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# City of Columbus Green Memo III

# Municipal Building Energy Management

EEDS Capstone Course

The Ohio State University

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Research Report

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# Table of Contents


1. Executive Summary ..... 2
2. Introduction ..... 3
2.1. Initial Research Objectives ..... 4
2.2. EPA ENERGY STAR® Portfolio Manager ..... 5
3. Current State of Columbus Municipal Building Energy Management ..... 6
3.1. Research Methods ..... 7
3.2. Columbus ENERGY STAR® Portfolio Manager Overview ..... 8
3.3. Evaluation of Energy Performance in Columbus Municipal Buildings ..... 8
3.4. Initial Recommendations ..... 10
3.5. Best Management Practices: City Comparison ..... 11
3.5.1 Atlanta Sustainability Office: Ruthie Norton & Matt Cox ..... 12
3.5.2 Philadelphia Sustainability Office: Mardi Ditz & Amanda Byrne ..... 12
3.5.3. Southface: Robert Reed ..... 13
3.5.4. Summary of Q&A Findings ..... 13
3.6. Calculating Energy and GHG Reductions from the BBC ..... 13
4. Final Recommendations ..... 16
5.1. Areas for Future Research ..... 18
Energy Monitoring Tools ..... 18
Funding Opportunities ..... 18
[Table 1: Suggested Energy Monitoring Tools and Funding Opportunities to be Utilized] ..... 18
6. Conclusions ..... 18
6. Appendices ..... 20
6.1. Appendix A: Data Analysis of Columbus ENERGY STAR® Portfolio Manager ..... 20
[Figure 1: Columbus Buildings with Baseline Data] ..... 20
[Figure 2: EPA ENERGY STAR® Benchmarking Energy Consumption Trends] ..... 21
[Figure 3: Energy Changes in Columbus Municipal Buildings] ..... 22
[Figure 4: Up-to-Date Buildings Categorized by Building Type] ..... 23
6.2. Appendix B: DOE Better Buildings Challenge Case Studies ..... 24
[Figure 5: DOE BBC Eligible Buildings] ..... 24
[Figure 6: Cleveland Firehouse Energy Efficiency Compared to Columbus Fire Stations] ..... 25
6.3. Appendix C: Q&A Best Management Practices City Comparison Transcripts ..... 26
Full Transcript of 3.4.1: Atlanta Sustainability Office: Ruthie Norton & Matt Cox ..... 26
Full Transcript of 3.4.2: Philadelphia Sustainability Office: Mardi Ditz & Amanda Byrne ..... 27
Full Transcript of 3.4.3: Southface: Robert Reed ..... 29
6.3. Appendix D: Final Recommendations Utilizing Three Additional Scenarios ..... 31
[Table 2: Scenarios of Theoretical Building Participation and Results] ..... 31
7. Glossary ..... 32
8. Works Cited ..... 35

## 1. Executive Summary

This report was prepared in response to the City of Columbus RFP for Analysis of Greenhouse Gas (GHG) Objectives in the Columbus Green Memo III. The following research examines the achievable GHG emissions through energy reductions within the City of Columbus municipal buildings and facilities sector.

In cooperation with the Columbus Energy Manager, Willie Overmann, preliminary research evaluated existing performance data for buildings in the Columbus ENERGY STAR® Portfolio Manager (PM). Overall, this research leverages Columbus PM by comparing the current utility bill reporting process in Columbus to the Best Management Practices (BMP's) of leading cities to identify opportunities for energy efficiency in municipal buildings. It was concluded that the reporting process for Columbus facilities is decentralized, and in order to provide higher precision benchmarking for city facilities, material within the Columbus PM should be reevaluated, updated, and benchmarked based on centralized annual reporting guidelines. Conversations held with individuals in the sustainability offices of Philadelphia, Chicago, and Atlanta, supported these assumptions. The final recommendations derived from these cities include:

1. Centralize annual utility bill reporting process through 3rd party management, non-profit support, and a full-time energy manager (Columbus employee) to evaluate PM.
2. Identify buildings with a high Energy Usage Intensity (EUI) and target capital improvements based on Life Cycle Costing (LCC), ROI, and overall energy flows.
3. Utilize 3rd Party Support by applying for the DOE Better Building Challenge (BBC).

The dynamics of these results are discussed further throughout the entirety of the *Municipal Building Energy Management* report.

## 2. Introduction

Green Memo III (GM III) is a conglomeration of nine sustainability goals that the City of Columbus has identified as needing priority action within the next five years. Of the nine sustainability goals GM III identifies, this report specifically addresses two goals within Climate Change and in Energy, which were guided by the following objectives to reduce GHG emissions:

- Climate Change Objective 1: Reduce GHG emissions by 30% from city operations and by 20% from the community over the next five years.
- Energy Objective 1: Reduce energy consumption community-wide by 20% (as measured on a per capita basis) over the next five years.
- Energy Objective 3: Manage and reduce energy costs over the next five years.

These objectives are highly interrelated in nature, as a reduction in energy consumption is coupled with a reduction in GHG emissions and overall costs. According to GM III, the GHG emissions from city buildings and facilities are 76,391 metric tons of CO2 equivalent (mtCO2e) in 2013, which was 31.7% of total city operations [1]. This report focuses on municipally owned facilities, so other GHG contributors from city operations (vehicle fleet, wastewater treatment, street lights & signals) and community GHG emission sources are not included in the analysis. This research seeks to improve energy management in municipal buildings by updating Columbus PM annual reporting guidelines to acquire complete utility bill data, and use Columbus PM to prioritize capital improvements based on energy efficiency metrics. By focusing on municipal buildings, the aim is to improve Columbus facility energy management to ultimately serve as the standard for the community to follow, specifically for large commercial

and industrial building owners. Please note that all supplemental figures, tables, transcripts, and glossary are to be found in the appendices.

### 2.1. Initial Research Objectives

Action 11 of Energy Objective 1 was evaluated first, which sought to prioritize the implementation of energy efficiency measures, such as procurement of ENERGY STAR® appliances, replacing inefficient lighting and HVAC equipment, and updating or upgrading to direct digital controls when practical. In order to target municipal buildings for potential energy efficiency measures, Columbus PM was used to evaluate energy usage per square foot, which is referred to as Energy Usage Intensity (EUI). However, upon review of the Columbus PM it was found that there are sufficient gaps in utility bill data for the majority of the 190 buildings registered (see **Appendix A, Figure 1**). Therefore, the initial analysis of Columbus PM shifted from the latter stages of energy efficiency projects, which revolve around assessing a potential energy conservation measure (ECM), to more preliminary efforts that establish a streamlined annual reporting process for Columbus municipal buildings. In further evaluations of the current performance of Columbus municipal buildings, the methods used by the City of Seattle are highlighted to prioritize their portfolio based on building type, gross floor area (GFA), and building specific EUI. However, a thorough analysis of Columbus buildings is an area for future research once sufficient performance data is gathered.

Action 8 of Energy Objective 1 was evaluated next, which sought to increase voluntary participation in the Columbus Energy Challenge (CEC), striving for enrollment of 70% (or 690) of large buildings (over 50,000 square feet) by December 2015. However, as a newly established program, there were only 41 buildings enrolled in the CEC in the most recent update as of December 2014. This makes a large increase in voluntary enrollment by the intended date

difficult to achieve. In order to meet this goal in the future, research would have to identify ways to improve access to energy management training and utility bill data for challenge participants. It was found that there are a number of cities that have made mandatory policies for energy monitoring with ENERGY STAR® PM in commercial and municipal buildings. Each of these cities have experienced positive results of benchmarking, such as lowered utility bills and energy usage in commercial buildings. Therefore, this analysis focuses on the BMP's of select cities (Philadelphia, Atlanta, and Chicago) in order to create potential annual reporting guidelines for Columbus municipal buildings. The final recommendations aim to make energy efficiency data more accessible to those who are in charge of making energy efficiency improvements, such as building managers and operations and maintenance employees. In the future, it is possible to use this report's recommendations for municipal buildings as an example for voluntary commercial buildings to follow.

