GREEN COMMUNITIES ENERGY EVALUATION

Town of Medway

Project Report

May 31st, 2019

EXECUTIVE SUMMARY

The Town of Medway has made bursts of progress through an ESCO agreement for the Town's school buildings with the vendor Trane since becoming designated as a Green Community in 2010. In 2018, two staff members earned their Building Operator Certifications. This report looks into building energy use changes since Medway's baseline year of FY 2009 up until FY 2018. Even though the data in this report does not explicitly cover the current year (FY 2019), there has been a concerted effort over the past fiscal year on energy efficiency in the school buildings which we expect to bring the town much closer to its 20% reduction target. The town has seen major equipment investments including boilers at two schools which are set to pay off soon. Many of the efforts this past year have been free or low-cost behavioral measures and maintenance of important large electrical loads such as the High School's chiller. As a result, the energy data in Mass Energy Insight for FY 2019 so far is significantly less overall than in 2018.

INTRODUCTION

Purpose/About the Program

This energy evaluation is intended to help a Green Community assess its energy reduction activities and to provide tailored recommendations to help the municipality achieve its 20% reduction goal. The evaluation has two primary components. First, a process review looks at how the municipality manages its energy reduction efforts, including how it utilizes its energy data, engages staff and stakeholders, and communicates with leadership. Improvements in process can have a positive impact across all sectors of the municipality's energy usage. Second, the review assesses priority buildings. The Building sector is typically the largest energy user in a city or town, and there are often just a handful of buildings that account for the majority of use within in it. As a result, the review focuses efforts on those largest buildings in order to maximize potential impact. The goal is to determine the major drivers of energy use changes in these buildings. It may document successful interventions so they may persist, identify hard-to-measure changes such as occupancy, and pinpoint gaps to address with remedial measures.

Accompanying this report is an Analysis tool. In addition to providing tables and graphs that drive insight, it is meant as a repository of energy-related information about the priority buildings. Such information can be highly valuable to assessing drivers of energy use change; however, it is generally not currently captured elsewhere. Further, it is often lost due during staff turnover. We encourage Green Communities to utilize the Analysis tool on an annual basis for its priority buildings.

The Town of Medway

The town of Medway was incorporated in 1713 and has a town-meeting structure of government. The area that is now Medway was originally settled by the Wampanoag tribe and was occupied by English settlers in 1657 and developed into a farming community. The town has a rich history of cotton and paper mills which ran off of hydropower from the nearby Charles River and Chicken Brook.

Medway has been a Green Community since 2010. With 2009 as their baseline year for their 20% energy reduction goal. The Town took the proactive step in 2010 to sign an ESCO agreement for the schools with Trane who conducted initial energy audits and has completed energy conservation measures in all of the school buildings. The majority of the Energy Conservation Measures (ECM's) that have been completed in the school buildings were done in the same year (2010) soon after the initial audits. In terms of data, this means that it can be difficult to parse out the impact of singular measures on changes in energy use for the year. Overall, we see some savings immediately after the measures taken in 2010, but not the sustained savings which were anticipated. Some of the measures were implemented before 2010 and may not show up in MEI and Annual Reports because the selected baseline year occurred afterwards.

In their annual reports to the Town, Trane identified some behavioral measures such as temperature set points which were preventing the Town from realizing full savings from these measures. In FY 2019 these recommendations were implemented where possible along with additional ECM's in the schools. Many of the non-school buildings underwent a separate audit recently and have more up to date energy saving estimates for ECM's. Future audits for the school buildings could help identify new Energy Conservation Measures for these buildings.

Energy Use in FY 2018

In fiscal year 2018, buildings made up 79% of municipal energy use, with vehicles as the second largest sector making up 15%. The town buildings used 38,306 MMBTU's of energy in FY 2018 which is a 9.2% decrease in building energy use over the baseline year (FY 2009). Over all sectors, the town saw a 5% decrease from the baseline. The top five largest municipal energy users were all school buildings, and include Medway High School, Medway Middle School, Memorial Elementary School, Francis J Burke Elementary School, and the John D McGovern Elementary School. Together, these five buildings make up 86% of the town's building energy use.

