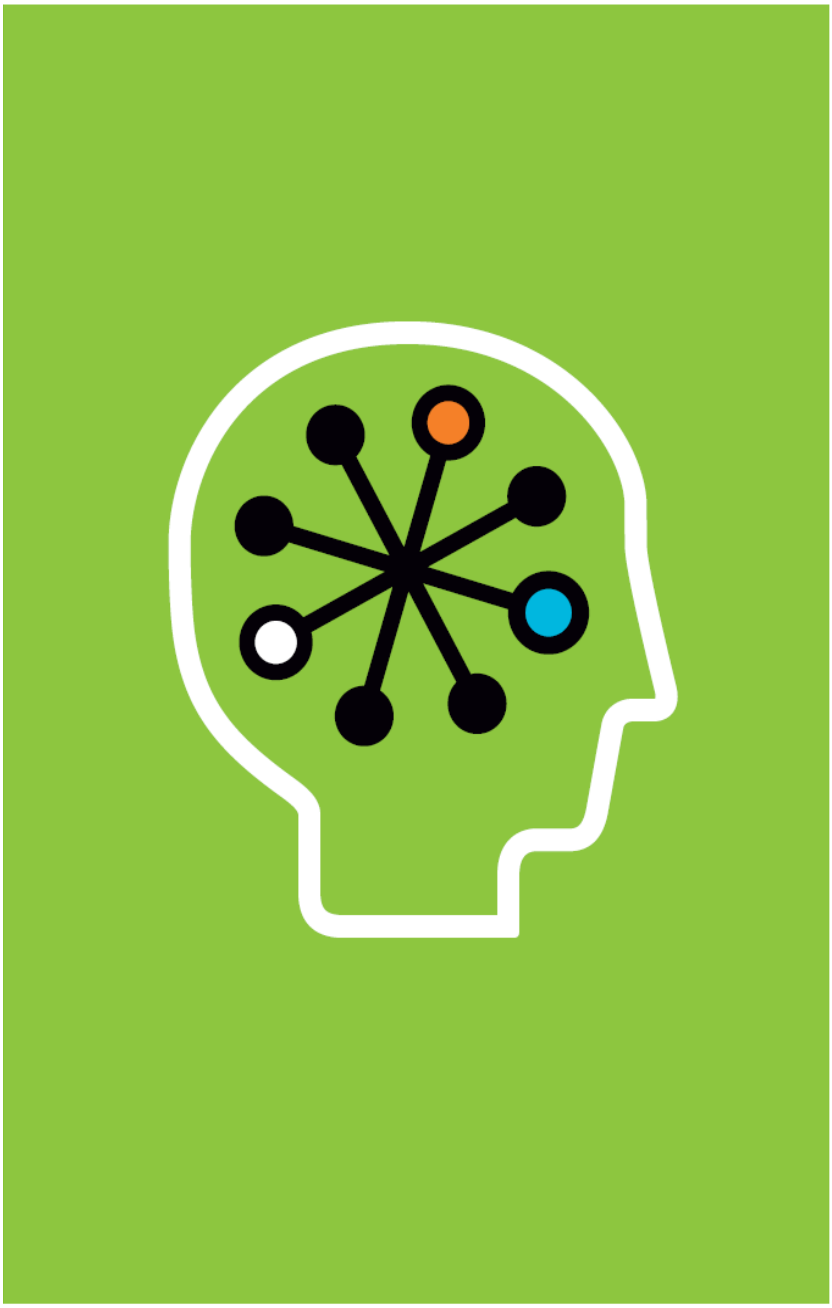

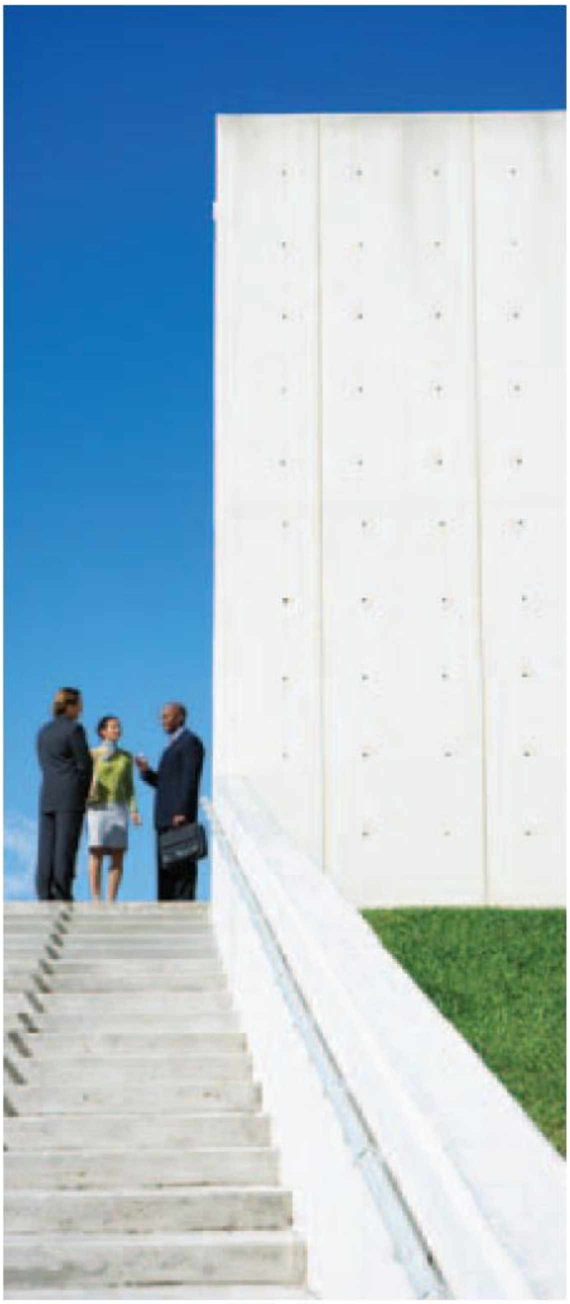

High Level Business Case for an EEMS System

City of Boston

August 10, 2012

I. Document Control

Revision History

Version	Date	Author	Revision Summary
1.1	07/16/12	Bill Kosik, PE, CEM, LEED AP, BEMP	Final Version
1.2	8/10/12	Bill Kosik, PE, CEM, LEED AP, BEMP	Revision based on City comments

Key Contributors

Department	Role	Name
HP CFS AMS	Consultant	Bill Kosik, PE, CEM, LEED AP, BEMP
HP CFS Worldwide	Consultant	Munther Salim, Ph.D., CEM, LEED GA

Approval / Verification

Role	Date	Name
Global Energy & Sustainability Practice Leader	07/16/12	Munther Salim, Ph.D., CEM, LEED GA

II. Contents

1. Executive Summary

Overview

HP was engaged to assist the City of Boston in a process to build a business case for the implentation of an EEMS. The goal of the buiness case is to look at elements, financial and non-financial, that would impact the decision to acquire an EEMS. Analyses on current and projected energy costs, potentials in energy efficiency savings, current City costs for handling utility billing, and others were developed to generate inputs to the financial model.

Some of the subjective elements that do not necessarily have a direct financial savings, but certainly can demonstrate efficiency in processes and reporting, are as follows:

Strategic Alignment - In order to find energy efficiency and effectiveness opportunities and how they relate to the City's overall energy and sustainability plan, the EEMS can construct a systematic process for aggregating, organizing and analyzing data. This includes providing solutions for data gaps, establishing KPIs and building benchmarks to help the City understand both excellence in energy efficiency and areas that need improvement.

Planning for Capital and Operational Expenditures - Capital and operational budget planning will enable the City to generate concrete plans of action to optimize the energy efficiency and savings identified by the EEMS. These plans include the creation of multi-year energy efficiency plans with specific targets, budgets, and timelines that reconcile business-as-usual scenarios with optimization goals.

Implementation and Validation - This enables organizations to track, monitor and review projects throughout their lifecycle, verify savings and match organizations with financing options and vendors for implementation.

