SUSTAINPVD

Municipal Energy Report *FY 2017*

Acknowledgements

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Glossary

Benchmarking: a means of comparing a building's energy use to the average of similar buildings or to an established baseline.

Commercial Building Energy Consumption Survey (CBECS): a national sample survey that collects information on the stock of U.S. commercial buildings, including their energy-related building characteristics and energy usage data. (https://www.eia.gov/consumption/commercial/about.php)

Heating Degree Days (HDD): indicators of energy consumption for space heating. HDD are calculated by taking the average of a day's high and low temperatures and subtracting from 65°. For example: If the day's average temperature is 50° F, its HDD is 15. If every day in a 30-day month had an average temperature of 50°, the month's HDD value would be 450 (15 x 30). HDD data comes from Weather Data Depot (http://www.weatherdatadepot.com/), an online weather data hub powered by AccuWeather©

Building Management System (BMS): a computer-based system that controls and monitors a building's mechanical and electrical equipment such as HVAC, lighting, power systems, fire systems, and/or security systems. Often used for energy efficiency, real-time views into facility operations and trend analysis can provide data to optimize energy management and minimize operational costs.

British thermal unit (Btu): a unit of heat defined as the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit. A kBtu equals 1,000 Btu. An MBtu, or MMBtu, equals 1,000,000 Btu.

ENERGY STAR Score: a measure of a building's energy performance relative to similar properties, when normalized for weather and operational characteristics.

Energy Use Intensity (EUI): measures the energy use per square foot of a building. It is calculated by dividing the total energy consumed by the building in one year by the total gross floor area of the building.

Kilowatt Hour (kWh): a unit of energy equal to 3.6 mega joules commonly used as a billing unit for energy delivered to consumers by electric utilities.

Renewable Energy Credit (REC): A Renewable Energy Credit, also known as a Renewable Energy Certificate, is a tradable non-tangible energy commodity equivalent to 1 megawatt-hour (MWh) of electricity generated from a renewable energy source such as solar energy, that has been fed into a power grid.

Site Energy: the amount of energy consumed at a specified location. It can be a mix of fossil fuel such as natural gas, and electricity that is transmitted to the facility. It can be measured at the campus, building, or sub-building level and is the basis for energy charges on utility bills.

Source Energy: Unlike site energy use, source energy use includes losses that take place during the generation, transmission and distribution of energy.

Steam Trap: A steam trap valve allows for the discharge of condensate and non-condensable gases with a negligible loss of steam.

Variable Frequency Drive (VFD): 25% of all the world's electricity is consumed by electric motors in industrial applications. Applying a variable frequency drive (VFD) to a pump allows control of the pump's speed electronically, while using only the energy needed to produce a given flow.

Watt: a unit of power defined in the International System of Units as a derived unit of 1 joule per second, and is used to quantify the rate of energy transfer. A kilowatt (kW) equals 1000 watts, and a megawatt (MW) equals 1,000,000 watts.

Zero Energy Buildings: buildings that produce at least as much energy as they consume over the course of a year.

Executive Summary

The Providence Municipal Energy Report discloses the City's facility energy data in an effort to track progress towards the City's energy goals, increase transparency, and lead by example. The City's 2014 Sustainable Providence plan set a goal to reduce energy consumption 30 percent by 2030. Measuring and monitoring energy consumption by benchmarking buildings is critical to ensuring we are achieving this goal.

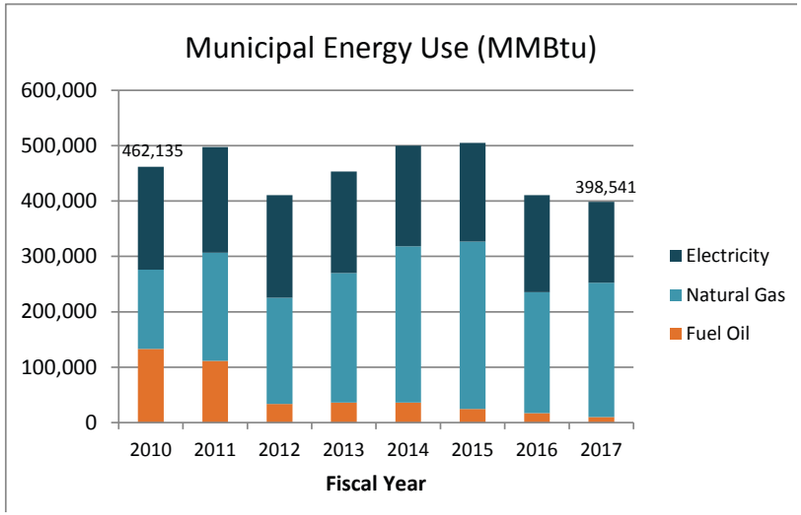


Figure 1: City of Providence's electricity, natural gas, and fuel oil consumption, FY 2010 - FY 2017. In FY 2017, the total amount of energy used by all City facilities declined 15.5% from the previous three-year average.

The City of Providence has been benchmarking and monitoring its energy consumption as part of its fiscal and environmental agenda since 2010. This FY 2017 report marks the third annual municipal energy report released by the Office of Sustainability. The Office of Sustainability uses the U.S. Environmental Protection Agency's Energy Star Portfolio Manager to track all of the City's electric, gas, oil, and water consumption. This data helps the City manage its energy consumption and identify opportunities for investment and savings. The information in this report summarizes the full dataset, which is available on the City's Open Data Portal.

The City's facilities, including buildings and outdoor lighting, used 398,541 MBtu of energy in FY 2017 in the form of electricity, natural gas, and oil.

Highlights:

- The City's expenditures on energy have declined by 28% between FY 2010 and FY 2017.
- In FY 2017, the amount of energy used by City facilities was down 15.5% from the previous three-year average.
- Greenhouse gas emissions from municipal facilities decreased 26% since 2010, reflective of cleaner fuels, LED lighting conversions, and heating system upgrades. Emissions in FY 2017 were 7% lower than in FY 2016.
- Recent investments in lighting and mechanical efficiency measures have reduced electricity consumption by 21% since 2010.
- The City has reduced #2 fuel oil consumption 92% since 2010. As of December 2016, heating oil was eliminated from all City school buildings.
- Projected energy savings from efficiency projects in five buildings completed in FY 2016 are expected to reach over $100,000 annually. In FY 2017, total energy use from these facilities was reduced by 14%, and greenhouse gas emissions were already down by nearly 30%.
- The City has converted all of its 16,800 streetlights to smart LED fixtures, estimated to save the City $18.9 million in the next ten years, and expected to reduce City carbon emissions by about 9,441 metric tons annually.
- About half (22 out of 45) of the City's Energy Star eligible buildings qualify for certification, meaning they perform better than 75% of similar buildings.
- 29 buildings increased their Energy Star scores between 2010 and 2017.
- In FY 2017, the average energy use intensity (EUI) at the 35 buildings ineligible for Energy Star scoring due their use type was down 7% from 2010.
- The average Energy Star scores of all City schools combined has risen 31% since FY 2014, largely due to energy efficiency upgrades and HVAC control retro-commissioning completed in the buildings.
- The City's efforts in energy efficiency were recognized by the Rhode Island Office of Energy Resources' Lead by Example Awards.

[1] Annual reports may reflect changes in certain historical energy use and cost figures due to corrections or revisions by National Grid and/or the Office of Sustainability. The differences are minor, usually less than one or two percent.

Contents

Introduction

The City of Providence has been monitoring its energy consumption as part of its fiscal and environmental agenda since 2010. The Providence Municipal Energy Report presents the City's energy data publicly to showcase this work and increase transparency and accountability. It also highlights the City's leadership in making investments in energy efficiency and renewable energy over the past several years.

The 2014 sustainability plan, Sustainable Providence, set a goal for the City to "achieve a minimum of 30 percent energy use reduction by 2030 on all City-owned property." To meet this goal, it calls for investments in clean and renewable energy and energy efficiency projects. In 2015, Mayor Elorza called for the plan to be expanded to also include a greenhouse gas reduction goal. This was marked by his joining the Global Covenant of Mayors (formerly the Compact of Mayors), a global coalition of mayors pledging to reduce greenhouse gas emissions and enhance climate resilience. On Earth Day of 2016, Mayor Elorza reinforced his commitment to climate action by signing an executive order, committing Providence to becoming a carbon neutral city by 2050.

Measuring and disclosing energy use is the first step in meeting the City's energy and greenhouse gas reduction goals. Under Mayor Elorza's continued leadership on fiscal and environmental responsibility, the City of Providence is following in the footsteps of many other U.S. municipalities by benchmarking its buildings and publicizing annual energy reports. Benchmarking is the practice of comparing building energy use to either other similar buildings, or historical data in an effort to manage energy consumption. Other cities that have produced similar reports in recent years include San Francisco, Boston, New York, and Seattle.

The City uses two primary energy management software applications to track all of the City's electric, gas, oil and water usage: the U.S. Environmental Protection Agency's Energy Star Portfolio Manager and Peregrine Focus. These programs allow the City to track performance on past energy efficiency projects, target buildings for new energy conservation measures, and manage energy spending.

These annual reports provide a transparent, easy to understand narrative that informs the public on City energy use. The monthly building electric, natural gas, and fuel oil consumption data from FY 2010 through 2017 used for the report is available via the City website on the Sustainability Dashboard. [2]

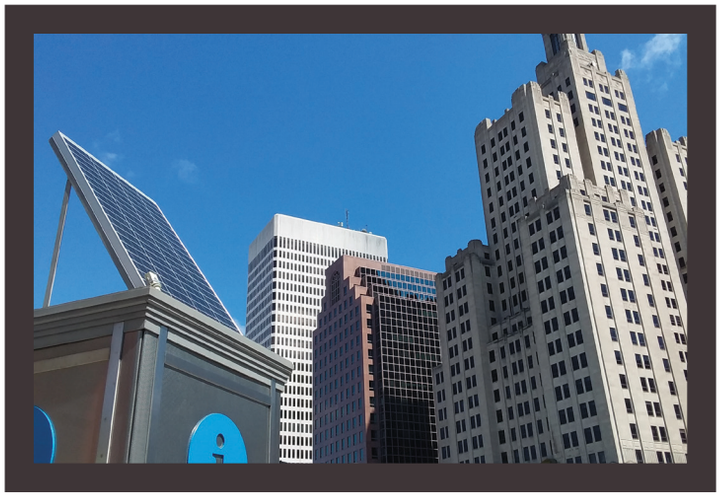
[2] https://performance.providenceri.gov/stat/goals/r6yh-954f

City Energy Use

Overview

The City's facilities, including buildings and outdoor lighting, used 398,541 MBtu of energy in FY 2017 in the form of electricity, natural gas, and oil (see Figure 1). The City has converted most of its oil-fired furnaces to natural gas, which has nearly eliminated the use of fuel oil but increased the use of natural gas. In 2017, natural gas accounted for roughly 61% of City facility energy consumption at 242,183 MBtu. Electricity accounted for 37% of the City's total energy use at 146,099 MBtu, while #2 heating oil accounted for only 2% 10,260MBtu.

Since 2010, energy consumption has declined by 14%, with some year-to-year fluctuations that are mostly attributed to weather patterns. Figure 2 shows the correlation between the City's energy consumption and weather. Weather patterns are tracked by Heating Degree Days (HDD), a standard means of normalizing energy data to weather. For example, 2012 HDD data showed an extremely mild winter; therefore the City's energy use dropped significantly. Other factors contributing to variations in energy consumption are investments in energy efficiency measures and changing use and/or operation of the building. However, weather is typically the primary factor in energy use fluctuations.