Building	FY 2018 Use in MMBTU's	% of Municipal Building Use
Medway High School	11,183	29%
Medway Middle School	11,134	29%
Memorial ES	6,000	16%
Francis J. Burke ES	2,221	6%
John D. McGovern ES	2,177	6%

KEY FINDINGS

The key findings are divided among process findings and priority buildings. These findings were generated through conversations with municipal staff, reviewing and analyzing energy data, and reviewing relevant documentation including; annual reports, Energy Reduction Plan, and contractor reports. At the end of each section, this report provides a set of key recommendations, which are summarized at the end of the report.

Process

Currently, the Green Communities reporting is led by the Compliance Coordinator, Stephanie Carlisle, who organizes the town buildings energy use data for the year, applies for Competitive Grants, updates manual data into the Mass Energy Insight Portal (MEI), and assembles the Town's Annual Reports. She is aided by the Facilities Managers for the Schools and Town Buildings who convey context about important updates in the buildings and the status of Energy Conservation Measures throughout the year. The facilities managers also ensure that behavioral measures are implemented. The Compliance Coordinator updates municipal leadership at least annually on the Green Communities progress overall, as well as informally through the year as needed. We recommend that the Town consider adopting the best practice of quarterly meetings with Green Communities stakeholders and municipal leadership to stay up to date on project process and prepare for both Competitive Grant applications and Annual Reports.

School Facilities Manager, Jim Kane, and the Compliance Coordinator, Stephanie Carlisle have completed the Building Operator Certification training, which is an important procedural measure to ensure that the energy saving equipment already installed is used to its fullest potential. This can be seen specifically in knowing appropriate set points for the building energy management systems.

In 2012, town buildings overall, but especially the High School and Middle School, experienced an anomalous dip in energy use according to the usage data in the Mass Energy Insight portal. This change is seen in both natural gas and electric accounts and isn't fully explained by the change in heating degree days for the year. As part of this energy evaluation, we looked into the energy data from FY 2012 and changes in the buildings to see if we could find an explanation. This anomaly seems to be a combination of unusual events in the buildings that year. Most notably, the Middle School had a major renovation in two wings and both were shut down for part of the year. The High School had a boiler replacement that year and the Middle School solar system was installed, resulting in a change in accounts for the building, which could account for part of this dip as well.

Since all of the priority buildings for this report are schools, we looked at the student populations at each school since the baseline year to get a sense of how much of the schools' energy use could be attributed to an increase in the number of building occupants. We found instead that the number of students decreased consistently in all schools since the baseline year. This indicates that remaining energy use in the buildings may have increased per student, or that there is inefficient equipment and spaces that run independently of the number of people in use of them. It could also be that the number of students has not dropped below a threshold where we would see changes in the equipment used, such as classrooms or part of a building not being in use. The increased energy demands of personal technology since the baseline may have increased the plug loads in classrooms and schools.

Another area where we expect change to have occurred, but where it was difficult to capture at the year-over-year level of information were policy changes. Without a long institutional knowledge of the buildings' use and occupancy schedules over time, it was very difficult to re-create what occupancy schedules may have looked like at the baseline year as opposed to now. The Trane reports give a

snapshot of what these schedules look like recently, but we have not seen these changes influencing the yearly data in a clear way.

Priority Buildings

This section of the report outlines key findings for the top five energy users in the building sector.