Validation and Departmental/Building Allocation of Utility Billing – Using data acquisition techniques, the EEMS can integrate utility bill data, usage data from building systems, meters, sub-meters and other assets, and reference other operational data, such as financials, which can be used as intensity factors and KPIs.

Results and Recommendations

The results of the return on investment (ROI) analyses show a favorble return for the acquisition of an EEMS system for the City of Boston. Of the three types of EEMS systems analyzed, the SaaS cloud delivery method yielded the best return, showing a five-year ROI of 158% when all ECM projects are implemented, and five-year ROI of 35% when only no/low cost ECM projects are implemented.

Based on the satisfactory outcome of the analyses and also taking into account the indirect benefits of the EEMS, it is our recommendaton that the City of Boston move forward with the development of a request for information (RFI) from the EEMS vendors identified in the "Market Assessment" report developed by HP dated 6/22/2012. The information obtained from the RFI will start to narrow down the best options for the City of Boston.

2. Introduction

2.1. Purpose

The City of Boston is in the process of developing technology requirements and a business justification for an Enterprise Energy Management System (EEMS) capable of consolidating Department- and Agency-wide energy related data, including sources, costs, and monitoring. The EEMS will be the "single copy of the truth" contained in a single system of record. Additionally, an EEMS provides capabilities around data collection, analysis, management and reporting through standard energy reporting protocols.

It is not unusual for large municipalities to have myriad complexities in monitoring and analyzing energy use due the diverse types of operations in the agencies, departments, and buildings as well as the geographic diversity of the buildings that house the City functions. It is:

- challenging to segment energy use and performance data throughout the City's organizational structure in some instances; and
- difficult to separately define whole-building energy use for facilities, sub-meters installed in locations such as offices, fire stations, and schools, or all boilers, chillers, and cooling towers) automatically, from a central management system.

Also, tracking energy use and performance is not always transparent. There is:

- a need to set energy use and cost targets based on historic, baseline or industry best practice values; and
- an advantage to allocate cost data from one account or meter to other departments or agencies, giving flexibility as programs move to different locations.

And after energy efficiency measures that reduce energy use are identified, another benefit will come from having the ability to standardize performance results of capital improvement projects that are designed to reduce or optimize energy use. This will enable the City to:

- make informed decisions regarding optimal efficiency ratings of equipment and systems; and
- verify proper equipment sizing through performance analysis after the capital projects are in place.

2.2. Scope

The market is crowded with EEMS vendors that offer systems that are each unique in their capability and each having different levels of sophistication. One report by HP dated 6/22/2012 (issued as a part of this project) entitled "High Level Market Assessment of Enterprise Energy Management Systems" provides insight into the offerings of the different EEMS vendors and high level information on the products offered by the company. Some have very robust monitoring, analytic and reporting capabilities geared for large, international corporations that have multiple locations. Others are more streamlined and used primarily for capturing energy use data at the utility meter, with little capability for granular analysis and reporting. The scope of this project is to develop a business case as a justification for the acquisition of an EEMS product.

2.3. Objectives

As described in the original Statement of Work (SOW), the primary requirements of this study are to generate data on:

- ongoing energy consumption costs for the city government operations;
- projected energy costs for a "business as usual" scenario for 5 years including low, expected, and high forward price scenarios;
- initial up-front cost estimates for an EEMS including licensing fees, installation costs, city staff resource requirements, and on-going maintenance costs; and
- projected energy cost savings based on ranges observed in other EEMS implementations.

These and other key data sets will be presented for further analysis and ultimately, EEMS procurement.

3. Summary of Study Results

In addition to the functionality in standardizing energy use and utility cost analysis and reporting, the main focus of the study is to identify areas where an EEMS could reduce operational costs for the City of Boston. The main areas of cost reductions come from the following process efficiencies:

- Increase in administrative efficiency in the analysis, auditing and cost allocation to the different departments and agencies within the City.

- Identification of additional energy efficiency projects based on analysis of KPIs associated with the different departments and buildings. While these upgrades have a capital cost component, there is a leveraging of funds made available for other improvement projects.

- Reduction of ongoing energy costs as a result of the energy efficiency upgrades. This constitutes a significant annual savings of energy and cost.

Based on the direct financial parameters listed above, and other indirect parameters, the EEMS will bring financial value to the City of Boston, having an ROI as high as 158% over a five-year period and a simple payback of fewer than five years. Based on the analysis contained in this report, it is recommended that the City continue the process, and pursuant to public procurement laws, request information from vendors in an attempt to narrow the number of EEMS vendors.

4. Description of Approach

4.1. Study Basis

4.1.1. Criteria

As mentioned in the introductory section, there are four main areas that this report will focus on: 1) current energy consumption; 2) projected energy consumption; 3) capital costs to implement an EEMS system; and 4) projected cost savings after implementing the EEMS. The analysis of investment decisions and life cycle costing are closely related methods for evaluating investments involving initial expenditures for equipment, installation, service and/or training, etc. that will have future benefits or will impact future costs. In business financial management the process of evaluating and choosing from among such investments is termed capital budgeting. In engineering economic analysis this process is referred to as "economic evaluation of investment proposals" or as “comparison or selection of alternatives." All of these terms refer to a common body of analytical techniques that are essential tools for investment decision making by government, private agencies, homeowners or business firms. Any IQP or MQP which recommends or evaluates courses of action involving investments requires the use of these techniques to support its conclusions.

The types of data and analytics that fit into a financial analysis or business case are termed direct impacts, meaning it is evident how the item does/does not support a financial decision-making process; there is objective evidence to use when making decisions. However, other parts of a business case that do not fit well into a financial analysis are termed indirect impacts, meaning that there might not be a direct financial impact that can be analyzed. Only until after the item is in place can it be measured for impacts on efficiency and effectiveness. Indirect impact items are often the most difficult to assess using analytic methods and the effectiveness will usually be judged based on experience and instinct.

4.1.2. Assumptions

Some of the primary assumptions used in this report are as follows:

- In a report by HP dated 6/29/2012 (issued as a part of this project) entitled "City of Boston Energy Consumption Assessment Report, Summary of findings, analyses and conclusions of 50 reviewed buildings" (the "Energy Consumption Assessment Report") energy data from 50 of the City's top energy-consuming buildings were reviewed and benchmarked against energy consumption data from buildings with similar geography, size, and use. In addition to the benchmarking completed for the report, data was developed on building area (measured in square feet - SF), electricity consumption (measured in kilowatt-hours per square foot of building area - kWh/SF), and natural gas consumption (measured in cubic feet of natural gas per square foot of building area - CF/SF).
- Data from U.S. Energy Information Administration (EIA) is used to study the current electricity and natural gas rates as well as make projections on the cost of these utilities over a five-year period.
- The EIA, more specifically data from the Commercial Buildings Energy Consumption Survey (CBECS) under the purview of the EIA, is used for further,

more granular benchmarking. Data for similar building types as the ones in the City's portfolio were used to analyze electricity and natural gas use for the subsystems in the building (space heating, cooling, ventilation, water heating, lighting, cooking, refrigeration, office equipment, computers, and other). With this data it is possible to estimate for the purposes of this report which subsystems in the City's buildings are using the largest percentage of the total energy consumption of the building. This was done primarily as a proof-of-concept, yielding percent overages in energy use when compared to the CBECS data.

- Assumptions on the number of City personnel that are involved in the process chain of analyzing, auditing and allocating energy costs attributable to the departments and buildings. The data on the number of personnel, percent of time allocated to dealing with energy issues and utility billing, and average salary information was provided by the City. With this information, assumptions on number of personnel required for the EEMS and potential reduction in time were developed for the financial analysis

4.1.3. Methodology

Analysis of building energy consumption

As a recap, the energy use data contained in the "Energy Consumption Assessment Report" was developed to:

- assign buildings to categories of facilities, schools, administration, libraries, and public safety;
- total the electricity use in kWh and natural gas use in CF - these values are the usage values; and
- calculate the kWh/SF and CF/SF of each building based on the area - these values are the intensity values.

