ENERGY AUDIT
REPORT

City of Jersey City
280 Grove Street
Jersey City, New Jersey 07302
Department of Administration

ENERGY AUDIT REPORT

of
CITY HALL
280 Grove Street
Jersey City, New Jersey 07302

PREPARED BY:

EMG
222 Schilling Circle, Suite 275
Hunt Valley, Maryland 21031
800.733.0660
410.785.6220 (fax)
www.emgcorp.com

EMG CONTACT:

Kalyana Vadala
Program Manager
800.733.0660, ext. 6236
kkvadala@emgcorp.com

EMG Project #: 93567.10R-001.269
Date of Report: July 8, 2011
On site Date: January 4 and 5, 2011

TABLE OF CONTENTS

1. CERTIFICATION

EMG has completed an Energy Audit of City Hall located at 280 Grove Street in Jersey City, New Jersey. The site was visited on January 4 and 5, 2011.

The assessment was performed at the Client's request using methods and procedures consistent with good commercial and customary practice and using methods and procedures as outlined in EMG's Proposal.

This report is exclusively for the use and benefit of the Client identified on the first page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and EMG.

This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of EMG.

The opinions EMG expresses in this report were formed utilizing the degree of skill and care ordinarily exercised by any prudent architect or engineer in the same community under similar circumstances. EMG assumes no responsibility or liability for the accuracy of information contained in this report which has been obtained from the Client or the Client's representatives, from other interested parties, or from the public domain. The conclusions presented represent EMG's professional judgment based on information obtained during the course of this assignment. The conclusions presented are based on the data provided, observations made, and conditions that existed specifically on the date of the assessment.

EMG certifies that EMG has no undisclosed interest in the subject property, EMG's relationship with the Client is at arms-length, and that EMG's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies.

Any questions regarding this report should be directed to Kalyana Vadala at 800.733.0660, ext. 6236.

Prepared by: Alex Israel
Energy Auditor
Project Manager

Reviewed by: 

Solomon Rosenbaum, PE, Reviewer for
Kalyana Vadala, CEM, CEA, CSDP
Program Manager

2. DISCLAIMER

The energy conservation opportunities contained in this report have been reviewed for technical accuracy. However, because energy savings ultimately depend on behavioral factors, the weather alongside many other factors outside our control, EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

Estimated installation costs are based on EMG's experience on similar projects and *RS Means*. We strongly encourage the owner to confirm these cost estimates independently.

Since actual installed costs can vary widely for particular installation, and for conditions which cannot be known prior to in-depth investigation and design, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein.

Finally, EMG will not benefit in any way from any decision by the owner to select a particular contractor, vendor or manufacturer to supply and install any materials described or recommended in this survey.

3. EXECUTIVE SUMMARY

The municipal property has one, 4-story building containing approximately 100,000 square feet. The site area is 1.79 acres. Construction of the property was completed in 1896.

Included, as part of the study, was a review of building's construction features, historical energy and water consumption and costs, review of building envelope, HVAC equipment, heat distribution systems, lighting, building's operational and maintenance practices.

City Hall is heated with steam boilers for upper floors and a hot water loop and heat exchanger for the basement, along with a split system for the finance area and computer room and recently installed package rooftop units for the council chamber area. Cooling is provided by window units for individual areas except for the council chamber, finance office, and computer room. Lighting systems generally use T12 fluorescent fixtures with magnetic ballasts and are manually controlled with light switches.

A boiler operator is on staff 24 hours per day during the heating season, and manual blow downs are performed three times per day. EMG recommends adding automatic blow down systems and conductivity meters for modernization if and when the recommended DDC control system is installed.

Steam heat systems are inherently less efficient than hot water systems. As part of long-term modernization planning, EMG recommends considering replacement of the existing steam boilers and distribution system with hot water systems.

Numerous models of window air-conditioning units are installed on site, and in most cases, frames were not specific to the units. Significant leakage and heat loss is occurring through the window air conditioner frames during the winter. EMG recommends removing window units for the heating season to prevent leakage and heat loss.

The following table summarizes the existing energy performance of the building.

Building's Energy Consumption	7,304,299 kBtu
Current Annual Energy Usage Costs	$183,566

EMG utilizes four key metrics to benchmark the energy usage profile for the subject property as follows:

- Building Site Energy Use Intensity - The sum of the total site energy use in thousand of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.
- Building Source Energy Use Intensity – The sum of the total source energy use in thousand of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.
- Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.
- Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

The following is a summary of the subject property's annual energy utilization and the projected reduction through implementation of the recommended ECMs.

Site Energy Use Intensity (EUI)	Rating
Current Site Energy Use Intensity (EUI)	76
Post ECM Site Energy Use Intensity (EUI)	30
Source Energy Use Intensity (EUI)	**Rating**
Current Source Energy Use Intensity (EUI)	137
Post ECM Source Energy Use Intensity (EUI)	77
Building Cost Intensity (BCI)	**Rating**
Current Building Cost Intensity	$1.91
Post ECM Building Cost Intensity	$1.19

The following table provides a summary of the projected Greenhouse Gas Emissions reductions as a result of the recommended Energy Conservation Measures:

Greenhouse Gas Emissions Reduction	Rating
Estimated kWh Reduction	32,427
Estimated Annual Thermal Energy Reduction	38,832
Total CO_2 Emissions Reduced	82
Total Cars Off The Road (Equivalent)*	15
Total Acres of Pine Trees Planted (Equivalent)*	19

*Equivalent reductions per DOE emissions calculation algorithms.

EMG has identified 15 Energy Conservation Measures (ECMs) for this property. The savings for each measure are calculated using standard engineering methods followed in the industry and detailed calculations for ECM are provided in Appendix I for reference. The actual energy and cost savings would vary from the above estimates once the interactive effects are analyzed.

The following table summarizes the recommended ECMs in terms of initial investment cost, estimated annual cost savings and net effective payment:

Item	Estimate
Total Initial ECM Investment *(Current Dollars Only)*	$934,654
Estimated Annual Cost Savings Related to ECMs *(Current Dollars Only)*	$71,135
ECM Effective Payback	13.14
Estimated Annual Energy Savings	60%
Estimated Annual Energy Cost Savings	38%

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

The 15 recommended Energy Conservation Measures (ECMs) EMG has identified for the subject property are summarized as follows:

List of Recommended Measures

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity								
		$	Therms	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations												
1	Install Automatic Lighting Controls	$648	0	4090	0	$766	$0	$766	0.85	20.58	$12,687	25
2	Replace Exit Signs With LED Exit Signs	$658	0	12527	0	$2,345	$1,251	$3,597	0.18	53.02	$34,237	20
3	Replace High Intensity Discharge Lamp (HID) with Induction Lighting	$724	0	1192	0	$223	$31	$254	2.85	3.87	$2,080	16
4	Replace Existing Lamps With Energy Efficient Lamps	$770	0	14618	0	$2,737	$266	$3,003	0.26	19.27	$14,058	6
5	Insulate Hot Water Tanks	$922	131	0	0	$137	$0	$137	6.75	2.20	$1,109	20
	Totals for No/Low Cost Items	**$3,721**	**131**	**32427**	**0**	**$6,208.02**	**$1,547.32**	**$7,755.34**	**0.48**		**$64,170**	
Capital Cost Recommendations												
1	Install Energy Savers on Vending, Snack Machines	$1,920	0.00	8740.00	0.00	$1,636	$0	$1,636	1.17	12.68	$22,426	20
2	Install Outside Air (OA) Temperature Reset Controls for Hot Water Boilers	$2,607	1467.00	0.00	0.00	$1,532	$0	$1,532	1.70	8.74	$20,190	20
3	New Natural Gas/Propane Fired Water Heater	$3,078	-190.91	5595.20	0.00	$848	$0	$848	3.63	2.35	$4,158	10
4	Replace Defective Steam Traps	$4,000	4602.35	0.00	0.00	$4,807	$0	$4,807	0.83	14.35	$53,389	15
5	Replace Lamps And Install Lighting Controls	$5,502	0.00	19849.00	0.00	$3,716	$0	$3,716	1.48	4.21	$17,653	7
6	Replace Existing Air Conditioners with Energy Star Air Conditioners	$16,416	0.00	14881.22	0.00	$2,786	$139	$2,926	5.61	1.69	$11,319	12
7	Improve Insulation Levels in Attic	$25,575	5893.21	13200.69	0.00	$8,627	$0	$8,627	2.96	6.61	$143,523	30
8	Replace Linear Fluorescent T12 Lamps With T8 Lamps	$42,784	0.00	35202.00	0.00	$6,591	$0	$6,591	6.49	1.08	$3,484	8
9	Replace Non-Programmable Thermostats With New Programmable Thermostats	$344,800	19979.14	0.00	0.00	$20,869	$0	$20,869	16.52	1.19	$64,235	30
10	Replace External Windows	$362,340	11265.40	42531.07	0.00	$19,730	$0	$19,730	18.36	1.07	$24,384	30
	Total For Capital Cost	**$809,022**	**43016.20**	**139999.17**	**0.00**	**$71,144.42**	**$139.32**	**$71,283.74**	**11.35**		**$364,759**	
	Interactive Savings Discount @ 10%		-4,315	-17,243		-7,735	-169	-7,904			$0	
	Total Contingency Expenses @ 15%	$121,911										
Total for Improvements		**$934,654**	**38832.20**	**155183.38**	**0.00**	**$69,617**	**$1,518**	**$71,135**	**13.14**		**$428,929**	

EMG has conducted pre-screening of following renewable energy measures for the property:

Solar Photovoltaic (PV) Screening

Solar Rooftop Photovoltaic Analysis	
Total PV Roof Area	8,236
Estimated KW Rating	85.7
Potential Annual KWh Produced	103,759
% of Current Electricity Used	136.17%
Investment Cost	$599,567
Estimated Energy Savings	$19,714

EMG Recommendation: As the facility is a potentially good application for solar PV, EMG recommends a detailed feasibility study be conducted for an in-depth economic analysis.

4. INTRODUCTION

The purpose of this Energy Audit is to provide The City of Jersey City and City Hall with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

The approach taken in this energy audit began with a benchmarking analysis of the building and associated building systems by:

1) Developing an energy baseline that becomes the basis for the energy savings plan and cost savings plan.

2) Gathering utility data for each building and benchmarking against models by square footage, by facility use and type of structure.

The next phase of the energy audit consisted of an on site visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. boilers, Make-up Air Units, DHW equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

ENERGY AND WATER USING EQUIPMENT

- EMG has surveyed the common areas, office areas, council chamber, maintenance facilities and mechanical rooms to document utility related equipment, including heating systems, cooling systems, air-handling systems and lighting systems.

BUILDING ENVELOPE

- EMG has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This also includes the inspection of the conditions of walls, windows, doors, roof areas, insulation and special use areas. Where we anticipated significant losses, we utilized infrared thermograph to analyze heat loss across the envelope.

RECOMMENDATIONS FOR ENERGY SAVINGS OPPORTUNITIES

- Based on the information gathered during the on site assessment, the utility rates and recent consumption data and engineering analysis, EMG has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

ANALYSIS OF ENERGY CONSUMPTION

- Based on the information gathered during the on site assessment and a minimum of one year of utility billing history, EMG has conducted an analysis of the energy usage of all equipment, and identify which equipment is using the most energy and what equipment upgrades may be necessary. This information has been used to identify which equipment upgrades or replacements that may provide a reasonable return on the investment and improve maintenance reliability.

ENERGY AUDIT PROCESS

- Interview staff and review plans and past upgrades;
- Perform energy audit for each different use type;
- Perform a preliminary evaluation of the utility system;
- Analyze findings utilizing ECM cost benefit worksheets.
- Make preliminary recommendations for system improvements.
- Estimate initial cost and changes in operating and maintenance costs based on implementation of energy efficiency measures;
- Ranking of recommended cost measures based on criticality of project and largest payback;

REPORTING

EMG Energy Audit report to include the following:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priority based on initial cost and payback;
- A narrative discussion of building systems/components considered and a discussion of options;
- A summary of ECMs including initial cost and simple payback based on current utility rates and expected annual savings.

5. FACILITY OVERVIEW AND EXISTING CONDITIONS

5.1. BUILDING OCCUPANCY

City Hall is generally open to the public from 8:00 am to 5:00 pm, Monday through Friday. Maintenance staff starts at 7:00 am, and selected offices are occupied after 5:00 pm several days during the week. Events scheduled in City Council Chambers create wide variations in building schedule.

Typically, 100 - 150 people occupy the facility during normal operating hours. After hours occupants include approximately four people. During the winter, a boiler operator is on the premises 24 hours per day.

The facility operating hours are summarized in the table below:

	Hours Open to the Public	Hours Open to Employees
Monday-Friday	8:00 am – 5:00 pm	7:00 am – 7:00 pm
Saturday	None	None
Sunday	None	None

5.2. BUILDING ENVELOPE

Based on structures of similar size, configuration, and geographic location, it is assumed that the foundations consist of cast-in-place concrete perimeter wall footings with concrete foundation walls with stone exterior finishes. The foundation systems include reinforced concrete column pads.

The following table describes the observed or reported insulation levels at the property:

Building Element	Type Observed	Estimated Insulation
Roof, Attic	Batt insulation (some areas)	R – 6
Floors	Not Accessible	R – 6
Walls Above Grade	None	None
Basement Walls // Slab Perimeter	None	None

The windows are wood-framed, double-pane glazed, vertically pivoting units with integral horizontal blinds and lower fixed pane. The caulking was observed to be in good to fair condition. Air infiltration was reported near some of the windows. Due to variations in space temperatures, function of radiator valves, and individual preferences in offices, many windows were observed to be open during the winter. Window air conditioner size varied widely and most units did not have frames that matched the units. EMG observed visible air gaps between frames and units in most cases, and we recommend removing units during the winter and reinstalling for the summer.

The main entrance doors are solid wood set in wood frames. The glazing is single paned. Weather stripping was observed around the door openings and appeared to be in fair condition.

The additional entrance doors were solid wood and service doors were hollow metal doors.

5.3. BUILDING HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

Steam for the central heating system is supplied by two, gas-fired steam boilers with a condensate return system. Each boiler has a rated input capacity of 9,730 MBH and is located in the ground floor boiler room. Combustion air is provided by two fans controlled by variable frequency drives. Heat is provided to all upper floors by a variety of steam radiators with thermostatic control valves. Many of the thermostatic control valves and steam traps appear to have failed. Temperatures in most areas of the building were 78° F, with some areas observed in excess of 80°.