Medway High School

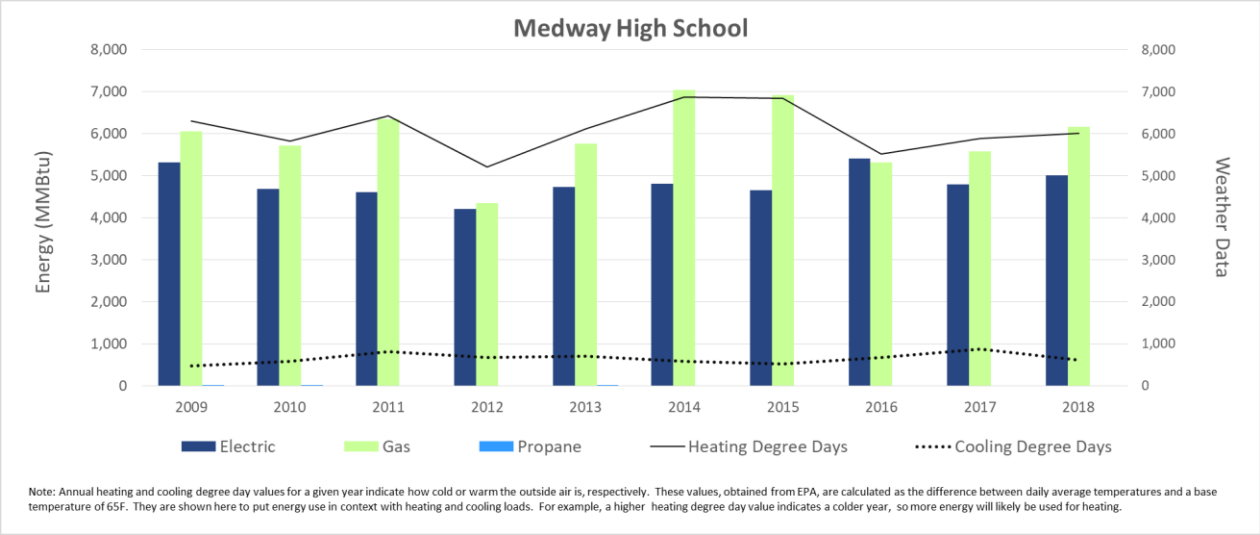

Figure 1. Energy Use (MMBTU) for Medway High School FY 2009-2018

The High School is 210,704 square feet and has an energy use intensity of for FY 2018 of 53 which is more efficient than EnergyStar's average of school buildings at an EUI of 61. The High School's energy use is about two thirds natural gas and one third electric. Medway's High School and Middle School together make up more than half of the energy use of the municipal building stock, making both buildings a high priority for energy conservation measures. The High School's gas use for the most part tracks pretty closely with the heating degree days. The exception to this is for fiscal year 2012, when there is some unusual data across the board. Specifically, natural gas use decreases more than would otherwise have been expected based on the change in heating degree days. At the High School though, this temporary change may be explained by a boiler replacement partway through the year. In terms of electric use, the chiller is the most significant load on site and the electric usage does follow the cooling degree days relatively closely. Because of this, ongoing maintenance of the chiller should continue to be a high priority.

Significant changes in energy data are expected for FY 2019. Unfortunately, one of the three boilers at the school failed this past winter and the remaining two had to be run more frequently than anticipated to keep the building at temperature. That boiler was replaced with a new, more efficient model this May and so the High School should see savings from this replacement in FY 2020 and onwards.

The High School has electric and gas accounts, one propane account which only shows a small amount of data in FY 2013, and a roof-mounted 134 kW Photovoltaic System. The electric use that the building drew from the grid has been combined with the solar production in Figure 1 in order to show comparable electric use year to year.

Similar to other priority buildings, many of the energy conservation measures were implemented all at once at the beginning of the Town's agreement with Trane in Fiscal Year 2010. ECM's included an interior lighting retrofit, Variable Frequency Drives on the chilled water pumps and booster pumps, a computer power management software, plug load controls and an Energy Management System upgrade. We can see some initial energy savings in electric use from FY 2010 for a few years, and then the use picks up again and varies year to year. There are some cooling loads in the building and apart from FY 2016, the electric use more or less maps to the cooling degree days.

Recommendations:

1. **Conduct Additional Energy Audits**
    - **a.** Explore weatherization measures and HVAC equipment (Air Source Heat Pumps) that may not have been studied in 2010
    - **b.** Receive more up to date cost estimates for measures to be able to make accurate estimates about the ROI of future energy conservation measures.
2. **Energy Conservation Measures**
    - **a.** Retro-commissioning of existing equipment such as the VFD's and Energy Management System to ensure they are functioning as intended and are capturing all the savings they can.
    - **b.** Additional occupancy sensors and plug load monitors to allow the building to use energy proportionally to the number of occupants.
    - **c.** Create a proactive maintenance plan to provide time to secure funding and research the feasibility of energy efficient alternatives.
3. **Behavioral Changes**
    - **a.** Conduct outreach and provide training for teachers and staff about the town's energy conservation goals and the existing energy management system in the High School. Energy management may be of interest to students as well. Where there is data or visual representations of energy use (or solar production), the building's energy could more easily be incorporated into a curriculum or project.
    - **b.** Consider creating a policy or guideline to consolidate spaces at times of lower occupancy in order to shut down other wings of the building. An example of this could be after school programing or sports events. Alternately, move uses from other buildings to the high-school when it would not be in use to be able to power down the other municipal building.
    - **c.** Explore opportunities for Peak Load Shedding with non-essential equipment or sections of the building that can be isolated.

