Building Energy Efficiency Plan

Reduction strategies for energy and emissions within municipal buildings

Photo Credit: Daniel Nissan

City of Fort Lauderdale
Department of Public Works
Sustainability Division

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Executive Summary

Located on the frontlines of climate change, the City of Fort Lauderdale has long prioritized efforts to increase its sustainability and resiliency. Since the development of its first Sustainability Action Plan in 2010, the City of Fort Lauderdale has focused on addressing the challenges of climate change by strategies that include establishing aggressive goals for sustainability and resiliency and incorporating sustainability into its planning efforts, its operations, and its programs. While the City has made significant progress towards these goals, much work remains to further reduce the City's carbon footprint and its resulting contribution to the global problem of climate change.

Fort Lauderdale's biggest climate change threat is rising sea levels rise. Consequently, the City is already planning and implementing multiple strategies to reduce the impact of sea level raise. However, the most effective long-term strategy is to stop global warming by reducing greenhouse gases and, therefore, halt the resultant sea level rise. Reducing the City's GHG emissions by itself is a small but essential part of the global solution to climate change. Based on its 2011 Sustainability Action Plan, the City has tracked key indicators of its operational GHG emissions since 2010 and has set targets for both GHG and electricity reduction of 20% by 2020 from a 2010 baseline. Currently, with annual bills greater than $9.3 million and usage of over 98 million kilowatt-hours (kWh), electricity accounts for over 70% of the City's GHG emissions. Increased energy efficiency has multiple benefits to the city included decreased energy costs, increased equipment life and decreased GHG emissions.

Energy efficiency is a key strategy to address both sustainability and resiliency. Energy efficient operations and processes minimize waste by achieving the same level of work output while using the least amount of resources necessary to accomplish the task. In the case of City buildings, the electricity provided by Florida Power and Light (FPL) to energize lighting, cooling, ventilation, IT infrastructure, and electric vehicles is generated primarily from fossil fuels which contribute to GHG emissions. Although over the last 10 years FPL has substantially reduced its amount of GHG emissions per kWh generated, to achieve City goals and make a significant dent in its GHG emissions, the City must consider multiple energy efficiency opportunities including improvement, modification, or replacement of electricity using equipment, systems, and operations. Energy efficiency offers the multiple benefits of reducing greenhouse gas (GHG) emissions and increasing cost savings.

In line with these efforts to increase energy efficiency, in 2017, the City was selected by the US Department of Energy (USDOE) to participate in its Reinvesting in Public Buildings Pilot Project to assist the City with achieving its public building energy efficiency goals. Specifically, through this program the City received technical support from a contractor of the USDOE for a limited study of a subset of its public buildings in order to develop a matrix of energy efficient measures that could be implemented. The analysis for this study utilized available data gathered from multiple sources including historical electricity usage, facility personnel, limited walk-throughs of select facilities and industry cost/savings assumptions, as the basis to develop recommendations. From these efforts, the Building Energy Efficiency Plan (BEEP) was developed and then finalized in 2020 to provide a roadmap for the City to accelerate its energy efficiency goals, focusing on opportunities for energy efficiency in the City's buildings used primarily for human occupancy. Due to the limitations of the methodologies used to gather data via field measurements, the assumptions used in modeling, and the changes in mechanical performance over time at the analyzed buildings, the datasets of this report should be utilized only as a framework to how the City proceeds. The cost and savings estimates included in the BEEP are intended as rough estimates to assist with ranking and prioritizing strategies. When BEEP strategies are implemented, actual project costs and realized savings will likely vary from the estimates in this report due to multiple factors including time since original estimates calculated, limitations and assumptions in the original analysis, changes in pricing of services and equipment, and changes in operation of City facilities, among other factors. The sections of this report outline the City's current **Building Portfolio**, its **Organizational Structure**, a **Resourcing and Efficiency Strategy**, and an **Action Plan** providing twelve recommended strategies for improving energy efficiency in the City's buildings.

The **Introduction** of this plan highlights the work that has been done to date. It uses previously established City plans such as the 2035 Vision Plan -*Fast Forward*, the five-year strategic plan - *Press Play*, and the *Sustainability Action Plan* as the foundation to review the City's building portfolio for potential investment in its energy systems. In **Section 2: Building Portfolio**, the structure and composition of the building asset inventory is reviewed in detail. Further analysis into energy consumption and cost trends, forecasting of the potential financial impacts by continuing with "business as usual", and the establishment of an in-depth methodology to aggressively target buildings with the greatest impact is expanded. **Section 3: Organizational Structure** provides insight into the existing resources, outreach initiatives to raise awareness, policies that have been established or are being developed , and an overview of the value capture model that can be leveraged to advance energy efficiency in the City.

In **Section 4: Resourcing and Efficiency**, financial instruments that can be utilized to create a dedicated energy management program are also reviewed considering the challenges faced in obtaining consistent budget allocations from traditional methods. In **Section 5: Action Plan,** the BEEP concludes with an examination of potential energy efficiency investments for implementation. It should be noted that this roadmap is not all-inclusive of every potential opportunity that may exist and serves as the first step to identify priority strategies and facilities that provide the greatest opportunity for energy efficiency. Their respective costs and savings were derived based on data available at the time and should be understood as estimates requiring a more in-depth investigation before pursuing implementation.

Table i summarizes the BEEP's recommended strategies, highlighting where and how the City can next invest into energy efficiency based upon the technical analysis of a subset of its buildings. Twelve (12) energy efficiency strategies have been identified with a total cost of $1,004,587 and projected annual savings of $661,925, which would provide a simple payback of just over 1.5 years for the subset of buildings studied. The strategies are presented from shortest return on investment (ROI) to longest and any pursued should have these estimates further investigated to ensure accuracy of current conditions.

Table i: Priority Energy Efficiency Investment Opportunities

Priority	Measure	Est. Base Cost	Est. kWh Savings	Est. Cost Savings	% Citywide kWh Reduced	$ / kWh Reduced	ROI (years)
1	HVAC Filters & Scheduling	$3,160	7,031	$159,739	0.01%	$0.45	0.40
2	Retro-Commissioning	$148,139	1,425,995	$156,860	1.46%	$0.10	0.94
3	Cool Roof Coating	$29,642	243,066	$26,737	0.25%	$0.12	1.11
4	LED Lighting and Controls	$200,307	1,436,316	$157,995	1.59%	$0.14	1.19
5	Weather Sealing	$32,807	185,891	$20,448	0.19%	$0.18	1.60
6	Plug Load Management	$13,451	72,310	$7,954	0.07%	$0.19	1.69
7	Variable Freq. Drives	$15,482	7,533	$8,944	0.01%	$2.06	1.73
8	DDC Thermostats	$57,354	274,333	$30,174	0.28%	$0.21	1.74
9	Planting Shade Trees	$12,240	34,567	$3,802	0.04%	$0.35	3.23
10	Solar Window Film	$250,849	602,590	$66,285	0.62%	$0.42	3.78
11	Roof Insulation Retrofit	$23,085	19,189	$2,111	0.02%	$1.20	10.94
12	High-Efficiency HVAC	$214,202	68,408	$7,525	0.07%	$3.13	28.1
	Total:	**$1,004,587**	**4,498,606**	**$661,925**	**4.60%**	**$0.71**	**1.52**

Key Takeaways

- This plan utilized industry methodologies to derive energy cost and savings calculations without conducting standardized, comprehensive energy audits. As such, certain assumptions for criteria were applied and are detailed within.

- Comprehensive energy audits of buildings larger than 10,000 square feet that are not scheduled for either decommissioning or rehabilitation should be considered for more accurate opportunity assessments, including better-estimated costs and savings.

- Investment in dedicated energy management personnel will improve building operations policy compliance. The Parks and Recreation Department can be prioritized due to their asset management responsibilities.

- Establishment of an energy training program will ensure investments into efficiency can better maintain its return over the anticipated life of the system.

- Existing analytics can readily demonstrate savings from efficiency investment, however, deeper analysis via robust software platforms could automate and expand capabilities.

- All demonstrated savings from efficiency investment should ideally be returned to the Sustainability Investment Fund to maintain and expand the program for even greater savings potential.

Next Steps

To implement the BEEP, the City can consider taking the following actions:

- Explore opportunities to obtain funding for implementation of BEEP strategies, such as Budget requests and transfers of energy cost savings from previous and current energy cost savings to the Sustainability Investment Fund;

- Select BEEP strategies to implement first based on available funding, logistical feasibility, impact, and other considerations;

- Continue to review effectiveness of completed strategies, monitoring changes in energy usage and any other operational impacts of the improvements; and

- Continue to seek additional opportunities for energy usage reductions and cost savings in the facilities analyzed in the BEEP and in other City facilities and operations.

1. Introduction

"Problems cannot be solved at the same level of awareness that created them."

Purpose

Energy management is one of the cornerstones of the science of environmental sustainability and yet quite often it is overlooked due to the presently inexpensive cost of energy itself. The City of Fort Lauderdale Sustainability Division, with support from the United States Department of Energy technical consultant, Alleghany Science and Technology, underwent a review of targeted buildings for efficiency investment opportunities and developed the **Building Energy Efficiency Plan** (BEEP) to provide key stakeholders with a path forward for cost reductions. The opportunities presented to save money and reduce our emissions footprint from this evaluation can then translate into broader strategies and inform future conversations involving the management of our municipal facilities.

To date, significant analysis of energy trends and the piloting of efficiency technologies over the course of the last decade has brought forth insights that have helped craft this plan. Leveraging this momentum, the City can further reduce its energy consumption and the associated costs to achieve a greater understanding of where energy efficiency options lie and what strategies can be pursued to address them. By doing so, the City will better meet the established regional and local emission targets, improve resiliency, increase equipment reliability and life expectancy, reduce maintenance costs, and encourage our community by leading through example to embrace such practices in their own properties.

Source: Canadian Energy Efficiency Alliance, Pembina Institute

Principles and Best Practices

This plan’s underlying ethos will be governed by following these values:

Lead by Example

Since 2011, the City has been made a concerted effort to actively integrate sustainability into its planning, operations, and services. Within the Department of Public Works, a dedicated Sustainability Division comprised of five groups including: Sustainability and Climate Resilience, Environmental and Regulatory Affairs, Solid Waste and Recycling, Stormwater Operations, and Fleet Services has led the charge on these efforts. Always being mindful of resource use, and now with a renewed focus on energy use, the City is in a position to lead the greater community toward a more efficient future. Commitment to the same energy efficiency behaviors that the City expects of its neighbors ensures community-wide partnerships will continue to grow.

Planning and Budgeting

Using a multi-faceted strategy to approach sustainability, as outlined in the Sustainability Action Plan (SAP), the City has begun to adopt more energy efficient behaviors and operations. While the SAP established a shared goals for energy efficiency for the City, the BEEP can establish how we get there. Planning energy efficiency into budgets is a responsibility that every Department and Division can pursue. The consideration of energy use in current and future buildings as well as renovations is paramount to the success of the BEEP. For example, in 2019 the public voted for general obligation bonds for Parks and Public Safety facilities while the City began pursuing a joint City/County Hall. These are opportunities to design energy efficient buildings.

The strategies outlined herein are a combination of recommended Energy Efficiency Measures (EEMs) and policies. The costs and savings for these measures, as described in the BEEP, are approximations and intended to be used as a resource for Departments in budgeting for operational improvements and upgrades. By doing can help the City achieve one of its goals that calls for leading a government organization that manages its resources wisely and sustainably.

Communicate Success

In addition to committing to decreasing energy consumption, Departments also can commit to sharing their successful strategies to encourage emulation and continuity of energy efficiency within other Departments. By doing so, a synergistic effect can often take hold that further improves the collective efficiency of municipal operations. Each department can consider who among their senior stakeholders could represent their operations to champion improving energy efficiency, their quality of built environment, and coordinate with the Sustainability Division to push these ideas to realization.

Collaboration

The City is currently collaborating with internal stakeholders on energy-related planning. These joint ventures have led to shared visions and solutions toward energy efficiency and can continue as new reduction goals are adopted. Critical to maintaining the focus on energy efficiency efforts and success of the BEEP is open information exchanges, targeted project development with strong financial return on investment and the requisite funding to implement.

Integration with City Plans

The City's energy reduction goals were originally published in its 2010 Sustainability Action Plan (SAP) and the Sustainability Division is currently developing an update to align the SAP with the City's newest Strategic Plan. In the City's Fast Forward Vision Plan under Sustainable Development, there is an idea for City facilities to be green. In the City's 2018 five-year Press Play Strategic Plan, Goal 12 highlights energy efficiency retrofits and a reduction in electricity consumption used in City facilities. These plans directly informed the creation of the BEEP. The implementation of the BEEP will support objectives in the 2024 five-year Press Play Strategic Plan.

Since adoption of the aforementioned plans, there has been significant investment to understand precisely where the priority areas within municipal operations that energy savings can be achieved and only with the coordinated efforts of each department can they be realized. This plan seeks to build upon these efforts in a more focused and strategic manner to address energy in a holistic manner.

The year 2020 marks a new opportunity to build greater relationships to collaborate on new programs that can fund and implement cost-effective efficiency upgrades in existing buildings while ensuring that future facilities meet the goal of being energy efficient with low operations and maintenance costs.

2. Portfolio Analysis

Municipal Building Asset Inventory

The City currently owns and operates 146 buildings[1] with the average year of construction for these buildings estimated to be 1977. While the energy efficiency of City buildings varies based on typology and year built, the City has built only two new facilities since the implementation of the Florida Building Commission's 2010 Florida Energy Efficiency Code for Building Construction (mandates 20% increase in Energy Efficiency for commercial buildings)[2]. To date, some efficiency retrofits have taken place which have shown immediate savings. Substantial opportunities remain for additional cost-savings in other facilities and can be examined in light of the requirement by Florida Statute 255.2575 calling for energy-efficient and sustainable buildings[3].

The City's building portfolio is comprised of a variety of building types, ranging from community centers, fire stations, facilities for water utilities, administration office buildings to maintenance buildings. Each space use requires a unique approach to maximize cost-effective reductions in energy usage. In fact, each facility will ideally be looked at individually to apply appropriate operational adjustments and/or upgrades. The BEEP focuses on identifying strategies for energy efficiency improvements in City buildings intended primarily for human occupancy (office buildings, community centers, recreational facilities, police stations, fires stations, etc.) and excludes buildings intended for industrial uses such as the water and wastewater facilities.

Currently, the most energy intense uses are at the City's water treatment plants (Charles W. Fiveash and Walter E. Peele Dixie) and wastewater treatment plant (George T. Lohmeyer). To provide context, in CY2019, these water and wastewater plants including their associated supporting infrastructure such lift stations, wells, and pumps comprised over 60% of the City's total annual energy consumption. As a result of this intensive energy consumption, numerous retrofits have been pursued to trim down while maintaining operations such as variable frequency drives for the large motors needed for pumping. Due to their large footprints, these facilities also make for potential opportunities to incorporate renewable energy systems to supplement these offsetting strategies.
Initial efforts to address these heavy users can focus on low-cost/no-cost operational modifications and simple retrofits such as lighting and motor upgrades to trim consumption while larger efficiency measures are analyzed for capital improvement. Although mostly outside the scope of the BEEP, energy opportunities in the City's water utilities can be further explored

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[1] City Facility List 2010
[2] https://www.lawserver.com/law/state/florida/statutes/florida_statutes_255-2575
[3] https://www.fpl.com/clean-energy/plant-projects.html

including during the design of upcoming new facilities and will be required if the city is to meet their overall goals for energy reductions.

Energy Supply Composition

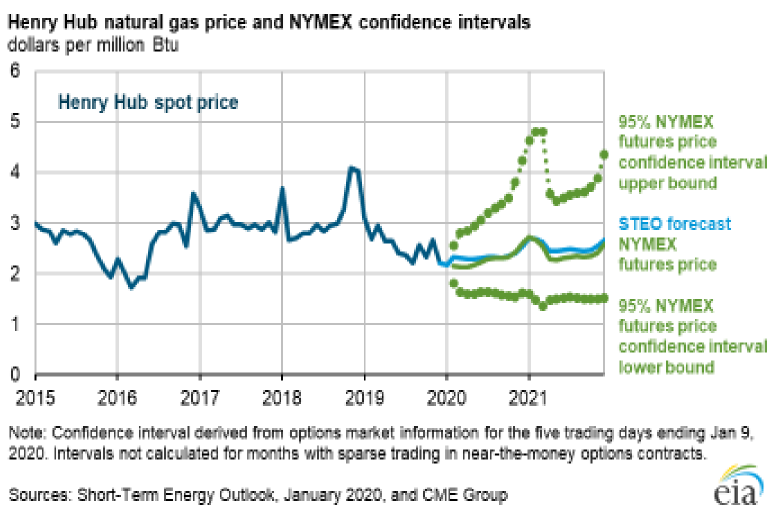
The City of Fort Lauderdale is served by the primary electrical utility in the region, Florida Power and Light. The fuel mix supplied to customers is currently comprised from 70% natural gas and another 17% from nuclear[1]. The remaining fuel sources consist of coal and market-purchased power and less than 1% is generated by renewables. As outlined in the Sustainability Action Plan (SAP), the City has an internal goal of sourcing 20% electricity from renewable sources by 2020. Further consideration and budget prioritization are needed to meet this goal.