The basement heating is provided by finned tube radiators on a hot water loop run on a heat exchanger supplied by the steam system. Control valves and dual circulation pumps for the system are operated by a Honeywell controller with outside air reset controls. EMG observed that the system was set in manual mode, with circulation pumps running manually and outside air temperature control overridden. Some offices were measured to be 80° with windows open and window air-conditioning units on in fan-only mode.

Heating and cooling for the computer room and personnel offices are provided by two split systems heated by the basement loop and cooled with remote condensers. The units are controlled by local thermostats in each space.

Council chambers are heated and cooled by two direct expansion constant volume gas-fired package rooftop units with capacity of 20 tons each. The cooling equipment uses R-410A as a refrigerant. Air distribution is provided to supply air registers by ducts concealed above the ceilings. Return air grilles are located in each space. The heating and cooling system are controlled by the council chamber lighting control system.

The Mechanical Equipment Schedule in Appendix E contains a summary of the HVAC Equipment at the property.

5.4. BUILDING LIGHTING

Interior lighting in the buildings is primarily provided by four and eight-foot linear and two-foot U-tube fluorescent light fixtures containing T12 lamps, currently equipped with magnetic ballasts. Select office areas have been renovated with T8 fixtures with electronic ballasts and other offices have incandescent lighting.

Council chambers are lit by a combination of recessed ceiling-mounted and track mounted halogen flood lights, decorative incandescent fixtures, and linear fluorescent T12 lighting. A full lighting control system is installed for the chambers.

The lighting in the building is controlled predominantly by light switches. Common areas are typically lit from 6:00 am until 10:00 pm, when maintenance staff leaves. Offices are typically lit 10 hours per day, Monday through Friday.

Exterior building and site illumination is provided by surface-mounted light fixtures on the exterior walls and pole-mounted CFL fixtures. Exterior lighting remains on from dusk through dawn.

The Lighting Systems Schedules in Appendix F contain a summary of the Existing Lighting Systems at the property along with proposed Lighting Energy Conservation Measures.

5.5. BUILDING ELEVATORS AND CONVEYING SYSTEMS

There are two hydraulic passenger elevators, with one permanently out of service. The operational elevator was manufactured by Dover and has a rated capacity of 3,500 pounds. The elevator machinery is located in a room adjacent to the shaft.

5.6. BUILDING DOMESTIC HOT WATER

The water meter is located in a vault in the center exterior area of the property.

Domestic hot water is supplied by three electric water heaters. The main water heater is located in the boiler room, with two smaller heaters in the laundry area and in a bathroom in the mayor's office.

The common area restrooms have commercial-grade fixtures and accessories including water closets and lavatories. The toilets consist of flush valves. The typical flush volume was observed to be 3.5 GPF. The lavatories are equipped with aerators rated at 2.0 GPM. Lavatories are operated by manual controls. The boiler room shower head have a rated capacity of 2.6 GPM.

5.7. BUILDING NATURAL GAS AND ELECTRICITY

The building is connected to the local natural gas utility (PSE&G). Natural gas service is supplied from the gas main on the adjacent public street. The gas meter and regulator is located along the wall in the tunnel between the back parking lot and the center of the building. The gas distribution piping within the building is malleable steel (black iron).

The facility is master-metered for natural gas.

The electrical supply lines run underground from pad-mounted transformers to an interior-mounted electrical meter.

The main electrical service size is 2,000 amps, 208/120-volt three-phase four-wire alternating current (AC). IF The electrical wiring is copper, installed in metallic conduit. Circuit breaker panels are located throughout the building.

The facility is master-metered for electricity.

6. ANALYSIS OF BASELINE ENERGY AND COSTS

Establishing the energy baseline begins with an analysis of the utility cost and consumption provided by the Building. Utilizing the historical energy data and local weather information we evaluate the existing utility consumption and assign the consumption to the various end-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

The historical energy data is analyzed using standard engineering assumptions and practices. The analysis serves the following functions:

- It allows our engineers to benchmark the energy and water consumption of the facilities against consumption of efficient buildings of similar construction, use and occupancy.
- It generates the historical and current unit costs for energy and water
- It provides an indication of how well changes in energy consumption correlate to changes in weather.
- It reveals potential opportunities for energy consumption and/or cost reduction. For example, the analysis may indicate that there is excessive simultaneous heating and cooling, which may mean that there is an opportunity to improve the control of the heating and cooling systems.

By performing this analysis and leveraging our experience, our engineers prioritize buildings and pinpoint systems for additional investigation during the site visit, thereby maximizing the benefit of their time spent on site and minimizing time and effort by the customer's personnel.

Based upon the utility information provided about the City Hall, the following energy rates were utilized in determining existing and proposed energy costs.

Electricity (Blended Rate)	Natural Gas
$0.19/kWh	$1.04/therm

The data analyzed provides the following information: breakdown of utilities by consumption, cost and annual profile, baseline consumption in terms of energy/utility at the facility, the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data was combined to illustrate annual consumption for each utility type.

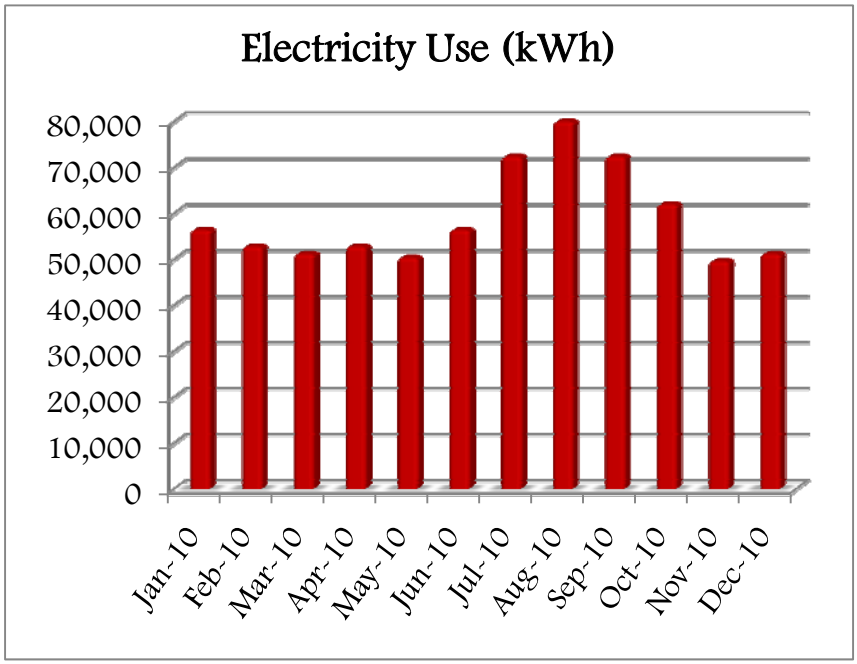
6.1. ELECTRICITY

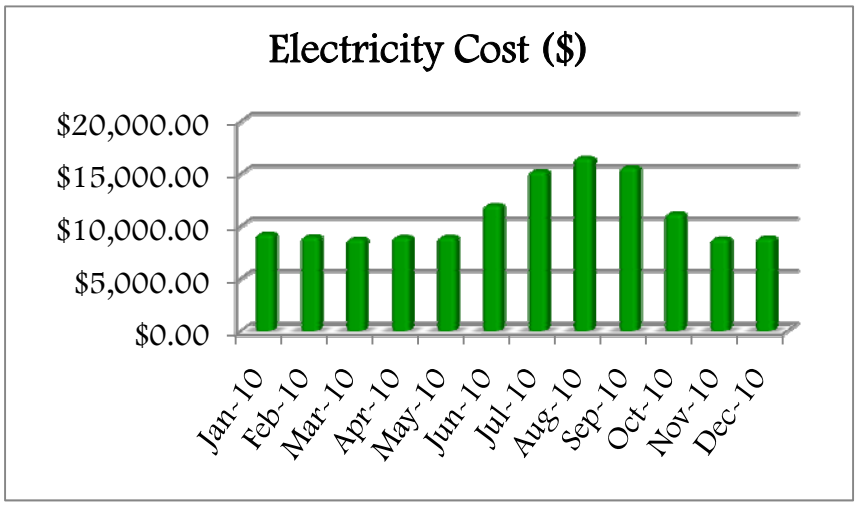
The electricity requirements of the facility are satisfied by **PSE&G**. Summer consumption rises due to use of air-conditioning units. Base electrical load for the building consists primarily of lighting, with domestic water heating and electronics accounting for the remainder.

Based on the 2010 electric usage & costs, the average price paid during the year was $0.19 per kWh. The total annual electricity consumption for the 12-month period analyzed is 707,600 kWh for a total cost of $132,489.23.

Billing Month	Consumption (kWh)	Unit Cost	Total Cost
January	56,400	$0.16	$9,195.84
February	52,800	$0.17	$8,941.59
March	51,200	$0.17	$8,729.08
April	52,800	$0.17	$8,897.37
May	50,400	$0.18	$8,906.80
June	56,400	$0.21	$11,937.48
July	72,400	$0.21	$15,176.82
August	80,000	$0.21	$16,448.41
September	72,400	$0.21	$15,549.58
October	62,000	$0.18	$11,135.49
November	49,600	$0.18	$8,743.99
December	51,200	$0.17	$8,826.78
Total/Average	**707,600**	**$0.19**	**$132,489.23**

Average	**58,967**	**$0.18**	**$11,040.77**
Maximum	**80,000**	**$0.21**	**$16,448.41**
Minimum	**49,600**	**$0.16**	**$8,729.08**


Electricity Use (kWh)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10


Electricity Cost ($)
$20,000.00
$15,000.00
$10,000.00
$5,000.00
$0.00
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10

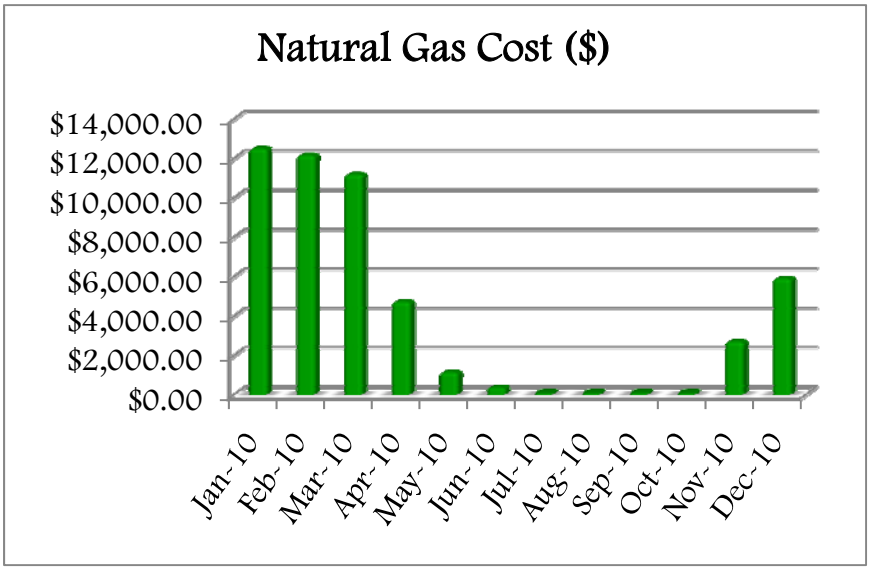
6.2. NATURAL GAS

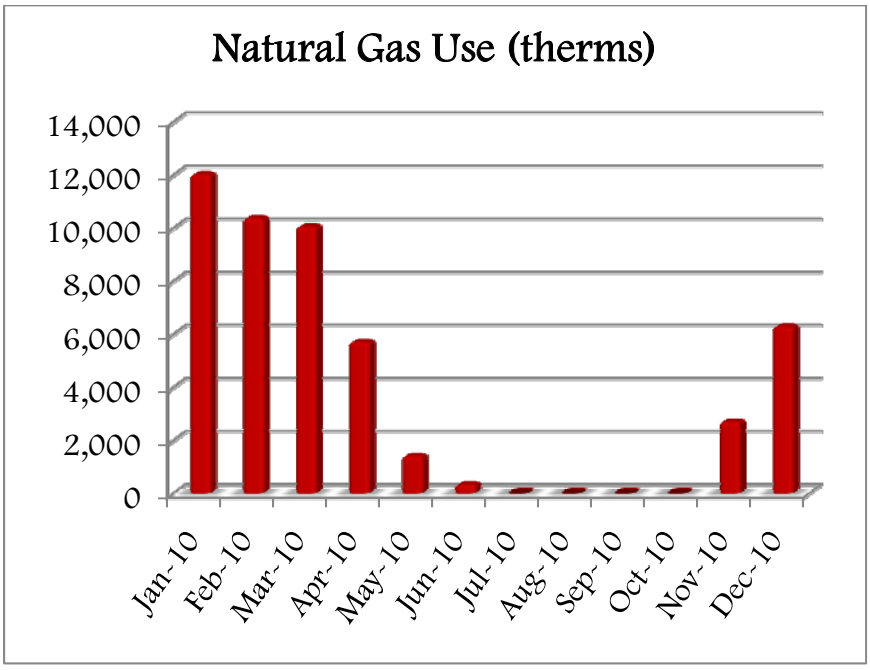
The natural gas requirements of the facility are satisfied by **PSE&G**. Gas load is strictly based on steam boiler use, so there is no consumption in the summer months.

Based on the 2010 natural gas usage & costs, the average price paid during the year was $1.04 per therm. The total annual natural gas consumption for the 12-month period analyzed is 48,900 therms for a total cost of $51,076.82.

