Better Buildings
U.S. DEPARTMENT OF ENERGY

Measuring Energy Savings and Tracking Consumption

May 27, 2015

U.S. DEPARTMENT OF ENERGY

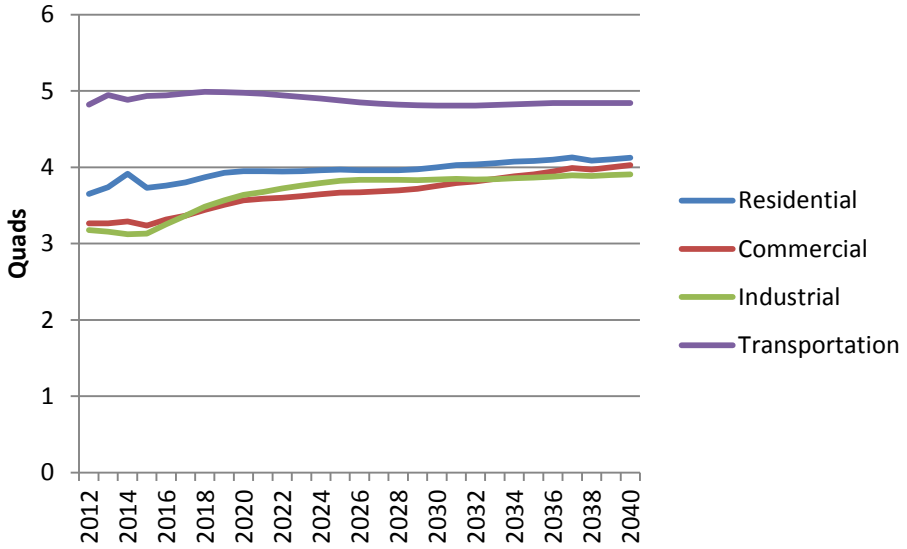
Measuring Energy Savings and Tracking Consumption

Presented by Dr. Matt Cox, Office of Sustainability

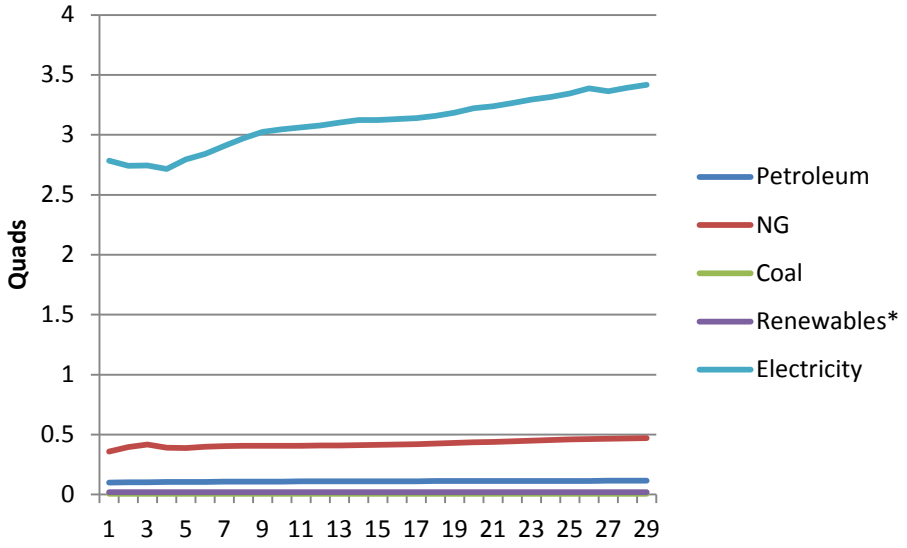
May 2015

EIA Projection of South Atlantic Energy Consumption

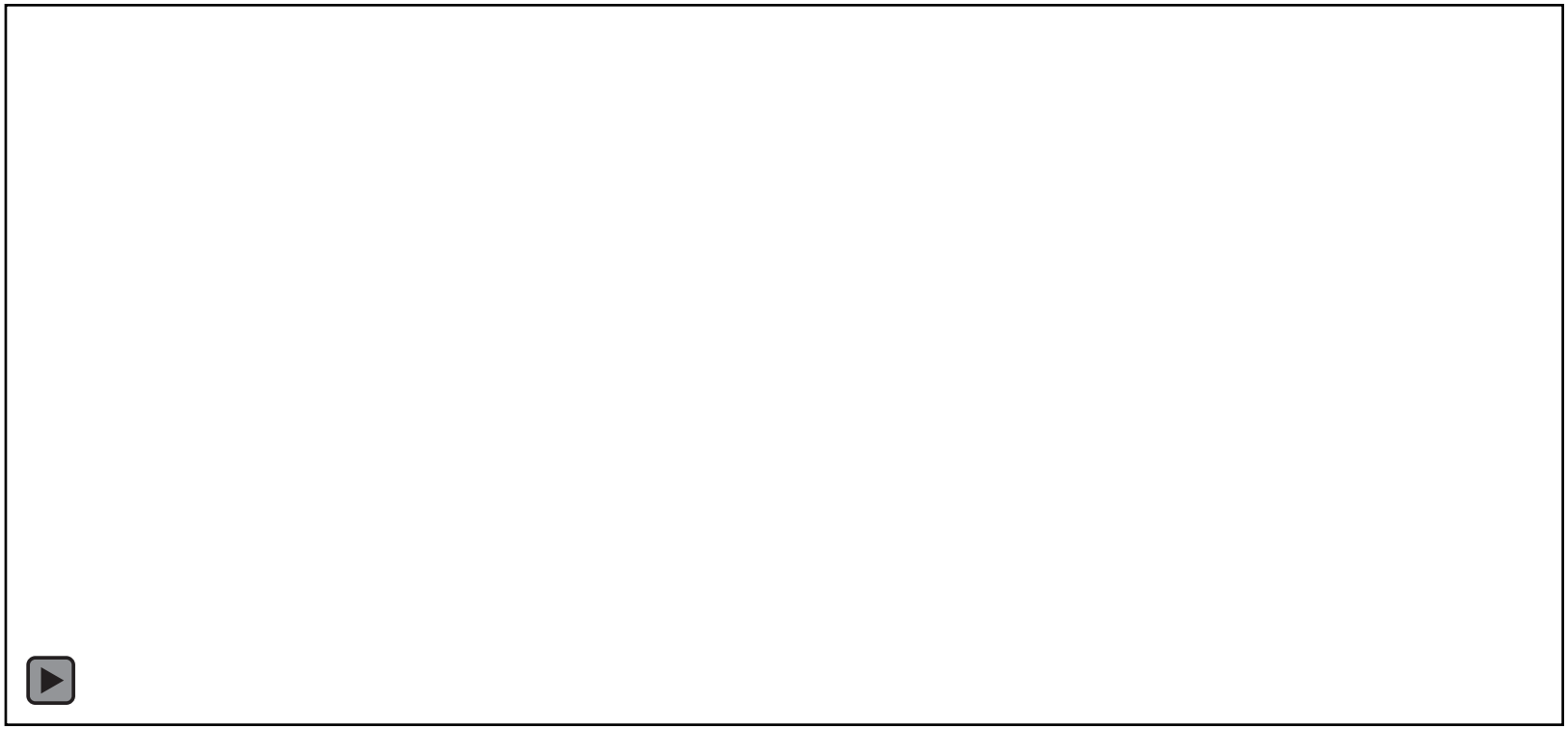
All Sectors



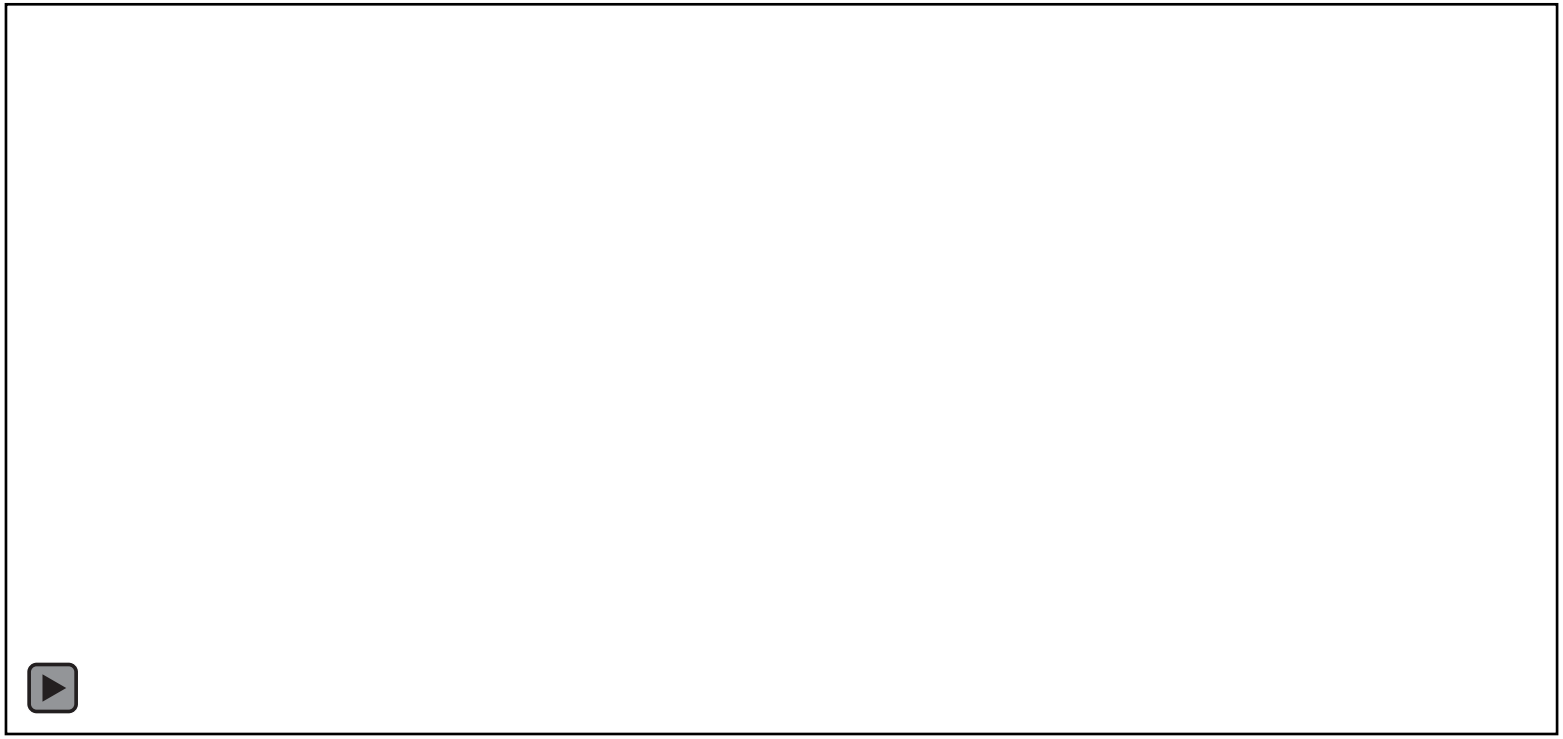
Commercial



Energy and Carbon in US MSAs, 2000-2010



Energy and Carbon, Commercial Sector, 2000-2010



Network Collaboration

ATLANTA'S BUILDINGS FOOTPRINT

Buildings are responsible for 66% of energy consumption within the City

Buildings are responsible for 59% of GHG emissions

Commercial buildings are the single biggest emitter/consumer in the City

The City of Atlanta is the largest owner of commercial buildings

A TALE OF TWO CITIES

Top 25 cities | About EPA's top cities rankings

TOP 25 CITIES

Rank	Metro area	Building Count	Total Floor Area (Million Sq ft)	Cost savings (million $)	Equivalent Homes' Electricity Use for 1 Year
1	Washington, DC	480	122.8	127.1	73,500
2	Los Angeles	475	109.7	155.8	44,300
3	Atlanta	328	69.6	55.8	48,700
4	New York	299	109.7	137.7	50,700
5	San Francisco	292	75.3	118.9	34,600
6	Chicago	251	119.9	90.1	98,300
7	Dallas-Fort Worth	248	62.1	42.1	40,100

Profile B.6 Atlanta

Table B.11 Atlanta MSA Energy and Carbon Dashboard

2010 Ranks	Energy Intensity*	Carbon Intensity*	Energy Improvement[a]	Carbon Improvement[a]
Residential	59	69	89	68
Commercial	37	63	93	81
Industrial	78	77	83	65
Transportation^	69	69	--	--
All Buildings	67	64	91	86

*Intensity rankings shown as per-capita for residential and transportation, and per-GDP for commercial, industrial and all buildings footprints.
[a]Improvement rankings show what rank the MSA scored; a "1" would be the "most improved" MSA on a percentage basis.
^2005 rankings

***Only 1.4% LEED or EnergyStar certified**

ATLANTA'S POWER 2 CHANGE AND THE CITY ENERGY PROJECT

Part I: Benchmarking

1

What is benchmarking?

Tracking energy and water consumption on site for properties over 25,000 sqft

2

How do you benchmark?

Utilize EnergyStar Portfolio Manager

*Free web-based platform

*13 cities currently follow this process nationwide; others are considering

3

Who benchmarks in Atlanta?

Currently over 500 buildings in ESPM

Part II: Transparency

1 What is transparency?

Reporting energy and water consumption characteristics of a property.

2 How does it work?

Properties will send a benchmarking submission using a two-step process in ESPM.

The City of Atlanta will check the data and make it publicly available.

Part III: Energy Audits

1

What is an energy audit?

A professional walk-through of a facility to check for opportunities to improve energy performance, focusing on equipment retrofits.

2

How does it work?

Property owners use a certified professional to perform the work and produce an itemized list of opportunities. Owners then choose which opportunities to pursue.

3

Who uses Energy Audits in Atlanta?

Currently, Georgia Power offers no-cost energy audits for commercial customers; GPC provided 1,400 state-wide last year.

Part IV: Retrocommissioning

1

What is Retrocommissioning?

Retrocommissioning is the process of improving the efficiency of existing building systems through repair and maintenance; it is a voluntary component of this proposal.

2

How does it work?

Property owners use a certified professional to perform the work and produce an itemized list of opportunities. Owners then choose which opportunities to pursue.

