Comprehensive Energy Audit
ASHRAE Level 2 Report

New York Power Authority

in cooperation with

City of Buffalo

ES-ESN-0593

NYPA's Energy Efficiency Program

for

City of Buffalo | City Hall

City Hall
65 Niagara Square
Buffalo, NY 14202

TABLE OF CONTENTS

TITLE **SECTION**

Section 1

EXECUTIVE SUMMARY

The City of Buffalo is positioning itself to be a leader in energy efficiency. As part of Governor Cuomo's Five Cities Energy Plan, the City of Buffalo has committed to reducing its consumption of energy compared to 2010 baseline period. However, like most cities the availability of capital is scarce and the City of Buffalo would like to maximize the amount of construction that can be done by cost effectively implementing energy efficiency improvements. The City of Buffalo choose to participate in the New York Power Authority's (NYPA) Energy Services Program (ESP) which provides assistance with the development and implementation of energy efficiency improvements. As such, NYPA and the City of Buffalo have chosen Wendel to determine the most appropriate and feasible energy efficiency measures to reduce energy and operating costs.

This focus of this study is on City Hall, which is already on its way to achieve the goal of a 20% energy reduction by 2020. The most recent 12 months of utility data shows a reduction of 15.6% in energy relative to the 2010-2011 baseline period.

	Annual Electric kWh/yr	*Annual Gas mmBtu/yr*	*Combined mmBtu/yr*
most recent 12 months	3,874,839	28,181	41,401.
2010-2011 Baseline	4,443,233	33,919	49,079.

During the course of the audit process, meetings and site visits were conducted to develop a proposed scope of work that could be implemented to decrease energy consumption while improving the general condition of the facility. Details of the analysis for each measure can be found in Section 4 of this report. Based on the energy savings detailed in the study, as well as the capital improvement needs of City of Buffalo, the following measures are recommended to be implemented as part of this NYPA ESP project:

ECM #	*Measure Description*
1B	Lighting (Option B) Retrofit
2	Radiator Controls & Trap Replacements
3	Window AC Units
5	Motor Replacement
7	Computer Power Management
10	Weatherization

The recommended improvements, as outlined below, will close this gap and are projected to result in an overall reduction of 31% over the 2010/2011 Baseline. The following tables summarize the recommended project economics and results of the study. Table 1-1 "Total Project Summary" details the estimated overall project economics for implementing the recommended measures under the NYPA Energy Services Program. The overall total project costs in this table include estimates of all indirect costs and fees. Table 1-2 “ECM Summary” details the direct construction costs, cost and energy savings, and simple payback periods for each measure studied.

Total Project Summary
New York Power Authority - Energy Efficiency Program
City of Buffalo | City Hall

ES-ESN-0593 December 15, 2016

Project Cost: ASHRAE Level 2 Study

	Material	Labor
Construction Costs:	$689,712.88	$692,875.40
Asbestos Abatement:	$0.00	$21,377.64
Payment and Performance Bonds:	$0.00	$21,059.49
Special Inspections:	$0.00	$0.00
Permits:	$0.00	$0.00
Totals:	**$689,712.88**	**$735,312.53**

Total Material, Labor, & Asbestos:	$1,425,025.41	
Contingency: 10%	$142,502.54	
Subtotal:	$1,567,527.95	
Abatement Design & Monitoring:	$3,206.65	
Hazardous Waste Disposal Cost:	$0.00	
Environmental Subtotal:	$3,206.65	
Material Handling Cost:	$0.00	
Audit, Design, & Construction Mgt:	$203,778.63	(See Note # 1)
NYPA Project Mgt. & Administrative:	$195,940.99	(See Note # 2)
Project Management Subtotal:	$399,719.63	
Other (SPECIFY HERE):	$0.00	(See Note # 5)
Project Subtotal:	**$1,970,454.23**	
Interest During Construction (IDC):	$92,704.54	(See Note # 3)
Total Project Cost:	**$2,063,158.77**	

Estimated Energy Savings

Estimated Electrical Savings:		Estimated Fuel Savings:			MMBtu Savings:	Cost Savings:
kWh Savings:	747,917	Natural Gas:	47,373	ccf	4,879.4	$21,964.86
kWh Cost Savings:	$44,146.06	Oil Savings:	0	gal	0.0	$0.00
Monthly kW Savings:	142.2	Steam (100 psi):	0	Lbs	0.0	$0.00
kW Cost Savings:	$17,120.94	Water:	0	Kgal	0.0	$0.00
Total Electrical Savings:	$61,266.99				4,879.4	$21,964.86
Total Energy Savings:	$83,231.86	Maint. Savings:	$3,346.42		Est. Total Savings:	**$86,578.27**

Simple Payback

Total Project Cost With IDC:	$2,063,158.77
Estimated Rebates & Incentives:	$0.00
Net Project Cost:	$2,063,158.77
Total Amount Saved:	$86,578.27
Simple Payback:	23.83

Project Financing

TOTAL AMOUNT FINANCED:	$2,063,158.77	(Rebates & Incentives Not Included)
Interest Rate:	4.00%	(See Note # 4)
Years Financed:	10.0	
Number of Payments:	120	
Annual Debt Service to NYPA:	**$250,661.75**	
Monthly Debt Service to NYPA:	**$20,888.48**	
Total Project Cost after Financing:	**$2,506,617.54**	
Total Annual Savings:	$86,578.27	
Payback With Financing:	28.95	
Annual Cash Flow:	**($164,083.48)**	

Notes:
1. Audit, Design, & Construction Mgt represents a cost of 12.0% of the direct Construction Costs and Asbestos Abatement and are applied to contingency to provide budget estimates. Final costs will exclude unused contingency and will be calculated at end of project based on final material and labor costs and applicable abatement costs.
2. NYPA Project Mgt. & Administrative represents a fee of 12.5% of the Construction Costs, Asbestos Abatement, and associated contingencies.
3. Interest During Construction (IDC) is estimated based on 4.00% interest rate. See Appendix 1.

4. The interest rate is estimated at 4.00%, a long-term conservative estimate. The 2016 Tax Exempt Interest Rate is 0.60%. The variable interest rate is adjusted on Jan 1 annually.
5. Other defined on an as needed basis

Table 1-2

City of Buffalo | City Hall

Energy Conservation Measure Summary

12/15/2016

ASHRAE L2 STUDY

(Y)es / (N)o	ECM #	Measure Description	Total Measure Cost[1]	Annual Electric Savings (kWh)	Annual Demand Savings (kW)	Annual Water Savings (kGal)	Annual Fuel Savings (mmBtu)	Annual O&M Cost Savings	Annual Electrical Cost Savings	Annual Fuel Cost Savings	Total Annual Savings	Simple Payback [2]
O	1A	Lighting (Option A) Relamp	$458,163	369,356	1,532.9	0	0	$3,317	$37,177	$0	$40,493	11.3
Y	1B	Lighting (Option B) Retrofit	$661,895	402,035	1,679.4	0	0	$3,346	$40,575	$0	$43,921	15.1
O	1C	Lighting (Option C) Refixture	$1,391,746	307,134	1,274.3	0	0	-$8,598	$30,910	$0	$22,311	62.4
O	1D	Lighting (Option D) Prefered Project	$915,069	392,451	1,628.5	0	0	-$655	$39,499	$0	$38,844	23.6
Y	2	Radiator Controls & Trap Replacements	$1,273,181	90,000	0.0	0	4,872	$0	$5,312	$21,933	$27,245	46.7
Y	3	Window AC Units	$57,891	71,336	0.0	0	0	$0	$4,211	$0	$4,211	13.7
N	4	AC Unit Replacements	$724,816	56,370	0.0	0	0	$0	$3,327	$0	$3,327	217.8
Y	5	Motor Replacement	$22,311	9,953	27.3	0	0	$0	$861	$0	$861	25.9
N	6	Exhaust Fan Controls & RCX	$125,094	7,552	10.7	0	0	$0	$553	$0	$553	226.2
Y	7	Computer Power Management	$47,467	174,250	0.0	0	0	$0	$10,285	$0	$10,285	4.6
N	8	Transformer Replacement	$241,629	64,524	0.0	0	0	$0	$3,809	$0	$3,809	63.4
N	9	Refrigeration Controls	$7,894	3,978	0.0	0	0	$0	$235	$0	$235	33.6
Y	10	Weatherization	$414	344	0.3	0	7	$0	$23	$32	$56	7.4
N	11A	Window Film	$1,169,339	107,504	0.0	0	-1,363	$0	$6,345	-$6,136	$209	5586.9
O	11B	Window Treatments	$1,248,546	148,131	0.0	0	0	$0	$8,743	$0	$8,743	142.8
		TOTALS - Recommended Measures	$2,063,159	747,917	1,707.0	0	4,879	$3,346	$61,267	$21,965	$86,578	23.8
		TOTALS - All Measures (w/ Options)	$4,331,930	987,845	1,717.7	0	3,516	$3,346	$75,536	$15,829	$94,711	45.7

NOTES:

1. TOTAL MEASURE COST includes direct construction costs (subcontractor material and labor), IC and NYPA Fees, Disposal for Hazardous Material, Bonding, Asbestos Design & Air Monitoring and accounts for the Intrest During Construction
2. SIMPLE PAYBACK periods do not include incentives.

Section 2

FACILITY DESCRIPTION

The Buffalo City Hall is located at 65 Niagara Square and was built in 1931. It is a 28-story building, 26 of which offer usable office space. The total floor area is 626,010 square feet, and the footprint of the site on Niagara Square is 71,700 square feet. There are 1,520 windows from the first to the 25th floor. There are eight elevators to the 13th floor, four to the 25th floor and one freight elevator.

The building is occupied for approximately 10 hours per day (7am to 5pm), five days per week and open to the public from 7:30am to 4:30pm daily. Times may vary slightly between the different departments. The building is unoccupied during the evening and weekend hours. There are between 700 and 800 people assigned to work in the building daily with a peak occupancy of 1,000 people when public visitors are accounted for.