The CBECS data details the breakdown of energy consumption by end use (space heating, cooling, etc.). Applicable end use percentages were applied to the 50 City buildings, included in the 'Energy Consumption Assessment Report." Having the percentage breakdown of the end uses allows for a comparison of how the City's buildings perform against the CBECS data, and can be used to generate order of magnitude energy savings potential.

The results of this type of analysis will lead to indicators, when used across a large building portfolio such as the City's, which will result in hypotheses on how to reduce energy consumption within the different building types. (However, to make more accurate, audit-grade suppositions, detailed energy modeling of the buildings is required).

In order to understand the difference in electricity and natural gas usage when comparing the CBECS data to the City data, the third quartile of the City electricity and natural gas usage data was used to determine the intensity in kWh/SF and CF/SF. These values were then compared to the CBECS energy consumption values. Finally, this variance was then used as a target energy reduction that would reduce the City facilities (on average) down to the CBECS average (Figures 1 and 2).

The analysis of the energy use of the City buildings' HVAC and electrical systems was consistently higher than that the CBECS data, indicating that generally there is a need to continue pursuing and implementing energy efficiency upgrade projects. The average increase of energy use over the CBECS data ranged from 21% to 37%, meaning that on-average the existing HVAC and lighting systems are consuming 21% to 37% more than comparable buildings in the CBECS data base.

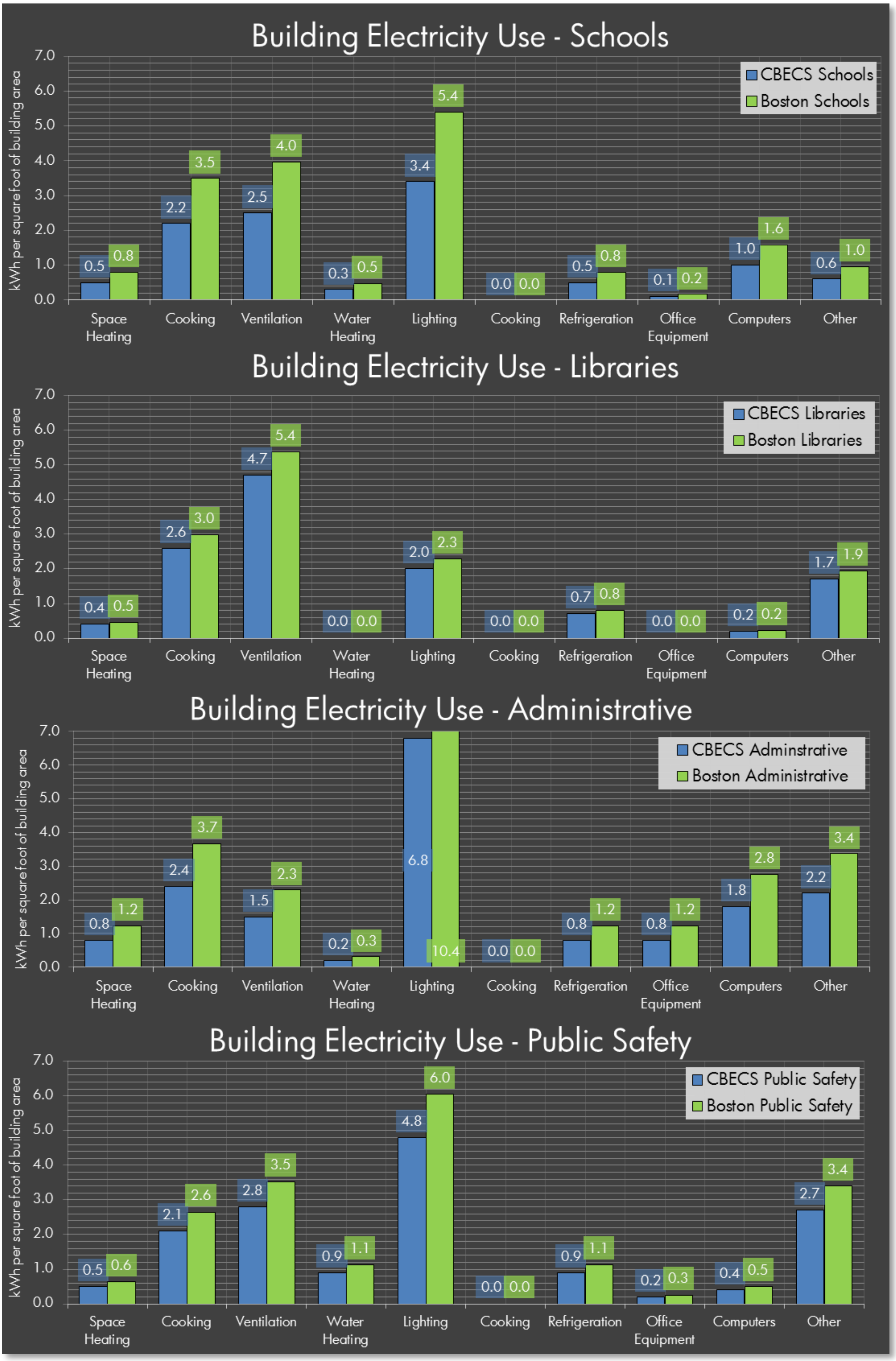

Figure 1: US Department of Energy building energy consumption data (aka CBECS) for US buildings compared to City data. Percentages used to develop end uses (space heating, etc.) are based on CBECS data.

