SUSTAINPVD

Municipal Energy Report *FY 2018*

Acknowledgements

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Southern Sky Renewable Energy RI
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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 one 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.

Shoulder Months: The months of the year when it is between 45° F and 65° F degrees outside, generally applying to the spring and autumn months, April through June and September through October.

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% by 2030. Measuring and monitoring energy consumption by benchmarking buildings is critical to ensuring we are achieving this goal.

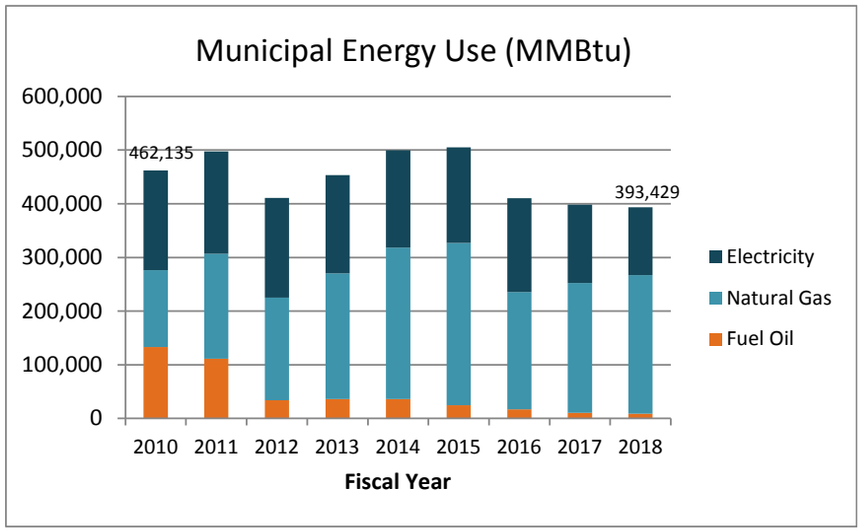

Figure 1: City of Providence's electricity, natural gas, and fuel oil consumption, FY 2010 - FY 2018.

The City of Providence has been benchmarking and monitoring its energy consumption as part of its fiscal and environmental agenda since 2010. This FY 2018 report marks the fourth 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 electric, gas, oil, and water used by City facilities . 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 393,429 MMBtu of energy in FY 2018 in the form of electricity, natural gas, and oil.

Highlights:

- The City has reduced its building and outdoor lighting energy use by 15% since FY 2010, halfway to the 30% energy reduction goal established in the 2014 sustainability plan, Sustainable Providence.
- The City's expenditures on energy have declined by 33% since FY 2010.
- Greenhouse gas emissions from municipal facilities have decreased 30% since FY 2010, a 2.4% improvement from last year. This is the result of cleaner fuels, LED lighting conversions, and heating system upgrades.
- Recent investments in lighting and mechanical efficiency measures have reduced electricity consumption by 32% since FY 2010 and 13.5% since last year.
- The City has reduced #2 fuel oil consumption 93% since 2010. As of December 2016, heating oil was eliminated from all City school buildings.
- 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.
- 15 buildings increased their Energy Star scores between FY 2017 and FY 2018.
- The average Energy Star scores of all City schools combined has risen 24% since FY 2014, largely due to energy efficiency upgrades and HVAC control retro-commissioning completed in the buildings.

Contents

Introduction

The City of Providence has monitored 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.

These efforts were recognized by the Rhode Island Office of Energy Resources (RIOER) in 2017 with their Lead by Example Award for municipalities making significant contributions toward the promotion and implementation of comprehensive clean energy measures.

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, the plan 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 for Climate & Energy (formerly the Compact of Mayors), a global coalition of mayors pledging to reduce greenhouse gas emissions and enhance climate resilience. On Earth Day 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. 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 2018 used for the report is available via the City website on the Sustainability Dashboard.[1]

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

City Energy Use

Overview

The City's facilities, including buildings and outdoor lighting, used 393,429 MMBtu of energy in FY 2018 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 2018, natural gas accounted for roughly 66% of City facility energy consumption at 258,061 MMBtu. Electricity accounted for 32% of the City's total energy use at 126,292 MMBtu, while #2 heating oil accounted for only 2% 9,076 MMBtu.

Since 2010, energy consumption has declined by 15%, 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.

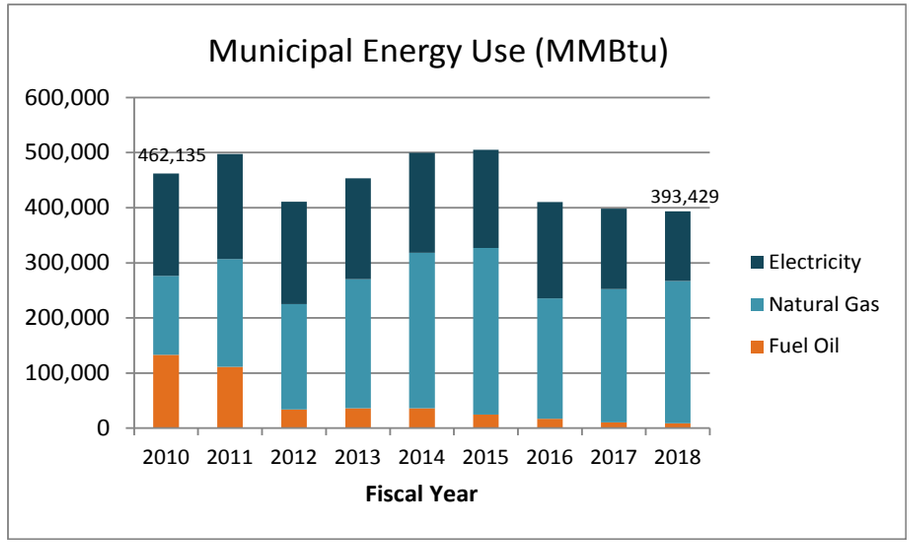

Figure 1: City of Providence's electricity, natural gas, and fuel oil consumption, FY 2010 - FY 2018.

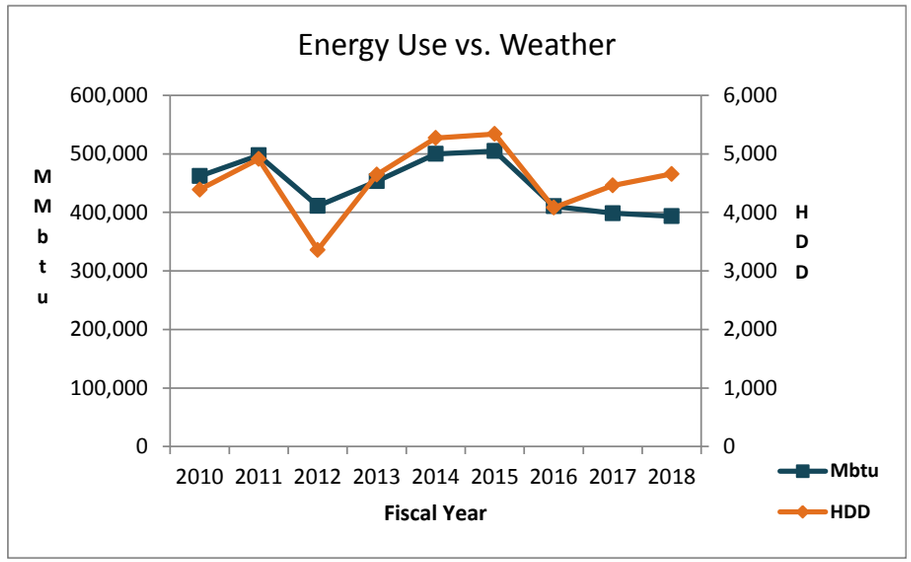

Figure 2: Because a significant amount of energy is needed for heating municipal buildings, weather is a driving factor in overall energy consumption.

Electricity

In FY 2018, the City of Providence used roughly 37,015,997 kWh of electricity; a 32% reduction from its 2010 baseline and 14 % reduction from FY 2017 (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. Switching from oil to natural gas provides a considerable greenhouse gas reduction, but it is still a fossil fuel. Furthermore, switching fuels 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.