The floors listed below are occupied by the followings departments and services:

Basement: Bldg. Serv., Dept. of Ed. Mail Rm, Cafeteria, Print Shops, Senior Services

1st: Assess. & Taxation, Parking Meter Enforcement, Parking Violations, Treasury

2nd: Mayor's Office, Adjudication, Admin. & Finance

3rd: Bldg. Code Review, Econ. Dev., Permits & Applications

4th: Board of Ed., Attendance Services

5th: Public Works Department

6th: Building Div., Telecommunications, Wellness programs

7th: Board of Education

8th: Board of Education

9th: City Planning Board, Environmental, Preservation Board, Strategic Planning

10th: Buffalo Sewer Auth., Civil Service, Comp. & Benefits, H.R., Labor Relations

11th: Law Department

12th: Audit & Control, Comptroller, MIS

13th: Birth Cert., City Clerk, Common Council, Doc. & Marriage Certificates, Records

14th: Counsel Staff

15th: Council Staff

17th: Community Services, Contract Compliance

19th: Division of Purchase

20th: Division of Inventory & Stores

21st: PAL (Police Athletic League)

23rd: Youth Bureau

24th: Block Club

25th: Inside Observation with Walkup to Outside Observation

HEATING

The building is being heated by approximately 2,073 cast iron, steam radiators with manual control valves. The building radiation system is being supplied with 4 to 6 psig steam from the District Steam System. The District Steam System is served by boilers located at the Buffalo Fire Headquarters. The building engineer stated that the heating set point is initially set at 72˚F, but varies throughout the building due to individual office/personnel comfort levels. The District Steam System is shutoff once the outdoor air temperature reaches 60°F through the boiler management controls. Areas within city hall that have a large occupancy density (council chambers) or chance for infiltration (entrances) are served by a single pass fresh air system that is heated by steam coils. These systems supply fresh air by separate supply/exhaust air fans. The supply fans are scheduled through a building automation system while the exhaust is manually operated.

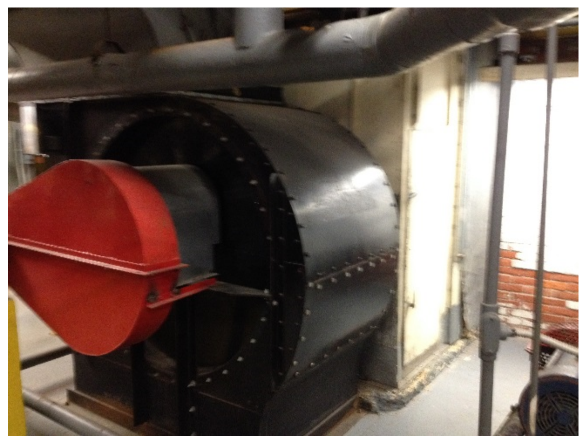
COOLING

Buffalo City Hall was designed and built with a non-powered, air-conditioning system, taking advantage of strong prevailing winds from Lake Erie. Large vents were placed on the west side of the building to catch wind, which would then travel down ducts to beneath the basement, to be cooled by the ground. This cooled air was then vented throughout the building. Through renovation projects many of these systems have been blocked off and transoms which would distribute air through the building have been blocked, disconnected or removed. Mechanical cooling was installed to condition the building. Currently there are approximately thirty, 2.5 to 15 ton, stand-alone/floor, refrigerated (R410A), air conditioning units used for supplemental cooling. These units are water cooled and reject heat to a single pass water system. This type of system does not require exterior mounted heat rejection, but is very water intensive. Three of these are used to cool the computer server room (which is unheated) on the twelfth floor. There are also approximately 300 electric plug-in, window-mounted, air-conditioning units which have been installed over the years to provide additional cooling to selective spaces.

DOMESTIC HOT WATER

Domestic hot water is supplied to the building and to the Cafeteria by two A.O. Smith domestic hot water heaters that are 80% efficient, consume 365 kBtu/hr, and have a recovery rating of 353.93 gallons per hour. These systems are on their own natural gas service and are separate from the central utility plant.

VENTILATION



There are 21 motor-driven ventilation fans circulating air to the building. These fans have been previously retrofitted with energy-efficient motors. They run continually from 6 AM until 6 PM. Six of the fans are equipped with heating coils that operate when the outside air temperature is under 40˚F and serve the Cafeteria, Print Shop Sub-Basement, Recycling Area, Treasury and Counsel Chambers. It was reported that the outside air, intake dampers would freeze up during the winter and have been disconnected. Plywood access doors were added in the air intake and operated manually to control air flow to the fans. According to the building engineer, each of these ventilation fans are capable of providing approximately 2,000 CFM. Bathrooms are equipped with smaller exhaust fans throughout the building and rely on undercut and louvered doors to provide makeup air.

BUILDING MANAGEMENT SYSTEM

The Building Management System is an Andover platform and is serviced by U&S Services. The system is limited to controls on the air handling ventilation units only. ECMs within this report such as radiator controls & exhaust fan controls investigate expanding this system.

BUILDING ENVELOPE

Buffalo City Hall is a 28-story, steel-framed, Art Deco building clad in sandstone and limestone with a granite water table and extensive terra cotta ornament. There are approximately 1,520 single-pane, operable windows from the first to the twenty-fifth floor. The windows were replaced in the 1970's but the glazing showed signs of deterioration and air leakage, especially on the south and west side of the building.

LIGHTING

The existing lighting consists primarily of three styles of luminaires as described below:

1. Recessed and surface mounted 2 foot x 4 foot fluorescent troffers luminaires with T8, 32 watt lamps, and prismatic lenses.
2. Surface mounted 4 foot fluorescent wrap around lensed luminaires with T8, 32 watt lamps.
3. Pendant mounted 1 foot x 4 foot luminaires with T8, 32 watt fluorescent lamps.

   A majority of these luminaires are in good condition, however in some cases lenses are damaged or removed in their entirety.

In the lobby there are recessed down lights, column mounted uplights, and decorative pendant cylinders all of which are in good condition and have LED or CFL lamps. There were no occupancy sensors observed during the audit.

The Common Council Chamber on the 13th floor has 250 watt incandescent halogen recessed downlights, 500 watt incandescent PAR56 narrow spot projectors, and surface mounted decorative luminaires. Exit signs have been replaced with LED's. Hallways were equipped with timers that turn these lights on at 5:30am and off at 6:30pm. External illumination is provided from dusk to midnight by 369, 50W LED flood lights installed in 2015.

Section 3

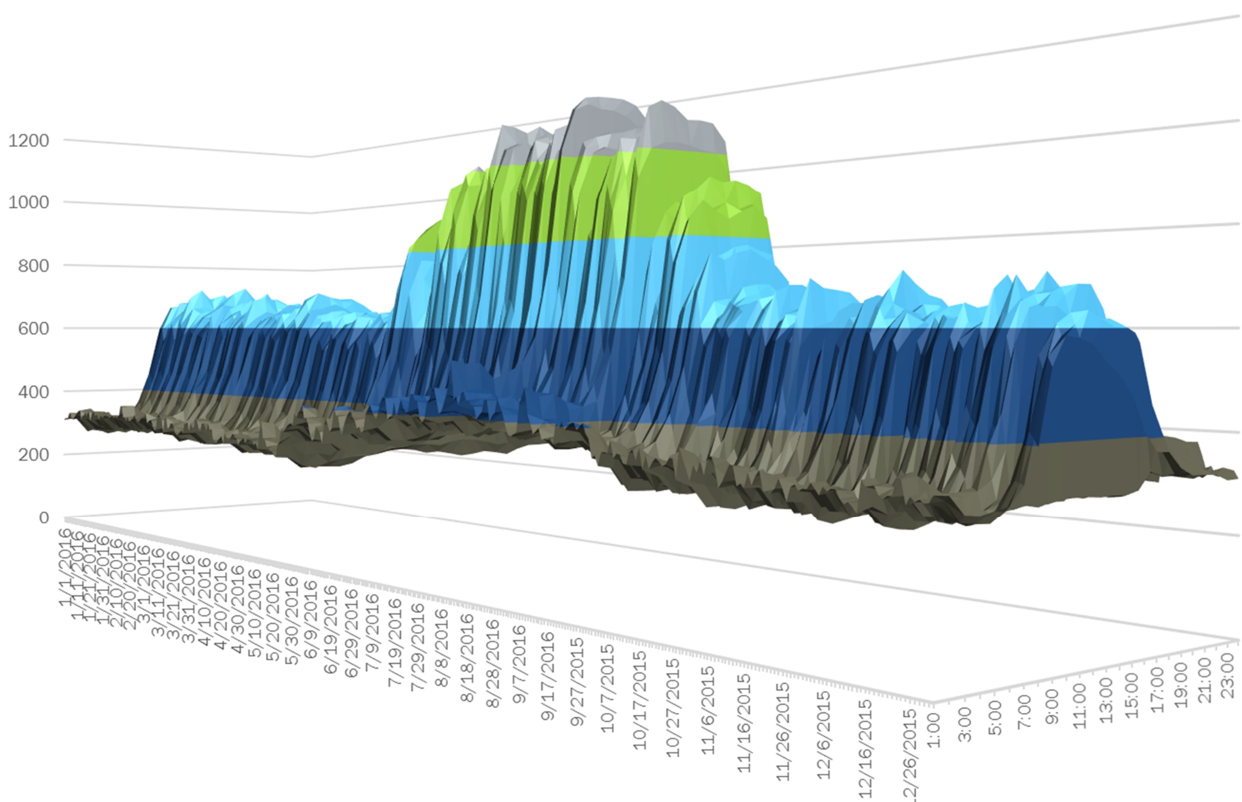
UTILITY ANALYSIS

UTILITIES

Energy costs for the City are managed by a third party consultant, Energy Advantage. Energy Advantage manages the City's accounts and negotiates with energy suppliers. For electricity, National Grid provides the distribution services, and ENGIE Energy Resources provides the commodity. For natural gas, National Fuel Gas provides the distribution services and National Fuel Resources provides the commodity.

Billing data was annualized from December 2013 to September 2016. The average rates over this period were used to establish typical billing rates for use in this report. The unit kWh cost for the above facilities was calculated by adding the annual supply and delivery costs minus the annual demand costs (including delivery and transition charges) from the bills provided by the Owner, and dividing this total by the annual kWh consumption. Interval electric meter data was provided for the most recent 1 year period. This period (October 2015 to September 2016) was used to establish the energy baseline.