### 2.2. EPA ENERGY STAR® Portfolio Manager

ENERGY STAR® Portfolio Manager (PM) is the energy monitoring platform endorsed by the United States Environmental Protection Agency (EPA). The EPA has released data trends for buildings utilizing ENERGY STAR® PM, which has provided a basis for a 16 states and 23 cities to implement mandatory and voluntary energy monitoring programs [2]. In their study, the EPA reviewed energy consumption trends in 35,000 buildings that entered complete energy data into PM. Benchmarking results compared reductions through a baseline established in 2008 over a four-year period, which represents three years of change. Savings were measured according to EUI and the weather-normalized ENERGY STAR® score. Average annual savings were 2.4 percent, with a total savings of 7 percent and an ENERGY STAR® score increase of 6 points over the period of analysis [3]. These results published by the EPA are displayed in **Appendix A,**

**Figure 2**. Therefore, it can be concluded that benchmarking practices can be a reliable source for energy reductions for commercial and municipal buildings.

In order to begin benchmarking with ENERGY STAR® PM, there needs to be sufficient data to establish a baseline. To determine a baseline measure for the desired year there needs to be 12 consecutive months of utility data from electricity and natural gas providers. Additionally, property use details such as gross floor area (GFA), year of construction, and number of building occupants are required. ENERGY STAR® PM automatically calculates a baseline from the first year a building enrolls; however, if there is insufficient data, it is not possible to establish a baseline. The EPA provides a number of online resources for companies and municipalities to gather data and begin the benchmarking process. There are additional federal programs, such as the DOE Better Buildings Challenge (BBC) that offer further assistance to evaluate ENERGY STAR® PM data and begin to implement energy efficiency measures. Therefore, the task of managing and reducing energy costs comes down to the level of commitment of organizations, building managers, and employees to leverage these resources to begin tracking and reducing their energy consumption.

## 3. Current State of Columbus Municipal Building Energy Management

Through interactions with the Energy Manager of Columbus, Willie Overmann, it was found that the reporting process for large municipalities is more difficult than commercial business because there can be a disconnection between departments, i.e. those who are in charge of operations and maintenance of buildings and those that are in charge of finances and accounting. The current reporting process for city facilities moves through the fiscal office of the four departments— Finance and Management, Public Utilities, Parks and Recreation, and Public Services. The following research evaluates the effectiveness of Columbus' annual reporting

process for utility bills based on data completion and accuracy within Columbus PM. It will include the current trends in energy consumption for Columbus municipal buildings and the BMP's of the City of Seattle that has been benchmarking municipal buildings through mandatory reporting policies.

### 3.1. Research Methods

Preliminary analysis evaluated the benchmarking savings projected by the EPA. Their trends in energy use focused on 35,000 buildings of various building types, and the following analysis will determine whether or not 2.4 percent savings annually can be achieved strictly in a municipal setting. The EPA's results will be compared to performance reports generated from Columbus PM and the BMP's from the City of Seattle 2011-2012 Annual Performance Report of Municipal Buildings [4]. In this manner, research can evaluate the progress the City of Columbus has made in benchmarking energy efficiency for municipal buildings, determine how effective benchmarking can be in municipal building types, and recommend ways to prioritize buildings based on EUI in the future. In order to do so, the following research tasks were pursued:

1. Analyze existing data within Columbus PM for completion and accuracy.
2. Identify buildings with a minimum of 12 months of data entry, buildings with at least two years data, and buildings that are up-to-date (2014).
3. Calculate change in EUI and percent change annually for buildings that are up-to-date and elaborate further based on building type.
4. Speculate where energy savings come from (gradual savings from benchmarking vs. large scale investment in ECM's).
5. Compare results to the energy efficiency trends and BMP's of Seattle.

### 3.2. Columbus ENERGY STAR® Portfolio Manager Overview

Energy efficiency data in the analysis was derived from an Energy Performance Report generated from Columbus PM on March 25th, 2015. The report was used to analyze select energy efficiency metrics available in PM, such as site EUI, GFA, and direct GHG emissions. Overall, the report compared energy performance of the baseline calculated by PM to the most current year recorded for each property. First, data from the report was exported into an excel document, cleaned, and refined for completeness and accuracy. In this comprehensive review of Columbus PM it was found that there are sufficient gaps in utility bill data for the majority of the 190 buildings registered. Of the total, 142 buildings have at least 12 consecutive months of utility data input into Columbus PM, and only 50 buildings had at least 2-years of data recorded. This observation is crucial because there needs to be a baseline measure established and at least one year of data from the baseline in order to begin monitoring current energy performance, benchmark future performance, and prioritize capital investments in energy efficiency. Therefore, the first step to begin benchmarking in Columbus municipal facilities will be to update and evaluate buildings that contain insufficient data to improve the quality of the baseline EUI. Further description of this evaluation of Columbus PM data based on completeness and accuracy is displayed in **Appendix A, Figure 1.**

### 3.3. Evaluation of Energy Performance in Columbus Municipal Buildings

The following research further analyzed the Performance Report generated by Columbus PM in order to determine the effectiveness of ENERGY STAR® benchmarking in municipal buildings. For the data analysis to be compared to the study conducted by the EPA, there needed to be a total of four years of data input into ENERGY STAR® PM. In order to determine which buildings qualify, Columbus PM performance data was categorized based on the number of years

each building has been benchmarking, and then the overall changes in EUI from the baseline were calculated. It was found that 17 buildings in Columbus PM have sufficient data through 2014 to be evaluated for the comparison. These buildings have been using PM for an average of six years, which makes them ideal for evaluating the effectiveness of benchmarking in municipal buildings. The building types that saw the largest energy reductions in the EPA study were retail, office, and non-refrigerated warehouses. Coincidentally, eight of the up-to-date buildings in Columbus PM were offices and three were non-refrigerated warehouses or self-storage units. Therefore, a comparison by building type was also included in the analysis. The comparison focuses on the percentage change in EUI to determine whether or not savings come from consumption side inefficiencies of energy use behavior (gradual improvements by increasing access to utility bill data) or by addressing inefficient energy consuming equipment (large improvements through investment in ECM's). The results of this comparison are displayed in **Appendix A, Figure 3.**

Overall, the results of the comparison contradict the benchmarking projections made by the EPA when focusing only on municipal buildings. A minimal amount of Columbus' facilities saw gradual improvements from benchmarking performance (reductions between 0-10 percent), and the majority of improvements must have come from large capital improvements (reductions over 10 percent). Additionally, over half of the buildings evaluated saw an overall increase in EUI. Most likely this is because municipal building types have irregular or constant hours of operation that are more difficult to manage simply by decreasing consumption among building occupants. This makes energy improvements from increasing access to utility bills less frequent in a municipal setting, especially if building managers are responsible for multiple buildings. Additionally, the structure of the utility bill reporting process for Columbus facilities has not

been updated to include building managers in the evaluation of energy efficiency data available in PM. The current reporting process, which is carried out by the fiscal office of each department, suggests that these buildings did not meet the EPA projections because although the utility bill data was entered into the Columbus PM, there were no personnel overseeing data entry and analyzing energy flows for possible low or no cost energy reduction activities. Until recently this role to analyze energy efficiency data in Columbus PM was vacant. However, as the Columbus Energy Manager, Willie Overmann now oversees this process in the Finance and Management Department.

### 3.4. Initial Recommendations

Based on the findings of the initial analysis, the lack of accurate and sufficient data within Columbus PM suggests that the current decentralized reporting process is inefficient. The task of inputting utility bills may become secondary to those within each Fiscal Office because they are not personally responsible for making energy efficiency improvements. Understandably, data input into Columbus PM should be carried out by someone who is knowledgeable about energy efficiency and the results should be transferrable to those employees who are in charge of making energy efficiency improvements. Therefore, it is crucial for a new centralized annual reporting process to make energy efficiency data available to all actors involved in the prioritizing, funding, and implementation of capital improvements for energy efficiency. Best practices of other cities were researched to identify ways to centralize the annual reporting process and begin to make energy improvements based on energy efficiency metrics opposed to a hierarchy of capital projects.