Cost Avoidance

In the City's SAP, the year 2010 was established as the baseline to measure performance for electricity use reductions. For that year, total annual kWh consumed (actual, not adjusted) was 104,989,216 kWh at a cost of $9,970,003. In 2019, total annual kWh consumed (actual, not adjusted) was 97,890,756 kWh at a cost of $9,367,714. This translates into a 6.76% overall reduction in kWh and a savings of $602,289.

While the City continues to reap the economic benefits of cheaper energy due to lower natural gas costs for its power generation, rates may once again revert to the incremental increase model to deal with utilities' aging infrastructure and responsibility to their investors. Without robust investment in energy efficiency as well as supplemental onsite renewables to ensure lower grid consumption, the City may find itself forced to pay these potential escalations.

Figure 1: Natural gas fuel cost forecast as of January 2020



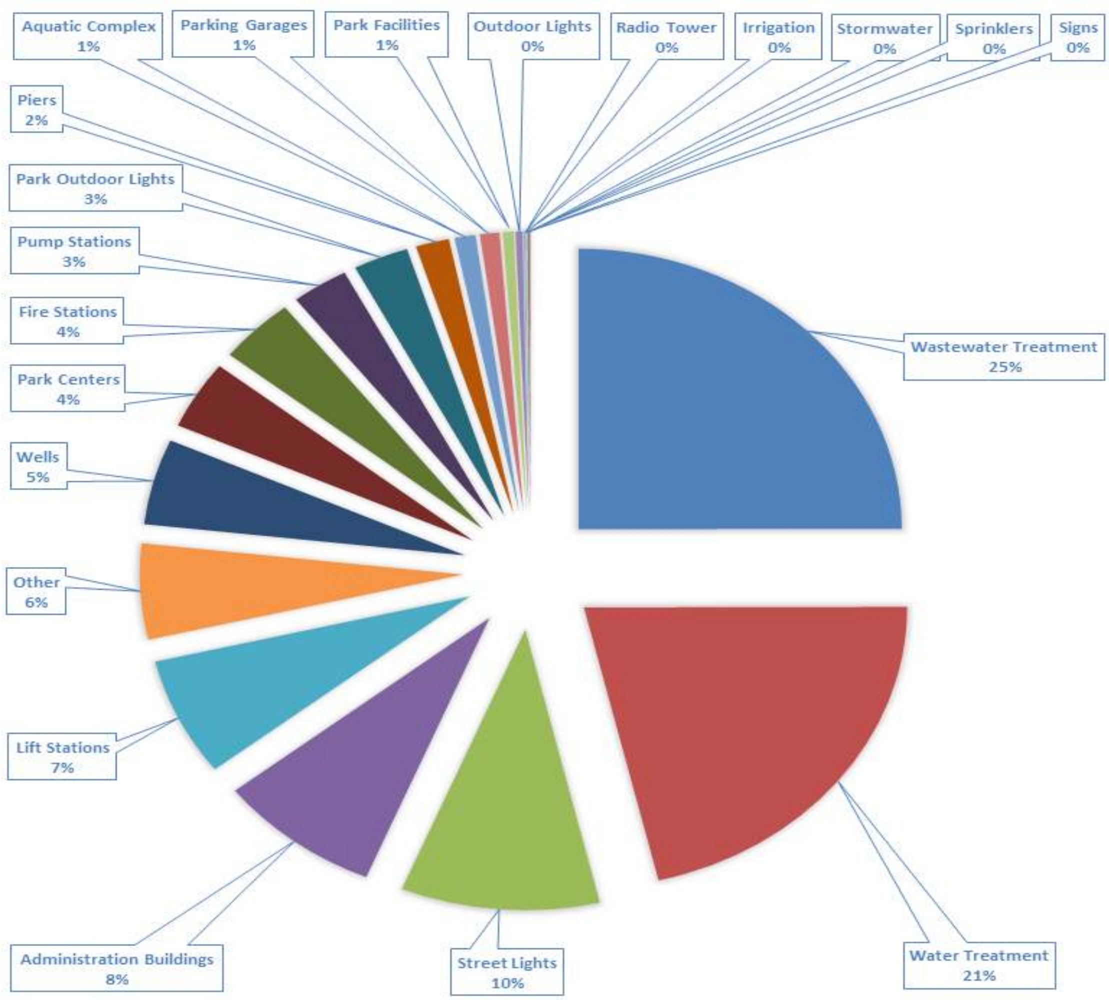
In addition to the above, the City's building equipment is in many cases approaching their end of useful life and will require investment to maintain their functionality and to reduce their increasingly energy-intensive operation. Even buildings that are slated for replacement within the next few years can be targeted for smaller investments with quick paybacks to decrease energy expenditures.

It also should be noted that we live in a rapidly digitizing landscape where attempting to target wasted energy through only behavioral improvements is far outpaced by new plug load such as Smart Boards and new computer workstations with multiple monitors coming online. By proactively pursuing energy efficiency through the implementation of retrofits, distributed renewable energy systems, and other solutions detailed in this plan, the City can effectively control energy expenditures from its budget and better serve its constituency.

Energy Usage Trends

In order to effectively plan on what we need to achieve, the City needs to constantly track both its energy usage and the associated costs. As previously discussed, wastewater and water treatment and distribution accounted for over 60% of the City's energy consumption. Figure 2 provides a graphical representation of the distribution of energy usage by building types.

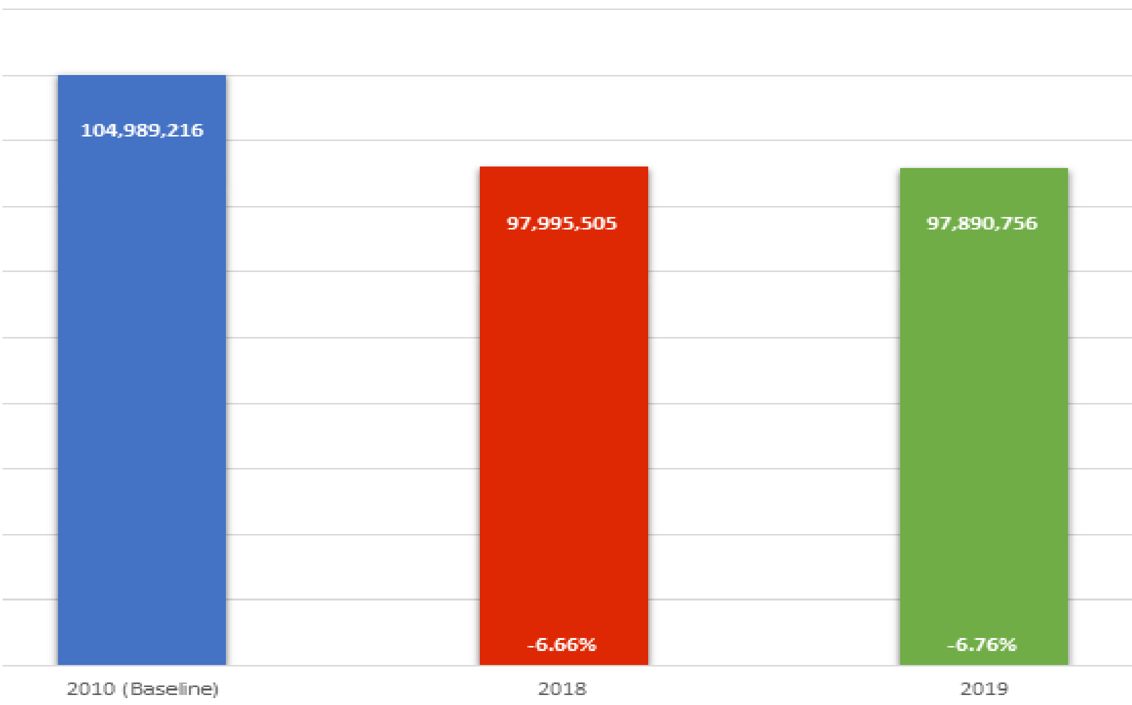
Figure 2: 2019 kWh usage by building typology as percentage of portfolio



Portfolio Performance

Utility bill analysis has enabled the City to track overall energy consumption from a 2010 baseline to present utilizing monthly data from Florida Power and Light. Each monthly bill spans approximately 30 days between two months; the current month of the bill and the preceding month. Thus, each year the City's January utility bill spans from December of the previous year to January of the current year. To track an accurate consumption pattern for each year, the City analyzes both January bills for two years and prorates each of the January bills in order to calculate one calendar year of kWh usage. The actual annual decrease of electricity, of all accounts, between 2010 and 2019 was 6.76% (see Figure 3), equating to $602,689 in energy cost savings:

Figure 3: Municipal annual kWh usage, baseline versus recent two years



It should be noted that this modest reduction in overall energy consumption since baseline 2010 occurred despite a 10% citywide population increase. Between FY2010 and FY2019, the number of full-time employees on the City payroll increased by 8% from 2,494 to 2,698. It is not uncommon for a City to add additional accounts when City services expand to meet growth. However, this increased energy consumption was mitigated through earlier sustainability efforts and further underscores the necessity for continued investment in energy efficiency.

Performance Forecast

The Sustainability Division has and continues to develop internal analytics to better understand how the City's buildings perform and also how future investments in energy efficiency can impact energy costs. Utilizing the 'Energy Dashboard' datasets to build forecasts provides informed decision-making that can then be further honed through targeted investigations based on selective building criteria. Examining the entire municipal portfolio, the following forecast was derived, demonstrating how the City will need to proceed if it intends to achieve aggressive reductions to its energy costs:

Figure 4: Municipal Energy Consumption and Costs Forecast

Benchmarking

An additional method the City used for analysis of building energy performance is the US Environmental Protection Agency's ENERGY STAR Portfolio Manager (EPA PM) online software tool. EPA PM helps measure and track energy consumption of select facilities and compares our buildings to national averages of buildings of the similar typology to give a sense of overall performance. Utilization of this system is required when an organization commits to the Department of Energy's Better Buildings Challenge, which the City joined in 2016 to better track its performance against peer cities.

Due to the limitations of the EPA PM platform, in 2019, the City began to develop an analytics engine to better assess how its facilities and portfolio perform. Figures 2 and 3 above are some of the earliest deliverables this new 'Energy Dashboard' tool has created and with time, more robust analytics will be developed, including the integration of energy use index heat mapping, interval data, and energy efficiency project performance.

3. Organizational Structure

Build Capacity

The maintenance of an active energy management program, that spans multiple Departments and Divisions, is essential to the successful integration of energy efficiency within City operations. The Sustainability Division's Sustainability and Climate Resilience group coordinates across City channels to track, encourage, and manage processes for ongoing energy projects. The Sustainability and Climate Resilience group serves as support in the development of new projects and guidelines.

As energy management becomes more prioritized, it will be important to ensure adequate staffing and resources to meet ambitious energy reduction targets. As early energy efficiency projects begin to demonstrate actualized savings, the City can look to leverage these avoided costs into investing in more energy efficiency projects and in training employees within each Department on energy management to work closely with the Sustainability Division. Technical training in best practices of building operations for staff is also critical to achieving the City's goals and will be investigated as potential offering as funds become available.

Citywide Partnerships

In the Sustainability Action Plan, the City's first objective is to increase organizational capacity. The City has been building capacity among its staff for the past ten years to address climate adaptation and sustainable best practices. More specifically, since 2016, the Sustainability Division has actively engaged the Engineering Division and the Parks and Recreation Facilities Maintenance Division in effort to build strategic partnerships during the implementation of key energy efficiency projects.

Additionally, the Sustainability Division actively conducts outreach initiatives to broadly raise awareness through programs such as Green Your Routine, the Green Team, and trainings. Efforts are currently underway to investigate an International Organization for Standardization (ISO) 50001 program to solidify a comprehensive energy management strategy for citywide operations as well as bringing on other third-party providers to provide buildings operations best practices training. Some examples of past outreach success stories:

1.) Citywide Climate Training for Employees - 2015

2.) Training for new employees that details the City's mission to be more sustainable

3.) Green Team monthly collaboration meetings to improve sustainable practices

4.) Green Team Challenge – Flip the Switch (reduce energy use) – 2016

5.) Green Team Challenge – Kick the Can (remove personal waste baskets) – 2016

6.) Green Team Challenge – Paper Wise (reduce waste) – 2017

7.) Green Team Challenge – Flip the Switch 2 (reduce energy use) – 2019

8.) Green Your Routine – Greening Your Meetings

9.) Green Your Routine – More Flavor, Less Plastic Pledge (eliminate plastic straw use)

The City will continue to communicate with key internal stakeholders to expand the adoption of energy saving principles and to elevate energy efficiency in departmental plans.

Protocols and Policies

In addition to this plan, those interested in energy management can review the following for key concepts:

Sustainability Action Plan

The original goals outlined with regards to energy are as follows. However, these will be undergoing review and update this year to achieve set longer term goals.

1.) Objective 1.1: Reduce Electricity Usage of City Operations by 20% below 2010 levels by 2020.

   a. *16% reduction in GHG emissions or reduction of 11,788 MTCO2e*

   b. *81% of GHG emission goal*

   c. *21 million kWh avoided*

   d. *$2.1 million in electricity cost savings*

2.) Action 1.1.1: Implement Energy Manager no cost/low cost recommendations.

3.) Action 1.1.2: Reduce energy use in City buildings by 20% by 2020.

4.) Action 1.1.3: Integrate electricity reduction goal into Capital Improvement Plan.

Thermostat/Set-point Policy

Currently in final stages of review, a thermal policy is being considered to guide building operators on maintenance of a temperature range within the low-mid 70s, contingent on type of use space. This will not only reduce current energy consumption from overcooling, but also chilly workspace complaints from tenants that now use inefficient space heaters. The policy is currently drafted as follows:

1.) *During occupied hours, thermostats at City facilities shall have a cooling setpoint no lower than 72 degrees Fahrenheit (^{o}F), with a recommended setpoint of 75 degrees Fahrenheit (^{o}F).*

2.) *During unoccupied hours, thermostats shall have a cooling setpoint no lower than 80^{o}F.*

Design and Construction Manual

The Fast Forward Fort Lauderdale Design and Construction Manual (DCM) describes a set of principles for development of a sustainable and resilient public infrastructure. This recently released publication provides in-depth guidance that all City Departments can review when considering making adjustments to their maintained assets in the public realm. While limited for the purposes of this plan, there is some content within the 'Utilities' subsection of the DCM that addresses best practices in outdoor lighting.

Best in Efficiency Procurement

Official policy that currently exists within the City that specifies precisely what equipment Departments should select is limited. When procuring replacements for existing equipment, decision makers should seek out solutions that provide the best in class energy efficiency even if their initial investment is greater than a typical "in-kind" replacement.

As a template for general guidance, within the City's Policy and Standards Manual (PSM 9.2.4) there exists policy that broadly outlines the City's goal to procure goods with best practices in environmental stewardship. Key factors that should be examined when investigating in a purchase:

1. Chemicals and other hazardous materials which may be released due to the use and disposal of products and/or resulting from services procured;

2. Waste generation and waste minimization;

3. Energy consumption;

4. Greenhouse gas emissions;

5. Recyclability and recycled content;

6. Depletion of natural resources;

7. Potential impact on human health and the environment;

8. Impacts on biodiversity;

9. Environmental practices that vendors and manufacturers have incorporated into their office and production process;

10. Whenever feasible, the factors listed above should be evaluated using life cycle assessment methodologies.

Social equity factors to be considered include, but are not limited to:

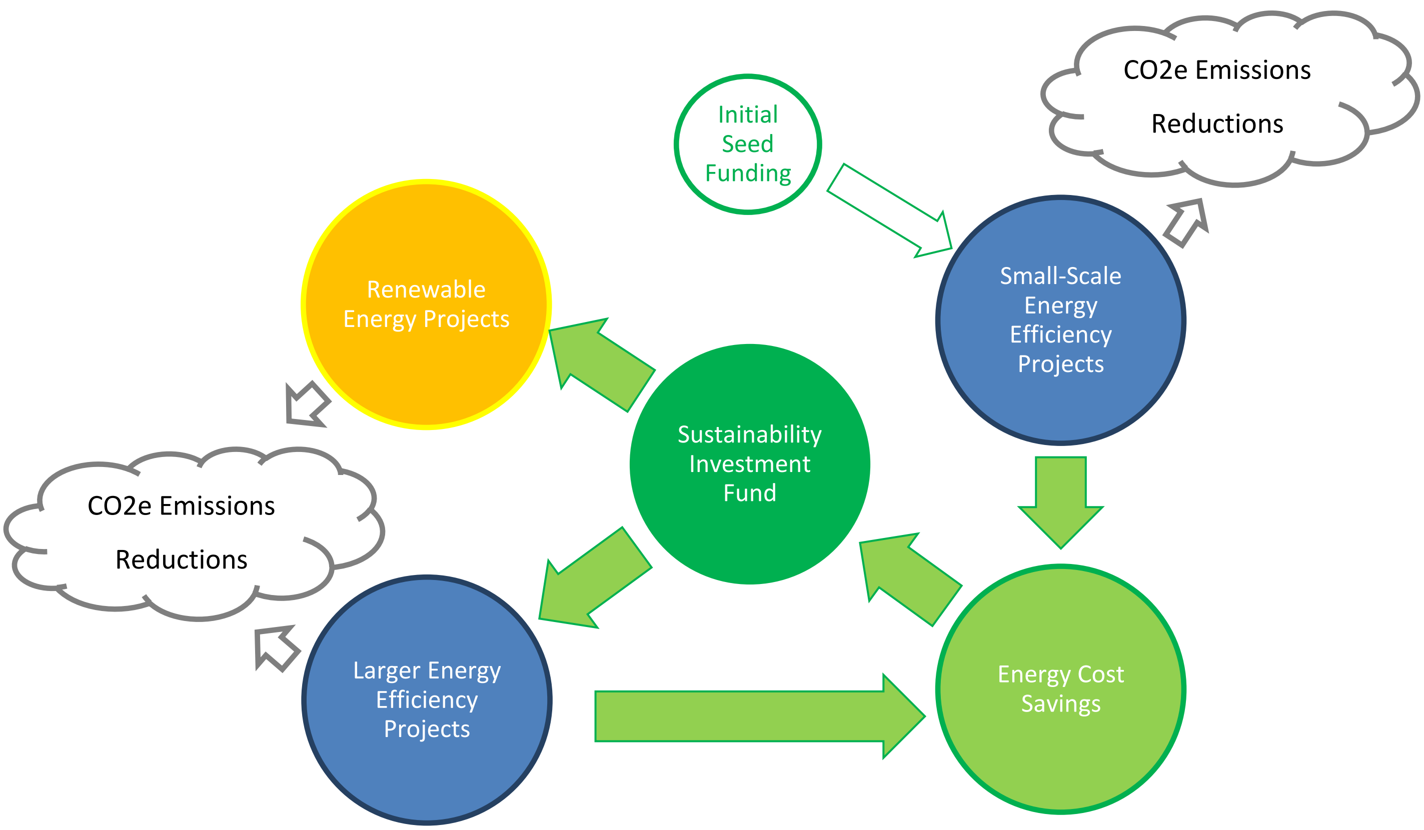
1. Human health impacts;

2. Use of local businesses, as defined by Code of Ordinance Sec.2199.2;

3. Minority and Women Owned Business Enterprises (MWBE)

Sustainability Investment Fund Resolution

Approved by the City Commission in 2018, this fund is intended to provide a revolving source of funding for energy and water conservation projects, potentially including renewable energy. Future savings from implemented projects will be allocated here to be reinvested in all departments for additional projects that provide even more savings. The infographic below provides a visual of this process:



4. Resourcing and Efficiency Strategy

Tools and Systems

Multiple physical and software aids exist to enable energy information to be collected, managed, and analyzed. These tools also assist in facility maintenance, auditing, and verification procedures. Some of that the City has already invested in and have begun using are:

- **Energy Dashboard**
  This tool provides valuable insights and allows the Sustainability Division to make data-driven decisions on what facilities to investigate and invest in further.