Electric Utility Interval Data



City Hall is served by a steam system connected to an adjacent central utility plant. While the central utility plant has a primary natural gas meter, there is no steam meter between City Hall and the Plant. The City provided hourly data from boiler logs, however these logs did not include natural gas consumption or steam output from the boilers serving City Hall. These logs also had several anomalies in the boiler output to other buildings served by the central plant. Due to a combination of these factors we were unable to establish a baseline using this data.

The following are examples of these discrepancies:

Day of Month	Degree day (°F)	Family Court Daily Total Usage (KBTU)	County Office Daily Total Usage (KBTU)	Delaware Ave Daily Total Usage (KBTU)	City Court Building Daily Total Usage (KBTU)
1	4	26,231	23,556	3,268,894	22,618
2	22	29,099	3,909,417	3,095	33,796
3	35	50,545	6,240,812	5,539	53,630
4	37	47,794	0	7,724	37,478
5	38	39,750	122,556	6,905	6,996,762
6	36	35,584	101,171	6,084	7,000,587
7	15	25,815	77,516	3,848	3,704,049
8	27	38,324	112,145	5,439	182,075
9	31	21,265	114,009	5,356	49,664
10	36	26,133	110,158	5,737	50,145
11	28	31,520	80,373	4,772	27,897
12	21	32,666	95,235	4,066	31,762
13	30	26,876	92,846	3,536	36,816
14	26	18,894	84,741	2,651	30,059
15	22	13,327	31,690	1,625	16,010
16	13	4,730	4,294,966	574	10,654
17	8	4,547	4,294,966	0	6,824
18	9	2,390	4,017	152	3,778
19	11	8,112	1,352	32	4,399
20	13	11,516	0	295	8,660

To establish the steam baseline for City Hall, we used the boiler plant natural gas records, an assumed boiler plant efficiency of 80% multiplied by a proportion (area of City Hall / area of all Buildings served).

	Building Name	*Address*	*Area*
1	City Hall[1]	65 Niagara Square	99,977
2	City Court	50 Delaware Ave	232,929
3	Old City Court	42 Delaware Ave	626,010
4	District Heat Plant/Buffalo Fire HQ	18 Staats St	130,025
5	Edward A. Rath County Office Building	95 Franklin St	513,188
6	Erie County Family Court	47 Niagara St	71,120
	Total		1,673,249

City Hall also has a small natural gas service which primarily serves domestic water and other small misc. systems.

Natural gas unit costs were calculated by dividing the total annual natural gas costs by the total annual consumption in mmBtu. Natural gas usage is reported in therms. The thermal content of 1 therm is assumed to be 100,000 Btu throughout this report. Savings are reported in mmBtu. Therefore, 10 therms is equal to 1 mmBtu.

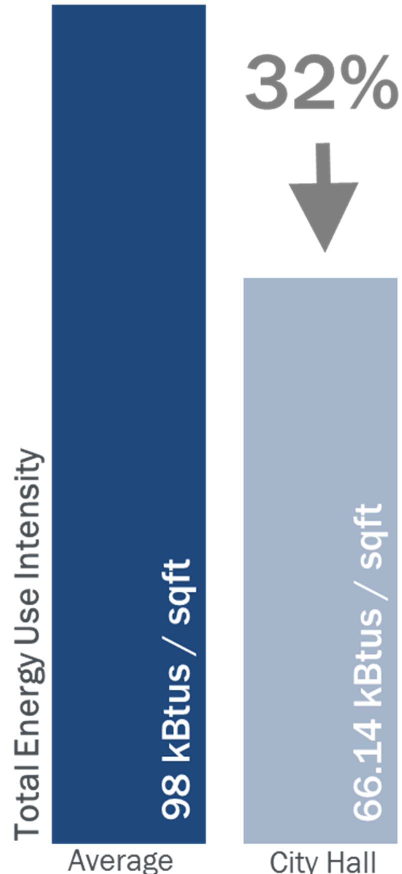
Monthly consumption details and graphs may be found at the end of this section. The table below summarizes the rates used for this study based on the utility data provided to Wendel.

City Hall	*Unit Cost ($)*	*Units*
Electric Usage	$0.06	/kWh
Electric Demand	$10.03	/kW
Natural Gas (Steam Plant)	$4.50	/mmBtu
Natural Gas (Domestic Water)	$6.81	/mmBtu

[1] Boiler plant submetering records were provided, however data anomalies were noted. As a result this data could not be used to establish a baseline. Wendel noted this to the City and NYPA during our check-in meeting on 11/17/16.

BENCHMARKING ANALYSIS

Energy benchmarking is the practice of comparing energy usage data for a select building against data from a national database of buildings in the same usage type and geographic region. Assessing the existing energy performance of your facilities provides multiple benefits. It allows for current energy use to be disaggregated to prioritize opportunities to save energy and utility costs and for the comparison of City Hall facilities to each other and to peers. It also provides the basis for understanding current energy usage and to set clear, attainable and measureable goals.



Source: EIA CEBEC 2012 survey for office in Mid Atlantic

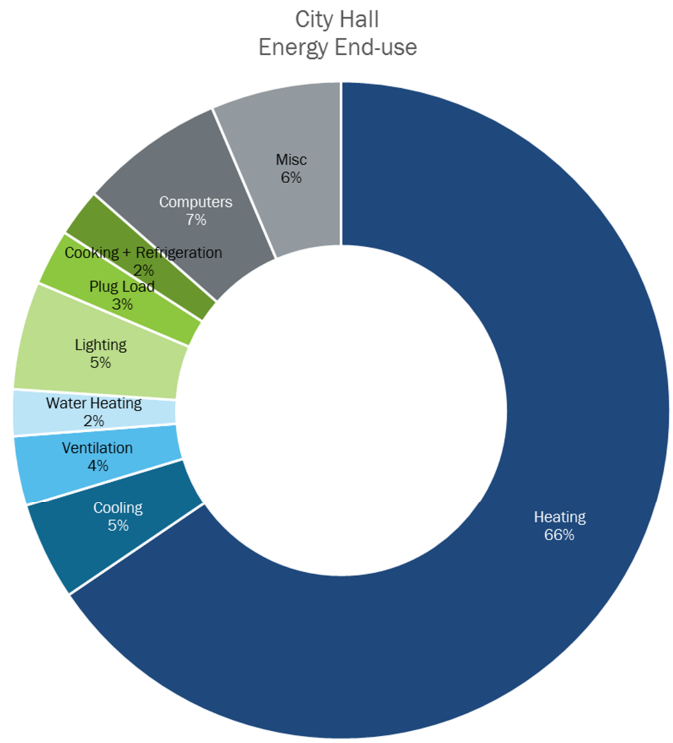
Typically a facility's energy usage data is compared to benchmarking data in the 2012 Commercial Building Energy Consumption Survey (CBECS) conducted by the U.S. Department of Energy for buildings across the country. The 2012 CBECS data is the most current data available to date. The CBECS commercial sector survey encompasses data available through the U.S. Energy Information Administration based on a specific U.S. region and division.

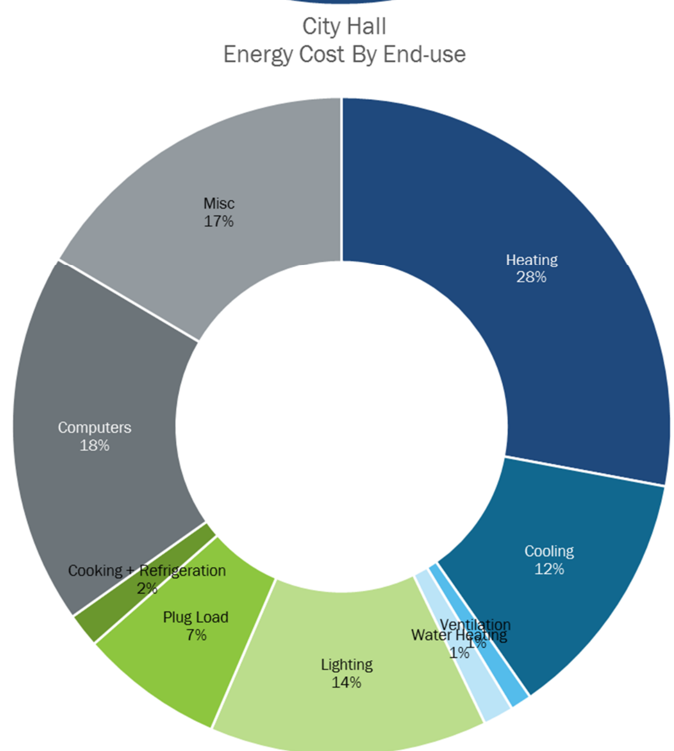
ENERGY USAGE BY END USE

This section describes the process by which electric and fossil fuel utilities were disaggregated to achieve energy consumption by end-use for this particular facility. Utilizing data collected in the field, energy usage was calculated for the various major categories of energy-consuming equipment.

Energy use was separated into lighting, heating, ventilation, cooling, fan and pump motors, domestic hot water, plug loads and miscellaneous energy use. Each category was disaggregated from the total energy usage through use of our standard energy calculations.

The charts to the right depict City's Hall's energy consumption areas by type and where energy costs are going (bottom). While the heating system makes up a significant portion of the building energy usage, it only comprises just over a quarter of the building's annual energy costs.





WEATHER NORMALIZATION

Some calculations in this report use 30 year weather data for Buffalo, NY to predict the energy savings likely to result in a given measure. The normal number of heating degree-days (HDD) for these areas were used to find the typical heating load of a given building for certain calculations.

Some calculations in this report required the use of BIN weather data. BIN weather data provides the average number of hours a location will observe temperatures in a certain range during a typical year. The temperatures are based on 30 year averages and grouped into temperature ranges of 5°F. For these calculations the weather information was used from the closest available location. Weather information was obtained from the National Weather Service website.

Section 4

ENERGY EFFICIENCY MEASURES & PROJECT ECONOMICS

This section provides an overview of the Energy Efficiency Measures for City of Buffalo City Hall. Each subsection is separated by Energy Efficiency Measure (EEM). In each of these section we provide:

1. Investigation – overview of the process used to identify and evaluate an EEM
2. Existing System Description – this details the existing system and its operation. The focus of this section is to outline the conditions that are present now that present an opportunity for savings.
3. Proposed System Description – this details the changes that will be made to reduce energy consumption and costs. In some cases a listing of options may be considered.
4. Recommendations – this section outlines Wendel's opinion regarding how the proposed solution will address the owner's return on investment requirements, capital improvement needs, differed maintenance costs, or other considerations.