In comparison to the energy trends published by the EPA, the City of Seattle saw similar results from benchmarking municipal buildings. In their 2011-2012 Annual Performance Report,

it was recognized that 50 percent of the 94 buildings benchmarked with ENERGY STAR® PM were below the national average, and their savings from benchmarking were modest compared to the 2.4 percent annual savings projected by the EPA. They found that cities must take a different approach to benchmarking since their portfolio is much larger compared to commercial building owners. The city of Seattle breaks down their ENERGY STAR® PM into seven building types—community, operations, office, libraries, fire stations, police stations, and other—and then determines their relative priority by overall GFA (square footage). They place the highest priority in large, community buildings, but also assess their strengths and weaknesses within each building type by targeting buildings with high EUI and applying previous energy efficiency projects that have been successful. Since they began in 2008, by prioritizing buildings by type, GFA, and EUI they have reduced overall consumption of benchmarked buildings by 1 percent (City of Seattle, 2013).

Therefore, further analysis of Columbus PM based on building type and EUI is displayed in **Appendix A, Figure 4**. The source of the issue that causes varying EUI between building types and specific buildings is an area for future evaluation by Columbus Building Managers. However, this task can only be achieved once sufficient data is entered into Columbus PM. The following research will attempt to address the issue by applying the BMP's of other cities to create annual reporting guidelines and employ a suite of tools to evaluate energy efficiency in municipal buildings.

### 3.5. Best Management Practices: City Comparison

To create a better understanding of how other cities are conducting new energy management initiatives to meet their respective sustainability goals, sustainability offices in Atlanta, Chicago, and Philadelphia were contacted, as these cities were ranked nationally in

achieving energy reductions. These cities were all ranked in the top 10 of cities with the most ENERGY STAR® certified buildings [5], and have all passed or are in the process of passing legislation mandating large buildings within the city to benchmark using ENERGY STAR® PM. City officials were asked specific questions that pertained to findings within Columbus, and they were extremely helpful in crafting recommendations based on what has worked for their cities. The following are brief summaries of why Atlanta, Philadelphia and Southface were chosen to interview, with the full transcripts of each conversation located in **Appendix C**. Chicago was not available for a phone call but was able to supply useful data.

### 3.5.1 Atlanta Sustainability Office: Ruthie Norton & Matt Cox

The City of Atlanta was one of the first cities selected by President Obama in 2011 to participate in the DOE BBC. As of 2014, Atlanta BBC encompasses more than 228 buildings, with over 100 million square feet. The City of Atlanta also practices centralized bill management by a third party system, uses EUI to value capital projects, and utilizes the guidance and assistance of non-profit support with audits and grants. To view the full Q&A transcript between Scott Semroc, Ruthie Norton, and Matt Cox, please refer to **Appendix C.**

### 3.5.2 Philadelphia Sustainability Office: Mardi Ditz & Amanda Byrne

The city of Philadelphia recently completed a guaranteed energy savings project on its four largest municipal buildings by using an energy savings performance contract and a city bond. Philadelphia looks at Life Cycle Costing (LCC), Return on Investment (ROI), and other energy efficiency metrics in addition to ongoing projects when evaluating capital projects. Furthermore, the city recently hosted an award event for employees that have spearheaded energy efficiency (EE) projects. To view the full Q&A transcript between Scott Semroc, Mardi Ditz and Amanda Byrne, please refer to **Appendix C.**

### 3.5.3. Southface: Robert Reed

Southface is a non-profit in Atlanta that has assisted the city through helping enroll over 100 million sq. ft. of buildings in the DOE's BBC. The company is comparable to Columbus Building Owners and Managers Association (BOMA). To view the full Q&A transcript between Scott Semroc and Robert Reed, please refer to **Appendix C.**

### 3.5.4. Summary of Q&A Findings

This information was compiled and assessed to determine what best practices could be transferred to the City of Columbus. Recommendations include a centralized utility bill intake that has an energy manager overseeing and verifying incoming data, and expanding capital project valuation to include EUI, LCC, and ROI metrics in addition to evaluating overall energy flows. It would also be beneficial if third party support from organizations such as the DOE and Southface were utilized to assist with these goals and ongoing energy management.

## 3.6. Calculating Energy and GHG Reductions from the BBC

From the analysis of Columbus PM data, it was determined that 10 municipal buildings were currently eligible to apply for the DOE's BCC (see **Appendix B, Figure 5** for a full list of eligible buildings). These buildings have complete utility data sets that are accurate enough to be considered for a partnership. Only 126 out of 190 municipal buildings in Columbus PM currently have enough utility data to establish a baseline EUI, which was used to extrapolate for the representation of all 186 buildings. Four wastewater treatment facilities were excluded in this analysis because their function results in an EUI much higher than the average building, which skewed the final calculations. The GFA and EUI averages for these 126 buildings were multiplied together to obtain the average energy consumption in kBtu's for one building. Different proportional calculations were made to represent various rates of adoption for

programs such as the BBC in city buildings. The following is a step-by-step explanation of calculations used to determine how energy and GHG reductions can be achieved from 2016-2020. It was assumed that the 10 buildings currently eligible in Columbus PM were accepted into the challenge and utilized the resources, expertise, and grants available through the program.

1. Ten municipal buildings had sufficient data to be eligible to apply for the BBC, and this number was used as a lower bound representation of energy savings.
2. Adoption rates of 20 percent, 50 percent, and 100 percent were selected to communicate the range of possible savings inherent to accurate data collection and assessment paired with 3rd party support and expertise.
3. For each of these four scenarios, total energy consumption in kBtu's was found and converted into the corresponding totals in kWh's and CCF of natural gas (70 percent kWh, 30 percent CCF).
4. These total consumption figures were reduced 12.5 percent to calculate the total reductions in kWh's and CCF from 2016-2020 based on the DOE's findings for 3.5 billion sq. ft. currently in the BBC. This is the equivalent of an annual reduction of 2.5 percent EUI over the next five years [6].
5. The 12.5 percent taken from the overall total usage is representative of total reductions over the five-year period. 70 percent of this total was multiplied by the market rate of electricity (.07 $/kWh) while 30 percent was multiplied by the price of natural gas (.0063 $/CCF). These figures were then added to make up the cost savings from electricity and natural gas usage reductions.
6. These reductions were then converted into tons of carbon (assuming coal generation for electricity) to evaluate the total benefit from reducing carbon emissions. The social cost

of carbon is an estimate of damages caused by a marginal increase in CO2 pollution. A social cost of carbon of $12 was used (the EPA's most conservative estimate) [7].

The largest expense is the labor costs involved with hiring a city employee dedicated to the energy management recommendations previously outlined. This cost over the next five years is $144,000 ($28,800 annually). The second expense is consulting fees for a third party to manage utility data centralization. According to the Energy Manager of Columbus, the target price for third party management that will appear in a similar RFP is $40,000, with a maximum cap of $50,000. This information allows the calculation of the net present value (NPV) for the upcoming 2016-2020 period, which is listed below is the lower bound (10 buildings) scenario:

- Five-year period total benefits: $233,854
- Five-year period total costs: $184,000
- Five-year period net total gain of $49,854
- NPV: $45,322 ($9,064/year) using a discount rate of 5 percent

There were several challenges inherent to this analysis that may have skewed the data, but overall the calculations are detailed enough to create a fairly accurate forecast of energy consumption reduction, taking into consideration a margin of error. By taking an average EUI of the 10 buildings eligible for the BBC, an accurate total reduction can be seen. Individual variance may be obscured, as some buildings inevitably have higher reductions than others. The same is true of using the DOE's statistic for average EUI reductions (2.5 percent per year) observed in the 3.5 billion sq. ft. participating in the challenge (DOE, 2013). Therefore, the calculations are meant to express the bigger picture in terms of aggregate energy reduction, and over time individual variance can be readdressed when more complete data sets are made available. The average Columbus building data was also applied to the 10 eligible buildings

instead of their actual data to maintain consistency when comparing to other adoption rates. This could cause some error but can easily be calculated and compared separately to the original scenario. For a more precise amount of potential energy reductions for the ten buildings currently eligible for DOE BBC see **Appendix B, Figure 5**. There are also some assumptions made:

1. All electricity is sourced from a coal burning power plant.
2. The energy mix for these buildings is 70/30-electricity/natural gas [8].
3. All ten buildings would be enrolled into the program by Jan. 1, 2016.