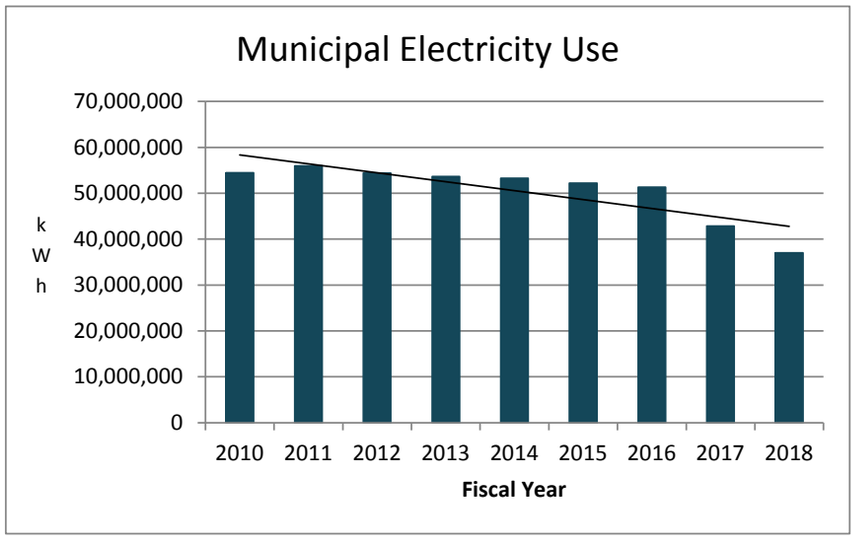

Figure 3: City of Providence's electricity use shown in kWh, 2010 - 2018. Electricity consumption has declined by 32% since 2010, with nearly 14% being achieved between FY 2017 and FY 2018.

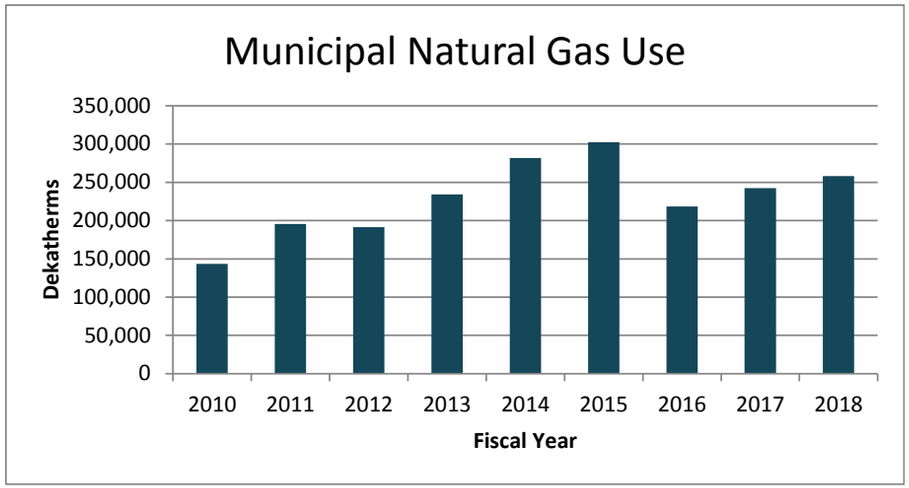

Figure 4: City of Providence's natural gas use, shown in dekatherms, FY 2010 - FY 2018.

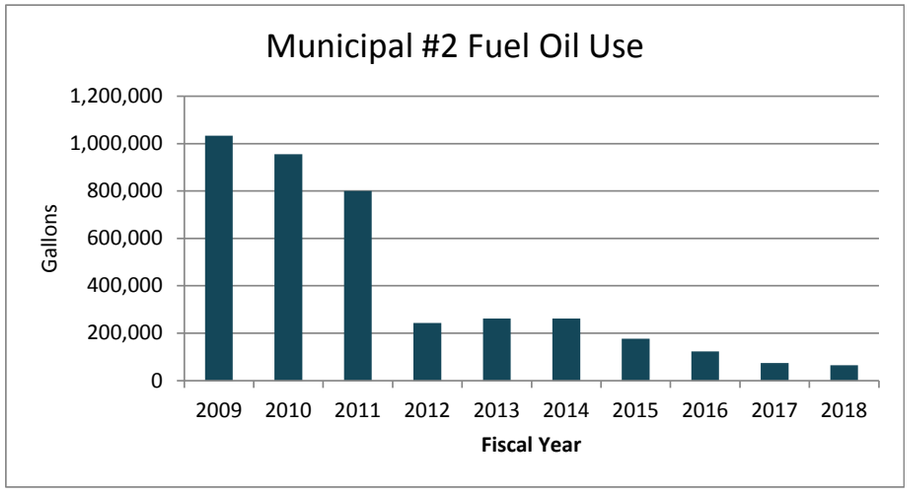

Figure 5: City of Providence's fuel oil consumption has declined by 93% since FY 2010 due to converting to natural gas systems.

Energy Supply: Renewables & Procurement Strategy

The Department of Public Property and the Office of Sustainability continue to identify energy conservation measures to maximize the City's operating budget and combat increasing energy costs. Despite rising energy prices, the City has reduced its operating costs for energy by nearly 29% since FY 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 $3.5 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.

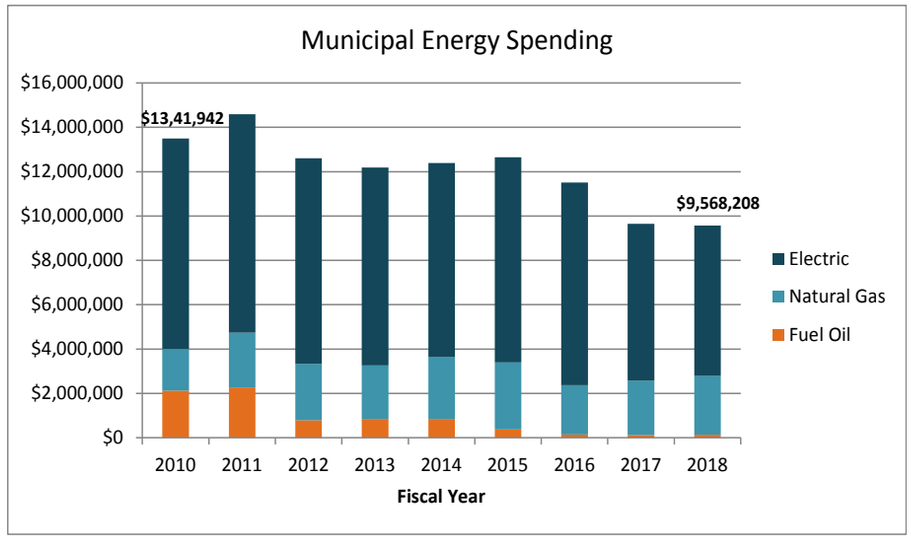

Figure 6: Despite rising energy costs, municipal spending on energy has decreased by 29% since 2010

Solar Procurement - Virtual Net Metering

In December 2018, Mayor Jorge Elorza joined Johnston Mayor Joseph Polisena, Rhode Island business leaders, and other officials to celebrate the official opening of a 3.9 MW solar array, built on a former landfill site in the Town of Johnston. Energy generated from the photovoltaic array, along with energy from a 23 MW solar farm opening in 2019, will provide 60% of Providence's municipal electricity needs. The projects were developed by Southern Sky Renewables and designed and built by Conti Solar and members of the International Brotherhood of Electrical Workers, IBEW Local 99.

The 30.5 million kilowatt hours of renewable energy produced by the nearly 58,000 panels will eliminate 22,670 metric tonnes of carbon dioxide equivalent (CO2e) from the atmosphere, and will provide roughly $1.66 million in annual electricity savings to the City. After the first ten years of the contract, the City will be able to retain the Renewable Energy Credits (RECs), meaning the City can claim the carbon reduction benefits of the solar production.