- **Psychrometer**
  Measures indoor air temperatures, relative humidity, dew point, and wet and dry bulb temperatures to determine if a space is efficiently treated

- **Photographic Light Meter**
  Measures the light level within spaces to diagnose potential over or under lit areas.

Measurement & Verification

In order to make a business case for funding energy efficiency and renewable energy technologies beyond what manufacturers purport that their products to achieve, the Sustainability Division can leverage analytical methodologies utilized globally to accurately quantify what a solution will accomplish. This is generally accomplished by undergoing a Measurement and Verification (M&V) analysis that utilizes the International Performance Measurement and Verification Protocol (IPMVP)[4], the industry standard utilized by public and private entities alike. The IPMVP outlines four basic strategies depending on the project scope of work to conduct a measurement and verification analysis. Selection of the appropriate M&V strategy will depend upon factors including required confidence interval and available resources.

M&V generally involves the systematic documentation of energy use before and after an energy efficiency measure is implemented to determine the effect the measure has had on energy performance at either a system level (i.e. Lighting, HVAC, motors) or on the building as whole. In general, the measurement and verification process should contain the following steps:

- Collection of energy use data before the measure is implemented. Can be achieved using utility monthly billing data (building) or precision equipment such as data loggers and meters (system).

[4] https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

- Documentation of key facts about the facility, such as the number of employees working in the facility, the times the facility is occupied, the building's opening schedule, any non-scheduled uses, or other factors that contribute to the building's energy use.

- Documentation of key facts about the system to be retrofitted such as hours of use and at what percent of its capabilities, age, listed specifications, associated controls systems, and any rebalancing and/or retrofits conducted on it in the past.

- Documentation of the assumptions for the measure, such as the expected changes in performance or operating frequency, if appropriate.

- Collection of energy use data after the measure is implemented.

Figure 5: Typical data collected during measurement and verification process (Source: kw-engineering)

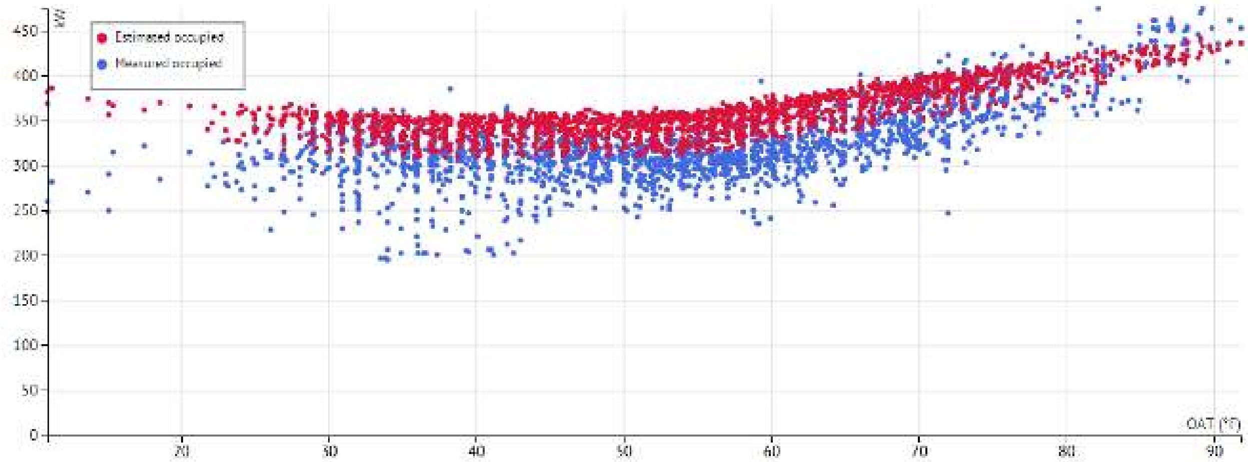
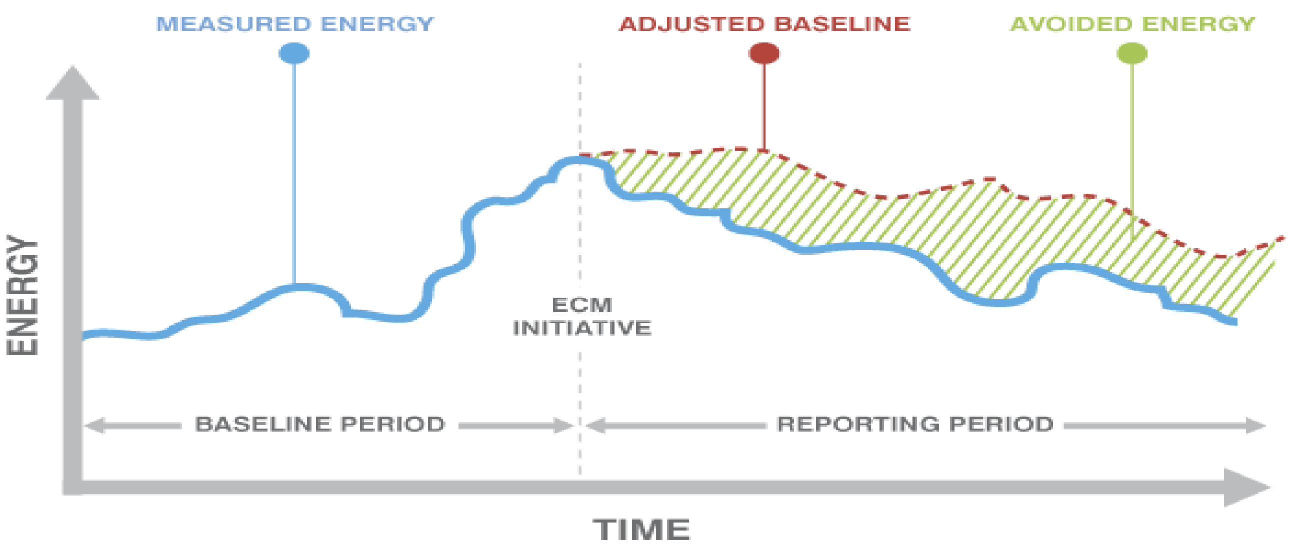


Figure 6: A measurement and verification visual analysis based on collected data (Source: Parvaneh Energy)



The main goal of measurement and verification is to ensure an "apples to apples" comparison of pre- and post-implementation energy usage so that the effect of the measure itself can be isolated. The data gathered from measurement and verification can also be used to refine expectations for how the measure will perform at other buildings in the portfolio, to prioritize energy efficiency measures for implementation, and quantify actualized energy cost savings for reinvestment.

Finally, the Sustainability Division maintains close partnerships with the City's utilities to not only capture potential grant funding and ensure proper invoicing, but also to better understand the effects of fuel costs. As mentioned earlier in this report, the majority of electricity generated by the City's utility is derived from the combustion of natural gas and this fuel input constantly fluctuates based on market and geopolitical conditions. Through constant monitoring, the City stands to potentially achieve avoided cost savings when fuel rates decrease as well as better forecast the needed investments in energy efficiency when rates inevitably increase.

Funding Streams

Where general fund dollars or operating budgets are not available, financing options can be critical to achieving energy efficiency goals. Cities have a wide menu of options to undertake upgrade efforts to improve the energy performance of their building portfolio, including public and private financing.

By nature of a city's ability to raise capital funds through budget appropriation and bond issuance, cities can self-fund energy efficiency projects. Publicly funded energy improvements can be made in coordination with planned replacements and repairs or as part of a dedicated upgrade program. Cities can also establish internal mechanisms to fund work, such as through an internal revolving fund program like the City's Sustainability Investment Fund—which can be funded using savings from energy efficiency projects, general fund allocations, or other means.

Cities may also take advantage of third-party financing to fund energy efficiency projects, such as for projects by Energy Services Companies (ESCOs) who may undertake upgrades for a fee or for some share of energy savings. Under the Energy Performance Contracting model, the City worked with Honeywell to install energy efficiency measures at the TAM Administration Building, City Park Garage, and Fleet Fenceline as well as to convert some streetlights to LED. Energy Performance Contracting provides energy, water, and operational savings which are guaranteed to equal the project cost over a specified time period. This project was funded by a third-party tax-exempt lease. Tradeoffs between these two strategies lead many municipalities to pursue a hybrid of both public and private financing solutions to achieve desired outcomes. This summary provides an overview of some field-tested financing options.

Internal Financing

Fort Lauderdale has several internal financing opportunities available to realize significant energy efficiency gains. These include, but are not limited to:

1) *Bond Leverage:* The City could fund energy efficiency (or renewable energy, sustainability, or resiliency) measures through of the Parks bonds for Park facility upgrades and new facilities.

2) *Revolving Loan Fund:* A revolving loan fund is a fund with dedicated capital that is loaned, not granted, to recipients. Fort Lauderdale has utilized this structure to create the Sustainability Investment Fund, to make loans to fund sustainability and resiliency improvements, including in existing buildings. For the fund to be self-sustaining, an initial principal is allocated and energy savings from projects are returned to the fund. Once capitalized, this fund could be used by the City to target lowest-cost, highest-impact measures (such as lighting retrofits) followed by successively deeper retrofits with higher capital costs that may have longer paybacks. The City of Orlando recently created such a fund, which is capitalized with funds from a bond issuance. In lieu of bond funding, the City might also capitalize a fund with a budget line item or with savings from initial projects. Under both structures, retrofits could be undertaken by third-party contractors or city employees, depending on program design.

Making the financial case for any of these strategies relies on the proper attribution of energy savings to energy efficiency measures. In the case of a revolving loan fund, ensuring a mechanism exists whereby projected (and realized) savings can be retained for additional investments is also critical.

Private Market Solutions

Energy Performance Contracting (EPC) is another solution to improve energy performance. Often undertaken by ESCOs, EPCs can benefit the City by lowering or removing the upfront costs of efficiency measures and allowing implantation at a greater scale than may be otherwise feasible. Under an energy performance contract scenario, the ESCO may guarantee energy savings. There are a variety of means to finance EPCs, including using existing reserves, public bonds, third party financing and tax-exempt municipal leases.

Energy Services Agreements (ESAs) are a strategy similar to energy performance contracts. Some ESA firms are compensated based on the amount of power saved, measured against a dynamic projected baseline; thus, they have the incentive to operate projects as efficiently as possible. In both cases, structures are negotiable. As a large city, Fort Lauderdale should be able to achieve a favorable agreement with a third-party entity of this type.

Incentives

- *Commercial Demand Reduction (CDR):* This is a load management program offered by the City utility provider, Florida and Power Light. The program provides monthly credits to customers who voluntarily participate to reduce power usage during peak demand periods.

- *Business Energy Evaluation:* A free, customized energy audit conducted by Florida Power and Light that delivers energy savings solutions.

- *Utility Invoice Auditing:* Third party providers (similar to the ESCO model) analyze the utility bills to ensure accuracy of recorded consumption as well as applicable rate charges and secure refunds from the utility where merited. The City is currently working with the City of Clearwater on a joint-RFP to pursue this cost-savings strategy.

Rebates

When available, the City will research and submit for applicable rebates and grants. As of 2020 Florida Power and Light (FP&L), has commercial rebate programs that cover applicable building improvements such as:

- Chillers
- Demand Control Ventilation
- Demand Response
- Direct-Expansion Air Conditioning
- Energy Recovery Ventilation
- LED Lighting
- Thermal Energy Storage

Through the City's Energy Performance Contract with Honeywell in 2017, the City was able to recover over $10,000, through the FP&L rebate program, associated with LED lighting and DX Air Conditioning units. Progression of new projects will consider utility rebates and/or manufacturer rebates to lower project costs and accelerate return on investment. Staff can also regularly visit www.dsireusa.org to investigate new rebates.

Grants

Available grants that the City may qualify will be evaluated based on criteria, applicability to energy goals, and outcomes. Sustainability Division staff are updated on state and national grants made available through state agencies and affiliated organizations and networks.

Key Takeaways

- Certain funding options work better with different project types. Consider strategic use of both public and private strategies to make the best use of limited staff time.

- A basic return on investment (ROI) analysis can be used to predict energy and cost savings for both individual measures and a portfolio of measures and calculate the return on investment via simple payback period.

- Explore feasibility of capitalizing the Sustainability Investment Fund (bonding, one-time seed funding, energy savings recapture mechanism) and deployment opportunities:

5. Action Plan

Methodology for Developing Savings Estimates

The energy efficiency measures (EEMs) outlined in this plan and their potential savings estimates were developed using an industry standard methodology for a portfolio of buildings. The sources of information used to develop the list of measures included walk-throughs of representative facilities, review of facilities condition reports, capital planning reports, industry references, federal agency guidelines, and case studies and reports completed by national laboratories. Before discussing which options to pursue, an explanation of this analytical method used to develop this action plan follows.

Audit

Building walk-throughs were completed for 10 buildings by a third-party engineer and members of the Fort Lauderdale staff. During these walk-throughs, building equipment and systems were identified, including: lighting type, HVAC type, roof condition (if accessible), and condition of weather stripping around windows and doors. This information was gathered and cataloged for each building and recommendations were made by the engineer for what improvements should be prioritized. City staff conducted additional on-site inspections at select locations and provided this knowledge to augment the database for buildings where no walk-throughs were originally completed.

Review

The Facilities Condition Summary was reviewed for opportunities for capital upgrades within each building. Planned upgrades were cross-referenced with the opportunities for building upgrades identified during the building walk-throughs for facilities where both data sources were available. Staff provided additional input on specific facilities.

Cost Analysis

Industry references include the *RSMeans Construction Cost* book and industry contacts were mainly used as a source of cost information for upgrades. The RSMeans Construction Cost book was used for more complex upgrades, such as HVAC systems, where it is difficult to identify the exact equipment that would be suitable for a specific upgrade, and therefore difficult to provide specific cost information. For energy efficiency measures that are more straightforward, such as lighting upgrades and occupancy sensors, City staff requested rough cost estimates directly from contractors, which provides the most accurate estimate for what the City would pay to complete the work.

Federal Agency Guidelines

Both the Department of Energy and the Environmental Protection Agency have developed numerous calculators that assist in calculating the energy savings from specific energy efficiency measures. Calculators were used where possible to ensure that savings estimates are in line with industry standards. Additionally, Federal agencies, such as the Department of Energy, develop efficiency standards as well as guidelines for various types of equipment. Federal guidelines were referenced to identify future efficiency standards that will come into effect for equipment, so that the City's energy efficiency measures would be in line with upcoming federal standards.

Case Studies and Reports

The National Labs, such as the National Renewable Energy Laboratory and the Pacific Northwest National Laboratory, regularly undertake studies to compare the effectiveness and efficiency of various technologies. Many of these technologies are related to buildings and these reports provide a good source of information for the energy savings of various technologies in real world conditions.

Additionally, reports were sourced from the General Services Administration, which researches specific upgrades that could reduce energy use at its facilities in various climate zones, and from utility research studies that evaluated the cost effectiveness of energy efficiency measures for the purposes of establishing utility programs to provide subsidies/incentives for those specific energy efficiency measures.