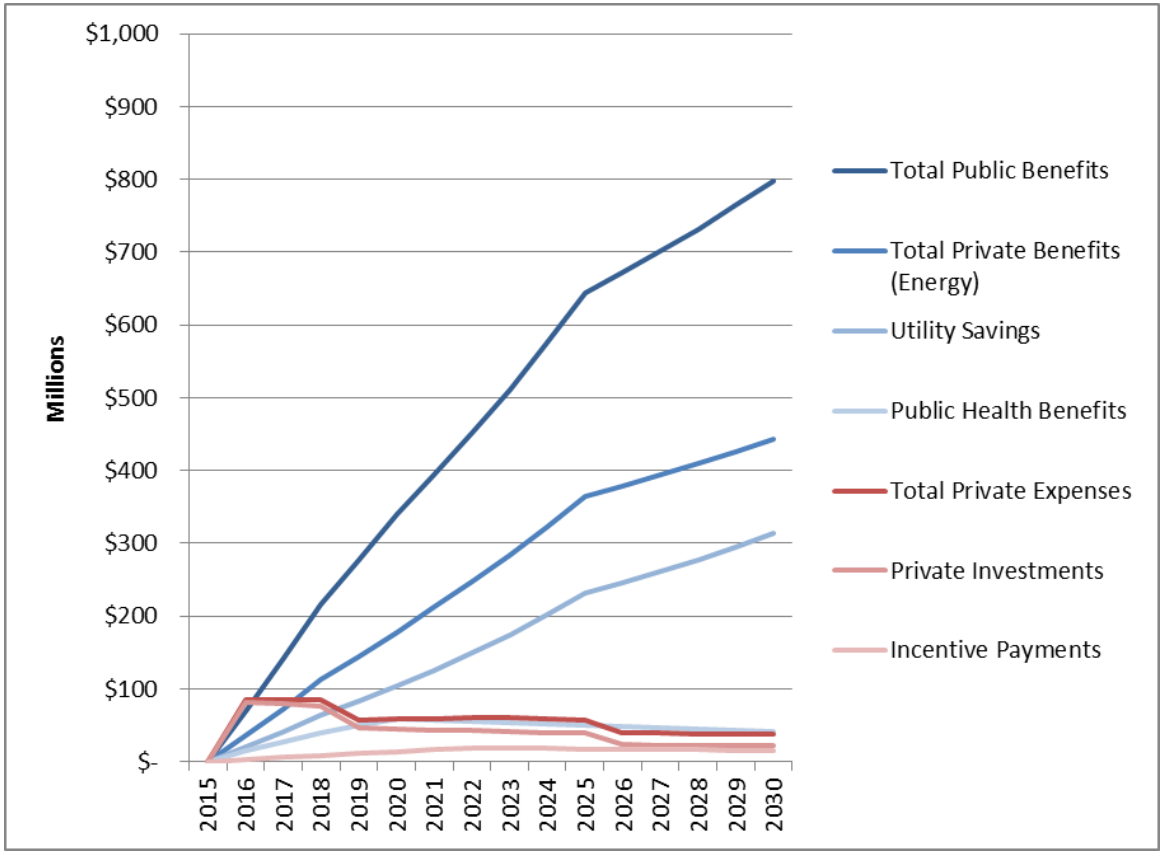
Context - Commercial Buildings Energy Efficiency

Category	Figures
Total Commercial Buildings	17,000
Buildings Subject to Proposal	2,400
Unique Building Owners	1,300
Largest Building Owner: CoA	111
Total Square Footage	402 M

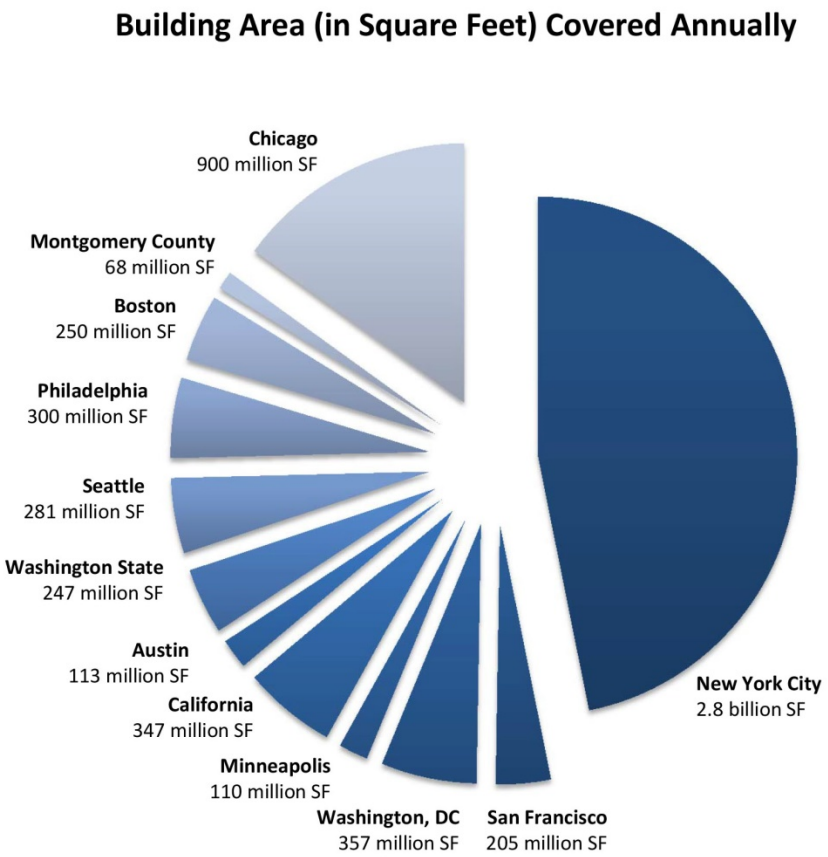
Atlanta is the:

- 1st City in CEP
- 1st in the Southeast
- 2nd largest w/ Audits
- 3rd largest with Benchmarking
- 6th with all 4 policies
- 12th to pass Benchmarking

ANTICIPATED POLICY IMPACTS

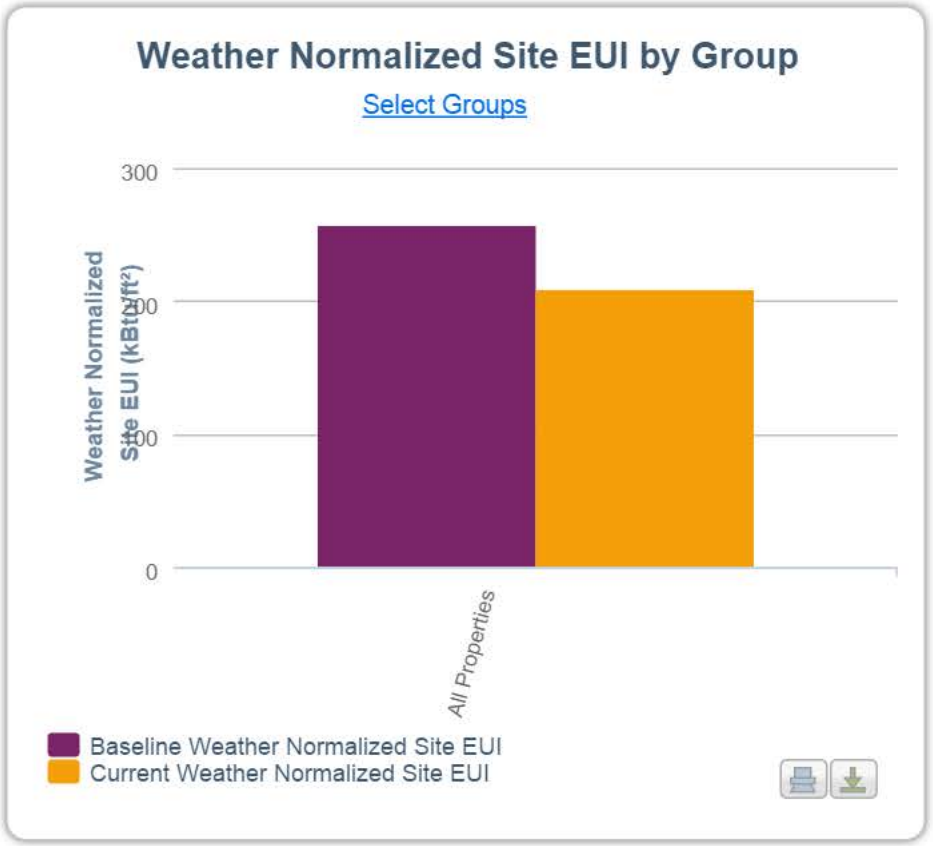


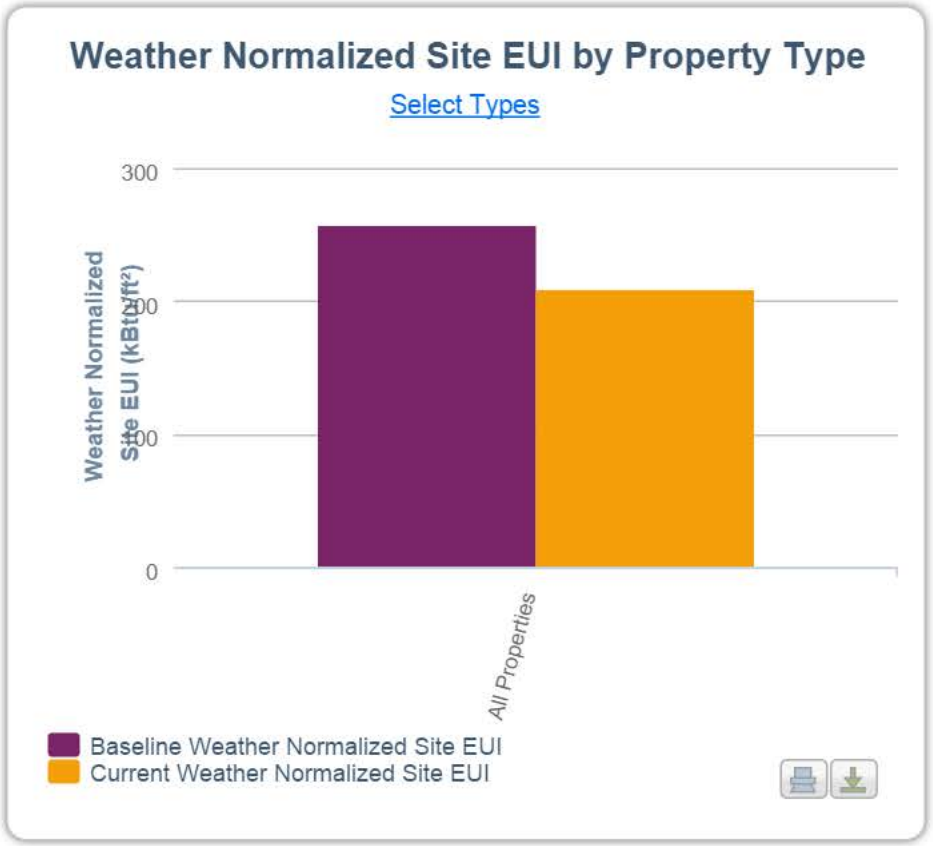
Other Cities' Coverage



Source: IMT

CITY OF ATLANTA SAVINGS TO DATE





KEY CONSIDERATIONS AND APPROACHES

Considerations

Can we model the impact of policy options?

- Cost effectiveness of given policy options

Ability of local efforts to feed into state goals and potentially requirements,

Establishing reliable baseline data

Approaches

Benchmarking, especially through advanced tools like ESPM which can normalize for weather and operating conditions.

- Atlanta is getting monthly consumption data; Georgia gets this annually but would prefer monthly data.

Continuous commissioning would be a great next step in terms of understanding that investments made in EE are having the intended effect on site and that those efforts are aggregating up to the City and State scale.

NEXT HURDLES

Issues to track

Investment in energy efficiency
Jobs created by those investments
Equipment installed throughout the city
Audit/RCx recommendations implemented and why (or not)

Barriers

Open Records Law in Georgia
    Cannot protect most business information from public records request
Job attribution is challenging, especially beyond direct jobs. Fertile ground for more academic study

Questions or Comments?

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Massachusetts Department of Energy Resources

Using Data to Track Energy Savings and Performance at State and local facilities

Better Buildings Summit
May 27 2015

Eric Friedman
MA Department of Energy Resources

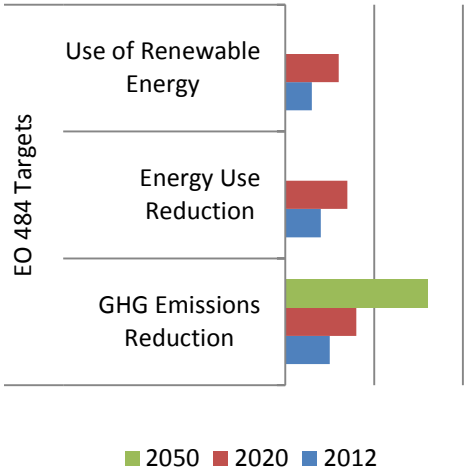
Data Collection and analysis: it's simple, right?

Agenda

- Policy Drivers behind energy performance
- Energy Tracking Requirements
- What and how does Massachusetts Track Energy Use Data
- Energy Tracking Costs
- How We use Data
- Challenges and Key Takeaways

State Policy Drivers

- **Leading by Example Exec Order 484**
  - Energy reduction, renewable and GHG emission targets for
  - Covers all of state government operations
- **Green Communities Act (GCA)**
  - All cost effective energy efficiency
  - Green Communities Program
  - Advanced building energy codes
- **Global Warming Solutions Act (GWSA)**
  - Clean Energy and Climate Plan set GHG emission reduction goals at 25% below 1990 Baseline Levels by 2020; 80% by 2050



Massachusetts Global Warming Solutions

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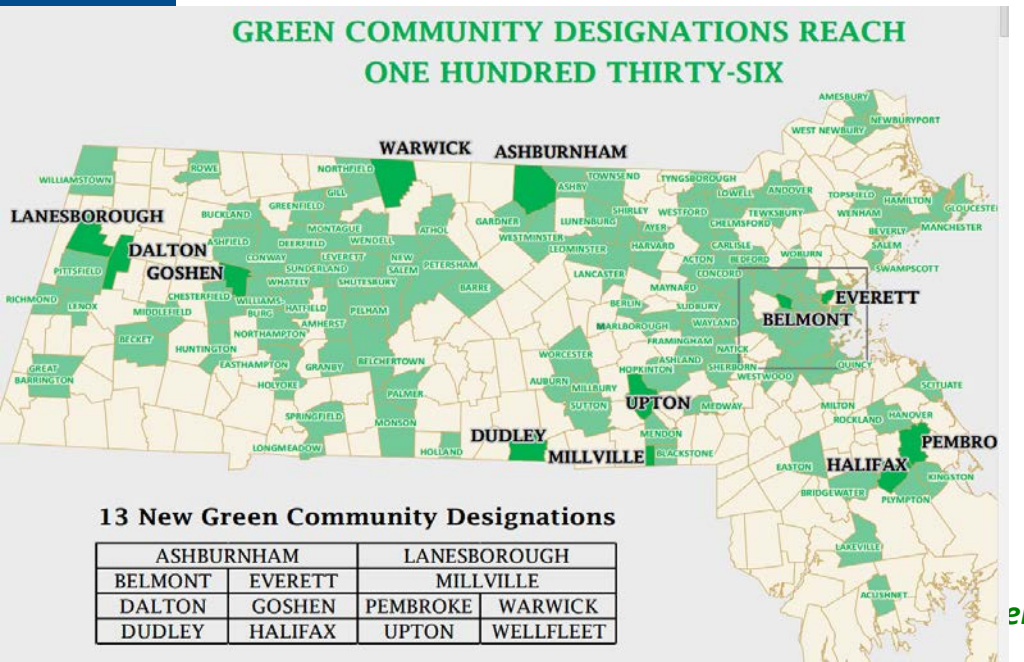
Energy Tracking Requirements