Month	Consumption (therms)	Unit Cost	Total Cost
January	12,017	$1.04	$12,500.81
February	10,375	$1.17	$12,160.57
March	10,052	$1.11	$11,188.31
April	5,704	$0.83	$4,721.09
May	1,409	$0.81	$1,143.15
June	350	$1.06	$372.33
July	0	$0.00	$94.37
August	0	$0.00	$97.09
September	0	$0.00	$107.02
October	0	$0.00	$90.80
November	2,704	$1.00	$2,698.43
December	6,289	$0.94	$5,902.85
Total	**48,900**		**$51,076.82**

Average	**4,075**	**$1.00**	**$4,256.40**
Maximum	**12,017**	**$1.17**	**$12,500.81**
Minimum	**0**	**$0.81**	**$90.80**


Natural Gas Cost ($)
$14,000.00
$12,000.00
$10,000.00
$8,000.00
$6,000.00
$4,000.00
$2,000.00
$0.00
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10


Natural Gas Use (therms)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10

7. ENERGY CONSERVATION MEASURE (ECM) RECOMMENDATIONS

EMG has identified a total of 8 Energy Conservation Measures (ECMs) for this property. All the ECMs are broken into two major categories:

1. No/Low Cost Recommendation: No/Low cost is defined as any project with initial investment of less than $1,000

2. Capital Cost Recommendations: Capital cost defined as any project with initial investment greater than $1000

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

The following table describes each recommended ECM in terms of initial investment, electricity and natural gas savings, water savings, annual energy cost and maintenance savings, payback and SIR:

List of Recommended Measures

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity								
		$	Therms	kWh	kgal	$	$	$	Years		$	Years
No/Low Cost Recommendations												
1	Install Automatic Lighting Controls	$648	0	4090	0	$766	$0	$766	0.85	20.58	$12,687	25
2	Replace Exit Signs With LED Exit Signs	$658	0	12527	0	$2,345	$1,251	$3,597	0.18	53.02	$34,237	20
3	Replace High Intensity Discharge Lamp (HID) with Induction Lighting	$724	0	1192	0	$223	$31	$254	2.85	3.87	$2,080	16
4	Replace Existing Lamps With Energy Efficient Lamps	$770	0	14618	0	$2,737	$266	$3,003	0.26	19.27	$14,058	6
5	Insulate Hot Water Tanks	$922	131	0	0	$137	$0	$137	6.75	2.20	$1,109	20
	Totals for No/Low Cost Items	**$3,721**	**131**	**32427**	**0**	**$6,208.02**	**$1,547.32**	**$7,755.34**	**0.48**		**$64,170**	
Capital Cost Recommendations												
1	Install Energy Savers on Vending, Snack Machines	$1,920	0.00	8740.00	0.00	$1,636	$0	$1,636	1.17	12.68	$22,426	20
2	Install Outside Air (OA) Temperature Reset Controls for Hot Water Boilers	$2,607	1467.00	0.00	0.00	$1,532	$0	$1,532	1.70	8.74	$20,190	20
3	New Natural Gas/Propane Fired Water Heater	$3,078	-190.91	5595.20	0.00	$848	$0	$848	3.63	2.35	$4,158	10
4	Replace Defective Steam Traps	$4,000	4602.35	0.00	0.00	$4,807	$0	$4,807	0.83	14.35	$53,389	15
5	Replace Lamps And Install Lighting Controls	$5,502	0.00	19849.00	0.00	$3,716	$0	$3,716	1.48	4.21	$17,653	7
6	Replace Existing Air Conditioners with Energy Star Air Conditioners	$16,416	0.00	14881.22	0.00	$2,786	$139	$2,926	5.61	1.69	$11,319	12
7	Improve Insulation Levels in Attic	$25,575	5893.21	13200.69	0.00	$8,627	$0	$8,627	2.96	6.61	$143,523	30
8	Replace Linear Fluorescent T12 Lamps With T8 Lamps	$42,784	0.00	35202.00	0.00	$6,591	$0	$6,591	6.49	1.08	$3,484	8
9	Replace Non-Programmable Thermostats With New Programmable Thermostats	$344,800	19979.14	0.00	0.00	$20,869	$0	$20,869	16.52	1.19	$64,235	30
10	Replace External Windows	$362,340	11265.40	42531.07	0.00	$19,730	$0	$19,730	18.36	1.07	$24,384	30
	Total For Capital Cost	**$809,022**	**43016.20**	**139999.17**	**0.00**	**$71,144.42**	**$139.32**	**$71,283.74**	**11.35**		**$364,759**	
	Interactive Savings Discount @ 10%		-4,315	-17,243		-7,735	-169	-7,904			$0	
	Total Contingency Expenses @ 15%	$121,911										
Total for Improvements		**$934,654**	**38832.20**	**155183.38**	**0.00**	**$69,617**	**$1,518**	**$71,135**	**13.14**		**$428,929**	

7.1. ECM CALCULATION ASSUMPTIONS

EMG has made the following assumptions in calculation of the Energy Conservation Measures.

- Building operating hours, as detailed in section 5.1 are assumed to be 60va hours per week.
- Annual Heating Equipment Operating Hours, as defined by the U.S. Department of Energy Annual Heating Hours reference are assumed to be 2,340 hours per year.
- Annual Cooling Equipment Operating Hours, as defined by the U.S. Department of Energy Annual Cooling Hours reference are assumed to be 1,007 hours per year.
- The building volume has been estimated based on the floor plan area and the average ceiling height. The estimated building volume is assumed to be approximately 1.6 million cubic feet.

7.2. NO/LOW COST ECM DESCRIPTIONS

EMG has identified five No/Low Cost Energy Conservation Measures (ECMs) for this property. This includes all measures which can be implemented below the cost threshold of $1,000. The following paragraphs describe each of these ECMs along with the initial installed cost, annual energy savings and payback period for each ECM.

7.2.1. Install Motion Sensors For Boiler Room Lighting

Lighting systems consume large amounts of energy in most buildings. Energy is saved by reducing both lighting power consumption and the additional cooling load imposed by lighting. In winter, lights do help heat the building; however, in most cases, lighting is a less efficient heating source than the building HVAC system. The lights should be turned off when an area is unoccupied, even if only for a short period. Rooms with intermittent use, such as storerooms, lavatories, etc., should have labeled, individual manual switches so that lights can be turned off when the room is not in use. Occupancy sensors are also effective in spaces that are used intermittently. EMG recommends installing ceiling-mounted occupancy sensors for controlling lighting in large areas and conference rooms and wall-mounted occupancy sensors in individual offices, copy rooms and restrooms.

Boiler room fixtures are on 24 hours during the heating season and around 10 hours per day in summer months. The majority of the fixtures are not required for most of the day, and they are circuited such that the occupied area will remain lit, presenting a good opportunity for savings.

The estimated initial investment is $648. The estimated annual cost savings are $766.

7.2.2. Install LED Exit Fixtures

Life safety of the occupants holds the primary importance for any facility; hence the exit signs need to be illuminated all the times irrespective of the occupancy in the building. This means that these signs remain on 24/7. In most cases, the exit sign fixtures are powered by either a 40W incandescent lamp or an 11-13 watt CFL lamp. EMG strongly recommends replacing the existing fixtures with LED fixtures powered by 2 or 4 watt LED lamps. At the same time the existing exit light fixture can be retrofitted with an LED lamp in place of an incandescent lamp. The latter turns out to be a more cost effective procedure, but might not apply to all the existing exit fixtures.

The City Hall has a total of 45 exit fixtures powered by 36 watt incandescent lamps. EMG recommends replacing the fixtures with LED exit fixtures. The proposed retrofit shall result in an annual energy saving of 12,527 kWh.

The estimated initial investment is $658. The estimated annual cost savings are $2,345. Additional cost savings in the amount of $1,251 will result from maintenance and operations savings. The net savings is $3,597.

7.2.3. Replace HID Fixtures With Induction

Induction lighting offers greater energy efficiency and longer life than metal halide, quartz halogen, and high pressure sodium lighting. They also strike and restrike instantly, don't suffer from reduced life due to restriking and have very low starting temperatures, making them a good option for tough environments and high demand applications. Additionally, induction lamps have a lower ballast factor, allowing them produce an equivalent amount of illumination at a slightly lower electrical consumption than metal halides. The cost savings in this ECM include the reduced electrical consumption, but do not account for the reduced maintenance costs. Including these cost savings will further decrease the payback period, making the installation more attractive.

Lamps and fixtures are more expensive than traditional systems, but the added cost is offset by much lower maintenance costs and slightly lower operating costs. This ECM recommends replacing all site exterior lighting with QL induction lights.

It is estimated that the proposed retrofit of the specified incandescent lamps shall result in an annual energy savings of 1,192 kWh.

The estimated initial investment is $724. The estimated annual cost savings are $223. Additional cost savings in the amount of $31 will result from maintenance and operations savings. The net savings is $254.

7.2.4. Replace Incandescent Lamps With CFL Lamps

Fluorescent lighting is recommended for areas where color sensitivity is an important criterion (e.g., offices or small parts assembly rooms). Screw-in fluorescent lamps are available to replace incandescent lamps. Power savings are typically 60%. Screw-in, self-contained lamps, with a 10,000-hour life, can replace flood lights that have a 7,000-hour life. Screw-in circle light fixtures are also available.

Screw-in fluorescent lamps are generally not compatible with dimmers. New energy-efficient fluorescent lamps are continually being introduced. It is important to stay abreast of this technology so that the most efficient products may be used.

The City Hall has 106 incandescent lamps, mostly 100 watt, with some 75, 150, and 250 watt lamps throughout the property. EMG recommends replacing all the incandescent lamps with CFL lamps as specified in the lighting ECM work sheet attached in the Appendix.

It is estimated that the proposed retrofit of the specified incandescent lamps shall result in an annual energy savings of 14,618 kWh.

The estimated initial investment is $770. The estimated annual cost savings are $2,737. Additional cost savings in the amount of $266 will result from maintenance and operations savings. The net savings is $3003.

7.2.5. Insulate Condensate Return Tank

The heat loss from steam system condensate return tanks must be continuously offset by a supply of heat to maintain steam pressure. This heat loss can be a significant portion of the total heating load. EMG recommends that City Hall insulate bare tanks or apply additional insulation to tanks that are not sufficiently insulated. Additionally, replacement or repairs should be made to all torn or missing insulation as required. Applicable insulation materials include flat blocks, beveled lags, curved segments, blankets, or mineral fiber-inorganic binders. Closed cellular insulation should be used for surfaces below 185EF (ASHRAE 1985).

The estimated initial investment is $922. The estimated annual cost savings are $137.

7.3. CAPITAL COST ECM DESCRIPTIONS

EMG has identified ten Capital Cost Energy Conservation Measures (ECMs) for this property. This includes recommended measures which have an estimated implementation cost of greater than $1,000. The following paragraphs describe each of these ECMs along with the initial installed cost, annual energy savings and payback period for each ECM.

7.3.1. Install Vending Controls & Water Cooler Controls

Vending machines are usually designed to operate all day irrespective of the occupancy level in the office. This means that the vending machines operate for more than 12 hours a day and on weekends when not required in case of commercial establishments.

In the case of City Hall, there are two vending machines located in the lobby. EMG recommends installing vend misers on these vending machines, which shall automatically reduce the running time of these machines during weekends and unoccupied hours. There are two types of vend misers; one has a timer in it, which is programmed to turn off or turn down the vending machines after the office hours and bring it back up a hour before the office opens. The other is a motion sensor based system that turns down the machines upon detecting un-occupancy for a pre-programmed duration of time. In the case of vending machines storing chilled products, the vend miser doesn't turn off the machine entirely, but reduces the operating time of the compressor, such that the machine maintains the products at a minimum tolerable temperature.

Similar to the vending machines, the water fountains too are designed to operate 24 hours a day. This means that the energy utilized by the compressor used for chilling the water during after office hours goes waste. EMG recommends installing cooler misers on individual water fountains. The chiller misers are simple timers that can be programmed to turn off the chiller compressors in the water fountain after office hours and turn them on just before the daily office hours. They also can be programmed to keep the fountains turned off on weekends.
There are eight water fountains located at various locations in the facility. EMG recommends installation of timer controls on the individual water fountains.

The estimated initial investment is $1,920. The estimated annual cost savings are $1,636.

7.3.2. Replace Existing Outside Air Reset and 3-way Valve For Basement Loop

HVAC equipment is generally sized to meet conditions at the design peak load. Coil water temperature set points are also chosen to meet the design load. However, during most hours of operation, the equipment operates at part-load. Use of design set points on water loops under part-load conditions results in unnecessary thermal losses and equipment inefficiencies. Resetting the set point reduces energy consumption by matching hot or chilled water supply set points to the actual equipment load.

Reset of supply water temperature may be based on the outside air temperature or on the hot or chilled water demand. Except for buildings with dominant internal loads, the space load generally may be considered to be a function of the outdoor temperature. For example, as the outside air temperature rises, chilled water temperature is adjusted upward and hot water temperature is adjusted downward. Alternatively, a more accurate method is to reset the water temperature based on instrumentation readings. For further discussion on the reset strategies and the selection algorithms of the hot and chilled water temperature set points, refer to a report by the National Bureau of Standards, Control Algorithms for Building Management and Control Systems--Hot Deck/Cold Deck/ Supply Air Reset, Day/Night Setback, Ventilation Purging, and Hot and Chilled Water Reset (NBS 1984a).

The existing outside air temperature reset is currently not utilized and is run in manual mode. Replacement with a fully automated unit is recommended, along with replacement of the 3-way valve to ensure proper operation.

The estimated initial investment is $2,607. The estimated annual cost savings are $1,532.

7.3.3. Replace Electric Water Heaters With Natural Gas-Fired Units

Utility bills for City Hall indicate that electricity costs over five times the amount per kBTU as natural gas. This ECM recommends replacing the existing electric storage tank style water heaters with comparable natural gas water heaters.

The City Hall has three electric water heaters.

The estimated initial investment is $3,078. The estimated annual cost savings are $848.

7.3.4. Replace Defective Steam Traps With New Steam Traps

Steam traps are found in steam piping, separators, and all steam-heated or steam-operated equipment. They are installed to remove condensate from the steam system as quickly as they accumulate. Over time, the internal parts of a steam trap begin to wear and fail to open and close properly. A closed trap reduces the heating capacity of the steam sys-tem. Condensate builds up in the system, which may cause water hammering and will eventually destroy valves and coils. In addition, condensate may freeze in cold climates and rupture lines and coils. When the trap fails to open, it passes steam to the condensate return lines, reducing system capacity and control (NCEL 1985). Steam traps should be periodically inspected and all worn or malfunctioning ones should be replaced. Alternatively, steam traps that fail open will result in energy being lost as full heating capacity is not gained from the steam.

EMG recommends a survey all existing steam traps to determine which traps have failed and the size of the steam orifice.

Steam traps appear to have been poorly maintained and are not audited yearly by maintenance staff. EMG observed that approximately half the steam traps are not functioning. In addition to replacement of defective traps, EMG recommends instituting a maintenance program that includes flushing radiators and checking steam traps yearly at the end of each heating season.

The estimated initial investment is $4,000. The estimated annual cost savings are $4,807.

7.3.5. Replace T12 Lamps With T8 and Add Motion Sensors In Restrooms and Storage Rooms

Fluorescent lighting is recommended for areas where color sensitivity is an important criterion (e.g., offices or small parts assembly rooms). Fluorescent tubes are currently available that produce a higher light output (more lumens per watt) than standard fluorescent tubes. There are efficient 40-watt lamps that produce 8% to 10% more light than standard lamps. The 34-watt fluorescent tubes use 15% less power than standard lamps, while producing about 8% less light. Since the human eye responds to light exponen-tially, rather than linearly, the difference is often unnoticeable. "T8" fluorescent lamps use only 32 watts, but existing fixtures must be replaced.