An opinion of probable cost is presented with each opportunity. The costs shown in the document were carefully developed using, recent similar project prices / unit costs, vendor provided pricing, contractor pricing or RS Means.

EEM1 | INTERIOR LIGHTING IMPROVEMENTS

INVESTIGATION

Wendel visited Buffalo City Hall to investigate lighting systems and determine opportunities to save energy. A room-by-room survey of all interior lighting was performed to identify the type of lighting fixtures, lamps, and lighting controls used on each floor. Buffalo City Hall was renovated at different times, resulting in the building having varying lighting designs and fixture types in use for general lighting in office areas. Light loggers were launched and retrieved from a sample of spaces in the buildings. These devices monitored the run hours of the lighting system and determined occupancy patterns for the monitored spaces. Light loggers collected data in various room types over a 2-week period. They were utilized in select locations such as, offices, restrooms, lobby, and common areas.

Wendel was able to evaluate the current level of energy efficiency and identify upgrades. These upgrades will result in direct energy savings by decreasing the overall energy usage necessary to provide general lighting. Since some areas will receive new lighting fixtures, LED lamps and ballasts, maintenance savings will result from the decreased cost of the replacements. The proposed upgrades will follow industry standard guidelines to ensure that proper lighting levels are maintained for the various illuminated areas, while maximizing the energy efficiency of the lighting system. These lighting levels have been selected based on criteria established by the Illuminating Engineering Society (IES). During the course of the survey, light levels were recorded in a variety of areas throughout the building. It was found that the light levels in some office, hallway, and storage areas exceed the levels recommended by IES. This presents an opportunity for additional energy savings by reducing the number of lamps or “de-lamping” fixtures to achieve the appropriate levels for each functional space. This measure also examined the use of occupancy sensors in beneficial areas of the buildings to control the lighting. Cost estimates were developed using pricing from previous projects. Refer to the following calculations and cost estimates for details.

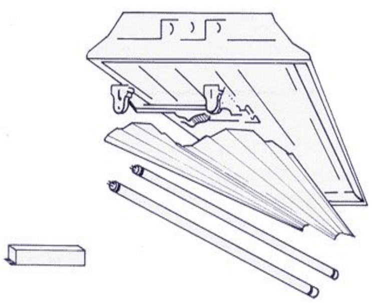
<u>Investigation of Luminaires</u>

The proposed lighting upgrade focuses on optimizing the current lighting system by re-lamping, retrofitting, or replacing the existing luminaire. Normally a re-lamp or retrofit is recommended in a situation where either:

a) removing the luminaire may cause disturbance of hazardous material
b) energy savings would not warrant the cost of the luminaire replacement

c) the luminaire is relatively new or in good condition and therefore replacing the entire luminaire does not make economic sense

The opportunity to re-lamp the existing luminaire occurs when the condition and power supply are suitable for a one-for-one replacement of the lamps. This straightforward approach to upgrading existing fluorescent technology to LED will yield significant energy savings while minimizing implementation costs.



Under a retrofit condition, the existing fixture body is left in place and the internal components are replaced with energy efficient LED tubes, external drivers, and new socket bars as needed. With the use of a reflector or lens kit, a retrofit can be further enhanced by accommodating the ability to de-lamp the existing fixture where the opportunity presents itself. Reflectors increase the efficiency of the fixture, greatly improving overall fixture photometric. With a retrofit, significant energy savings can be realized at a much lower cost than a complete fixture replacement. Although the costs will be greater than in the re-lamping option, the benefits to providing dedicated drivers with lamps include:

a) avoiding future maintenance costs when existing ballasts reach the end of their useful life
b) improved fixture efficacy measured in lumens/watt
c) maximize energy and maintenance savings and improve system reliability

The opportunity for luminaire replacement is highest when the existing technology is High Intensity Discharge (HID) and/or the fixture has high run hours such as corridors, exit signs, mechanical room fixtures, etc. New luminaires are inherently clean, and are designed to have excellent performance and rated life due to the nature of the current LED industry. New luminaires will only be considered for certain spaces such as the first floor treasury space, or in instances where the existing luminaires are damaged. The presence of asbestos materials will limit the deployment of new luminaires.

Investigation of Lamps & Ballasts

Improvements in lighting technology have resulted in more energy efficient lamp and ballast combinations. An emerging technology has been the introduction of LED (light emitting diode) linear lamps and drivers. The performance, cost and applicability varies by manufacturer. Philips Instafit, iBright, CREE, and Sylvania products were investigated for their potential energy savings and project costs.

LED lamps have a great life expectancy typically from 50,000 to 70,000 hours. The end of life for an LED is defined as the point when an LED reaches 70% of its initial light output. Conversely, LED lamps will typically produce 1,600 to 2,000 lumens, where as a T8 lamp will produce 2,800 lumens. However, these lamps are more directional than standard fluorescent tubes. As a result, a higher percentage of the lumens produced will reach the desired work surface.

Investigation of Sensors

Occupancy sensors were investigated to be integrated into the lighting design in the most beneficial areas. A space-by-space approach was taken to determine the potential savings and cost. Spaces with significant lighting loads and a tendency for lights being left on were targeted. Light logger data was utilized to determine the most cost-effective areas and the likely percent savings that would result from controlling the lighting load in those spaces.

Several types of low-voltage occupancy sensors may be utilized to reduce the run time of lighting fixtures. The type of sensor used would be based on the ability to incorporate the sensor into the luminaire without disturbing ceilings, or other surfaces that may contain asbestos. A few variations of the equipment are proposed to address the various design requirements encountered in different space types.

Smaller areas, such as offices and storage rooms, will have the standard wall-mounted light switch retrofitted with a wall switch sensor. A standard wall-switch sensor recesses into the existing lighting

control switch box, and is capable of controlling up to 600 watts of lighting load. A wide-view, wall-mounted or ceiling-mounted sensor would be installed in applications where furniture or walls may obstruct the field of view of a wall-switch sensor. Sensor design will include investigating the coverage pattern and appropriate technologies.
Sensor technology and mounting types will need to be field verified during design prior to construction. Variations may include wall-switch, wide-view, wall-mounted, ceiling-mounted sensors.

All of the sensors include passive infrared (PIR) technology that detects changes in motion as well as infrared energy given off by occupants as they move within the field-of-view. The sensors use a pyro-electric sensing element that is polarized positively and negatively and directed through a lens to produce collector beams. As a human body passes through the beam, it is detected. The signals are canceled if both beams change simultaneously (as from a constant source of infrared energy such as a baseboard heater or sunlight shining through a window). The sensor will distinguish between body motion and other heat-producing signals. A self-contained relay switches the connected lighting load once the timer allows. The timer is adjustable and is factory set for a minimum of 15 minutes.

In areas with a lack of line of site, dual-technology sensors would be proposed. Dual-technology sensors utilize both PIR and ultrasonic technology for maximum reliability and coverage with a minimum of false triggers. In addition to motion, micro-phonics (sound) is also detected. Both ultrasonic and PIR signals are required to switch on the lights and switch them off, while one or the other is required to keep the lights on.

Investigation of incentives

To maximize potential incentives as a result of implementing lighting improvements, where available, the proposed material include Energy Star labeled LED lamps and Design Lights Consortium tested and verified LED luminaires.

The City has had great success in the past on other projects implementing lighting programs offered by the utility (National Grid). The direct install program was for buildings that consumed under 100 KW of total load and offered an incentive that equated to a lower simple payback time period making lighting improvement projects more viable. Buffalo City Hall consumes on average 858 KW and therefore will not be eligible for these type of incentive programs.

EXISTING SYSTEM

The existing lighting consists primarily of three styles of luminaires:

1. Recessed and surface mounted 2 foot x 4 foot fluorescent troffers luminaires with T8, 32 watt lamps, and prismatic lenses.
2. Surface mounted 4 foot fluorescent wrap around lensed luminaires with T8, 32 watt lamps.
3. Pendant mounted 1 foot x 4 foot luminaires with T8, 32 watt fluorescent lamps.

A majority of these luminaires are in good condition, however in some cases lenses are damaged or removed in their entirety.

In the lobby there are recessed down lights, column mounted uplights, and decorative pendant cylinders all of which are in good condition have been fitted with LED or CFL lamps.

The Common Council Chamber on the 13th floor has 250 watt incandescent halogen recessed downlights, 500 watt incandescent PAR56 narrow spot projectors, and surface mounted decorative luminaires. Exit signs have been replaced with LED's.

External illumination is provided from dusk to midnight by 369, 50W LED flood lights installed in 2015.

All lighting is of various ages and efficiencies.

Switching is done manually, however, the corridors are on timers that turn these fixtures on at 5:30AM and off at 6:30PM. There were no occupancy sensors observed during the audit.

PROPOSED SYSTEM

Wendel evaluated three generic options for this report, with a final recommendation that combines a portion of each option.

<u>Option A</u>

The focus of this option includes:

- Retrofit existing T-8, 4-foot fluorescent luminaires with high efficiency LED lamp and maintain the existing ballast.
- Replace incandescent lamps in the Common Council Chamber with LED lamps.
- Retrofit existing decorative pendant luminaires in the first floor corridors with LED lamps.

This option produced the shortest simple payback due to the fact that we assumed re-use of the existing electronic ballasts. We don't recommend this approach as the ballast could present reduced performance and potential premature failures.

Option B

The focus of this option would be to perform the following upgrades:

- Retrofit existing T-8, 4-foot fluorescent luminaires with high efficiency LED lamps and provide a new electronic ballast.
- Replace incandescent lamps in the Common Council Chamber with LED lamps.
- Retrofit existing decorative pendant luminaires in the first floor corridors with LED lamps.

Option C

The focus of this option will be to perform the following upgrades:

- Retrofit existing 2x4 fluorescent fixtures with LED kits that have an integral occupancy sensor.
- Retrofit existing T-8, pendant mount 4-foot fluorescent luminaires with high efficiency LED lamps and provide a new electronic ballast.
- Provide new corridor luminaires.
- Provide new stairwell luminaires with integral occupancy sensor.
- Replace some lamps in the Common Council Chamber with LED lamps.
- Retrofit existing decorative pendant luminaires in the first floor corridors with LED lamps and new electronic ballast.