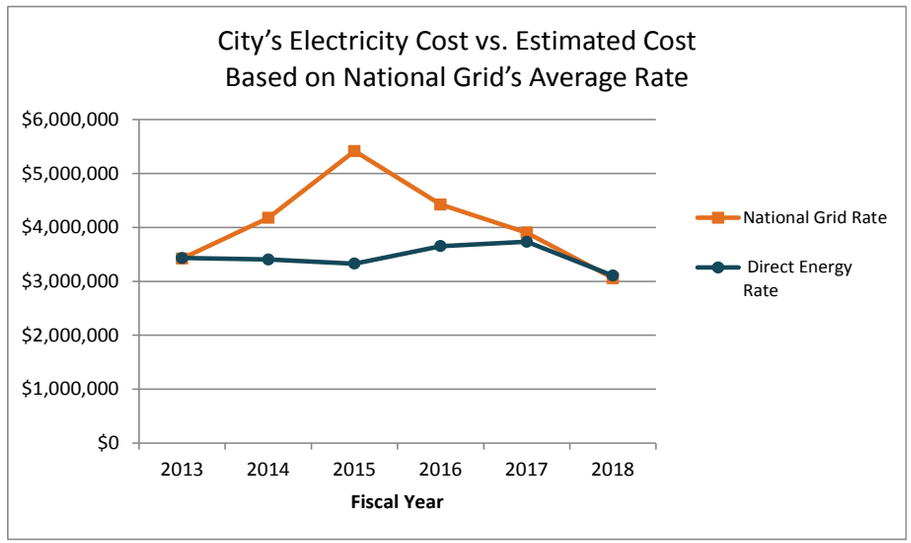

Figure 7: The graph provides a comparison of the City's actual electricity cost based on its third-party supplier rate versus estimated cost using National Grid's average rate.

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,[2] one central public safety complex, nine district police sub-stations, 12 fire stations (the Humboldt Fire Station closed in 2017), 11 recreation centers,[3] 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 79% of the City's portfolio (see Figure 8). Of the remaining 21% of building space (see Figure 9), public safety buildings account for 28%, buildings for public assembly such as The Casino at Roger Williams Park, and those at the North Burial Ground account for 25%, administration buildings, such as City Hall, account for 24%, recreation centers and DPW buildings total 21%, and 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 150 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 (RIDES) 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.

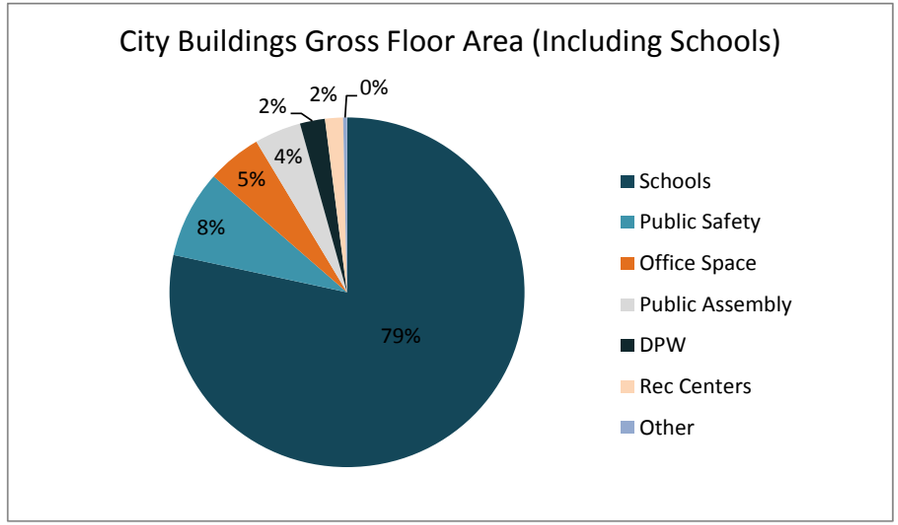

Figure 8: Total municipal building area percentage by facility type in 2018. Percentages based on building square footage.

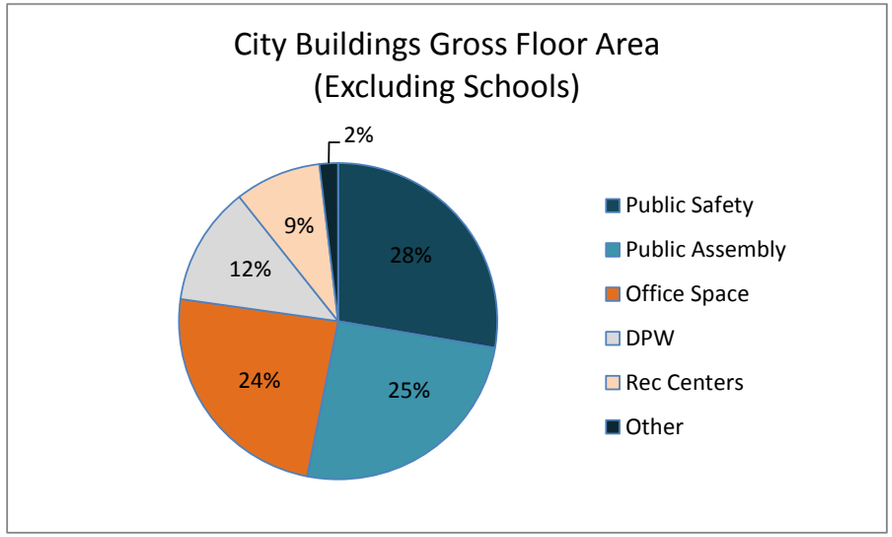

Figure 9: Municipal building area percentage by facility type in 2018. This graph excludes schools, which accounts for 78% of the building portfolio.

[2] Some buildings house more than one school.
[3] 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 Lillian Feinstein Elementary Schools also opened their new rec centers in 2017.

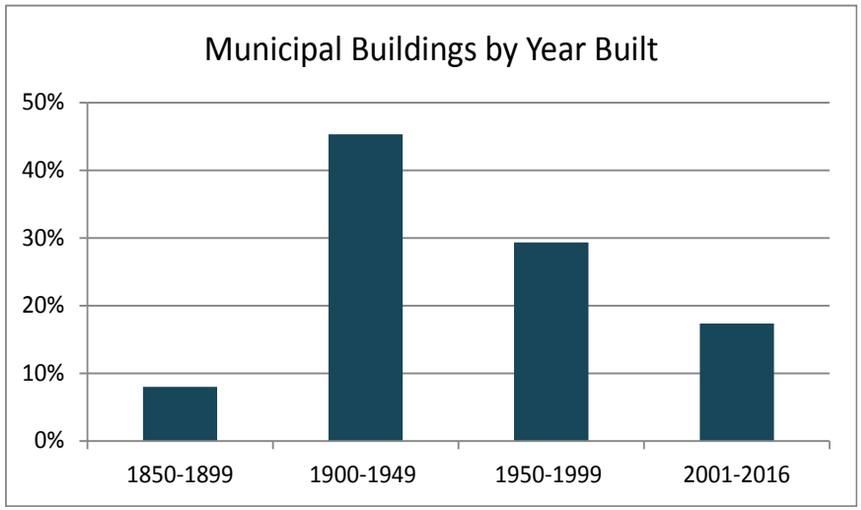

Figure 10: Municipal buildings by year built shown as a percentage. Most of the City's building portfolio was built in the early 20th century.

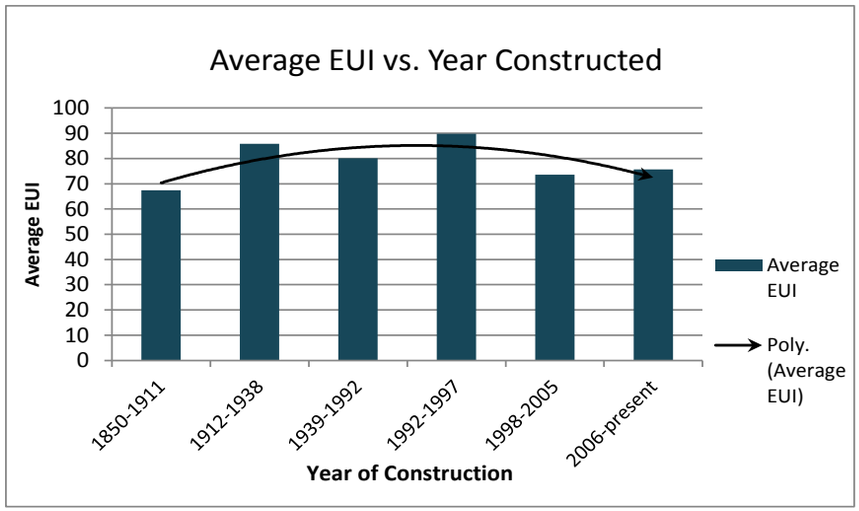

Figure 11: This graph compares year of construction with building's energy use intensity (EUI). Older municipal buildings, built before the advent of energy-intensive heating, cooling and lighting systems, are some of the City's lowest energy consumers per square foot. New policies such as the International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

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 11, 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.