These variables may change over time and need to be monitored for any change that varies from these assumptions. These findings of possible economic savings can be used to justify the costs of utility data centralization and additional employees that are devoted to energy management, as the benefits are certainly greater.

## 4. Final Recommendations

Upon completion of research, the following three recommendations were created for the City of Columbus to implement in order to fulfill the objectives initially stated. The city should prioritize the three recommendations before addressing other actions in GM III because of the immediate and substantial economic, social, and environmental benefits that will result from implementation. The research and recommendations include funding opportunities to pursue energy efficiency in municipal buildings, such as the BBC. The first step to achieving this task will be to centralize the annual reporting process and begin to make energy improvements based on energy efficiency and life cycle costing (LCC). These recommendations are drawn from the extensive analysis of Columbus PM, BMP's of exemplary cities, and the possible GHG reduction potentials when partnering with the DOE BBC and 3rd party support.

1. Centralize Annual Utility Bill Reporting Process through 3rd party management, non-profit support, and a full-time energy manager (Columbus employee) dedicated to Columbus PM.
2. Identify Buildings With a Higher Than Average EUI and target capital improvements based on LCC, ROI, and overall energy flows.
3. Utilize 3rd Party Support by applying for the DOE BBC and support from non-profits such as Southface.

The City of Columbus should first prioritize centralized bill management; without sufficient and complete data, it is difficult to establish an accurate baseline. A baseline is necessary to calculate the change in EUI, which then allows the building manager to assess where energy savings can be made. Following the establishment of centralized bill management and identification of buildings with a high EUI, it is then possible to apply for a partnership with the DOE and/or other 3rd party support assistance programs. These resources are available for the City of Columbus to utilize, and have produced substantial results as illustrated in the Cleveland Firehouse Headquarters energy efficiency reduction and savings (see **Appendix B, Figure 6** for a comparison with Columbus Fire Stations). This report identifies ten Columbus municipal buildings that are currently eligible to apply to the DOE BBC or other 3rd party support, which will result in a reduction of 2,287 tons of $CO_2$, and energy reduction savings of $206,410 and $27,444 saved from the social cost of carbon. **Appendix D, Table 2** further expands upon three additional scenarios of building participation that results in GHG emissions reductions, energy reduction savings, and savings from the social cost of carbon.

Limitations of current analysis include incomplete and inaccurate data within the Columbus PM, lack of incentives to implement municipal building energy conservation

measures, lack of prioritized energy saving sources within the buildings, and lack of communication amongst the energy auditors, building managers, and employees within the building.

### 5.1. Areas for Future Research

Recommendations for further research are to prioritize accurate and complete data within the Columbus PM; buildings with a minimum of 24 months of data will allow analysis of energy consumption trends and an accurate overview of the City of Columbus Municipal Energy Management. Furthermore, based on the recommendation from contacts within other cities the following topics should also be research further, also summarized in Table 1. The energy monitoring tools and funding opportunities provide additional support to implement energy efficiency measures highlighted in our initial research task (Energy Objective 1, Action 8). In combination with the reductions speculated by enrollment in DOE BBC, these topics could move past marginal improvements from benchmarking to make substantial energy reductions in municipal buildings and make Columbus a leader in energy efficiency.

[Table 1: Suggested Energy Monitoring Tools and Funding Opportunities to be Utilized]

| Energy Monitoring Tools | Funding Opportunities |
|---|---|
| ● Energy Flow Analysis<br>● IAQ<br>● Energy Direct<br>● Demand Response Monitoring<br>● Community Improvement Districts | ● Specific qualifications for DOE BBC by building type<br>● Non-Profit energy partnerships in Columbus (comparable to Southface)<br>● ARRA Funding<br>● DOE Solar America City |

## 6. Conclusions

In conclusion, it has become apparent that the city has already made some progress in regards to these recommendations, even before this research was finalized. The city hired an

Energy Manager six months ago, and before this position was filled the spot was vacant for six years. This was a crucial move towards greater energy management for the city, and will allow for greater coordination amongst buildings and departments. The city is also preparing an RFP for a 3rd party to perform the following services:

a.) Utility bill collection and verification

b.) Input data into centralized energy management software (ex. EPA's PM)

c.) Additional tasks that would increase energy management capabilities in Columbus.

The city has not made any notable strides towards including EUI and energy efficiency metrics in ECM evaluation, but they do conduct an informal LCC analysis on capital projects based on structural reports gathered through building audits. The CEC is partnered with BOMA (Building Owners and Managers Association) to achieve greater adoption of the program by informing building owners and managers about the challenge and how to enter. There is room for additional partnerships with organizations such as the DOE, and it is uncertain at this time if the city will pursue partnerships with outside organizations mentioned. One limitation of the City of Columbus' funding process to engage 3rd party support is the avoidance of Energy Performance Contracts that are common practice by other cities. By taking these recommendations and including them in the cities energy management policy, the city could simultaneously reduce operating costs significantly while also meeting goals set out in GM III in regards to GHG emissions and city energy use.

# 6. Appendices

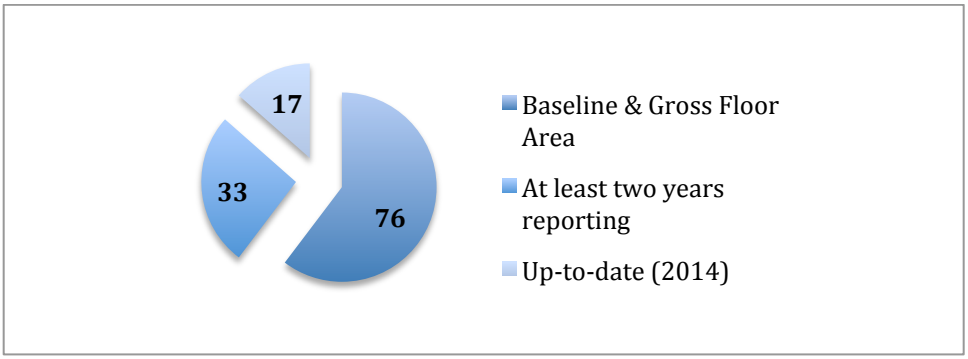
## 6.1. Appendix A: Data Analysis of Columbus ENERGY STAR® Portfolio Manager

Energy efficiency data in our analysis was derived from an Energy Performance Report generated from Columbus PM on March 25th, 2015. The performance report compared baseline EUI to the most current year recorded for each property. In this analysis, data from the report was exported into an excel document, cleaned, and refined for completeness and accuracy**.** Buildings were further analyzed based on the number of years they have been benchmarking energy performance and their percentage change in EUI. All energy performance metrics used to calculate these values were provided by the Columbus ENERGY STAR® PM database.