Establishing the Covered Buildings List and 2010 Baseline

The 2010 energy use baseline and covered buildings list was established to enable a direct comparison between 2010 buildings and current energy consumption. Energy use data, from FPL billing statements and the submeters at Fleet Fenceline, was collected for the buildings that represent the majority of building energy use in the City's portfolio (i.e., some buildings with very low energy use were not included). Tracked buildings lists were compiled for both 2010 and 2017. The buildings lists were then compared between years to identify any buildings that may have been demolished, fallen below the minimum energy use that is tracked, and to identify any other anomalies. Buildings were eliminated that appeared only in one of the two years and not both.

For example, if a building appeared on the 2010 list but was subsequently demolished, the building and its associated energy use for 2010 was removed from the list. This ensured that changes in energy use between the baseline year and future years was not the result of a changing number of tracked buildings. Buildings constructed or purchased since 2010 that may benefit from EEMs were analyzed using a strategies matrix.

After the buildings list was verified between the 2010 baseline year and the 2017 plan start year, the buildings list was reviewed to identify and adjust usage estimates for any unusual building profiles. For example, a building that contains a highly specialized use, such as a pool, but doesn't have separately metered pumps, would skew results if its energy use reductions were calculated in the same way as an office building. The buildings where energy use was reduced (as compared to the FPL bill) from the 2010 baseline and the 2017 plan start year are the police station headquarters (14% reduced—this is approximately the amount of energy the old Parks Administration building and Fleet Fenceline use—all three areas share a single meter), 501 Seabreeze Blvd International Hall of Fame Swimming Pool (50% reduction) and 501 Seabreeze Blvd Museum and Training Pool (50% reduction).

Data Compilation

After the sources of data were gathered, the results were compiled for each energy efficiency measure and for each building. Energy reductions are supported by references to one or more sources of data, and the City also considered the potential for overlapping savings from similar measures. For example, the thermostat replacement measure overlaps with the thermostat set point policy measure. In this case, savings were only attributed to the thermostat replacement measure, though both measures are necessary to achieve the expected savings. Further, for buildings that share a meter with another end use (e.g., sports lighting), the baselines and savings were adjusted to prevent overestimating savings.

Once the energy savings were calibrated to account for potential overlaps or other end uses, the average utility rate was applied to the energy savings (kWh) to achieve the expected cost savings. The cost savings analysis doesn't contemplate savings from demand reduction (kW). While demand reduction savings would reduce costs, it wouldn't save any additional energy, therefore demand was therefore identified as a separate energy efficiency measure within the set of financial strategies.

Interpretation of Savings Estimates

While savings estimates were calculated for each energy efficiency measure and for each facility, the savings should always be aggregated across all buildings for any individual measure to arrive at a savings estimate. There are several reasons why this is necessary, and one important reason is that ASHRAE Level II audits were not completed for the facilities. While ASHRAE Level II audits produce accurate estimates of potential energy savings at the building level, they are costly and time consuming, and these two factors make them a frequent impediment to developing an energy management plan across a portfolio of facilities.

An alternate strategy, which is to rely on walk-throughs, existing knowledge of staff about facilities, and industry references, produces savings estimates that are reliable *at the portfolio level only.* By always aggregating savings estimates across buildings, any over-estimates and under-estimates of energy savings balance out.

The energy savings calculated for each individual building are a helpful directional tool for the relative amount of savings that the building could contribute towards the particular energy efficiency measure. They are not meant to be used as a measure against which the success of the energy efficiency measure is evaluated. That evaluation should be calculated at the building portfolio level only.

Additionally, other external factors can significantly influence the savings achieved in any one building. These factors include changes in use, occupant density, or operating schedule. These factors should be carefully considered when comparing actual energy savings to expected savings for an energy efficiency measure.

Limitations

The analysis for this study utilized available data gathered from multiple sources including historical electricity usage, facility personnel, limited walk-throughs of select facilities and industry cost/savings assumptions, as the basis to develop recommendations. The datasets of this report should be utilized only as a framework and are intended as rough estimates to assist with ranking and prioritizing strategies. When BEEP strategies are implemented, actual project costs and realized savings will likely vary from the estimates in this report due to multiple factors including time since original estimates calculated, limitations and assumptions in the original analysis, changes in pricing of services and equipment, and changes in operation of City facilities, among other factors.

Energy Efficiency Opportunities

With the aforementioned methodology, a strategic investigation of 65 select properties was chosen in order to structure a strategy for implementation of which 46 buildings provided actionable next steps. Born from this is the following, listed in order of priority to achieve energy reductions in the quickest amount of time should funding become available. Please note that not all Energy Efficiency Measures (EEMs) are applicable for all of the 46 facilities identified and each category prioritizes these buildings in order of the applicable metric (ROI or % annual reduction). The $/kWh reduced metric indicates the respective cost to invest in order to reduce one kilowatt hour of energy consumption for that specific conservation measure and should also be considered when determining a strategy.

Table 1: Energy Efficiency Strategies to Consider

Priority	Measure	Est. Base Cost	Est. kWh Savings	Est. Cost Savings	% Citywide Annual kWh Reduced	$ Invested per kWh Reduced	ROI (years)
1	HVAC Filters & Scheduling	$3,160	7,031	$159,739	0.01%	$.45	0.4
2	Retro-Commissioning	$148,139	1,425,995	$156,860	1.46%	$.10	0.94
3	Cool Roof Coating	$29,642	243,066	$26,737	0.25%	$.12	1.11
4	LED Lighting and Controls	$200,307	1,436,316	$157,995	1.59%	$.14	1.19
5	Weather Sealing	$32,807	185,891	$20,448	0.19%	$.18	1.6
6	Plug Load Management	$13,451	72,310	$7,954	0.07%	$.19	1.69
7	Variable Freq. Drives	$15,482	7,533	$8,944	0.01%	$2.06	1.73
8	DDC Thermostats	$57,354	274,333	$30,174	0.28%	$.21	1.74

9	Planting Shade Trees	$12,240	34,567	$3,802	0.04%	$.35	3.23
10	Solar Window Film	$250,849	602,590	$66,285	0.62%	$.42	3.78
11	Roof Insulation Retrofit	$23,085	19,189	$2,111	0.02%	$1.20	10.94
12	High-Efficiency HVAC	$214,202	68,408	$7,525	0.07%	$3.13	28.1
	Total:	**$1,004,587**	**4,498,606**	**$661,925**	**4.60%**	**$.71**	**1.52**

Priority 1: HVAC Efficiency Filter Replacements

It comes as no surprise that the systems within a building that consume the highest amount of energy will achieve a great return on investment in cost savings when they are effectively maintained. Moving away from the current "triage" approach to establishing a quarterly schedule for filter replacement during winter months, bi-monthly during the summer months, and ensuring this guideline is strictly followed along with replacing with the highest quality available will provide instant savings at a relatively small outlay of funding. The following buildings were identified to consider:

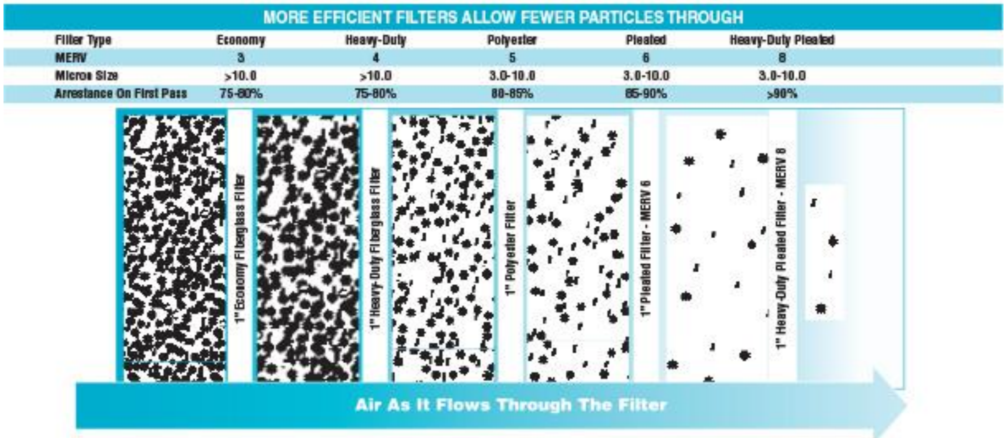
Table 2: HVAC Efficiency Filter Replacement Cost and Savings Strategy

Building(s) to Target, by Priority	Count of Filters to Replace (annually)	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
100 N ANDREWS AVE #CITY HALL	286	$636	24,275	0.99%	$2,670	0.24
1101 BAYVIEW DR # GE REC BLDG	10	$22	523	0.99%	$58	0.39
1300 W BROWARD BLVD #POLICE STATION & JAIL	711	$1,582	35,515	0.99%	$3,907	0.40
700 NE 9th ST #BARN 1 (Holiday Park- Police Horse Barn)	11	$24	561	0.99%	$62	0.40
528 NW 2 ST #FIRESTATION 2 | ADMIN	207	$461	10,359	0.99%	$1,139	0.40
700 NW 19 AVE #DSD MAIN	204	$454	10,196	0.99%	$1,122	0.40
800 NE 8 ST #WAR MEMORIAL AUDITORIUM	149	$332	7,463	0.99%	$821	0.40
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53	140	$312	7,008	0.99%	$771	0.40
6000 NW 21 AVE #Airport Admin FXE	23	$51	1,158	0.99%	$127	0.40
2250 NW 21 AVE # OSSWALD COMM CENTER	22	$49	1,107	0.99%	$122	0.40
1150 G. Harold Martin Dr. (H.Park- Social Ctr)	20	$44	1,022	0.99%	$112	0.40
1200 G HAROLD MARTIN DR # HOLIDAY PARK GYM	66	$147	3,307	0.99%	$364	0.40
4250 NW 10 AVE # CMS	51	$113	2,568	0.99%	$282	0.40
2801 SW 4 AVE # FIRE STATION 3	49	$109	2,464	0.99%	$271	0.40
1000 SW 27 AVE # FIRE STATION 47	64	$142	3,199	0.99%	$352	0.40
2002 NE 16 ST #FIRE STATION NO. 29	60	$134	3,014	0.99%	$332	0.40
1015 SEABREEZE BLVD #FIRE STATION NO. 49	46	$102	2,308	0.99%	$254	0.40
1971 E COMMERCIAL BLVD #FIRE STATION 35	62	$138	3,088	0.99%	$340	0.41
736 N FEDERAL HWY #HOLIDAY PARK ACTIVITY CTR	61	$136	3,037	0.99%	$334	0.41
5301 E PERIMETER RD # CUSTOMS	59	$131	2,932	0.99%	$323	0.41
1515 NW 19 ST # FIRESTN 46	53	$118	2,630	0.99%	$289	0.41

1800 SW 4 AVE # CROISSANT PARK CTY CENTER	44	$98	2,187	0.99%	$241	0.41
1340 Chateau Park Dr. (Lauderdale Manors Park)	43	$96	2,144	0.99%	$236	0.41
2871 E SUNRISE BLVD # FIRE STATION 13	42	$93	2,081	0.99%	$229	0.41
3351 NE 33 AVE # BEACH COMMUNITY CENTER	40	$89	1,997	0.99%	$220	0.41
290 NE 3 AVE #PARKING DIV	34	$76	1,683	0.99%	$185	0.41
2750 NW 19 ST #BASS PARK	31	$69	1,536	0.99%	$169	0.41
1000 N ANDREWS # WARFIELD PARK REC CENTER	29	$65	1,441	0.99%	$158	0.41
1450 W SUNRISE BLVD # CARTER PARK GYM	66	$147	3,286	0.99%	$361	0.41
950 SW 27 AVE #RIVERLAND PARK	65	$145	3,234	0.99%	$356	0.41
3200 NE 32 ST #FIRE STATION NO. 54	16	$36	796	0.99%	$88	0.41
2020 EXECUTIVE AIRPORT WAY # MAINTENANCE	16	$36	783	0.99%	$86	0.41
2800 SW 8 AVE # FLOYD HULL MORTON CENTER	14	$31	694	0.99%	$76	0.41
1450 W SUNRISE BLVD # CARTER PARK REC CENTR	13	$29	646	0.99%	$71	0.41
6000 NW 21ST AVE Police	12	$27	579	0.99%	$64	0.42
4250 NW 10TH AVE # REAR BLDG	17	$38	827	0.99%	$91	0.42
501 SEABREEZE BLVD #E MUSEUM & TR POOL	179	$398	4,461	0.99%	$491	0.81
501 SEABREEZE BLVD # ISHOF	145	$323	3,629	0.99%	$399	0.81
Total:	**3,160**	**$7,031**	**159,739**	**N/A**	**$17,571**	**0.40**

Assumptions: The Department of Energy estimates replacing dirty filters could result in 5-15% energy savings in HVAC load. DOE recommends a MERV rating of 8-13. For the calculation, a MERV rating of 11 was used, and online vendor cost estimates were used to determine an average cost of $92.97 for a 6-pack of filters. Base comparison costs used a MERV rating of 8 at $79.62. Within the facility list of filters there are varying sizes of filters, and estimates are based on an average 16x25x4 filter size. Estimated cost does not consider shipping or bulk discounts. For the estimated kWh savings and estimated dollar savings, it is assumed the filters would be replaced on average once per quarter. A 3% savings on HVAC load was used.

Management of HVAC filters has the potential to reduce energy use, reduce strain on HVAC equipment, extend equipment life, and improve occupant comfort by delivering better quality air. While Facilities staff are already replacing HVAC filters on a regular basis, this EEM represents a modification of the current practice. An audit and tracking program for HVAC filter replacement should include a log of when filters are currently being replaced, the estimated percent clog of the filters when replaced, and the type of filter being used (specifically, the MERV rating). Filter selection and replacement can then be optimized over time, such that filters that are still good aren't being thrown out before their useful life and filters that are putting strain on equipment and causing costly repairs to HVAC equipment can be changed more frequently.



Source: HDsupplysolutions.com

By instituting a replacement schedule that coincides with the actual needs of the equipment and spaces served, Facilities staff can allocate their time efficiently and the MERV rating of filters can be optimized to improve air quality, occupant health, and productivity as clean, high-rated MERV filters are more effective at removing pollutants from the air including viruses, bacteria, dust, and pollen.

Priority 2: Retro-Commissioning (RCx)

Prior to allocating funding for major capital upgrades, RCx is a viable measure to realign mechanical systems back to their designed operation thus improving efficiency at a far lower cost and can be accomplished via third party providers or more commonly hiring dedicated staff with expertise in such processes. The following buildings were identified to consider:

Table 3: Retro-Commissioning Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
5301 E PERIMETER RD # CUSTOMS	$1,350	29,619	10.0%	$3,258	0.41
1340 Chateau Park Dr. (Lauderdale Manors Park- Rec Center)	$1,188	21,658	10.0%	$2,382	0.50
1800 SW 4 AVE # CROISSANT PARK COMMUNITY CENTER	$1,446	22,089	10.0%	$2,430	0.59
1000 N ANDREWS # WARFIELD PARK REC CENTER	$1,013	14,553	10.0%	$1,601	0.63
950 SW 27 AVE #RIVERLAND PARK	$2,318	32,663	10.0%	$3,593	0.65
528 NW 2 ST #FIRESTATION 2 | ADMIN	$8,343	104,637	10.0%	$11,510	0.72
1300 W BROWARD BLVD #POLICE STATION & JAIL	$31,208	358,734	10.0%	$39,461	0.79
1450 W SUNRISE BLVD # CARTER PARK REC CENTER	$578	6,522	10.0%	$717	0.81
2002 NE 16 ST #FIRE STATION NO. 29	$2,779	30,445	10.0%	$3,349	0.83
100 N ANDREWS AVE #CITY HALL	$22,485	245,206	10.0%	$26,973	0.83
2801 SW 4 AVE # FIRE STATION 3	$2,360	24,887	10.0%	$2,738	0.86
1450 W SUNRISE BLVD # CARTER PARK GYM	$3,240	33,194	10.0%	$3,651	0.89
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53 & EOC	$7,374	70,788	10.0%	$7,787	0.95
1971 E COMMERCIAL BLVD #FIRE STATION 35	$3,296	31,189	10.0%	$3,431	0.96
1150 G. Harold Martin Dr. #SOCIAL (H. Park- Social Center)	$1,118	10,328	10.0%	$1,136	0.98

2750 NW 19 ST #BASS PARK	$1,703	15,516	10.0%	$1,707	1.00
1515 NW 19 ST # FIRESTN 46	$2,921	26,563	10.0%	$2,922	1.00
700 NW 19 AVE #DSD MAIN	$11,610	102,991	10.0%	$11,329	1.02
1200 G HAROLD MARTIN DR # HOLIDAY PARK GYM	$3,915	33,408	10.0%	$3,675	1.07
1000 SW 27 AVE # FIRE STATION 47	$4,156	32,311	10.0%	$3,554	1.17
1015 SEABREEZE BLVD #FIRE STATION NO. 49	$3,286	23,316	10.0%	$2,565	1.28
2250 NW 21 AVE # OSSWALD COMM CENTER	$1,620	11,181	10.0%	$1,230	1.32
800 NE 8 ST #WAR MEMORIAL AUDITORIUM	$11,341	75,383	10.0%	$8,292	1.37
1101 BAYVIEW DR # GE REC BLDG	$850	5,285	10.0%	$581	1.46
3351 NE 33 AVE # BEACH COMMUNITY CENTER	$3,395	20,172	10.0%	$2,219	1.53
2800 SW 8 AVE # FLOYD HULL MORTON CENTER	$1,715	7,013	10.0%	$771	2.22
700 NE 9th st #BARN1 (H.Park- Police Horse Barn)	$1,623	5,663	10.0%	$623	2.60
736 N FEDERAL HWY #HOLIDAY PARK ACTIVITY CENTER	$9,908	30,681	10.0%	$3,375	2.94
Total:	**$148,139**	**1,425,995**	**N/A**	**$156,860**	**0.94**

Assumptions: Typical cost is $0.27 per square foot, with a range of $0.20 - $2.00 per square foot. Savings estimated at 10 to 15% of energy use per year. A 10% savings rate was used.

