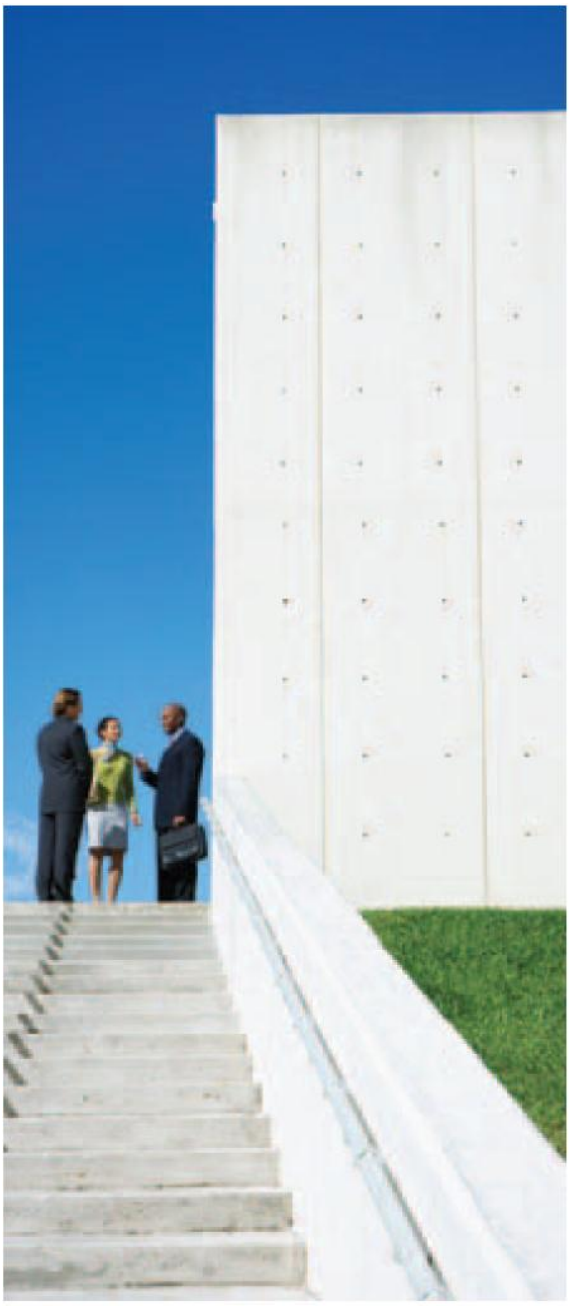

EEMS Functional Requirements

City of Boston

I. Document Control

Revision History

Version	Date	Author	Revision Summary
1.0	07/05/12	Munther Salim, Ph.D., CEM, LEED GA	Internal Draft Revision 1
1.1	07/15/12	Munther Salim, Ph.D., CEM, LEED GA	Final draft-customer comments
1.2	07/22/12	Munther Salim, Ph.D., CEM, LEED GA	Final report

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Approval / Verification

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II. Contents

III. Executive Summary

The City of Boston, as an enterprise, can benefit from an EEMS solution that dramatically reduces costs and risks, and substantially improves operating budget and sustainability performance. A comprehensive EEMS framework can align the City's broader financial and strategic goals to key opportunities for reducing energy expenditures and resource consumption at each level within the City's departments and facilities. In order to find these opportunities and determine their impact on the City's budget and sustainability plan, it is important to establish a systematic process for aggregating, organizing and analyzing data. This includes providing solutions for data gaps, establishing Key Performance Indicators (KPIs), and building benchmarks to help the City recognize the best and worst performing portions of its energy supply chain. At a minimum, roadmap for the acquisition of an EEMS solution should have the following objectives:

- Streamlining resource consumption and cost data entry;
- Establishing reliable bill validation and auditing;
- Establishing consumption tracking and reporting capabilities;
- Incorporating standardized greenhouse gas emissions calculations;
- Integrating energy management with existing financial systems.

Various functional requirements have been presented, summarized and categorized into three major categories. Detailed presentations are provided throughout the report and touch on the following topics.

- Setup, technology design and support requirements; including features and functionalities related to deployment method, tracking of municipal resource consumption, future upgrades for sub-metering and parallel metering, licensing, training, warranty, support and maintenance, graphical user interface, communications, multiple data type support, remote system administration, data hosting, standard and custom reporting and others.
- Resource and operations requirements; including features and functionalities related to historical use profile, data aggregation, resource procurement, demand management and response, peak demand limiting strategies, equipment diagnostics and health monitoring, rate modeling, benchmarking and Key Performance indicators (KPIs), interface to green certifications (ENERGY STAR), alarming and notifications and greenhouse gas emissions .
- Financial and accounting requirements; including features and functionalities related to bills import, audit and error checking, quantity and cost allocation, bill verification and complex pricing, tracking and normalization, budget

variances, bill calculation methods, carbon finance, and reduction project workflow.