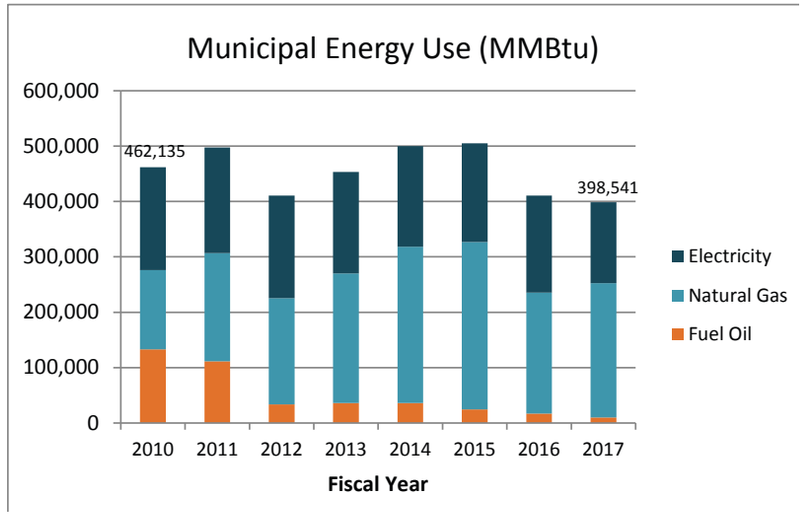


Figure 1: City of Providence's electricity, natural gas, and fuel oil consumption, FY 2010 - FY 2017. In FY 2017, the total amount of energy used by all City facilities declined 15.5% from the previous three-year average.

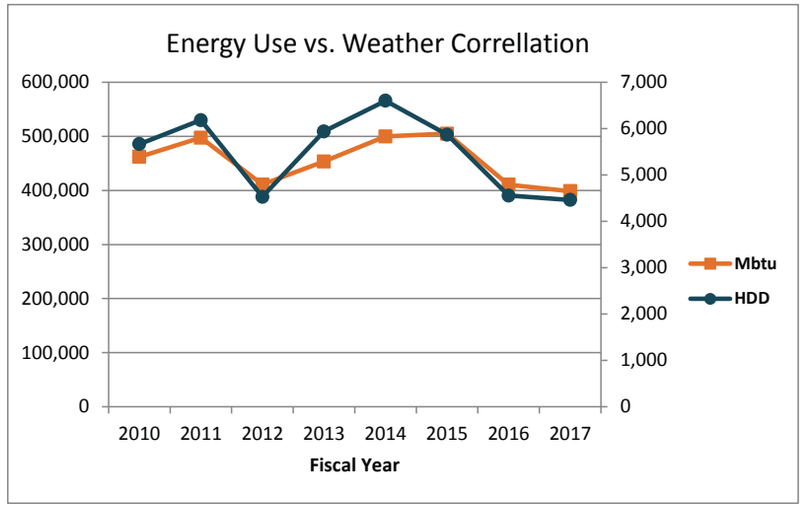


Figure 2: Because a significant amount of energy is needed for heating municipal buildings, weather is a driving factor in overall energy consumption.

Electricity

In FY 2017, the City of Providence used roughly 42,819,260 kWh of electricity; a 21% reduction from its 2010 baseline and 16.5 % reduction from FY 2016 (see Figure 3). Though the primary driver for electricity reduction was the conversion of the City's streetlight to LEDs, other factors included lighting retrofits at Providence's schools and municipal buildings, along with transitions to more energy efficient electronics and appliances.

Thermal

The City of Providence uses two sources of thermal energy for heating its facilities: natural gas and #2 fuel oil. Relative to fuel oil, natural gas is a cleaner-burning fuel and provides a considerable greenhouse gas reduction; however, switching from fuel oil to natural gas is only considered an energy efficiency measure when performed in concert with energy efficient upgrades such as installing condensing boilers or advanced monitoring systems.

Natural gas remains a cheaper alternative to #2 fuel oil, and natural gas-fired boilers require less maintenance, which also helps save the City money. Fuel-switching efforts at City schools began in 2009, and by the end of 2016, #2 fuel oil was no longer in use in any of the district's buildings. Subsequently, the City has focused efforts on HVAC controls and retro-commissioning for maximum energy savings.

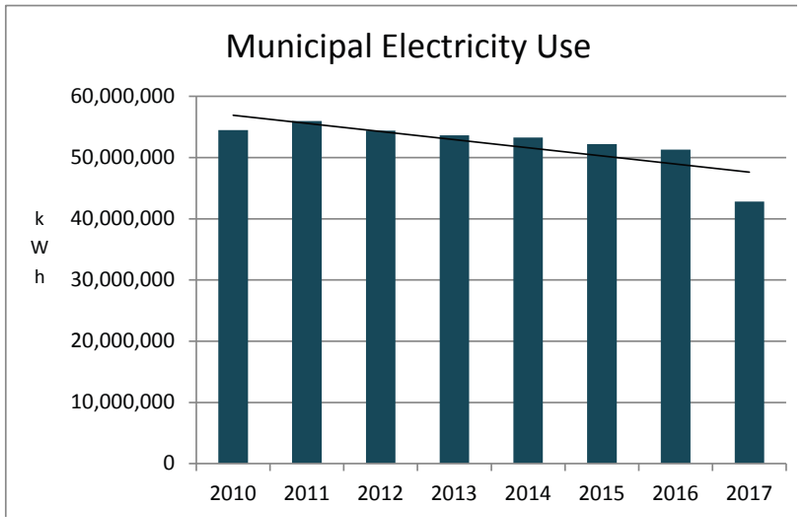


Figure 3: City of Providence's electricity use shown in kWh, 2010 - 2017. Electricity consumption has declined by 21% since 2010.

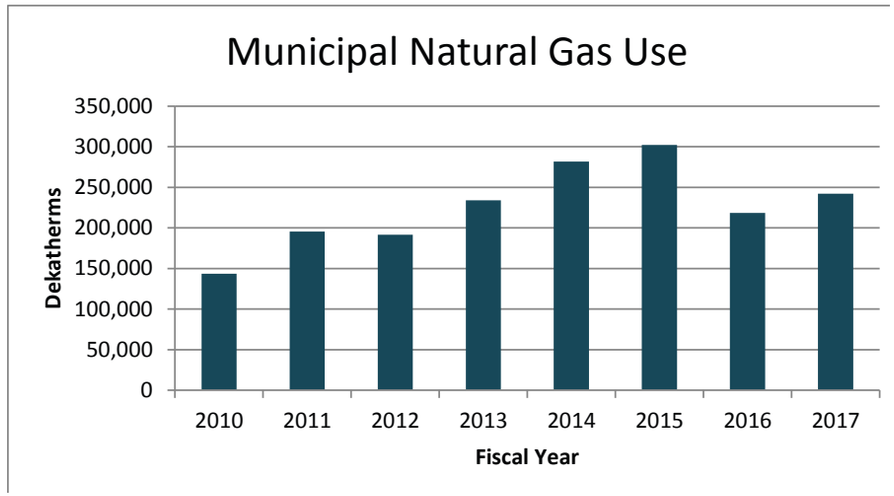


Figure 4: City of Providence's natural gas use, shown in dekatherms, 2010 - 2017

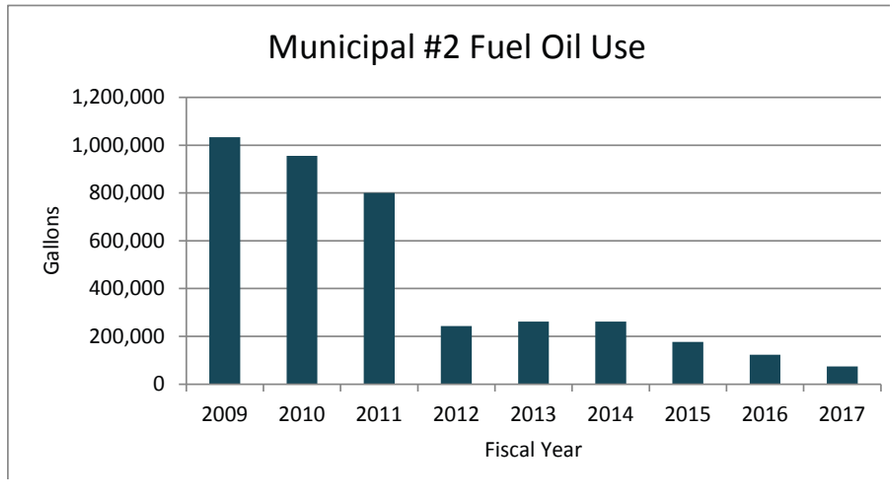


Figure 5: City of Providence's fuel oil consumption has declined by 92% since 2010 due to converting to natural gas systems.

Energy Supply: Renewables & Procurement Strategy

The Department of Public Property continues to work with the Office of Sustainability to identify energy conservation measures to maximize its operating budget and combat increasing energy costs. Rhode Island Public Utility Commission (RIPUC) historic data shows that National Grid's average cost of electricity rose roughly 78% between 2009 and the end of FY 2015, from an average cost of 6.09 cents/kWh to 10.82 cents/kWh, dropping to 9.6 cents/kWh in FY 2016 (see Figure 7). Despite these rising prices, the City has reduced its operating costs for energy by nearly 28% since 2010 (see Figure 6).

Energy procurement strategies have played a significant role in reducing the City energy costs while also providing stability for budgeting. The City continues to work with a third party energy supplier, Direct Energy, to secure long-term, fixed prices for its electricity supply. These contracts, covering FY 2012 through FY 2016, saved the City over $4.3 million compared to what it would have paid for electricity supplied by National Grid for that same time period (see Figure 7). Such contracts are enabled by the Energy Policy Act of 1992, which decoupled electricity distribution (retained by the utilities) from suppliers.

Virtual Net Metering

The City has partnered with Southern Sky Renewable to develop a 23 megawatt (MW) solar development in Cranston, RI. The solar farm will provide virtual net metering credits that will cover roughly half of the City's total electricity consumption and will save the City an estimated $800,000 per year and about $20 million over 20-years. After the first seven years of the contract, the City will also be able to claim the Renewable Energy Credits (RECs) and claim the carbon reduction benefits of the solar production. Construction on the solar farm began in 2017 and it is estimated that the system will be online at the end of the calendar year.

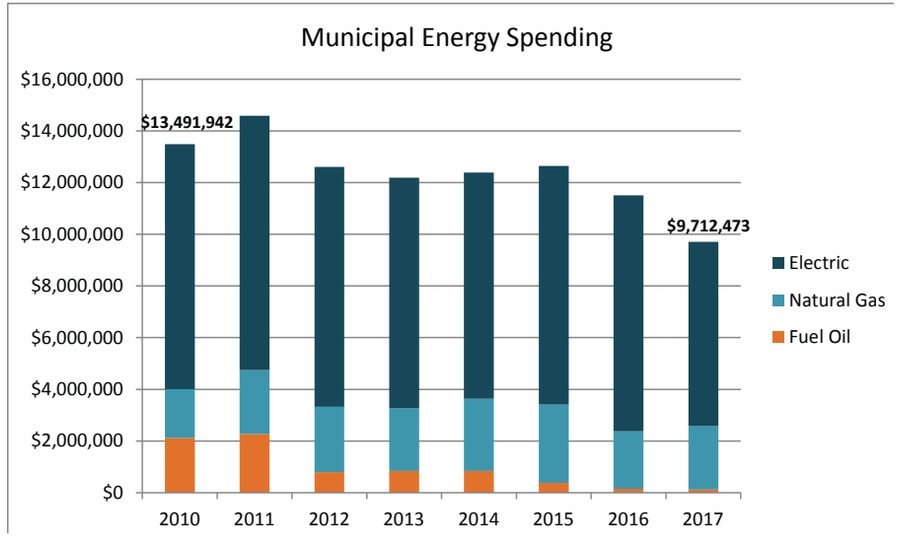


Figure 6: Despite rising energy costs, municipal spending on energy has decreased by 28% since 2010.