This measure is a systematic process that examines the existing base building systems (including the HVAC system, electrical and lighting systems, building envelope, etc.) and optimizes each to ensure that they are operating within their specified parameters. RCx also ensures that equipment manuals are on site (or readily available), and that operators are trained on the building's equipment.

Retro-commissioning is highly desirable due largely to simple wear and tear, deferred maintenance, intensive changes to the building use typology, or equipment schedule changes that are not accounted for. Collectively, small changes from the specified optimal settings or condition of equipment can result in wasteful processes such as systems running when they aren't needed, simultaneous heating and cooling, or incorrect temperature set points. It can be performed as a one-time event every few years or as a "continuous" process whereby a schedule is created to check building systems on an annual basis (also known as Preventative Maintenance).

Priority 3: Cool Roof Coating

Largely dependent on its existing condition and average daily exposure to direct sunlight, the application of a high-reflectance coating to a rooftop can achieve measurable energy reductions to the cooling equipment. The following buildings were identified to consider:

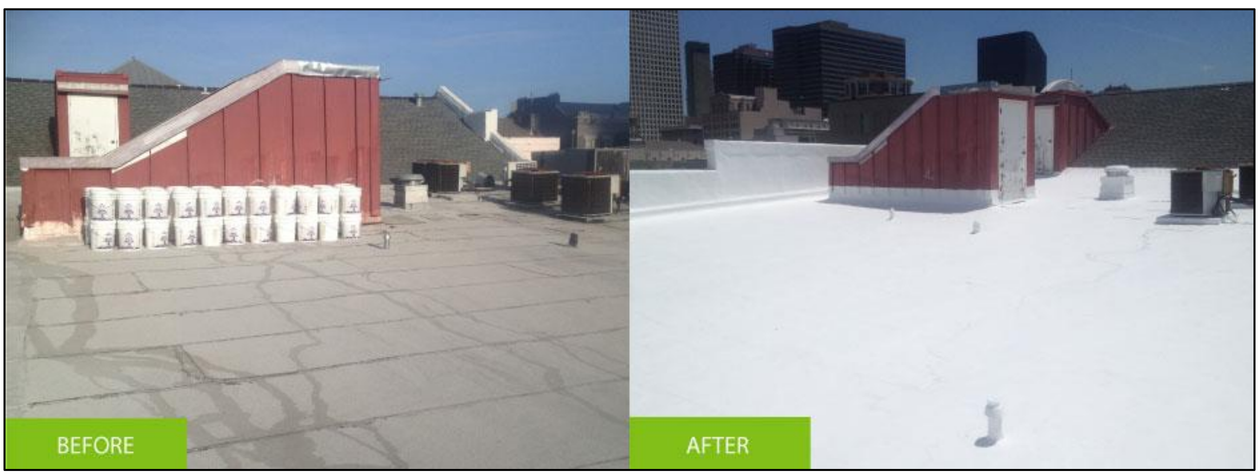
Table 3: Cool Roof Coating Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
2250 NW 21 AVE # OSSWALD COMM CENTER	$1,436	11,772	10.53%	$1,295	1.11
736 N FEDERAL HWY #HOLIDAY PARK ACTIVITY CENTER	$3,936	32,275	10.52%	$3,550	1.11
2871 E SUNRISE BLVD # FIRE STATION 13	$1,754	14,386	6.84%	$1,582	1.11
700 NW 19 AVE #DSD MAIN	$8,008	65,666	6.38%	$7,223	1.11

501 SEABREEZE BLVD #E MUSEUM & TR POOL	$3,353	27,496	6.10%	$3,025	1.11
2801 SW 4 AVE # FIRE STATION 3	$1,610	13,205	5.31%	$1,453	1.11
1000 SW 27 AVE # FIRE STATION 47	$1,935	15,867	4.91%	$1,745	1.11
1340 Chateau Park Dr. (Lauderdale Manors Park- Rec Center)	$1,184	9,709	4.48%	$1,068	1.11
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53 & EOC	$3,393	27,823	3.93%	$3,060	1.11
1000 N ANDREWS # WARFIELD PARK REC CENTER	$657	5,384	3.70%	$592	1.11
528 NW 2 ST #FIRESTATION 2 | ADMIN	$2,376	19,483	1.86%	$2,143	1.11
Total:	**$29,642**	**243,066**	**N/A**	**$26,737**	**1.11**

Assumptions: To calculate the estimated energy savings, average values were used for the calculator inputs and produced an average savings of 1.64 kWh per square foot of roof area per year. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

White or "cool" roofs are roofing systems that reflect more visible, infrared, and ultraviolet wavelengths of the sun back into the sky than standard or darker roofs. The ability to reflect these wavelengths reduces the amount of heat absorbed by the roof membrane and therefore the amount of heat transferred to the building. Cool roofs, therefore, reduce cooling loads for buildings and can also increase the lifespan of the roof membrane itself since it doesn't undergo changes in temperature that are as significant as darker or non-cool roofs.



Source: greenstarcoatings.com

Cool roofs should be installed at the time of any re-roofing, but coatings can also be applied to existing roof membranes that may not have reached the end of their useful life. All the same benefits of "new" cool roofs apply to the cool roof coatings. One caveat is that not all white roofs are cool roofs. It's important to confirm that the roof coating is in fact a cool roof coating and not just a white coating.

Priority 4: LED Lighting and Controls

Upgrading obsolete lighting to LED technology is accepted as one of the easiest methods for energy reductions and this holds true within the analyzed dataset of selected buildings. Where missing, such retrofits should be paired with occupancy sensors to drive further savings. In rare instances where a building is slated for replacement it may make financial sense to install a cheaper solution such as T8 fluorescents as their payback will be achieved prior to the replacement. The following buildings were identified to consider:

Table 4: Lighting and Controls Cost and Savings Strategy

Building(s) to Target, by Priority	Energy Savings Strategy	Fixture Count	Sensor Count	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
528 NW 2 ST #FIRESTATION 2 ADMIN	Sensors	N/A	40	$3,869	51,795	4.95%	$5,697	0.68
700 NW 19 AVE #DSD MAIN	Sensors	N/A	40	$3,869	50,980	4.95%	$5,608	0.69
1300 W BROWARD BLVD #POLICE STATION & JAIL	Sensors, T8s, LED Exits	2760	40	$88,019	1,107,029	30.86%	$121,773	0.70
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53 & EOC	Sensors	N/A	39	$3,772	35,040	4.95%	$3,854	0.98
1000 SW 27 AVE # FIRE STATION 47	Sensors	N/A	39	$3,772	15,994	4.95%	$1,759	2.14
1971 E COMMERCIAL BLVD #FIRE STATION 35	Sensors	N/A	39	$3,772	15,438	4.95%	$1,698	2.22
2002 NE 16 ST #FIRE STATION NO. 29	Sensors	N/A	39	$3,772	15,070	4.95%	$1,658	2.28
1515 NW 19 ST # FIRESTN 46	Sensors	N/A	39	$3,772	13,149	4.95%	$1,446	2.61
1015 SEABREEZE BLVD #FIRE STATION NO. 49	Sensors	N/A	40	$3,869	11,541	4.95%	$1,270	3.05
2871 E SUNRISE BLVD # FIRE STATION 13	Sensors	N/A	39	$3,772	10,405	4.95%	$1,145	3.30
2801 SW 4 AVE # FIRE STATION 3	Sensors, LED	67	39	$13,822	31,828	12.79%	$3,501	3.73
2800 SW 8 AVE # FLOYD HULL MORTON CENTER	LED	76	N/A	$11,400	14,652	20.89%	$1,612	7.07
501 SEABREEZE BLVD # ISHOF	LED	289	N/A	$43,350	55,049	15.02%	$6,055	7.16
3200 NE 32 ST #FIRE STATION NO. 54	Sensors	N/A	39	$3,772	3,979	4.95%	$ 438	8.62
950 SW 27 AVE #RIVERLAND PARK	LED	38	N/A	$5,700	4,367	1.34%	$480	11.9
	Total:	**3,230**	**472**	**$200,307**	**1,436,316**	**N/A**	**$157,995**	**1.19**

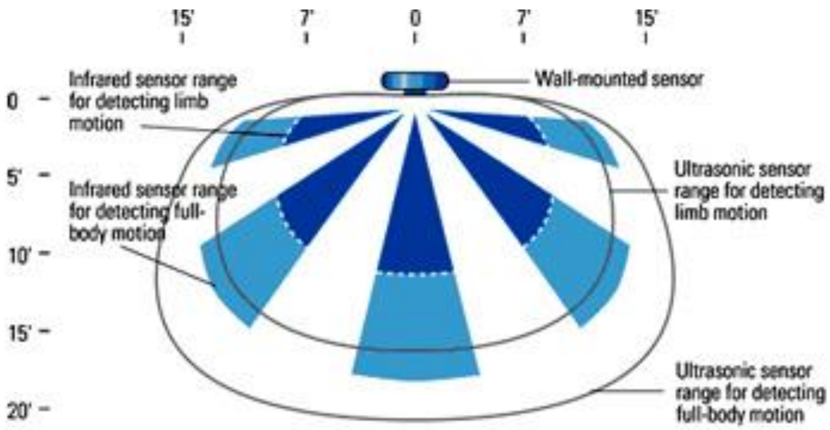
Assumptions (Sensors): 20-25% savings in open space offices- Doty Turner EMH. 10% open office space DOE. 15% savings Energy Star. Estimated savings considers a 15% reduction of the lighting *load assuming lighting is 33% of energy costs. Installation, labor and materials, and a 10% contingency fund is factored in the Estimated Cost total. Costs taken from the average of two electrical contractor estimates. The total amount of office spaces/rooms in those buildings is a '"rough" count (512) provided by Engineering. DSD has been reorganized several times, thus for this strategy, we will estimate DSD has 100 rooms/offices. The cost used for an occupancy sensor is $19.97. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.*

Assumptions (T12 to T8): Estimates based on 4-lamp T8 fixtures replacing 4-lamp T12 fixtures. Estimated Cost assumes bulb replacement and not a whole fixture replacement, and discounted bulk purchase pricing not factored into the cost. Locations of retrofits can be for previously audited facilities found within AST's engineer analysis. Installation costs are not factored in due to assumption that Facilities Maintenance will be available to install the light bulbs. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

Assumptions (T12 to LED): Estimates based on LED fixtures and bulbs replacing T12 fixtures. Estimate Cost of $150 for material and labor derived from contractor estimates and online materials costs. Estimated kWh savings and estimated cost savings derived from AST Engineer analysis and lighting calculator. The buildings that currently have T12, 4-lamp fixtures as observed in the limited AST/FTL audit. The estimated cost includes a 10% contingency cost to cover unanticipated install costs, bonds and insurance, administration and legal costs, safety audits, and any other expenses that may occur. This measure is currently applied to a sample of buildings and can be applied to more buildings upon completing fixture counts. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

Assumptions (LED Exit Signs): Figures calculated from Energy Star Exit Sign Calculator. Labor costs are not factored in due to feedback provided by Facilities suggesting they would be able to handle the swap outs of old exit signs with new LED exit signs. Maintenance cost savings of $6.74 per exit sign is not included in the energy savings analysis. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

The energy code for new buildings requires motion sensors in some common spaces such as conference rooms, kitchens, baths, and others. These ultrasonic or infrared sensors detect movement when rooms are in use and turn lights on. Similarly, lights are turned off once occupants leave the room, avoiding situations where lights are accidentally left on all day or night in unoccupied spaces. While older building codes didn't require the use of occupancy sensors, they are an ideal retrofit solution to reduce lighting energy use, and the simplest type of occupancy sensors require replacement of just the light switches.



Courtesy: E SOURCE Lighting Technology Atlas (2005)

For City buildings for which there is no plan to replace or renovate, a conversion from T12s (or T8) to LED fixtures can save even more energy while also further reducing maintenance costs, when compared to a T12 to T8 fluorescent conversion. LED lighting retrofits are among the most cost-effective energy efficiency retrofits available to building owners, and the conversion to LEDs can generate significant energy savings.

Source: homeelectrical.com

Installation of LEDs also significantly lowers maintenance costs, as they have a longer service life than fluorescent and incandescent. LEDs have the added benefit of containing no mercury or other toxic gasses, which reduces potential environmental contamination from bulb disposal. Exterior lighting should also be examined for LED solutions as typically these fixtures operate at higher wattages and for longer hours than their interior counterparts.

Older exit signs can be retrofitted with LED lighting to substantially improve their energy usage performance. These signs require significantly less energy and ongoing maintenance than older types of lighting. Further, by improving their ongoing operation, these exit signs are more likely to be available to occupants in the event of an emergency.

Priority 5: Weather Sealing the Building Envelope

While individually small in savings, performing comprehensive weather sealing for all applicable doors and windows upon a building's exterior can aggregate into a significant impact on energy use. Weather sealing has a synergistic effect to all HVAC systems that currently operate insofar that even if the mechanical plant equipment is aged and inefficient compared to the newest offerings, it will improve efficiency overall when it does not have to work as hard to maintain a conditioned atmosphere due to envelope penetration. The following buildings were identified to pursue:

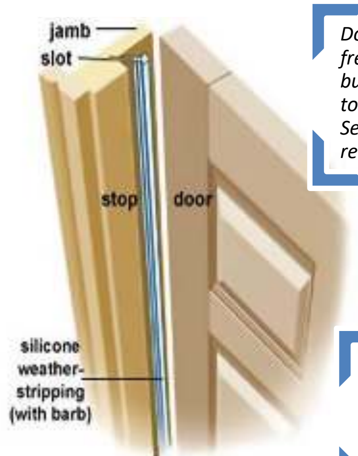
Table 5: Weather Sealing Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
5301 E PERIMETER RD # CUSTOMS	$250	3,554	1.20%	391	0.64
1340 Chateau Park Dr. (Lauderdale Manors Park- Rec Center)	$220	2,599	1.20%	286	0.77
1800 SW 4 AVE # CROISSANT PARK COMMUNITY CENTER	$268	2,651	1.20%	292	0.92
1000 N ANDREWS # WARFIELD PARK REC CENTER	$188	1,746	1.20%	192	0.98
950 SW 27 AVE #RIVERLAND PARK	$429	3,920	1.20%	431	1.00
2871 E SUNRISE BLVD # FIRE STATION 13	$305	2,522	1.20%	277	1.10
528 NW 2 ST #FIRESTATION 2 | ADMIN	$1,545	12,556	1.20%	1,381	1.12
1300 W BROWARD BLVD #POLICE STATION & JAIL	$5,779	43,048	1.20%	4,735	1.22
1450 W SUNRISE BLVD # CARTER PARK REC CENTER	$107	783	1.20%	86	1.24
2002 NE 16 ST #FIRE STATION NO. 29	$515	3,653	1.20%	402	1.28
100 N ANDREWS AVE #CITY HALL	$4,164	29,425	1.20%	3,237	1.29
2801 SW 4 AVE # FIRE STATION 3	$437	2,986	1.20%	329	1.33
1450 W SUNRISE BLVD # CARTER PARK GYM	$600	3,983	1.20%	438	1.37
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53 & EOC	$1,366	8,495	1.20%	934	1.46
1971 E COMMERCIAL BLVD #FIRE STATION 35	$610	3,743	1.20%	412	1.48
1150 G. Harold Martin Dr. #SOCIAL (H.Park- Social Center)	$207	1,239	1.20%	136	1.52
1515 NW 19 ST # FIRESTN 46	$541	3,188	1.20%	351	1.54

2750 NW 19 ST #BASS PARK	$315	1,862	1.20%	205	1.54
700 NW 19 AVE #DSD MAIN	$2,150	12,359	1.20%	1,359	1.58
1200 G HAROLD MARTIN DR # HOLIDAY PARK GYM	$725	4,009	1.20%	441	1.64
1000 SW 27 AVE # FIRE STATION 47	$770	3,877	1.20%	426	1.80
4250 NW 10 AVE # CMS	$655	3,113	1.20%	342	1.91
1015 SEABREEZE BLVD #FIRE STATION NO. 49	$609	2,798	1.20%	308	1.98
2250 NW 21 AVE # OSSWALD COMM CENTER	$300	1,342	1.20%	148	2.03
800 NE 8 ST #WAR MEMORIAL AUDITORIUM	$2,100	9,046	1.20%	995	2.11
1101 BAYVIEW DR # GE REC BLDG	157	634	1.20%	70	2.26
3351 NE 33 AVE # BEACH COMMUNITY CENTER	$629	2,421	1.20%	266	2.36
290 NE 3 AVE #PARKING DIV	$722	2,040	1.20%	224	3.22
6000 NW 21 AVE #Airport Admin FXE	$500	1,404	1.20%	154	3.24
2800 SW 8 AVE # FLOYD HULL MORTON CENTER	$318	842	1.20%	93	3.43
501 SEABREEZE BLVD #E MUSEUM & TR POOL	$2,511	5,408	1.20%	595	4.22
736 N FEDERAL HWY #HOLIDAY PARK ACTIVITY CENTER	$1,835	3,682	1.20%	405	4.53
3200 NE 32 ST #FIRE STATION NO. 54	$982	965	1.20%	106	9.25
Total:	**$32,807**	**185,891**	**N/A**	**$20,448**	**1.60**

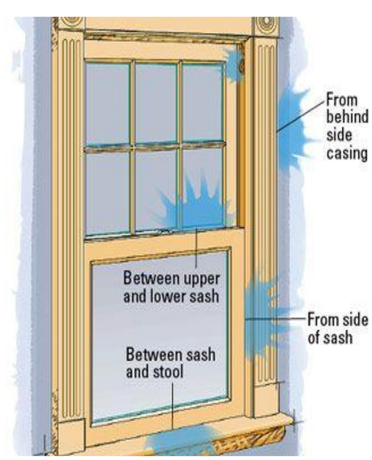
Assumptions: Estimated cost of $0.05 per square foot of building area. Estimated savings of 4% of HVAC energy costs per year.