1. Introduction

One obvious goal for an Enterprise Energy Management System (EEMS) is to improve the ability of City departments and facilities to effectively and efficiently manage their utility and commodity consumption, and costs. This solution is anticipated to help achieve the following objectives for City departments and facilities

Streamline Resource Consumption and Cost Data Entry
Currently departments and facilities enter their utility and commodity consumption and cost data into spreadsheets and other ad hoc management systems, often resorting to manual data entry, and often with multiple departments entering the same data into those spreadsheets and management systems. An objective of an EEMS solution is to streamline the data entry process, allowing departments and facilities users to enter data once, either manually or electronically, and to have that data viewable by employees in multiple departments.

Establish Reliable Bill Validation and Auditing
City departments and facilities currently validate and audit utility and commodity bill data using spreadsheets and visual verification. These methods are time-consuming, do not automatically alert the agencies to anomalies and potential billing errors, and are susceptible to human error. It is important to seek an energy management solution that will provide the agencies with tools to validate and audit utility and commodity bills in a more efficient and effective manner.

Establish Tracking and Reporting Capabilities
City departments and facilities currently track their consumption and costs related to utilities and commodities using spreadsheets. An objective of the EEMS is to provide the departments with a database application for tracking their consumption and costs related to electricity, natural gas, water, steam, diesel fuel and gasoline by meter, account, facility, and agency. Additionally, the solution should provide the ability to track diesel fuel and gasoline consumption for the vehicle fleet.

Because spreadsheets have limited analytical capabilities, City departments and facilities are currently unable to easily conduct robust analyses or produce informative reports related to energy consumption or costs. The EEMS solution should provide City departments and facilities with robust reporting capabilities that produce easily comprehendible reports for ever level of the City's administration. The solution should have the capability to produce comparison reports across like facilities, conduct trend analyses at a single facility and across a category of facilities, and produce reports that compare consumption and costs to budget. These reports should be able to be

normalized by a variety of variables including, but not limited to, weather, number of days in billing period and building square footage.

Standardize Greenhouse Gas Emissions Calculations

The City currently quantifies the greenhouse gas emissions using a spreadsheet model. The model requires considerable data collection from various sources and the conversion of consumption into carbon dioxide equivalent values. The EEMS solution should be capable of automatically converting utility and commodity consumption data into standardized measures of greenhouse gas emissions. The solution should provide the agencies with the ability to compare greenhouse gas emissions levels across similar facilities and visualize trends in greenhouse gas emissions at a single facility, across facility categories and for each department as a whole.

Integrate Energy Management with Financial Systems

It is recommended that the EEMS solution be capable of being integrated with the City's existing financial management system. The solution should allow the Auditing department to upload billing data into the existing financial management system for distribution to City department managers, eliminating the need for manual data entry. Currently, the City uploads natural gas and electric commodity charges, and utility distribution billing data into the existing financial management system.

1.1 EEMS deployment models

EEMS solutions are typically deployed using one of three methodologies:

- On-premises client deployment with maintenance (client-side deployment – perpetual license model);
- SaaS hosted (single-tenant hosting – subscription license model) deployment
- SaaS cloud (multi-tenant hosting – subscription license model) deployment:

Generally, the cloud-based delivery model provides several key advantages including faster deployment, scalability for a dispersed enterprise, flexibility, no IT hardware/software support on client's side, configurability for organizations of all sizes, and immediate access to the latest releases with options for selecting or de-selecting features. This is the recommended model for deployment at the City of Boston. More details and financial analysis on the three models are presented in the business case report.

2. Setup and Support

The EEMS solution should have the following features from design, setup and support perspectives.

2.1 Setup & Design

The EEMS design should allow authorized users full access via standard web browsers, such as Microsoft® Internet Explorer 7.0 or above. The EEMS shall be a web-based solution, requiring no plug-ins or middleware on the users' desktop/laptop. The EEMS system should support access to departments and facilities' reporting functions through the Internet and/or Internet utilizing browser-based technology.

The EEMS should permit system administration to be performed in-house and not require vendor services. System administrators will remotely access the EEMS for facility, equipment, and department access configuration. System administrators should log in to the EEMS from their office locations to administer and maintain most aspects of EEMS.