Option D

The focus of this option will be to perform the following upgrades:

- Provide new corridor luminaires in the basement level through the second floor.
- Provide new stairwell luminaires with integral occupancy sensor.
- Provide new surface mounted luminaires in the first floor treasury space.

- On the first and second floors retrofit existing 2x4 fluorescent fixtures with LED kits that have an integral occupancy sensor.
- On floors 3-28 retrofit existing T-8, 4-foot fluorescent luminaires with high efficiency LED lamps and provide a new electronic ballast.

RECOMMENDATIONS

In general, Wendel does not recommend the Option A approach. The reuse of existing ballasts can present issues with compatibility as well as premature failure of the new lighting assembly. By replacing the ballasts the life cycle of the new lights and ballasts will coincide.

We evaluated an option proceeding with a variation of Option B & C for design. The City could select which corridors could be considered for new luminaires. Retrofit LED kits with integral occupancy sensors could be provided in some (not all) office spaces, and then provide T8 LED lamps and ballasts in others. Where the pendant mount fluorescent luminaires exist provide the T8 LED lamps and ballast.

With this approach the City could provide energy savings, while also addressing some of the damaged luminaires, maintenance issues, and provide a more pleasing work environment.

Option D "Preferred Project" includes new corridor lighting in the basement level through the 2nd floor. New stairwell lighting with integral occupancy sensors will also be provided throughout the building on all floors. The luminaires will have a sensor on each end for motion from above or below that will reduce the light output to 30% in the absence of human traffic. The first floor treasury space will be fitted with new surface mounted LED luminaires. In the office spaces on floors 1 and 2 retrofit kits with integral occupancy sensors will be provided. On floors 3 through 28 all four foot luminaires (surface, recessed, or pendant mounted) shall be retrofitted with T-8 LED lamps and ballasts.

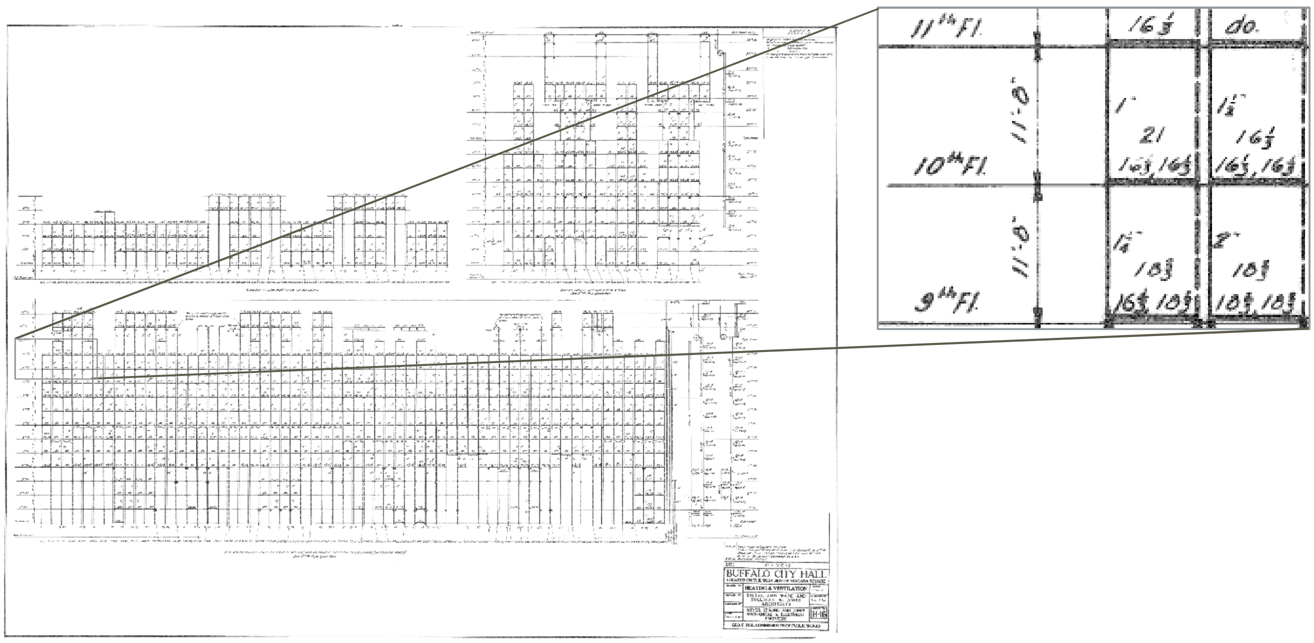
Multiple occupancy sensor solutions were considered for the building, both wired and wireless. The wired ceiling mounted approach was quickly dismissed due to the asbestos materials present in the building. Wireless options require gateways or antennas placed in the building with network cabling and Ethernet switches, again disqualifying deployment. Integral to the luminaire occupancy sensors proved to be the only available option. The retrofit kits specified in this report include sensors.

In order to support a comprehensive project that impacts both the lighting and heating systems, Wendel elected to recommend option B. However this is only a preliminary recommendation. If additional funds become available through incentives or grants, the City may want to implement options C or D which will provide energy savings while improve the appearance of the space.

EEM2 | Radiator Controls & Trap replacements

INVESTIGATION

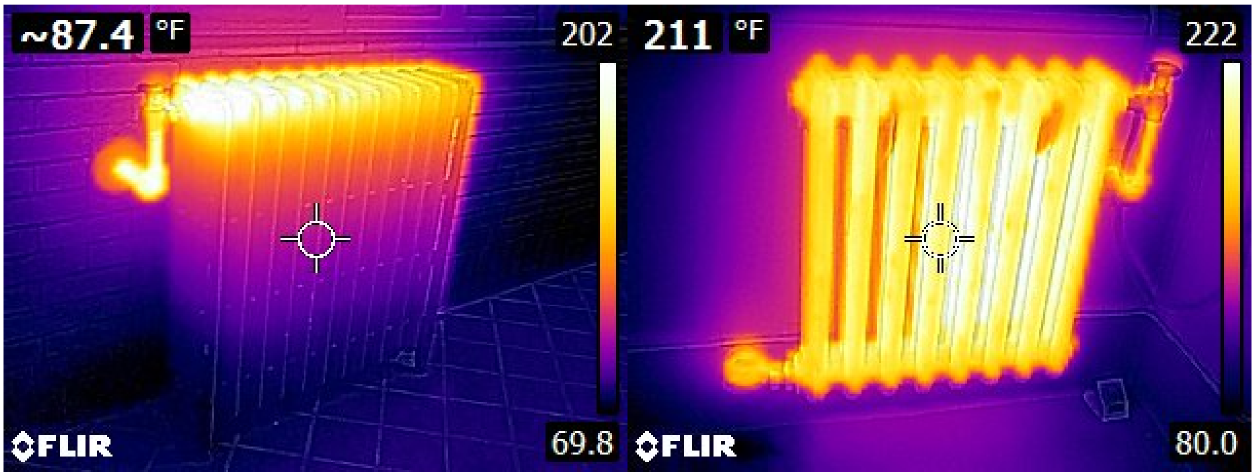
The primary source of heating in City Hall are the steam radiators. Wendel reviewed the building plans and interviewed facility personnel who are familiar with the building and these systems. Our team discovered that the radiators are piped vertically (think of a ladder) rather than horizontally by floor. This limits the opportunities for improvement since the system cannot be zoned or sub metered.



EXISTING

Steam from the central plant enters the building through the sub-basement. Steam radiators are located throughout the building in hallways, offices, conference rooms, etc. There are 2,073 radiators in City Hall that utilize hand valve controls. The facility staff indicated that many of the areas served by this system overheat during the heating season. As a result the occupants often open windows during the winter. In other areas the heating is not sufficient to meet the space load. As a result the occupants utilize space electric heaters to supplement the steam system. Analysis of the building's electrical profile implies that these heaters are left on during unoccupied periods. This problem persists during the shoulder periods as well.

It is likely that many of the existing controls valves have failed or are not accessible to the occupants. In areas where there is overheating, the method of failure is likely a blow through allowing uncontrolled steam flow into the unit. It is also understood that many of the steam radiator traps have also failed resulting in a higher condensate return temperature at the unit that would otherwise be anticipated if the trap was working properly. In areas where there is insufficient heating the radiator traps are likely clogged resulting in flooded radiators. When a radiator is flooded its capacity to reject heat into the room is reduced.



flooded radiator left; blown through radiator right

The condensate return is under a vacuum system. The system is connected to shell and tube heat exchanger that cools condensate to 140˚F before sending it back to the boilers. The cooling source is single pass water.

PROPOSED

To improve the operation of the steam system and reduce energy consumption the following steps can be taken.

1. Replacement of manual radiator valves with thermostatic valves.
2. Replacement of radiator steam traps
3. Targeted replacement of Float and Thermostatic (F&T) and Inverted bucket traps.

By addressing these differed maintenance items, issues such as flooded radiators and uncontrolled heating will be addressed. This will create a better controlled steam system. The resulting energy savings will be seen as follows:

1. Reduction in over heating resulting in open windows and uncomfortable environment
2. Reduction in cold zones resulting in the need for personal electric resistance heaters
3. Decommissioning of the vacuum condensate return system and the after cooler.

OPTION

The above improvement could be further enhanced by a battery operated programmable radiator thermostatic valve. These valves can be programmed with a time of day schedule allowing of night setback control. However these units require frequent maintenance (once per year) to change batteries.