It is important to replace all lamps when re-lamping a fluorescent fixture, never mix energy-efficient and standard lamps with the same ballast. Ensure that the fluorescent ballast is compatible with the energy-efficient lamps. It must be noted that when switching from T-12 magnetic ballast to T8 lamps, the ballasts should be replaced with instant start electrical ballast. Also it should be noted that when installing an occupancy sensor/motion sensor, rapid start electronic ballast should be used.

The majority of restroom lighting and some storage areas throughout the building were observed to be on while the areas were unoccupied. Motion sensors will greatly reduce operational hours, while replacement with T8 lamps will reduce overall consumption.

The estimated initial investment is $5,502. The estimated annual cost savings are $3,716.

7.3.6. Replace Window Air-conditioning Units with Energy Star Certified Units

The City Hall has 38 window-mounted air conditioners of varying age and efficiency. Based on an average SEER rating of 8, replacement of the window units with Energy Star certified units is recommended to achieve an average SEER of 10.8.

The estimated initial investment is $16,416. The estimated annual cost savings are $2,786.

7.3.7. Insulate Ceiling and Roofs

The amount of heat conduction through ceiling and roof is proportional to its overall heat transfer coefficient (commonly called the U-factor) and the temperature difference between the conditioned space and its surrounding, modified by the effect of solar intensity and wind velocity on the exterior surfaces. One of the most effective ways to reduce heat transfer through ceilings and roofs is to retard heat conduction by adding insulation.

Where the existing roof is sound and directly accessible from an attic or ceiling void, polyurethane foam or mineral fiber may be sprayed on the underside with rigid batt or other applicable insulation for the inside surface. Insulation, typically fiber-glass batt, may also be laid on the top of a ceiling, taking care not to cover up light fixtures. It is generally not practical to insulate the exterior of the roof unless the roof needs to be replaced. In this case, rigid insulation may be used, and protected with a new roof membrane. As buildings become more insulated, the heat transfer through structural members becomes more significant, especially for buildings with metal structural members. Un-insulated structural members can degrade the performance of the insulation up to 20%, and resultant condensation can cause the structure to deteriorate. Therefore, care should be taken to properly insulate the structural members. Often more energy can be conserved by insulating the ceiling rather than the roof unless the attic is being used for special storage, frequent access is required, or a moderate attic temperature is desired. However, if only the ceiling is insulated, any ducting or piping should be insulated to avoid excessive heat transfer or freezing. It is important to be sure that the attic is ventilated by providing one to two inches of ventilation area per square foot of attic.

The attic is currently partially insulated in a few areas. The space is not heated, but temperatures of 61 degrees were observed. Maintenance and office staff reported that the top floor is typically much cooler than other floors, indicating that much of the heat is leaking into the attic. Adding insulation will better regulate the temperature throughout the building as well as saving energy related to heat loss into unconditioned area.

The estimated initial investment is $25,575. The estimated annual cost savings are $8,627.

7.3.8. Replace T12 Lamps With T8 Along With New Electronic Ballasts

Fluorescent lighting is recommended for areas where color sensitivity is an important criterion (e.g., offices or small parts assembly rooms). Fluorescent tubes are currently available that produce a higher light output (more lumens per watt) than standard fluorescent tubes. There are efficient 40-watt lamps that produce 8% to 10% more light than standard lamps. The 34-watt fluorescent tubes use 15% less power than standard lamps, while producing about 8% less light. Since the human eye responds to light exponen-tially, rather than linearly, the difference is often unnoticeable. "T8" fluorescent lamps use only 32 watts, but existing fixtures must be replaced.

It is important to replace all lamps when re-lamping a fluorescent fixture, never mix energy-efficient and standard lamps with the same ballast. Ensure that the fluorescent ballast is compatible with the energy-efficient lamps. It must be noted that when switching from T-12 magnetic ballast to T8 lamps, the ballasts should be replaced with instant start electrical ballast. Also it should be noted that when installing an occupancy sensor/motion sensor, rapid start electronic ballast should be used.

T12 lamps were observed in all areas of the property besides the finance office and boiler room. Strictly replacing fixtures and lamps will greatly reduce electrical consumption property-wide.

The estimated initial investment is $42,784. The estimated annual cost savings are $6,591.

7.3.9. Install Building Management System With Complete DDC Control and Programmable Radiator Thermostats, Steam Zone Valves

Turning off energy-consuming systems when they are not needed is the most basic energy conservation technique. When a building is occupied intermittently, energy savings can be realized by minimizing the time the heating or cooling system is operated when the building is closed. Adding a full building management system with DDC tied into the thermostatic radiator valves will allow City Hall to see several layers of energy savings, as well as increased employee comfort.

Varying space temperatures were observed throughout the building and many employees reported that they keep their windows open in the winter because they cannot adjust their radiators. Space temperatures were typically between 76 and 80 degrees.

The steam system is not zoned and DDC will allow steam zone valves to provide heating to the areas that need it, reducing overall heating load. Zoning and thermostats will also provide the ability to keep space temperatures at reasonable levels, further reducing heating load and natural gas consumption.

The estimated initial investment is $344,800. The estimated annual cost savings are $20,869.

7.3.10. Install Multiple Glazed Windows

Conduction and long-wave radiation heat transfer can contribute significantly to the heating load. Adding extra panes of glazing to windows reduces this heat loss by increasing the thermal resistance and lowering the transmittance. A small reduction in the cooling load will also occur.

Storm windows may be added to either the inside or outside of existing windows. Existing single glazed windows may also be converted to double-glazed windows by adding additional permanent panes of glazing. In either case, the space between the window panes should be vented or otherwise protected against moisture buildup. If the existing window frame is in good condition and the glazing system permits, a single sheet of glass can be replaced by a sealed, double-glazed unit. If the existing window frame is in poor condition, a double or triple-glazed replacement unit, which will also reduce air infiltration, should be used.

Windows in the facility are in varying condition and are reportedly over thirty years old. Much of the hardware was damaged and drafts were observed on approximately 25% of the operable units. According to maintenance staff, quotes for replacement have been received in the past, but were dismissed as cost prohibitive.

The estimated initial investment is $362,340. The estimated annual cost savings are $19,730.

8. IMPLEMENTION OF AN OPERATIONS AND MAINTENANCE PLAN

The quality of the maintenance and operation of the facility's energy systems has a direct effect on its overall energy efficiency. Energy efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property. These actions, which have been divided into specific and general recommendations, will insure that the energy conservation measures identified in this report will remain effective. The following general recommendations should be continued or implemented.

Building Envelope

1. Caulking and weather stripping is functional and effective at all times.
2. Walls observed weekly and holes are patched in the building envelope as required.
3. Windows to be inspected monthly for damaged panes and failed thermal seals.
4. Automatic door closing mechanisms are repaired and adjusted as needed.

Heating and Cooling

1. The burners are cleaned and fuel/air ratios are optimized during routine maintenance checks.
2. Boiler tubes should be inspected and cleaned annually.
3. Temperature settings are reduced in unoccupied areas and set points are seasonally adjusted.
4. Control valves and dampers should be checked for functionality monthly and repaired.
5. Equipment is inspected for worn or damaged parts as part of a monthly maintenance check.
6. Ductwork visually inspected and checked for leaks or damaged insulation as part of a monthly maintenance check.
7. Hot air registers, radiators and covers, and return air ductwork are clean and unobstructed.
8. Air dampers are operating correctly.
9. Test and balance is completed annually to ensure heating is uniform throughout the spaces.
10. Radiators are flushed and steam traps are checked annually.
11. Air filters are inspected monthly and replaced prior to excessive visual buildup. (May increase filter costs, but will reduce fan energy costs).

Domestic Hot Water

1. Domestic hot water heater temperature is set to the minimum temperature required.
2. Hot water piping should be checked routinely for damaged insulated and leaks.
3. Tank-type water heaters should be flushed monthly.

Lighting

1. Over-lit areas should be managed by bi-level switching or photocell controls.
2. Only energy efficient replacement lamps should be used and in-stock for replacement.
3. Lighting fixture reflective surfaces and translucent covers are clean.
4. Walls should be clean and bright to maximize lighting effectiveness.
5. Timers and/or photocells are operating correctly on exterior lighting.

Existing Equipment and Replacements

1. Office/ computer equipment is either in the "sleep" or off mode when not used.
2. All other recommended equipment specific preventive maintenance actions are conducted,
3. Usage demands on the building/ equipment have not changed significantly since the original building commissioning or the most recent retro-commissioning.

In addition, equipment replacement should be performed assuring that:

1. All equipment replacements are not over/undersized for the particular application, and
2. All equipment replacements should be with energy conserving and/or high efficiency devices.

9. APPENDICES

APPENDIX A: Photographic Record
APPENDIX B: Site Plan
APPENDIX C: Records of Communication
APPENDIX D: Glossary of Terms
APPENDIX E: Mechanical Equipment Inventory
APPENDIX F: Lighting Systems Schedules
APPENDIX G: ECM Calculations
APPENDIX H: Solar PV and DHW Analysis Results
APPENDIX I: Supporting Documents

APPENDIX A:
PHOTOGRAPHIC RECORD

EMG DUE DILIGENCE FOR THE LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #1:	South elevation

Photo #2:	East elevation

Photo #3:	North elevation

Photo #4:	West elevation

Photo #5:	Interior elevation

Photo #6:	Front commons

EMG DUE DILIGENCE FOR THE LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #7:	Roof

Photo #8:	Roof

Photo #9:	Steam boilers

Photo #10:	Combustion air VFDs

Photo #11:	Steam boiler

Photo #12:	Gas train

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #13:	Combustion air

Photo #14:	Burner controller

Photo #15:	Condensate system

Photo #16:	Condensate pumps

Photo #17:	Basement hot water circulation pumps

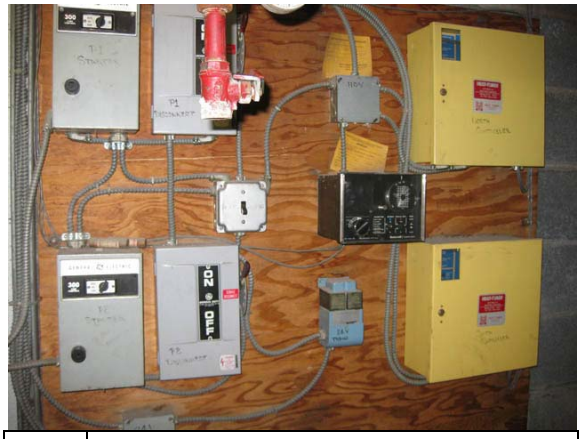


Photo #18:	Basement hot water control system

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #19:	Basement hot water loop heat exchanger

Photo #20:	Typical window air conditioning unit

Photo #21:	Typical window air conditioning unit

Photo #22:	Computer room condensers

Photo #23:	Budget office air handler

Photo #24:	Budget office condenser

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #25:	Council chamber RTU 1

Photo #26:	Council chamber RTU 2

Photo #27:	Radiator

Photo #28:	Radiator

Photo #29:	Radiator

Photo #30:	Radiator

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #31:	Domestic water heater

Photo #32:	Heating system makeup backflow preventer

Photo #33:	Main electrical distribution center

Photo #34:	Budget office transformer and panel

Photo #35:	Typical corridor lighting

Photo #36:	Typical office lighting

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #37:	Office bathroom incandescent lighting

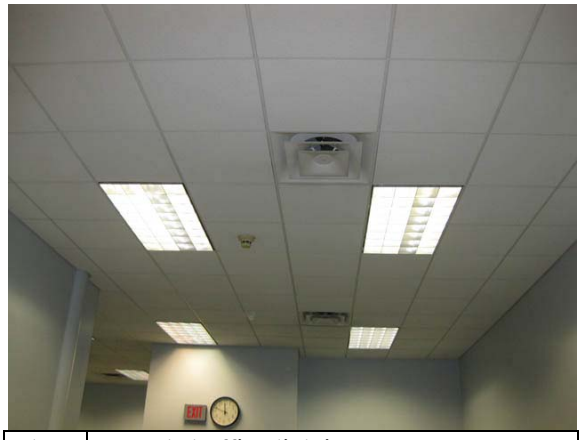


Photo #38:	Upgraded office lighting

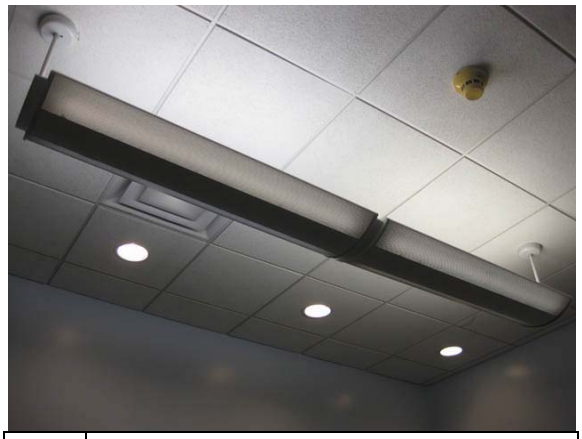


Photo #39:	Upgraded office lighting

Photo #40:	Council chamber pendant lighting

Photo #41:	Council chamber sconces

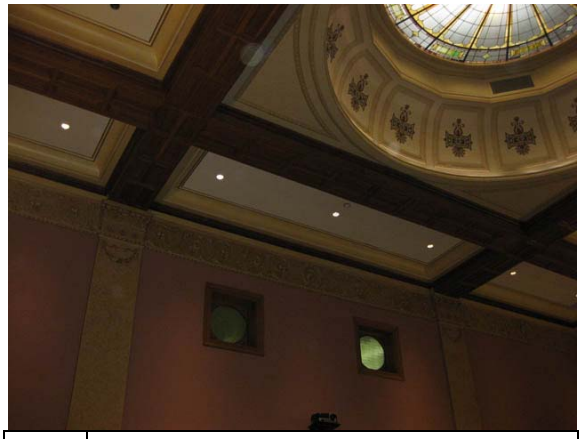


Photo #42:	Council chamber metal halide flood lights

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #43:	Exterior metal halide fixture

Photo #44:	Exterior high pressure sodium fixture

Photo #45:	CFL pole lights

Photo #46:	Typical exit sign

Photo #47:	Elevator controller and machine

Photo #48:	Gas meter

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

Photo #49:	West entry – locked

Photo #50:	Third floor door to flag balcony

Photo #51:	Fourth floor window

Photo #52:	Typical window air conditioning configuration

Photo #53:	Small window

Photo #54:	Typical window

EMG PHOTOGRAPHIC RECORD

Project No.: 93567.10R-001.269 **Project Name: City Hall**

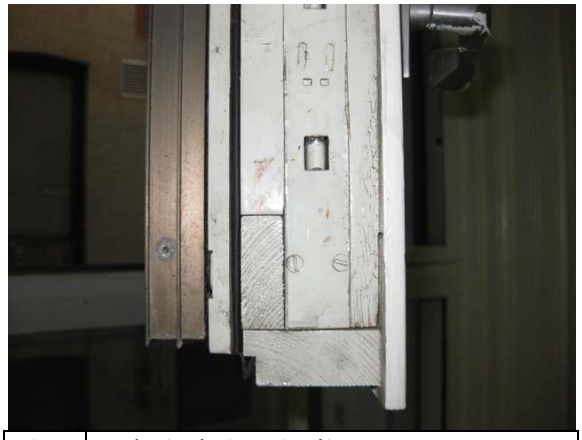


Photo #55:	Typical window detail

Photo #56:	Typical window detail

Photo #57:	Attic – note lack of insulation

Photo #58:	Attic – note lack of insulation

Photo #59:	Attic above council chamber– note lack of insulation

Photo #60:	Attic above council chamber– note lack of insulation

APPENDIX B:
SITE PLAN

THIS APPENDIX IS INTENTIONALLY LEFT BLANK.