The vendor will be responsible for setting up the solution so that it is ready for use. This task includes the installation of any necessary software and/or hardware, the setup of any applications and/or databases, the input of meter and account information and metadata (i.e. facility name, facility type, location, etc.), and the establishment of usernames and passwords for users of the system. City of Boston should provide the vendor all the information and metadata to be inputted into the solution in spreadsheet or database format. Additionally, the names and email addresses of the initial users of the system should also be provided.

The EEMS solution should be based on commercially available software and not a costly to maintain customized solution. The primary database will be commercially supported and accessible by analysis and reporting software applications. The primary platform technology will be based on industry standard protocols.

The EEMS should support Internet use for data communication between facilities and central software applications to minimize communication costs. The system should be able to transmit data through firewalls and contain local data storage capabilities to avoid lost data due to Internet communications failure. All utility readings should be capable of being displayed in real-time.

The EEMS should be scalable to include hundreds of thousands of monitoring points within hundreds of buildings all supported by single instance of the database and

application. System performance should comply with commercial standards. The database should support scalability to grow as needs expand.

The EEMS should process data from various building automation and sub-metering systems for analysis and reporting. The EEMS should support a variety of hardware data collection devices without requiring hardware device replacement and upgrades. System flexibility must be compatible with different data entry frequencies (e.g., monthly with non-standard start/end dates, quarterly, semi-annual, annual, etc.)

The system should have a flexible and customizable graphical user interface to permit departments and facilities to define and build their own screens to navigate the EEMS, view real-time meter reading values and/or operating variables, extract standard reports, or perform control activities for additional systems in the field.

The EEMS should contain a comprehensive library of standard and custom resource-specific reports types delivered without requiring system administrators to setup and define reports. All reports should be easily exported to MS Excel/Word/Access.

It is recommended also that the EEMS support accessing and pushing data to and from external sources such as weather from weather content services, real-time price and market settlement data from local market operators, accounting data to the accounts payable system; and electronic bill data from utility providers.

The EEMS should support multiple data types for analysis and reporting purposes, such as energy, temperature, occupancy, financial, and other department and facility related data.

The above features are considered essential for almost all organizations and enterprises and are considered standard within most available leading EEMS solutions.

2.2 Software Licensing

It is recommended that City pursue a cloud based software license (SaaS) with unlimited usage (enterprise license) to manage energy use, cost, and risk. The EEMS should have flexibility to allow City department and facility users to have full, around-the-clock, web-based access. The license should not limit the total number of users or concurrent number of users. The users may have an administrative role where they can make entries, modifications and create conservation projects or can have view-only access and create various reports to satisfy various business needs. It is typical for at least one person in each department to receive EEMS system training, and to develop familiarity with the EEMS system so they can develop department-specific reports and

metrics. The solution should include all of the required server(s) with backup system, media, and tape backup software.

2.3 Solution Warranty & Support

The City should ask potential EEMS vendors to provide a warranty (contractual services agreement) that shall commence after successful EEMS implementation and acceptance of work by City departments and facilities. It is recommended that a warranty period of at least one year from the acceptance date be pursued. During the warranty period, all of the services listed, but not limited to the following, should be provided to the City at no additional charge:

- Bug patches and fixes within 12 months of release;
- Updates and upgrades within 12 months of release;
- Firmware within 12 months of release;
- Technical support to include telephone helpdesk/online help service with guaranteed response time;
- Remote diagnostic support;
- On-site support for error resolution events.

The 12 month period above is considered minimum acceptable and the City should seek vendors who are able to provide a post warranty itemized yearly cost for an ongoing maintenance agreement. The vendor(s) should identify a fixed cost for a defined period during which a full support is to be provided.

2.4 User Training

Standard practice requires the vendor to be responsible for providing a minimum of one on-site training session for employees who will be initial users of the energy management system. The vendor should also be responsible for providing the appropriate solution documentation and user training modules. The vendor should also be responsible for providing future on-site training classes, as requested by the departments and facilities.

2.5 Data Hosting

SaaS hosted or cloud solutions involve data hosting by the vendor, the vendor will be responsible for the hosting of City data in a secure and reliable data center. The City should retain ownership of data that is provided or inputted into the proposed system, and retain the rights to remove that data from the system at any time. It is anticipated that data can be exported out of the system if the City decides to maintain a concurrent record, .csv or .xls.

3. Functional Resource & Operations Requirements

At a minimum, the EEMS system should be able to provide the following requirements and functionalities to the City of Boston.