[Figure 1: Columbus Buildings with Baseline Data]

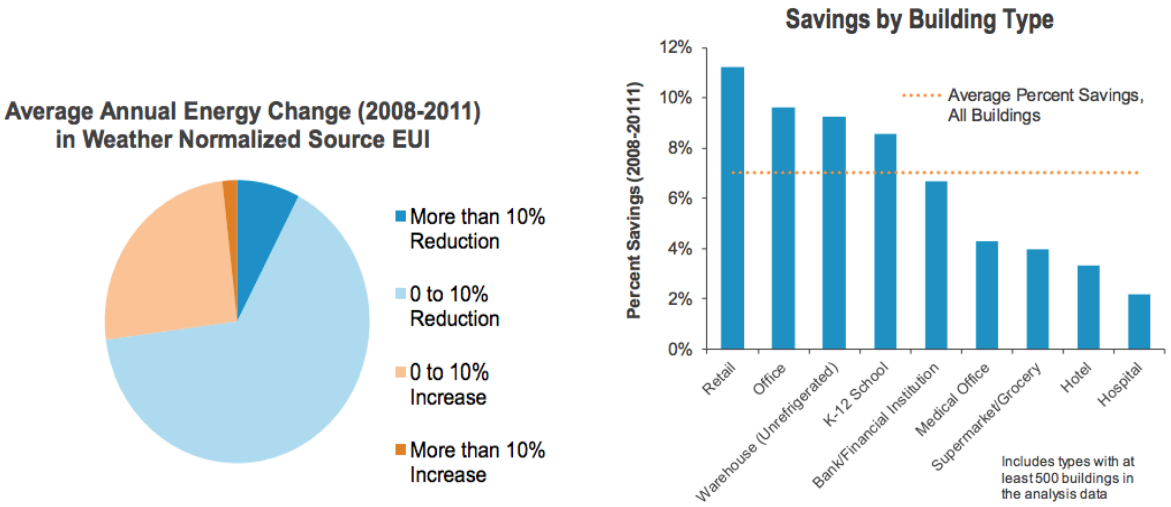
In the comprehensive review of Columbus PM, all 190 buildings were reviewed for complete data. Of the total, 142 had twelve months of data, which is necessary to determine a baseline. However, upon further analysis, only 126 buildings had sufficient information, such as gross floor area (GFA), in order to calculate EUI. Of these buildings, only 50 had two years of data from their established baseline, and only 17 buildings had data that was up-to-date (baseline—2014). For each of these categories, the number of buildings with reduction in EUI was calculated. As may be seen in Figure 1, the percentage of buildings with EUI reductions increases overall as buildings have more complete data.

| | Baseline & Gross Floor Area | At least two years reporting | Up-to-date (2014) |
|---|---|---|---|
| **Number of Properties** | 126 | 50 | 17 |
| **Reductions in EUI** | 39 Buildings (30%) | 16 Buildings (32%) | 6 Buildings (35%) |



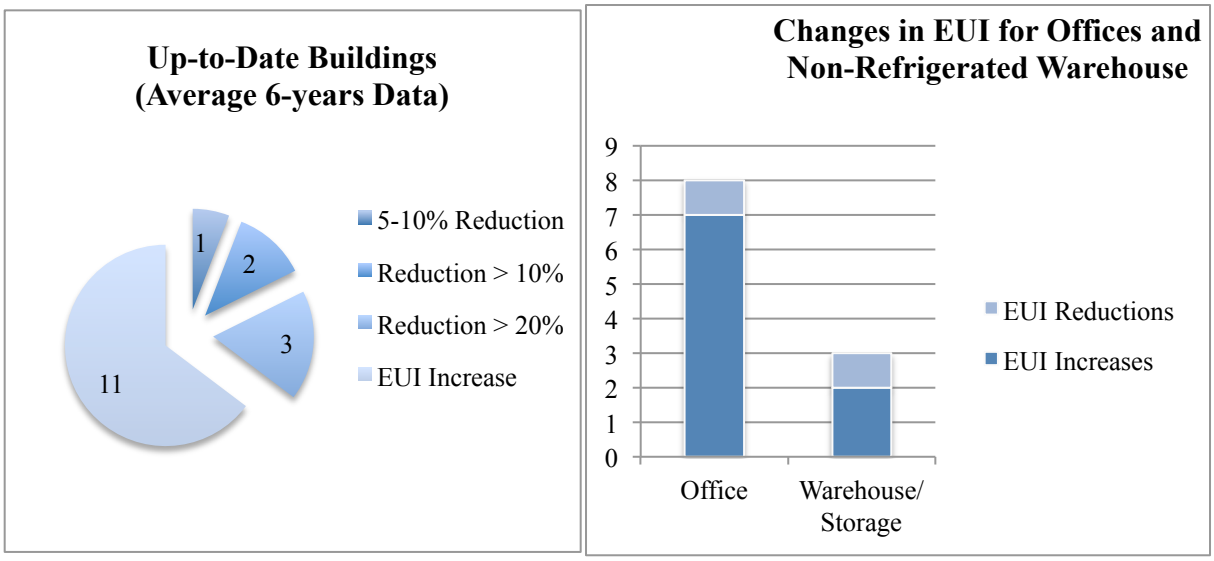
[Figure 2: EPA ENERGY STAR® Benchmarking Energy Consumption Trends]

In 2012, the EPA published trends in energy efficiency for buildings using ENERGY STAR® Portfolio Manager. This study has been used by both cities and states to establish annual reporting guidelines for commercial and municipal buildings. The report is available online at the ENERGY STAR® website. In their study, the EPA reviewed energy consumption trends in 35,000 buildings that entered complete energy data into ENERGY STAR® PM. Benchmarking results compared reductions from a baseline, established in 2008, over a four-year period. Average annual savings were 2.4 percent, with a total savings of 7 percent over the period of analysis. Overall, 70 percent of buildings reduced energy consumption, and close to 90 percent of these buildings experienced average annual reductions within the range of 0 – 10 percent (EPA, 2012).



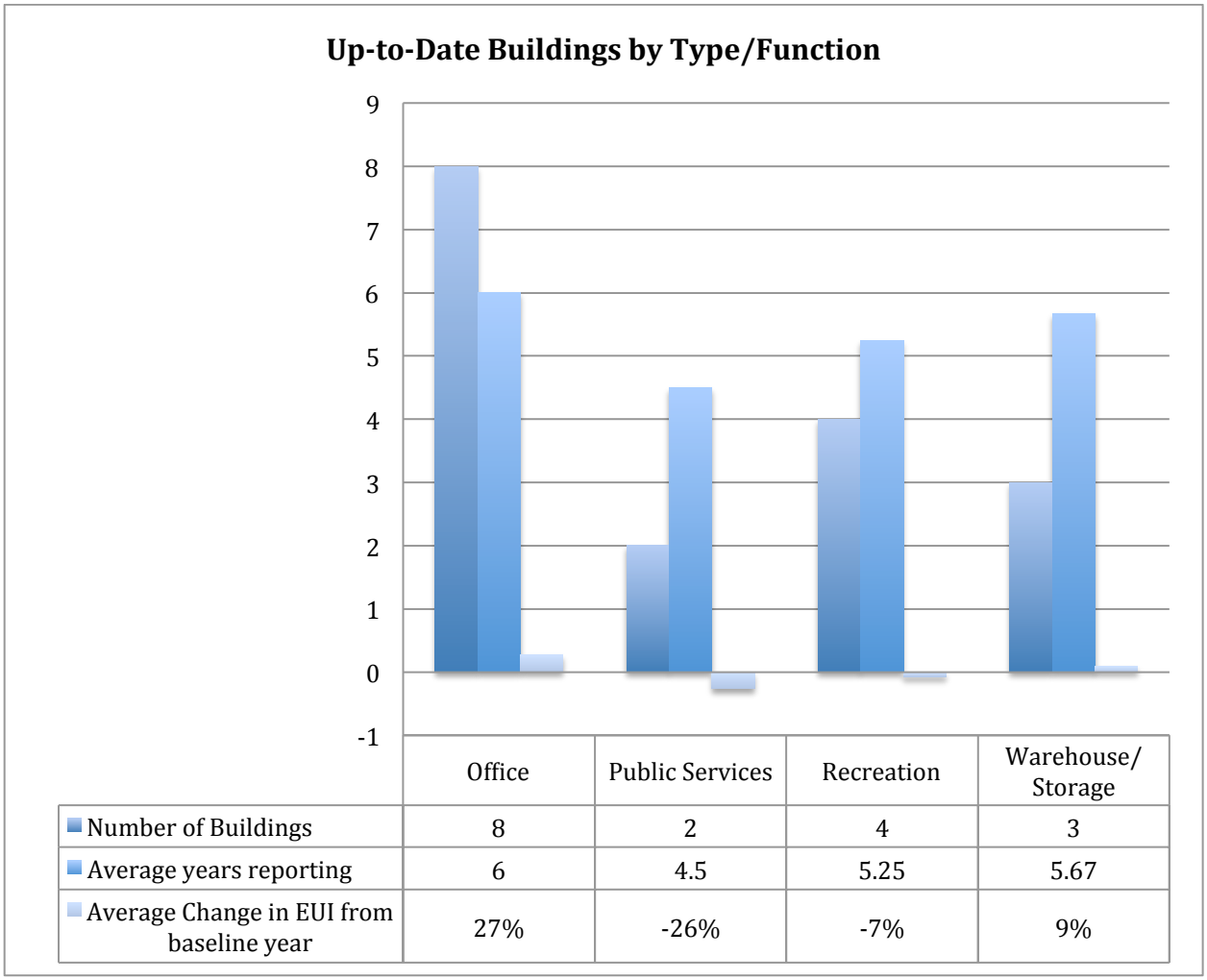
[Figure 3: Energy Changes in Columbus Municipal Buildings]