Medway Middle School

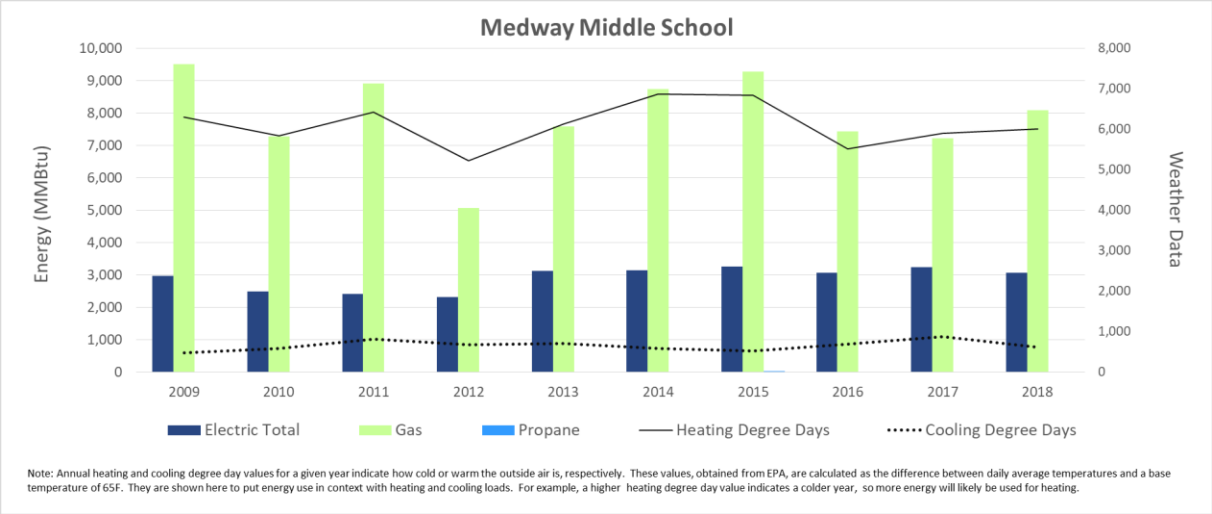

Figure 2. Energy Use (MMBTU) for Medway Middle School FY 2009-2018

The Middle School also makes up 29% of the municipal building energy use in Medway. The Middle School's energy composition is about three quarters from natural gas and the remaining quarter from electricity. The building is 257,634 square feet and has an energy use intensity of 43 (kBTU/SQFT), significantly better than the median EUI of 61 for school buildings. The building underwent a significant renovation in FY 2012, in which two wings of the building closed for a period of time, this shows as a temporary dip in the energy use data for 2012.

The Middle School has a 484 kW roof-mounted solar PV array. In the same way that the High School's total electric energy use was calculated, the solar production was added to the electricity pulled from the grid to make the total electric use in Figure 2. The solar system was installed in FY 2012, and we suspect that the change in account numbers from one typically-metered account to two net-meter accounts during this year may explain another part of the anomaly in the 2012 data. In the switch between accounts, data may have been missed in Mass Energy Insight.

The building has had a few changes in use since Medway became a Green Community. Notably, the Town's Department of Public Works relocated to the Middle School in 2016. The IT Department in the Middle School now houses the municipal servers which has increased the building's energy load. Overall, this seems to be an efficient use of the building since the school was designed for more students than are currently enrolled. The location of the computer servers in the Middle School also provides an opportunity for more specific energy conservation measures around this load.

The natural gas use in the Middle School has tracked with the heating degree days with the exception of 2012. There are individual AC units present in the building now, but in the past, the electric use doesn't look like it has matched up with the cooling degree days, so there may be other large electric uses or a culmination of smaller electric uses having an impact in the data. Some energy conservation measures were implemented in 2010 including VFD on the hot water pumps, some plug load controls, and computer power management software on 138 computers.