Weather sealing windows and doors involves re-sealing or re-caulking around building façade elements. While windows and doors may have been tightly sealed against drafts and air leaks when a building was first built, caulk and other sealants degrade over time and require replacement to address any gaps and cracks that may have developed. Leaks around windows and doors can let in a significant amount of outside air, which requires the HVAC system to provide additional cooling. Air sealing can also help with water penetration and pests.



Doors are the most frequently used opening in a building envelope and subject to increased wear and tear. Seek robust sealing when retrofitting.

Windows require a more comprehensive solution but once installed, should last longer than on doors



Source: thisoldhouse.com (left); bhg.com (right)

Priority 6: Plug Load Management

Coordinating a comprehensive approach that addresses gaps in best practice knowledge by the occupants in the building and marrying the benefit of their participation in conserving energy to their overall wellbeing is easier said than done when compared to other strategies. That said, there exists solutions that handle the operational logistics of powering down unneeded devices so that decisionmakers can focus on educational campaigns to ensure compliance. The following buildings were identified to pursue:

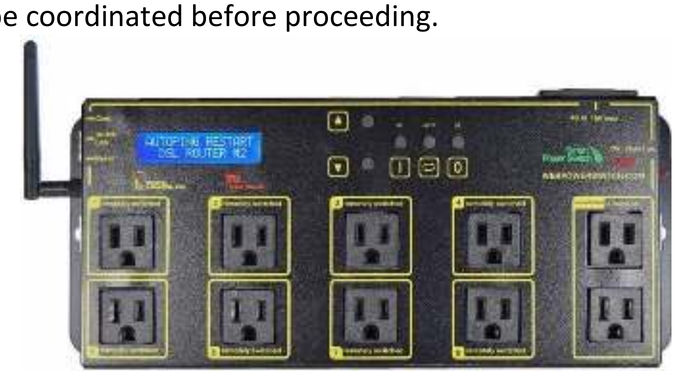
Table 6: Plug Load Management Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
290 NE 3 AVE #PARKING DIV	$68	3,367	1.98%	$370	0.18
100 N ANDREWS AVE #CITY HALL	$6,705	48,551	1.98%	$5,341	1.26
700 NW 19 AVE #DSD MAIN	$6,678	20,392	1.98%	$2,243	2.98
Total:	**$13,451**	**72,310**	**N/A**	**$7,954**	**1.69**

Assumptions: Estimated cost of $26.50 is per power strip without bulk purchase. Energy savings is estimated at 6.6% per year for each building where power strips are implemented. Savings calculated using Schedule Timer Control strip. Assumes plug load is 33% of building load. Savings estimates for a behavioral-only approach are 1% of plug loads. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

Plug load management involves the use of behavioral programs and/or power strips to reduce plug load energy demand, which represents a significant portion of energy use in office settings. Office equipment, such as printers, computers, monitors, and even coffee makers are often left on and in “stand-by” mode 24/7. While not operating at maximum power, stand-by modes still consume a surprising amount of energy.

Advanced power strips come in several styles, and a US General Services Administration (GSA) report recommends the “schedule timer control” style, wherein the user programs the time of day that the power strip is on and the time of day that it is off. This will enable equipment to be completely shut off on nights and weekends, with the added benefit of not requiring any changes to occupant behavior, as they will most likely not even notice that the equipment is on a schedule once it is set. Currently, IT policy requires that computer workstations remain powered overnight to ensure security and other software patches are installed. As such, any implementation of such power strips should be coordinated before proceeding.



In offices that operate with erratic hours, other types of advanced power strips, such as the "load-sensing control" style can be useful to shut off related equipment if the "master" piece of equipment is turned off. One example would be turning off a monitor when a computer is powered down.

Finally, tenant behavioral programs can also be implemented to train staff to turn off office devices at the end of the day. These programs only require staff time (and outreach materials in some cases) and can produce immediate results. Friendly competitions between departments, like the City's *Flip the Switch* challenges, can help to incentivize participation and make the process more meaningful.

Priority 7: Variable Frequency Drives (VFDs)

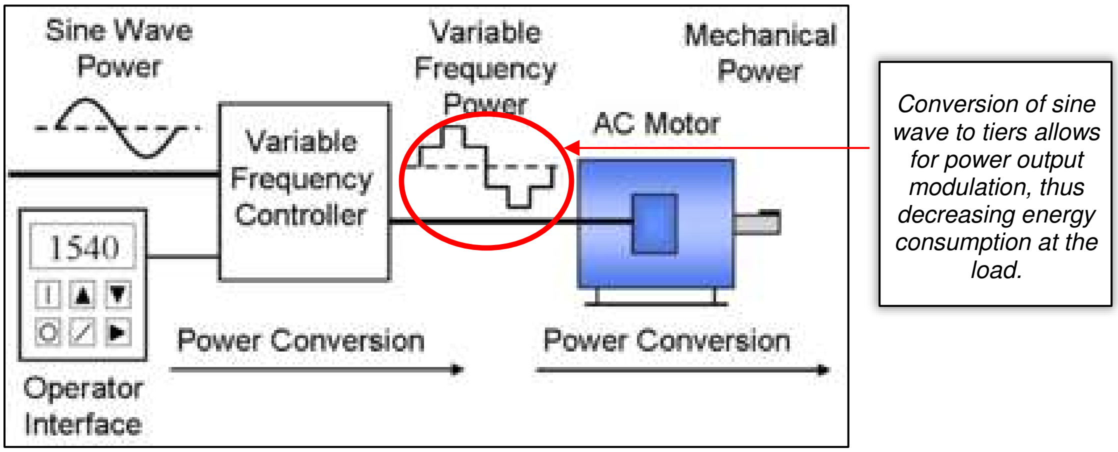
VFDs are generally a more costly approach to take that will provide energy savings, though certainly more economical than complete system replacement. The key takeaway should this type of solution be pursued is to ensure training on the usage of the device is held so that facilities personnel are adept at their operation. Far too often staff are unaware of a VFD's purpose and will simply leave the device in "manual override" mode, resulting in no savings. The following buildings were identified to pursue:

Table 7: Variable Frequency Drives Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
736 N FEDERAL HWY #HOLIDAY PARK ACTIVITY CENTER	$4,924	35,437	11.55%	$3,898	1.26
1450 W SUNRISE BLVD # CARTER PARK GYM	$5,432	38,338	11.55%	$4,217	1.29
1450 W SUNRISE BLVD # CARTER PARK REC CENTER	$5,126	7,533	11.55%	$829	6.19
Total:	**$15,482**	**81,308**	**N/A**	**$8,944**	**1.73**

Assumptions: Assume adding VFDs to the scheduled maintenance for HVAC equipment would add approximately 3% to the cost listed in the Facilities Condition Assessment for the particular building. Based on industry averages for VFD replacement savings, assumed a 35% savings rate for switching to VFDs. HVAC usage is assumed to be 33% of total energy use. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

Existing HVAC systems can be retrofitted with Variable Frequency Drives (VFDs) for fans or pumps to better regulate the amount of warm or cool air that is delivered to a space. They are considered one of the most successful energy management tools introduced into HVAC systems, and many modern systems have VFD options built in. Older systems, however, frequently have constant speed motors which use excessive energy when the HVAC demand is lower than the motor's output, resulting in wasted energy. By reducing the speed of the HVAC's motor when demand is low, VFDs can lower energy use significantly to more precisely meet load requirements, while also improving occupant comfort.



Source: Wikipedia.org

Priority 8: Programmable Thermostats

Replacing obsolete HVAC controls that rely on pneumatic systems can achieve significant savings from tighter setpoints, less costly maintenance, and the ability to set schedules during unoccupied hours. For the fire stations analyzed, occupancy sensors were included to address sporadic occupancy due to operations. The City has already committed to targeted installation of this EEM with approximately 60 thermostats retrofitted to date. The following buildings were identified to consider:

Table 8: Programmable Thermostats Cost and Savings Strategy

Building(s) to Target, by Priority	T'Stat Count	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
528 NW 2 ST #FIRESTATION 2 | ADMIN	6	$3,563	62,154	5.94%	$6,837	0.52
701 NE 12th Ave #TENNIS COMPLEX (H. Park)	1	$394	4,745	4.95%	$522	0.75
1015 SEABREEZE BLVD #FIRE STATION NO. 49	2	$1,188	13,849	5.94%	$1,523	0.78
1450 W SUNRISE BLVD # CARTER PARK GYM	4	$1,576	16,431	4.95%	$1,807	0.87
1450 W SUNRISE BLVD # CARTER PARK REC CENTER	1	$394	3,228	4.95%	$355	1.11
700 NE 9th st #BARN1 (H.Park- Police Horse Barn)	1	$394	2,803	4.95%	$308	1.28
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53	10	$5,939	42,048	4.95%	$4,625	1.28
2250 NW 21 AVE # OSSWALD COMM CENTER	2	$788	5,534	4.95%	$609	1.29

1150 G. Harold Martin Dr. #SOCIAL (H.Park- Social)	2	$788	5,112	4.95%	$562	1.40
1700 SW 14TH CT Hortt Park	1	$394	2,359	4.95%	$259	1.52
1000 SW 27 AVE # FIRE STATION 47	6	$3,563	19,192	5.94%	$2,111	1.69
Old Parks Admin (2%)	2	$788	4,228	4.95%	$465	1.69
2002 NE 16 ST #FIRE STATION NO. 29	6	$3,563	18,084	5.94%	$1,989	1.79
2801 SW 4 AVE # FIRE STATION 3	6	$3,563	14,783	5.94%	$1,626	2.19
1515 NW 19 ST # FIRESTN 46	7	$4,157	15,778	5.94%	$1,736	2.40
6000 NW 21 AVE #Airport Admin FXE	4	$1,576	5,790	4.95%	$637	2.47
2871 E SUNRISE BLVD # FIRE STATION 13	6	$3,563	12,486	5.94%	$1,373	2.59
1101 BAYVIEW DR # GE REC BLDG	2	$788	2,616	4.95%	$288	2.74
1130 SW 5TH PL #RIVERSIDE PARK	2	$788	2,024	4.95%	$223	3.54
401 SE 21ST ST PRINT SHOP	2	$788	1,576	4.95%	$173	4.54
1971 E COMMERCIAL BLVD #FIRE STATION 35	20	$11,878	18,526	5.94%	$2,038	5.83
533 NE 13TH ST Police Substation Acct 1 (LE)	2	$788	472	4.95%	$52	15.2
533 NE 13TH ST Police Substation Acct 2 (LW)	2	$788	203	4.95%	$22	35.2
6300 NW 21ST AVE # FIRE STATION 88	9	$5,345	312	4.95%	$34	156
Total:	**106**	**$57,354**	**274,333**	**N/A**	**$30,174**	**1.74**

Assumptions: Assumed a cost of $153.90 for materials plus $240 for labor for each thermostat. Estimated figures are for analyzed first priority buildings that have a majority of electricity load coming from a single building meter that make measurement and verification simpler. A 15% savings on HVAC load for buildings with programmable thermostats was used in calculations. HVAC load is calculated as 33% of total building energy load. The proposed City thermostat temperature policy will help support savings calculations. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

Assumptions (Fire Stations): Assumed a cost of $153.90 for new thermostats, $200 for occupancy sensors, plus $240 for labor for each thermostat. Following a temperature audit of 5 fire stations, the current temperature average is 69F. For every 1 degree you raise on the thermostat, it is estimated you save 3-5% on cooling costs. Assume cooling for 75% of the year. A temperature adjustment to 75F is equivalent to 14% savings on cooling costs using an average of 3% savings for each degree. To that is added an additional 4% savings from occupancy-based usage for a total of 18% savings.

Thermostats control the temperature and humidity in buildings in order to create a comfortable environment for occupants and prevent moisture-related issues (such as mold and mildew). Since many thermostats are simple mechanical devices, they often do not stop working outright despite failing to function properly; while still functional, they frequently become inaccurate. They also lack the ability to set schedules for HVAC equipment to reduce energy use when buildings are unoccupied, such as overnight and on weekends, due to their manual operation.

Older thermostats such as in City Hall differ from other more common varieties in that they use compressed air as a medium of control for HVAC systems instead of electrical wiring. A pneumatic thermostat system requires very clean, dry air and all controllers and thermostats need to be continually maintained otherwise they will drift out of calibration. In 2019, the Sustainability Division replaced these thermostats with direct digital control (DDC) thermostats that produced better temperature control with less maintenance, improved occupant comfort, and reduced energy waste and utility bill costs.

Existing thermostats also generally lack the ability to adjust set points (desired temperature range for space) based on occupancy without someone having to manually adjust the thermostat several times a day. For buildings that are operational 24 hours a day, selecting a thermostat that can adjust conditioning and ventilation based on whether a space is in use, rather than a more typical set point adjustment based on time of day, is a good way put new technology to work saving energy.

When paired with an occupancy sensor (generally used for efficient lighting control), these thermostats can be used with existing HVAC equipment to modify ventilation and adjust the temperature by a few degrees when a room has been occupied. Combined with a revised set point policy, these technology upgrades are a relatively low-cost solution that can be quickly implemented and achieve immediate results.

Most occupational health studies show that indoor temperatures in the 70s – generally from 72 to 77 degrees Fahrenheit are most conducive to occupant comfort and productivity. This range can vary with the type of space, special events with high occupancy as well as the climate in general. As an example, office spaces in Fort Lauderdale should be set at ~75 degrees as an appropriate temperature however, many City buildings currently operate with set points at significantly lower temperatures.

In addition to wasting electricity and money, the impact on employee comfort can be significant as many employees currently must dress warmly even in summer, while others use small inefficient space heaters under their desks. The latter is especially problematic due to their high energy usage and safety risks.

Source: ivaluesafety.com

Making this set point change will increase efficiency at almost no cost. For buildings with manual/mechanical thermostats, the only costs for the City are new lock boxes placed around thermostats to ensure set points are only adjusted by Facilities or other authorized staff. In buildings with programmable thermostats, the thermostats can utilize a digital locking function and don't require the boxes.