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% 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.

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. Unlike the City's past reports, the FY 2018 Municipal Energy Report includes weather-normalized building EUIs. This metric allows the City to track year-to-year energy fluctuations outside of changes in weather. The weather-normalized EUI for each facility can then compared to that of other City municipal buildings of a similar type. This helps the City benchmark buildings that cannot get Portfolio Manager scores.[4]

In August of 2018, the EPA updated its 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 has resulted in lower City building scores for this year's fiscal report, the new calculations have been applied to historical scores as well, 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.

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.

[4] 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.

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 the Providence Public Schools Department (PPSD) 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 2018, Providence's schools used 259,308 MMBtu, or 65% of the City's energy consumption (see Figure 12). After seeing a substantial drop in 2016, the energy used by the City's school buildings has increased slightly the past two years, coinciding with a dramatic up-tick in after-school and summer programs that began being offered by the City in FY 2017, including Summer Learning Programs, and Summer Day and Specialty Camps.

While there are many unavoidable factors that can impact energy use in schools (i.e. extended hours of use, increase in electronics and computers, and increasing student and teacher population), the City continues to make on-going investments in energy efficiency. Though some elementary school and high school Energy Star scores dipped slightly in FY 2018, average scores for all school buildings have increased substantially since 2014 (see Figure 13). In addition, the average weather-normalized EUI for all City schools has improved via an 11% decrease since FY 2010 (see Figure 14). The reductions have 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.

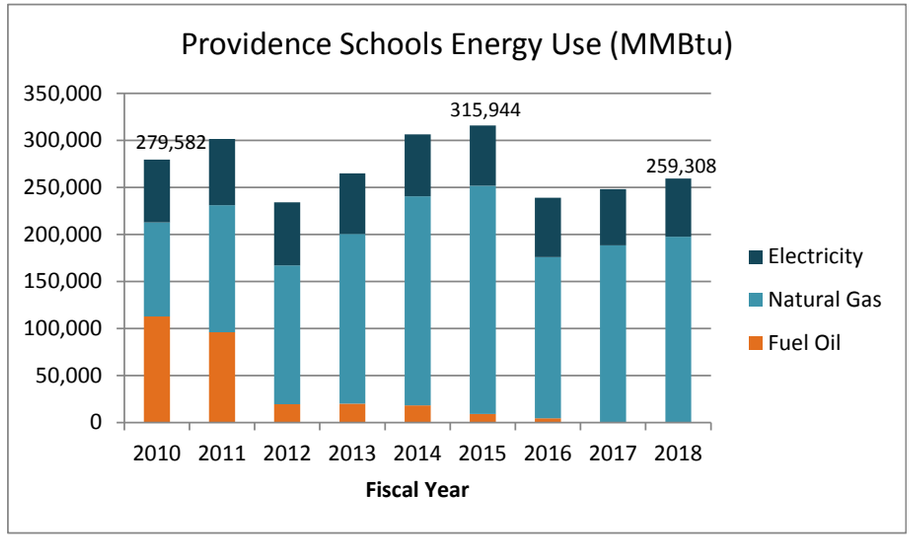

Figure 12: In FY 2018, Providence Schools electricity, natural gas, and fuel oil consumption was down 18% from an eight-year high of 315,944 MMBtu in FY 2015.

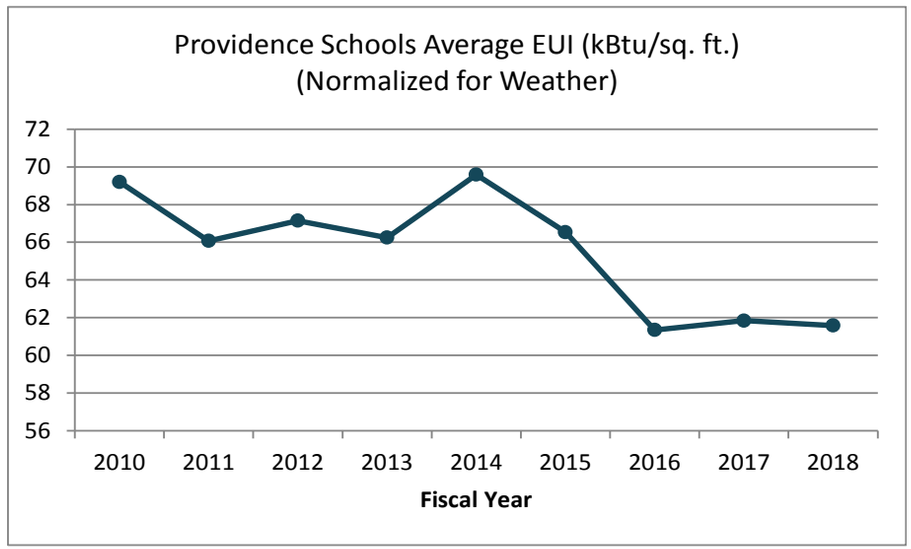

Figure 13: Weather-normalized average energy use intensity (EUI) for all City school buildings.

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 Public 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]

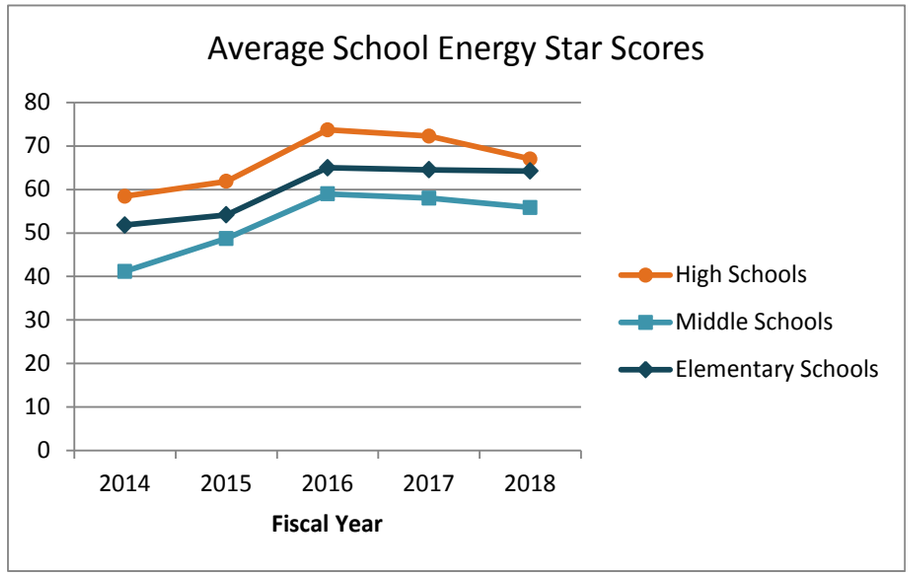

Figure 14: Though some elementary schools and high school Energy Star scores dipped slightly in FY 2018, average scores for all school buildings have increased substantially since 2014.

[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 2018, seven of the 22 elementary schools had Energy Star scores of 75 or above, qualifying them to be Energy Star certified buildings. The decrease in the number of elementary school buildings eligible for certification since last year is attributed to the 2018 Portfolio Manager score realignment (see p. 21) Robert L. Bailey, IV Elementary School's score of 94 was the highest Energy Star score of all the City's schools in FY 2018. 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 both are eligible for certification with their scores of 88 and 80. In addition to the scoring realignment, increased building activity is responsible for scores at some schools dipping in FY 2017 and FY 2018, such as 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 2018, Aramark continued its ongoing maintenance and monitoring of Building Management Systems (BMS) district-wide. In FY 2018, BMS upgrades were completed at the Leviton Complex, which is home to both the Alfred Lima, Sr. and Charles N. Fortes Elementary Schools. This complimented two high-efficiency condensing boilers installed in 2016, and variable frequency drives (VFDs) added in 2017.