APPENDIX C:
RECORDS OF COMMUNICATION

RECORD OF COMMUNICATION

Date:	**January 4, 2011**	**Time:**	**8:30 AM**
Project Number:	**93567.10R-001.269**	**Recorded by:**	**Alex Israel, Field Observer/Project Manager**
Project Name:	**City Hall**		

Communication with: **Adalberto Ortiz**
of: **Public Works – Maintenance**
Phone: **201.547.4432**

Communication via:

- **Telephone Conversation**
- **X** **Discussions During Site Assessment**
- **Office Visitation/Meeting at:**
- **Other:**

RE:

Summary of Communication:
Mr. Ortiz was the site point of contact and escorted EMG throughout the building and property, provided operation and maintenance information, and described building systems and use.

APPENDIX D:
GLOSSARY OF TERMS

Glossary of Terms and Acronyms

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates are typically based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR - The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost - The sum of the present values of (a) **I**nvestment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity - The sum of the total site energy use in thousand of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousand of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

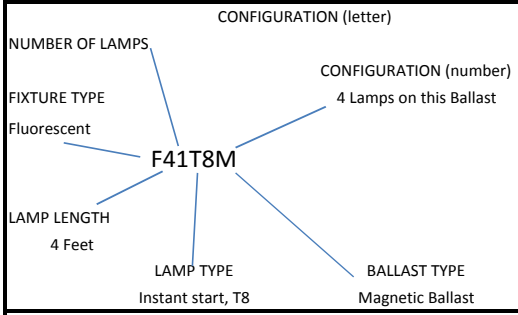
APPENDIX E:
MECHANICAL EQUIPMENT INVENTORY

Equipment	Manufacturer	Age	Location	Model/ Type	Capacity	Serves
Boiler	Smith	6	Boiler	4500A-S-22	9730 MBH	
Boiler	Smith	6	Boiler	4500A-S-22	9730 MBH	
Draft Fans	Tjernlund	6	Boiler		2 x 2 HP	
AHU/Split	Trane	13	Finance	TWE120B300CA	30 MBH	
Condenser	Trane	3	Core	XB13	2.5 T	Finance
Condenser	Trane	3	Core	XB13	2.5 T	Comp.
RTU	AAON	2	Roof	RM-020-8	20 T	Council Chamber
RTU	AAON	2	Roof	RM-020-8	20 T	Council Chamber

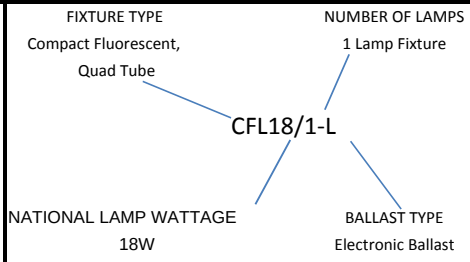
APPENDIX F:
LIGHTING SYSTEMS SCHEDULES

Fixture Code Legend and Notes

Sample Linear Fluorescent Fixture Code



Sample of Other Fixture Code:



Code Explanations

Fixture Type

CF	Compact Fluorescent
CFD	Compact Fluorescent, double-D shape
CFS	Compact Fluorescent, Spiral
CFT	Compact Fluorescent, Twin tube (including "Biaxial" fixtures)
CFQ	Compact Fluorescent, Quad tube
ECF	Exit sign, Compact Fluorescent
EI	Exit sign, Incandescent
ELED	Exit sign, LED
F	Fluorescent, linear
FC	Fluorescent, Circline
FU	Fluorescent, U-tube
H	Halogen
HLV	Halogen, Low Voltage
HPS	High Pressure Sodium
I	Incandescent
LED	Light Emitting Diode (LED) traffic signal
MH	Metal Halide
MHPS	Metal Halide, Pulse Start
MV	Mercury Vapor
QL	Induction

Lamp Type

for fluorescent fixtures

A	"F25T12" - 25 watt, 4ft, T12 lamp
IL or T8	T8, Instant start
SIL	T8, Instant start, Super 30 watt
SSIL or T8N	T8, rapid start, Super 28 watt
L	T8, rapid start
T5	T5, standard
T5HO	T5, standard, High output lamp
T12	T12, Energy efficient
EH	T12, Energy efficient, High output lamp
EI	T12, Energy efficient, Instant start
EV	T12, Energy efficient, Very high output
T12M	T12, Standard magnetic
SIL	T12, Standard, Instant start
HO	T12, Standard, High output lamp
SV	T12, Standard, Very high output lamp
T	T10, Standard

Ballast Type

for fluorescent fixtures

E	Electronic
M	Standard magnetic

Configuration (letter)

T	Tandem wired fixture
DL	Delamped fixture, i.e. some lamps permanently removed but ballasts remain

Configuration (number)

for delamped fixtures

Number signifies the total number of ballasts in the fixture: e.g. An "F42EEID2" is an "F44EE" with two lamps removed so that there is one extaneous ballast

for tandem wired ballasts

Number signifies the total number of lamps being run by the ballast: e.g. An "F42LLIT4" would indicate that a four-lamp ballast is wired to run two-lamp fixtures.

with no preceding letter

Number indicates the number of ballasts in an ambiguous multiple ballast fixture: e.g. An "F43ILU2" indicates a three-lamp fixture with two ballasts (as is often the case if there is A/B switching).

Notes:

1) The column labeled Watts/Fixtures in the data table includes ballast loads.

2) The fixture wattage values represent an average value, rounded to the nearest whole watt.

Existing Facilities Program Lighting Form:

Performance Based

Project Number:	93567.10R-001.269		
Facility Name:	City Hall		
Project Manager	Alex Israel		
Date: 1/4/2011	Square Footage (ft2)	95900	

Existing Control Legend

LS	Light Switch
PS	Photosensor
TM	Timer
MOS	Motion/Occupancy Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend

CF	Compact Fluorescent	I
F	Fluorescent, linear	LED
H	Halogen	MH
HPS	High Pressure Sodium	MV
I	Incandescent	QL

PRE-INSTALLATION

Line Item	ECM	Type of ECM Code (Refer to ECM Code Worksheet)	Additional ECM Code (if applicable)	Floor	Area Description	Light Reading (Record if ECM)	Usage	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM" if used)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ week	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
1	ECM	RB		1	Lobby/Common Areas		80	LS	17	F82T12	134	2.28	4,160	9,476
2	ECM	RB		1	Lobby/Common Areas		80	LS	4	F41T12	50	0.20	4,160	832
4	ECM	RB		0	Common Area		80	LS	15	F82T12	134	2.01	4,160	8,362
6	ECM	MS		0	Boiler Room		107.6923	LS	18	F42T8	59	1.06	5,600	5,947
7	ECM	RB	MS	0	Boiler Room		107.6923	LS	1	I60	60	0.06	5,600	336
8	ECM	RB	MS	0	Storage		60	LS	21	F82T12	134	2.81	3,120	8,780
9	ECM	RB	DL	0	Offices	550-800	50	LS	25	F44T12	144	3.60	2,600	9,360
10	ECM	RB		0	Offices	550-800	50	LS	21	FU2ES	82	1.72	2,600	4,477
11	ECM	RB		0	Offices	550-800	25	LS	6	I75	75	0.45	1,300	585
12	ECM	RB		0	Offices	550-800	50	LS	20	F42T12	72	1.44	2,600	3,744
14	ECM	RB	MS	0	Bathrooms		50	LS	10	I40	40	0.40	2,600	1,040
15	ECM	RB		0	Offices	550-800	50	LS	13	F43T12	115	1.50	2,600	3,887
16	ECM	RB		0	Offices	550-800	50	LS	16	I100	100	1.60	2,600	4,160
17	ECM	RB		0	Map Office	750	50	LS	10	F44T12	144	1.44	2,600	3,744
18	ECM	RB		0	File Storage		3	LS	6	F42T12	72	0.43	156	67
19	ECM	RB	MS	0	Bathrooms		75	LS	6	F44T12	144	0.86	3,900	3,370
20	ECM	RB	MS	0	Bathrooms		75	LS	4	I100	100	0.40	3,900	1,560
23	ECM	RB		1	Offices	760	50	LS	15	F82T12	134	2.01	2,600	5,226
24	ECM	RB		1	Offices	250-400	50	LS	4	F44T12	144	0.58	2,600	1,498
25	ECM	RB		1	Offices	250-400	50	LS	6	F82T12	134	0.80	2,600	2,090
26	ECM	RB	MS	1	Bathrooms		80	LS	4	F44T12	144	0.58	4,160	2,396
27	ECM	RB		1	Offices	250-400	50	LS	67	F43T12	115	7.71	2,600	20,033
28	ECM	RB		1	Offices	250-400	50	LS	32	FU2ES	82	2.62	2,600	6,822
29	ECM	RB		1	Offices	250-400	50	LS	15	F42T12	72	1.08	2,600	2,808
30	ECM	RB		1	Offices	250-400	50	LS	1	F22T12	51	0.05	2,600	133
31	ECM	RB		1	Offices	250-400	50	LS	2	I100	100	0.20	2,600	520
32	ECM	RB	MS	1	Storage		50	LS	7	F42T12	72	0.50	2,600	1,310
33	ECM	RB		Attic	Attic		98	TM	4	H250	250	1.00	5,096	5,096
34	ECM	RB		2	Common Area		80	LS	16	F82T12	134	2.14	4,160	8,919
36	ECM	RB		2	Mayor's Office		50	LS	15	F84T12	268	4.02	2,600	10,452
37	ECM	RB		2	Mayor's Office		50	LS	13	F44T12	144	1.87	2,600	4,867
38	ECM	RB		2	Mayor's Office		50	LS	2	F42T12	72	0.14	2,600	374

PRE-INSTALLATION

Line Item	ECM	Type of ECM Code (Refer to ECM Code Worksheet)	Additional ECM Code (if applicable)	Floor	Area Description	Light Reading (Record if ECM)	Usage	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM" if used)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ week	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
41	ECM	RB		2	Council Chambers		20	Lighting Ctrl	36	I100	100	3.60	1,040	3,744
42	ECM	RB		2	Council Chambers		20	Lighting Ctrl	30	I100	100	3.00	1,040	3,120
44	ECM	RB		2	Council Chambers		20	Lighting Ctrl	7	F81T12	60	0.42	1,040	437
46	ECM	RB		2	Offices		50	LS	4	I150	150	0.60	2,600	1,560
49	ECM	RB		3	Offices		50	LS	16	F82T12	134	2.14	2,600	5,574
50	ECM	RB		3	Offices		50	LS	111	F44T12	144	15.98	2,600	41,558
52	ECM	RB		3	Offices		50	LS	8	I100	100	0.80	2,600	2,080
53	ECM	RB		3	Offices		50	LS	2	F84T12	268	0.54	2,600	1,394
54	ECM	RB		3	Common Area		80	LS	12	F82T12	134	1.61	4,160	6,689
55	ECM	RB		3	Common Area		80	LS	3	F84T12	268	0.80	4,160	3,345
56	ECM	RB	MS	3	Bathrooms		80	LS	2	F84T12	268	0.54	4,160	2,230
57	ECM	RB	MS	3	Bathrooms		80	LS	2	F44T12	144	0.29	4,160	1,198
58	ECM	RB	MS	3	Bathrooms		80	LS	2	FC22/32/1	58	0.12	4,160	483
59	ECM	RB		All	Exit signs		168	EC	25	EI25/1	25	0.63	8,760	5,475
60	ECM	RB		All	Exit signs		168	EC	20	EI25/2	50	1.00	8,760	8,760
63	ECM	RB		Ext	Core		84	PS	1	HPS150	188	0.19	4,380	823
64	ECM	RB		Ext	Core		84	PS	1	MH250	295	0.30	4,380	1,292

Light Intensity	0.975 Watt/ ft2	**Usage Intensity**	2.75 KWh / ft2

Existing Facilities Program Lighting Form:

Performance Based

Project Name: 93567.10R-001.269

Facility Name: City Hall

Date: 1/4/2011 Project Manager Alex Israel

Existing Control Legend	
LS	Light Switch
PS	Photosensor
T	Timer
MS	Motion Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend			
CF	Compact Fluorescent	I	Incandescent
F	Fluorescent, linear	LED	Light Emitting Diode
H	Halogen	MH	Metal Halide
HPS	High Pressure Sodium	MV	Mercury Vapor
I	Incandescent	QL	Induction