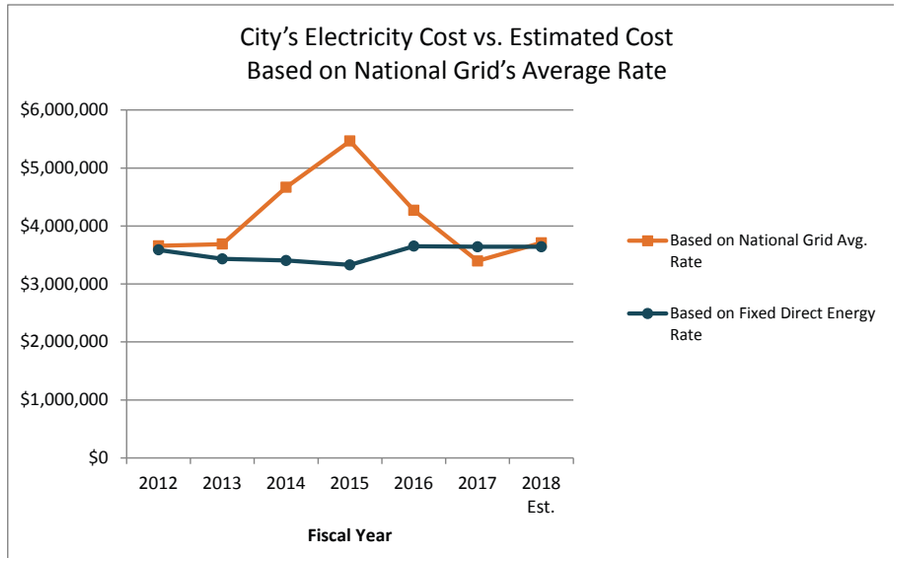


Figure 7: The graph provides a comparison of the City's actual electricity cost based on its third-party supplier rate versus estimated cost of National Grid's average rate.

Building Portfolio

The City's Department of Public Property manages and maintains approximately 130 buildings totaling 5.4 million square feet of floor space. This includes 38 school buildings, [3] one central public safety complex, nine district police sub-stations, 12 fire stations (the Humboldt Fire Station closed in 2017), eleven recreation centers,[4] three maintenance buildings, 35 park buildings, one multi-level parking garage, one police academy training facility, and seven administration buildings. The school's roughly 4.2 million square feet of space accounts for 78% of the City's portfolio (see Figure 8). Of the remaining 27% of building space (Figure 9), public safety buildings account for 30%, buildings for public assembly such as The Casino at Roger Williams Park account for 25%, administration buildings such as City Hall account for 21%, DPW buildings total 13%, and recreation centers account for 9%. The remaining two percent of properties include buildings such as the City's animal shelter and historic buildings including the Esek Hopkins House, on Admiral Street, and the Garvin House on Mashapaug Pond.

The buildings in the City's portfolio were constructed within a span of over one hundred fifty years, with Providence City Hall being one of the oldest, built in 1855 (see Figure 10). The newest City-owned building is the Providence Career and Technical Academy, built in 2009. The state-of-the-art technical education facility was built in conjunction with The Rhode Island Department of Education and their partners, the Collaborative for High Performance Schools, who provided guidelines on design and construction best practices for saving energy. Newer buildings owned by the City have incorporated more advanced lighting and HVAC technologies, and efficiency guidelines, resulting from advancements in the Rhode Island State building codes, particularly the SBC-8 (RI Energy Conservation Code), the 2013 sixth edition of which aligns with the 2012 International Energy Conservation Code.

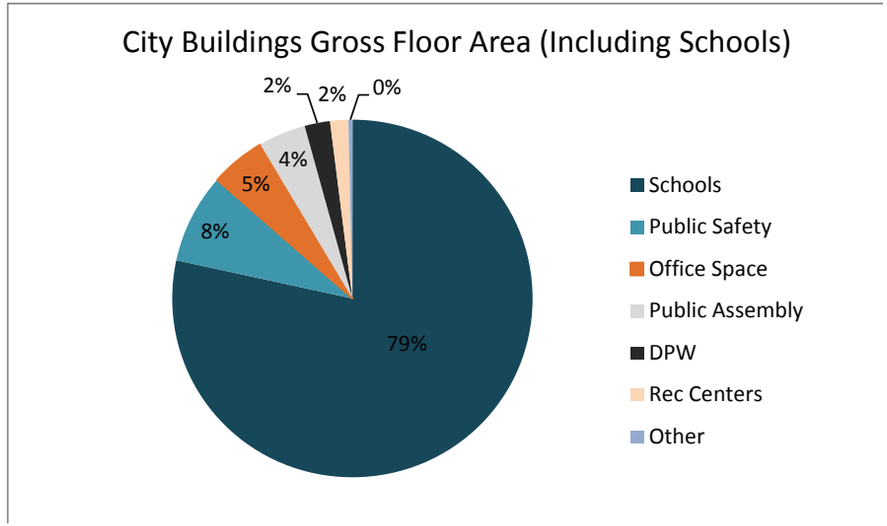


Figure 8: Total municipal building area percentage by facility type in 2017. Percentages based on building square footage.

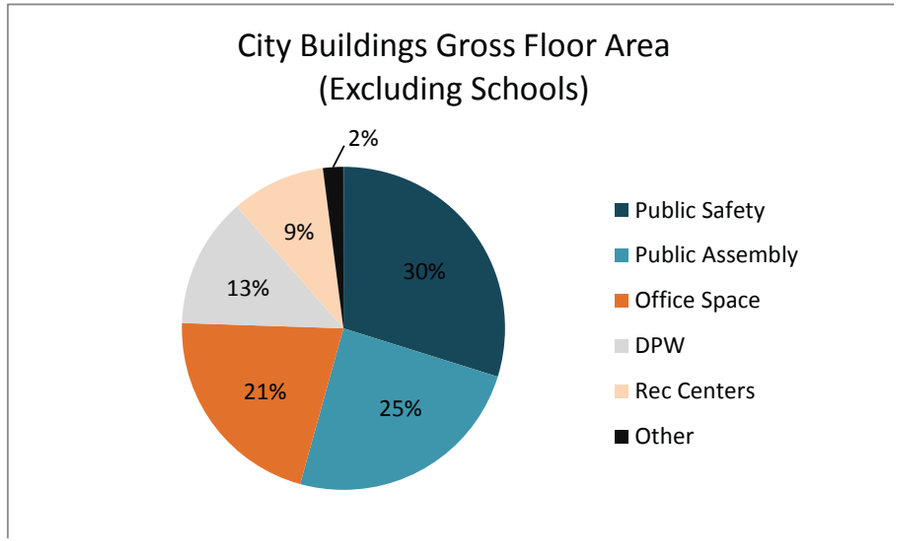


Figure 9: Municipal building area percentage by facility type in 2017. This graph excludes schools, which accounts for 78% of the building portfolio.

[3] Some buildings house more than one school.
[4] Several of the City's schools double as neighborhood rec centers such as the B. Jae Clanton Educational Complex that serves as the John H. Rollins Rec Center, and Pleasant View Elementary School that now doubles as the new Armand E. Batastini Jr. Rec Center. Robert F. Kennedy and Sacket Street Elementary Schools also opened their new rec centers in 2017.

Identifying building use-types and age in this way helps in understanding the energy needs. For instance, a public safety building such as a fire station, compared to an office building of similar size, may use more energy for heating and cooling, based on the fact that its garage doors are opened often during shifts. Fire and police stations are also generally occupied around-the clock, unlike offices or recreation centers.

Building age is also a factor. It is often perceived that older buildings are less efficient; however, buildings constructed before the advent of HVAC systems and cheap and accessible energy, were designed to be comfortable without these technologies. As a result, they are often low consumers of energy when compared to more modern facilities. As you can see in Figure 10, buildings built in the mid-century are actually some of the least efficient buildings in our portfolio. These buildings were designed and constructed during a time when energy was cheap and building codes were not focused on energy efficiency measures.

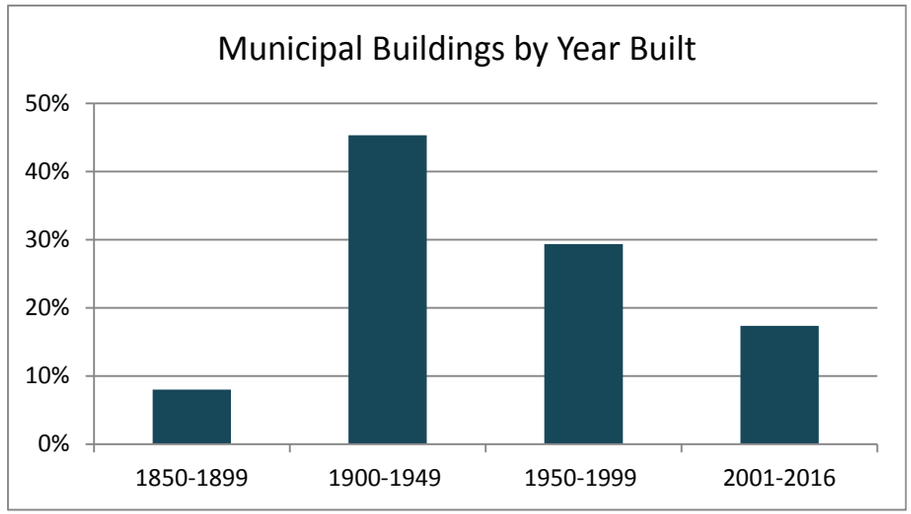


Figure 10: Municipal buildings by year built shown as a percentage. Most of the City's building portfolio was built in the early 20th century.

Benchmarking Buildings

Benchmarking allows for the review of a building's energy performance despite variables such as its size, age, type of use, level of occupancy, and weather. Benchmarking is a critical practice that enables the City to identify opportunities for energy efficiency savings, track building performance, and measure the effectiveness of energy efficiency measures. The City has benchmarked nearly 100 percent of all City-owned buildings. Only a small handful of buildings, including a number with no utility use, have been omitted. To benchmark its buildings, the City uses Energy Star Portfolio Manager, a free online building benchmarking tool developed by the United States Environmental Protection Agency. It enables users to create building profiles by entering basic site information, such as year built and total square footage, and provides an Energy Star score, which is a 1-100 standardized metric of energy efficiency.

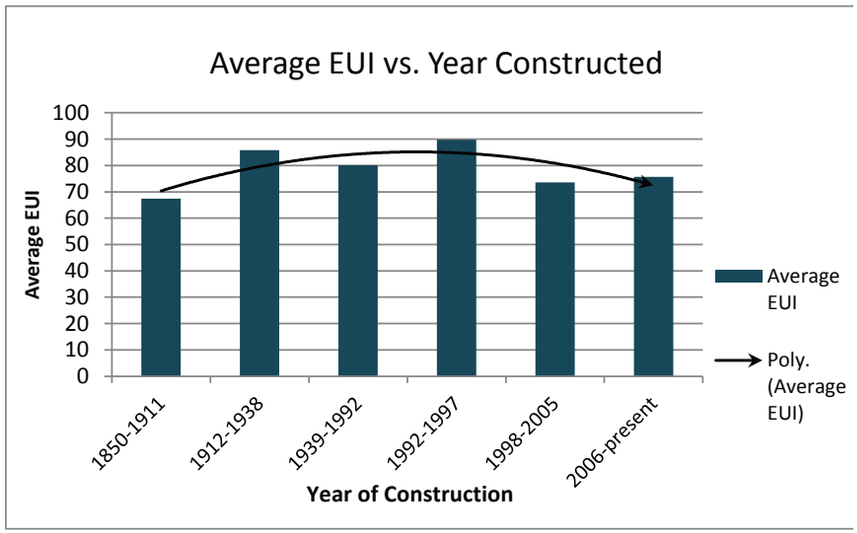


Figure 11: This graph compares year of construction with building's energy use intensity (EUI). Older municipal buildings, built before the advent of energy-intensive heating, cooling and lighting systems, are some of the City's lowest energy consumers per square foot. New policies such as the International building code of 1997 and energy policy act of 2005 have also influenced energy performance in modern buildings.