Heating and Cooling System Upgrades

In FY 2018, HVAC and BMS upgrades were completed for the gym and swimming pool area at Pleasant View Elementary School including the addition of cooling functions, as the site also now serves as Armand E. Batastini Jr. Rec Center. In 2017 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. That project cost $300,000 after a $20,000 rebate from National Grid. A separate boiler for the swimming pool was also commissioned that year. 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. The new "mini' pool boiler is believed to be responsible for the 63% reduction in natural gas use in between FY 2017 and FY 2018, despite a colder winter.

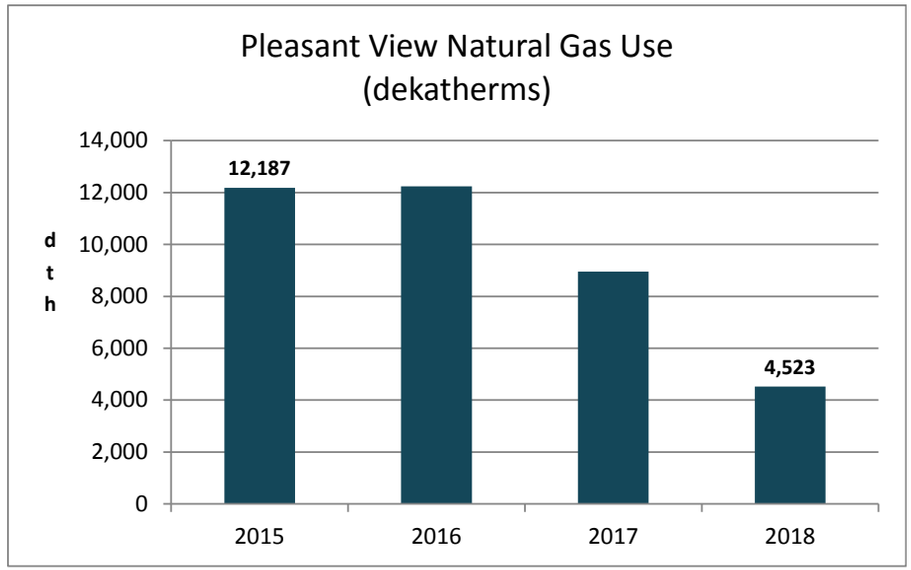

Figure 14: The evolution of heating system upgrades at Pleasant View is reflected in the buildings natural gas use.

[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.

Heating and Cooling System Upgrades

Regular maintenance of heating system steam traps is essential to preventing leaks that can waste thousands of dollars each year. Through incentives from National Grid, 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 CO2e from entering the atmosphere every year.

Included in Providence Schools master facilities plan heating and cooling system projects for summer 2019 are steam boiler replacement at Carl Lauro, boiler feedwater system replacement at Harry Kizirian, and steam trap repair/replacement at Alan Shawn Feinstein Elementary School at Broad Street.

LED Lighting Retrofits

As of 2018, nine out of 22 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 2018 was down by about 678,520 kWh relative to FY 2015, saving Providence schools over $100,000. The increased life span of the new LED lamps (up to 70,000 hours) is also significantly reducing maintenance costs.

Highlight: Anthony Carnevale Elementary School

Energy efficiency measures at Anthony Carnevale Elementary School including weather-stripping, LED retrofitting and Building Management System BMS upgrades have all contributed the building's Energy Star score improvement, lower electricity use, and lower EUI. Carbon emissions at the site are 16% below FY 2010 levels.

Table 1: Elementary School Buildings Energy Performance and Benchmarking

Facility Elementary Schools	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2018 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2018 ENERGY STAR Score	ENERGY STAR score Change
					Averages:	**169.5**	**71.9**	**60.3**	**52.7**	**64.2**	
Allan Shawn Feinstein Elementary School @ Broad Street	1895	77,899	129,964	49,803		5,423,713	264.5	74.9	73.3	80	80	→
Anthony Carnevale Elementary School	1999	78,000	503,425	18,226		3,540,287	96.8	56.7	46.3	47	66	↗
Asa Messer Elementary School @ Samuel W. Bridgham	1972	109,255	428,367	19,426		3,404,167	103.2	70.8	32.3	39	87	↗
B. Jae Clanton Complex	2004	103,000	449,842	26,240		4,158,832	139.4	89.4	41.5	41	89	↗
Carl G. Lauro Elementary School	1921	117,482	174,746	63,164		6,912,622	335.5	62.6	63	71	73	↗
Dr. Martin Luther King Elementary School	1959	71,724	234,316	30,394		3,838,918	161.4	59.4	55.5	71	79	↗
Frank D. Spaziano Elementary School	1908	58,015	106,051	20,197		2,381,514	107.3	73	42.8	56	88	↗
Frank D. Spaziano Elementary School Annex	1910	19,585	92,530	11,353		1,451,052	60.3	73.5	76.3	42	27	↘
George J. West Elementary School	1959	112,030	231,042	63,392		7,127,559	336.7	70.2	67.2	64	64	→
Harry Kizirian Elementary School	1959	73,950	267,003	37,906		4,701,611	201.3	68.3	66.3	57	55	↘
Leviton Dual Language School	2002	40,000	280,488	10,529		2,009,931	55.9	49.6	50.8	73	70	↘
Lillian Feinstein Elementary School @ Sackett Street	1921	68,400	243,596	29,559		3,787,048	157	59.3	57.2	71	76	↗
Mary E. Fogarty Elementary School	1959	51,400	158,007	25,304		3,069,554	134.4	61.8	63	60	61	↗
Reservoir Avenue Elementary School	1924	22,000	92,495	10,329		1,348,482	54.9	81.7	64.1	28	42	↗
Robert F. Kennedy Elementary School	1921	49,840	147,811	34,935		3,997,862	185.6	84.6	83.7	38	39	↗
Robert. L Bailey, IV Elementary School	2000	78,000	319,241	15,387		2,627,949	81.7	46.7	34.1	79	94	↗
The Leviton Complex	1908	178,654	827,312	51,847		8,007,458	275.4	56.6	46.2	52	68	↗
Vartan Gregorian Elementary School	1954	63,000	270,120	47,079		5,629,505	250.1	108.6	93	16	23	↗
Veazie Street Elementary School	1909	110,000	303,063	52,323		6,266,341	277.9	90.2	59.6	31	66	↗
Webster Avenue Elementary School	1904	44,290	148,814	21,166		2,624,352	112.4	56.7	59.6	65	59	↘
William D'Abate Elementary School	1959	44,174	188,140	31,545		3,796,432	167.6	115.3	89.9	25	43	↗
Pleasant View Elementary School	1971	74,800	368,949	45,230		5,781,816	240.2		77.4		59	↗

Middle Schools

Five of the City's seven 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, and along with Nathaniel Greene, is one of two middle schools that qualified for Energy Star certification in FY 2018. This has been the result of targeted energy efficiency improvements such as HVAC controls upgrades, steam trap replacement, and LED lighting. Governor Christopher DelSesto Middle School's Energy Star score rose seven points in FY 2018 to a 74, just short of the score of 75 needed to qualify for Energy Star recognition.

Energy Efficiency Improvements

Building Management System Upgrades

A new BMS at Governor Christopher DelSesto Middle School installed in 2017 helped the building increase its Energy Star Score from a 67 to a 74 in FY 2018. Aramark continued its on-going maintenance and monitoring of all middle school BMS through FY 2018. 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. In FY 2018, Energy Star scores at both of those schools improved as well.

Heating and Cooling System Upgrades

A new #1 boiler and vacuum condensate receiver were installed in 2018 at the Nathanael Greene Middle School, significantly enhancing heating efficiency at the facility. Condensate is the liquid formed when steam passes from the vapor to the liquid state. A vacuum condensate receiver recovers the water and residual heat contained in the discharged condensate for the purposes of reusing it for the boiler. Recovering condensate, instead of discharging it completely, can lead to significant savings of energy. Ongoing steam trap maintenance and other measures at the site contributed to the building earning an Energy Star score of 82 in FY 2018. The #2 boiler at Gilbert Stuart Middle School was replaced in 2016, along with a new vacuum return system, and a properly-sized condensate tank to provide better efficiency. Roger Williams Middle School's replacement boiler was 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. 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. As of FY 2018, these LED retrofits have saved about 1,054,800 kWh, and about $169,000.