												POST-INSTALLATION						
				PRE-INSTALLATION														
Line Item	**ECM**	**Type of ECM Code** (Refer to ECM Code Worksheet)	**Additional ECM Code (if applicable)**	**Floor**	**Area Description**	**Light Reading** (Record if ECM)	**Usage**	**Baseline Annual Hours**	**Existing Control**	**Pre Fixt. No.**	**Pre Fixt Code**	**Post Fixt No.**	**Post Fixt Code** (Refer to Wattable Table Worksheet)	**Post Watts/ Fixt**	**Proposed Weekly Hours**	**Proposed Control**	**kW Saved**	**Annual kWh Saved**
Integer line number	(Type 'ECM" if applied)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux (link to light standards)	hrs/ week	Existing annual hours for the usage group	Pre-installation control device	# of existing fixtures	TypWattage Table Link	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	hrs / wk	Post-installation control device	Pre kW/Space - Post kW/Space	(PreFixt #*PreWatts/Fixt * Baseline Hrs) - (PostFixt#*PostWatts/Fixt * Proposed Hours)
Ex.		*RB*		*10*	*Men's Room*		*5*	*3,000*	*Light Switch*	*3*	*F44T12*	*3*	*F42T8*	*59*		*Motion Sensor*	*0.26*	*765*
1	ECM	RB - Replace Bulb	#N/A	1	Lobby/Common Areas	-	80	4,160	LS	17	F82T12	17	F82T8	109	80.00	LS	0.43	1,768
2	ECM	RB - Replace Bulb	#N/A	1	Lobby/Common Areas	-	80	4,160	LS	4	F41T12	4	F41T8	31	80.00	LS	0.08	316
4	ECM	RB - Replace Bulb	#N/A	-	Common Area	-	80	4,160	LS	15	F82T12	15	F82T8	109	80.00	LS	0.38	1,560
6	ECM	MS - Install Motion Sensors	#N/A	-	Boiler Room	-	108	5,600	LS	18	F42T8	18	F42T8	59	39.49	MS	0.00	3,767
7	ECM	RB - Replace Bulb	MS - Install Motion Sensors	-	Boiler Room	-	108	5,600	LS	1	I60	1	CFL13	17	14.00	MS	0.04	324
8	ECM	RB - Replace Bulb	MS - Install Motion Sensors	-	Storage	-	60	3,120	LS	21	F82T12	21	F82T8	109	10.00	MS	0.53	7,589
9	ECM	RB - Replace Bulb	DL - Delamping	-	Offices	550-800	50	2,600	LS	25	F44T12	25	F43T8	89	50.00	LS	1.38	3,575
10	ECM	RB - Replace Bulb	#N/A	-	Offices	550-800	50	2,600	LS	21	FU2ES	21	FU2T8	59	50.00	LS	0.48	1,256
11	ECM	RB - Replace Bulb	#N/A	-	Offices	550-800	25	1,300	LS	6	I75	6	CFL18	26	25.00	LS	0.29	382
12	ECM	RB - Replace Bulb	#N/A	-	Offices	550-800	50	2,600	LS	20	F42T12	20	F42T8	59	50.00	LS	0.26	676
14	ECM	RB - Replace Bulb	MS - Install Motion Sensors	-	Bathrooms	-	50	2,600	LS	10	I40	10	CFL11	11	8.00	MS	0.29	994
15	ECM	RB - Replace Bulb	#N/A	-	Offices	550-800	50	2,600	LS	13	F43T12	13	F43T8	89	50.00	LS	0.34	879
16	ECM	RB - Replace Bulb	#N/A	-	Offices	550-800	50	2,600	LS	16	I100	16	CFL26	33	50.00	LS	1.07	2,787
17	ECM	RB - Replace Bulb	#N/A	-	Map Office	750	50	2,600	LS	10	F44T12	10	F44T8	112	50.00	LS	0.32	832
18	ECM	RB - Replace Bulb	#N/A	-	File Storage	-	3	156	LS	6	F42T12	6	F42T8	59	3.00	LS	0.08	12
19	ECM	RB - Replace Bulb	MS - Install Motion Sensors	-	Bathrooms	-	75	3,900	LS	6	F44T12	6	F44T8	112	10.00	MS	0.19	3,020
20	ECM	RB - Replace Bulb	MS - Install Motion Sensors	-	Bathrooms	-	75	3,900	LS	4	I100	4	CFL26	33	10.00	MS	0.27	1,491
23	ECM	RB - Replace Bulb	#N/A	1	Offices	760	50	2,600	LS	15	F82T12	15	F82T8	109	50.00	LS	0.38	975
24	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	4	F44T12	4	F44T8	112	50.00	LS	0.13	333
25	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	6	F82T12	6	F82T8	109	50.00	LS	0.15	390
26	ECM	RB - Replace Bulb	MS - Install Motion Sensors	1	Bathrooms	-	80	4,160	LS	4	F44T12	4	F44T8	112	12.00	MS	0.13	2,117
27	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	67	F43T12	67	F43T8	89	50.00	LS	1.74	4,529
28	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	32	FU2ES	32	FU2T8	59	50.00	LS	0.74	1,914

										PRE-INSTALLATION			POST-INSTALLATION						
Line Item	**ECM**	**Type of ECM Code** (Refer to ECM Code Worksheet)	**Additional ECM Code (if applicable)**	**Floor**	**Area Description**	**Light Reading** (Record if ECM)	**Usage**	**Baseline Annual Hours**	**Existing Control**	**Pre Fixt. No.**	**Pre Fixt Code**	**Post Fixt No.**	**Post Fixt Code** (Refer to Wattable Table Worksheet)	**Post Watts/ Fixt**	**Proposed Weekly Hours**	**Proposed Control**	**kW Saved**	**Annual kWh Saved**
Integer line number	(Type 'ECM" if applied)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux (link to light standards)	hrs/ week	Existing annual hours for the usage group	Pre-installation control device	# of existing fixtures	TypWattage Table Link	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	hrs / wk	Post-installation control device	Pre kW/Space - Post kW/Space	(PreFixt #*PreWatts/Fixt * Baseline Hrs) - (PostFixt#*PostWatts/Fixt * Proposed Hours)
29	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	15	F42T12	15	F42T8	59	50.00	LS	0.20	507
30	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	1	F22T12	1	F22T8	33	50.00	LS	0.02	47
31	ECM	RB - Replace Bulb	#N/A	1	Offices	250-400	50	2,600	LS	2	I100	2	CFL26	33	50.00	LS	0.13	348
32	ECM	RB - Replace Bulb	MS - Install Motion Sensors	1	Storage	-	50	2,600	LS	7	F42T12	7	F42T8	59	6.00	MS	0.09	1,182
33	ECM	RB - Replace Bulb	#N/A	Attic	Attic	-	98	5,096	TM	4	H250	4	CFL55	56	98.00	TM	0.78	3,954
34	ECM	RB - Replace Bulb	#N/A	2	Common Area	-	80	4,160	LS	16	F82T12	16	F82T8	109	80.00	LS	0.40	1,664
36	ECM	RB - Replace Bulb	#N/A	2	Mayor's Office	-	50	2,600	LS	15	F84T12	15	F84T8	219	50.00	LS	0.73	1,911
37	ECM	RB - Replace Bulb	#N/A	2	Mayor's Office	-	50	2,600	LS	13	F44T12	13	F44T8	112	50.00	LS	0.42	1,082
38	ECM	RB - Replace Bulb	#N/A	2	Mayor's Office	-	50	2,600	LS	2	F42T12	2	F42T8	59	50.00	LS	0.03	68
41	ECM	RB - Replace Bulb	#N/A	2	Council Chambers	-	20	1,040	Lighting Ctrl	36	I100	36	CFL26	33	20.00	Lighting Ctrl	2.41	2,508
42	ECM	RB - Replace Bulb	#N/A	2	Council Chambers	-	20	1,040	Lighting Ctrl	30	I100	30	CFL26	33	20.00	Lighting Ctrl	2.01	2,090
44	ECM	RB - Replace Bulb	#N/A	2	Council Chambers	-	20	1,040	Lighting Ctrl	7	F81T12	7	F81T8	58	20.00	Lighting Ctrl	0.01	15
46	ECM	RB - Replace Bulb	#N/A	2	Offices	-	50	2,600	LS	4	I150	4	CFL32	39	50.00	LS	0.44	1,154
49	ECM	RB - Replace Bulb	#N/A	3	Offices	-	50	2,600	LS	16	F82T12	16	F82T8	109	50.00	LS	0.40	1,040
50	ECM	RB - Replace Bulb	#N/A	3	Offices	-	50	2,600	LS	111	F44T12	111	F44T8	112	50.00	LS	3.55	9,235
52	ECM	RB - Replace Bulb	#N/A	3	Offices	-	50	2,600	LS	8	I100	8	CFL26	33	50.00	LS	0.54	1,394
53	ECM	RB - Replace Bulb	#N/A	3	Offices	-	50	2,600	LS	2	F84T12	2	F84T8	219	50.00	LS	0.10	255
54	ECM	RB - Replace Bulb	#N/A	3	Common Area	-	80	4,160	LS	12	F82T12	12	F82T8	109	80.00	LS	0.30	1,248
55	ECM	RB - Replace Bulb	#N/A	3	Common Area	-	80	4,160	LS	3	F84T12	3	F84T8	219	80.00	LS	0.15	612
56	ECM	RB - Replace Bulb	MS - Install Motion Sensors	3	Bathrooms	-	80	4,160	LS	2	F84T12	2	F84T8	219	12.00	MS	0.10	1,956
57	ECM	RB - Replace Bulb	MS - Install Motion Sensors	3	Bathrooms	-	80	4,160	LS	2	F44T12	2	F44T8	112	12.00	MS	0.06	1,058
58	ECM	RB - Replace Bulb	MS - Install Motion Sensors	3	Bathrooms	-	80	4,160	LS	2	FC22/32/1	2	CFL26	33	12.00	MS	0.05	441
59	ECM	RB - Replace Bulb	#N/A	All	Exit signs	-	168	8,760	EC	25	EI25/1	25	ELED3/1	3	168.46	EC	0.55	4,818
60	ECM	RB - Replace Bulb	#N/A	All	Exit signs	-	168	8,760	EC	20	EI25/2	20	ELED3/2	6	168.46	EC	0.88	7,709
63	ECM	RB - Replace Bulb	#N/A	Ext	Core	-	84	4,380	PS	1	HPS150	1	QL85	85	84.23	PS	0.10	451
64	ECM	RB - Replace Bulb	#N/A	Ext	Core	-	84	4,380	PS	1	MH250	1	QL120	125	84.23	PS	0.17	745
									Total Pre Fixt.	**698**		**698**	**Total Post kW**	**3,992.00**		**Total kW Saved**	**24.29**	**88,977.95**

APPENDIX G:
ECM CALCULATIONS

UIC	Replace External Windows
EAE2	Details: Replace external windows throughout building

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	9,960	sq.ft
Approximate number of windows:	305	
Total existing window area:	9,960	Sq.Ft
Existing U-value of window: (1/R)	0.416666667	Btu/ ft².°F·h
New U-value with Double pane Low E window: (1/R)	0.25	Btu/ ft².°F·h

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	1.15	
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.80	
Estimated Space Volume Under Consideration	1548350.00	Cu.ft
Is the Property Cooled ?	Yes	*(Select)*

WINTER

Select Type of Heating Fuel	Natural Gas	*(Select)*
Net heating plant & distribution system efficiency:	60.75	%
Annual Heating Degree Days (HDD):	4,812	
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	3155.85	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controling Air Leakage Through Windows	11265.40	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	14421.25	Therms

SUMMER

Select Type of Cooling Fuel	**Electric**	*(Default)*
Cooling Plant Efficiency (EER):	8.00	**EER**
Annual Cooling Degree Days (CDD):	1,242	
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	6185.41	Kwh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controling Air Leakage Through Windows	36345.66	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	42531.07	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel: (Cost/Unit)	$1.04	$	Annual Heating Cost Savings:	$15,063.30	$$
Insert Cost of Cooling Fuel: (Cost/Unit)	$0.19	$	Annual Cooling Cost Savings:	$7,963	$$
Total Annual Cost Savings	$23,026.71		Total Annual Cost Savings From Heating & Cooling:	**$23,027**	$$
Cost of window upgrade:	**$362,340**		Estimated Annual O&M Savings	$0.00	$
Simple payback:	**15.74**	**years**	*Type of Recommendation*	Capital Cost ECM Recommendation	

UIC	Improve Insulation Levels in Attic
EAE3	Details: Increas attic insulation to R-30 nequivalent

ENTER EXISTING CONDITION

Select Climatic Zone Related To The Property Location:	Zone-4	(Select)	ASHRAE 90.1 Attic- Insulation Requirement:	R-38	
Enter Total Surface Area Under Consideration:	23250.00	Sq.Ft	Existing Net Effective R-Value: (Sq.Ft deg F/btu)	6	
Proposed Type of Insulation To Be Added:	Loose Fill/ Cellulose	(Select)	Proposed Insulation Recommendation:	Partial Upgrade	(Select)
Recommended Level of Insulation To Be Added:	R-30		Proposed Net Effective R-Value: (Sq.Ft deg F/btu)	30	

ENTER CLIMATIC & SYSTEM DATA

Annual Cooling Degree Days (CDD):	1242.00		Estimated Annual Cooling Plant Efficiency (EER):	7.00	EER
Annual Heating Degree Days (HDD):	4812.00		Estimated Annual Heating Plant Efficiency: %	60.75	%

WINTER			SUMMER		
Select Type of Heating Fuel	Natural Gas	(Select)	Is the Property Cooled ?	Yes	(Select)
Annual Conduction Losses From Existing Insulation	447516.00	kBtu	Annual Conduction Losses From Existing Insulation	115506.00	Kbtu
Annual Conduction Losses From Proposed Insulation	89503.20	kBtu	Annual Conduction Losses From Proposed Insulation	23101.20	kBtu
Savings In Conduction Losses After Adding Insulation	358012.80	kBtu	Savings In Conduction Losses After Adding Insulation	92404.80	kBtu
Estimated Total Annual Input Heating Energy Savings	5893.21	Therms	Estimated Total Annual Input Cooling Energy Savings	13200.69	kWh
Cost of Heating Fuel/Unit: Therms	$1.04	$$	Cost of Electricity/Unit	$0.19	$$
Annual Heating Cost Savings	$6,155.59	$$	Annual Cooling Cost Savings	$2,471.66	$$

COST ANALYSIS

Estimated O&M Savings	$0.00	$$	Estimated Cost To Add Insulation on	$25,575.00	
Total Estimated Annual Cost Savings	$8,627.25	$$	Estimated Total Installation Cost	$27,621.00	$$
Simple Pay Back Period	3.20	Years	*Type of Recommendation*	Capital Cost ECM Recommendation	

UIC	Replace Non-Programmable Thermostats With New Programmable Thermostats
EAC3	Details: Install Complete DDC System With Programmable Thermostats and Steam Zone Control Valves

No of Programmable Thermostats To Be Installed : 84 Qty.