RECOMMENDATION

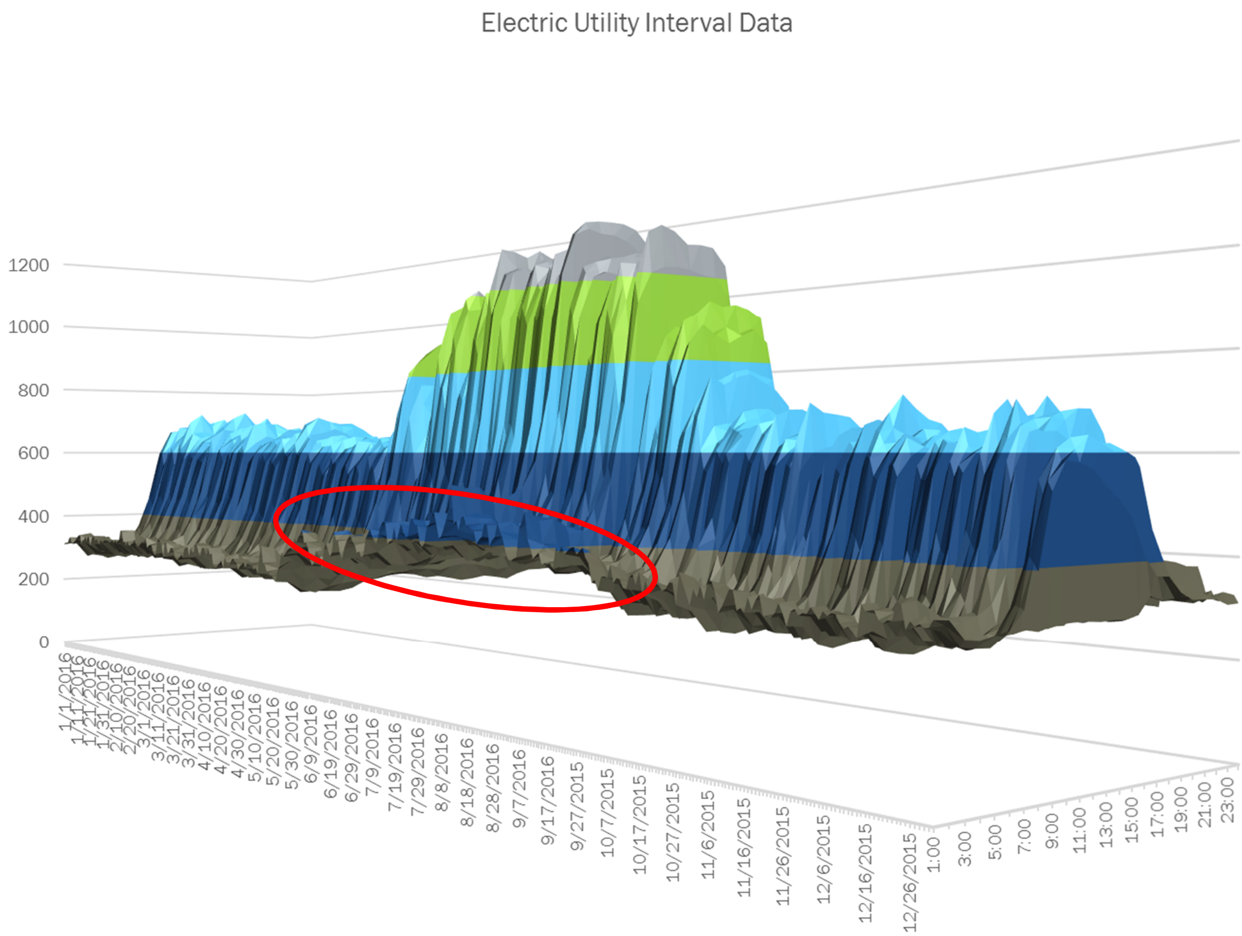
The proposed improve will have a positive impact on the building's operation and help address maintenance and comfort issues in addition to saving energy. Due to the number of radiators the relative overall cost is high resulting in a longer return on investment. The City's maintenance team has done a great job maintaining this system, however due to the size and age of the infrastructure this can be a real challenge. Another considerations for implementing these solutions would be to address differed maintenance items. This EEM would help the City's maintenance department get ahead of these issue and better manage the system.

Wendel is recommending this EEM since it will address differed maintenance items, save energy, and improve space control and comfort.

EEM3 | AC WINDOW UNIT CONTROLS

INVESTIGATION

Wendel reviewed the utility bills and noticed that the unoccupied load during the summer months is roughly 100kW larger than the winter months. Since this change is profile is weather dependent this implies that AC units are left on during unoccupied periods. Wendel reviewed the two major cooling systems within the building. There are the 23 AC units and 240 window AC units. We discovered that 21 of the 23 AC units have programmable thermostats. However the 240 window AC units do not have any sort of time of day controller. An opportunity for energy savings was identified to use plug-in programmable thermostats to help control the window AC units.



EXISTING

Offices in Buffalo City Hall are cooled utilizing commercial window AC units. These units range in cooling capacity from 1 to 3 tons with a weighted average of 2.5 tons. There are a combined 240 window AC units throughout the facility. The unit's controls which allow a desired space temperature to be set. However these controls cannot achieve a setback temperature. It is up to the occupants to turn them off in the evening.

PROPOSED

The City will see energy savings by implementing setback control of the window AC Units. This measure proposes to install plug controls that will include time-of-day programming to turn the unit OFF at night and over the weekends. Turning the units OFF at night would eliminate unnecessary cooling when the space is unoccupied which will save electrical energy.

The scope of work for the proposed measure consist of:

- Adding a control device that plugs into the existing electrical outlet. The control device would include an electrical outlet for the existing AC unit plug.

RECOMMENDATIONS

Window AC units are recommended to be retrofitted with plug in timers to reduce run hours when the office spaces are unoccupied. Direct energy savings will be achieved by reducing unoccupied electrical consumption during the summer.

EEM4 | AC UNIT REPLACEMENTS

INVESTIGATION

As part of Wendel's survey we reviewed the HVAC distribution systems. We noted that there are 23 "AC Units" that may be approaching the end of their useful life. HVAC equipment replacements can yield energy savings resulting from increased energy efficiency as well as right-sizing equipment to match existing building load requirements.

EXISTING

Select spaces are served by 29 water-source heat pumps that operate in cooling only. The heat pumps reject heat to a single pass water cooling system. The heat pumps are of various sizes and efficiencies. A majority of the heat pumps are on setback controls with two currently lacking any controls. Many of the existing heat pumps are past their effective useful life, warranting replacement.

PROPOSED

Existing heat pumps will be replaced in-kind with new water-source heat pumps that include digital scroll compressors and ECM motors. These newer units have a projected EER of 15 to 18 depending on the unit size. This is a 45% increase in efficiency compared the existing units. The two uncontrolled units will be provided controls to allow for night and weekend setbacks. Energy and operational savings will result from increased equipment efficiency, reduced run hours, and a decrease in maintenance expenses.

RECOMMENDATIONS

Wendel does not recommend including this EEM as part of the energy project. However, as equipment reaches the end of its useful life, equipment energy efficiency equipment replacements should be considered. Wendel also recommends placing the two uncontrolled units on programmable thermostats. The new equipment will also require less cooling due to the higher efficiency of the compressors. This will result in a reduction in water utility consumption. While no additional financial savings can be limited this my help to address an ongoing plumbing associated with low water pressure when these units are running.

EEM5 | MOTOR REPLACEMENTS

INVESTIGATION

Energy efficiency standards for motors have gradually increased as demand for high efficiency motors and the technology to achieve those efficiencies have developed. Motors in HVAC systems such as fan motors can often have high run hours and account for substantial electrical energy usage. Typically motors that are 5 horsepower and greater can be viable candidates to upgrade. Wendel identified the size, existing efficiency, and average annual run hours of fan motors throughout the facility. Recommended replacements are shown by "R" followed by the quantity to replace.

	Supply Fans	*Exhaust Fans*
2 HP Motor		R – 1
3 HP Motor		R – 1
5 HP Motor	R – 1	R – 2
7.5 HP Motor	R – 1	R – 2
10 HP Motor		R – 1
15 HP Motor	R – 1	

A list of specific motor energy savings are shown in Appendix B of this report.

EXISTING

Buffalo City Hall has a multitude of motors serving exhaust and supply air fans. Motors were found to be of various sizes and efficiencies. There are ten standard efficiency exhaust fan motors and four standard efficiency supply fan motors. All motors are on constant speed drives and have timed controls.

PROPOSED

Standard efficiency motors will be replaced in-kind with NEMA premium efficiency motors. The new motors will match the existing motors, horsepower, voltage, and frame size. The existing starters will be replaced with variable speed drives to reduce motor speeds when there exists less demand on the fan systems.

RECOMMENDATIONS

Wendel recommends replacement of standard efficiency motors with NEMA efficiency motors where economical. New induction rated (class F & H) motors are required for applications with variables speed drives.

EEM6 | EXHAUST FAN CONTROLS & RCX

INVESTIGATION

Ventilation is a primary energy consumer for all buildings, it also is a driver in indoor air quality for facilities. The ventilation for City Hall is provided by active and passive systems. The active systems are comprised of several air handling units to provide fresh tempered air and multiple exhaust fans to relieve the served areas. The passive ventilation is provided by the operable windows.

EXISTING

The air handling units and exhaust fans are separately controlled currently. The air handling units are controlled by the building management system which uses a schedule based time of day control strategy. The exhaust fans are not currently tied into the building management system, they are individually controlled by time clocks. Facility personnel confirmed as a time based control the existing system functions fairly well. The total building balance was identified as a concern, an example was given of the building pressurization being negative and drawing exhaust fumes into the building from street level. Also some instances were noted where equipment needed to be manually turned on or off to provide acceptable conditioning to certain areas.

PROPOSED

There are several savings opportunities involved with the ventilation equipment and control. For the purposes of this evaluation it is assumed that all the equipment motors have been upgraded to premium efficiency as shown in EEM 5.

First opportunity changing all of the motor starting equipment from older across the line starters to soft starts or variable frequency drives (VFDs). This change limits the starting current of the motors and reduces the overall electrical demand billed at the meter. This evaluation includes VFDs as the difference in price between soft starts and VFDs being negligible and there are additional benefits of the VFD equipment. The second opportunity is to tie in the VFD equipment into the existing building management system. This by itself would provide limited energy savings however would allow remote schedule modifications and shut downs. Finally Retro-commissioning would be used to tie all of the proposed and existing equipment together. Retro-commissioning would include full functional testing of the equipment as well as balancing of the intake and exhaust air to prevent the need to turn of specific equipment to try to adjust the conditioned area as well as hopefully eliminating the condition where street level contaminants are drawn into the building. Savings for retro-commissioning vary greatly from facility to facility and are difficult to quantify until after it has been implemented, due to this a conservative estimate of 3% of the fan energy has been assumed per NYPA standards.