Highlight: Nathanael Greene Middle School

Nathanael Greene Middle School achieved an Energy Star score of 82 the end of FY 2018, making the building eligible for Energy Star certification. LED retrofits, steam trap maintenance, and other measures have all contributed to better energy efficiency, and lower emissions at the school. The data shows that the building saw a sharp increase in efficiency after 2015.

Table 2: Middle School Buildings Energy Performance and Benchmarking

Facility Middle Schools	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2018 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2018 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**63.3**	**60.3**	**57.8**	**62.2**	
DelSesto Middle School	1998	146,000	745,600	41,181		6,662,071	218.7	57	47	52	74	↗
Esek Hopkins Middle School	1916	87,560	244,567	32,876		4,122,088	174.6	49.1	49.2	73	78	↗
Gilbert Stuart Middle school	1929	154,450	287,108	81,814		9,161,021	434.6	56.1	63.2	70	64	↘
Nathan Bishop Middle School	1929	136,000	1,357,862	52,892		9,922,219	280.9	68.9	75	50	24	↘
Nathanael Greene Middle School	1930	159,070	232,503	76,217		8,415,045	404.8	61.9	52.2	66	82	↗
Roger Williams Middle School	1929	135,228	295,020	88,234		9,829,988	468.7	86.7	75.1	36	51	↗
West Broadway Middle School	1966	46,000	210,344	36,199		4,337,592	192.3		97.9		18	↗

High Schools

The City owns nine high school buildings with a few of the buildings housing two or more different schools. For example, 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 three of the City's high school buildings qualifying for Energy Star certification.

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. In 2017, 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.

Energy Efficiency Improvements

Heating and Cooling System Upgrades

In 2017, the City leveraged 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.

Included in slated Providence Public Schools master facilities plan heating system projects is the replacement of the boiler feedwater system at Hope High School. The plan also entails the replacement of Roof Top units (RTUs) at Central High School. Though the main purpose of both projects is to replace antiquated, failing equipment, the projects wil augmnet efiiciency and provide considerable maintenance cost

Highlight: Central and Classical High Schools

In order to benchmark thermal energy use and emissions, the Central and Classical High School buildings are grouped together due to the fact that the two facilities share a common, centrally-located heating plant. Boilers heating the buildings were retrofitted from #2 heating oil to natural gas in 2011. Additional energy efficiency measures completed include LED retrofits, hot water VFDs, weather-stripping replacement and BMS upgrades.

Table 3: High School Buildings Energy Performance and Benchmarking

Facility High Schools	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2018 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2018 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**59.9**	**61.0**	**66.6**	**67.0**	
Central/Classical High School	1962	454,059	1,916,429	170,047		23,543,533	903.2	61.3	53.6	61	77	↗
Dr. Jorge Alvarez High School	2007	88,000	748,987	52,674		7,822,957	279.8	55.6	91.9	61	28	↘
E-Cubed Academy	2004	44,600	288,817	15,018		2,487,266	79.8	52.8	56.6	67	76	↗
Hope High School	1938	257,089	607,685	177,689		19,842,274	943.8	73.1	80.1	76	71	↘
Juanita Sanchez Educational Complex	2004	110,000	864,366	30,017		5,950,955	159.4	69.6	54.7	53	71	↗
Mount Pleasant High School	1938	320,000	890,753	151,416		18,180,894	804.2	74.9	60.3	75	86	↗
A-Venture Academy	1930	25,060	65,055	10,195		1,241,463	54.2	51.7	51.8	73	60	↘
Providence Career and Technical Academy	2009	300,000	1,726,395	54,434		11,333,864	289.1	40.2	39.1			

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, the 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 uses more electricity than any other single building in the City's portfolio, energy use has been reduced at the site by 28% since FY 2010. 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. The measures helped reduce annual electricity use at the site by 139,200 kWh for FY 2018.

Energy Efficiency Improvements

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. The measures, along with the measures at the Department of Telecommunications building (home to the City's 911 call center) were identified during energy audits by the Antares Group, courtesy of National Grid, for consideration in future funding opportunities.

Highlight: Providence Public Safety Complex

Energy use at the Providence Public Safety Complex, the headquarters and central station for the Providence Police and Providence Fire Departments, has been reduced at the site by 28% since FY 2010.

Table 4: Public Safety Buildings Energy Performance and Benchmarking

Facility Public Safety Buildings	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2018 Site EUI (kBtu/ft^2)
							Averages:	**115.4**	**118.6**
Department of Communications	1987	11,752	263,065	8,006		1,698,195	42.5	151	126.2
Peter A. Rochio Substation	2006	914	26,332			89,845		78.2	101.2
Providence Emergency Management Agency	1991	12,776	37,524	17,555		1,883,492	93.2	90.6	99.3
Providence Police Academy	1928	20,175	2,746,858	18,455		11,217,773	98	131.6	94.5
Public Safety Complex	2002	119,002	9,069	608		91,742	3.2	125.5	171.6
Steven M. Shaw District 5 Substation	1996	546	155,738	3,015	159,390	992,222	27.8		

*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 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 20178 Site EUI (kBtu/ft^2)
							Averages:	**93.9**	**97.4**
Admiral Street Fire Station	1951	1924	63,456	7,333	69,828	1,019,635	44.1		90.1
Allens Avenue Fire Station	1948	1948	46,868	6,746		834,506	35.8	103.2	144
Atwells Avenue Fire Station	1948	1948	62,047	12,122		1,423,946	64.4	80.7	89.6
Branch Avenue Fire Station	1948	1948	84,460	10,081		1,296,313	53.5	74.8	94.7
Broad Street Fire Station	1942	1942	73,706	6,191		870,592	32.9	92.2	84.8
Brook Street Fire Station	1932	1950	55,678	4,542		644,183	24.1	90.4	88.1
Hartford Avenue Fire Station	1948	1948	56,554		616,418	809,381	45.7	88.7	131.1
Humboldt Avenue Fire Station	1950	1905	20,884		908,178	979,435	67.4	114.3	91.3
Messer Street Fire Station	1924	1948	72,316	623	536,020	845,102	43.1	79.9	105.7
Mount Pleasant Avenue Fire Station	1948	1903	29,700	384	424,930	564,708	33.6	126.5	55.4
North Main Street Fire Station	1903	1951	79,825	5,424		814,813	28.8	65.5	92.6
Reservoir Avenue Fire Station	1905	1932	38,228	678	474,637	672,893	38.8	84.8	101.1
Rochambeau Avenue Fire Station	1928	1928	7,089	6,865		710,722	36.5	126.3	

Administrative Offices

Providence City Hall and the Joseph Doorley, Jr. Municipal Building[8] 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. The building, recognized in 2016 for having achieved an Energy Star score of 94, continued to perform well in FY 2018. While the Energy Star score dropped to an 80 due to the score realignment, the building's weather normalized EUI improved from a 61.5 in FY 2017, to a 59.7 for FY 2018. Providence City Hall is a great example of how properly performed energy-efficiency retrofitting measures can reduce building emissions and provide energy and cost savings.

The Joseph Doorley, Jr. Municipal Building, named after Providence's thirty-first mayor, and leased from Paolino Properties, houses the City's Department of Inspections and Standards, and the Department of Planning and Development, along with several other City offices. The building's annual weather-normalized energy use has been reduced by 36% since FY 2013. Given that this building is one of Providence's larger energy consumers, the City continues to explore ways to advance energy efficiency as tenants of the space. A no-cost investment-grade energy audit was performed at the facility in 2016 that identified a number of investments that the City is considering to reduce operational costs of the building through energy conservation.

Other City buildings in this category include the Department of Recreation main office building, the Department of Public Works Administration Building, and Providence Public Schools' Dr. Robert F. Roberti Administration and Family and Community Engagement Center.

Energy Efficiency Improvements

LED Lighting Retrofits

In the beginning of FY 2017, 22 exterior 400-watt metal halide flood lights illuminating Providence City Hall were replaced with 129 watt LED fixtures. This, in addition to the replacement of 10 500 watt halogen floodlights in the building's atrium, resulted in a 19% reduction in the building's electricity use between FY 2017 and FY 2018. These recent measures, combined with past LED tube retrofits in the building's offices, conference rooms and corridors have reduced annual electricity consumption at City Hall by 45% since FY 2010.

Highlight: Providence City Hall

Interior and exterior LED retrofits, BMS controls, and other energy efficiency upgrades have all played a part in having reduced the energy use intensity (EUI) at City Hall from 86.1 in FY 2010 to 59.7 in FY 2018, an energy use reduction of 31%.