Energy Star Portfolio Manger uses utility billing data, along with details about the facility itself including gross floor area (sq. ft.), year built, and occupancy, to benchmark buildings against a national median of buildings with the same characteristics. The software also tracks how buildings perform over time. Users enter a minimum of one year's worth of energy bills for each fuel type. Portfolio Manager then calculates a building's Energy Use Intensity (EUI), a metric that represents the amount of Btu's (British thermal units) that a building uses per square feet. The higher the EUI, the more inefficient the building is. Portfolio Manager also calculates scores for buildings in certain categories, so that they can be recognized with Energy Star certification. To score a building, Portfolio Manager takes the building's source energy use intensity (EUI) then uses a regression equation specific to each property type that reflects data from the US Energy Information Administration's (EIA) Commercial Building Energy Consumption Survey (CBECS) to calculate predicted EUI. The resulting actual/predicted EUI ratio is what determines the building's 1-100 Energy Star score. Buildings with a score of 50 perform better than fifty percent of peer buildings, while buildings scoring 75 or above are in the top 75th percentile, making them eligible for Energy Star certification.

ENERGY STAR® PortfolioManager®
The most-used energy measurement and tracking tool for commercial buildings.

An Energy Star score is dependent on a nationally representative data set and robust analysis. Because of this technical foundation, many of the City's municipal buildings, such as fire stations, recreation centers, and service buildings cannot be benchmarked with an Energy Star score. Alternatively, these buildings are benchmarked on the basis of site EUI. For the purpose of this report, site EUI for each facility is compared to the site EUI of other City municipal buildings of a similar type, all sharing the same climate and weather patterns, characteristics not represented by the national survey data. Although Portfolio Manager is capable of measuring energy use for all types of buildings, some building types are not eligible for scoring such as public safety buildings, DPW buildings and rec centers. The Providence Career and Technical Academy, unlike other City schools, is also not eligible to receive an Energy Star score.

In August of 2018, the EPA will be updating scoring models to reflect 2012 Commercial Buildings Energy Consumption Survey (CBECS) data supplied by the U.S. Energy Information Administration. The new data, published in 2016, is a 29% larger sampling, with a 14% increase in the total number of buildings, and a 22% increase in total building floor space. Though the change may result in lower City building scores for next year's fiscal reports, the new calculations will be applied to all time periods so that the ability to compare performance over time will be maintained.

Strategic Energy Management

In 2017, an outside team of consultants, funded by the U.S. Department of Energy, engaged with the City of Providence to develop a strategic approach to energy management. The team, which included New Buildings Institute (NBI), Eco Edge and Maalka, has worked with several other cities to embrace a data-driven approach to conserving energy as well as a people-oriented process.

The consultants used Providence's strong foundation of benchmarking energy data in NBI's FirstView software to analyze energy usage trends, much like a virtual energy audit, of all feasible buildings in the portfolio. This led to a process of prioritizing buildings for deeper facility assessments in a more targeted approach based on relative energy use, total energy consumption, and peer building comparisons. The end use disaggregation of energy identified top performers vs. those buildings with an opportunity for improvement in heating, thermal baseload or electric baseload.

The recommendations from this analysis align with the candidates selected for the Efficient Building Fund application. This team is continuing to work on developing more interim targets towards Providence's existing goals, as well as supporting the development of additional standards and policies that support Providence's efforts to save energy in municipal buildings and engage the community. This initiative is being captured in a strategic energy management (SEM) plan and is leading to more advanced visualization of tracking energy performance using Maalka software.

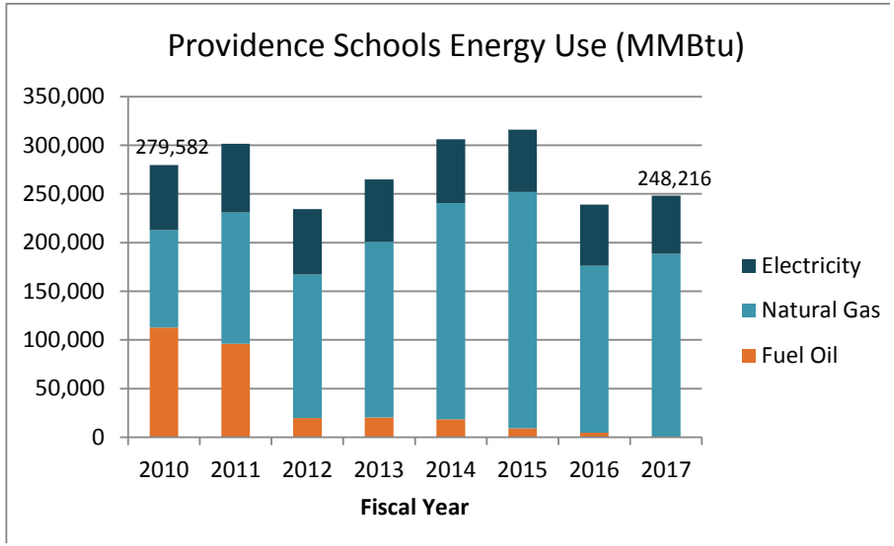


Figure 12: Providence Schools electricity, natural gas, and fuel oil consumption, FY 2010 - FY 2017. In FY 2017, the total amount of energy used by all City schools declined 13.6% from the previous three-year average.

Municipal School Buildings

The City of Providence has 42 K-12 schools operating in 38 municipal school buildings. The buildings are owned by the City, and maintained by Aramark™ with oversight by Providence Schools Department and the City's Department of Public Property. Five of the buildings house more than one school, such as the Charles N. Fortes and Alfred Lima, Sr. Elementary Schools, which are housed in different wings of The Leviton Complex building, and the Evolutions and 360 High Schools, which are located in Hope High School.

Representing the majority of the City's building space, and with a student, teacher, and staff population of nearly 28,000, City schools account for most of Providence's municipal energy use. In FY 2017, Providence's schools used 248,216 MBtus, or 62% of the City's energy consumption (see Figure 12). The energy used by the City's school buildings in FY 2017 was down 13.6% from the previous three-year average.

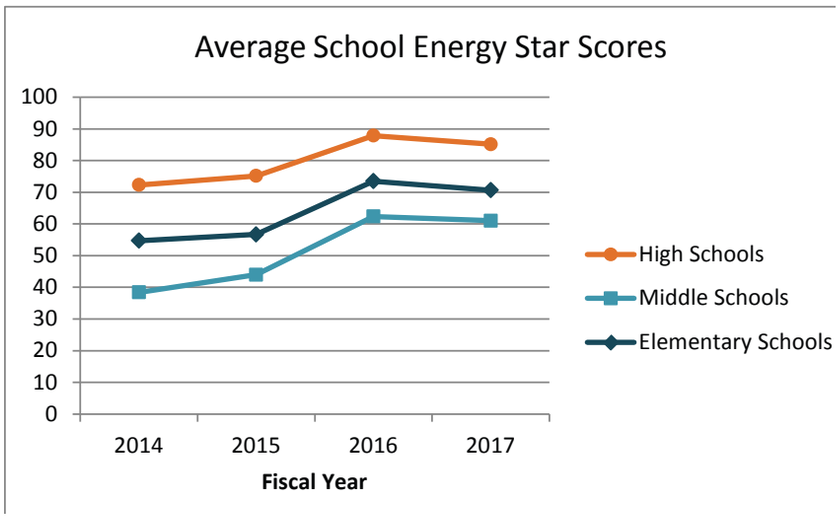


Figure 13: Through investments in weatherization and heating system upgrades, Energy Star scores of Providence Public Schools have increase substantially since 2014.

On-going investments in energy efficiency are improving the performance of Providence Public School buildings. Energy Star scores have increased substantially since 2014 (see Figure 13). This has been largely driven by HVAC upgrades, controls retro-commissioning, and building weatherization completed by Aramark and the Department of Public Property. Under the direction of the Department of Public Property, Aramark monitors and maintains all of the equipment associated with heating and cooling the school buildings. They also are an important partner in coordinating all energy efficiency projects in the City's schools and working with National Grid to leverage financial incentives from the utility. In 2016, this strategy paved the way for weather-stripping replacement in school buildings district-wide, a project that netted $42,148 in National Grid incentives and is projected to reduce the district's natural gas use by 32,074 therms and save about $45,000 a year. Aramark's HVAC control technicians have also recommissioned outdated building management systems (BMS) at schools district-wide, in addition to fine tuning boilers and controls.

While much of the work for maintaining and upgrading HVAC systems is included in Aramark's operating budget, large-scale projects depend on financing from the City, which relies heavily on Rhode Island Department of Education (RIDE) School Building Authority (SBA) school housing aid reimbursements and the SBA Capital Fund. To qualify for the funding, projects need to comply with all current Northeast Collaborative for High Performance Schools Protocol (Northeast-CHPS) requirements "so that approved projects provide high quality learning environments, conserve natural resources, consume less energy, are easier to maintain, and provide an enhanced school facility".[5] Large-scale projects are normally included in Providence Schools' master plan, which is updated every five years. Some recommendations for the master plan come from the SBA, who provides facility condition assessments to the City so it can effectively use its limited resources to provide the best outcomes. Data collected during the facility condition assessments are the basis for the SBA Recommended Action Plan that provides guidance throughout the master planning process. The facility condition assessments contain "detailed information associated with each building component, including the overall condition of school facilities, as well as life cycle forecasting information that attempts to identify future building and system needs."[6]

[5] RIDE School Construction Regulations (5/24/07)
[6] http://www.ride.ri.gov/FundingFinance/SchoolBuildingAuthority/FacilityDataInformation.aspx#37541392-condition-assessments

Elementary Schools

In FY 2017, ten of the 22 elementary schools had Energy Star scores of 75 or above, qualifying them to be Energy Star certified buildings, compared to just six school buildings in FY 2010. Robert L. Bailey, IV Elementary School's score of 98 was the highest Energy Star score of all the City's schools in FY 2017. The current data, in addition to showing better performance amongst the newer buildings, also demonstrates that older schools are capable of achieving high scores. For example, Allan Shawn Feinstein and Frank D. Spaziano elementary schools were constructed in 1908 and 1895, respectively, yet they have two of the highest Energy Star scores in the portfolio at 97 and 98. Increased building activity is in most cases responsible for scores at some schools dropping in FY 2017, such as those at Lillian Feinstein and Robert F. Kennedy where the City opened two of three new recreation centers. The third new recreation center was opened at Pleasant View Elementary School. [7]

Energy Efficiency Improvements

Working closely with Aramark and National Grid, the City has implemented numerous energy efficiency measures throughout the City's elementary schools including heating and cooling systems, building management systems (BMS), and lighting upgrades.

Building Management System Upgrades

In FY 2017, Aramark continued its ongoing retro-commissioning and monitoring of BMS systems district-wide. In 2015, building management systems (BMS) were upgraded at four elementary schools including B. Jae Clanton, Lillian Feinstein, Dr. Martin Luther King Jr., and Veazie Street. This year, BMS were upgraded at Anthony Carnevale, and at the Leviton Educational Complex, which houses the Charles N. Fortes and Anthony Lima, Sr. Elementary Schools. Upgrades at those two schools are projected to reduce City energy use by about 1,116 MBtu.