For State Agencies

- EO requires reporting and collaboration on data with LBE Program
- **Requires annual reporting by LBE staff**
- Track progress toward goals
- Better Buildings Challenge annual reporting



13 New Green Community Designations

ASHBURNHAM		LANESBOROUGH	
BELMONT	EVERETT	MILLVILLE	
DALTON	GOSHEN	PEMBROKE	WARWICK
DUDLEY	HALIFAX	UPTON	WELLFLEET

For Municipalities

Provides grants to ***qualifying*** **Green Communities** to fund energy efficiency initiatives, renewable energy, innovative projects

1. Adopt as of right siting for RE/AE generation, R&D, or manufacturing
2. Adopt expedited permitting process
3. **Create an Energy Reduction Plan to reduce energy use by 20% in 5 years**
4. Purchase only fuel efficient vehicles
5. Minimize life cycle cost in new construction -- adopt the Stretch Code

Data Collection and Tracking Methodologies

For State Agencies

- Annual Tracking Forms
- MassEnergyInsight Utility Bills
- State accounting system
- Fuel Contracts
- Real time metering
- Renewables Production Tracking System
- Capital Asset Management Information System

	CATEGORY	FY14 CONSUMPTION	UNIT*	TOTAL COST
4	**Building Energy Use (Fuels other than Electricity)**			
5	* Please remember to indicate units of measurement used in "Notes" if different from units listed.			
6	Natural Gas	132,664.00	therms	$ 121,475.00
7	Liquid Natural Gas		therms	$ -
8	Fuel Oil #2 for buildings	4,415.00	gallons	$ 15,500.00
9	Bioheat #2 Heating oil		gallons	$ -
10	Fuel Oil #4		gallons	$ -
11	Fuel Oil #6		gallons	$ -
12	Propane (cooking and/or heating)		gallons	$ -
13	Diesel/ Fuel Oil #2 for Emergency Generators	1,812.00	gallons	$ 6,975.00

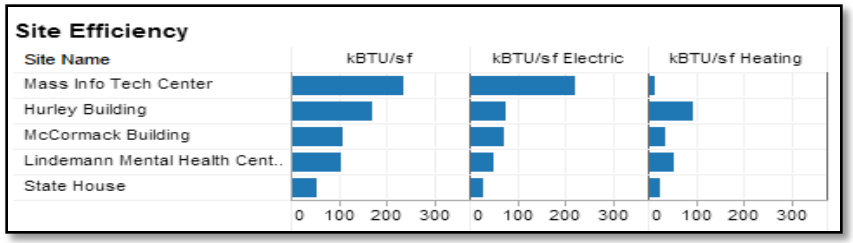
Fuel Information Tracked Annually

Building Fuels	
• Grid Electricity • Natural Gas • #2 Oil • #4 Oil • #6 Oil • Diesel for emergency generation • Liquid Natural Gas • Propane • Purchased Steam • Bituminous Coal	• Paper Cubes • Wood Chips • Biofuels • On-Site A.D. Electricity • On-Site CHP Electricity • On-Site CHP Thermal Output • On-Site Hydro Power Electricity • On-Site Solar PV Electricity • On-Site Wind Electricity
Fleet Vehicle Fuels	**Other Fuels**
• Gasoline • Diesel • Compressed Natural Gas • Electric Vehicle kWh • E85 • Propane	• Jet Fuel • Fuel for other uses (boats, training facilities) • Excess renewable generation

Data Collection and Tracking Methodologies for Municipalities

MassEnergyInsight

POWERING EFFICIENCY



FREE online tool for Municipalities

- Automated electronic download of utility data (gas & electricity)
- All energy costs (from utilities) and accounts in one place
- Standard and custom reporting

One tool to do it all:

- **Benchmark**: track energy use by agency, department or building
- **Identify**: least efficient buildings for efficiency action
- **Measure and verify**: energy use trends by building over time

*data is by account, not necessarily by building

Fuels Tracked - Municipalities

- Automatic Download
  - Grid Electricity
  - Natural Gas
- User Input
  - Oil (gallons)
  - Propane (gallons)
  - Steam
  - Gasoline (gallons)
  - Diesel (gallons)
  - Renewable Energy

Data Resources

Municipal

- MEI originally funded at cost of $1.3m
- Current 3 year contract: $850,000
- Minimal ongoing support required -- mostly on auto pilot
- Over 200 munis track usage
- Tracking tens of thousands of accounts, including from state

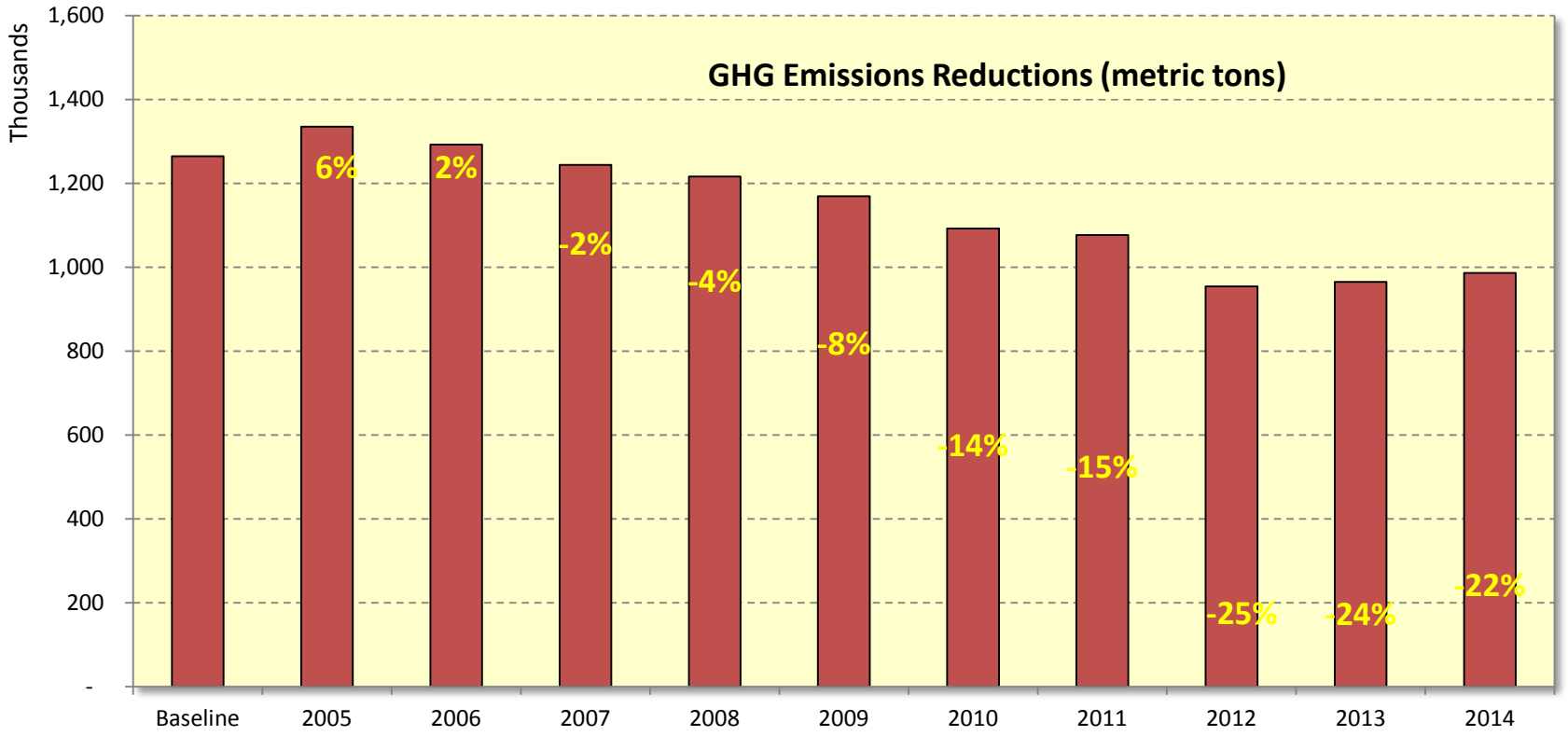
State Government

- $9.7 million in ARRA funds for 1,300 real-time meters and 3 years of data and analytics
- Approx. $1 million per year for data and analytics
- New Contract 2015 – budget unknown
- LBE retains 1 FTE for all data requirements

Using the Data

LBE Progress: GHG Progress

Target: Reduce GHG emissions 25 percent by 2012, 40 percent by 2020, and 80 percent by 2050.



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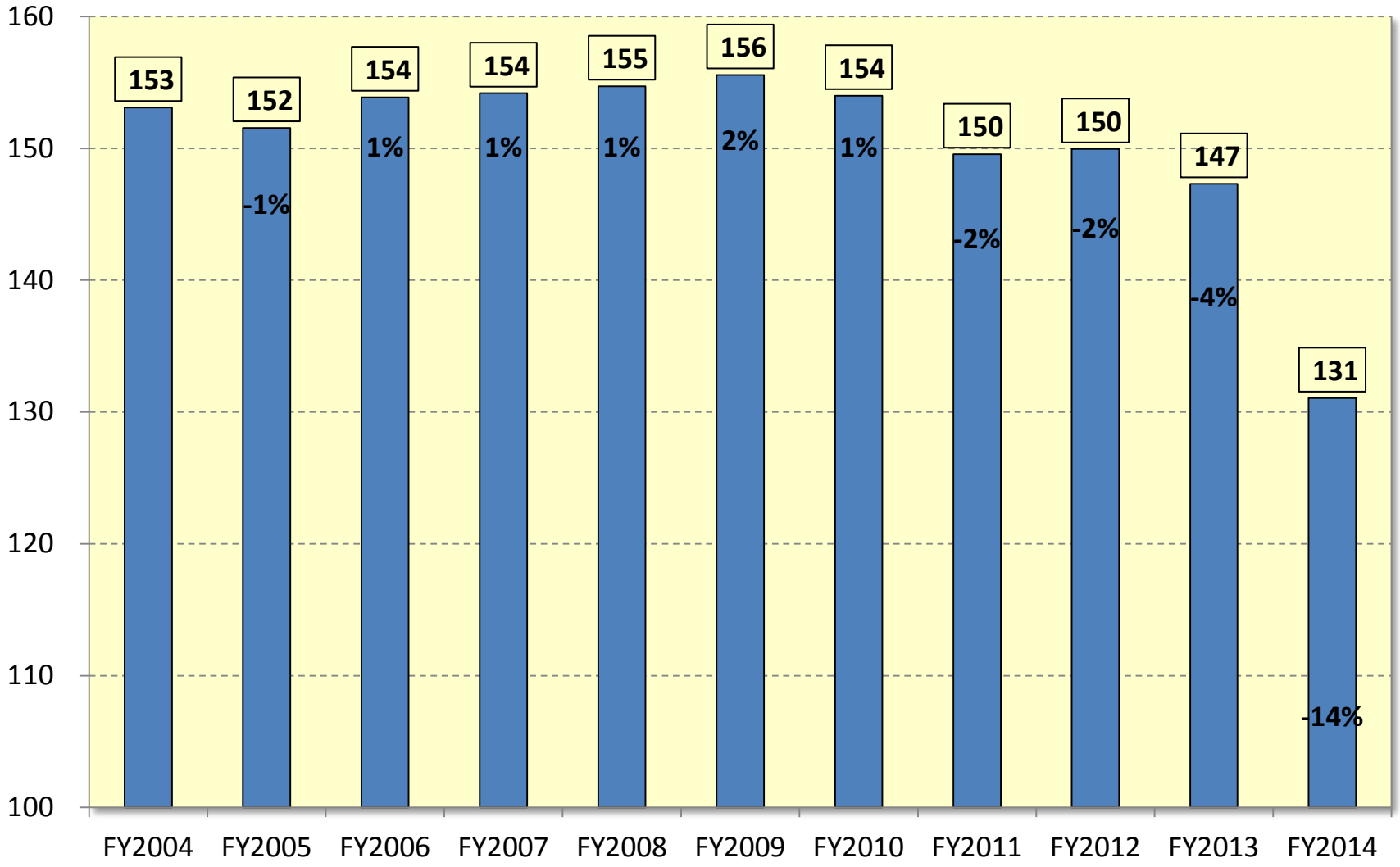
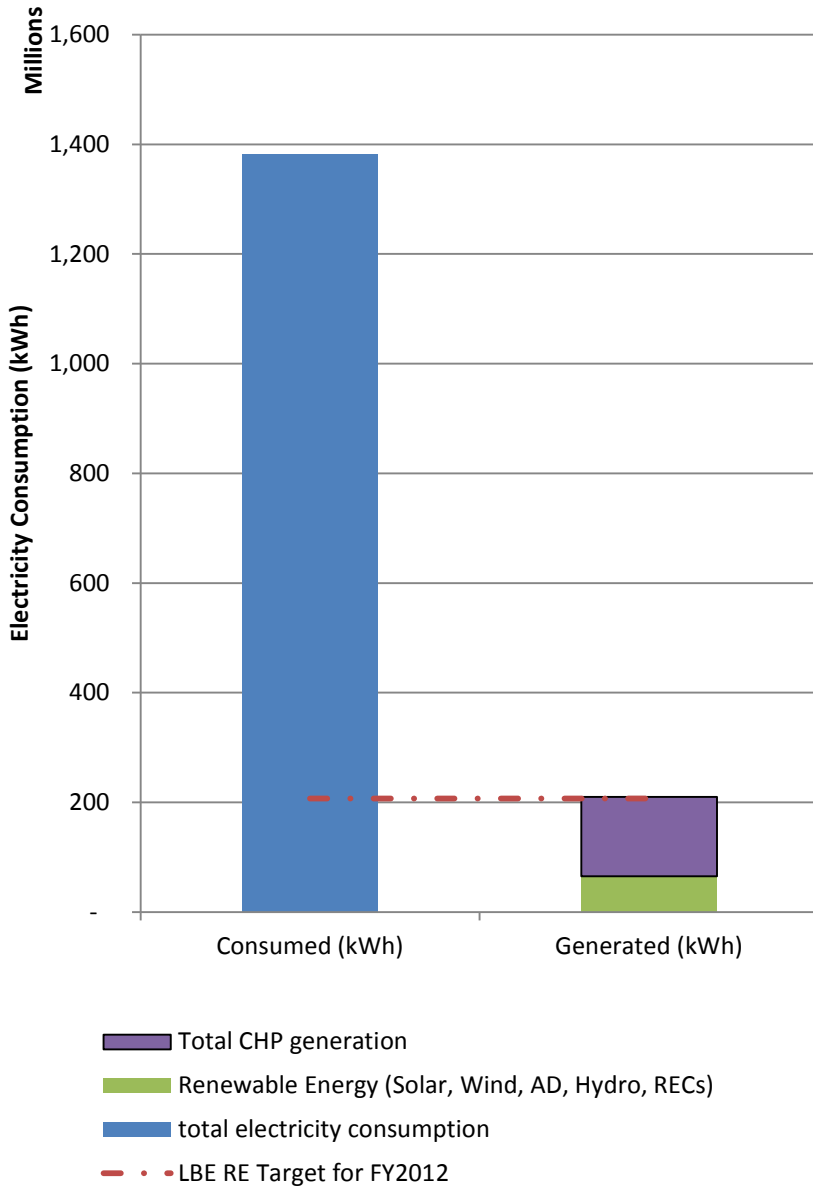
LBE Progress: Energy Usage