3.1 Resource & Utilities Usage

The system must track periodic (monthly) utility consumption data (electricity, natural gas, steam, water, fuel) from electronic billing files when that data is made available by the City's utilities. The system must have the capability to integrate sub-metering for parallel metering and commissioning for future EEMS expansion. Resource tracking should have the capability to track all resources including electricity, water, steam, natural gas, district heating, or district cooling.

All utility billing determinants (elements that define the specifics of the bill) should be automatically imported and downloaded from utilities into the EEMS.

It is expected that the EEMS will download and store bills from utility providers electronically in an online database for subsequent reporting and analysis through a browser-based user interface. It is important to streamline the utility data entry process, allowing City departments and facilities to enter data, either manually or electronically.

3.2 Historical Use & Energy Procurement

The system should generate usage and demand profiles for energy procurement and energy risk management. Each department within the City should have the ability to identify time periods and data frequency (i.e. hourly, daily, monthly) for individual or multiple facilities. In addition, the system shall develop average weekday and weekend profiles for user-defined monthly periods, meters, sites or aggregate points.

It is recommended that the City require the EEMS vendor to be responsible for loading a minimum of two years' of utility and commodity consumption and cost data, as provided by the City, into the EEMS. Historical electricity and natural gas data in flat file format or other format should be provided to the vendor. Historical data for water, chilled water, diesel fuel, gasoline and fuel cards will be provided in a combination of flat file and hard copy formats.

The system should allow department users to define and analyze flexible profile scenarios to optimize energy pricing and risks in energy procurement. The EEMS should allow departments and facilities to identify and save alternative utility metering

groups by building type, size, geographic location, etc. for analysis, reporting, and procurement purposes.

The EEMS should generate the required data to serve as the basis for requests for proposal and other procurements for energy efficiency and sustainability projects. Data may include forecasted energy profile and volume data for actual and typical day types, throughout selected accounts and account categories.

The EEMS should have the capability to provide alternative rate plan comparisons and conduct sensitivity analyses around volume forecast variances. Departments and facilities should be able to model alternative rate and pricing plan proposals for decision making purposes. City decision-makers should be able to compare energy use forecast sensitivities against the proposed rate plan to establish the optimal risk proposal.

3.3 Resource Benchmarking

Benchmarking capabilities must be inherent in the EEMS system. This should allow for comparison of facilities for benchmarking by size, activity, space occupancy, and weather variances. Benchmarking should include industry standards or best practices, and Key Performance Indicators (KPIs)* that are either built into the software or easily defined by users. KPIs may include Energy Use Intensity (EUI, kWh/sq ft, therms/sq ft), Data Center Power/Carbon/Water Usage Effectiveness (P/C/WUE), lbs CO_2 emissions/employee, $/pupil, gallons water/sq ft, lbs solid waste/occupant and other relevant financial and performance metrics, as required. Benchmarking with respect to existing national databases such as EPA ENERGY STAR via built-in interface should also be either accessible.

3.4 Demand Management

EEMS should provide demand response programs participation by allowing City departments to reduce energy use in response to short notice pricing incentives. Demand response should cover multiple facilities and include capability of balancing load reductions throughout facilities. This can be accomplished by having the capability to subscribe to activation notices from ISO-NE issued to the demand response provider.

The EEMS should provide monthly peak demand monitoring. Demand monitoring is expected to cover multiple facilities and consist of aggregate demand levels monitoring for facilities under a specified energy contract.

3.5 Notification Capabilities

The EEMS should provide generation, prioritization, notification, and analysis of alarm events. Alarm events should be stored in the EEMS to allow trend analysis for maintenance purposes.

The EEMS should contain flexibility to perform data point calculations, comparisons, and any user-defined data manipulation. It should represent business logic encompassing any energy or non-energy related data points to generate alerts or send controls signals to building automation systems.

3.6 Diagnostics Capabilities

One EEMS capability that has started to gain momentum is the ability to provide facility equipment monitoring, indentifying anomalies, and assisting in diagnostics to resolve the situation. Analysis may include quantifying the correlation of energy use to operational variables to improve productivity of maintenance management personnel. Historical data should be leveraged for predictive maintenance and fault detection purposes.

3.7 Units Conversion

The EEMS should have capability to store multiple units of measure for the same commodity and automatically execute unit conversion for reporting in common units. Also, the EEMS should manage several currency units in a single instance of the database and allow automatic conversion into a single currency unit for reporting purposes. A robust database of converting between the various quantities of resources should be built into the system allowing to see a given resources quantity in several units.

3.8 Greenhouse Gas Emissions

The EEMS should automatically calculate and report processes for greenhouse gas emissions “scope 1& 2” and pollution reporting that is tightly linked to measurement and verification features to support carbon finance. Manual data entry for direct emissions (scope 1 items) should be a capability as such also for indirect emissions (scope 2). The solution should also comply with carbon protocols suitable for credit sale. The vendor should demonstrate ability to create new sustainable fund sources for local government energy efficiency projects through carbon finance.