Recommendations:

1. **Energy Conservation Measures**
    a. Repair or Replace Lighting Controls: The building has existing lighting control panels for lighting in common areas, but these are run through a computer system which is difficult to access and some of the panels are broken. Fixing or replacing this equipment can help the lighting retrofits done in 2010 be used to their full efficacy.
    b. Retro commission the building's energy management system with Trane

c. Weatherization and HVAC measures with the aim of lowing the natural gas usage in the building.

2. **Behavioral**
    a. Coordination between municipal Staff and school staff is essential to make the Middle School building as efficient as it can be.
    b. Education and outreach on existing technology and equipment, the set points for the energy management system, and how to use plug load sensors and controls.
    c. Consider creating a set point policy for the Middle School to ensure ongoing savings
    d. Explore opportunities for Peak Load Shedding

Memorial Elementary School

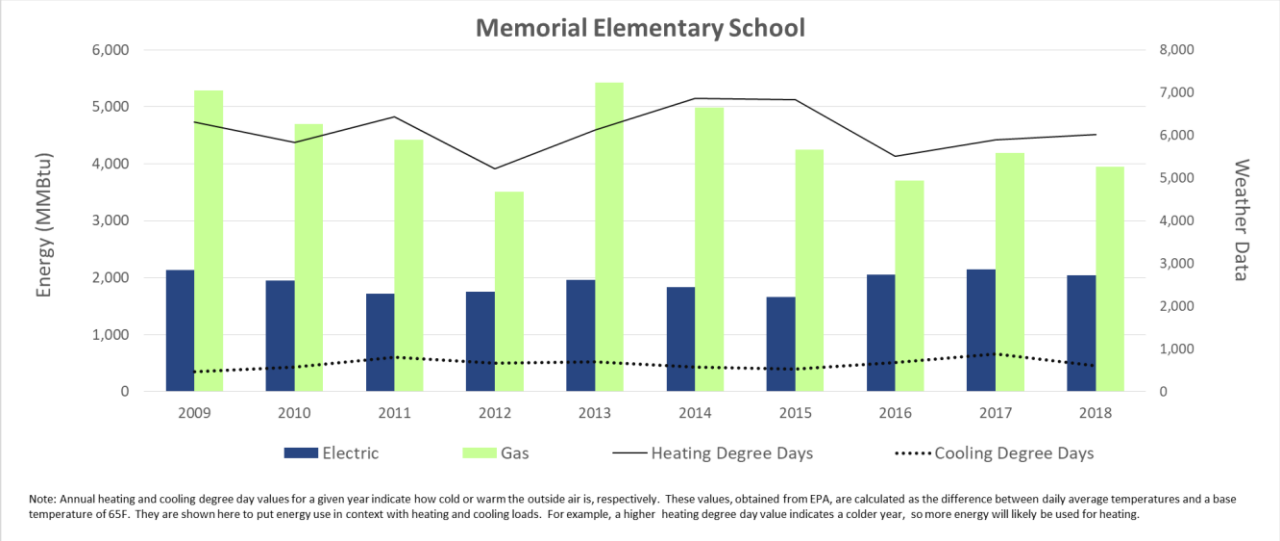

Figure 3. Energy Use (MMBTU) for Memorial Elementary School FY 2009-2018

Memorial Elementary School makes up about 16% of the buildings energy use for the Town of Medway. The school is 72,699 square feet, and has an EUI of 83 (kBTU/sq. ft.), which is significantly higher than the median for schools at 61. Memorial Elementary School has individual air conditioners for offices, and mostly tracks with the cooling degree days, suggesting that the air conditioners are the highest electric use in the building.

The natural gas usage mostly matches the curves of the heating degree days, although in 2013, the gas usage went up surprisingly. It would be good to dig further and determine what caused this spike in 2013, and if there was a data entry error in Mass Energy Insight. In 2015, a new BAS system was installed, which appears to have an influence on the annual energy use.