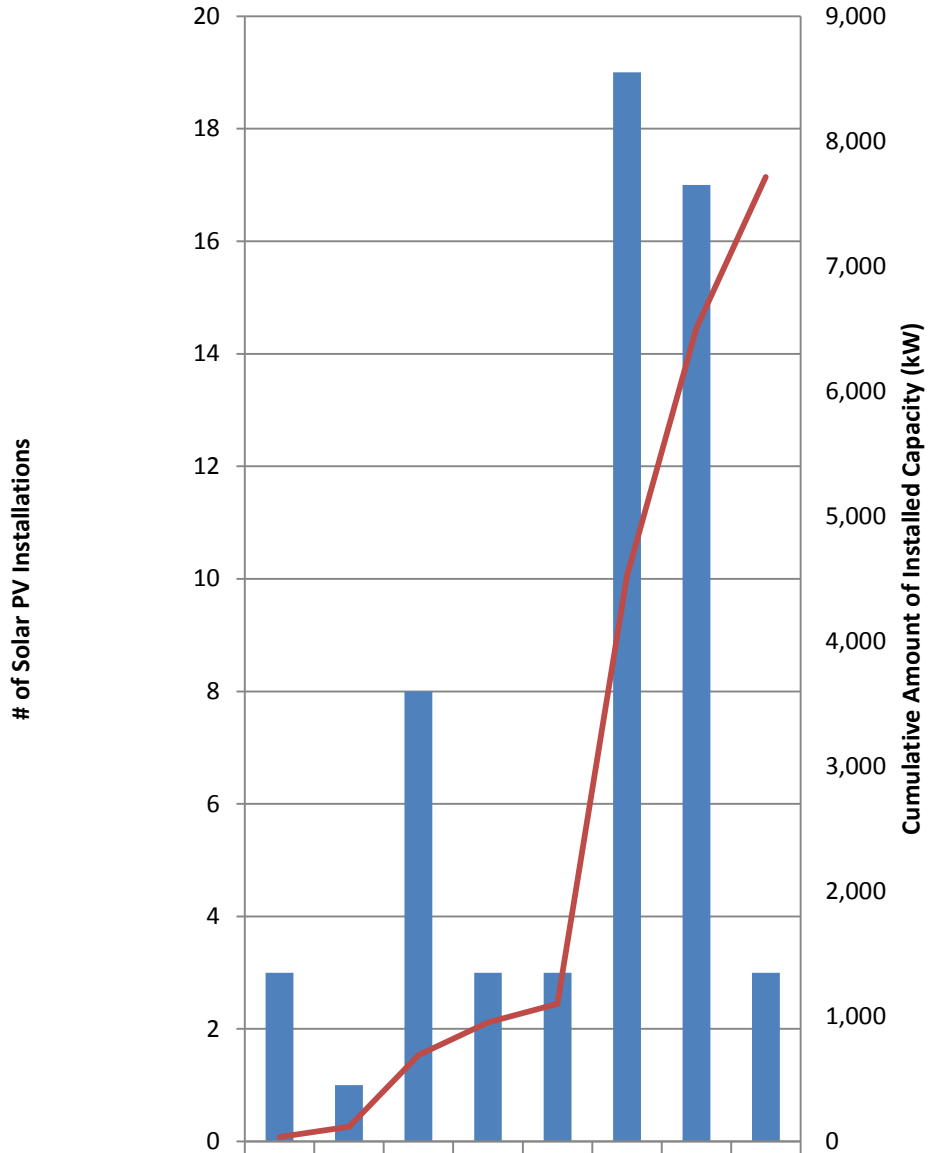
Target: Reduce energy use (normalized by weather and square footage) 20 percent by 2012 and 35 percent by 2020



EO 484 Target FY12: Percent On-Site Generation vs Total Consumption

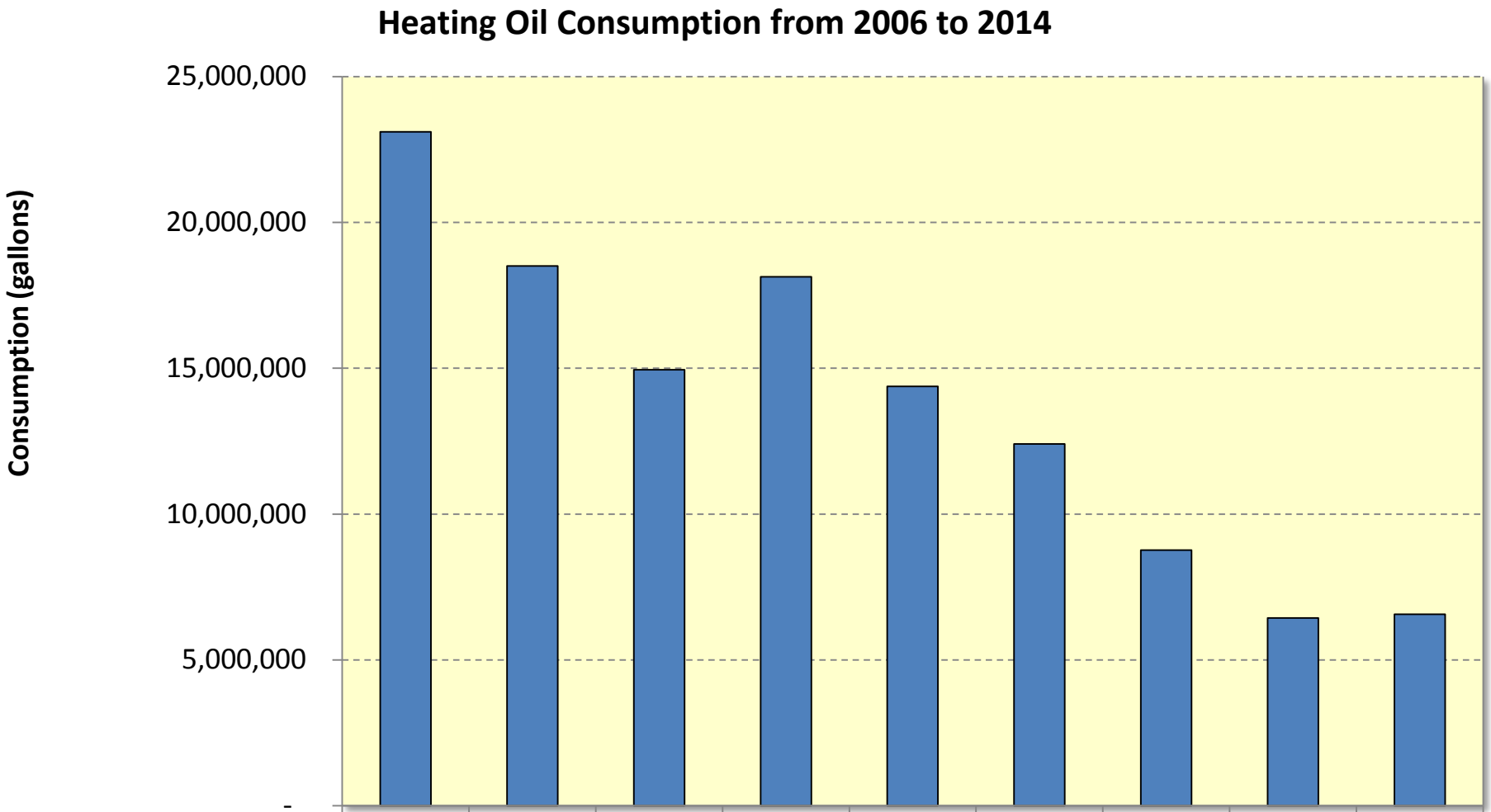


Solar PV installations & kW since FY2006



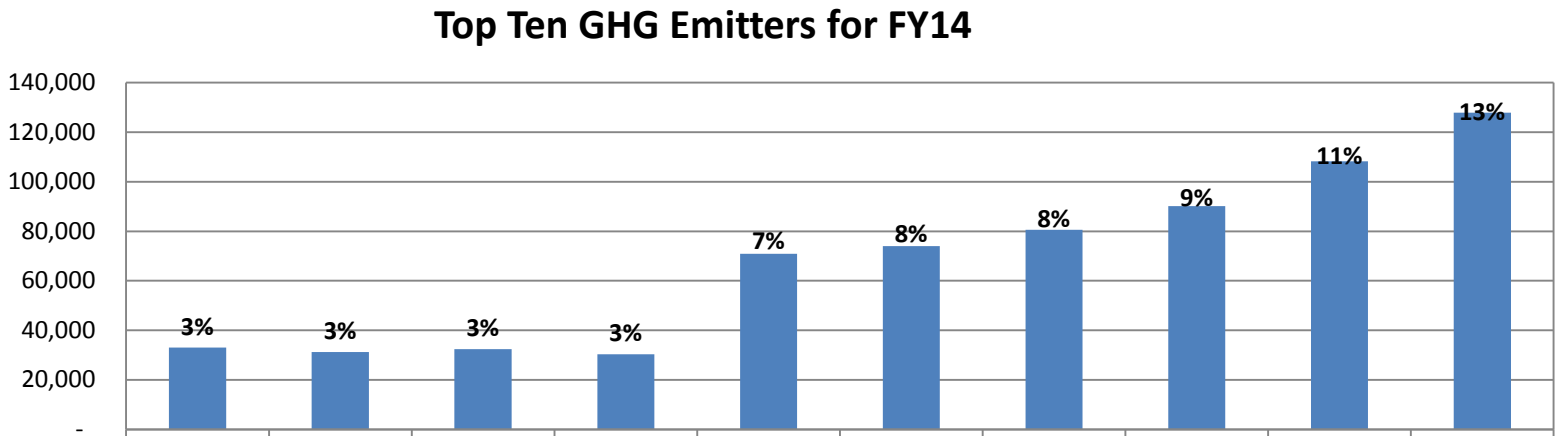
	2006	2007	2008	2009	2010	2011	2012	2013
"# of Solar PV installations"	3	1	8	3	3	19	17	3
"Cumulative Amount of kW Installed"	37	118	692	952	1,100	4,519	6,504	7,714

LBE Progress: Oil Reduction



	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Gallons of Heating Oil	23,103,9	18,504,6	14,949,7	18,131,5	14,377,9	12,402,7	8,763,80	6,438,64	6,563,17
% Change from FY06	0%	-20%	-35%	-22%	-38%	-46%	-62%	-72%	-72%

LBE Top 10 Green House Gas Emitters



	UMass Lowell Total	Trial Court Total	State Police Total	DDS Total	MassDOT Total	MWRA	DOC Total	UMass Medical Total	MassPort Authority Total	UMass Amherst Total
GHG Emissions (metric tonnes)	33,075	31,244	32,453	30,346	70,891	73,998	80,555	90,109	108,291	127,903
% of Overall GHG Emissions FY13	3%	3%	3%	3%	7%	8%	8%	9%	11%	13%

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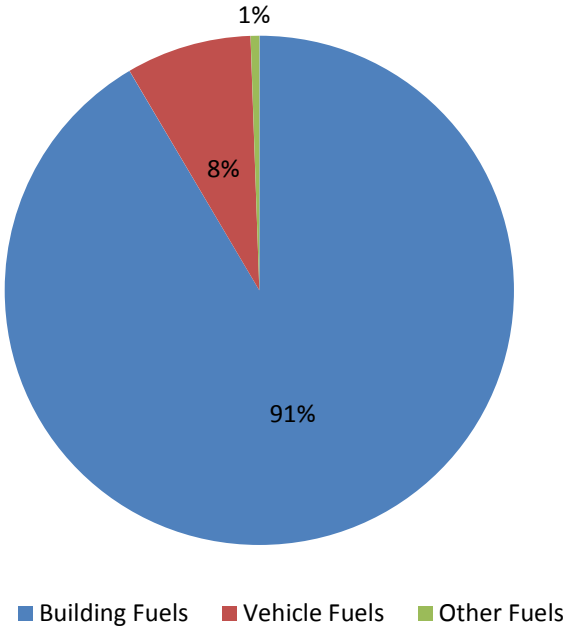
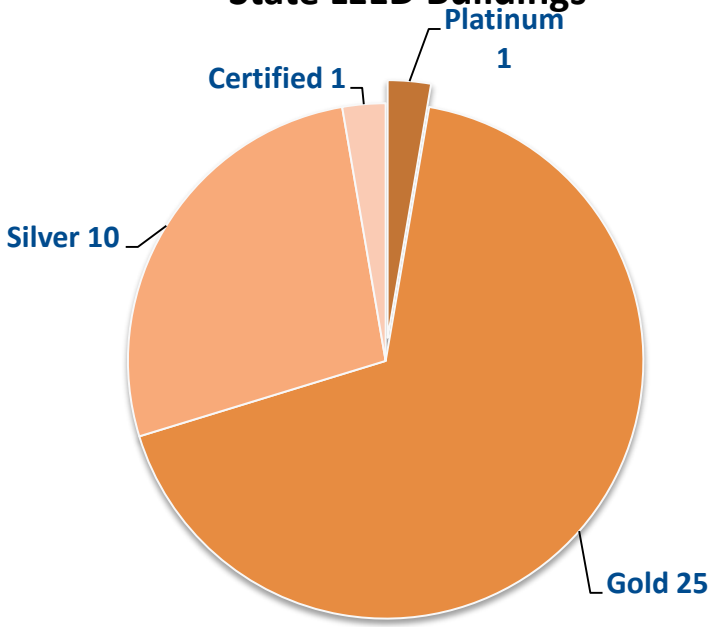
LBE: Other Data Points