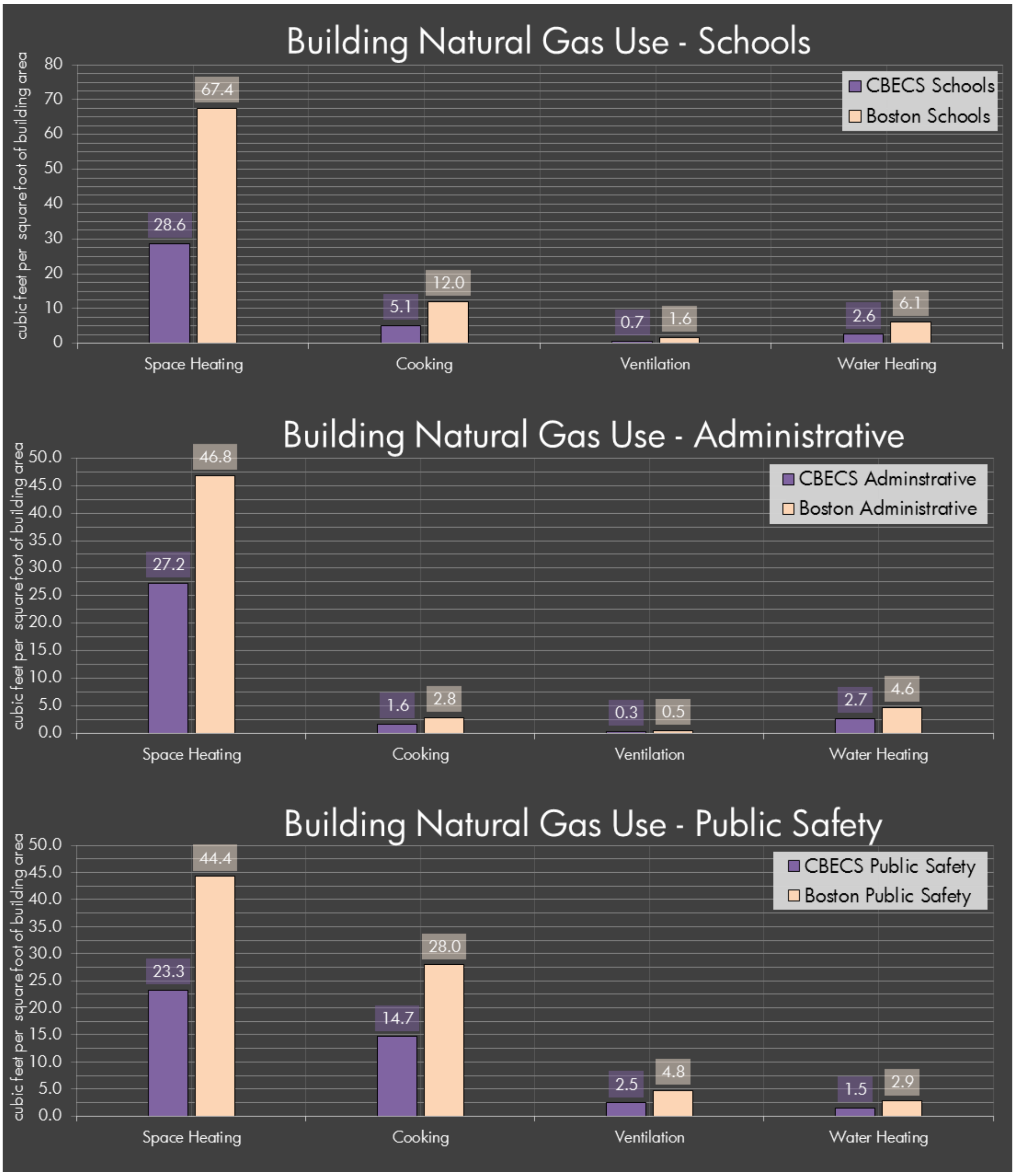

Figure 2: US Department of Energy building energy consumption data (aka CBECS) for US buildings compared to City data. Percentages use to develop end uses (space heating, etc.) are based on CBECS data. Libraries are not shown due to small sample size and very large range between natural gas consumption of the two facilities.

Building energy use simulation was used in order to develop a proof of concept to determine if it is possible to reduce the amount of electricity and natural gas consumed by the HVAC and lighting systems in City's buildings down to levels comparable to the ones in the CBECS data. The City schools were used as a test case due to the fact that the average energy consumption across the buildings exceeded the CBECS data for schools by 37%, the highest margin of all the buildings included in this report.

The energy model was first calibrated so the energy consumption and breakdown of end uses (HVAC and lighting) were approximately equal to that of the average of the Boston Schools. Several iterations were required before the results converged. Incremental energy conservation measures (ECMs) were modeled until acceptable reductions in energy use were reached. The primary ECMs analyzed for the HVAC system included increasing the cooling set point, installation of variable speed drives on fan motors, and optimization of HVAC sequences of operation. The primary ECMs for the lighting system included replacement of inefficient lamps and lighting, optimizing lighting schedules, and improved lighting controls such as bi-level lighting in the classrooms. (It is important to state that these ECMs are indicative of the types that would be used on a building-by-building basis and may not necessarily be applicable to all of the buildings. These ECMs were chosen because they are typically lower-capital cost improvements and might not require major system replacement. A detailed energy audit, such as an ASHRAE Level 2 audit is necessary to generate a complete list of ECMs, associated costs and energy use reduction).

Using these types of ECMs resulted in a reduction in lighting energy of 40%, HVAC energy 29%, and an overall reduction in annual electricity use of 33%. The following shows energy use per square foot before and after the modeling of the ECMs:

System	Before EEM (kWh/SF)	After EEM (kWh/SF)	Percent Change
HVAC	7.7	5.5	40%
Lighting	5.3	3.2	29%
Total Building	16.9	11.3	33%

Table 1: Energy use reduction of HVAC, cooling and overall building calculated from the use of building energy use simulation

Table 2 shows the detailed modeling analysis of a typical school building, using industry-standard input parameters. The overall reduction from pre-ECM to post-ECM is 33%. It must be stressed that the modeling was done on a prototypical school building; simulating energy use of a specific building will most like result in different conclusions, but the process and input parameters are valid and represent the operation of a typical school.

Base Line Case	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	12.4	11.2	12.6	13.9	26.5	16.7	26.2	22.1	42.8	18.4	13.0	12.4	228.2
Heat Reject.	0.0	0.0	0.0	0.2	1.4	1.2	2.6	1.8	3.3	0.5	0.1	0.0	11.2
Refrigeration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Space Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HP Supp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hot Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vent. Fans	51.1	46.5	52.0	49.7	51.7	26.3	27.2	27.2	49.7	51.4	49.7	51.1	533.5
Pumps & Aux.	19.5	17.7	19.8	19.0	19.7	11.9	12.3	12.3	19.0	19.6	19.0	19.5	209.3
Ext. Usage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Misc. Equip.	18.6	17.5	20.9	18.5	20.1	2.6	2.7	2.7	18.5	19.4	18.5	18.6	178.3
Task Lights	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area Lights	54.1	50.9	60.5	53.8	58.3	10.9	11.3	11.3	53.7	56.3	53.7	54.1	528.9
Total	155.7	143.8	165.8	155.0	177.8	69.6	82.2	77.3	186.9	165.6	153.9	155.8	1689.5
EEMs Implemented	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Space Cool	5.1	4.6	5.1	5.4	11.0	7.1	13.4	10.3	20.4	6.8	5.2	4.9	99.2
Heat Reject.	0.0	0.0	0.0	0.1	0.8	0.7	1.6	1.0	2.1	0.3	0.1	0.0	6.5
Refrigeration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Space Heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HP Supp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hot Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vent. Fans	42.5	38.6	43.2	41.3	43.0	21.8	22.6	22.6	41.3	42.7	41.3	42.5	443.1
Pumps & Aux.	8.7	7.9	8.8	7.8	7.5	3.6	4.4	4.2	7.4	7.3	8.3	8.5	84.3
Ext. Usage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Misc. Equip.	18.6	17.5	20.9	18.5	20.1	2.6	2.7	2.7	18.5	19.4	18.5	18.6	178.3
Task Lights	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Area Lights	32.3	30.3	36.0	32.0	34.8	6.5	6.7	6.7	32.0	33.5	32.0	32.3	315.1
Total	107.0	98.9	114.0	105.1	117.1	42.2	51.3	47.4	121.6	109.9	105.3	106.7	1126.6

Table 2: Results of energy modeling, baseline case (top) and after ECM implementation (bottom)
Units = (kWh x1000)

Summary of the City energy billing and ECM planning processes

The following is a summary of information regarding the City's process of accounting for utility and gasoline/diesel usage and performance measurement:

- There are a total of 47 departments, 12 with utilities and gas/diesel budgets, and 9 with just gas/diesel budgets.

- The remaining 26 department do not have energy budgets and are budgeted and funded from a single line item.
- Approximately 1 to 2 individuals manage utility bills in each of the 12 departments. This is based on major vendor emails having 1 or 2 departmental contacts.
- Staying within the amount budgeted for energy expenditures is the primary KPI, which is measured monthly. The budgets are set based on units and rates at the department level, not by building. Statistical rate account has a "–R" and statistical unit account has a "–U."
- Electric kWh, natural gas therms and gallons of gasoline/diesel are also entered into the "Boston About Results" performance system and converted to tons of greenhouse gas emissions.
- Most departments track utilities bills and do some forecasting, mostly on prior use averages.
- The City gets a monthly report for the energy use for all 2864 electricity meters. This includes building electrical meters, traffic lights, etc. This is the data that gets rolled up into the City's master file.
- The Office of Budget Management tracks the energy budgets on a monthly basis (Attachment "A"). The energy supply charges and distribution charges are sent by the Auditing department to the departments for verification that the energy consumption and related cost are valid. There will be correspondence back only if there is a discrepancy.
- It was indicated that depending on the department's size, the consumption and cost figures will be viewed with more or less diligence before they are approved or disapproved.
- At the end of the billing cycle, a third-party vendor audits the consumption, cost, and rate data to ensure the billing is accurate.

In addition to the record-keeping processes for the utility bills and energy budgets, there is a process in place for assessing and budgeting for energy efficiency upgrade projects. The spreadsheet provided by the City called "project-rebate tracking" provides details on projects including first cost, anticipated utility rebates, anticipated kWh savings and annual energy cost savings (Table 3). The projects that were identified in the spreadsheet have average payback of 2.1 years and an annual energy reduction of 20.4%. The average annual energy reduction of 20.4%

is on par, albeit on the low end, with the energy use reductions predicted by the energy use simulation.