Select Type of Programmable Thermostat Recommended: 7-Day Programmable Thermostat *(Select)*
(Selection Based on Type of Property)

Heating Load Calculation

Select Type of Heating Fuel: Natural Gas *(Select)*

Estimated Total Current Annual Consumption of Energy For Winter Heating: 48900 Therms

	Weekdays	Weekends
Night Time Set Back Hours	14.00	24.00
Hours Without Set Back	10.00	0.00

Existing Indoor Temperature	79.00 °F
Day Time Temp Set Point	71.00 °F
Temp Set Point With Set Back During Night Time	63.00 °F
Average Heating Set Point	65.38 °F
Savings Per Degree Set Back For Heating Season *(Industry Standard, 2004)*	3%
Estimated Annual Heating Energy Consumption	4890000.00 kBtu
Estimated New Annual Heating Energy Consumption	2892085.71 kBtu
Estimated Annual Heating Energy Savings	19979.14 Therms

Cooling Load Calculation

Select Type of Cooling Fuel: Electric *(Default)*

Estimated Total Current Annual Energy Consumption For Summer Cooling: 0 kWh

	Weekdays	Weekends
Night Time Set Back Hours	8.00	8.00
Hours Without Set Back	7.00	12.00

Typical Indoor Temp	74.00 °F
Temp Set Point With Set Back During Day Time	85.00 °F
Temp Set Point With Set Back During Night Time	78.00 °F
Average Cooling Set Point	78.80 °F
Savings Per Degree Set Back For Cooling Season *(Industry Standard, 2004)*	6%
Estimated Annual Cooling Energy Consumption	0.00 kBtu
Estimated New Annual Cooling Energy Consumption	0.00 kbtu
Estimated Annual Cooling Energy Savings	0.00 kWh

Cost Analysis

Average Annual Cost of Heating Fuel: ($$/Unit)	$1.04 $/Therm
Average Annual Cost of Electricity: ($$/kWh)	$0.19 $/kWh
Estimated Annual Heating Cost Savings:	$20,868.64 $$
Estimated Annual Cooling Cost Savings:	$0.00 $$
Type of Recommendation	Capital Cost ECM Recommendation

Estimated Instalation Cost Per Sq Foot *(Includes Material, Labor & Installation Costs)*	$4.00 $$
Total Estimated Cost For System Installation	$344,800.00 $$
Total Estimated Cost Savings From All Programmable Thermostats	$20,868.64
Estimated Simple Pay Back Period	16.52 Yrs

UIC	**Install Outside Air (OA) Temperature Reset Controls for Hot Water Boilers**
EAC5	**Details: Replace Existing Outside Air Reset and 3-way Valve For Basement Loop**

Select Type of Heating Fuel	Natural Gas	(Select)	
Estimate Actual Heating Fuel Used Annually		9,780	Therms
Total Estimated Efficiency Gain by Reducing the Discharge Water Temperature To 120 deg F:		15%	%
Estimated New Heating Fuel Consumption With Improved System Efficiency:		8313.00	Therms
Estimated Annual Heating Fuel Savings:		1467.00	Therms
Cost Per Unit of Heating Fuel:	$$/ Therms	**$1.04**	$$
Estimated Annual Cost Savings:		$1,532	
Programming Labor Cost:		$2,607	
Simple Payback:		1.70	years
Type of Recommendation	No/Low Cost ECM Recommendation		

UIC	Install Energy Savers on Vending, Snack Machines
EAC8	Details:

No. of Vending Machines:	2.00	Qty	No. of Chilled Water Fountains:	8.00	Qty
No. of Snack Machines	0.00	Qty			

Vending Machines (Cold Beverage Vending Machines)		
Estimated Annual kWh Consumption of Vending Machine:	3500.00	kWh
Estimated Annual kWh of Vending Machine With VendMiser:	1890.00	kWh
Total annual kWh savings:	1610.00	kWh
Total Annual kWh Savings for All Vending Machines:	3220.00	kWh

Beverage Cooling Machines		
Estimated Annual kWh Consumption of Beverage Cooling Machine:	2300.00	kWh
Estimated Annual kWh of Cooling Machine With CoolerMiser:	1610.00	kWh
Total Annual kWh savings:	690.00	kWh
Total Annual kWh Savings For All Cooling Machines:	5520.00	kWh

Snack Vending Machines		
Estimated Annual kWh Consumption of Individual Snack Machine:	873.60	kWh
Estimated Annual kWh of Individual Snack Machines With VendMiser:	366.91	kWh
Total Annual kWh savings:	506.69	kWh
Total Annual kWh Savings For All Water Fountain Coolers:	0.00	kWh

Cost Analysis		
Total estimated annual kWh savings withEnergy Misers:	**8740.00**	kWh
Cost/kWh:	**$0.19**	
Estimated Cost of Vendmiser/ Vending Machine:	$200	
Estimated Cost of Coolermiser/ Water cooler:	$190	
Estimated Cost of Vendmiser/ Snack Machine:	$70	
Estimated total installed cost of all VendMisers:	**$1,920**	
Estimated Total Annual Electricity Savings Using VendingMisers and CoolerMisers:	**$1,636**	
Simple Payback:	1.17	years

Type of Recommendation Capital Cost ECM Recommendation

UIC	Replace Existing Air Conditioners with Energy Star Air Conditioners
EAH3	Details:

Please Input The Total Number of Air-Conditioners In The Building: 38 Cost/kWh: $0.19

Existing Air Conditioner		Proposed new Energy Star Air Conditioner	
Please Input the Btu/Hr of the air conditioner:	12000	Please Input The Btu/Hr of The New Air-Conditioner:	12000
The Equivalent tonnage is:	1.00	The Equivalent Tonnage Is:	1.00
Please Enput The Existing EER of The Air-Conditioner	8.00	Please Input The EER of The New Air Conditioner:	10.80
Existing kW/ton:	1.50	New kW/ton:	1.11
Estimated Annual Operating Hours:	1007.00	Estimated New Annual Operating Hours:	1007.00
Existing Annual kWh Consumption Per Air-conditioner:	1510.50	Annual kWh Consumption For New Energy Star Air Conditioner:	1118.89
Total Existing Annual kWh Consumption For All Air Conditioners:	57399.00	Total New Annual kWh Consumption For All Air Conditioners:	42517.78

Air Conditioner Cost and Energy Saving Results

Annual kWh savings for all air conditioners:	14881.22
Estimated total annual cost savings:	$2,786.32
Estimated Annual O&M Savings:	$139.32
Total Annual Cost Savings:	$2,925.64
Estimated installed cost for one air conditioner:	$400.00
Estimated installed cost for all air conditioners:	$16,416.00
Simple Payback (years):	5.89

Type of Recommendation

Capital Cost ECM Recommendation

UIC	Insulate Hot Water Tanks
EAH7	Details: Condensate tank insulation jacket

ENTER EXISTING CONDITION

No. of Tanks	1				
Type of Heating Fuel	Natural Gas	(Select)	Enter Estimated Surface Area of Tank (Sq.Ft)	56.55	Sq.Ft
Average Ambient Space Temperature Around The ExposedTank (F)	80.00	◦F	Average Temperature of Fluid In The Tank (◦F)	160.00	◦F
Estimated Annual Heating Plant Efficiency (%):	61%		Estimated Annual Hours of Operation (Hrs)	2340.00	Hrs

EXISTING STATE			PROPOSED		
Enter The Existing Net Effective R-Value of The Tank Insulation	1.00	Sq.Ft deg F.hr/btu	Enter The Proposed Net Effective R-Value of The Tank Insulation	4.00	Sq.Ft deg F.hr/btu
Annual Conduction Losses From Existing Insulation	10585.91	kBtu/Yr	Annual Conduction Losses From Proposed Insulation	2646.48	kBtu/Yr

ENERGY SAVINGS

Estimated Energy Savings	7939.43	kBtu	Estimated Total Annual Input Heating Energy Savings	13069.03	kBtu
Cost of Heating Fuel/Unit:	$1.04	$$	Estimated Total Annual Input Heating Energy Savings	130.69	Therms

COST ANALYSIS

Estimated Cost For Adding Insulation	$921.74	$$	Total Annual Estimated Cost Savings	$136.51	$$
Simple Pay Back Period	6.75	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

UIC	**Replace Defective Steam Traps**
EAH10	**Details:**

Annual heating natural gas usage:		39120.00	therms
Name plate thermal efficiency of the steam boiler system:		81.00%	
Estimated current distribution system efficiency with defective traps:		75%	
Total aggregated available kBtus for heating at the radiators/load:		2376540.00	kBtu
Estimated new distribuion system efficiency with new steam traps:		85%	
Estimated annual heating natural gas usage with new steam traps:		34517.65	therms
Estimated natural gas savings with new steam traps:		4602.35	therms
Annual average cost of natural gas:		**$1.04**	
Estimated annual heating cost savings:		$4,807	
Estimated installed cost of steam traps:	cost/trap:	$100	
	Total No. of traps to be replaced:	40.00	
	Total project cost:	$4,000	
Simple payback:		0.83	years

Type of Recommendation Capital Cost ECM Recommendation

UIC	**New Natural Gas/Propane Fired Water Heater**
EAD3	**Details: Replace existing water heater With NG fired water heater**

	Number of Water Heaters Being Replaced:	2	
	Size of Existing Water Heater Storage Tank:	100	gallons
Step 1	**Existing Water Heater Details**		
	Select Existing Hot Water Heater Fuel	Electric	
	Input Existing Water Heater Input Rating	5.38	kW
	Input Annual Hours of Operations	1,040	hrs
	Estimated Annual Current Hot Water Heater Energy Consumption	5,595	kWh
	Total Estimated Annual Operating Energy Costs	$1,047.63	$
Step 2	**Proposed New Natural Gas Fired Water Heater**		
	Select Proposed Hot Water Heater Fuel	Natural Gas	
	Enter Energy Input Per Hour in kBtu For New Water Heater	18.36	kBtu/hr
	Proposed Annual Hours of Operations	1,040	hrs
	Annual kBtuh Consumption of the Proposed Water Heater	19090.82	kBtuh
	Estimated Annual Water Heater Fuel Consumption	191	Therms
	Estimated Annual Energy Costs	$199.41	$
Step 3	**Energy & Cost Saving Calculation**		
	Estimated Cost of New Water Heater/Unit	$1,100.00	$$
	Estimated Installation Cost Per Heater	$325.00	$$
	Total Estimated Installation Cost	$3,078.00	$$
	Total Estimated Annual Cost Savings	$848.22	$
	Simple Pay Back Period	3.63	Years
	Type of Recommendation	Capital Cost ECM Recommendation	

UIC	Replace Existing Lamps With Energy Efficient Lamps								
EAL 1B	**Details: Replace incandescent bulbs with CFL bulbs**								
Step:1	Current Wattage of Lamp		**75.00**	watt	**100.00**	watt	**150.00**	watt	**250.00**	watt
Step:2	Proposed Replacement		18.00	watt	26.00	watt	32.00	watt	55.00	watt
Step:3	Number of Lamps to Be Replaced		6.00		92.00		4.00		4.00	
Step:4	Total labor Cost For Replacing lamps *Estimated Rate of $35/hr To Replace 20 Lamps/Hr*		$10.50	$$	$161.00	$$	$7.00	$$	$7.00	$$
Step:5	Estimated Annual Energy Savings		382.00	kWh	9128.00	kWh	1154.00	kWh	3954.00	kWh
Step:6	Estimated Cost Per Lamp	*(Select)*	$4.50	$$	$4.50	$$	$6.50	$$	$15.00	$$
Step:7	**Cost For Retrofit**		$37.50	$$	$575.00	$$	$33.00	$$	$67.00	$$
Step:8 A	Current Annual Hours of Operation		1300.00	hrs	1482.00	hrs	2600.00	hrs	5096.00	hrs
Step:8 B	Proposed Annual Avg. Hours of Operation		1300.00	hrs	1482.00	hrs	2600.00	hrs	5096.00	hrs

Step:8	Total Initial Investment For Retrofit	$769.50	$$	Total kWh Saving	14618.00 kWh
Step:9	Current Electric Tarriff Per kWh	**$0.19**	$$	Total Annual O&M Savings	$265.63 $$
Step:10	Estimated Annual Cost Savings	3002.663659	$$		
Step:11	Simple Pay back Period	0.26	Yrs		

Type of Recommendation — No/Low Cost ECM Recommendation

UIC	**Replace Linear Fluorescent T12 Lamps With T8 Lamps**
EAL2	**Details:**

And Replace Magnetic Ballast With Electronic Instant Start Ballast

Step: 1	Number of T12 lamps to Be replaced by T8's	1371	
Step 1.1	Number of Fixtures Modified	468	
Step:2	Price Per Lamp	$5.00	
	TOTAL	$6,855.00	
Step 2.1	Are both the lamps AND Ballast being replaced?	Yes	
Cost for Just Replacing Bulb			
Step2.2	Labor Cost of Replacing T12 to T8 (12 fixtures/Hour)	$0.00	
(Step 2 is applicable if just the lamps are being replaced and not the ballast)			
Cost for Replacing Bulb and Ballast			
Step:3	Number of Ballast To Be Replaced	468	
(There Exist Only One Ballast Per Fixture (not per lamp). T8 only run on			
Step:4	Price of a New Instant Start Electronic Ballast	$20.00	
	SUBTOTAL	$9,360.00	
Step:5	Labor Cost **Per** Fixture To Replace Ballast & Lamps	$50.00	
	SUBTOTAL	$23,400.00	
	TOTAL ESTIMATED COST FOR RETROFIT	$42,784.20	
Step:6	Total Energy Saved	35202.00	kWh
Step:7	Existing Electric Tariff per kWH	**$0.19**	$
Step:8	Estimated Annual Cost Savings	$6,591.13	
Step:9	Estimated Return on Investment	6.49	Years

Type of Recommendation Capital Cost ECM Recommendation

UIC	Replace Lamps And Install Lighting Controls
EAL3	Details: Restrooms and Storage Rooms

Total Number of Restrooms		9
Total Number of T12 lamps to Be replaced by T8's in All Restrooms		112
Total Number of Incandacent Lamps to be replaced with CFL's		16
Total Number of Fixtures To Be Retrofitted with Rapid Start Ballast		42
Are Ballast being replaced?		Yes
Total Number of Occupancy Sensors To be Installed		9
Price Per Lamp $6.00/CFL Lamp & $3.00 /T8 Lamp		
Cost / Rapid Start Electronic Ballast		$35.00
Type of Occupancy Sensor	Wall Mounted Occupancy Sensor	(Select)
Cost of Individual Occupancy Sensors		$55.00
Total Material Cost		$2,357.00

LABOR COSTS

Total Labor Cost For Installing Occupancy Sensors ($ 65X)	$585.00
Total Labor Cost For Replacing Ballasts ($50X)	$2,100.00
Labor Cost For Replacing CFL Lamps ($65/20 Lamps)	$52.00
Total Labor Cost For Replacing Individual Linear Fluroscent Lamps ($65/12 Lamps)	$0.00
Total Labor Costs	$2,737.00
TOTAL INSTALLATION COSTS	$5,501.52