Priority 9: Shade Trees

More difficult to implement holistically due to each building's unique footprint, planting trees near buildings can have an appreciable impact on reducing solar heat gain thus reducing cooling loads. Care should be given to ensure plantings are native to the climate and located appropriately so as to provide shade to buildings while the root structures will not damage the adjacent building's foundation and utility interconnections. It should also be noted that shade trees planted on City properties can be paid for via the City's Tree Trust Fund and will not require payment from the 'General Fund' as with other EEM. The City's Urban Forester should be consulted prior to any plantings to ensure the appropriate tree is selected. The following buildings were identified to consider:

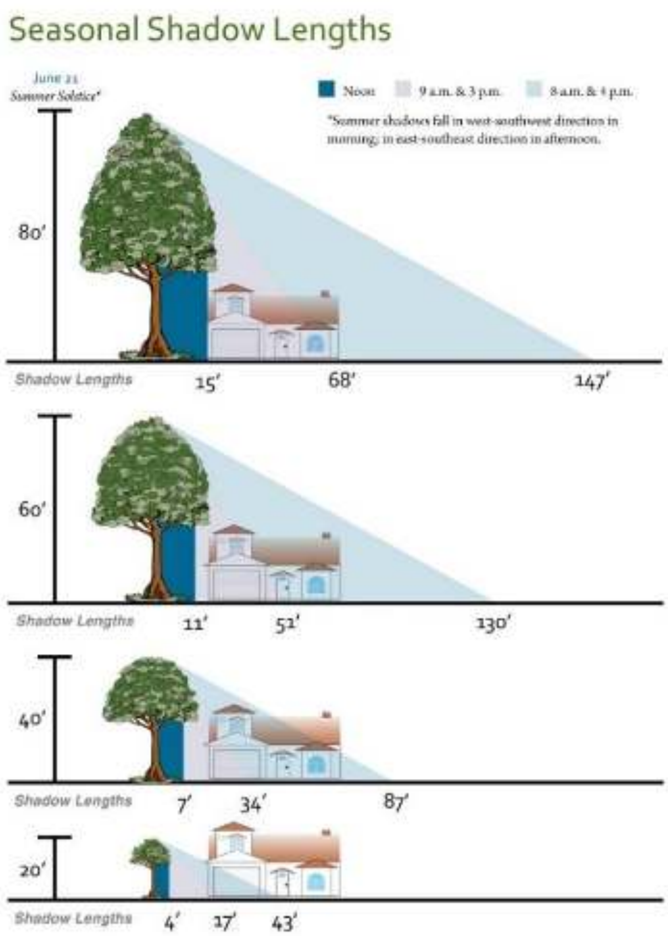
Table 9: Shade Trees Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
2200 EXECUTIVE AIRPORT WAY # FIRESTATION 53 & EOC	$1,020	11,680	1.65%	$1,285	0.79
1000 SW 27 AVE # FIRE STATION 47	$1,020	5,331	1.65%	$586	1.74
1515 NW 19 ST # FIRESTN 46	$1,020	4,383	1.65%	$482	2.12
1340 Chateau Park Dr. (Lauderdale Manors Park- Rec)	$1,020	3,573	1.65%	$393	2.59
2750 NW 19 ST #BASS PARK	$1,020	2,560	1.65%	$282	3.62
2250 NW 21 AVE # OSSWALD COMM CENTER	$1,020	1,845	1.65%	$203	5.03
1150 G. Harold Martin Dr. #SOCIAL (H.Park- Social Centr)	$1,020	1,704	1.65%	$187	5.44
2800 SW 8 AVE # FLOYD HULL MORTON CENTER	$1,020	1,157	1.65%	$127	8.01

1101 BAYVIEW DR # GE REC BLDG	$1,020	872	1.65%	$96	10.63
1700 SW 14TH CT Hortt Park	$1,530	786	1.65%	$86	17.69
1130 SW 5TH PL #RIVERSIDE PARK	$1,530	675	1.65%	$74	20.61
Total:	**$12,240**	**34,567**	**N/A**	**$3,802**	**3.23**

Assumptions: *Several studies have varying ranges of savings, from 1% to 47% cooling energy savings, though these studies looked primarily at residential buildings. However, the buildings that we would consider for this strategy would be one to two stories tall and have a smaller building footprint. In the calculation, we used a conservative number of 5% cooling savings. Estimated Cost uses two trees per property and only accounts for initial year of purchase, installation, and maintenance of trees. Estimates calculated by the City's Urban Forester. $410 for initial installation and purchase of tree and $100 maintenance fee by outside contractor.*

Often overlooked due to not being a part of the physical building, trees can reduce energy usage naturally by providing shade upon the exterior envelope that reduces the need for air conditioning. While a long-term strategy – trees typically must grow from saplings to mature trees before they shade a building – the benefits can be significant, long-lasting, and above all cost-effective. The City's "Right Tree, Right Place" program can serve as a guide when selecting and locating trees for this energy conservation measure.



Source: tid.org

Priority 10: Solar Window Films

Another solution to address energy loss via the building envelope is to address the window glazing. Major capital upgrades would focus on the addition of 2-3 glazings with different noble gas infills to provide efficiency. However, a far less expensive solution is the application of tinting to existing glazing to reduce solar radiation heat gain. The following buildings were identified to consider:

Table 10: Window Film Retrofit Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
528 NW 2 ST #FIRESTATION 2 | ADMIN	$8,258	57,446	5.49%	6,319	1.31
700 NW 19 AVE #DSD MAIN	$14,954	56,542	5.49%	6,220	2.40
2200 EXECUTIVE AIRPORT WAY FIRESTATION 53 & EOC	$10,490	38,863	5.49%	4,275	2.45
100 N ANDREWS AVE #CITY HALL	$48,630	134,618	5.49%	14,808	3.28
1800 SW 4 AVE # CROISSANT PARK COMMUNITY CENTR	$4,464	12,127	5.49%	1,334	3.35
800 NE 8 ST #WAR MEMORIAL AUDITORIUM	$15,252	41,385	5.49%	4,552	3.35
2002 NE 16 ST #FIRE STATION NO. 29	$6,473	16,714	5.49%	1,839	3.52
501 SEABREEZE BLVD #E MUSEUM & TR POOL	$9,932	24,741	5.49%	2,721	3.65
1000 SW 27 AVE # FIRE STATION 47	$7,589	17,739	5.49%	1,951	3.89
950 SW 27 AVE #RIVERLAND PARK	$7,700	17,932	5.49%	1,973	3.90
1971 E COMMERCIAL BLVD #FIRE STATION 35	$7,440	17,123	5.49%	1,883	3.95
1200 G HAROLD MARTIN DR # HOLIDAY PARK GYM	$8,035	18,341	5.49%	2,017	3.98
1340 Chateau Park Dr. (Lauderdale Manors Park- Rec)	$5,729	11,890	5.49%	1,308	4.38
1015 SEABREEZE BLVD #FIRE STATION NO. 49	$6,361	12,800	5.49%	1,408	4.52
2801 SW 4 AVE # FIRE STATION 3	$6,994	13,663	5.49%	1,503	4.65
1000 N ANDREWS # WARFIELD PARK REC CENTER	$4,315	7,990	5.49%	879	4.91
1450 W SUNRISE BLVD # CARTER PARK GYM	10,193	18,223	5.49%	2,005	5.08
1515 NW 19 ST # FIRESTN 46	$8,816	14,583	5.49%	1,604	5.50
2871 E SUNRISE BLVD # FIRE STATION 13	$6,994	11,540	5.49%	1,269	5.51
736 N FEDERAL HWY #HOLIDAY PARK ACTIVITY CENTER	$10,565	16,844	5.49%	1,853	5.70
2750 NW 19 ST #BASS PARK	$6,845	8,518	5.49%	937	7.30
290 NE 3 AVE #PARKING DIV	$7,961	9,335	5.49%	1,027	7.75
2250 NW 21 AVE # OSSWALD COMM CENTER	$6,361	6,138	5.49%	675	9.42
3351 NE 33 AVE # BEACH COMMUNITY CENTER	$11,792	11,075	5.49%	1,218	9.68
6000 NW 21 AVE #Airport Admin FXE	$8,705	6,422	5.49%	706	12.32
Total:	**$250,849**	**602,590**	**N/A**	**$66,285**	**3.78**

Assumptions: 18.3% of HVAC energy use per year. (29% savings for perimeter HVAC per year. Whole building savings estimated to be at least 1/3 of the perimeter savings but varies based on shape of building. Savings are for buildings with single pane windows.) Assumed a window to wall ratio of 20%, and an exterior building height of 12 feet.

Tinted window films are a good solution for windows that currently allow a significant amount of solar radiance (light and heat) from the sun into a space and make it uncomfortable for occupants. The window film is applied to the windows in a sheet or liquid form and serves as a physical block for heat while still allowing visible light to pass through. Applying window films to windows is a minimally invasive solution that both improves occupant comfort and reduces cooling demand by reducing the amount of heat entering the building through the windows.

Source: amazon.com (HOHO Industries, Ltd.)

Solar films are of the most simplistic of window treatments facility operators can install to mitigate solar gain via radiance, however their application is a static treatment. Newer offerings have reached the market in the form of electrochromic shading systems that provide dynamic tinting to windows based on the needs of the space and seasonality. These solutions require a nearby electrical service connection to operate their minimum load and are far more expensive than simple film. If a facility is slated to undergo window replacement with a focus on improvements then the electrochromic option might make sense to consider, especially with buildings that are of cultural significance (museums, libraries, convention centers, etc.).

Priority 11: Above Deck Roof Insulation Retrofit

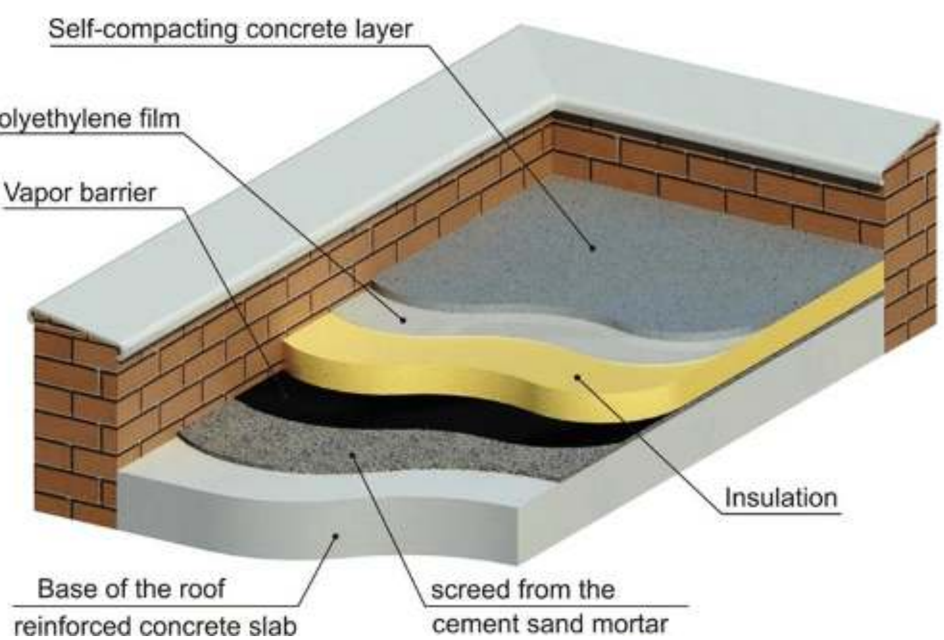
Adding above deck roof insulation can significantly reduce a building's heat load and associated energy usage. Installing insulation onto roofs outside of the renovation and replacement cycle is often less cost effective. Generally adding insulation should be considered whenever the roof is scheduled to undergo replacement. By doing so the major costs of the retrofit are largely removed thus giving an attractive return from the mitigated energy losses due to extra cooling. The following buildings were identified to consider as they do not have any upcoming roof replacements scheduled:

Table 11: Roof Insulation Retrofit Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Project Cost	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
1450 W SUNRISE BLVD # CARTER PARK REC CENTER	$7,040	5,852	8.97%	$644	10.94
2250 NW 21 AVE # OSSWALD COMM CENTER	$11,485	9,547	8.54%	$1,050	10.94
701 NE 12th Ave #TENNIS COMPLEX (H. Park)	$4,560	3,791	3.95%	$417	10.94
Total:	**$23,085**	**19,189**	**N/A**	**$2,111**	**10.94**

Assumptions: Assumes R-20 above deck, rigid roof deck insulation is installed as part of the roof replacement to meet the requirements of the 2015 ICC for Climate Zone 1. The cost for every additional R-5 value is $0.40 per square foot, installed. Assume installation of an additional R-20 and EER of HVAC equipment is 10. Typical cost: $1.60 per square foot of roof area. Assumed incremental savings is 1.33 kWh savings per square foot per year. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

Insulation was gradually introduced into the commercial building code over the last 30 years. As a result, insulation in older buildings tends to be minimal or non-existent and results in significant heating and cooling losses through the building envelope. While retrofitting a building's entire envelope with insulation is often challenging and invasive, installing above-deck roof insulation at the time of re-roofing is a great way to reduce cooling demand.



Source: researchgate.net

The current building code requires above deck roof insulation and by installing more than the minimum requirement helps future-proof the facility while reducing additional energy consumption.

Priority 12: High Efficiency HVAC Equipment

Replacement of HVAC equipment can offer substantial energy efficiency improvements. Due to the high cost of the equipment the ROI is generally higher than other strategies. However, when replacing HVAC equipment due to mechanical failure or end of useful life, the marginal cost to buy higher efficiency units may offer a better ROI and high efficiency specifications should be included in these purchases. The following buildings were identified to consider:

Table 12: HVAC High Efficiency Replacement Cost and Savings Strategy

Building(s) to Target, by Priority	Est. Base Cost	Est. Efficiency Premium	Est. kWh Savings	% Annual kWh Reduced	Est. Cost Savings	ROI (yrs)
1200 G HAROLD MARTIN DR HOLIDAY PK GYM	$10,952	$1,095	16,537	4.95%	$1,819	6.02
1450 W SUNRISE BLVD # CARTER PARK GYM	$31,086	$3,109	16,431	4.95%	$1,807	17.2
950 SW 27 AVE #RIVERLAND PARK	$61,300	$6,130	16,168	4.95%	$1,778	34.5
700 NW 19 AVE #DSD MAIN	$43,911	$4,391	11,216	1.09%	$1,234	35.6
2250 NW 21 AVE # OSSWALD COMM CENTER	$10,952	$1,095	2,767	2.48%	$304	35.9
1000 N ANDREWS # WARFIELD PARK REC CTR	$23,228	$2,323	3,602	2.48%	$396	58.6
1150 G. Harold Martin Dr. (H.Park- Social Cntr)	$13,300	$1,330	1,687	1.63%	$186	71.7
Total:	**$194,729**	**$19,473**	**68,408**	**N/A**	**$7,525**	**28.5**

Assumptions: With the Department of Energy issuing new efficiency standards that step up efficiency in 2018 and in 2023, installing equipment now that meets the 2023 minimum efficiency standards (a 27% to 31% improvement over 2017 baseline) will lock in significant energy savings for the life of the equipment, which can exceed 20 years. Assumed the high efficiency equipment is a 10% cost premium over the standard equipment, and the high efficiency equipment would result in 15% more energy savings than the standard equipment. This measure is applied to a subset of buildings for which information was available at the time the savings calculations were compiled. Additional buildings should be evaluated for inclusion in the measure.

When an HVAC system is retired due to the City's ongoing capital replacement schedule, or when required by necessity, utilizing the most efficient equipment practical locks in energy savings for the life of the equipment, which can be 20 years or longer. The purchase or replacement of HVAC equipment should meet or exceed the efficiency requirements of the City's HVAC replacement guidelines.

The US Department of Energy issued HVAC equipment standards in 2015 that increased the minimum efficiency for HVAC rooftop units. Phase one mandates an 11% - 15% energy-efficiency increase in all air conditioning rooftop units as of January 1, 2018. Phase two, slated for 2023, will increase efficiency again, making units produced beginning in January 2023 to be 27%-31% more efficient than those produced in 2017. For equipment replaced between 2018 and 2023, careful consideration should be given to requiring equipment that meets the future standard since there are models available now that meet the 2023 standard.

Secondary Strategies

The above are the top twelve priorities the Sustainability Division should pursue within their partnerships across the City portfolio. In addition, establishing a long-term, energy management process, such as the International Organization for Standardization ISO 50001: Energy Management protocol should be sought out. This designation has been pursued by other Cities to set a baseline for success and can assist the City's Departments in creating their own robust energy efficiency strategy tailored to their respective missions.

Once these efforts come to fruition, there are additional measures that can be explored that provide some savings but also push for implementation of greater sustainability and resiliency within operations of our buildings.

Building Operator Training

EEM Type	Strategy	Problem	Est. Cost	Est. kWh Savings	Est. Cost Savings	ROI (years)
Misc.	Training	Facilities staff may not be aware of best practices in operations including identifying RCx opportunities	$15,950	273,231	$22,596	0.71

Building operator training focuses on educating staff about best practices in energy management so that they can more effectively manage building schedules and controls as well as identify and implement operational efficiencies during the normal course of their work. This in turn reduces energy consumption, improves occupant comfort, and mitigates the need for intensive RCx. There are several organizations that provide national trainings and certification programs. For example, the Northwest Energy Efficiency Council offers Building Operator Certification (BOC®) training, appropriate for operators of most commercial properties and is widely accepted as the go-to for attaining best-practices knowledge.

Enterprise Energy Management

EEM Type	Strategy	Problem	Est. Cost	Est. kWh Savings	Est. Cost Savings	ROI (years)
EM	Plug Load Management Technologies	Appliances, task lighting, and other peripherals left on or in stand-by contribute to energy waste (aka "Vampire Voltage")	$13,451	72,310	$5,980	2.25
EM	IT Power Management System	Computer workstations are left fully powered 24/7 due to IT Dept. policy	Staff Time	376,330	$31,122	0.00

In addition to targeting specific building systems for energy savings retrofits, additional reductions can be achieved from using a holistic strategy that employs a collective effort on behalf of tenants and other supporting departments.

Power Management Systems

Computer power management systems are centralized IT solutions that are installed on each workstation within an organization. Power management systems enable computers to be powered off or put into sleep mode based on a schedule that is set remotely by the IT department. Power management systems are particularly beneficial in work environments where computers are left on overnight or over the weekends as a significant amount of energy is consumed by equipment when no one is using it. Power management systems are flexible and can be tailored to a specific organization's needs and scheduling requirements. The City has a power management system that could be implemented by IT if supporting actions and/or policies were approved.

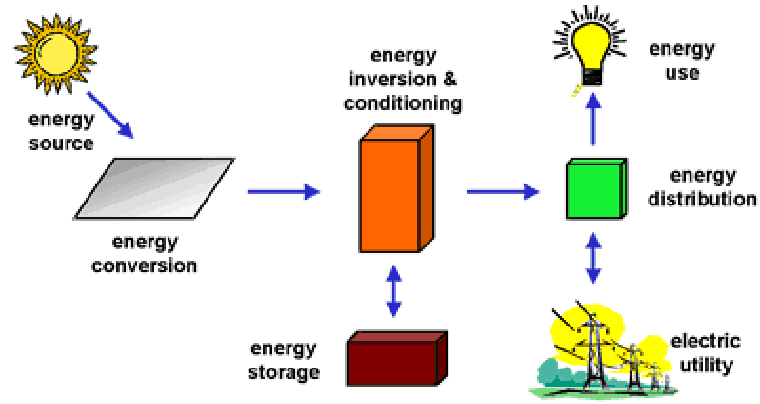
A computer power management policy should be adopted in conjunction with deploying a power management system. The policy should describe which computers could be enrolled in the program, how the scheduling will be set, and how the policy will be modified during unusual circumstances or emergencies, among other considerations. Thought should also be given to whether the computers could be turned off (which produces the maximum amount of energy savings) or put into sleep mode (which doesn't deliver maximum energy savings but has other benefits, such as preserving documents on workstations where applications were accidentally left open at the end of the day).

