM	Follow-up w/ #4
8	01/27/16	HV-1	OAD is calling for 50%, but it is not clear if the damper is opened as SAT is still fairly close to room temp	We manually opened damper to 100% w/ the HW valve locked out and were able to see a response.	None	
9	01/27/16	HV-4	CO2 reading high in "Zone 1"	Recalibrate. For now increased CO2 setpoint to 1,100 ppm so that OAD is not @ 50%	Follow-up service by BCM	Readings are ok today. Setpoint dropped back to 800 ppm
10	01/27/16	HV-4	Not sure why there are two CO2 zones in hallway, when H&V return conditions should suffice.	Consider using existing temp sensor and return CO2. Suggest putting a cage over active temp sensors in the hallways	Mark ok'd update - BCM to program	Follow-up to reconfigure for return CO2 control.
11	01/27/16	HV-4, -5, -6	Effective setpoint = setpoint +/- differential off TSTAT sliders	Reconfigure for direct setpoint, disable sliders & update graphic	Complete	
12	01/27/16	HV-4, -5, -6	From above, setpoint is 74, effective 71 to 73F	New setpoint is 70F	Complete	
13	01/27/16	HV-4	This unit has been off more often than not during the last week according to trends.	Determine who's turning unit off and reason	Follow-up w/ Mark	Optimal start issue found - see new comment below
14	01/27/16	HV-4	Both reheats showing considerable temp differential w/ valves off	Checked coils and there is definitely HW flow to the coils. Suggest checking & adjusting actuators. If necessary service valve(s)	Follow-up by BCM & plumber (if necessary)	HW continues to be supplied with no call. Preheat coil and both reheats. Actuators need to be checked
15	01/27/16	HV-6	Confirmed valve leaking by. Actuator was stroked and stem adjusted. Also noted small water leak that has saturated pipe insulation	Fix water leak and if necessary remove valve body for service / replacement	Follow-up by plumber	
16	01/27/16	HV-6	This unit serves an unoccupied storage area & maint shop. OAD min is set at 0%	Consider changing sequence so unit cycles	Update programming by BCM	Completed today - setup to go to occupied mode when is 2F below occ/unocc space temp setpoint.
17	01/27/16	HV-6	Space temp near 80F	Changed setpoint to 68F	Complete	
18	01/27/16	HV-6	This unit (5 hp) came on at 3:45 a.m. on Opt Start.	Troubleshoot program. Needs to be an OA cutoff, below which system do not start for cooling (applies to all non-cooling units in the bldg)	Follow-up services by BCM	Optimal start has been removed via fan cycling change from above
19	01/27/16	HV-6	Unit not being scheduled?	Check trend	Follow-up services by BCM	Follow-up needed to build unoccupied sequence.
20	01/27/16	HV-7	Min. OAD is set at 0% This is a locker room and it needs some fresh air	Changed to 10%	Complete	
21	01/27/16	RTU-1, -2	Setpoint 72F	Changed to 70F		
22	01/27/16	RTU-2, -3	OAD is at 0% and HRU isn't working. No fresh air coming in	There should be at least 10% fresh air on systems w/o CO2 control	School to maintain min. 10% OA setting on all RTU's	
23	01/27/16	RTU-3	From data, it looks like OAD is open, even though is not being commanded open	Field confirm damper position / movement	Follow-up services by mechanic	Appears to be closed today