Memorial Elementary school also had lighting retrofits, motor replacements, and a new VFD in 2010. The town just this year replaced two condensing boilers, which is expected to have an impact on the building's data for FY 2019 and beyond. The roof of Memorial Elementary School is to be redone in FY 2022 which provides a good opportunity to add additional insulation and get savings in heating use.

Recommendations:

1. **Energy Conservation Measures**
    a. Retro-commissioning of the BAS system
    b. Weatherization and other HVAC measures.
    c. Occupancy sensors and plug load controls for the computer servers.
2. **Behavioral Measures**
    a. Set up a standing meeting for the school staff to meet with municipal staff and discuss updates to the building and how the community is progressing towards its 20% reduction goal.
    b. Consider creating a set point policy for the school with buy in from school staff.
    c. Consider partnering with Francis J Burke Elementary School in educational efforts around energy conservation.

Francis J Burke Elementary School

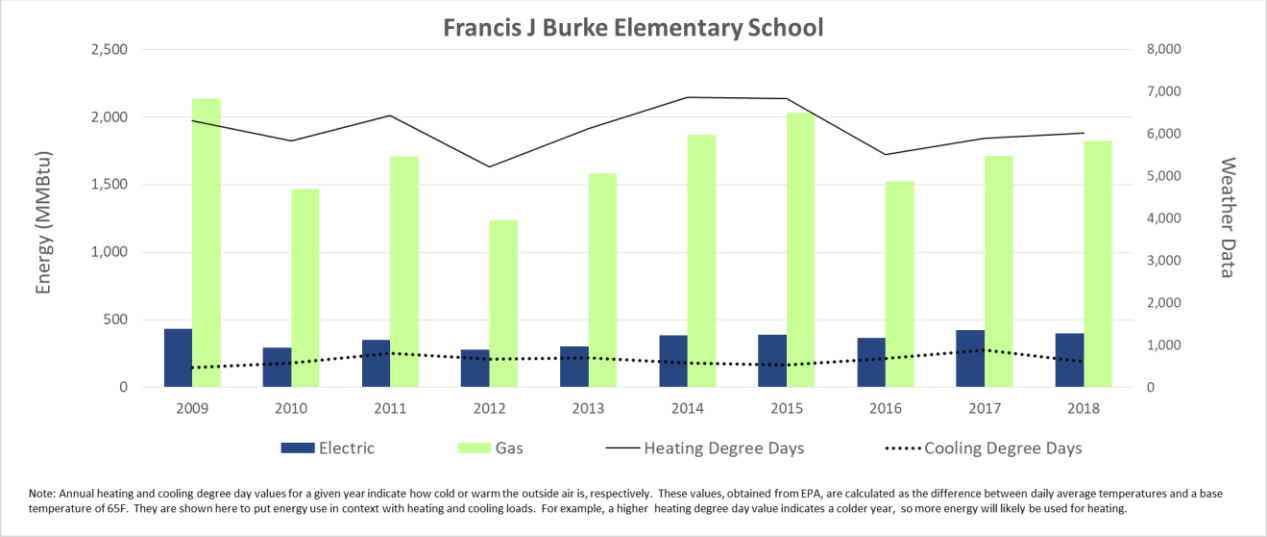

Figure 4. Energy Use (MMBTU) for Francis J Burke Elementary School FY 2009-2018

The Francis J Burke Elementary School and the John D McGovern Elementary School each account for 6% of the town's building energy use. The school is 39,640 square feet and is a little under the median EUI for schools at 56 kBTU/sqft. The natural gas usage appears to have gotten more efficient in 2010 right after the energy conservation measures were implemented. The usage then went back up a little since these measures, which makes the building a good candidate for retro-commissioning to make sure these systems are still being used effectively and do not need repair.