Heating and Cooling System Upgrades

In FY 2016, two antiquated steam boilers were replaced with high-efficiency condensing boilers at the Leviton Educational Complex, home to both the Alfred Lima, Sr. and Charles N. Fortes Elementary Schools. The new units, projected to reduce natural gas use at the site by roughly 15%, have already begun to have an impact. National Grid data shows that the building used 42,207 therms of natural gas in FY 2017, down 19.7% from the 52,582 therms used in FY 2016. In the spring of 2017, Aramark also installed variable frequency drives (VFDs) for both primary boiler pumps.

Regular maintenance of heating system steam traps is essential to preventing leaks that can waste thousands of dollars each year. National Grid offers incentives for steam trap maintenance. The City receives $3 for every therm saved, up to 50% of the repair costs. The City is also reimbursed for 100% of the cost of the steam trap surveys, needed to identify traps in need of repair. Large buildings with steam heat can have hundreds of steam traps such as Mount Pleasant High School, which has 602 steam traps located throughout the school. Other schools where traps are regularly surveyed and maintained include Hope High School, Nathanael Greene, Gilbert Stuart, and Roger Williams Middle Schools. The Harry Kizirian, Robert F. Kennedy, Carl G. Lauro, Mary E. Fogarty, George J. West, and Allan Shawn Feinstein Elementary Schools also have their steam traps regularly maintained through the National Grid program. Together, these projects are helping save about 300,000 therms of natural gas annually, and are keeping about 1,591 metric tons of CO2 from entering the atmosphere every year.

Several significant energy saving measures have recently been completed by the City and Aramark at Pleasant View Elementary School (also serving as the newly-opened Armand E. Batastini Jr. Rec Center). This past spring, the building's two main boilers were replaced with condensing boilers, and a 750 gallon hot water storage tank was replaced with a 200 gallon tank. The project cost $320,000, which was supplemented by a $20,000 rebate from National Grid. Also recently commissioned was a separate boiler for the swimming pool. Since the building's construction in 1971, the pool had relied on hot water from the main boiler to heat the pool through a heat-transfer system, facilitating the need to run school boilers during the warmer, shoulder months.[8] The new "mini' pool boiler is expected to reduce natural gas consumption at Pleasant View by over 10%.

[7] Data quality on energy use at Pleasant View Elementary School began to improve in late FY 2017. The City will publish a new baseline score in the FY 2018 report.
[8] The shoulder months are the months of the year when it is between 45 and 65 degrees outside, generally applying to the spring and autumn months, April through June and September through October.

LED Lighting Retrofits

As of 2017, nine elementary schools have been retrofitted with new interior LED lighting. Despite increased activity at the City's elementary schools, both before and after school, electricity consumption at the retrofitted schools in FY 2017 was down by about 594,000 kWh, saving Providence Schools over $80,000. The increased life span of the new LED lamps (up to 70,000 hours) is also significantly reducing maintenance costs.

Table 1: Elementary School Buildings Energy Performance and Benchmarking

Facility Elementary Schools	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2017 ENERGY STAR Score	ENERGY STAR score Change
						Averages:	**168.1**	**67.8**	**57.6**	**61.2**	**70.9**	
Allan Shawn Feinstein Elementary School @ Broad Street	1895	77,899	130,257	39,149		4,359,356	207.9	70.8	56	92	97	↗
Anthony Carnevale Elementary School	1999	78,000	535,675	18,126		3,640,318	96.3	53.7	46.7	61	75	↗
Asa Messer Elementary School @ Samuel W. Bridgham	1972	109,255	440,670	33,168		4,820,409	176.2	68.8	44.1	48	88	↗
B. Jae Clanton Complex	2004	103,000	492,475	25,768		4,257,124	136.9	85.1	41.3	56	94	↗
Carl G. Lauro Elementary School	1921	117,482	180,278	79,694		8,584,522	423.3	56.9	73.1	69	53	↘
Dr. Martin Luther King Elementary School	1959	71,724	236,626	28,015		3,608,833	148.8	58.6	50.3	81	89	↗
Frank D. Spaziano Elementary School	1908	58,015	102,056	20,662	747,270	2,414,385	109.7	68.5	41.6	71	95	↗
Frank D. Spaziano Elementary School Annex	1910	19,585	95,203	11,040		1,428,798	58.6	67.2	73	55	36	↘
George J. West Elementary School	1959	112,030	221,421	63,001		7,055,578	334.6	65.6	63	64	64	→
Harry Kizirian Elementary School	1959	73,950	273,200	35,662		4,498,315	189.4	64.2	60.8	65	64	↘
Leviton Dual Language School	2002	40,000	295,348	8,425		1,850,231	44.7	47.4	46.3	90	88	↘
Lillian Feinstein Elementary School @ Sackett Street	1921	68,400	255,469	28,019	350,244	3,673,565	148.8	56.9	53.7	81	85	↗
Mary E. Fogarty Elementary School	1959	51,400	155,456	25,368		3,067,264	134.7	61	59.7	72	72	→
Reservoir Avenue Elementary School	1924	22,000	94,859	11,108		1,434,465	59	74.8	65.2	43	50	↗
Robert F. Kennedy Elementary School	1921	49,840	139,277	34,978		3,972,987	185.8	84.4	79.7	60	62	↗
Robert. L Bailey, IV Elementary School	2000	78,000	346,018	15,217		2,702,321	80.8	44.3	34.6	92	98	↗
The Leviton Complex	1908	178,654	857,375	42,207		7,146,107	224.2	52.9	40	30	53	↗
Vartan Gregorian Elementary School	1954	63,000	297,984	46,668		5,683,550	247.9	98.9	90.2	18	23	↗
Veazie Street Elementary School	1909	110,000	292,945	48,559		5,855,425	257.9	81.7	53.2	22	65	↗
Webster Avenue Elementary School	1904	44,290	121,697	17,191	1,619,706	2,371,430	103.9	56.5	53.5	79	82	↗
William D'Abate Elementary School	1959	44,174	210,677	30,109		3,729,730	159.9	104.6	84.4	37	55	↗
Pleasant View Elementary School	1971	74,800	358,767	82,949		9,518,973	440.6		127.3		16	↗

Middle Schools

Five of the City's six middle school buildings are some of the oldest buildings in the City's portfolio. Constructed in 1916, Esek Hopkins is the oldest of the City's middle schools, yet it has performed well over the past several years, earning an Energy Star score of 89 for FY 2017, up two points from last year, and a significant improvement over FY 2015's score of 76. Energy efficiency measures attributed to the higher score include the building's 2015 school-wide LED lighting retrofit and BMS upgrades. Natural gas consumption has been reduced overall in six of the City's seven middle schools (see Figure 14). Only West Broadway, where both during and after school activities have increased significantly, saw an uptick in Natural gas use for FY 2017.

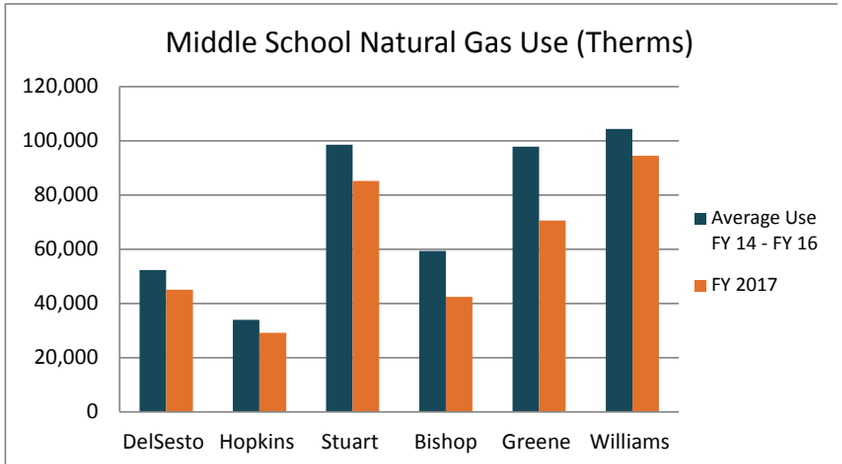


Figure 14: Middle School natural gas use was down 17.8% in FY 2017 compared to the previous three-year average.

Energy Efficiency Improvements

Building Management System Upgrades

In spring, 2017, Aramark used a $40,100 National Grid rebate incentive to supplement the cost of a new BMS at DelSesto. The new controls are expected to reduce total energy use at the building by about 10%, or 750,000 MBTu. In addition, Aramark continued its on-going upgrading, recommissioning, and monitoring of all middle school BMS systems through FY 2017. BMS are also updated and retro-commissioned as part of new boiler replacements such as those completed in 2015 and 2016 at Gilbert Stuart and Roger Williams.

Heating and Cooling System Upgrades

There have been significant upgrades at Gilbert Stuart Middle School including replacement of the #1 boiler and controls in 2014 and 2015. In 2016, the #2 boiler was also replaced, along with a new vacuum return system, and a properly-sized condensate tank to provide better efficiency. Roger Williams Middle School also has a new boiler, installed in 2016.

LED Lighting Retrofits

To date, LED lighting has been installed in all of the classrooms and common spaces at Esek Hopkins, Nathanael Greene, Roger Williams, Gilbert Stuart, and Governor Christopher DelSesto. In 2016, exterior lighting was replaced with LEDs at Nathan Bishop, Nathanael Greene, and West Broadway. As of FY 2017, these LED installations have saved about 300,000 kWh, and roughly $52,000. In August of 2017, Aramark also replaced 250 watt metal halide lamps with 50 watt LED lamps in the auditoriums at Nathanael Greene and Roger Williams Middle School.

Table 2: Middle School Buildings Energy Performance and Benchmarking

Facility Middle Schools	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2017 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	66.5	60.5	54.3	61.0	
DelSesto Middle School	1998	146,000	849,600	45,120		7,410,799	239.7	53.8	50.8	57	69	↗
Esek Hopkins Middle School	1916	87,560	224,293	29,261		3,691,409	155.4	45.7	42.2	78	89	↗
Gilbert Stuart Middle school	1929	154,450	349,682	85,047		9,697,794	451.7	52.3	62.8	67	50	↘
Nathan Bishop Middle School	1929	136,000	1,227,588	42,195		8,408,021	224.1	69.9	61.8	50	58	↗
Nathanael Greene Middle School	1930	159,070	251,271	70,630		7,920,363	375.2	61.5	47	50	78	↗
Roger Williams Middle School	1929	135,228	357,970	94,579		10,679,311	502.4	87	79	33	36	↗
West Broadway Middle School	1966	46,000	180,712	30,628		3,679,390	162.7	95.3	80	45	47	↗

High Schools

The City owns nine high school buildings with a few of the buildings housing two or more different schools. For example the Juanita Sanchez Educational Complex, houses both William B. Cooley, Sr. High School, and The Providence Academy of International Studies. Similarly, Mount Pleasant and Hope High Schools now house two of the City's "Opportunity by Design" high schools, Evolutions and 360, respectively.

Providence's high schools support a wide variety of on-going academic, athletic, and cultural programs. They are bustling centers of activity where lighting, computers, and heating and cooling systems are relied on by students, faculty, and the community even after the end of the normal school day. Despite this fact, aggressive approaches by the City to target energy efficiency in its high schools have resulted in six of the buildings achieving Energy Star scores of 85 or higher!

It is important to note that for the purposes of this report, Central and Classical High Schools are grouped together for measuring heating energy used due to the fact that the two facilities share a common, centrally-located heating plant. This results in a single Energy Star score for the two schools. Last spring, National Grid rebates covered over 60% of the cost of a new building management system (BMS) and hot water pump variable frequency drives (VFDs) for the Classical Auditorium and Café. The Department of Public Property is currently reviewing a proposal to be included in the new Providence Schools master plan that would permanently place the two high schools on separate heating systems. Boilers in the heating plant would be replaced with high-efficiency condensing boilers and used to service only Central High. Heat exchangers in the main building, cafeteria/auditorium, and athletic buildings at Classical High would be replaced by separate, dedicated condensing boilers.