This analysis compared the results published by the EPA strictly to a municipal setting by evaluating the trends in energy consumption of up-to-date buildings in Columbus PM. In order to determine which buildings qualify, Columbus PM performance data was categorized based on the number of years each building has been benchmarking, and then the overall changes in EUI from the baseline were calculated. It was found that 17 buildings in the Columbus PM have sufficient data through 2014 to be evaluated for comparison. These buildings have been using Columbus PM for an average of six years, which makes them ideal for evaluating the effectiveness of benchmarking in municipal buildings. This comparison to Columbus municipal buildings showed that 11 buildings saw an increase in energy consumption, only one building saw a reduction between 5-10 percent, and five buildings saw an increase of over 10 percent. Therefore, only one building saw gradual improvements from benchmarking performance (reductions between 0 - 10 percent), and the majority of improvements must have come from large capital improvements (reductions over 10 percent).



[Figure 4: Up-to-Date Buildings Categorized by Building Type]

In addition to the results presented in Figure 3 of the main analysis, the up-to-date buildings within Columbus PM are dissected by building type and the average change in EUI. This corresponds to the BMP employed by the City of Seattle. In Columbus, the top performer was public services buildings, which was lead by the Municipal Courthouse that is in the top 75$^{th}$ percentile of all courthouses. In the future, if our recommendations are pursued Columbus could use these successful projects as an example to improve areas of weakness, which can make benchmarking more useful in a municipal setting.




| | Office | Public Services | Recreation | Warehouse/ Storage |
|---|---|---|---|---|
| Number of Buildings | 8 | 2 | 4 | 3 |
| Average years reporting | 6 | 4.5 | 5.25 | 5.67 |
| Average Change in EUI from baseline year | 27% | -26% | -7% | 9% |

## 6.2. Appendix B: DOE Better Buildings Challenge Case Studies

In order to visualize the potential savings from the DOE BBC further analysis reviewed two potential case studies. The first case study evaluated potential energy savings if ten of Columbus' office buildings and warehouses were enrolled in the DOE BBC. The second case study compared baseline and current EUI in select Columbus Fire Stations and a Fire Station in Cleveland that is an active participant of the BBC. Performance data for Columbus buildings was derived from PM and projected energy savings were determined by the energy performance trends advertised on the DOE website.

[Figure 5: DOE BBC Eligible Buildings]

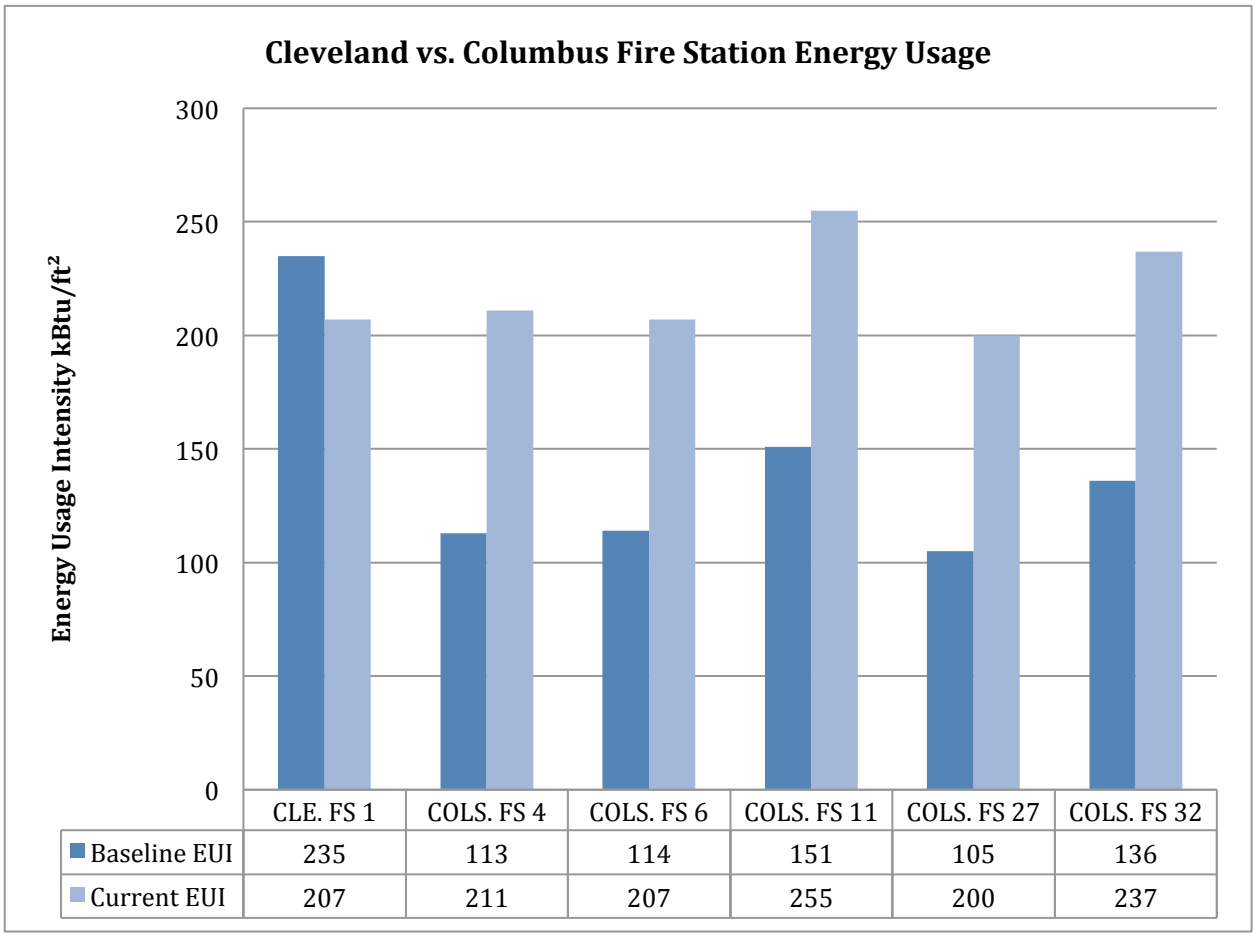
By categorizing each type of building with up-to-date data, it was noticed that office buildings and non-refrigerated warehouses were performing the worst. Conversely, these building types were supposed to see the largest decrease in energy use, according to the EPA. Therefore, these buildings were used to analyze the potential improvements projected by the DOE BBC. Each building was assigned a 2.5 percent reduction annually from its current site EUI. The property DMF_Technology was assigned a reduction of 25 percent because it falls under a special program for data centers [9].