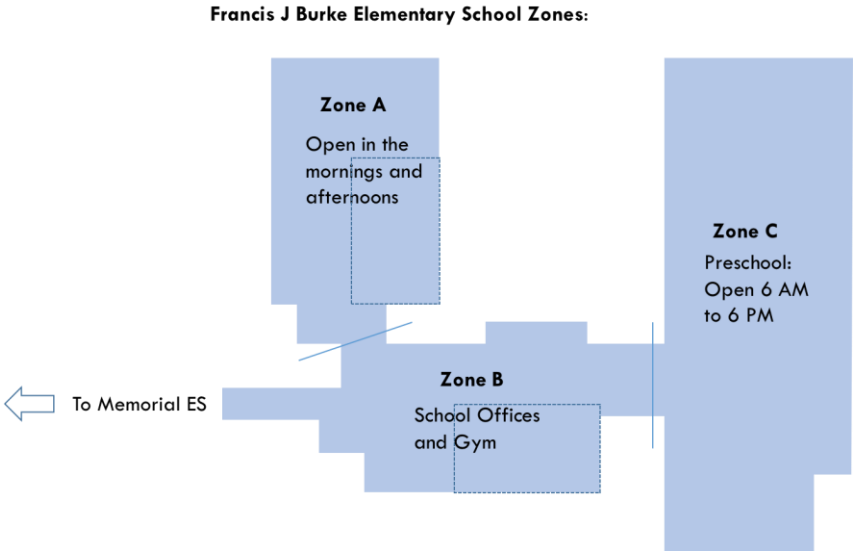

Figure 5. Heating Zones Corresponding to Boilers at Francis J Burke Elementary School

The building is home to many different use types including a preschool from 6 AM to 6 PM and a before and after school program from 7 to 8 AM and again from 3 to 6 PM. In order to run these programs in

different wings of the building currently, the heat has to run between 9 AM and 3 PM consistently. There may be the potential to run this building more efficiently by consolidating some of the uses to one wing of the building at a time, enabling one or two boilers to power down.

Recommendations:

1. **Energy Conservation Measures**:
    a. Retro-Commissioning
    b. Additional HVAC measures where applicable
    c. Weatherization measures for the building
2. **Behavioral Measures:**
    a. Consider opportunities to consolidate uses to one or two wings of the building.
    b. Consider partnering with Memorial Elementary School in educational efforts around energy conservation.

John D McGovern Elementary School

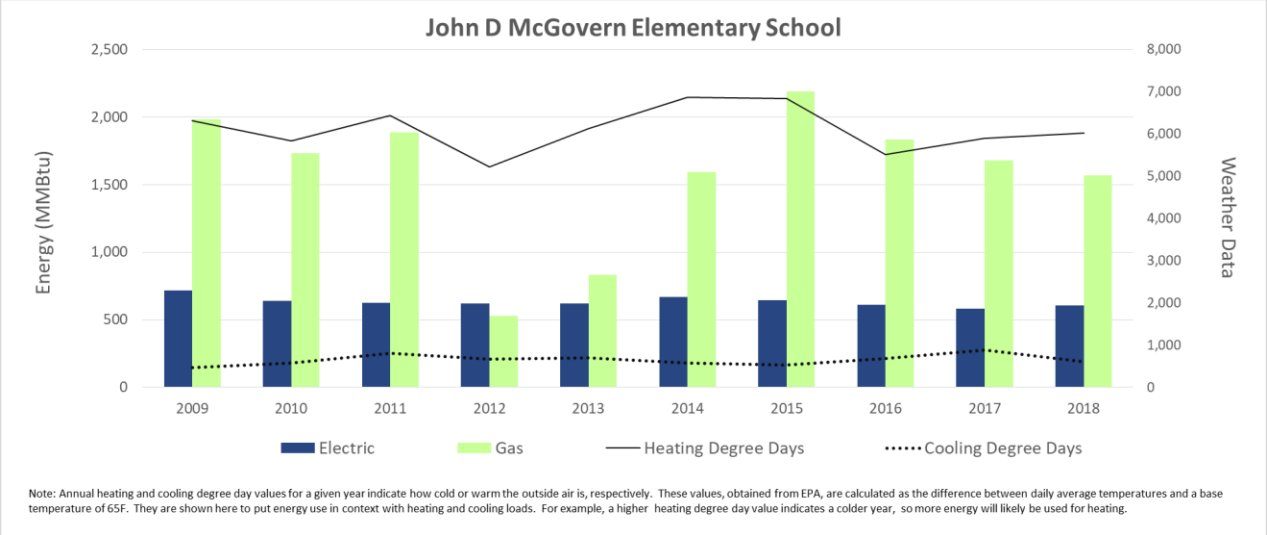

Figure 6. Energy Use (MMBTU) for John D. McGovern Elementary School FY 2009-2018

The John D. McGovern Elementary School also makes up 6% of the town's municipal energy use. The school has the best EUI out of the priority buildings at 36 kBTU/sqft, approximately half of the use intensity of the median school building. The gas data for FY 2012 through FY 2014 appears to be incorrect or partially missing, unless there was a significant equipment change during these years. We did not find an obvious explanation for this drop within the timeline of this evaluation.