Energy Efficiency Improvements

Heating and Cooling System Upgrades

Natural gas use at the City's high schools continued to trend downward in 2017, declining by 13.7% since FY 2010. Last spring, the City used utility rebates to help pay for two new condensing boilers at the Juanita Sanchez Educational Complex. The project also included a new BMS for the building's mechanical room that will monitor boilers, chiller, chiller pumps, and primary pumps. BMS systems at all of the high schools continue to be maintained and monitored by Aramark, who performs repairs, upgrades, and recommissioning when needed.

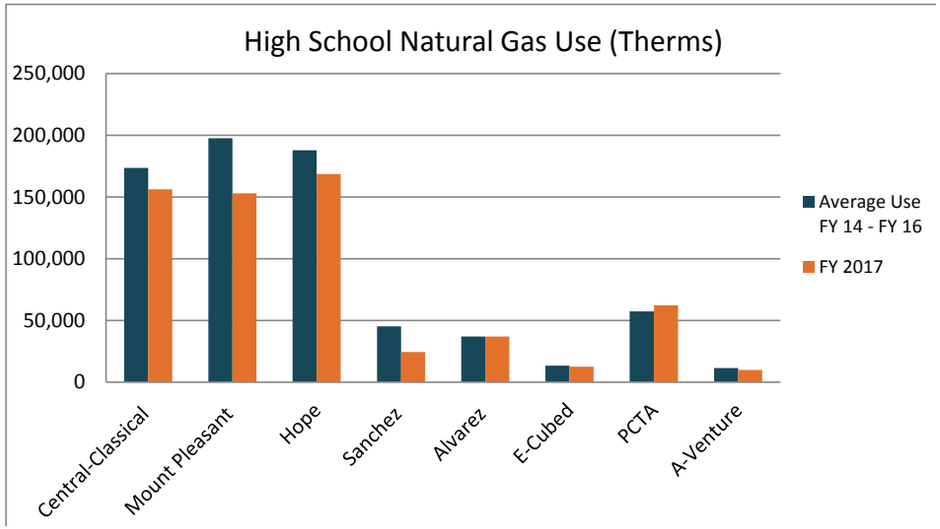


Figure 15: The City's high schools are consuming less-than-average amounts of natural gas, with their combined natural gas use down 13.7%.

Table 3: High School Buildings Energy Performance and Benchmarking

Facility High Schools	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2017 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**57.2**	**55.4**	**77.7**	**85.1**	
Central/Classical High School	1962	454,059	1,936,189	156,282		22,234,459	830.1	57.3	49	56	97	↗
Dr. Jorge Alvarez High School	2007	88,000	686,160	37,195		6,060,685	197.6	50.3	68.9	79	58	↘
E-Cubed Academy	2004	44,600	308,704	12,635		2,316,840	67.1	71.3	51.9	91	89	↘
Hope High School	1938	257,089	745,770	168,684		19,412,957	896	67.3	75.5	92	89	↘
Juanita Sanchez Educational Complex	2004	110,000	851,784	24,605		5,366,815	130.7	53.3	48.8	70	86	↗
Mount Pleasant High School	1938	320,000	833,852	153,090		18,154,076	813.1	66.2	56.7	65	96	↗
A-Venture Academy	1930	25,060	64,379	10,050		1,224,634	53.4	51.6	48.9	91	81	↘
Providence Career and Technical Academy	2009	300,000	1,981,537	62,369		12,997,901	331.3	40.2	43.3			

Public Safety

Public Safety buildings present considerable energy efficiency challenges due to the intense nature of their use. All of the City's fire stations, as well as the Public Safety Complex, are occupied twenty-four hours a day, seven days a week by emergency responders. The Providence Public Safety Complex, headquarters, and central station for the Providence Police and Providence Fire Department, serves the City around the clock, 365 days a year. Though the building used more electricity than any other single building in the City's portfolio, 2017 saw a 12% reduction from the building's three-year average electric use. Measures reducing electricity used at the site have included the 2014 installation of a new rooftop package unit for heating and cooling, and interior and exterior LED lighting upgrades. In 2017, LED retrofits were completed in the seven-floor Public Safety Garage, and lighting for the main parking lot was also upgraded to LED lighting. Combined savings from the two projects is expected to reach 44,915 kWh annually, saving about $7,600 every year.

Energy Efficiency Improvements

At the beginning of 2017, work was completed on new energy efficiency measures at three City fire stations including Atwells Avenue, Broad Street, and Branch Avenue, as well as the Public Safety Maintenance Garage and the Providence Police Academy. Using investment-grade audits completed in partnership with Emerald Cities Providence, as well as audits completed with support from the State's Office of Energy Resources and National Grid, the City applied, and was subsequently approved for $1 million is low-interest project financing. The loan was provided by the Rhode Island Infrastructure Bank's (RIIB) Efficient Buildings Fund (EBF) to invest in energy efficiency upgrades at the sites. The upgrades are estimated to reduce energy consumption by about 32% and yield and average annual energy cost savings of over $100,000. The projects, commissioned just last spring, are already showing a 13.7% reduction in total energy use, and a nearly 30% in GHG emissions (oil-fired boilers at all of the properties were replaced with ones that use natural gas).

Heating and Cooling System Upgrades

The Mount Pleasant Avenue, Hartford Avenue, Reservoir Avenue, and Messer Street Fire Stations are the latest buildings to be targeted for fuel switching and heating system upgrades. These four buildings, along with the Department of Telecommunications building (home to the City's 911 call center) have recently been audited by the Antares Group, courtesy of National Grid, for prospective inclusion in the latest round of RIIB financing through the EBF.

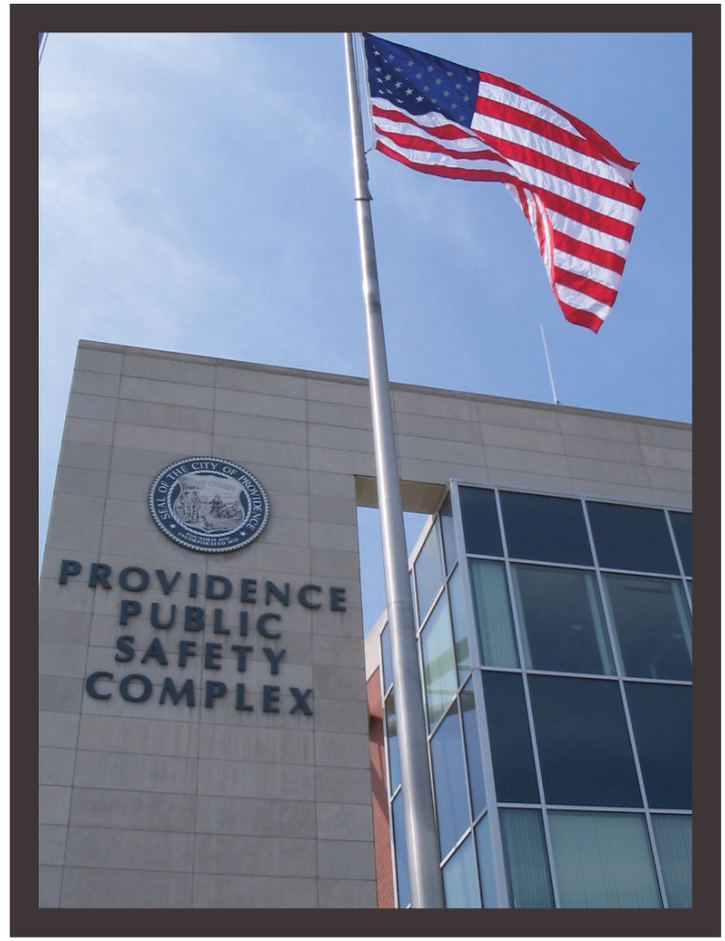


Table 4: Public Safety Buildings Energy Performance and Benchmarking

Facility Public Safety Buildings	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)
							Averages:	103.2	98.2
Department of Communications	1987	11,752	270,651	7,547		1,678,150	40.1	151	123.3
Peter A. Rochio Substation	2006	914	25,321			86,395	0	78.2	94.5
Providence Emergency Management Agency	1991	12,776	146,019	3,271	173,742	999,094	30.3	42.1	78.2
Providence Police Academy	1928	20,175	33,218	7,225	404,616	1,234,217	68.1	90.6	61.2
Public Safety Complex	2002	119,002	2,892,097	18,000		11,667,793	95.6	131.6	98
Steven M. Shaw District 5 Substation	1996	546	7,105	488		73,043	2.6	125.5	133.8

*Because the Peter A. Rocchio Police Substation uses only electric heat, there are no direct GHG emissions for that site to report.

Table 5: Fire Station Buildings Energy Performance and Benchmarking

Facility Fire Stations	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)
							Averages:	92.3	84.7
Admiral Street Fire Station	1951	1924	69,785	11,387	42,090	1,418,860	63.6	103.9	110.4
Allens Avenue Fire Station	1948	1948	44,011	4,975		647,666	26.4	101.3	68.6
Atwells Avenue Fire Station	1948	1948	57,293	8,108		1,006,265	43.1	79.8	100.4
Branch Avenue Fire Station	1948	1948	84,729	5,132	102,120	904,398	34.8	70.8	61.9
Broad Street Fire Station	1942	1942	73,648	3,095	140,484	701,222	26.9	91.1	74.4
Brook Street Fire Station	1932	1950	66,036	3,933		618,582	20.9	85.6	81.6
Hartford Avenue Fire Station	1948	1948	58,578		509,082	708,951	37.8	89.2	77.5
Humboldt Avenue Fire Station	1950	1905	29,612		659,364	760,399	48.9	114.3	101.9
Messer Street Fire Station	1924	1948	74,118	422	322,782	617,855	26.2	80.3	67.5
Mount Pleasant Avenue Fire Station	1948	1903	32,376	370	338,790	486,285	27.1	120.4	91.2
North Main Street Fire Station	1903	1951	81,722	4,786		757,392	25.4	65.7	51.3
Reservoir Avenue Fire Station	1905	1932	47,502	615	415,380	638,987	34.1	79.6	86.8
Rochambeau Avenue Fire Station	1928	1928	29,446	8,423		942,724	44.7	118.3	127.4

Administrative Offices

Providence City Hall and the Joseph Doorley, Jr. Municipal Building[9] are the two primary administrative offices of the City. The Mayor's Office, Public Property, Human Resources, Retirement Office, Tax Assessor, and The Office of Sustainability, are just a small sampling of the numerous City departments housed at Providence City Hall. Other City office buildings include the Department of Recreation building, the Department of Public Works Administration Building, and Providence Schools' Dr. Robert F. Roberti Administration and Family and Community Engagement Center. Also included in this list is the Joseph Doorley, Jr. Municipal Building, named for Providence's thirty-first mayor, and leased from Paolino Properties. The building houses the City's Department of Inspections and Standards, and the Department of Planning and Development, along with several other City offices.

For the second year in a row, Providence City Hall achieved an Energy Star score of 96. The building is a great example of how properly performed energy-efficiency retrofitting measures can reduce building emissions and provide energy and cost savings.

The Joseph A. Doorley Jr. Municipal Building's Energy Star score rose 33%, from a 49 in FY 2016 to a 65 for FY 2017. However, there is still room for improvement and a no-cost investment-grade energy audit was performed at the facility in 2016 for potential participation in the EBF. The building was also the subject of an energy use study performed by Brown University's School of Engineering. The audit and study identified a number of investments that the City is considering to reduce costs through energy conservation.

[9] The Joseph A. Doorley Municipal Building was first leased at the end of 2011, and therefore saw no energy used by the City in FY 2010.