DOE BBC Eligible Office Buildings/ Non-Refrigerated Warehouses (10)

| **Property Name** | **Site EUI (kBTU/ft2)** | **DOE BBC Pledge (Annually)** | **Final EUI (2020)** | **GHG Reductions (Metric Tons CO2e)** |
|---|---|---|---|---|
| DFM_Technology | 417.8 | 5% reduction | 313.35 | 416.4 |
| Police_PoliceAcademyCPD15 | 120.2 | 2.5% reduction | 108.18 | 226 |
| Police_PoliceHQ | 98.9 | 2.5% reduction | 89.01 | 245.43 |
| Police_911Center | 91.4 | 2.5% reduction | 82.26 | 287.54 |
| DFM_Jerry Hammond | 87.2 | 2.5% reduction | 78.48 | 249.99 |
| DFM_Health | 92.9 | 2.5% reduction | 83.61 | 264.63 |
| DFM_Beacon | 104.7 | 2.5% reduction | 94.23 | 103.87 |
| DFM_Weights | 121.4 | 2.5% reduction | 109.26 | 104.55 |
| CRPD_Storage_B | 2.5 | 2.5% reduction | 2.25 | 3.28 |
| CRPD_WarehouseMaint | 50.9 | 2.5% reduction | 45.81 | 49.83 |
| **Totals** | **1187.9** | **15%** | **1,006.44** | **1,151.92 (11%)** |

[Figure 6: Cleveland Firehouse Energy Efficiency Compared to Columbus Fire Stations]

In addition to the eligible offices and warehouse, figure 6 depicts the framework of potential EUI reductions within five City of Columbus Fire Stations. The five City of Columbus Fire Stations within this graph have increased their EUI from the baseline year. The City of Cleveland utilized the DOE BBC to fund a retrofit project, which included lighting upgrades and infrared heating. This resulted in a 12 percent energy savings and $14,000 reduction in annual energy cost. As depicted in the graph below, the City of Cleveland Fire Station now has a EUI reduction from the baseline.




| | CLE. FS 1 | COLS. FS 4 | COLS. FS 6 | COLS. FS 11 | COLS. FS 27 | COLS. FS 32 |
|---|---|---|---|---|---|---|
| Baseline EUI | 235 | 113 | 114 | 151 | 105 | 136 |
| Current EUI | 207 | 211 | 207 | 255 | 200 | 237 |

## 6.3. Appendix C: Q&A Best Management Practices City Comparison Transcripts

Full Transcript of 3.4.1: Atlanta Sustainability Office: Ruthie Norton & Matt Cox

**Q: What are the cities sustainability goals for municipal and commercial buildings (all-non profits, hospitals, etc.)?**

A: Atlanta is working on getting all buildings in PM, they have a centralized utility bill management system, working with Southface to create an audit grant program for rec. centers

**Q: What support have you received from the Department of Energy in terms of energy management and savings?**

A: DOE Better Buildings Challenge partners are seen throughout the entire city with 100 million sq. ft. in total, along with the creation of a community improvement district that works with many partners throughout the city. Currently the city has 15% of commercial buildings participating in the better building challenge. Additionally, Atlanta makes use of a revolving loan fund supplied by the DOE that totaled $2 million in 2010. Currently, the revolving loan stimulates energy efficiency installations as savings from previous projects fund new ones.

**Q: Has there been any political action taken specifically focusing on energy management and efficiency?**

A: Recently drafted legislation is going to a vote soon in the city. The legislation has four components: mandatory benchmarking, transparency, mandatory energy audits every 10 years, and retro commissioning all buildings 25,000 sq. ft. and more (starts optional and becomes mandatory in the future).

**Q: How does the city utilize Portfolio Manager?**

A: One person manages PM, two others use it, and the non-profit Southface provides training for city employees.

**Q: What challenges has the city come across while implementing these energy strategies?**

A: Not many issues arose, as property managers and engineers have the technical know how and support programs to achieve these goals. One issue was local building owners and realtors of

lower quality buildings have pushed back, as they didn't want energy information disclosed for unsavory reasons, however this had little impact.

**Q: What are the current energy numbers for the city's buildings?**
A: All buildings over 10,000 sq.ft. are in PM, 111 total buildings are in it, 600 total municipal buildings in Atlanta (some very small scale). 214 buildings in Atlanta are non-municipal ENERGY STAR® certified as of July 2014. Within the entire metropolitan area 318 buildings are ENERGY STAR® certified. No municipal buildings are ENERGY STAR® certified, as most aren't eligible (ENERGY STAR® scores not particularly suited for city buildings with eligibility).

**Q: What did the city find most successful of all these various strategies and initiatives?**
A: The most useful tools for energy adoption would be the better buildings challenge and the advanced commercial building initiative, which was granted by the DOE and supported by Southface. Some internal engagement programs have been made for powering down at the workplace, and incoming employees have energy policy lessons. Atlanta tracks consumption annually, and EUI and ROI metrics are utilized for possible retrofits.

Full Transcript of 3.4.2: Philadelphia Sustainability Office: Mardi Ditz & Amanda Byrne
**Q: How many of your cities municipal buildings are entered into Portfolio Manager?**
A: Legislation is in effect that requires benchmarking of all buildings over 50,000 sq. ft., and currently there are 30-35 municipal buildings that meet those criteria. For municipal buildings, centralized software for utility bill management is used along with automatic benchmarking (Energy Cap).

**Q: How many total, and more specifically municipal buildings are ENERGY STAR® certified?**
A: Citywide there has been two years of mandatory benchmarking, in 2013 the city had 1,900 buildings benchmarked that represented a 90 percent compliance rate for all buildings 50,000 sq. ft. or higher. Many municipal buildings aren't eligible for certification because of building type.

**Q: What programs have you found successful for increasing adoption of energy management tools?**

A: There are statewide energy efficieny rebate programs offered by utilities required by law[I].

**Q: What incentives are offered to improve city employee energy management engagement?**

A: There is an energy efficiency incentive program throughout five departments. It helps to get employees engaged, implement ECMs on their own as they know buildings better than an outsider, with the benefits going to the department or a general fund (where central bill intake happens). Retrofits are paid for by capital funds that don't necessarily originate within the department.

**Q: Have you tracked total energy reductions in municipal buildings as a result of energy management?**

A: A report was provided that detailed benchmarked utility data, and this was the data that the city used to creative an interactive map on the Mayor's Office of Sustainability website [II].

**Q: How have your city's energy related sustainability goals impacted city policy and adoption?**

A: They started by inspiring city employees with Greenworks goals, the health department created policies for replacing equipment based on energy efficiency because of old equipment that could impact IAQ. Timing is also important as ARRA funding came out same time as Greenworks, and Philadelphia became a DOE Solar America city. In Philadelphia LEED construction is prevalent and encouraged.

**Q: Are there specific training programs for city employees that focus on energy management?**

A: Not yet, the city is working towards getting a building certification class for employees to understand software and what resources are available. There is a demand response program for 19 municipal buildings, which has software that allows people to log in, and view energy flows of a buildings on a cell phone (Enernoc).

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[I] Rebate programs are similar those offered by AEP according to Senate Bill 221 in Ohio.

[II] Energy Benchmarking Map available at: http://visualization.phillybuildingbenchmarking.com/#/map

**Q: What challenges arose when implementing energy strategies, such as mandatory PM entry?**

A: There was no real push back, there was some difficulty getting the data and uploading it into PM. We waited to attain full data sets before full benchmarking began.

**Q: What were the requirements to becoming a DOE Better Buildings partner?**

A: To engage with the DOE in some capacity to start a working relationship, plan on a specific project for the challenge in the beginning.

Full Transcript of 3.4.3: Southface: Robert Reed

**Q: What strategies have been effective in a city such as Atlanta in terms of getting all buildings benchmarked and maintaining their utility data?**

A: The city is doing it themselves (see Atlanta section) and some at Southface have worked on the project (will contact again for more information).