Facility	Projected kWh Savings	Incentives	Project Cost	Projected Annual Operational Cost Savings		5-Year Energy Cost Reduction
'12 City Hall Phase 3 - HVAC	1,625,674	$263,752	$376,789	$243,851	2012	$1,219,255
'12 City Hall Phase 4 - pmp, mtr, drv	56,632	$51,655	$73,794	$8,500	2013	$42,500
'12 City Hall Phase 5 - EMS	650,000	$74,891	$106,988	$97,500	2013	$487,500
City Hall - Lighting Upgrades 2nd	63,729	$13,604	$19,435	$10,119	2012	$50,595
City Hall - Lighting Upgrades 3rd	251,177	$66,390	$94,844	$32,653	2012-14	$163,265
City Hall - Lighting Upgrades 8th	27,290	$4,974	$7,931	$3,302	2012	$16,510
Total	2,674,502	$475,266	$679,781	$395,925		$1,979,625
Annual electricity usage	13,907,920					
Reduction in annual electrcity usage	19.2%		Payback	1.7	years	

Table 3: Example projects from the "project-rebate tracking" spread sheet showing savings from utility rebates and reduction in energy use

These data are a very important part of the business case.

Analysis of electricity and natural gas costs

Using the EIA's Annual Energy Outlook 2012 with Projections to 2035, (DOE/EIA-0383(2012), June 2012), electricity and natural gas pricing projections were determined. The following is a summary of the projections.

- Electricity - Following the recent rapid decline of natural gas prices, real average delivered electricity prices fall from 9.8 cents per kilowatt-hour in 2010 to as low as 9.2 cents per kilowatt-hour in 2019, as natural gas prices remain relatively low. Electricity prices in 2035 are 9.5 cents per kilowatt-hour (2010 dollars).

- Natural Gas - With increased production, average annual wellhead prices for natural gas remain below $5 per thousand cubic feet (2010 dollars) through 2023. After 2023, natural gas prices generally increase as the numbers of tight gas and shale gas wells drilled increase to meet growing domestic demand for natural gas and offset declines in natural gas production from other sources. Natural gas wellhead prices (in 2010 dollars) reach $6.52 per thousand cubic feet in 2035, compared with $6.48 per thousand cubic feet (2010 dollars).

- Despite the fact that the EIA projections show a relatively flat cost increase for electricity and natural gas for the next decade, it is important to study the fluctuations in price that might occur within that period and develop independent analyses to minimize risk. Data was mined for Massachusetts electricity pricing to commercial customers back to 2001 (Figures 3, 4), and natural gas pricing to commercial consumers back to 1989 (Figures 5, 6). The purpose of this data is to generate additional what-if scenarios for electricity and natural gas pricing into the next half-decade. Although the EIA is predicting relatively flat electricity and natural gas prices over the next 10 years, it is good practice to use these what-if scenarios when performing a sensitivity analysis on different energy efficiency measures.