FY12: Buildings vs Vehicle Emissions



State LEED Buildings



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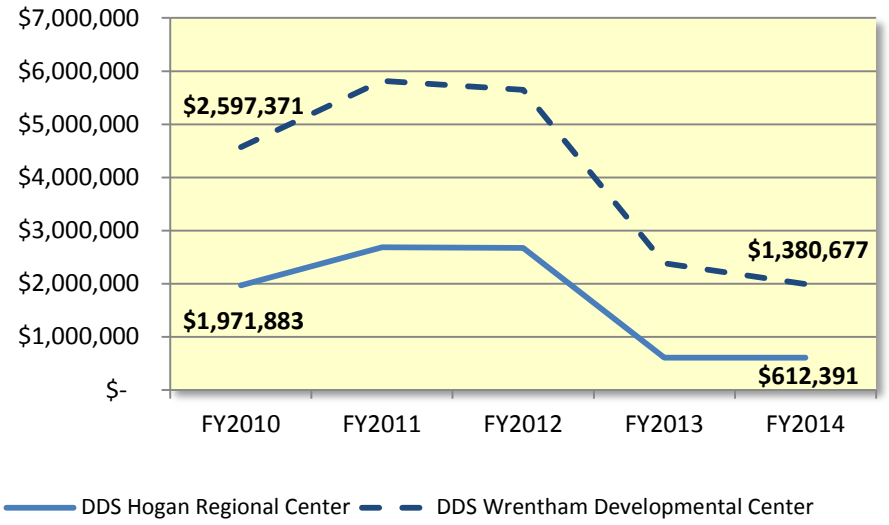
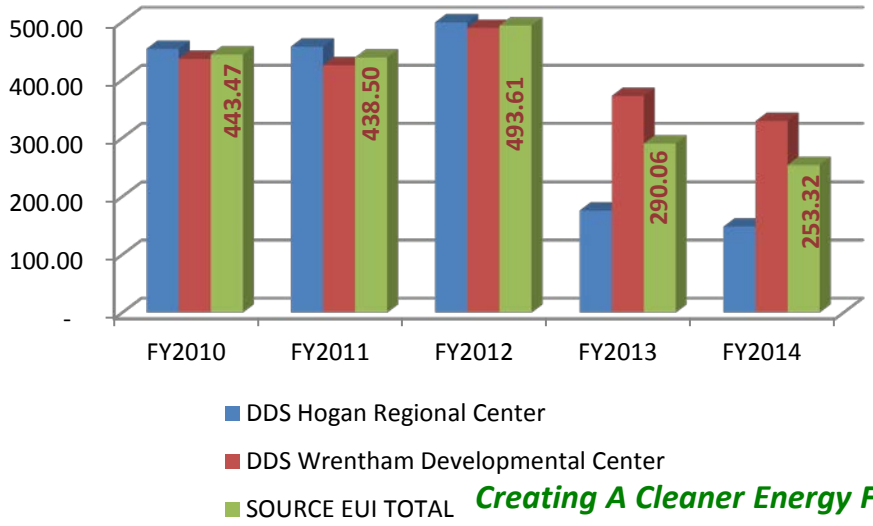
Tracking Project Performance-Hogan Wrentham Sites

- Projected energy reduction 48%
- Projected annual energy savings - $2.5 million

Actual: $2,576,186 in savings





Actual: 43% EUI Reduction

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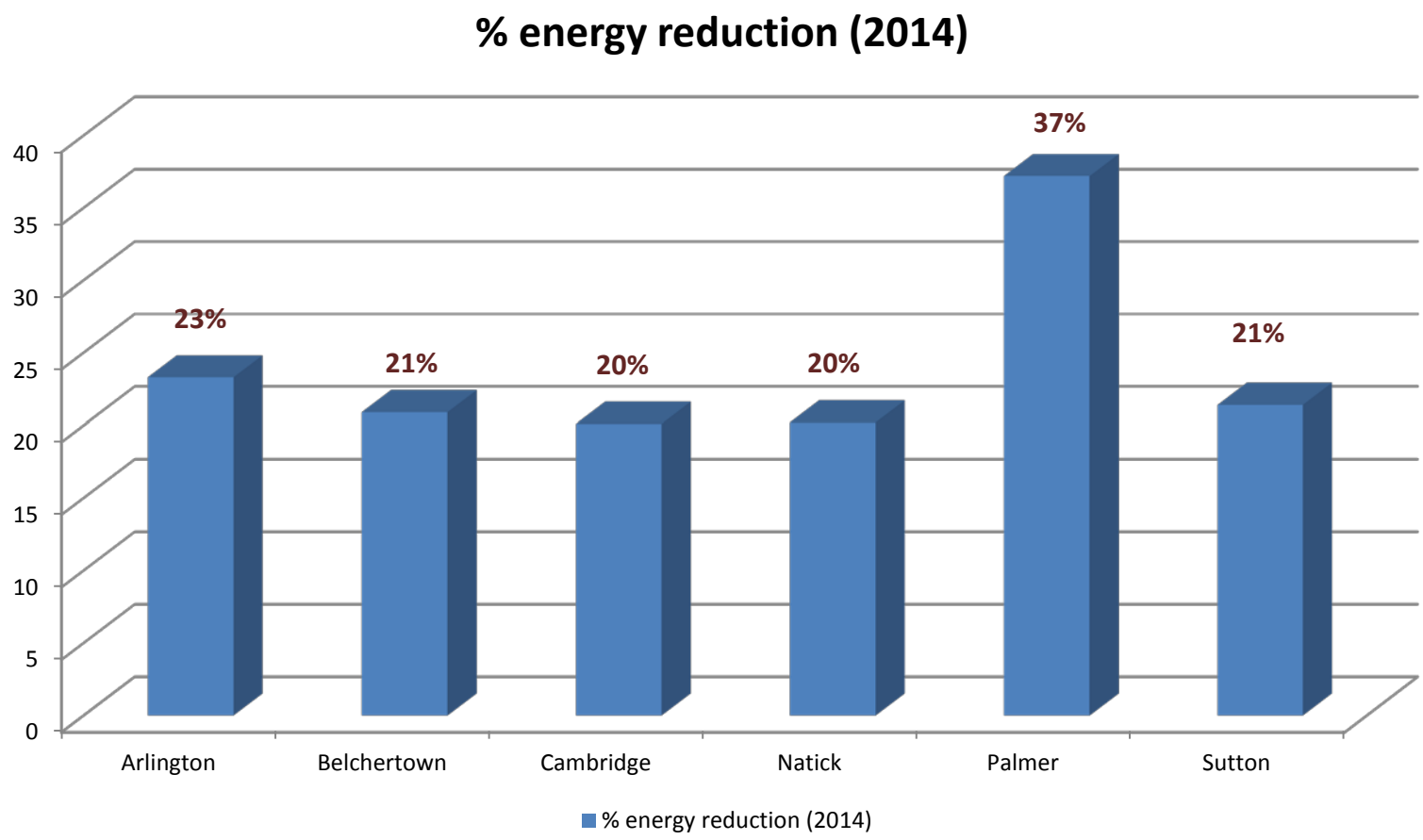
Municipal Progress toward 20% Targets



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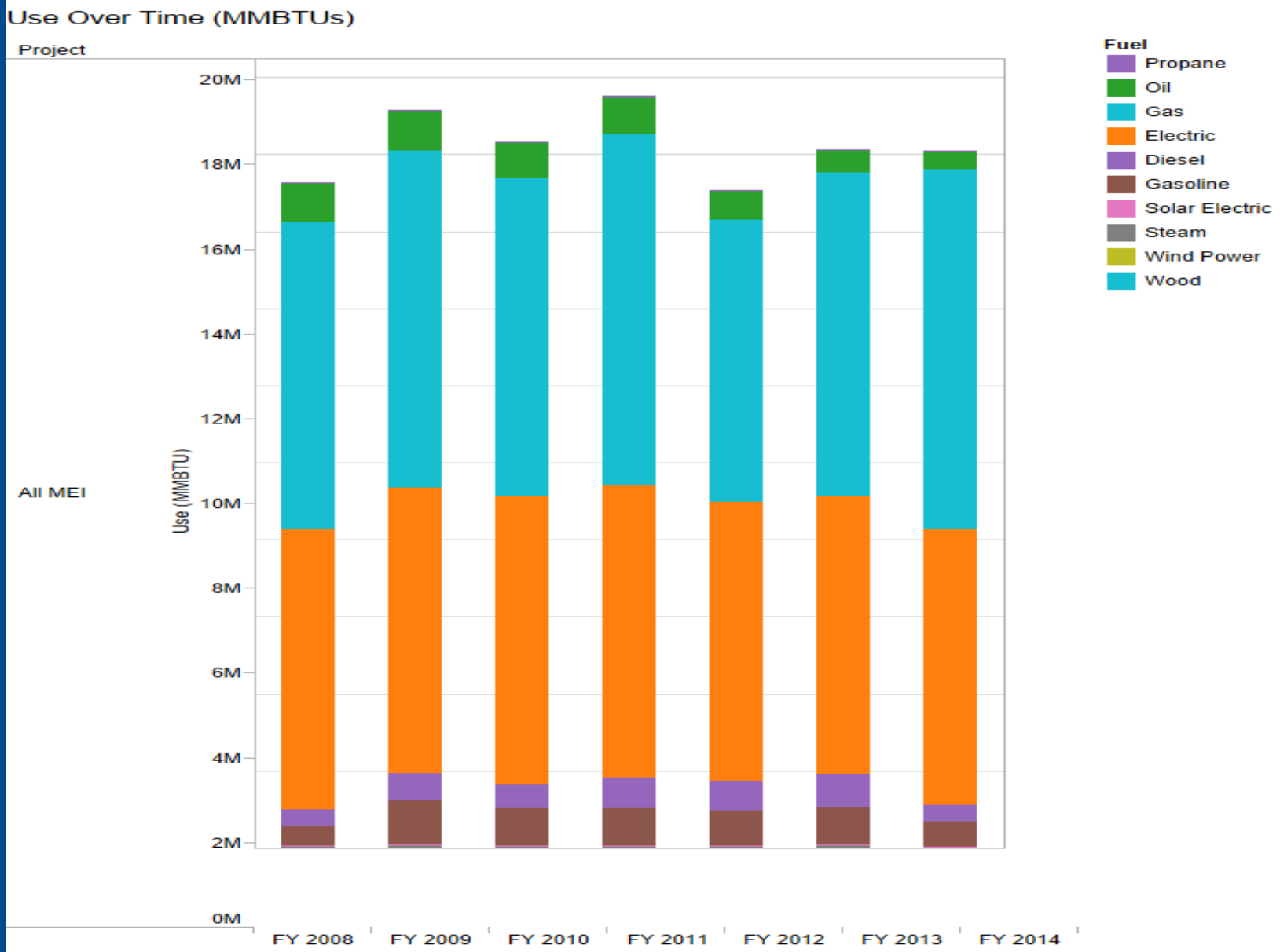
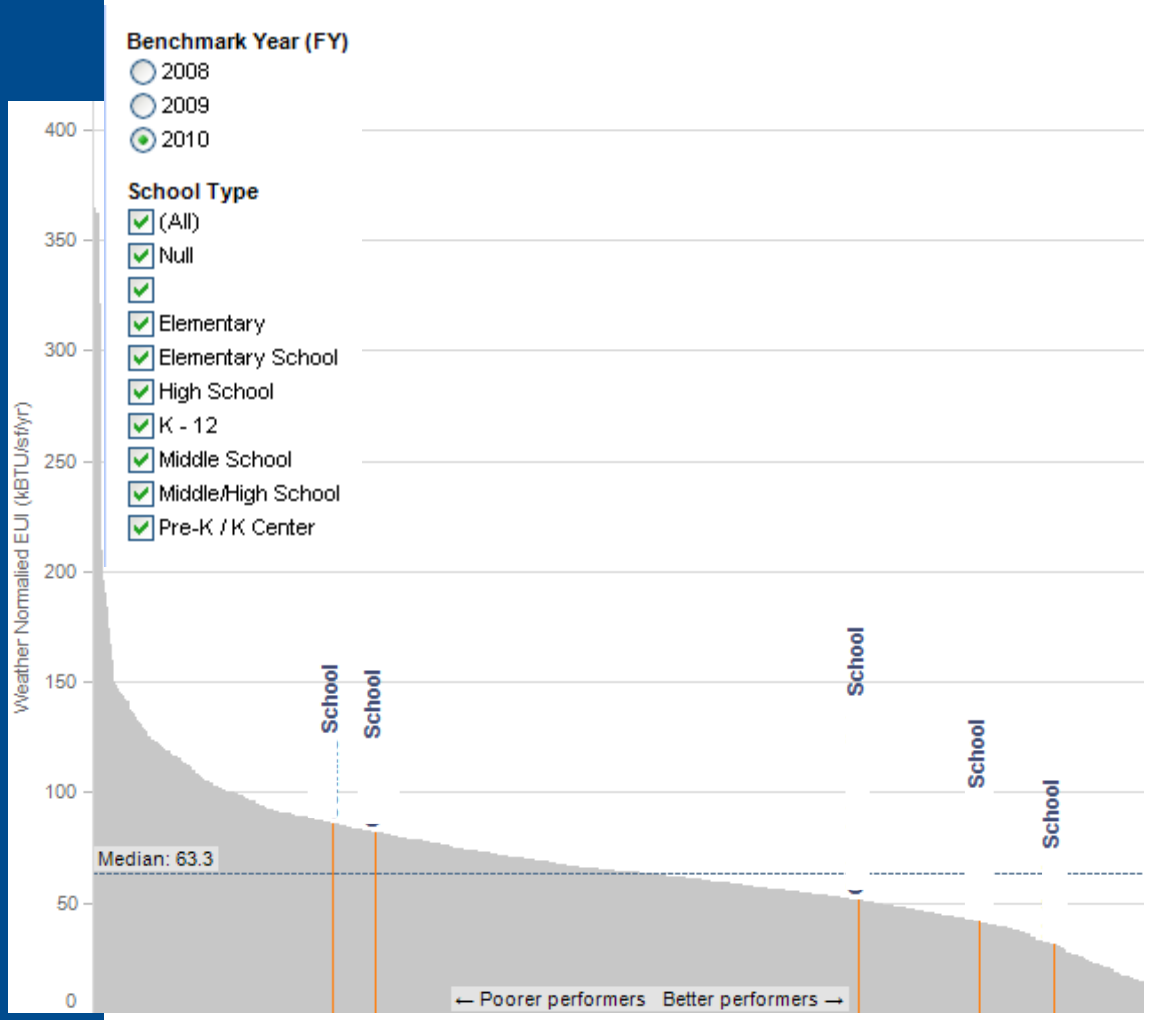
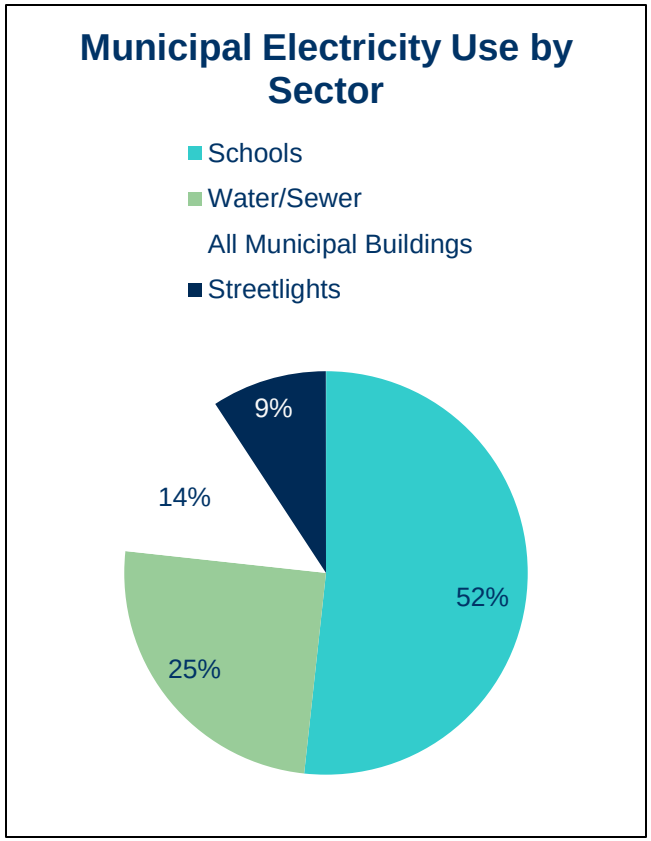
MEI: Aggregate Trends