RECOMMENDATIONS

Savings do not justify full scale implementation of this measure. It is recommended that as equipment fails that it be replaced with equipment selected with energy efficiency and increased functionality in mind. If specific areas are identified as requiring frequent adjustment and attention from facility personnel, balancing and commissioning may be justified in a targeted area to reduce repeat work orders and increase occupant comfort.

EEM7 | COMPUTER POWER MANAGEMENT

INVESTIGATION

In the typical office environments, users tend to leave desktops and laptops powered on when not using these devices. Even basic power management settings of PC operating systems are typically in-efficient and waste energy, especially if they really on the user to engage them. The amount of power computers draw during this time can be reduced by forcing the computers with a central program to enter a deep “sleep/suspend” mode after a specific period of inactivity or and at scheduled intervals. The bulk of this reduction in energy consumption is normally overnight. Utilizing computer management software will reduce the electrical consumption of the equipment when the opportunity is present.

EXISTING SYSTEM

City Hall includes approximately 1,903 computers are used from 7 am to 5 pm. These computers, however, are more than often left running 24/7. The computers are mainly located in offices. The computers are split approximately 45% to 55% between desktops and laptops (Respectively) with the desktops utilizing LCD Displays. During our walkthrough, computers were noted to be running in unoccupied offices or work stations.

The computers and monitors consume a wide range of wattage depending on the size, type, and age of screen and computer. An average wattage was estimated for calculations purposes. These assumptions are defined in the calculations located in Appendix B.

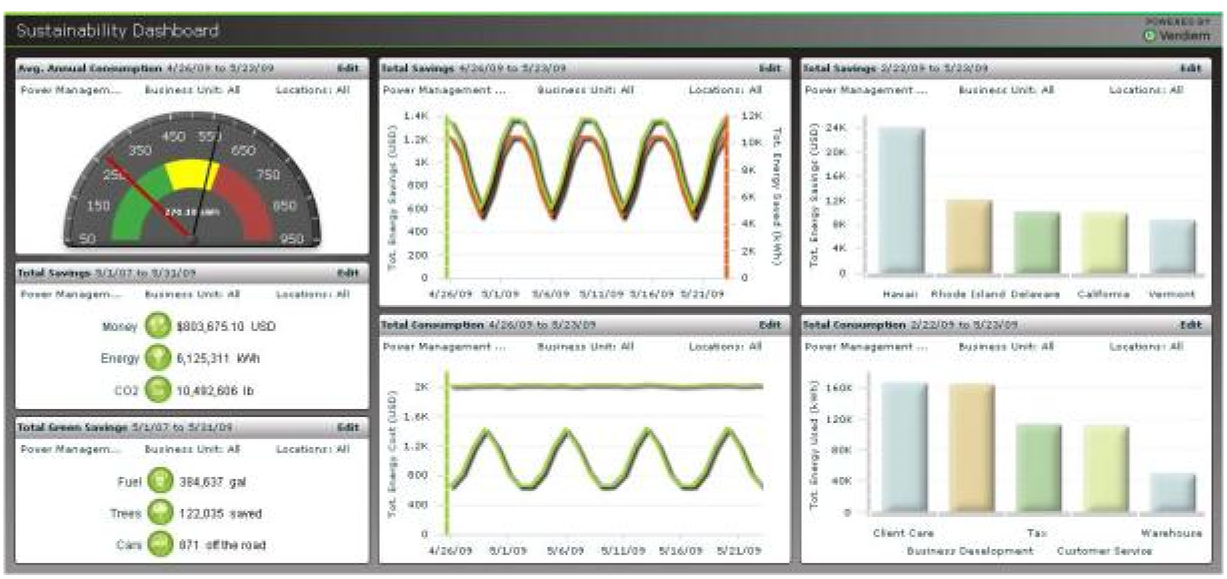


Figure 12.1 –Sample output from computer power management software

PROPOSED SYSTEM

The proposed software will be installed at a server level and remotely deploy to all computers on the network. Computers and monitors can be set to enter into sleep mode after a specified period of inactivity (usually around 20 minutes). Computers can also be set on a schedule to turn off at a specified time in the evening to ensure they are not left on overnight. Computers and monitors typically consume 80% less energy when in sleep mode and do not require a lengthy boot-up time when returning from this state. Industry studies show that computers in this setting are actively used an average of 10 hours per day. In addition, each computer can be classified into groups with different settings. For example, office computers may have a later"off" time than workstation or IT computers. Additionally, the computers can be set to turn on at specified times overnight for IT software updates. Energy cost savings calculations were based on the current operation of the existing computers and were compared to a projected future operation of the existing computers.

RECOMMENDATIONS

Wendel recommends installing the software on a central computer or server that is deployed to all computers on the network. This installation is transparent to all users and allows the IT Manager to synchronize the power options of all the PCs in a way that gives users full flexibility but still insures energy-efficient operation of the hardware and compatibility with network operations.

EEM8 | TRANSFORMER REPLACEMENTS

INVESTIGATION

Over time the load on the City's electrical system as hanged with the addition of a large number of computers and servers. Computers and servers will result in a non-linear loads on transformers. It has been found that transformers installed before 2005 do not efficiently meet this type of loading scenario when compared to modern transformers and standards. An opportunity for energy savings exists by replacing the current transformer with a more energy efficient transformer that can better meet non-linear loading. While the incremental saving is little, since transformers operate 24/7, the opportunity for a positive return on investment project is possible.

EXISTING SYSTEM

There are currently 27 secondary transformers ranging in size from 3 to 225kVA. These transformer receives power at 480 volts and transmits power at 208/120 volts. The transformers were documented and efficiency determined based on nameplate data. The transformer's loading was conservatively estimated based on typical loading of transformers in similar applications.

PROPOSED SYSTEM

The proposed transformers will meet and exceed NEMA TP-1 standards and is designed to more efficiently meet non-linear load applications. The transformer will also be a harmonic mitigating transformer (HMT). In HMT's the harmonic "canceling" is accomplished through simple phase shifting techniques to clean up the power by using different types of transformers and filtering.

RECOMMENDATIONS

This measure is not recommended for implementation as part of this project due to the long return on investment. The City may want to consider the proposed equipment when selecting replacement transformers as equipment reaches the end of its useful life.

EEM9 | REFRIGERATION CONTROLS

INVESTIGATION

Walk-in refrigeration units provide storage for food and goods that are used by the facility during regular business hours. These walk-in refrigeration units are designed for the hottest/highest demand day of the year and a full/newly stocked unit, resulting in excess capacity the rest of the year. Wendel identified one (1) walk-in cooler contains that stores various food items in the cafeteria located in the basement.

EXISTING SYSTEM

The size of the walk-in cooler is 6 feet wide by 6 feet long and 7 feet high and does not have any means of controlling evaporator fan or compressor usage. A single medium profile (2) evaporator fan unit is assumed to run continuously regardless if cooling is required resulting in additional fan energy and additional cooling requirements, since the fans generate heat. The compressor on the condensing unit was recently replaced and is located in a hallway near the unit. A 115 watt door heater is utilized to the door from frosting. The door heater runs constantly to prevent frosting around the door.

PROPOSED SYSTEM

One opportunity for Walk-in coolers is to install a controller at each unit. The controller provides improved temperature readings, evaporator fan control and a door heater option.

Temperature controls for the unit is critical for reducing compressor and evaporator fan usage. Temperature readings will communicate to the system controller and determine if cooling is needed. The controller will run the compressor and vary the speed of the evaporator fans depending on cooling requirements. In order to vary the evaporator fan speed when full-speed operation is unnecessary, the motors shall be replaced with electronically commutated (EC) motors. The controller takes advantage of a basic principle of motor operation: the lower the voltage applied to a motor, the less rotational force it produces resulting in less energy usage. The controller does this by sensing when refrigerant has ceased flowing through the evaporator coil and cuts the voltage to the motor by almost two-thirds. The lower speed is considered the bare minimum required to provide defrosting and prevent air in the cooler from stratifying into layers of higher and lower temperature. Additionally, the evaporator fans will generate less heat inside the unit due to the reduced speed/usage. With less heat generated by the fans, cooling requirements will be reduced, lowering the demand from the compressor. The door heater option identifies the appropriate voltage required for the heating element to prevent frosting on the door.

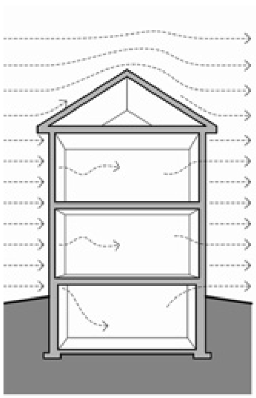
The controller can also monitor and store temperature, energy consumption, and savings data on a daily basis. Data for as many as 120 days can be stored and the information can be downloaded via a serial port included in the unit. The controller also includes three warning lights: one to indicate that the temperature has dropped below a set point (set at the factory according to health department codes), another to signal that the evaporator is icing, and the third to indicate that the compressor is running longer than necessary. The controller also monitors and records when the warning lights are activated.

RECOMMENDATIONS

This measure is not recommended for implementation as part of this project due to the long return on investment. The City may want to consider the proposed equipment when selecting replacement refrigeration units as equipment reaches the end of its useful life.

EEM10 | WEATHERIZATION

The building envelope is a critical part of a facility's energy efficiency. Thermal energy is transferred through the building's exterior by various modes of heat transfer. The largest single component is conductive heat transfer through stationary masses such as the walls, windows, roofs and other external surfaces. This energy loss is most notably mitigated by insulation installed during construction. Energy is also transferred through radiation, also known as solar heat gain, where heat is absorbed by the building through the transparent glazing of windows. The final component is convective heat transfer (airflow), also known as infiltration or exfiltration.