Renewable Energy Systems

Probably one of the most recognizable sustainability initiatives within the energy sector are renewable energy systems that provide cleanly-generated electricity to a building or system thus partially or fully mitigating the need to purchase energy from the utility grid. These solutions were initially cost-prohibitive and largely inefficient but have since improved in both aspects and should be examined for potential offsetting of a building's energy needs. If seeking a large deployment, it is generally advisable to pursue efficiency measures first to lower the base load of the building before committing to any renewable system as this will help with the financial return on investment.

Solar Photovoltaic (PV)

Utilizing the sun's radiant energy, these systems generate direct-current electricity with recent efficiency reaching upwards of 30%. This energy can then be stored in a local battery system for future use or converted to alternating-current via inverter and sent to meet a building's load (losing some efficiency due to conversion). This process can be scaled up or down to meet any electrical demand and is largely contingent on funding and on how much available space there is to site the system:



Source: gosunsolutions.com

A PV system is comprised of solar panels that when combined create larger arrays that are very simple systems. With no mechanical moving parts, PV usually requires very little in terms of maintenance (cleaning panels and inspecting for any damage). Careful planning and preliminary modeling should be undertaken to forecast for future production of the system based on its siting. Further, Florida is subject to intense tropical storms that requires additional hardening of a PV system to ensure it does not break loose from its site and damage anything nearby.

It should be noted that PV systems do not necessarily require being installed on a building's rooftop nor do they need to be large. While certified as a 'Solsmart Community', constrained environments such as in Fort Lauderdale can be addressed with more unique solutions such as parking canopies that collectively can offset a building's load or act as an off-grid method for recharging electric vehicles. Other solutions can be even more compact such as for streetlighting, parking meters, traffic safety devices, local irrigation pumping, and for the greater public benefit such as in local parks/green spaces.

PV Streetlights

PV Parking Canopies

PV Parking Meters

PV Irrigation

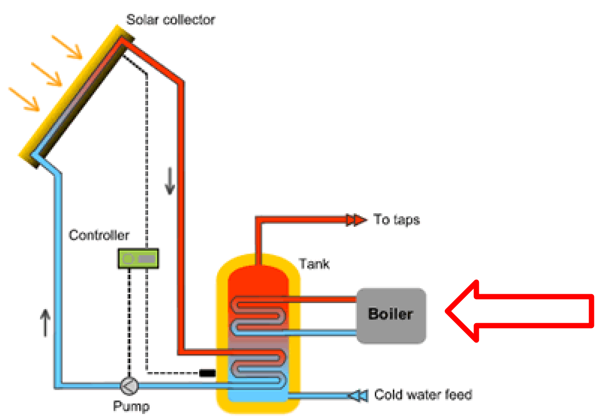
Community PV

(shade, WiFi, USB charging)

PV Weather Monitoring

Solar Thermal

An additional method to harness the sun's energy for servicing a building's load are solar thermal systems. Solar thermal utilizes the heat generated from the sun to directly heat water. Florida has very little heating load and rarely uses hydronic systems typically found in colder climates such as boilers. However solar thermal can still be leveraged successfully to provide domestic hot water and heat pools.

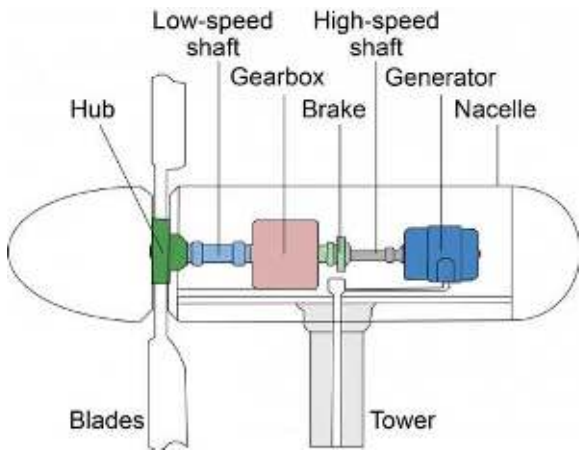


Boiler represents primary heating system within your building

Source: firstenergysystems.com

Wind Energy Systems

As either an alternative or supplement to solar PV systems, wind-powered renewable energy can be an effective measure to trim load from a facility or mitigate the need for grid connections in remote applications. These systems provide direct-current electricity by harnessing the wind to drive a turbine and as with PV can either be stored in a battery storage system or converted to alternating-current for use. Wind systems are more complex than PV due to their mechanical nature thus requiring more maintenance and similarly require careful planning in siting the system due to variability of wind patterns and safety concerns from potential toppling. It should be noted that wind energy potential in Florida is substantially less than other states and, generally, solar energy is a more feasible renewable energy resource.



Source: plantarchives.org

To leverage wind system energy doesn't necessarily require large capital investment as these systems have the potential to scale down to very small sizes and are frequently paired with solar PV to provide redundancy. Safety has been engineered into their inherent design so that during exceptionally high-wind conditions the system will lock to prevent burn-out of its components. If pursuing a wind system, there are two designs that can be utilized:

Horizontal-Axis Wind Turbine (HAWT)

Probably the most familiar model, these are generally the most efficient and hence widely used due to their ability to better capture wind current. Their primary flaw is the need for larger spaces when siting if scaling up, however small-scale systems do exist for more strategic use:

Large-Scale

Integrated w/ Building

Small-Scale

Integrated w/ PV

Vertical-Axis Wind Turbine (VAWT)

A more recent alternative is the vertical design that come in a variety of specifications and have the advantage of easier siting due to their slimmer footprint. This comes at a cost however both financially due to their more complex design as well as lesser efficiency in capturing wind current.

A more thorough analysis should be pursued if a VAWT is desired to ensure it generates enough electricity to provide meaningful return on the investment:

Large-Scale

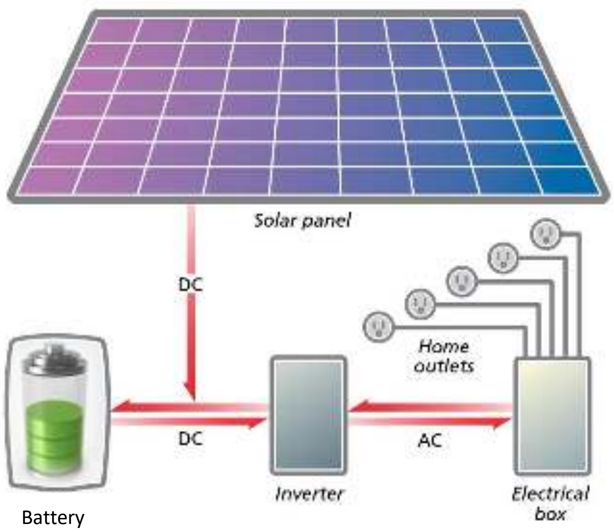
Integrated w/ Building

Small-Scale

Integrated w/ PV

Energy Storage Systems

In order to provide resiliency and grid-relief during peak demand events, more renewable energy systems are being paired with a local battery storage. These storage systems are not necessary if the renewable energy system to generate will not generate excess capacity to be stored and used at later times (night, low wind speed) and these systems can increase the cost of the project substantially. It should also be noted that inclusion of battery storage in a project may also require more effort to comply with local building codes due to the potential for thermal runaway of an improperly designed battery system.



With these challenges in mind, decision makers should still examine if a battery storage component to a renewable energy project makes financial and logistical sense. For high-impact buildings such as police, fire, and locations used for emergency shelters, having such redundancy readily available can make life-saving differences.

Analytics

Monitoring buildings' energy performance in real time is now an achievable solution to address variances in systems from their desired specifications and may tease out additional savings via new insights as well as data for future decisions in capital expenditures. The Sustainability

Division explored utilizing a 3rd-party provider to develop performance tracking software, however the contract was cancelled due to unmet expectations. Now that an internally developed 'Energy Dashboard' tool has been built that brought deeper understanding of where the data needs improvement, a renewed effort should be explored to see what options are available.

EEM Type	Strategy	Problem	Est. Cost	Est. kWh Savings	Est. Cost Savings	ROI (years)
Performance Tracking	Energy Data Software	Manual data entry to track, analyze, and report on electricity consumption and cost can be time-intensive and subject to user error/oversight.	$23,500*	86,804*	$7,179	3.27
Performance Tracking	Demand Charge Analysis	Many accounts have significant demand charges with potential for peak load shaving	Staff Time	TBD	TBD	0.00

**Assumption of 0.05% total energy savings per facility analyzed for this measure*

Energy Management Software

Software designed to track, analyze and report on energy use data can dramatically improve the ability of staff to manage building energy use, prioritize buildings for retrofits, and generally empower city staff to make stronger, more data-driven decisions about the state of the City's energy consumption and energy conservation measure deployment. It can also enable staff to better identify and flag anomalies, overcharges and discrepancies in billing. While the software itself doesn't save energy, converting from manual data entry, analysis, and reporting significantly reduces staff time dedicated to simple data entry tasks and ensures that more time is spent on the more valuable aspects of energy planning, more complex analysis, and strategy.

Demand Charge Analysis

When discussing savings, it is important to distinguish the different rates that an electric utility customer is charged for. Most customers pay for the energy they use (measured in kilowatt-hours, abbreviated kWh) however larger users of electricity are also charged for demand (measured in kilowatts, abbreviated kW). The electric utility uses demand meters that measure electricity flow to a facility and record the highest average 15- or 30-minute flow during the billing period (depending on the rate applicable to that account).

Figure 7: A typical consumption and demand pattern over a 24hr period (source: solarpowerrocks.com)

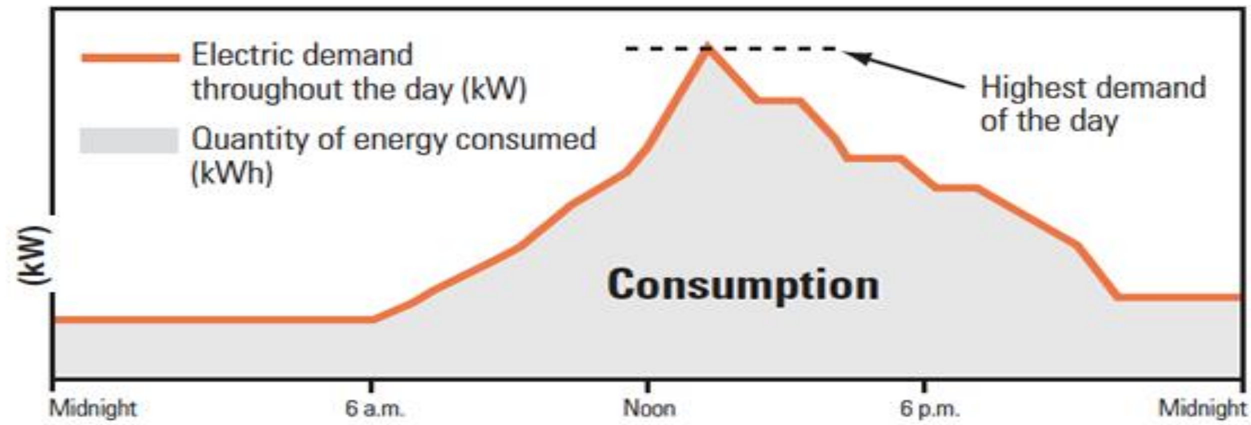
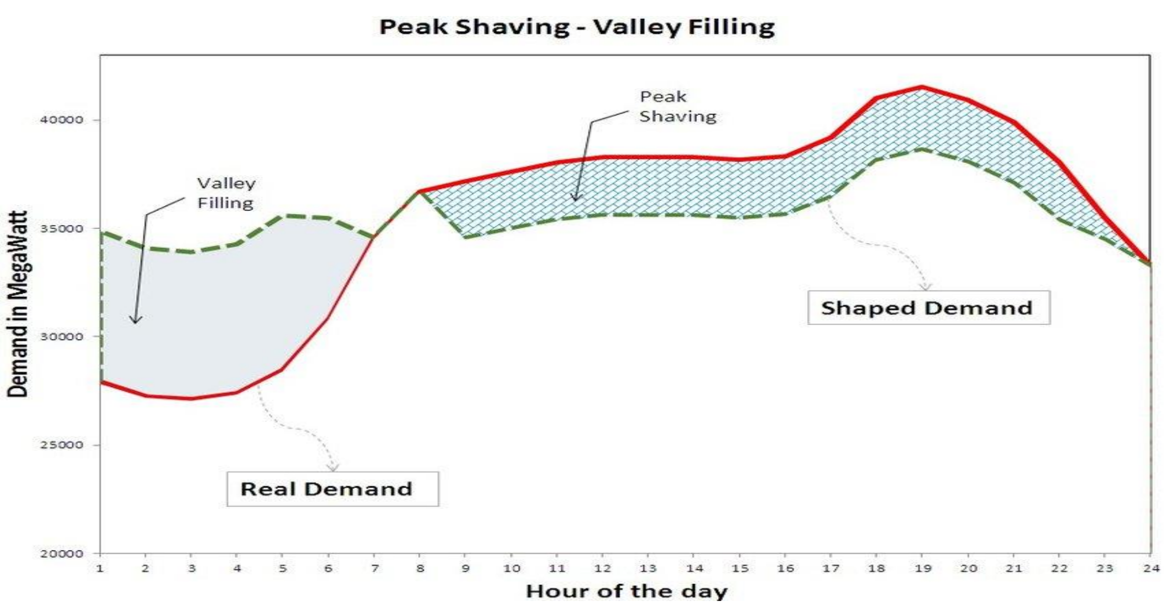


Figure 8: Demand analysis for "peak load shaving" over a 24hr period (source: researchgate.net)



Identifying why a facility is experiencing high demand charges is an important step in ultimately reducing these (sometimes) avoidable costs. Strategies to reduce demand charges include leveling out the energy load to reduce spikes in energy usage, reducing overall energy usage, shifting load to different times of day if on a time of use rate, and retrofitting equipment that uses a lot of energy, such as HVAC systems.

6. Conclusion

The City of Fort Lauderdale is poised to reap significant savings with energy efficiency investment throughout its diverse portfolio of building assets. More importantly will be to ensure these investments continue to provide a return by instituting a comprehensive training curriculum, for those who maintain and operate the buildings to the senior management tasked with developing and enforcing policy that will play a part in how tenants use their workspaces. This multi-prong approach can only be achieved with a dedicated funding stream and a focus on achieving established goals. The City should study how other municipalities both large and small were able to navigate this challenge to pick the best approach that works for its local conditions.

Once a robust energy efficiency strategy is implemented, the City can then look towards leveraging these savings into installing renewable energy systems which would further reduce greenhouse gas emissions and increase resiliency. This will likely require significantly more capital to scale up to an appreciable impact. However, through its partnerships with other cities across the State can broader discussions and alliances coalesce to change policies to permit better participation from the private sector. From here the City can gain access to alternative strategies to renewable energy sourcing that other cities across the country currently in use such as the popular Community Distributed Generation (CDG) model.

Through coordination, collaboration and innovation can the City make a measurable impact in the fight against climate change and strive for a more environmentally sustainable and resilient future.

7. Resources

Thermostat Replacement

- Programmable Thermostat Calculator. U.S. Environmental Protection Agency. Date unknown. https://www.energystar.gov/sites/default/files/asset/document/ProgrammableThermostat_Calculator.xls
- *Remote Thermostats Offer Benefits to Buildings without Building Automation Systems.* Smart Building Center, Northwest Energy Efficiency Council. 2015. *https://www.smartbuildingscenter.org/sbcwp/wp-content/uploads/2015/09/SBC_Whitepaper_Remote_Thermostats_lowres.pdf*

Pneumatic Thermostat Replacement

- *Non-Invasive Pneumatic to DDC Retrofit.* Energy Exchange, U.S. Department of Energy Federal Energy Management Program presentation. Harry Sim, Cypress Envirosystems. August 2017. http://www.2017energyexchange.com/wp-content/uploads/T2S6_Sim.pdf
- *Converting an Old building into an Intelligent Building*. AABC Commissioning Group presentation. Leo O'Loughlin, Jones Lang LaSalle and Harry Sim, Cypress Envirosystems. April 2015. http://commissioning.org/downloads/2015/Sim-O'Loughlin.pdf
- *City of Gillette City Hall Case Study.* Better Buildings, U.S. Department of Energy. Date unknown. https://betterbuildingssolutioncenter.energy.gov/showcase-projects/city-gillette-city-hall

HVAC Temperature Set Point Policy

- *Top tips to make energy savings simple.* Florida Power and Light. Date unknown. https://www.fpl.com/save/pdf/top-10-tips.pdf
- *Energy Efficiency Facts: Cooling.* Energy Efficiency Arkansas. Date unknown. http://energyefficiencyarkansas.org/images/cooling.pdf
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