The solution should provide the departments and facilities with the ability to compare greenhouse gas emissions levels across similar facilities and visualize trends in

greenhouse gas emissions at a single facility, across facility categories and for each department as a whole.

4. Functional Financial Requirements

From the financial perspective, it is recommended that the EEMS system to include the following capabilities.

4.1 Utility Bill Analysis, Validation & Audits

The EEMS should be able to provide automatic bill auditing to identify and report use and pricing errors in monthly utility bills. This includes all resources such as electricity, natural gas, water, district steam, etc.

In addition, the EEMS should be able to recalculate and verify utility bills for complex rates, including real-time pricing, time-of-use, demand ratchets, reactive power, power factor penalties, and unbundled pricing structures for commodity, transmission, and distribution charges. Bill recalculation will incorporate standard rate plans and negotiated specific pricing arrangements. Bill recalculations should be performed utilizing interval data collected from the field and not utilizing bill determinants taken from utility provider's bill.

The EEMS should perform reliability checks on incoming bills from utility providers. Checks should include evaluating current month energy use, demand, price, and cost to prior months and years. The EEMS should check for billing cycle continuity to detect possible billing errors.

The EEMS should be capable of automating the import of interval data from various data sources including advanced metering infrastructure (AMI) interfaces, meter data databases, building control systems, IP meters, meter serial interfaces, meter pulse options, and batch data import (e.g. csv files).

Additionally, it is required that the EEMS include interval data validation to detect gaps and/or spikes. The EEMS should include an option to automatically fill and/or correct data.

The system should use various methods to calculate bills for utilities produced onsite and purchased. Bill calculation methods may include:

- Use multi-component rate structures to metered usage;
- Apply rates to estimated usage;
- Determine usage estimates based on square footage and usage indices;
- Split incoming utility bills between multiple recipients.

4.2 Resource and Cost Allocation

The EEMS should allocate quantities and costs to different departments sharing a facility. Departments may elect to allocate monthly utility bills through a percentage/fixed fee allocation method, and calculation of cost-based on-metered usage and internal transfer prices. The EEMS will allocate energy use (kWh, therms) to different departments by meter or facility.

4.3 Budget Tracking & Normalization

Another recommended feature is the ability to monitor and report actual energy use and cost versus baselines and normalize information for weather and other energy drivers. EEMS should store actual baseline usage and cost values for analysis and reporting purposes.

The system should also support energy budget development and energy expenditures against monthly budgets tracking. The EEMS should notify departments or facilities of budget variances. Monthly budget data will be stored in EEMS for energy use, cost and reporting purposes.

The EEMS system is expected to have the capability to model and apply rates with the following:

- Separate rates for commodity, transmission, and distribution;
- Unlimited channels per meter;
- Maintain rate change and adjustment histories;
- Index to real-time price feeds from price exchanges;
- Load factor, power factor, and price blocks;
- Demand ratchets and demand charges;
- Multiple calendar definitions such as different definitions of winter and summer, break periods that can be defined once and referenced various times;
- Multiple Time of Use (TOU) definitions that can be defined once and referenced various times;
- Referenced charges such as fuel adjustments or surcharges that can be defined once and referenced various times.

4.4 Integration into Other Financial Management Systems

It is expected that the solution will allow City departments and facilities to pass utility bill data directly to their financial systems and to eliminate the need to manually enter data into those systems

4.5 Emissions/Energy Reduction Project Workflow

The EEMS solution should have a robust project tracking tool that at a minimum includes the creation of an energy/emission reduction project, tools to support the decision-making process for project proposal selection and sequencing, scope, resources, budget, timelines, automatic generated alerts and notifications and success criteria. The EEMS should also track the status of individual projects and view the overall status of the energy/emission management program across multiple projects.

4.6 Projects' Cost-Benefit Analysis

The EEMS solution should plot energy and sustainability reduction plans, and then develop measured strategies to reduce and abate both energy and sustainability costs and impacts. Based on the user-forecasted savings and costs information as well as incentives information, the system should calculate financial metrics such as Payback Period, Net Present Value (NPV) and Internal Rate of Return (IRR). At the same time, the system should quantify the environmental impact of the projects based on the reduction in energy consumptions. Furthermore, using a scenario modeling tool, a user should have the option to conduct what-if and Life Cycle Cost Analysis (LCCA) on how different combinations of projects affect financial projections.