The windows and doors of the school were replaced around FY 2015. We see the gas use drop off after this point, despite an increase in heating degree days during the same period. This indicates that these weatherization measures have had a continued impact on the gas use at the building. There may be other factors at play in the continued decrease, since we would expect to see these savings as a one-time drop which is maintained.

Another factor in the school's gas use over time is that the school previously has had only one boiler, which meant that it would have to run 24/7 in some instances. In FY 2019 the school got a new high efficiency boiler which is anticipated to result in significant savings over the coming years. This new boiler will be running as the primary boiler with the original boiler as backup.

Recommendations:

1. **Data**
    a. Additional Energy Audit including weatherization measures
    b. Find utility bills or records for FY 2012 through FY 2014 to look for data errors for these years in Mass Energy Insight.
2. **Energy Conservation Measures**
    a. Retro-commissioning for HVAC measures
3. **Behavioral Measures**
    a. Consider creating a set point policy for the school

SUMMARY OF RECOMMENDATIONS

Data Recommendations

Consider Energy Accounting Adjustments for the Middle School and other school buildings with new uses. Consider building energy use changes that have happened since the baseline year such as the relocation of the Department of Public Works to the Middle School or instances where the building is used by an organization other than the town. These may be opportunities to adjust the energy use accountable to that building or the town in the progress towards the 20% reduction goal.

Consider Energy Use before the Baseline Year for accounts where Energy Conservation Measures were implemented at the beginning of the program. For these accounts, it may be difficult to see the full savings from measures implemented within FY 2009. The town may want to consider moving the baseline year back to FY 2008 if there is enough data for that year, and if it would enable the town to demonstrate the savings obtained in the beginning of the ESCO with Trane.

Energy Conservation Measures

Consider new Energy Audits to get more up to date estimates on the return in energy and cost savings that Energy Conservation Measures would have now. There are likely new ECM's that Trane or another vendor would recommend for the school buildings in a second audit, as well as energy efficient technology that has become more affordable. We recommend that additional audits pay particular attention to weatherization measures and other areas that may not have been explored initially. New audits would enable the Town to accurately update the Energy Reduction Plan for the future.

Match Weatherization Opportunities to the Roof Replacement Schedule. As the school roofs are replaced over the next seven years, plan to install additional insulation in order to realize energy and cost savings in heating. Roof replacements present a unique opportunity to implement weatherization measures cost effectively and allow the town to plan for roof-mounted solar installations.

Consider Retro Commissioning where Energy Conservation Measures have not resulted in expected savings. Work with Trane, and continue to make recommended adjustments from their annual report to the Town in order to ensure savings continue for measures already taken.

Behavioral Measures

Plan Regular Maintenance of Large Equipment. The town should expect to see significant savings for FY 2019 both from equipment replaced and equipment maintained. Preventative maintenance is a low-cost way to continue these savings.

Consider a Town-Wide Temperature Set Point Policy. One of the big takeaways from Trane's reporting was the importance of maintaining set points in order to keep saving. Creating a Town-Wide policy could be a way to gain buy-in from different stakeholders within Medway and to ensure town buildings are both comfortable and efficient.

Explore Peak Load Shedding and Consolidation of Building Use Peak Load Shedding could be particularly effective at the Middle and High School and would serve to save the town in energy costs. Consider looking for ways to consolidate building uses such as the different zones of Francis J Burke Elementary School. By identifying non-essential uses and opportunities to effectively use space, the schools can have more flexibility in their energy use.

Consider Opportunities for Education and Outreach to get staff buy in on set points and behavioral measures for energy efficiency. An example of this is the relatively slow warm up rate of the High School. Some outreach about the buildings energy systems could result in more strategic selection of spaces for different uses as well as effective temperature set point setting.