Wind Effect

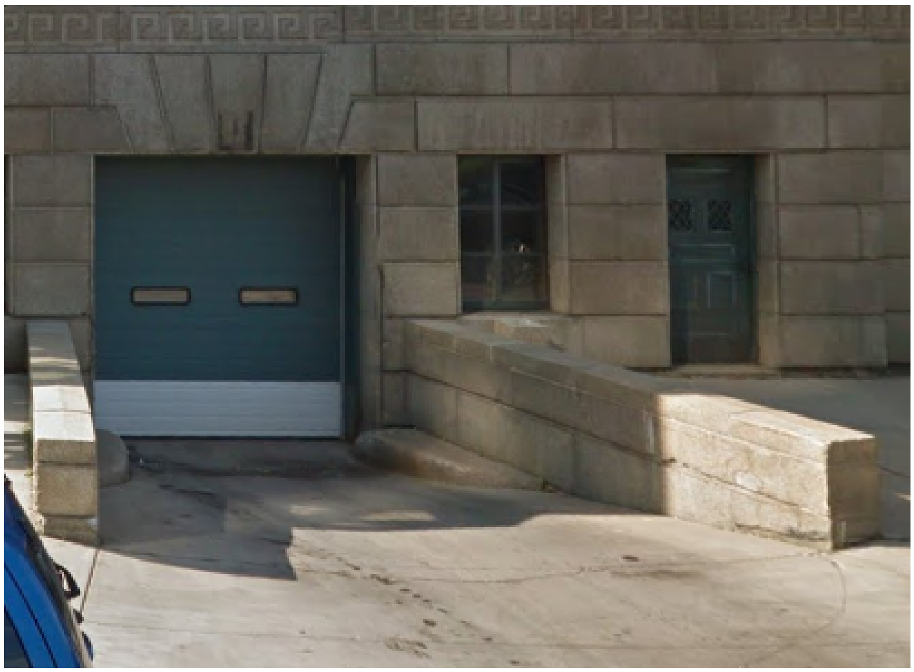
The building envelope was investigated and assessed. Air infiltration was identified as cracks in the building envelope. These breaks throughout the facilities' exterior develop over time and result in outside air penetrating into the conditioned space, which increases the load on the cooling and heating equipment. Energy losses were identified in locations where gaps were present at exterior doors. For air flow to occur there must be both a pressure difference between two points and a continuous flow path or opening connecting the points. There are three main forces that create a pressure difference: wind forces, the stack effect, and mechanical air handling equipment. Based on the geographic location temperature and wind data, existing heating and cooling system temperature set points, equipment efficiencies and the occupancy schedule, energy losses due to wind contributing infiltration and exfiltration were calculated.

INVESTIGATION

The intent of this measure is to reduce leakage of conditioned air by replacing or implementing door sweeps where needed. Door sweeps ensure a tight fit between the door and the ground thereby reducing infiltration of outside air and exfiltration of conditioned air. Infiltration and exfiltration cause the HVAC system to have to condition more air than would be required with a properly sealed building. Often times, existing door sweeps deteriorate due to exposure to the elements and normal wear and tear. By implementing this measure, heating and cooling savings will be realized by reducing the load on the HVAC system caused by unwanted airflow.

EXISTING

Buffalo City Hall has approximately 16 man doors and one overhead door for the Mayor's Garage. Most of the doors were found to be in good condition, including having properly functioning door sweeps. However, the overhead door and some of the man doors appeared to have degraded bottom door sweeps in need of replacement. The doors in need of new sweeps include the overhead door and man door to the Mayor's Garage as well as several roof access doors.



Overhead Door and Man Door to Mayor's Garage

PROPOSED

The proposed system include new bottom sweeps for man doors and overhead doors.

RECOMMENDATIONS

Wendel recommends replacement of bottom door sweeps on all exterior man doors with degraded bottom sweeps as well as a new bottom sweep on the overhead door.

EEM11A | WINDOW FILM

INVESTIGATION

Energy transfer through a window glazing takes two forms. Conductive heat transfer is associated with energy transmitted through the windows surface. In the winter when you put your hand on the glass and it feels cold, that is conductive heat transfer. The U-value measures a window's performance against conductive heat transfer. This is also known as the thermal resistance.

The other mechanism for heat transfer is radiation. Radiation is the radian energy from the sun that is transmitted through the glazing and heats internal services. In the summer when you feel the sun beating on you through a window, that is radiation. This is also referred to as solar heat gain. A window's resistance to solar heat gain, is measured by what is called the solar heat gain coefficient (SHGC).

Window film provides thermal energy savings and increased occupant comfort by improving a window's u-value and SHGC. When evaluating the impact of window film on a building's performance, it is often best to look at in three parts. The first is the cooling savings from reducing solar heat gain. However this is a double edge sword. Since this is a passive system (meaning once installed it doesn't change) the analysis must also include (part two) a heating penalty associated with reduced solar heat gain in the winter. The final part is the conductive heat transfer reduction from the increased u-value. Our analysis outlines these factors using local solar irradiance data.

EXISTING

Buffalo City Hall has approximately 2,000 windows in total. The windows are all single pane of various styles and framing constructions. A portion of the windows were covered with window film during a previous project. This project included:

1. Silver reflective window film for all of the windows on the low rise elevator tower
2. Combination security and sun control window film for the windows on the South and West orientations of floors 1, 2, and 3
3. Sun control window film for the windows on the South and West orientations of floors 5, 6, 9, 13, and 20

PROPOSED

There exists the opportunity to provide sun control window film to the windows not completed under the previous window film project. This would include floors 4, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, and 25 for all orientations as well as the East and North orientations of floors 1, 2, 3, 5, 6, 9, 13, and 20.

RECOMMENDATIONS

Wendel does not recommend the implementation of this improvement. The impact on the building energy usage will be low relative to the total anticipated costs. If windows are scheduled for replacement, the City may want to consider the factors when selecting glazing for the new windows.

EEM11B | WINDOW TREATMENT

INVESTIGATION

Similar to window film, window treatments provide a mechanism to reduce solar heat gain. Window treatments however have a couple tradeoffs to consider. Window treatments do not offer any conduction (u-value) improvement. There is also assumed to be no solar heat gain penalty since user have the ability to modulate the position, it is assumed they will take advantage of solar heat gain in the winter.

EXISTING

Buffalo City Hall has approximately 2,000 windows in total. The windows are all single pane of various styles and framing constructions. Select areas of the building are equipped with a variety of window treatments.

PROPOSED

The proposed improvement would replace the existing window treatments with roll-up blinds. These systems offer uniformity across the facility. The also come in “black-out”; translucent or light filtering options. Since they are roll-ups, they can be adjusted to limit interference with window AC units.

RECOMMENDATIONS

Wendel does not recommend the implementation of this improvement. The impact on the building energy usage will be low relative to the total anticipated costs. If areas are scheduled for a remodel, the City may want to consider the blinds as options to enhance the space.

NR | WATER CONSERVATION

Since the City does not pay for water, water conservation improvements would not yield a simple payback. During the check-in meeting in November, Wendel agreed to provide general water conservation recommendations for the City to consider during future capital improvement projects.

The City should consider the following when upgrading facilities.

- Sink aerators should be replaced with a 0.5 and 1.5 GPM aerators depending on faucet use.
- Flush valves and tank toilets are to be upgraded to more modern “low flow” options. The water closets of today use 1.6 GPF and are as effective as the previous versions at removing waste.
- Urinal flush valves are also proposed to be replaced with more modern 0.5, 1.0, or 1.6 GPF valves depending on urinal size.
- Additionally for Hand wash medical and food service sinks hands free pedal faucet controllers will be installed, these not only reduce water usage but also eliminate the need to touch the faucet controls eliminating hand contamination at the faucets.

NR | IMPROVEMENTS CONSIDERED AND DISMISSED

Wendel, working with City's staff, reviewed the building's operation, interviewed building staff, and conducted several facility tours. From these initial visits, Wendel identified several potential opportunities. Wendel reviewed these opportunities with the City's staff during a meeting held on November 17, 2016. At that time, Wendel received input and direction that guided our detailed investigation of energy savings opportunities.

Following that meeting, Wendel utilized utility data, drawings, equipment data, energy management system trend data, and loggers to perform a detailed evaluation of the energy savings opportunities and their costs. This section outlines ECMs that were briefly evaluated and deemed not feasible. ECMs were deemed not feasible if:

- The proposed modifications could not be cost effectively implemented
- The proposed modifications were not feasible based on current operations
- The proposed modifications would not be compatible with current systems or operations
- The proposed modifications were being pursued under a separate effort.

The following is organized by systems.

LIGHTING

Advanced Lighting Controls

The architecture of building (heavy construction) and the presence of asbestos containing materials (ACM) would make an advance lighting control system (wireless or wired) cost prohibitive. These types of systems include technologies for daylight harvesting, occupancy sensing, and integrated demand response. With the exception of select spaces where "on-fixture" sensors will be used.

Exterior Accent Lighting

The exterior accent lighting has been changed to LED technology at the time of the visit.

BUILDING ENVELOPE

Window Replacements | Caulking

While the windows are an older style system, replacing these windows would not be cost effective. Caulking the windows was briefly considered, however the interior caulking on most windows appeared to be in good condition. Exterior caulking would be cost prohibitive from performing. This is further complicated by the presence of ACM within the existing caulking.

HEATING & COOLING SYSTEM

HVAC System Replacement

The HVAC system within the building is and older style system. Modern HVAC systems such as Variable Air Volume (VAV) or Variable Refrigerant Flow (VRF) provide an easier to maintain system as well as a more controllable and more comfortable environment. The cost for installing such as system would likely be on the order of magnitude of $25/sqft to $35/sqft not including costs for abatement. This is cost prohibitive.

AC Unit Replacement with New Heat Rejection

The City currently uses once through City water as the heat rejection source for water cooled units. Due to the architecture of the building locating a cooling tower or dry cooler on the outside of the building is not feasible. As such we assumed all replacement options would need to use the same heat rejection method.

Radiator Zone Control Valves

Due to the piping arrangement of the radiator supply lines, zone control valves are not feasible.

Radiator Submetering

Due to the piping arrangement of the radiator supply lines, sub meters are not feasible.

Passive Cooling / Natural Ventilation

As outlined in the Memo dated November 9, 2016, Based on this the best case scenario (removing all cooling) would result in 398,991 kWh in savings annually. This would equate to roughly $31,200 in annual savings. A major HVAC renovation of an existing building is between $5/sqft to $10/sqft. Using this range that would equate to a project cost in the range of $3M to $6M. In addition information provided by the City implies that hazardous material in the form of asbestos and/or lead paint may be disturbed as part of any improvement project to return these to operation. Based on this high level analysis it was agreed to list this opportunity as not recommended.