[8] 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.

Table 6: Administration Buildings Energy Performance and Benchmarking

Facility Administration Buildings	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 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 2018 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2018 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**105.9**	**83.8**	**30.2**	**36.4**	
City Hall	1855	99,675	436,510	42,650		5,737,324	221.9	86.1	59.7	47	80	↗
Department of Recreation	2001	4,186	48,111		280,830	345,088	26.7			4	2	↘
DPW Administration Building	1925	20,511	72,712	15,218		1,748,004	81.6	99.9	90.9	66	25	↘
Dr. Robert F. Roberti Administration Building	1945	56,744	774,039	29,507		5,109,792	129.3	122.8	101.6	28	50	↗
Joseph A. Doorley, Jr. Building	1966	72,000	959,299	29,875		6,088,643	148.8	121.1	89.3	8	33	↗
The Family and Community Engagement Center	1960	8,700	47,705	4,777		606,707	21.6	99.5	77.5	6	25	↗

Neighborhood Recreation Centers

Each of the City's 11 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.

Despite FY 2017 LED retrofits in recreation centers City-wide, the average weather-normalized EUI of all the non-school centers combined increased by 15.7% in FY 2018 largely due to the City's new summer day camps and expanded athletic programs. Industrial refrigeration equipment was also added to these sites in 2017 for meals and snacks included as part of free program(s).

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 the City's recreation centers that are saving over 95,000 kWh annually, and about $16,000 a year in City electricity costs.

Multiple investment-grade 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. Though funding for deep efficiency and resiliency remain elusive, the Office of Sustainability and Department of Public Property have nonetheless 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 to also meet the challenges of climate change adaptation.

Department of Public Works and Other Buildings

City buildings in this category include the Lillian Feinstein Senior Center, DPW, and school buildings owned by the City, but not currently under PPSD administration. Also being benchmarked is the Public Safety Maintenance Garage on Dexter Street where all City-owned police and fire vehicles are sent for repairs. Buildings at Roger Williams Park included in this category are the Dalrymple Boathouse, the Casino, and the newly renovated Museum of Natural History and Planetarium. Two buildings showing some notable improvement in FY 2018 in this category were the City's DPW buildings which lowered their collective weather-normalized EUI by 7% from FY 2017, and the Casino which reduced its EUI by 5%.

Table 7: Recreation Center Buildings Energy Performance and Benchmarking

Facility Recreation Centers	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2018 Site EUI (kBtu/ft^2)	
							Averages:	**87.6**	**99.6**	
Vincent Brown Recreation Center	1997	18,111	24,208	12,617		1,344,251	67	57.4	78.8	
West End Recreation Center	1997	25,760	186,692	9,336		1,570,598	49.6	56.1	63	↗
Neutaconkanut Recreation Center	1997	15,345	48,231	8,856		1,050,213	47	89.4	72.7	↘
Zuccolo Recreation Center	1949	11,592	49,503	6,552		824,108	34.8	83.5	75	↘
Davey Lopes Recreation Center	1948	11,860	102,393	14,210		1,770,376	75.5	146.5	158	↗
Selim Madelin Rogers Recreation Center	2000	9,350	52,550	11,726		1,351,900	62.3	92.8	149.8	↗

Table 9: Miscellaneous Buildings Energy Performance and Benchmarking

Facility DPW & Other Buildings	Year Built	Gross Floor Area (sq. ft.)	FY 2018 Electricity Use (kWh)	FY 2018 Natural Gas Use (therms)	FY 2018 Fuel Oil #2 (kBtu)	FY 2018 Total Site Energy Use (kBtu)	FY 2018 Direct GHG Emissions (Metric Tons CO2e)	FY 2010 Site EUI (kBtu/ft^2)	FY 2018 Site EUI (kBtu/ft^2)	FY 2010 ENERGY STAR Score	FY 2018 ENERGY STAR Score	ENERGY STAR score Change
							Averages:	**48.0**	**51.1**			
Alex & Ani City Center	1999	6,373	579,761									
Camp Cronin	1960	4,362	152			519		2.2	0.1			
Central Supply Providence Schools	2004	15,525	80,087	7,418		1,015,058	39.4	129.3	68.4	3	26	↗
Dalrymple Boat House	1894	17,474	51,975		346,256	523,594	25.7	36.8	29.9			
Dexter Street Garage	1905	17,000	82,909	17,941		2,076,946	95.3	110.4	122.2			
DPW Maintenance, Traffic and Roller Shed	1930	110,450	227,227	63,544		7,129,667	337.5		68.6			
Lillian Feinstein Senior Center	2001	8,520	54,510	4,391		625,063	23.3	36.9	76.7			
Museum of Natural History and Planetarium	1894	19,500	249,885		768,522	1,621,129	57	109	81.9			
Oliver Hazard Perry (Providence Mayoral Academy ES)	1929	182,488	429,817	87,226		10,189,167	463.3	54.1	59.1	33	43	↗
Public Safety Garage	2002	162,976	192,115			655,497		4.8	4.1			
The Casino at Roger Williams Park	1894	16,782	89,018	10,249		1,328,631	54.4	92.1	80.5			
Windmill Street School (closed)	1915	86,140	46,345		1,717,962	1,876,091	127.5		21.8	31	99	↗

Outdoor Lighting

Outdoor lighting, which includes the City's streetlights, accounted for 15% of the City's total electricity use in FY 2018, compared to 34% in FY 2015. 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.

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 and dimming schedule were able to reduce City streetlight electricity use by 12.5 million kilowatt hours (kWh) for FY 2018 (see Figure 15), with that reduction expected to reach 12.6 million KWh for FY 2019. In FY 2018, the streetlight purchase and subsequent LED retrofitting successfully saved the City over $2.4 million in streetlight electricity use and maintenance (figure 16).

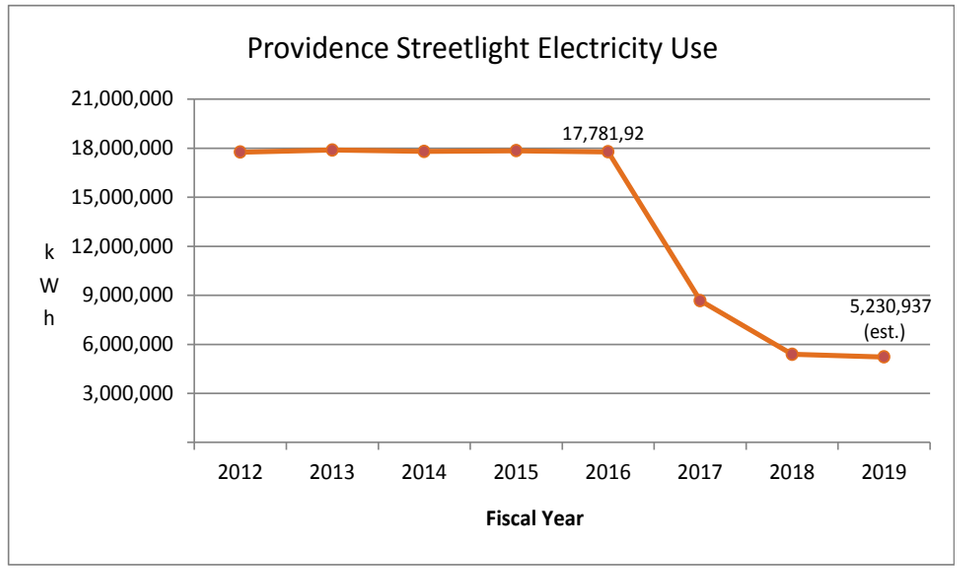

Figure 15: Providence streetlight electricity use was reduced by 12.5 million kilowatt hours (kWh) between FY 2015and FY 2018.