24	01/27/16	RTU-3 (applies to all the other RTU's as well)	SAT setpoint is 73.4F, but space is considerably over setpoint (70F). Would expect SAT setpoint to be lower and heat off when space temp is too high by about 2-3 F	Troubleshoot reset strategy. Recommend using zone temp to drive the valve / DX stages off PID loop. Let SAT be whatever it needs to be to achieve results	Follow-up service by BCM	There are two sensors and the system DAT is trying to meet the average of the two. We update the graphic to show both, plus calculated average temp.
25	01/27/16	RTU-4	SAT is 78F, but no heating coil in unit?	Field confirm no heating coil in RTU. If there is a coil, need to "discover" additional points and resolve why heat is on. Otherwise troubleshoot	Follow-up service by BCM	This unit has been replaced
26	01/27/16	RTU's	There isn't any accommodation for free-cooling	Update sequence to shutoff wheel or use auxiliary OA vent to free cool the AHU	Follow-up service	1) suggest commissioning on new units, (2) for operational existing units, these are integration to older LON cards - can't change sequence.
27	01/27/16	RTU-6	EF status appears to be faulty	Resolve	Lower priority	Today command is off, status is on. Unit operating in hand? Status faulty? Follow-up on this issue.
28	01/27/16	RTU-1, 6, 7	Controllers are obsolete and no access to sequence for modifications. Applies to FTRs and other small devices running off these controllers	Consider replacement w/ Sneider product as was done for other RTUs	BCM to provide pricing for update	Follow-up. RTU-7 is no longer working
29	01/27/16	HRU-14, -15	Controllers are obsolete and failed. Inorder to operate this equipment, staff have to manually turn on/off. At present equipment is off.	Consider replacement w/ Sneider product as was done for other RTUs	BCM to provide pricing for update	Follow-up
30	01/27/16	FTR - Rm 393	Zone temp reading 83F	Troubleshooting revealed linked to old controller (removed). Correct link established to old room # 121	None	
31	01/27/16	FTRs	These devices are not linked to schedule	Add unoccupied setpoint and link to "A" schedule		The six pieces on "radiation" page needs sequence update
32	01/27/16	FTR associated w/ RTU-7	Same as above	Consider building an "outside" solution to change setpoint in unoccupied mode	Follow-up service	Looks like 8 pieces. Failed controller. Fix and then build new sequence, including unoccupied
33	01/27/16	Radiant heat panels	These are in new wing on 1st and 2nd Flr. Don't think these are following unoccupied mode.	Check logic and if necessary build an unoccupied setpoint sequence.	Follow-up service by BCM	Confirmed radiation valve remain closed in unocc mode. No further changes required.
34	01/27/16	Radiant heat panels	This side of the bldg is very hot. Solar load, or are there leaking valves?	Check a sample of valves on the units	Follow-up service by BCM	See below
35	01/27/16	UV Room 238	Unit is down. The controller is down	Troubleshoot controller - replace if neoessary	Follow-up service	Still out of service. Needs follow-up. UV is off, coil flooded
36	01/27/16	UVs	Unoccupied setpoint not seen on graphic	Internal setpoint is 55F	None	
37	01/27/16	FTR in A001	The HW valve is opening, even though the room temp is satisfied. The controller for this unit is off RTU-6, which is an old unit without access.	Need to replace this controller	Discussion w/ Mark	Looks ok today - See above needs new controller
38	01/27/16	Room 295	Space temp reading 0F. FCU is manually turned off	Fix space temp reading and place unit back in auto operations	Follow-up service	Follow-up
39	01/27/16	FCU Room 171	This is the unit in the industrial area that was observed to be on during Xmas break when the bldg was in unoccupied mode	Checked trend and unit looks like its scheduling now	Monitor	Checked trend and turning on 7:30. Looks ok
40	01/27/16	FTRs & VAVs	Various setpoints in use - typically 72F	Update all to 70F	Complete	
41	11/01/16	HV-5	This unit is down. VFD is tripped. From trend log, unit has been down for at least a month.	VFD was reset and unit restarted. Monitor unit. If it goes down again, suggest troubleshooting VFD / electrical.		
42	11/01/16	HV-4	Trend shows unit consistently starting at 5:30 am, although scheduled start is 8 am. Optimal start issue?	Troubleshooting required		
43	11/01/16	HW valves on FCU's and radiation panels	The valves have a high rate of failure.	BCM tested all and replaced roughly 25% of the valves. Suggest testing again next year.		

Appendix B – Hildreth School Engineer's Log

Harvard Hildreth ES Cxing Comments

Comment No.	Comment Date	Reference	Comments	Recommendation
1	01/21/16	UV's	Approximately 35 old UV's that are not controlled. This units can be considered "beyond end of life"	Consider UV replacement project. New equipment to be furnished with BACnet or LON compatible controller to be integrated w/ DDC system
2	01/21/16	Pneumatic system	Air leaks reported. Some leaks are in wall spaces	To the extent possible, repair leaks. TSTAT's bleed a small amount of air. Ultimately the pneumatic system should be replaced with a DDC system
3	01/21/16	EF's	These run on local time clocks	Confirm operating hours and refine if possible. The fans should be running only during official school hours. Probably ok to schedule 8:00 AM to 3:30 PM. These should be brought onto the energy management system
4	01/21/16	HW pumps	Pump VFD's run off an OA rest schedule. The valves in the system are 3-way and therefore not possible to use differential pressure control. There is also a HW temp reset, which amplifies impact of pump turndown. This is not a recommended pump operating strategy with potential to leave HVAC devices at the end of pipe runs without sufficient heating capacity.	Consider replacing valves with 2-way. This would only make sense with a UV replacement project where new equipment would be furnished with the correct 2-way valve.
5	01/21/16	HV-1	This unit did not respond to CO2 setpoint change below current value.	Troubleshoot and resolve
6	01/21/16	HV-5	This unit has a high discharge temp and 0% valve position.	Check functionality of valve and if water is leaking through it.
7	01/21/16	HV-6A	No start/stop control? Appears this unit runs 24/7	Verify and consider adding points of control
8	01/21/16	HV-7	This space is too hot and unit is not responding with OA free cooling	Troubleshoot and resolve