Energy Efficiency Improvements

Heating and Cooling System Upgrades

Recent upgrades at the Dr. Robert Roberti School Administration Building that included installing condensing boilers, variable frequency drives (VFDs), and high efficiency air-handling unit (AHU) motors, have been instrumental in improving the building's Energy Star score. The score rose from a 74 in FY 2016 to a 77 in FY 2017, making the building eligible for Energy Star certification, a dramatic improvement from its FY 2010 baseline score of 47. All of the building's weather-stripping is scheduled to be replaced as well.

LED Lighting Retrofits

Current electricity usage data shows that City Hall added an additional $1,000 a month in electricity savings in FY 2017. In February 2016, National Grid's upstream lighting program provided incentives that were used to help the City replace 1,391 fluorescent T-8 and T-12 bulbs in offices and meeting rooms at City Hall with new LED tube lighting. The project, expected to reduce annual electricity use at the building by 83,458 kWh, saving the City over $12,000 a year, paying for itself in 1.4 years.

In the first year since LED retrofits there, electricity use at the Dr. Robert Roberti School Administration Building was already down by 60,600 kWh, saving the City over $10,000. The building was another site retrofitted with interior and exterior LED lighting by the City in 2016, with upgrades expected to reduce City electric use by 74,946 kWh annually, saving nearly $12,000 a year.

Table 6: Administration Buildings Energy Performance and Benchmarking

Facility Administration Buildings	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2017 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**84.2**	**76.3**	**60.8**	**73.6**	
City Hall	1855	99,675	457,158	41,775		5,737,324	221.9	86.1	57.6	77	96	↗
Department of Recreation	2001	4,186	59,537		141,947	345,088	26.7	75.6	70.6		n/a	
DPW Administration Building	1925	20,511	61,958	15,366		1,748,004	81.6	41.5	85.2	94	71	↘
Dr. Robert F. Roberti Administration Building	1945	56,744	784,142	24,343		5,109,792	129.3	118	90	47	77	↗
Joseph A. Doorley, Jr. Building	1966	72,000	963,418	28,015		6,088,643	148.8		84.6		65	
The Family and Community Engagement Center	1960	8,700	58,482	4,072		606,707	21.6	99.8	69.7	25	59	↗

Neighborhood Recreation Centers

Each of the City's eleven recreation centers is open, free of charge, to all Providence residents. In addition to athletics, the City's recreation centers house a wide range of youth and family programs. In 2017, three new recreation centers were opened at elementary schools in Providence, increasing the total number of rec centers owned by the City to eleven, and the number of schools doubling as recreation centers to six. The Armand E. Batastini Jr., Robert F. Kennedy, and Sackett Street Recreation Centers were newly opened at Pleasant View, Kennedy, and Lillian Feinstein, respectively. Since the energy consumed by the six recreation centers headquartered in school buildings is only a portion of the total use, their EUIs do not appear in Table 7. Average EUI of the non-school housed recreation centers increased by 3.4% from FY 2016 to FY 2017.

Energy Efficiency Improvements

LED Lighting Retrofits

In 2017, with the help of rebates from National Grid, the Department of Property oversaw LED lighting retrofits at several City recreation centers that are expected to save over 95,000 kWh annually, and about $16,000 a year in City electricity costs. Recreation centers recently retrofitted with the new LED lighting include Rollins, Neutaconkanaut, Rogers, West End, Zuccolo, and Davey Lopes. Multiple energy audits have been completed at the Davey Lopes Recreation Center in the past several years as part of a variety of potential funding programs. The Office of Sustainability and Department of Public Property have been working to identify the best solutions for conserving energy at the facility, and to identify external funding sources that could potentially allow for a zero energy approach to updating the aging facility.

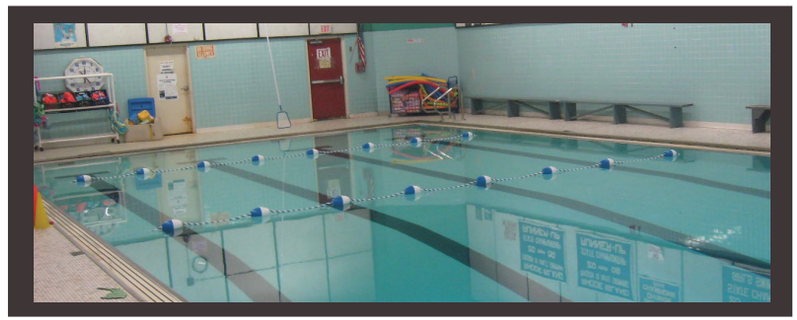


Table 7: Recreation Center Buildings Energy Performance and Benchmarking

Facility Recreation Centers	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)
							Averages:	**82.4**	**81.0**
Vincent Brown Recreation Center	1997	18,111	22,728	10,363		1,113,890	55	52.5	61.5
West End Recreation Center	1997	25,760	191,191	9,292		1,581,538	49.4	53.2	61.4
Neutaconkanut Recreation Center	1997	15,345	49,863	8,417		1,011,802	44.7	82.5	65.9
Zuccolo Recreation Center	1949	11,592	62,016	5,515		763,129	29.3	77.8	65.8
Davey Lopes Recreation Center	1948	11,860	97,117	10,343		1,365,625	54.9	142.6	115.1
Selim Madelin Rogers Recreation Center	2000	9,350	50,231	9,139		1,085,276	48.5	85.9	116.1

Department of Public Works and Other Buildings

Across the street from the City's Department of Public Works Administration Building, are two large structures housing the work force, trucks, and equipment and tools necessary to keep Providence's infrastructure in good repair. Energy use at the Traffic and Engineering building, and the airport hangar-like structure affectionately known by City workers as "the Roller Shed," is also being benchmarked by the City. The Public Safety Maintenance Garage on Dexter Street is where all City-owned police and fire vehicles are sent for repairs. Buildings at Roger Williams Park that have been included in this category are the Dalrymple Boathouse, the Casino, and the newly renovated Museum of Natural History and Planetarium. Despite recent structural improvements, and lighting upgrades at the museum, thermal energy systems have yet to be addressed. In 2016, the building was audited by the Antares Group with the intent of applying EBF financing. Antares identified six electric and thermal measures that performed in concert would reduce energy by 24%. Fuel switching, boiler replacement, DHW replacement, and pipe insulation could lower thermal energy use by 325,900 kBtu, and VFDs and additional lighting measures could reduce electricity use by 13,570 kWh. Total annual cost savings at the site would be about $5,040 according to Antares. These projects are being considered for future funding opportunities.

Energy Efficiency Improvements

Heating and Cooling System Upgrades

The Public Safety Maintenance Garage was one of five buildings that the City invested in via the EBF in 2017. Anticipated performance projections, provided by American Development Institute, LLC, the City's services partner on the project, are of an overall energy reduction of 37%, with a 39,306 kWh reduction in electricity, and a thermal energy reduction of 570,396 kBtu. By the end of the fiscal year, just a few months since new systems were installed; annual energy use had been reduced at the building by over 348,000 kBtu since FY 2016.

Table 9: Miscellaneous Buildings Energy Performance and Benchmarking

Facility DPW & Other Buildings	Year Built	Gross Floor Area (sq. ft.)	FY 2017 Electricity Use (kWh)	FY 2017 Natural Gas Use (therms)	FY 2017 Fuel Oil #2 (kBtu)	FY 2017 Total Site Energy Use (kBtu)	FY 2017 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2017 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2017 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**61.5**	**50.7**			
Alex & Ani City Center	1999	6,373	551,482									
Asa Messer Annex (WSPS)	1925	20,360	15,268	7,084		760,494	37.6	42.5	37.4	82	97	↗
Camp Cronin	1960	4,362	27,987			95,491		2.3	21.9			
Central Supply Providence Schools	2004	15,525	70,990	7,773		1,019,518	41.3	118.3	65.7	3	19	↗
Dalrymple Boat House	1894	17,474	49,231		368,460	536,435	27.3	36	30.7			
Dexter Street Garage	1905	17,000	109,647	853	1,344,534	1,415,059	75.4	103.5	83.2			
DPW Maintenance, Traffic and Roller Shed	1930	117,618	215,230	68,749		7,609,268	365.2	90	68.9			
Lillian Feinstein Senior Center	2001	8,520	41,171	3,170		457,454	16.8	35.1	53.7			
Museum of Natural History and Planetarium	1894	19,500	251,852		789,912	1,649,233	58.6	104.4	84.6			
Oliver Hazard Perry (Providence Mayoral Academy ES)	1929	182,488	387,842	83,380		9,661,286	442.9	49.4	52.9	33	22	↗
Public Safety Garage	2002	162,976	198,491			677,252		4.8	4.2			
The Casino at Roger Williams Park	1894	16,782	137,595	8,373		1,306,799	44.5	86.5	77.9			
Windmill Street School (closed)	1915	86,140	58,579		2,161,218	2,361,088	160.4	65	27.4	31	98	↗

Outdoor Lighting

Outdoor lighting accounted for 29% of the City's total electricity use in FY 2017, and accounted for 32% of its total $6,898,687 electricity cost. The City provides lighting for City roadways, sidewalks, parks, athletic fields, playgrounds, school yards and municipal parking lots. The Department of Public Property continues to identify opportunities for low-cost outdoor LED replacement, so that outdated lighting can be replaced at all of its facilities.

Mayor Elorza assists with the first streetlight conversion.

In FY 2017, Providence began seeing the energy saving impacts of its highly visible streetlight LED retrofit project. The project began in 2016 when the City purchased its 16,800 cobra-style streetlights from National Grid (formerly Narragansett Electric), who previously owned and maintained the system. By purchasing the asset, the City has been able to avoid costly maintenance charges, known as "facility" charges, which were previously billed by the utility. The City's 2016 streetlight maintenance contract with the Rhode Island Partnership for Streetlight Management (PRISM) replaced these charges, about $138 annually per fixture, and totaling about $2.3 million a year, with PRISM's all-inclusive maintenance program that costs about $463,000 annually. Rhode Island General Law (RIGL) 39-30, enacted in 2014, made the purchase and subsequent transfer of maintenance responsibility to the City possible. Additionally, Providence's purchase of the streetlight system paved the way for the City to replace the high-pressure sodium (HPS) heads with energy saving LED fixtures capable of supporting open portal control applications, such as remote dimming. The new LED lamps were able to reduce City streetlight electricity use by 7.4 million kilowatt hours (kWh) for FY 2017 (Figure 16), with that reduction expected to reach nearly 8.5 million KWh for FY 2018. In FY 2017, the streetlight purchase and subsequent LED retrofitting successfully saved the City over $2.4 million in streetlight electricity use and maintenance (Figure 17).

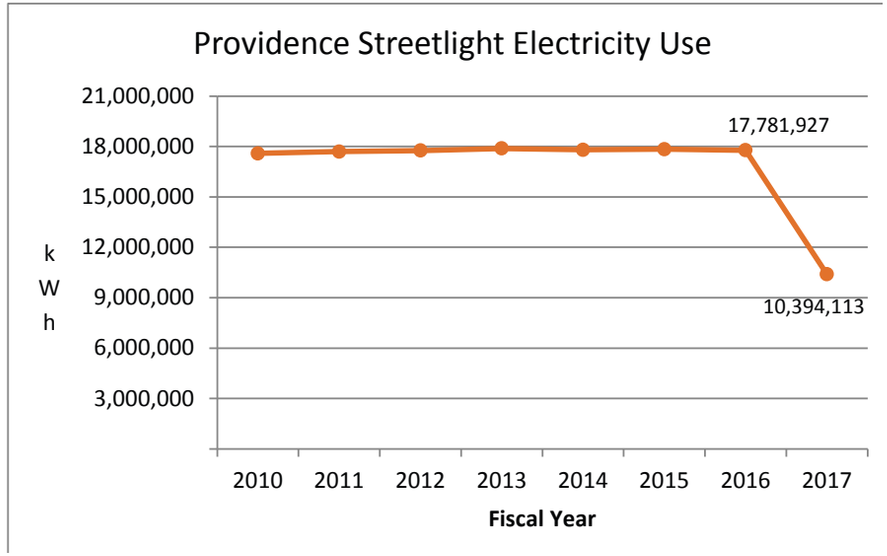


Figure 16: Providence streetlight electricity use was reduced by 7,387,814 kilowatt hours (kWh) between FY 2016 and FY 2017.