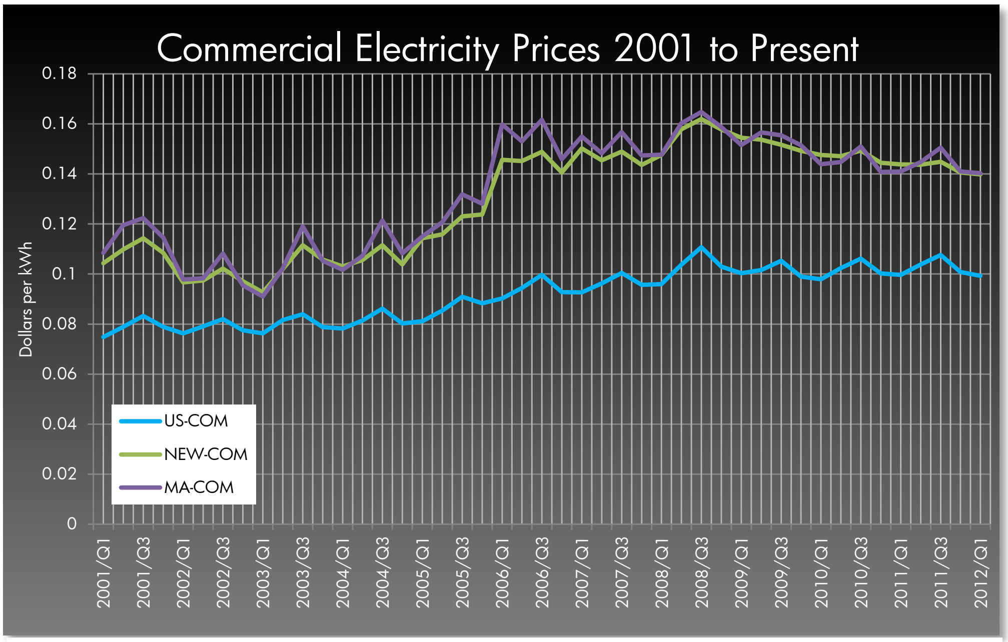

Figure 3: Commercial electricity price projections

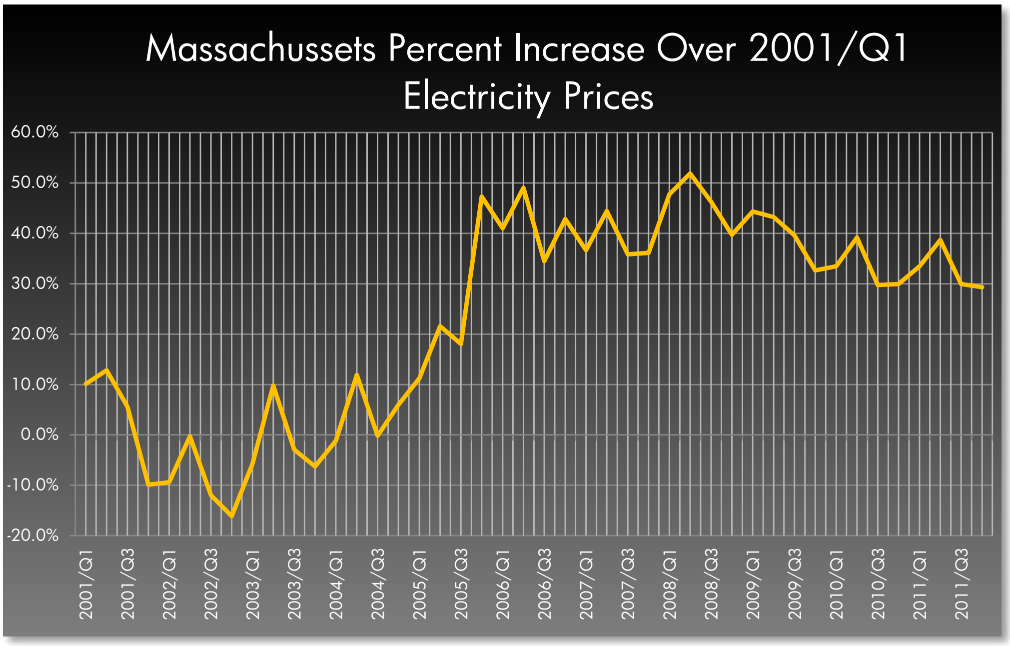

Figure 4: Commercial electricity year over year price changes

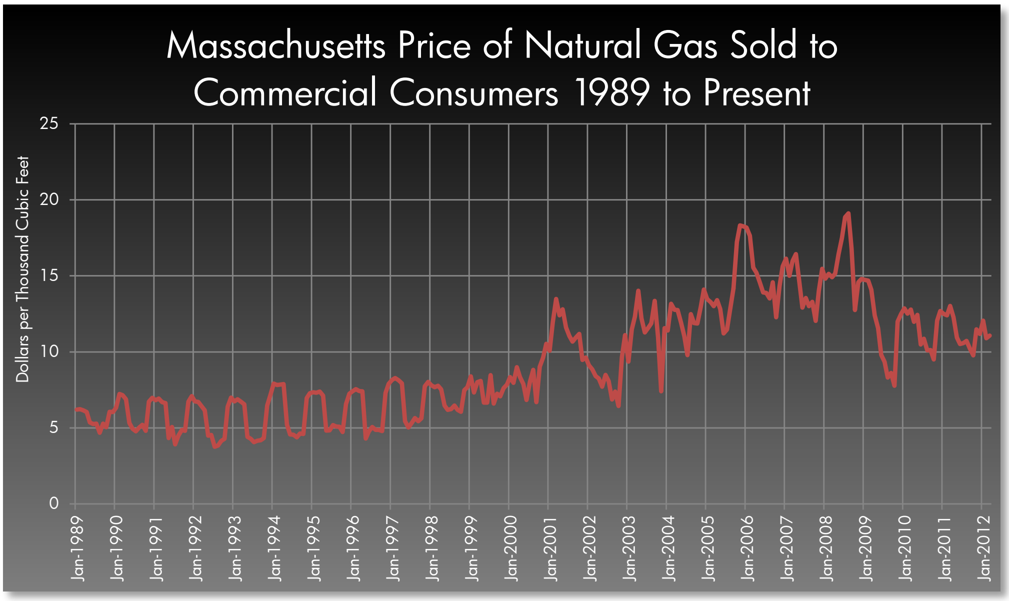

Figure 5: Commercial natural gas price projections

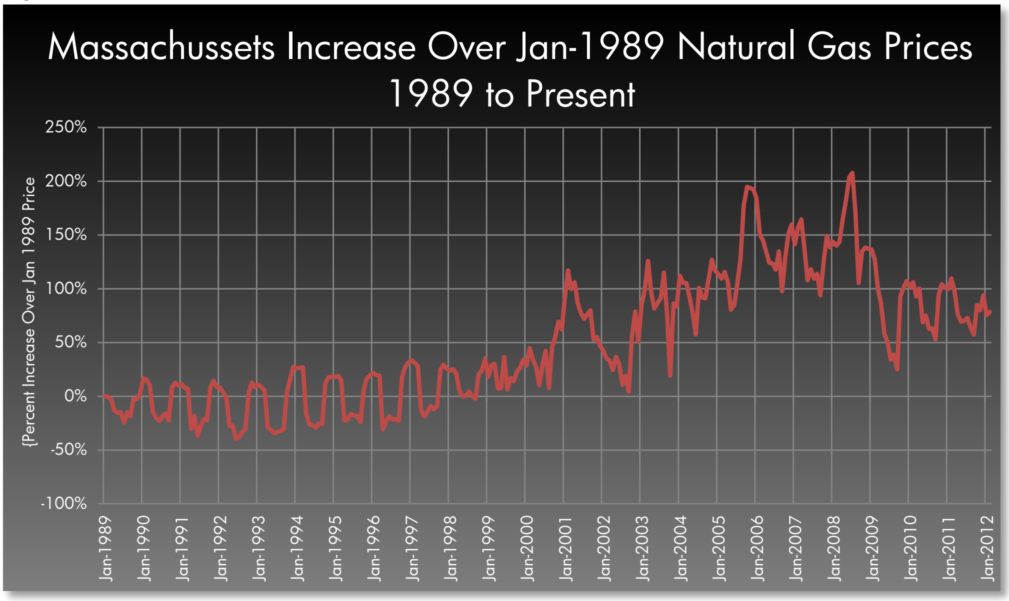

Figure 6: Commercial natural gas year over year price changes

Three growth scenarios for the period 2012 to 2021 were developed for both electricity and natural gas prices.

- Low - a linear growth rate is based on the percentage increase from the 2012 rates to the average of the rates for the period 2001 to 2011.
- Middle - a linear growth rate is based on the percentage increase from the 2012 rates to the third quartile of the rates for the period 2001 to 2011.

- High - a linear growth rate is based on the percentage increase from the 2012 rates to the maximum of the rates for the period 2001 to 2011.

The following data was generated based on the results of the analysis.

- Electricity - Based on fluctuations in price since 2001, the lowest change represented a 23% increase; the third-quartile represented a 28.4% increase; the highest increase was 34.2%. Based on the analysis, five-year low, middle and high electricity rates are respectively $0.155, $0.158 and $0.162 per kWh (Table 4).

Massachussets Ten-Year Projected Electricity Prices										
Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Low	0.140	0.144	0.148	0.151	0.155	0.158	0.162	0.166	0.169	0.173
Middle	0.140	0.145	0.149	0.154	0.158	0.162	0.167	0.171	0.176	0.180
High	0.140	0.146	0.151	0.156	0.162	0.167	0.172	0.177	0.183	0.188

Table 4: Projected electricity costs to be used for "what-if" scenarios

- Natural gas - based on fluctuations in price since 1998, the lowest change represented a 31.1% increase; the third-quartile represented a 97.7% increase; the highest increase was 207%. Based on the analysis, five-year low, middle and high natural gas rates are respectively $7.068, $8.908 and $11.948 per 1000 cubic feet (Table 5).

Massachussets Ten-Year Projected Natural Gas Prices										
Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Low	6.210	6.424	6.639	6.853	7.068	7.282	7.496	7.711	7.925	8.140
Middle	6.210	6.884	7.559	8.233	8.908	9.582	10.256	10.931	11.605	12.280
High	6.210	7.644	9.079	10.513	11.948	13.382	14.816	16.251	17.685	19.120

Table 5: Projected natural gas prices to be used for "what-if" scenarios

EEMS return on investment analysis

While the EEMS is considered a capital cost, there are on-going costs that need to be accounted for in any business case. And as previously discussed, each vendor has different offerings that will affect the life cycle cost of the EEMS. Descriptions and financial details for the three main types of EEMS delivery types used in the analysis are as follows:

Service Type	SaaS Hosted Single-tenant hosting – subscription license model Deployment
Non recurring fee	$75-$100k; 5-years of historical data upload; 100 facilities; up to 10participating business units, with designated personnel from each business unit trained in data input and management
Annual subscription costs	~$100k include maintenance, support, computing infrastructure, software infrastructure, new product releases
Contract length	3, 5, 7 years
Additional training	$1600/per day for 1 consultant
Service Type	SaaS Cloud Multi-tenant hosting – subscription license model Deployment
Non recurring fee	$75-$100k; 5-years of historical data upload; 100 facilities; up to 10 participating business units, with designated personnel from each business unit trained in data input and management
Annual subscription costs	~$75k include maintenance, support, computing infrastructure, software infrastructure, new product releases
Contract length	3, 5, 7 years
Additional training	$1600/per day for 1 consultant
Service Type	On-premise Client Deployment with Maintenance (client-side deployment – perpetual license model)
Non recurring fee	$350-$375k; 5-years of historical data upload; 100 facilities; up to 10 participating business units, with designated personnel from each business unit trained in data input and management
Annual subscription costs	~$60k include maintenance, support, BUT NOT computing infrastructure and software new releases
Contract length	3, 5, 7 years
Additional training	$1600/per day for 1 consultant

Table 6: In the single tenant model, the City would be the only entity on the server. In the multi-tenant model, several entities' data will reside on a server, with the proper safeguards in place to prevent data migrating from one tenant to another.

(For the purposes of this report, detailed functionality of the different types of delivery types are not included as these are to be published in a separate report on the functional requirements of the EEMS system).

The goal of the return on investment analysis is to understand how the EEMS can reduce operating costs on an on-going basis, and since there is a capital expenditure that is required to acquire the EEMS, it is important to understand what the return on investment would be by evaluating the savings and costs over a five-year life cycle. For each year, the capital costs and savings are calculated using a 5% discount rate.

The return-on-investment analysis concentrates on four main areas that have the greatest impact on the costs and savings resulting from an EEMS installation:

1. **Increase in administrative efficiency** in analyzing, auditing and allocating costs to the different departments and agencies within the CoB. Included in this area are costs for consultants that currently assist the City in the auditing and validation of energy consumption and energy provider billing.
2. **Identification of additional energy efficiency projects** based on analysis of KPIs associated with the different departments and buildings. Some of these upgrades have a capital cost component, leveraging funds already made available for other improvement projects. On-going monitoring and measurements avaliable through the EEMS will also increase visibity to identify low- or no-cost energy efficiency projects. These projects achieve savings from tactics such as reducing nighttime baseload electricity use, smart HVAC for startup and energy coasting for shutdown, temperature setpoint adjustment, voluntary tenant curtailment and selective exhaust fan shutdown during off-hours.
3. **Reduction of ongoing energy costs** as a result of the energy efficiency upgrades. This constitutes a significant annual savings of energy and cost.
4. **Monitor and maintain** reduced levels of energy in buildings where energy efficiency projects have been completed.