MEI: Compare buildings and sectors





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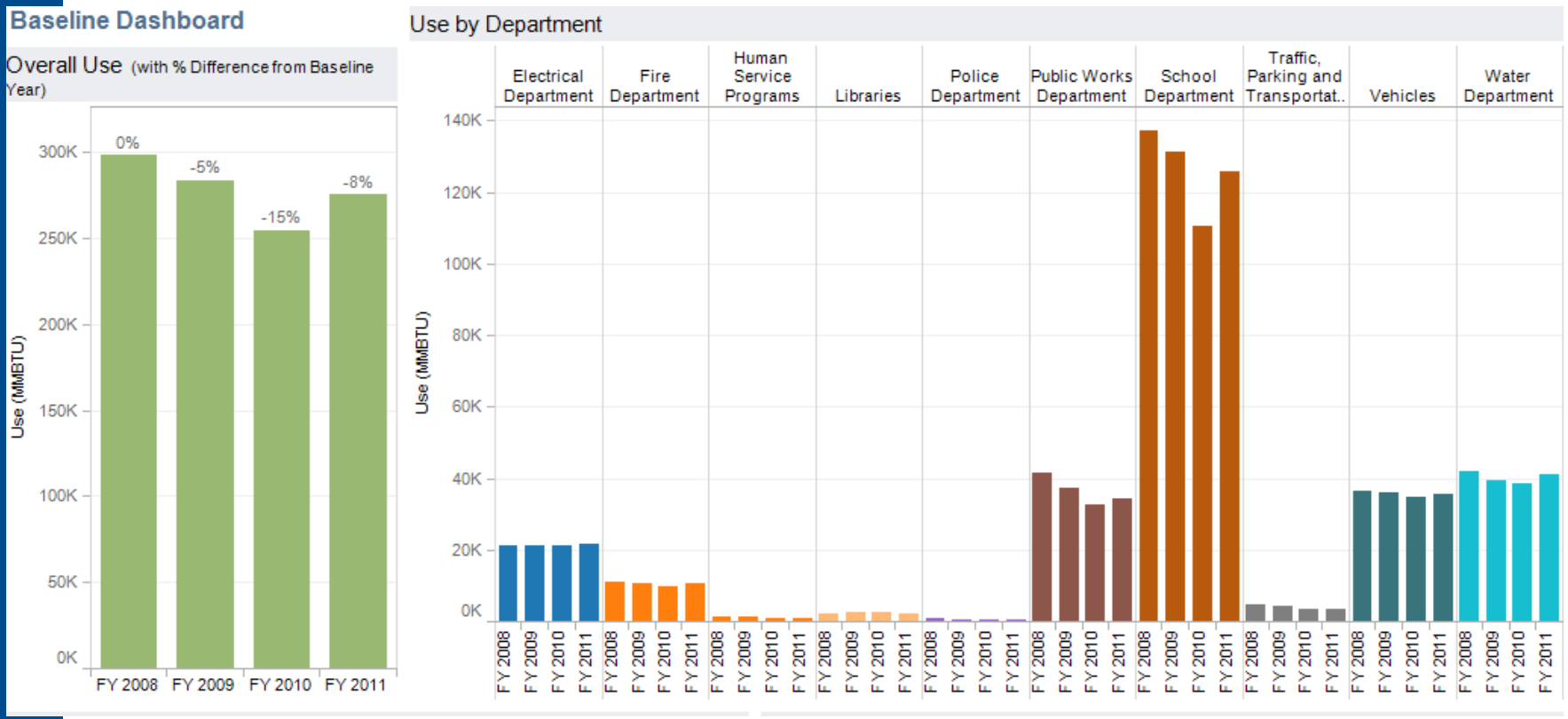
Summarize Energy Use at Town-Wide Level



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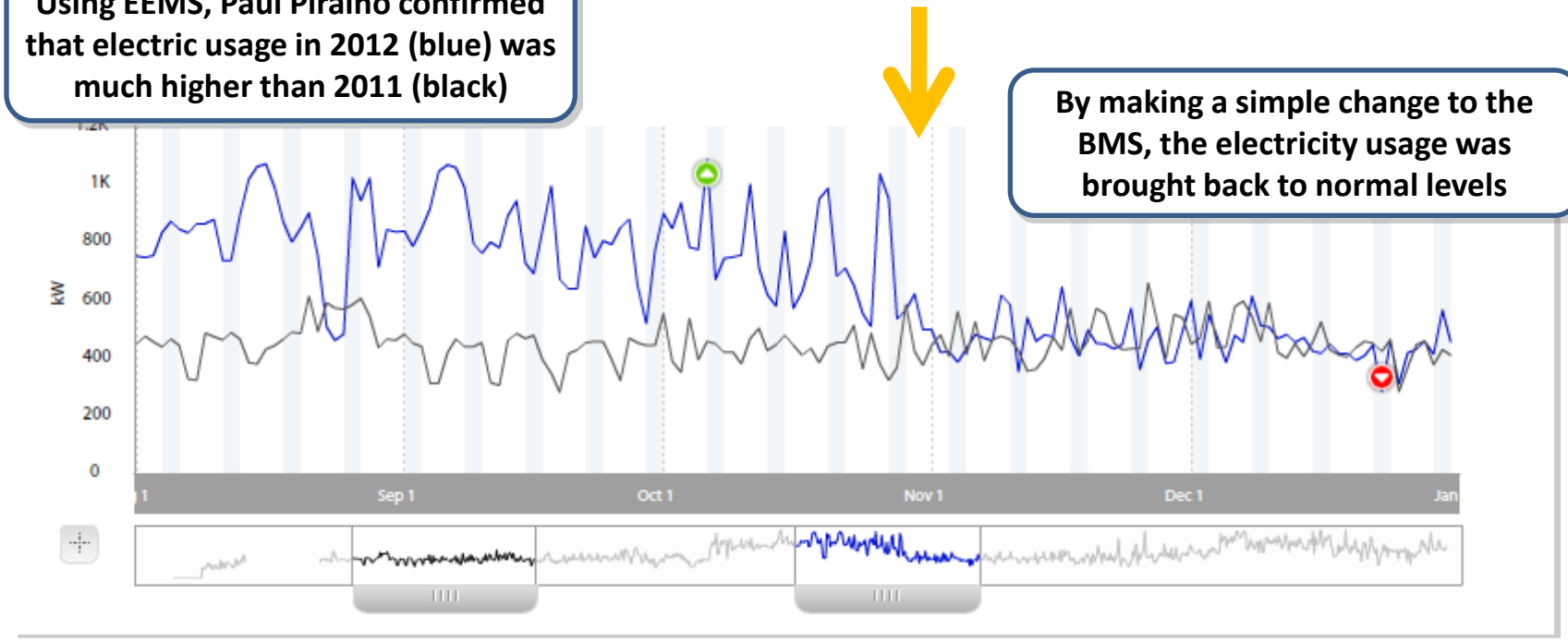
Real Time: Energy Usage Compare to Past – UMass Lowell

Using EEMS, Paul Piraino confirmed that electric usage in 2012 (blue) was much higher than 2011 (black)

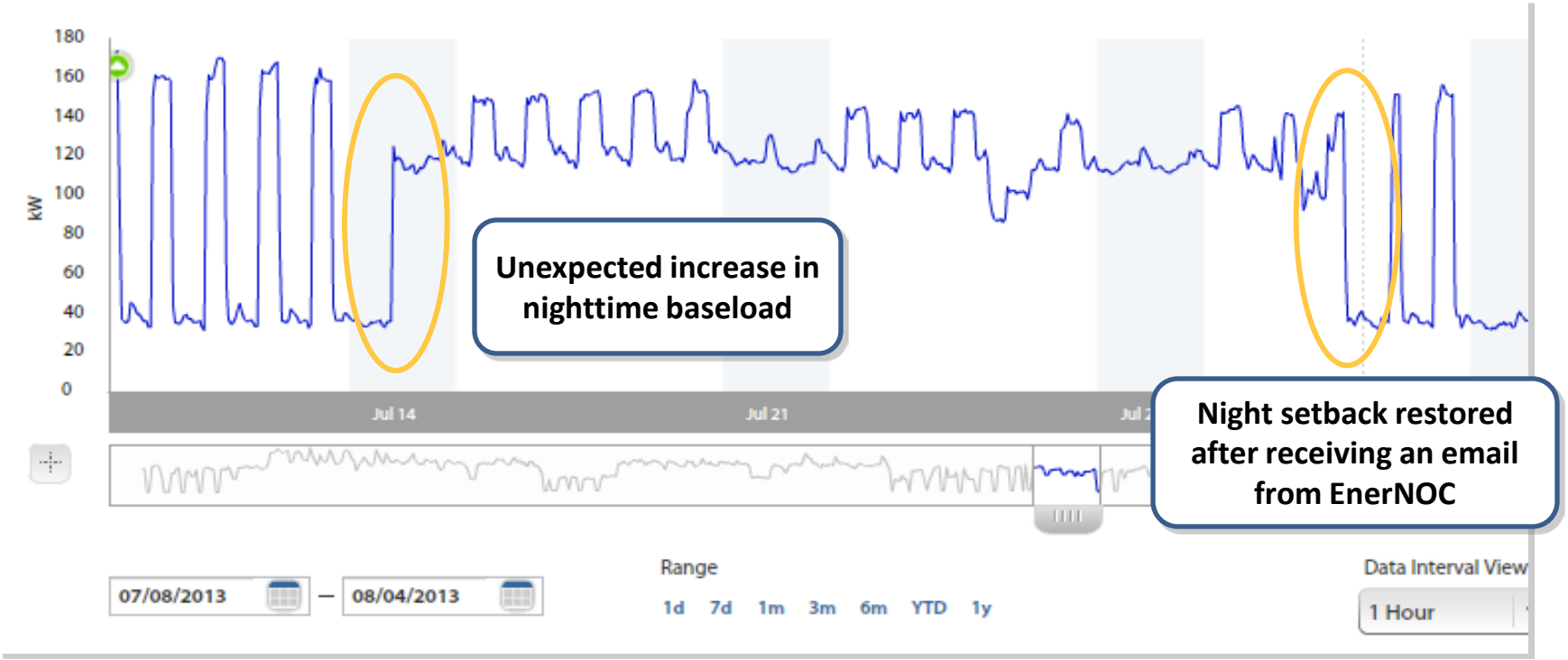
By making a simple change to the BMS, the electricity usage was brought back to normal levels



SAVINGS $45,000

kW Savings	kWh Savings	Reduced Carbon Emissions
600 kW	**409,000 kWh**	**970,000 lb**

Real Time: Night Setback – Framingham State Univ



SAVINGS $16,700

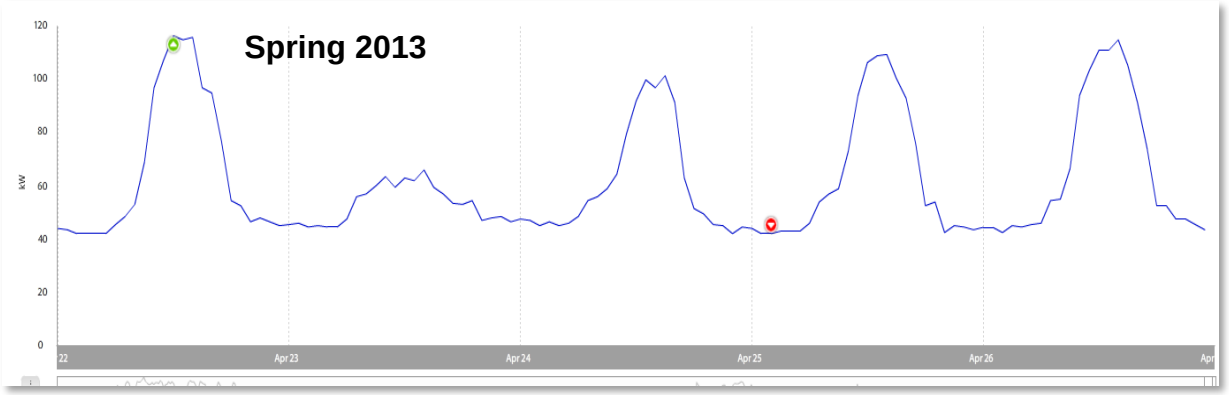
kW Savings	kWh Savings	Reduced Carbon Emissions
80 kW	152,000 kWh	361,000 lb

Real Time: Morning Startup Peaks Chelsea Soldiers' Home

Spring 2012

In the spring of 2012, chillers were being turned on simultaneously leading to unnecessary peaks

Spring 2013



After speaking with an EnerNOC analyst, the building was able to implement a staged startup sequence and eliminate the peaks