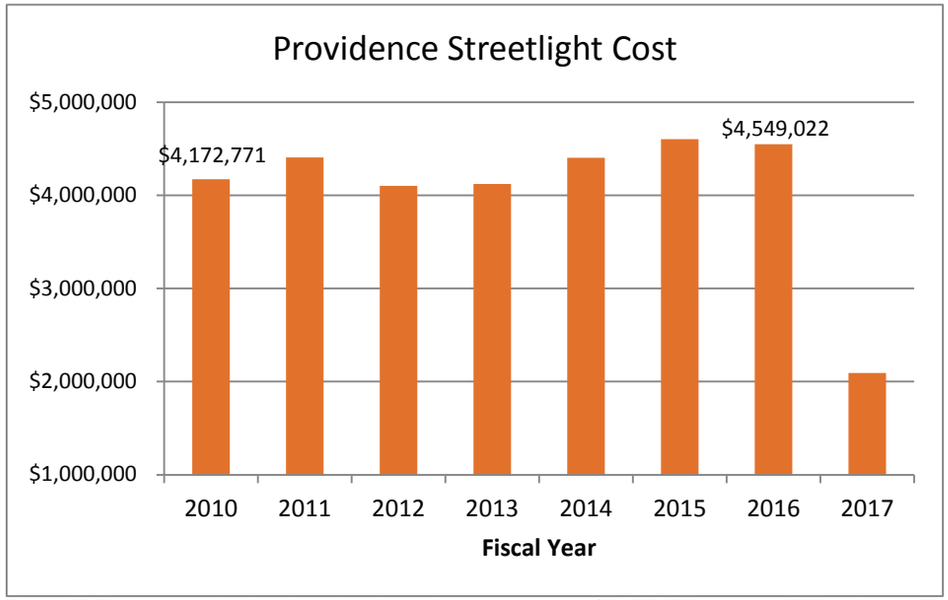
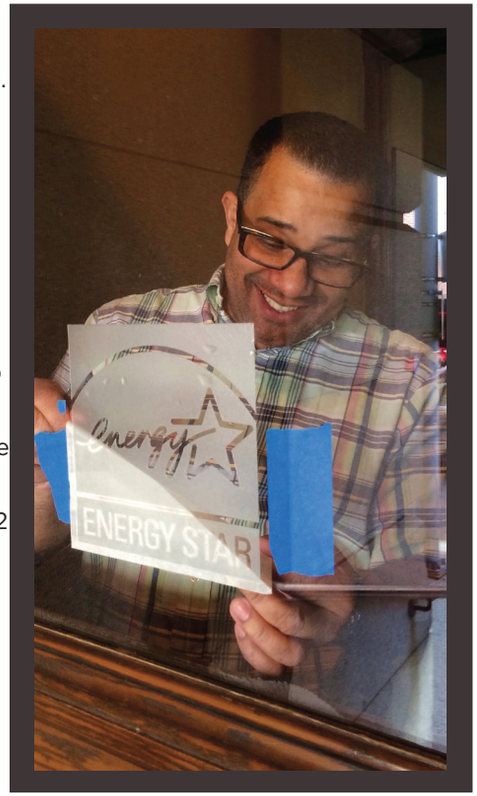


Figure 17: Providence streetlight electricity cost was reduced by $2,455,270 or nearly 50%, between FY 2016 and FY 2017.

Park Lighting

National Grid's commercial and industrial customer rebate programs helped the City tackle LED lighting retrofits at 24 of the City's parks, playgrounds and ballfields in 2017. Northeast Energy Supply (NES), which expedited the program by the utility for the City, retrofitted floodlighting and wall packs at the Ardoene, Amos Earley, Miguel Luna, Billy Taylor, and Gano Street Parks, just to name a few. Total annual electricity savings from the retrofits is expected to reach 486,272 kWh, reducing City electricity costs by about $72,000.

2015 LED lighting upgrades at the Roger Williams Park Zoo, supported by National Grid's upstream LED lighting program, and expedited by Northeast Efficiency Supply (NES) are continuing to provide an annual operational savings of about $15,000. In 2016, NES retrofitted lighting at the Casino bandstand to LEDs. 23% of the project cost was covered by National Grid incentives, and the new lighting is expected to provide $3,382 in annual operational savings. NES also expedited the replacing of 375 existing 32-watt T8 florescent tubes at the Public Safety Complex's parking garage. The bulbs were replaced with 12-watt LED tubes. National Grid provided LED upstream lighting program incentives for the project that is generating about $7,800 in annual savings.



Also as of 2017, new exterior LED fixtures have also been installed at fifteen elementary schools. The new lighting for school grounds is expected to save about 176,262 kWh annually, contributing to reduced electricity use in City schools.

Traffic Lights

Figure 18 demonstrates that electricity use for the Providence traffic lights continued to see a downward trend in FY 2017, with electricity consumed down 2% from the previous 7-year average. LED technology, and in some cases renewable energy technologies, are credited for the trending.

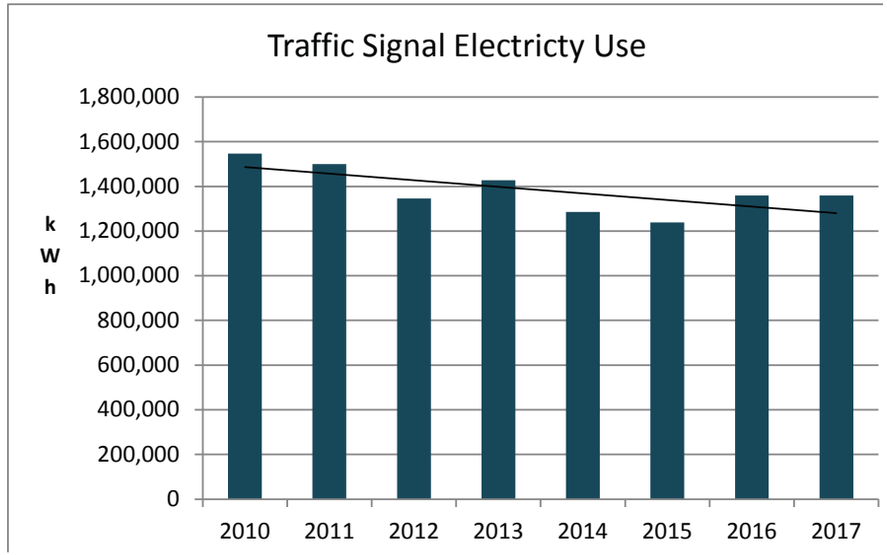


Figure 18: Electricity use for traffic lights in the City has been trending downward since FY 2010.

Greenhouse Gas Emissions

In July of 2015, Mayor Elorza joined thousands of other local government leaders around the world in signing the Compact of Mayors, which is now called the Global Covenant of Mayors, pledging the City to adopt "measurable climate and energy initiatives that lead to an inclusive, just, low-emission and climate resilient future." The agreement committed the City to developing a citywide greenhouse gas (GHG) emissions inventory consistent with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The agreement also called for the City to report on climate hazards and vulnerabilities, emission reduction targets, and climate change mitigation and adaptation planning. Mayor Elorza subsequently issued an executive order on April 22, 2016 committing Providence to becoming a carbon-neutral city by 2050.

The Office of Sustainability oversees the City's baseline 2015 GCOM-compliant GHG inventory which includes all emissions from all sectors within the physical city boundary. The citywide greenhouse gas inventory provides an emissions profile that is informing policy and programs to help Providence achieve its goal of becoming a carbon neutral city by 2050. Citywide emissions total about 1.7 million metric tons of CO2e. Buildings are the largest GHG contributor, accounting for roughly 70% of citywide carbon emissions.

The Office of Sustainability is working on policy and programs aimed at reducing citywide GHG emissions through energy conservation and renewable energy. At the core of this initiative is the measurement and tracking of emissions directly related to City operations. Greenhouse gas emissions from our City building and outdoor lighting energy consumption have been steadily decreasing since 2010. FY 2017 municipal GHG emissions are estimated to be 27,980 metric tons, down 26% from FY 2010. Emissions reductions have occurred at both the building-level, for thermal energy (oil to natural gas conversions, and energy efficiency measures), and at the region's power plants, as many have replaced coal and oil with natural gas to generate electricity.

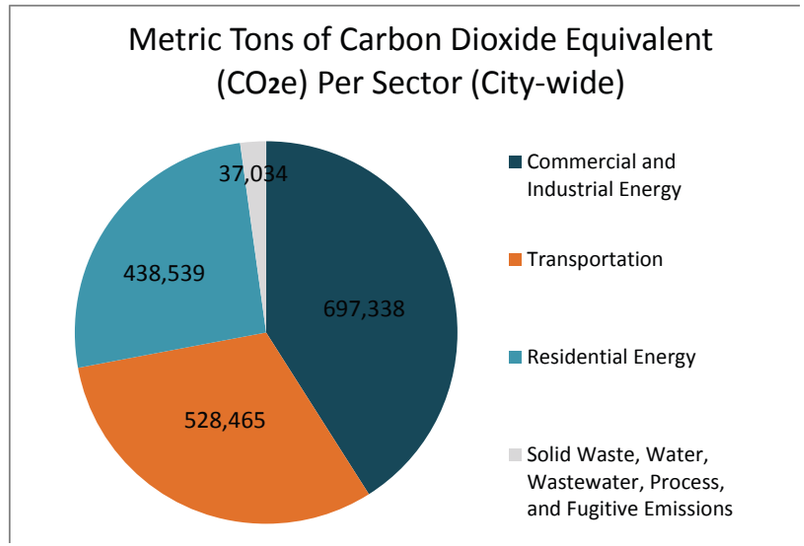


Figure 19: Providence FY 2017 greenhouse gas emissions by sector.

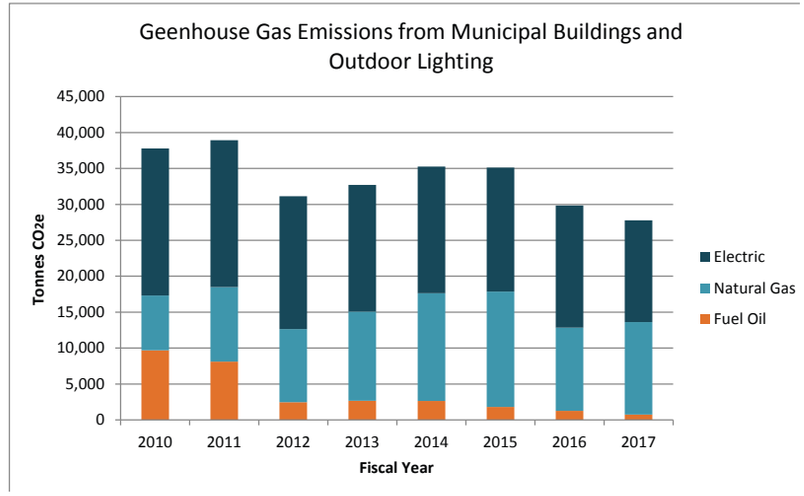


Figure 20: Greenhouse gas emissions from municipal buildings and lighting, shown in metric tons of CO2 equivalents, 2010 - 2017.