Energy Efficiency Projects[1]

	Current Annual Energy Efficiency Projects[1]	Annual Energy Efficiency Projects After ECMs	Difference Between pre- and post-ECMs
Annual Project Cost[2]	$12,934,217	$13,594,551	$660,334
Annual Utility Incentives and Rebates[3]	$5,159,662	$5,484,158	$324,496
Annual Savings[5]	$2,852,167	$3,481,030	$628,862
Annual kWh Savings[6]	35,935,806	43,841,684	7,905,877

[1]data based on 2012-2014 proposed projects
[2]based on City data, project costs increase at a rate of 0.42:1 to energy efficiency gains.
[3] based on City data, utility incentives increase at a rate of 0.44:1 to energy efficiency gains.
[4] assume with ECMs 20% additional energy efficiency projects are identified and put in place
[5] $0.0794/kWh was used for electricity rate
[6] assume low- and no-cost energy efficiency gains account for 10% of the annual kWh savings and have project costs 5% of capital projects

Table 7: Data for energy efficiency projects used to develop the business case

Table 7 shows the potential additional savings achievable by having the ability to dashboard both energy management and financial drivers in one complete view, allowing the City to understand their current energy spend, projected energy use and KPIs, and departmental and building energy use allocation. Knowing the City currently has a process in place for assessing and budgeting energy efficiency projects, an increase of 20% is estimated in additional energy savings projects that result in on-going cost reduction. Auditing a building, identifying possible energy efficiency upgrades, developing scope of work for the projects, developing construction and project related costs, estimating annual energy savings and generating a life cycle cost analysis is beyond the scope of this report, so estimates of project cost, utility rebate value and energy reduction were all extrapolated from the report (the spreadsheet "project-rebate tracking") that is used by the City to estimate and track energy efficiency projects.

An important assumption that is used comes from extrapolating the energy savings data as well as the utility rebates and project costs. The analysis suggests that the energy savings increases at a greater rate than the project costs, which is reasonable based on economies of scale. The life cycle analysis assumes a 20% increase in energy efficiency savings, and the cost of those projects increases by 5.1%. Additional sensitivity analysis should be performed to determine at what project cost the ROI starts to make less economic sense. In the scenario where only low/no cost ECM projects are implemented, the assumption is that the projects will yield 10% of what could be achieved if all of the ECM projects were implemented,

SaaS Hosted (first cost and annual fee)						
	Period					
	0	1	2	3	4	5
One-Time Cost	-$100,000					
Annual Fees		-$100,000	-$100,000	-$100,000	-$100,000	-$100,000

SaaS Cloud (first cost and annual fee)						
	0	1	2	3	4	5
One-Time Cost	-$100,000					
Annual Fees		-$75,000	-$75,000	-$75,000	-$75,000	-$75,000

On Premise (first cost and annual fee)						
	0	1	2	3	4	5
One-Time Cost	-$375,000					
Annual Fees		-$60,000	-$60,000	-$60,000	-$60,000	-$60,000

Common to All EEMS Platforms (all ECM projects implemented)						
Benefit	Period					
	0	1	2	3	4	5
Annual Energy Efficiency Project Cost		-$132,067	-$132,067	-$132,067	-$132,067	-$132,067
Annual Utility Incentives and Rebates		$64,899	$64,899	$64,899	$64,899	$64,899
Annual Savings		$0	$157,216	$314,431	$471,647	$628,862

Common to All EEMS Platforms (only low/no cost ECM projects implemented)						
Benefit	Period					
	0	1	2	3	4	5
Annual Energy Efficiency Project Cost		-$6,603	-$6,603	-$6,603	-$6,603	-$6,603
Annual Utility Incentives and Rebates		$6,490	$6,490	$6,490	$6,490	$6,490
Annual Savings		$0	$15,722	$31,443	$47,165	$62,886

Table 9: Two scenarios were developed for the ROI analysis:

1. Annual costs and savings for implementation of all ECM projects identified by the use of the EEMS
2. Annual costs and savings for implementation of only low/no cost ECM projects identified by the use of the EEMS

and will cost 5% of the total of the full ECM projects. The rebate and incentives will also track at 10% of what the total amount would be.

The data from the energy efficiency projects were used to develop a five-year life cycle cost analysis (Tables 10 and 11). For the analysis, taxes were not included. The analysis uses a discounted benefit flow with a discount rate of 5%. The ROI analyses are for the three EEMS delivery models discussed earlier. For the three delivery models, the only parameters that vary are the initial costs and annual fees. It is assumed that all three systems will have functionality resulting in the same costs and savings in each of the three scenarios.

All ECM Projects Implemented (Table 10): When analyzing the different options, the SaaS cloud delivery method has the shortest ROI and will pay for itself in the fourth year of use. The SaaS hosted model has the second-best ROI, with a payback occurring in the fourth year of use. The on-premise model has the lowest ROI and will pay for itself in the fifth year of operation.

Only Low/No Cost ECM Projects Implemented (Table 11): When analyzing the different options, the SaaS cloud delivery method has the shortest ROI and will have a five-year ROI of 35%. The SaaS hosted model has the second-best ROI, with a five-year ROI of 28%. The on-premise model has the lowest ROI and will have a five-year ROI of 24%.

SaaS Hosted (all ECM projects implemented)						
Period	0	1	2	3	4	5
EEMS One-Time Cost	-$100,000					
EEMS Annual Fees		-$95,238	-$90,703	-$86,384	-$82,270	-$78,353
Annual Energy Efficiency Project Cost		-$125,778	-$119,788	-$114,084	-$108,652	-$103,478
Annual Utility Incentives and Rebates		$61,809	$58,866	$56,062	$53,393	$50,850
Annual Energy Savings		$0	$142,599	$271,617	$388,025	$492,730
Total Discounted Costs		-$221,016	-$210,491	-$200,468	-$190,922	-$181,830
Total Discounted Savings		$61,809	$201,465	$327,680	$441,418	$543,580
Total discounted benefit flow		-$159,207	-$9,027	$127,212	$250,496	$361,750
Total cumulative discounted benefit flow		-$259,207	-$268,234	-$141,022	$109,474	$471,224
ROI		19%	50%	81%	112%	143%

SaaS Cloud (all ECM projects implemented)						
Period	0	1	2	3	4	5
EEMS One-Time Cost	-$100,000					
EEMS Annual Fees		-$71,429	-$68,027	-$64,788	-$61,703	-$58,764
Annual Energy Efficiency Project Cost		-$125,778	-$119,788	-$114,084	-$108,652	-$103,478
Annual Utility Incentives and Rebates		$61,809	$58,866	$56,062	$53,393	$50,850
Annual Energy Savings		$0	$142,599	$271,617	$388,025	$492,730
Discounted Costs		-$197,206	-$187,816	-$178,872	-$170,354	-$162,242
Discounted Savings		$61,809	$201,465	$327,680	$441,418	$543,580
Total discounted benefit flow		-$135,398	$13,649	$148,808	$271,063	$381,338
Total cumulative discounted benefit flow		-$235,398	-$221,749	-$72,941	$198,122	$579,461
ROI		21%	54%	89%	124%	158%

On Premise (all ECM projects implemented)						
Period	0	1	2	3	4	5
EEMS One-Time Cost	-$375,000					
EEMS Annual Fees		-$57,143	-$54,422	-$51,830	-$49,362	-$47,012
Annual Energy Efficiency Project Cost		-$125,778	-$119,788	-$114,084	-$108,652	-$103,478
Annual Utility Incentives and Rebates		$61,809	$58,866	$56,062	$53,393	$50,850
Annual Energy Savings		$0	$142,599	$271,617	$388,025	$492,730
Discounted Costs		-$182,921	-$174,210	-$165,915	-$158,014	-$150,489
Discounted Savings		$61,809	$201,465	$327,680	$441,418	$543,580
Total discounted benefit flow		-$121,112	$27,254	$161,765	$283,404	$393,091
Total cumulative discounted benefit flow		-$496,112	-$468,857	-$307,092	-$23,688	$369,403
ROI		11%	36%	66%	98%	131%