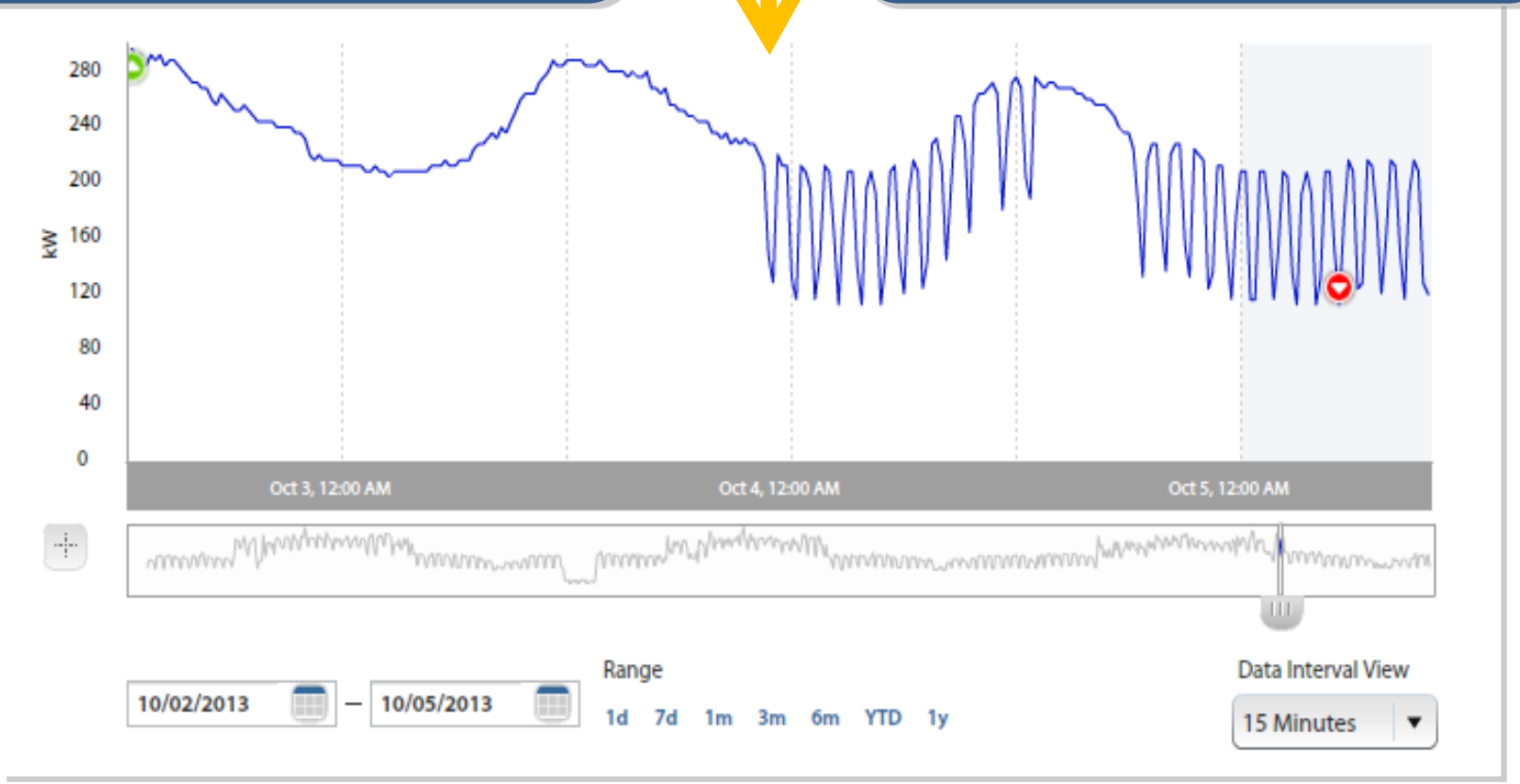
SAVINGS $19,000

kW Savings	kWh Savings	Reduced Carbon Emissions
60 kW	173,000 kWh	411,000 lb

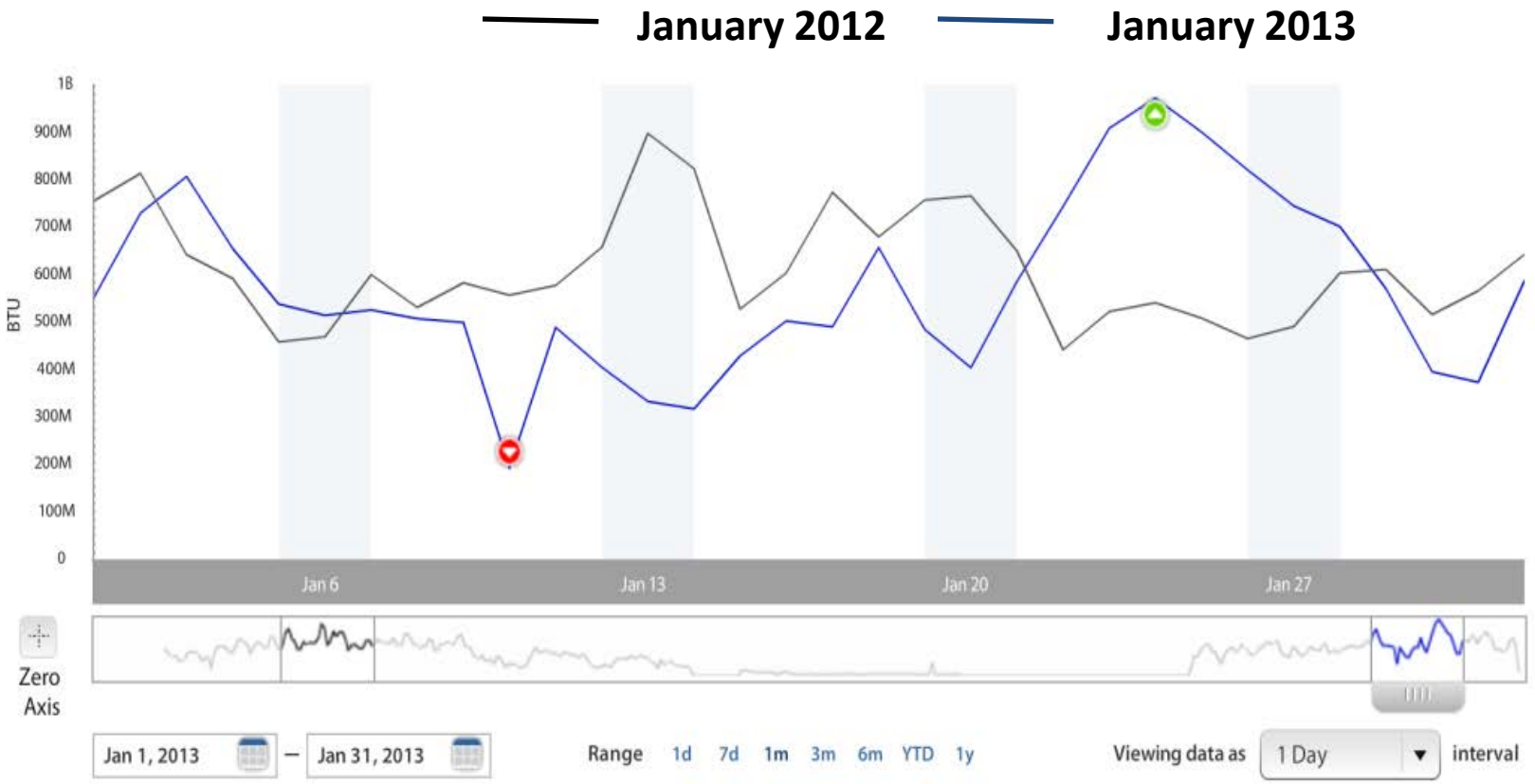
Maintenance Cost Avoidance – UMass Lowell

Using granular EEMS data, this site was able to identify a large piece of equipment that was cycling on and off.

Proactively identifying and eliminating this issue will significantly increase equipment lifespan and reduce maintenance costs



Measurement & Verification – UMass Lowell



EEMS is a great way to track the results of efficiency projects. The college's Energy Manager is using the EnerNOC application for M&V, to determine the level of savings achieved and to help inform his decisions going forward.

Challenges

- Amount of data can be overwhelming
- Can be expensive
- How to manage/analyze the data once you get it
- Compliance from agencies is varied
- Data is not perfect

Key Takeaways

- Identify why you want data
  - Measure progress?
  - EM&V?
  - Prioritize future projects?
  - Communicate success?
- What needs to be tracked
  - Agency-wide vs. site vs. building
  - All/some fuels
- Multiple solutions
  - Annual, monthly and real-time
  - Use & Fiscal data
- Develop verification system
  - Cross referencing
  - Compare to past
- Adjust historical data
- Hire/appoint dedicated staff

Contacts

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Steven Winter Associates, Inc.

U.S. DOE Benchmarking & Transparency Policy and Program Impact Evaluation Handbook

Prepared for the U.S. Department of Energy

By Navigant Consulting, Inc.
and Steven Winter Associates, Inc.

May 27, 2015

DISPUTES & INVESTIGATIONS • ECONOMICS • FINANCIAL ADVISORY • MANAGEMENT CONSULTING

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The Purpose of the DOE Handbook is to Assist Jurisdictions by Providing Relatively Simple Methods and Tools for Evaluating their B&T Policy and Program Impacts

Assist jurisdictions in:

- **Measuring Policy Results and Impacts**
  -- Market Transformation, Energy Savings, GHG Reductions, Jobs and Market Valuation

- **Assessing B&T Policy Market Transformation Progress** -- over the life of the effort

- **Defining Consistent and Credible Evaluation Approaches to B&T Policies** -- to assist jurisdiction in understanding and interacting with ratepayer and other voluntary and mandatory policies and programs

- **Having the Tools and Knowledge Base for Long-term Evaluation of all aspects of B&T Policies and Programs**

The DOE Handbook Provides Jurisdictions with a "How-to-Guide" with Clear Steps and Data Requirements for the Recommended Primary Methods

Two Methods:

Primary Methods: Relatively simple to implement methods are for jurisdictions wishing or needing to evaluate the market, energy and non-energy impacts of policy implementation

Supplemental Methods: More advanced and generally more expensive methods are included to guide researchers who wish to go beyond the basic, primary evaluation methods recommended for B&T policy jurisdictions

The DOE Handbook Provides Jurisdictions with a *B&T Planning Framework* Tools and Standard Evaluation Methodologies to Assess the Progress Key Outcomes that Policies Typically are Designed to Achieve

B&T Efforts are *Foundational Policies* that Desire to Impact the Commercial and Multi-family Sectors to:

(1) *Internal:* Encourage Building Owners' to Energy Savings Actions

(2) *Market:* Educate and Transform the Market Towards Higher States of Awareness of the Potential and Need for Increased Energy Efficiency Actions

(3) *External:* Provide Market Information that Enhances Other Energy Efficiency Program Administrator Energy Savings' Efforts

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B&T Policy and Programs Impacts Evaluation Handbook » *Four Sections*

B&T Policy & Programs Impacts Evaluation Handbook Sections

Section 1: B&T Policy Planning Framework

- B&T policy theory and logic model
- Barriers, activities, and expected outcomes over time
- Market transformation indicators (MTI)

Section 2: Market Transformation Progress Evaluation

- MTIs as milestone indicators
- Tracking changes in market structure and market actor behavior
- Market actor interviews and surveys

*Section 3: Gross and Net Energy Savings Impacts Evaluation

Gross Savings:
- Analysis of iterative energy use intensity (EUI) Outputs from ENERGY STAR Portfolio Manager

Net Savings:
- Historical Tracing
- Structured expert judgement panel

*Section 4: Non-Energy Benefits Impacts Evaluation

GHG Reductions:
- Calculated from Portfolio Manager® outputs

Jobs:
- Policy created direct, indirect & induced jobs

Real Estate Value Enhancement:
- Comparative sales method

(Source: Navigant Consulting)

* *Sections contain both primary and supplemental recommended evaluation methods*

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Key Elements of a Planning Framework for Implementing B&T Policies

1. **B&T Policy Logic Model:** A planning roadmap for meeting *jurisdictional goals* that includes three key planning components:

Identified:

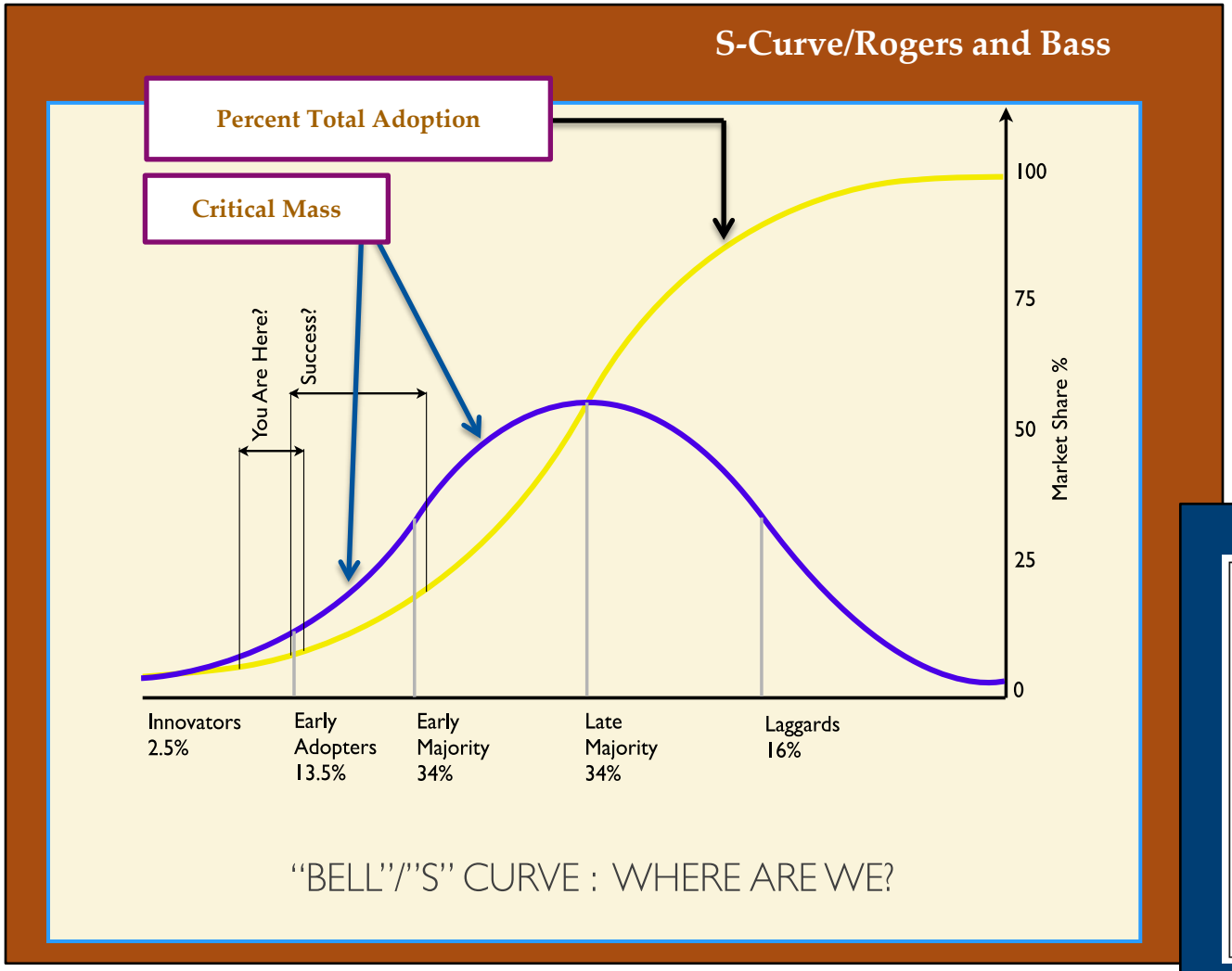
- ***BARRIERS*** to policy energy savings and market transformation success
- ***ACTIVITIES*** to overcome those barriers
- ***EXPECTED OUTCOMES*** from the actions