Total Energy Savings From Retrofits in Restrooms:	19,849	kWh
Insert Current Tariff Rate For Electricity	**$0.19**	$$
Total Cost Savings	$3,716.48	
Simple Pay Back Period	**1.48**	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

UIC	**Install Automatic Lighting Controls**		
EAL5	**Details: Install Boiler Room Motion Sensors**		
	Type of Sensor	Ceiling Mounted Occupancy Sensor	
Step: 1	Total Number of Sensors	3	
Step: 2	Purchase Cost/Lighting Control Sensors	$135	
Step: 3	Installation Cost /Sensor	$65	
Step:4	Total Installation Costs	$648.00	
Step:5	Total Energy Savings	4090.00	kWh
Step:6	Electric Tariff Rate	**$0.19**	$
Step:7	Total Cost Savings	$765.80	
Step:8	Simple Pay Back Period	0.85	Years
Type of Recommendation		No/Low Cost ECM Recommendation	

UIC	Replace Exit Signs With LED Exit Signs
EAL7	**Details:**

Total Existing Fixtures:	45	
Currrent Watts/ Fixture:	36	Watts
Annual Hours of Operation *(24hrsx365 days):*	8760	Hrs
Total Annual Energy Consumption:	14235.00	kWh
Insert Current Tariff Rate For Electricity:	$0.19	$$
EMG Recommends:	**Replace Incandescent Lamps With LED Lamps**	
Number of Lamps To Be Replaced With LED Lamps: *(3W/Fixture)*	65	(Qty)
Total Material Cost of Replacement $5/2 lamps: *Source www.1000bulbs.com*	$325.00	$$
Estimated Annual Energy Consumption By Replacing Lamps Keeping The Same Fixture:	1708.20	kWh
Total Cost Savings:	$319.84	$$
Total Labor Costs For Retrofit:	$284.38	
Estimated Total Investment:	$658.13	$$
Estimated Annual Energy Savings From EXIT Sign Retrofits :	12526.80	kWh
Estimated O&M Savings From The Proposed Retrofit: *(Average Life of Incandescent Lamps in Exit Fixtures is 2000 hrs)*	$1,251.04	$$
Estimated Total Cost Savings:	$3,596.52	$$
Simple Pay Back Period:	**0.18**	
Type of Recommendation	No/Low Cost ECM Recommendation	

UIC	**Reduce Light Levels By Delamping of Lamps**		
EAL8	**Details:**		
No of Incandescent lamps to be removed		0	Qty
No. of Linear Fluroscent Lamps To Be Removed		25	Qty
No. of Fixtures To Be Delamped		25	Qty
Estimated Cost of Delamping			
(Assuming Labor Charge of $65/hr)			
Delamping of Incandescent Lamps *($65/30 Lamps)*		$0.00	$
(Assuming Lamp Location at a 8-10' Ceiling Height)			
Delamping of Linear Fluroscent Lamps *($65/20 Lamps)*		$81.25	$
(Assuming Lamp Location at a 8-10' Ceiling Height)			
	Total Estimated Delamping Cost	$87.75	$
Total Energy Saved		1885.00	kWh
Existing Electric Tariff per kWH		**$0.19**	$
Estimated Annual Cost Savings		$352.94	$
Estimated Return on Investment		0.25	Years
Type of Recommendation	No/Low Cost ECM Recommendation		

UIC	**Replace High Intensity Discharge Lamp (HID) with Induction Lighting**
EAL9	**Details:**

Step:1	Number of 60-100W HID Lamps Replaced by 40W Induction	0	
	Number of 100-150W HID Lamps Replaced by 70W Induction	0	
	Number of 150-200W HID Lamps Replaced by 85W Induction	**1**	
	Number of 200-250W HID Lamps Replaced by 120W Induction	**1**	
	Number of 250-300W HID Lamps Replaced by 165W Induction	**0**	
	Number of 300-400W HID Lamps Replaced by 250W Induction	**0**	
	Number of 1000W HID Lamps Replaced by (2)300W Induction Lamps	**0**	
	Installation Cost Analysis		
Step:2	Subtotal Cost of 40 Watt Induction Self Ballast Retrofit	$0	
Step:3	Subtotal Cost of 70 Watt Induction Retrofit	$0	
Step:4	Subtotal Cost of 85 Watt Induction Retrofit	$385	
Step:5	Subtotal Cost of 120 Watt Induction Retrofit	$285	
Step:6	Subtotal Cost of 165 Watt Induction Retrofit	$0	
Step:7	Subtotal Cost of 250 Watt Induction Retrofit	$0	
Step:8	Subtotal Cost of 300 Watt Induction Retrofit	$0	
Step:9	**Total Cost For Retrofit**	$723.60	
	Energy & Cost Saving Analysis		
Step:10	Estimated Annual Energy Savings	1192.00	kwh
Step:11	Current Electric Price Per kWh	**$0.19**	$
Step:12	Estimated Annual Cost Savings	$223.19	
Step:13	Existing Annual Usage *(For O&M Savings)*	4380	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	4380	hrs
	Estimated Annual O&M Savings	$30.66	$$
Step:14	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$253.85	$$
Step:15	Simple Pay back Period	2.85	Yrs

Type of Recommendation No/Low Cost ECM Recommendation

NOTE: Induction Lamps contain 3 to 4 times the life of HID lamps where significant Operation and Maintanence Savings are attained through minimizing frequency of bulb and ballast replacements

APPENDIX H:
SOLAR PV AND DHW ANALYSIS RESULTS

Solar Energy Feasibility

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current electricity via the photovoltaic effect. The power that one module can produce is seldom enough to meet requirements of a home or a business, so the modules are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can plug into the existing infrastructure to power lights, motors, and other loads. The modules in a PV array are usually first connected in series to obtain the desired voltage; the individual strings are then connected in parallel to allow the system to produce more current. Solar arrays are typically measured by the peak electrical power they produce, in watts, kilowatts, or even megawatts.

When determining if a site is suitable for a solar application, two basic considerations must be evaluated:

At minimum, the sun should shine upon the solar collectors from 9 AM to 3 PM. If the duration is less, the application may still be worthwhile, but the benefits would be less.

The array should face south and be free of any shading from buildings, trees, rooftop equipment, etc. If the array is not facing directly south, there will be a penalty in transfer efficiency, reducing the overall efficiency of the system.

Photovoltaic cells have been powering satellites the US Space program for 50 years. PV dependably powers critical systems in the armed forces, ships at sea, US highway control systems as well as our watches and calculators. It is a simple dependable technology.

A photovoltaic array is a linked collection of photovoltaic modules, which are in turn made of multiple interconnected solar cells. The cells convert solar energy into direct current. Modules of cells are linked together to form an array. Most PV arrays use an inverter to convert the DC power produced by the modules into alternating current that can connect to existing AC infrastructure to power lights, motors, and other loads.

Solar PV Questionnaire	Response
Does the property have a south facing roof or available land of more than 250 square feet per required Solar Array Panel?	**Y**
Is the area free from any shading such as trees, buildings, equipment etc. throughout the whole day?	**50% of roof**
Can the panels be mounted at an incline of roughly 25-45 degrees? (equal to latitude of property)	**Y**
Is the property in an area with acceptable average monthly sunlight levels? http://www.verdeenergy.com/InsolationMap.pdf	**Y**
Has the roofing been replaced within the past 3-5 years?	**N**
Is the roof structure sufficient to hold solar panels?	**Unknown**
Is the property located in a state eligible for net metering? http://www.verdeenergy.com/SolarNetMetering.pdf	**Y/N**

The analysis through the use of National Renewable Energy Laboratory's solar photovoltaic software assisted in calculating the potential electricity generated from the allocated roof area set for solar photovoltaic installment. The allocated roof area was through looking at the roof and surrounding areas at a bird's eye view. Also detailed in the report are incentives and rebates that can potentially bring down the installation cost of the ECMs and result in a higher return on investment and quicker payback period.

The approach taken in the solar photovoltaic (PV) roof analysis begins with.

1) Surveying the roof and determine areas on the roof where solar PV panels can potentially be installed
2) Conducting a preliminary sizing of solar PV panels on the roofs and its potential electricity production for its first year of installment using the National Renewable Energy Laboratory (NREL) PV WATTS Version 2 Software.
3) Calculate energy and cost savings for the site as a sole proprietor of the system and as a property owner offering the roof to multiple investors. It should be noted that certain parts of the country have Third party Investors are capable of collecting state, local, and federal tax credits and incentives and interconnecting and selling the renewable energy electrical production to the building.

Cost of production has fallen years with increasing demand and through production and technological advances. The cost dropped from $8–10/watt. The market is diversifying with new types of panels suited to unique installation methods including stick on sheets and PV spray coating. The solar PV cost used in the analysis was set at $9.00/Watt which includes installation and maintenance cost throughout the life of the solar panels.

One breakthrough for PV is "Net Metering". When more PV electric power is generated than is consumed on site, the electric service meter reverses to "sell" the excess power directly back onto the power grid. Germany has created a booming PV build-out industry simply by mandating that excess power sold to the grid is valued at a substantially higher rate that the consumer pays. A kilowatt-hour costing $0.15 might be valued at $0.30 when produced by PV and sent to the grid. The economics of PV for commercial industrial installations become attractive when coupled with incentives from Federal and state agencies, as well utility companies.

The low payback period is highly dependent on the marketing potential of selling Solar Renewable Certificates to electricity generated providers who are under state regulations to contain a certain percentage of their electricity generation derived from renewable energy such as wind and solar.

Solar facilities are encouraged to sell their SRECs on the market (either spot market or through long-term contracts). Utilities may use SRECs for compliance under the state RPS for the year in which they are generated. Utilities may purchase up to 10% more SRECs than they require for compliance and "bank" those surplus SRECs for compliance during the following two years. Any SRECs pricing can range from $300 - $450/MWh and can be sold across state borders to other utility providers looking to purchase SRECs. EMG has selected to use the market value of $300/MWh minus 5% administrative fee in the analysis.

Maryland and other states and corresponding electrical utility supplier are required under regulation to have a certain percentage of its electricity be produced by solar energy. To offset that they allow Pepco and other utility companies to buy Renewable Energy Credits (REC) credit off their customers and facilities that produce their own solar energy. After speaking with the Maryland Public Commission, they charge $400 per MWh to Maryland and Utility Suppliers for not meeting this standard percentage so these REC credits are sold for $350 per MWH. (1 REC credit = 1 MWH).
Maryland charges these utility companies to meet their state compliance of 0.2% of the entire electricity consumption from solar energy by 2022 (from.005% in 2008 aggregated up to 0.2% by 2022). The REC credits correspond to these percentages as they aggregate each year.

[1] (http://www.dsireusa.org/incentives/?State=US&ee=1&re=1)
[2] (http://energy.maryland.gov/incentives)
[3] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD55F&re=1&ee=1

The annual performance of a solar water heating system with a storage tank is dependent on system characteristics, solar radiation available, ambient air temperature and on heating load characteristics. We have used the following assumptions to build the estimate:

- Water heater fuel type: Dependent on Building existing plumbing and mechanical system
- Equivalent electricity (kWh) produced by solar is calculated using SRCC OG-100 ratings with the following assumptions:
- Water heater thermostat is set at 120°F (48.9°C)
- Solar collector type: 3 sq-meter. Glazed, indirect flat-plate type for centers.
- Solar collector slope and azimuth: Set at Latitude of installation, South facing
- Solar Fraction=79.44%. Sized for 100% solar water heating in the peak solar month.
- Shading: None
- Ambient air temperature: 58 °F
- Cold-water temperature: Same as average ambient temperature
- Heating load characteristics: Solar used 100% of every month to supplement domestic hot water heater
- Losses due to soiling, piping, solar tank or heat exchanger: 20% (80% of SRCC OG-100 production rating).
- Average wind speed and relative humidity: per SRCC OG-100 test conditions

Other Assumptions:

- Daily volumetric load is constant over the season of use.
- Preheating of water; it does not consider standalone systems that provide 100% of the load. For service hot water systems without storage, only low solar fractions (and penetration levels) should be considered as it is assumed that all the energy collected is used.
- Sun tracking and solar concentrator systems are not evaluated with this model

Tax Credits and Incentives for Solar PV and Solar Hot Water:

Since City Hall is a public entity, it does not qualify for certain tax credit and incentives. Outside investors who take ownership of the solar energy project can qualify for these incentives and attain quicker return on their investment. The types of state and federal tax credits applicable to solar PV are listed below:

Federal Incentives[1]

- **Renewable Energy Production Incentives (REPI)** – 1.5 cents / kWh produced for first 10 years
- **U.S. Department of Treasury – Renewable Energy Grant** – 30% of the installment cost
  Or
- **Business Energy Investment Tax Credit** (ITC) – 30% of expenditures

State Incentives[2]

- **Public Utility Commission Solar Renewable Certificates** (SRECS) – Solar Credits purchased from Electricity suppliers who must purchase solar renewable energy credits (SRECs) in order to meet their compliance obligations under the law, or pay a Solar Alternative Compliance Payment (SACP) for any shortfalls in SREC purchases ($300/MWH).

PEPCO Commercial & Industrial Custom Incentives Program – PEPCO offers a pricing of $0.05 / KWh saved for custom retrofit projects that reduce KW demand and KWH consumption

Solar PV Analysis

UIC	Install Rooftop Solar Photovoltaic System		
EARE1	Details:		
	Type of System : Fixed Tilt Solar PV Array Analysis for Flat or South, SE, SW Facing Roof Space		
Step: 1	Building Roof Square Footage	24,957	ft^2
Step: 2	Does the Roof contain at least 33% of Open Area for Solar PV? (Y/N)	Y	
	If not, what percentage?		
	Building's Annual Electricity Consumption	76,200	KWh
Step: 3	Roof Area for Fixed Tilt PV Array	8,236	ft^2
Step:4	DC Rating of PV System (10.4 Watts/ft^2)	85.7	KW
Step:5	Total Estimated Electricity Generated	103,759	kWh
Step:6	Electric Tariff Rate	**$0.19**	$
Step:7	Total Cost Savings	$19,714.28	
Step:8	Installation Cost: ($7.0/Watt)	$599,567	$
Step:9	Simple Pay Back Period without Incentives	30.4	Years
			$
Step:10	Simple Pay Back Period with Incentives	30.4	Years

Solar Hot Water Analysis

Solar hot water analysis results are pending.

APPENDIX I:
SUPPORTING DOCUMENTS

THIS APPENDIX IS INTENTIONALLY LEFT BLANK.