**Q: Have you used the DOE better building challenge and what did it entail? How did it help buildings achieve energy reduction?**

A: The simple act of benchmarking and monitoring reduce energy (2.4% just benchmarking from the EPA), along with double-checking energy flows and utility data. The program itself was funded by a local foundation and started off with free audits that are now part of utilities (Columbus has some of both). Southface helps get data in ENERGYSTAR® PM and benchmarking and auditing is performed by utilities.

**Q: What do you recommend for holistic strategies for determining ECM priority (LCC and EUI) if the system in Columbus system is need and rebate oriented?**

A: The biggest opportunity lies in making sure that data is systematically entered and everyone knows where the energy is going, and identifying some buildings that aren't used as often. Some buildings are left on 24/7 unnecessarily. Get all the data in one place and accurate and use a pivot table where there is enough data. It is not glamorous work, as managers have to go building by building, however energy direct is offered by some utilities that allows for direct download.

**Q: What has been successful for engaging employees to address the behavior end of energy management in municipal and commercial buildings (similar to the lights out program, CEC, and employee incentives)?**

A: Don't focus on this initially in the entire energy management process. Instead, first assess operational issues such as thermostat setting, making sure buildings are not running 24/7, and forming complete datasets. Other considerations are: minor comfort issues that are present with individual activities (blocking a vent with a sweater because an occupant is cold), IT issues (turning computers and printers on sleep mode), and using signs that remind occupants to turn lights off.

**Q: What has been most successful in your experience to achieving full-scale adoption of energy management programs by getting government, business, and general population working together to reduce energy?**

A: The mayor of Atlanta took it upon himself to move towards sustainability and the business community was on board. Some negativity came with commitment to mandatory benchmarking and auditing, as a community working on voluntary measures may be forced to do so too quickly, when a step-by-step process would have been more effective and coordinated.

### 6.3. Appendix D: Final Recommendations Utilizing Three Additional Scenarios

[Table 2: Scenarios of Theoretical Building Participation and Results]

The scenarios below illustrate potential GHG emissions reductions, energy reduction savings, and savings from the social costs of carbon. The lower bound scenario was calculated using the average value across all building types in Columbus PM. This scenario assumes that the 10 eligible buildings in Columbus PM would be accepted into the DOE BBC program. Additionally, the energy savings for 20 percent, 50 percent, and 100 percent acceptance/ adoption rates were calculated.

| Scenarios | Total Energy Consumption (kBtu) | Total Energy Conserved (kWh) | Total Energy Conserved (CCF) | Tons CO2 Reduced | Savings in SCC ($12) | Energy Reduction Savings |
|---|---|---|---|---|---|---|
| 5.3% (10 buildings) | 115 million | 2,948,125 | 42,262 | 2,287 | 27,444 | 206,410 |
| 20% (37 buildings) | 423 million | 10,844,662 | 155,452 | 8,414 | 100,968 | 759,381 |
| 50% (93 buildings) | 1.1 billion | 28,201,250 | 404,250 | 21,883 | 262,596 | 1,974,429 |
| 100% (186 buildings) | 2.1 billion | 53,838,750 | 771,750 | 41,778 | 501,336 | 3,769,485 |

**7. Glossary**

American Recovery and Reinvestment Act Funding (ARRA): The ARRA of 2009 is an economic stimulus bill created to help the United States economy recover from an economic downturn that began in late 2007. The ARRA allocates $787 billion to fund tax cuts and supplements to social welfare programs as well as increased spending for education, healthcare, infrastructure and the energy sector. (http://whatis.techtarget.com/definition/ARRA-American-Recovery-and-Reinvestment-Act-of-2009)

Columbus Energy Challenge: The Columbus Energy Challenge is a free program that makes achieving energy efficiency as easy as possible from start to finish. Each participating business is provided with quality information, training opportunities, a tutorial for how to register buildings using ENERGY STAR® Portfolio Manager, a spreadsheet template to make it easy to auto-upload utility data. Participants will also be connected to utility rebates and other resources to help reduce energy use and save money. Help reach the community goal to have 70 percent of commercial and industrial buildings over 50,000 square feet registered in the program and a 20 percent reduction in building energy use by the year 2020. (http://www.columbus.gov/energychallenge/)

Community Improvement District (CID): A Community Improvement District (CID) may be either a political subdivision or a not-for-profit corporation. CID's are organized for the purpose of financing a wide range of public-use facilities and establishing and managing policies and public services relative to the needs of the district. (http://www.missouridevelopment.org/Community%20Services/Local%20Finance%20Initiatives/Community%20Improvement%20District.html)

Department of Energy Better Buildings Challenge (DOE) (BBC): The Better Building Challenge supports commercial and industrial building owners by providing technical assistance and proven solutions to energy efficiency. The program also provides a forum for matching Partners and Allies to enhance collaboration and problem solving in energy efficiency. Both Partners and Allies are publically recognized for their leadership and innovation in energy efficiency. (https://www4.eere.energy.gov/challenge/about)

Department of Energy Solar America City: In 2007 and 2008, the U.S. Department of Energy (DOE) selected 25 major U.S. cities as Solar America Cities, the foundation of DOE's Solar America Communities program. Through this effort, these cities have been working to accelerate the adoption of solar energy technologies for a cleaner, more secure energy future. These unique federal-local partnerships have enabled DOE to identify barriers to solar energy use in diverse locations and at various stages of market development, and to collaboratively develop solutions to those barriers.

(http://solaramericacommunities.energy.gov/)

Demand Response (DR): Changes in electricity usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.
(http://www.ferc.gov/industries/electric/indus-act/demand-response/dem-res-adv-metering.asp)

Digital Controls: Consists of microprocessor-based controllers with the control logic performed by software.
(http://www.ddc-online.org/Digital-Control-Systems/Control-Responses.html)

Energy Conservation Measures (ECM): A project conducted or technology implemented that reduces the consumption of energy in a facility.
(http://www.sitebasedenergy.com/content/Energy+Services/energy_service/ecm)

ENERGY STAR® Certification: ENERGY STAR® certified buildings and plants meet strict energy performance standards set by EPA. They use less energy, are less expensive to operate, and cause fewer greenhouse gas emissions than their peers.
(http://www.energystar.gov/buildings/about-us/energy-star-certification)

ENERGY STAR® Score: A score, 1-100, which allows one building to see how its energy consumption measures up against similar buildings nationwide. It allows everyone to quickly understand how a building is performing.
(http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/how-1-100)

Energy Usage Intensity (EUI): Energy per square foot per year. It's calculated by dividing the total energy consumed by the building in one year (measured in kBtu or GJ) by the total gross floor area of the building.
(http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/what-energy)

Gross Floor Area: The area within the perimeter of the outside walls of a buildings as measured from the inside surface of the exterior walls, with no deduction for hallways, stairs, closets, thickness or walls, columns, or other interior features. Gross floor area is used in determining the required number of exits or in determining occupancy classification.
(http://encyclopedia2.thefreedictionary.com/Gross+floor+area)

HVAC: Short for heating, ventilation, and air condition. The system is used to provide heating and cooling services to buildings.
(http://www.businessdictionary.com/definition/HVAC.html)

Indoor Air Quality (IAQ): The quality and general healthfulness of air within a building, as affected by temperature, humidity, and airborne contaminants.
(http://www.dictionaryofconstruction.com/definition/indoor-air-quality-iaq.html)

Informal Benchmarking: Informal benchmarking is when one's performance is being compared to someone others, and learning from the behavior and practices of others.
(http://www.bpir.com/benchmarking-what-is-benchmarking-bpir.com.html)

Life Cycle Costing (LCC): An important economic analysis used in the selection of alternatives that impact both pending and future costs. It compares initial investment options and identifies the least cost alternatives for a given time period.
(http://www.gsa.gov/portal/content/101197)

Performance Benchmarking: this involves comparing the performance levels of organizations for a specific process. This information can then be used for identifying opportunities for improvement and/or setting performance targets. Performance levels of other organizations are normally called benchmarks and the ideal benchmark is one that originates from an organization recognized as being a leader in the related area.
(http://www.bpir.com/benchmarking-what-is-benchmarking-bpir.com.html)

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