Table 10: ROI analysis with all ECM projects implemented

SaaS Hosted (only low/no cost ECM projects implemented)						
Period	0	1	2	3	4	5
EEMS One-Time Cost	-$100,000					
EEMS Annual Fees		-$95,238	-$90,703	-$86,384	-$82,270	-$78,353
Annual Energy Efficiency Project Cost		-$6,289	-$5,989	-$5,704	-$5,433	-$5,174
Annual Utility Incentives and Rebates		$6,181	$5,887	$5,606	$5,339	$5,085
Annual Energy Savings		$0	$14,260	$27,162	$38,802	$49,273
Total Discounted Costs		-$101,527	-$96,692	-$92,088	-$87,703	-$83,527
Total Discounted Savings		$6,181	$20,146	$32,768	$44,142	$54,358
Total discounted benefit flow		-$95,346	-$76,546	-$59,320	-$43,561	-$29,168
Total cumulative discounted benefit flow		-$195,346	-$271,892	-$331,212	-$374,773	-$403,942
ROI		3%	9%	15%	22%	28%

SaaS Cloud (only low/no cost ECM projects implemented)						
Period	0	1	2	3	4	5
EEMS One-Time Cost	-$100,000					
EEMS Annual Fees		-$71,429	-$68,027	-$64,788	-$61,703	-$58,764
Annual Energy Efficiency Project Cost		-$6,289	-$5,989	-$5,704	-$5,433	-$5,174
Annual Utility Incentives and Rebates		$6,181	$5,887	$5,606	$5,339	$5,085
Annual Energy Savings		$0	$14,260	$27,162	$38,802	$49,273
Discounted Costs		-$77,717	-$74,017	-$70,492	-$67,135	-$63,938
Discounted Savings		$6,181	$20,146	$32,768	$44,142	$54,358
Total discounted benefit flow		-$71,537	-$53,870	-$37,724	-$22,994	-$9,580
Total cumulative discounted benefit flow		-$171,537	-$225,407	-$263,131	-$286,124	-$295,705
ROI		3%	10%	18%	27%	35%

On Premise (only low/no cost ECM projects implemented)						
Period	0	1	2	3	4	5
EEMS One-Time Cost	-$375,000					
EEMS Annual Fees		-$57,143	-$54,422	-$51,830	-$49,362	-$47,012
Annual Energy Efficiency Project Cost		-$6,289	-$5,989	-$5,704	-$5,433	-$5,174
Annual Utility Incentives and Rebates		$6,181	$5,887	$5,606	$5,339	$5,085
Annual Energy Savings		$0	$14,260	$27,162	$38,802	$49,273
Discounted Costs		-$63,432	-$60,411	-$57,534	-$54,795	-$52,185
Discounted Savings		$6,181	$20,146	$32,768	$44,142	$54,358
Total discounted benefit flow		-$57,251	-$40,265	-$24,766	-$10,653	$2,173
Total cumulative discounted benefit flow		-$432,251	-$472,516	-$497,282	-$507,935	-$505,762
ROI		1%	5%	11%	17%	24%

Table 11: ROI analysis with only low/no cost ECM projects implemented

5. Conclusions and Next Steps

Based on the analyses, investing in an EEMS will result in on-going savings, both from energy consumption, and from gains in efficiency for activities related to handling, auditing and allocating energy billing. With the dashboarding and analytics capability that is inherent in most EEMS systems, it will be simpler and less time consuming to assess, develop, budget, implement and track energy efficiency projects. This will also lead to the ability to identify energy efficiency projects that might not be discovered using traditional methods. The quicker these types of projects can be brought on line, the quicker the City will save money.

6. References

Interdisciplinary and Global Studies, Douglas W. Woods, Worcester Polytechnic Institute, 2012.

"High Level Market Assessment of Enterprise Energy Management Systems," HP, 6/22/2012. (for the City of Boston)

US DOE Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS)" – 2012.

EIA's Annual Energy Outlook 2012 with Projections to 2035, (DOE/EIA-0383(2012), June 2012.

"City of Boston Energy Consumption Assessment Report, Summary of Findings, Analyses and Conclusions of 50 Reviewed Buildings," HP, 6/29/2012.

Conference calls with City of Boston personnel, including:

Christine Dennehy, Todd Isherwood, Joseph LaRusso, Johanna Bernstein, Dennis Coughlin, Jim Williamson

"No Cost/Low Cost Ideas to Reduce Energy Use in Office Buildings", Strategic Planning for Energy and the Environment, Vol. 32, No. 1, 2012.

ATTACHMENT "A"

Date: May 03, 2012

From: **Sally D. Glora**
City Auditor

Re: **Electric Billing Usage Report**
For Fiscal Month 09 Fiscal Year 2012

The City of Boston uses a Local Distributor and a Supplier for the delivery of electricity. The Local Distributor is NSTAR and the current Supplier is HESS Corporation. Each department responsible for managing electrical services is responsible for authorizing payment for electrical services.

The attached worksheets are the Billing/Usage Reports for electrical services supplied and billed for the fiscal month and fiscal year mentioned above. There are two worksheets: the NSTAR worksheet provides the detail for the Local Distribution Charges and usage (LDC) and a limited number of Supplier Charges and usage for accounts being transitioned to HESS ; the HESS worksheet provides the detail for the Supplier Charges and usage. These worksheets provide detail for each account assigned to your Department, including Account Numbers, Location, Service Dates, Usage and Amounts Billed.

The following steps are required to authorize payment for electrical services:

(1) Verify that the Accounts listed are appropriately assigned to your Department
(2) Review usage and charges to determine each is reasonable and accurate
(3) Approve/Dispute the charges for each Account (see below)
(4) Return Billing/Usage Report to Auditing/Accounts Payable as authorization for payment (Email to: Hazel.McAfee@cityofboston.gov; Julie.Tippet@cityofboston.gov) within five (5) days of receipt.

<u>Approve/Dispute Billing And Return Billing/Usage Reports to Auditing</u>

To Approve/Dispute the charges go to the far right columns on the Billing/Usage Report. Columns headed 'Dispute' and 'Reasons'.

In the column headed 'Dispute' (1) enter 'N' (No – not disputed) if the Account is appropriately assigned to your Department and you authorize payment of the charges; (2) enter 'Y' (Yes – File Dispute).

If you enter Y – File Dispute, complete the column headed ‘Reasons’ by indicating in this column a clear explanation for the reason for your dispute [Examples: (1) this account is not assigned to this Department; (2) the usage/charges for this account is 3 times the expected use/charge for this account]

Each Account line must be completed with a Y/N in the ‘Dispute’ Column.

Once the Account review is completed return the file by email to Auditing/Accounts Payable to the contact personnel at the e-mail locations on page one. This report should be filed even if there are no disputed items; this is your authorization to pay.

Auditing/Accounts Payable will file the dispute with the vendor. Accounts Payable will notify you of the outcome of your dispute. Your account will be credited should the dispute be resolved in your favor.

To budget and account for local distributor charges and supplier charges separately additional BAIS Financials Account Values have been established. The following is a list of all valid Account Values for electricity:

Account	**Account Description**
52202	Utilities Electric Bldg
52208	Utilities St Elec Meter
52209	Utilities St Elec Unmtr
52211	Utilities Traffic Signals
52232	Utilities Electric Bldg Supply
52238	Utilities St Lt Elc Meter Supply
52239	Utilities St Lt Elc Unmtr Supply
52241	Utilities Traffic Signals Supp

If you have questions regarding the Electric Billing Usage Reports or how to complete the worksheets to authorize payment, please contact Hazel McAfee at 617-635-4187 or Julie Tippet at 617-635-4186.