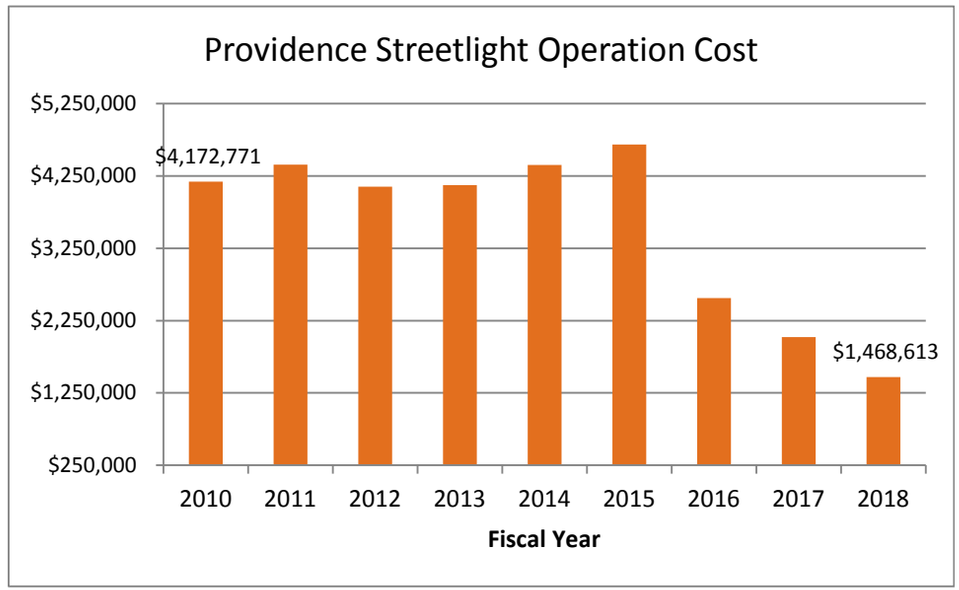

Figure 16: Providence streetlight combined electricity and operational cost was reduced by $3.2 million or nearly 70%, between FY 2015 and FY 2018.

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 fields in 2017. Northeast Energy Supply (NES), which expedited the program by the utility for the City, retrofitted floodlighting and wall packs[9] 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.
In FY 2018, the City began retrofitting sidewalk and pathway induction lighting around the City to LED technology. The project will reduce annual City electricity consumption by over 1,000,000 kWh, and an annual savings of about $178,000.

[9] Wall Packs are lighting fixtures usually found mounted on exterior walls of commercial buildings.

Traffic Lights

The Department of Traffic Engineering is responsible for the maintenance and operation of all City traffic lights. LED technology, and in some cases renewable energy technologies are being utilized in efforts to keep electricity consumption down. More work is needed to identify other measures to insure that downward trending from FY 2010 can be maintained. Electricity consumption from traffic signals saw a 3% increase in FY 2018 (Figure 17).

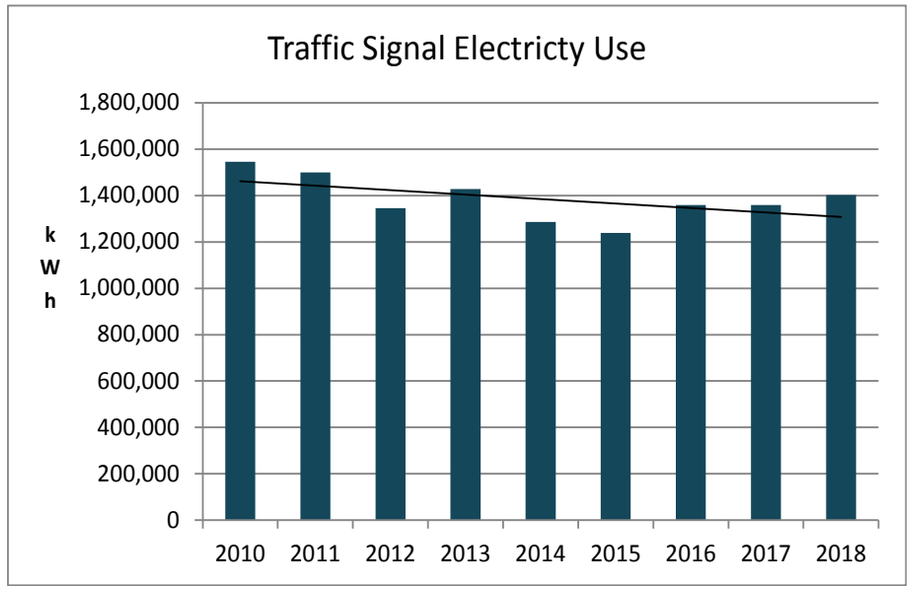

Figure 17: Despite recent increases in the past few years, electricity use for traffic lights in the City is down 9% from FY 2010.

Greenhouse Gas Emissions

In July 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 (see Figure 18) 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 CO_2e. 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 2018 municipal GHG emissions are estimated to have been 26,600 metric tons, down 2.4% from FY 2017, and down 30% from FY 2010 (see Figure 19). 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.

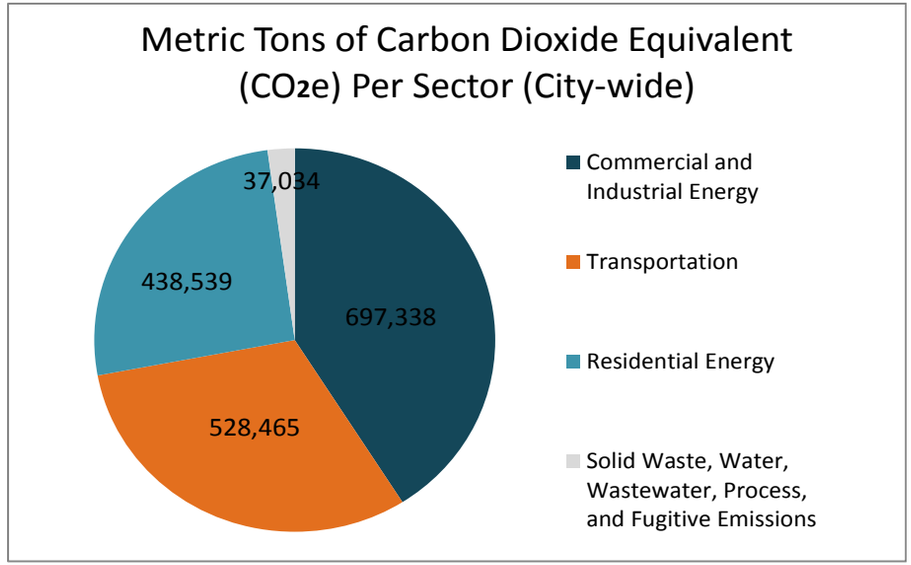

Figure 18: Providence FY 2018 greenhouse gas emissions by sector.

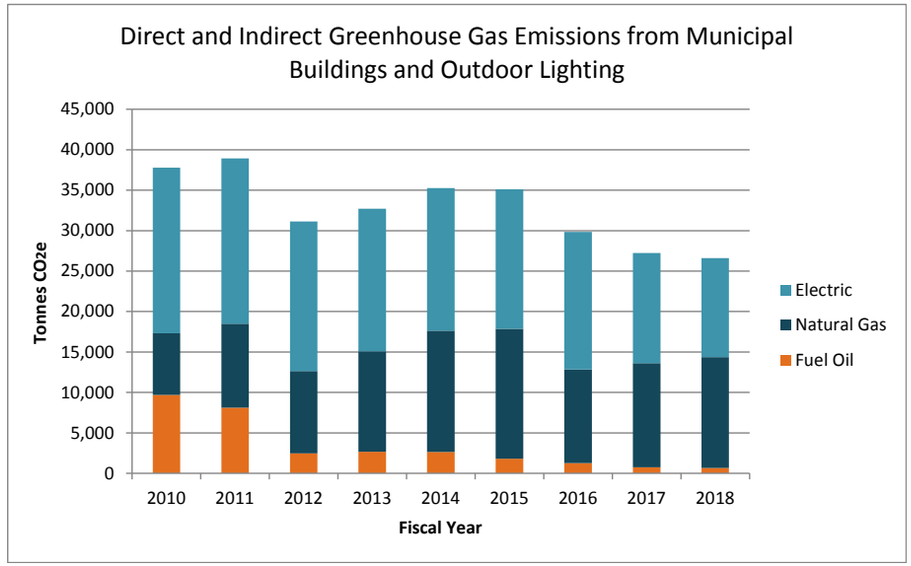

Figure19: Greenhouse gas emissions from municipal buildings and lighting, shown in metric tons of CO2 equivalents, FY 2010 - FY 2018.