2. **Market Transformation Indicators (MTIs):** Market metrics assigned as a means of evaluating B&T policy MT progress at different periods of market transformation

3. **Market Transformation Time Periods:** Transformation takes place over time in somewhat regular patterns

(Source: Navigant Consulting)

B&T Policies are a Components of an Overall Effort to Transform Large Commercial and Multi-Family Market Sectors Towards Higher States of Efficiency



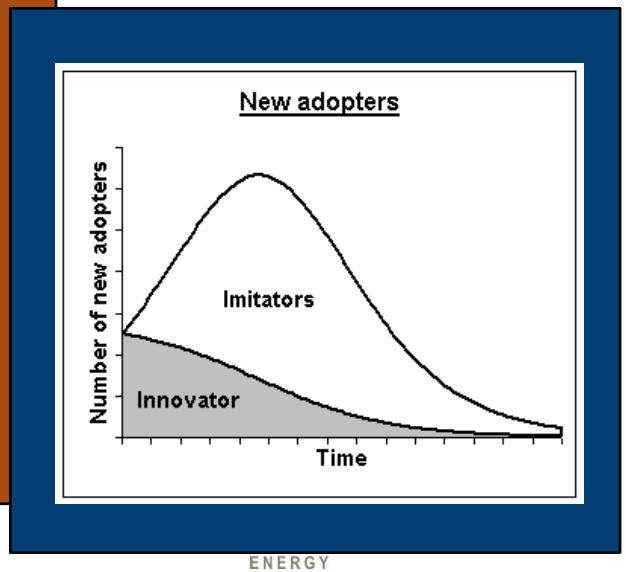


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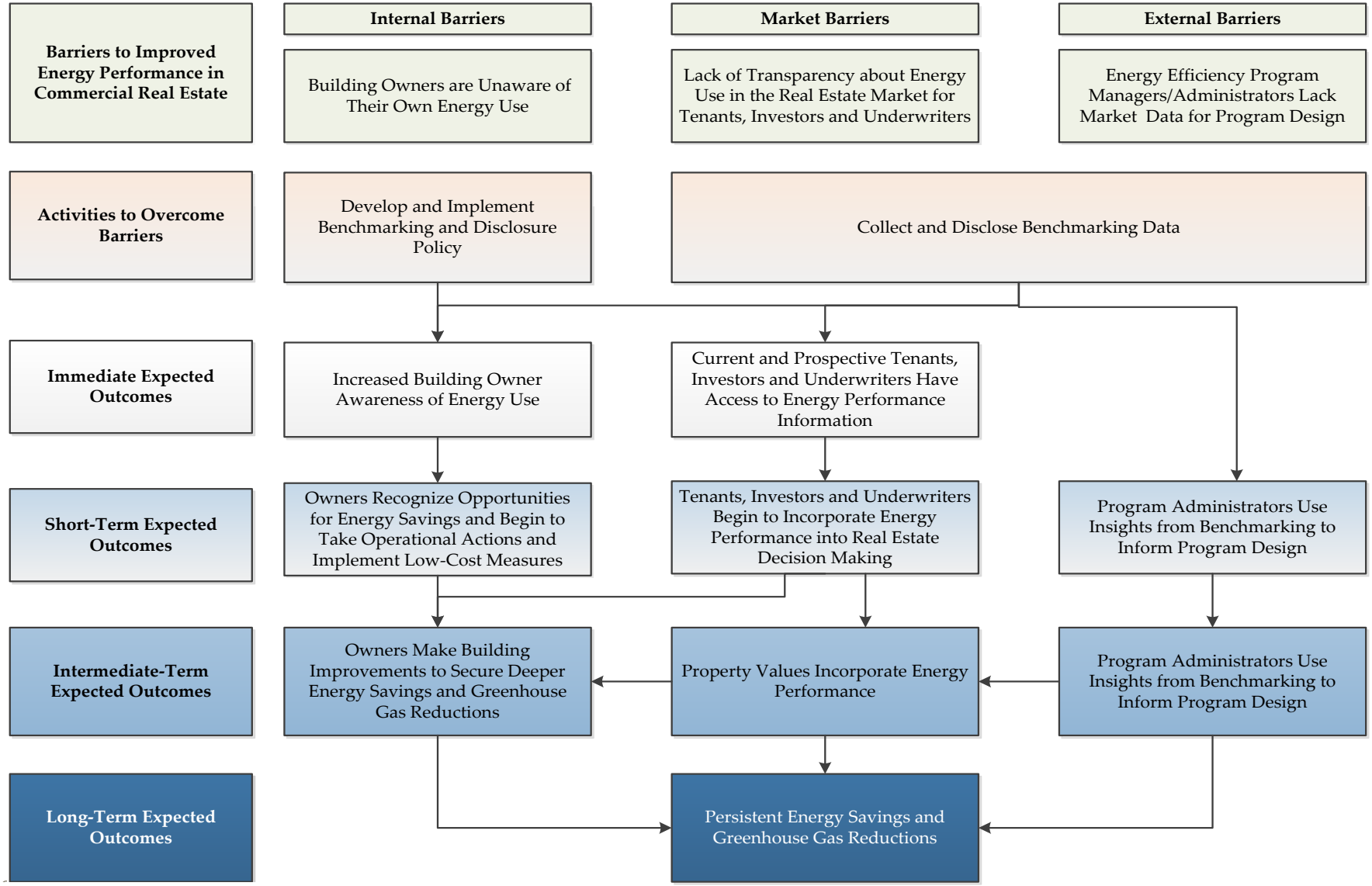
Figure 1-3. Illustrative Benchmarking and Transparency Policy Logic Model Diagram



[1]

(Source: Navigant Consulting)

Th MTI focus is on identifying key market indicators related to the important audiences and activities the policy wishes to influence; and on MTI evaluation data gathering approaches and market progress criteria

Important B&T Audiences

- **Building Owners and Property Managers**
- **Real Estate Professionals** (brokers, investors, appraisers, lenders)
- **Energy Efficiency Program Administrators**

Evaluation Methods Recommended

- **Interviews** (market actors and B&T staff) – 3 time periods
- **Online Surveys** (building owners and managers)
- **Structured expert panel** – Later periods

Evaluation Criteria

- **Market Awareness / Understanding** (owners, tenants, brokers, underwriters, appraisers, etc.)
- **Savings Actions /Activities** (owners, property managers, tenants)
- **Efficiency Program Design Adjustments** (based on availability / transparency of B&T performance information)
- **Non-energy Benefits** (persistence of energy savings related GHG reductions, jobs and market valuation – qualitative assessments)

Example of MTIs for Building Owner Awareness

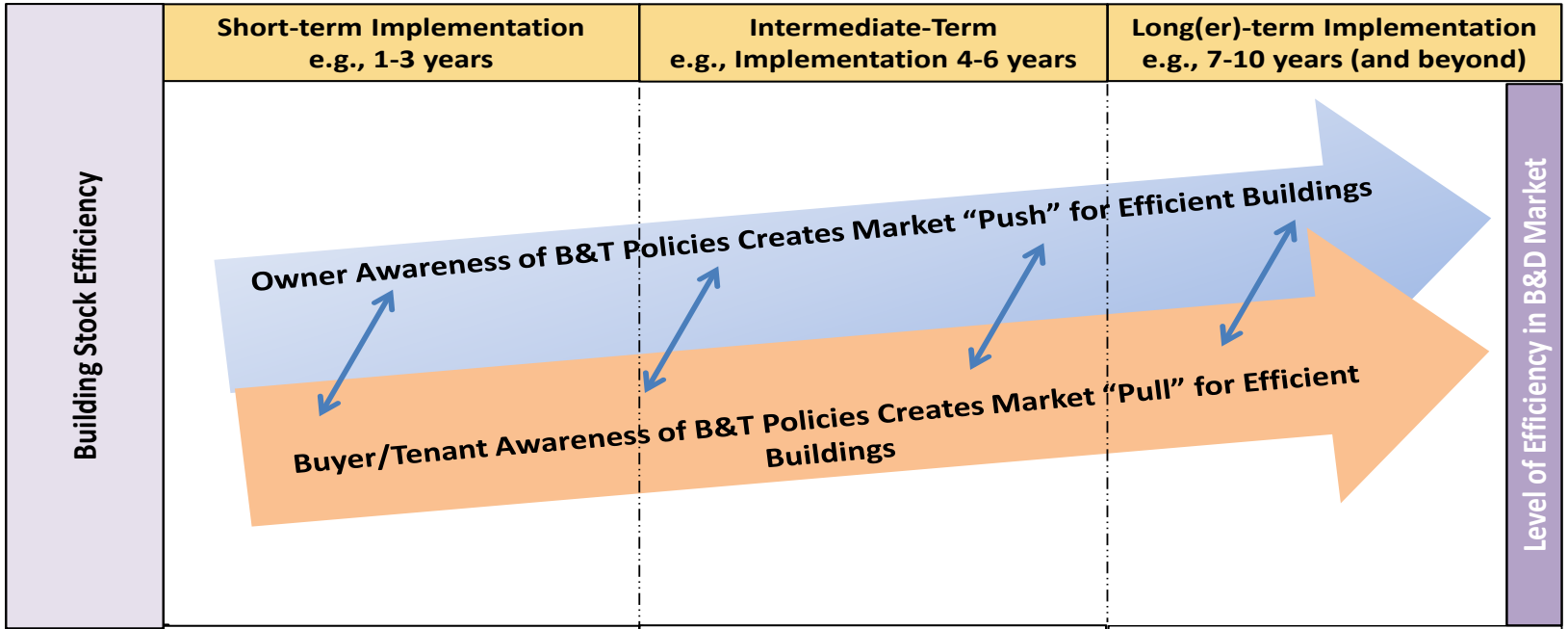
Immediate / Short-Term MTI (e.g., 1 to 3 Years)	Intermediate MTI (e.g., 4 to 6 Years)	Long-Term MTI (e.g., 7 to 10 Years)	Primary Data Sources	Supplemental Data Collection Methods	Potential Actions in the Case of Absent or Partially Absent Indicator
Building owners are aware of annual energy performance per building or leased space for all fuels	Building owners are increasing aware of annual energy performance trends for all fuels	Building owners incorporate B&T data into energy management decisions as a matter of standard practice	Interviews and surveys of building owners and property managers	Secondary research of trade periodicals	The absence or partial absence of this indicator would justify additional educational outreach to building owners
Building owners can identify specific energy performance opportunities in their own buildings	Building owners include energy performance as a component of retrofit/renovation planning	Building owners increasingly incorporate energy performance in to expansion and retrofit design and construction practices	ENERGY STAR Portfolio Manager inputs and outputs	Surveys of utility account representatives	The absence or partial absence of this indicator would justify additional educational outreach to building owners by both the B&T program sponsor (local municipality) as well as local utilities

Example MTIs for Transparency of Energy Use in the Real Estate Market

Immediate/Short-Term MTI (e.g., 1 to 3 Years)	Intermediate MTI (e.g., 4 to 6 Years)	Long-Term MTI (e.g., 7 to 10 Years)	Primary Data Sources	Supple-mental Data Collection Methods	Potential Actions in the Case of Absent or Partially Absent Indicator
Tenants are increasingly aware of energy performance information and their understanding of this information increases over time	Tenants incorporate disclosure information into lease negotiations	Tenants expect improving energy performance as a standard practice by building owners	Interviews with Real Estate Professionals; Lease contract documents	Survey of tenants; survey of commercial real estate brokers	If tenants are unaware or uncertain of the value of benchmarking disclosure information, their transition from awareness to understanding to incorporation of the information into real estate decisions will stagnate or cease.
Investors and underwriters are increasingly aware of energy performance information	Investors and underwriters begin to include disclosure information as a valuation criteria	Investors and underwriters include improving energy performance as a standard valuation metric	Interviews with Real Estate Professionals; Lease contract documents	Survey of tenants; survey of commercial real estate brokers	If investors or underwriters do not incorporate benchmarking and transparency information into their valuation process, it may mean that they have not observed sufficient demand for buildings with improved energy performance or that they lack a methodology to monetize any demand that they do observe. Programs that demonstrate tenant demand and/or valuation techniques to quantify this demand would be viable options to address these challenges.

Bottom line: The Policy Aims to Accelerate Market *Push-Pull Dynamics*

Figure 2-1. Illustrative Example of the Push-Pull of the B&T Market Space



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Evaluating the B&T Policy's MT Progress involves Mapping MTIs to the Interview Questions to Identify Evidence of MT Indicator in the Market

Table of Building Owner and Property Manager Interview Findings with Comparison to MTIs (Immediate and Short-Term Policy Implementation Period)

	Outcome	Internal MTIs	Market MTIs	External MTIs	Interview Findings
Immediate	Increased building owner awareness of energy use.	Building owners are aware of annual energy spent per building or leased space for all fuels.	N/A	N/A	There was a high level of awareness among the limited number of building owners and managers interviewed. Six out of eight owners (of mostly larger buildings) were tracking energy use before the policy, and five out of eight were already benchmarking. For four of the interviewees, the policy improved their understanding of energy use, while for others the policy was reported to have had no impact other than changing their behavior to meet the law.
Short Term	Owners recognize opportunities for energy savings and begin to take operational actions and implement low-cost measures. Tenants, investors, and underwriters begin to incorporate energy performance into real estate decision making.	Building owners can identify specific energy savings opportunities in their own buildings. Building owners can describe implementation of specific low-cost measures within their own buildings.	Tenants are increasingly aware of benchmarking disclosure information and their understanding of this information increases over time. Investors and underwriters are increasingly aware of benchmarking and disclosure information.	N/A	Six of those interviewed were already participating in utility or government run programs before the enactment of the policy. The B&T policy was not a strong influence in these building owners' decisions to participate in energy efficiency programs, but tenants, investors, and underwriters are beginning to request energy data more often.
Intermediate Term	Owners make building improvements to secure deeper energy savings and greenhouse gas reductions. Property values incorporate energy performance.	Building owners are increasingly aware of annual energy spend trends for all fuels. Building owners include energy savings as a component of retrofit/renovation planning. Retrofits and renovations preserve and expand upon previously installed measures.	Tenants incorporate disclosure information into lease negotiations. Investors and underwriters begin to include disclosure information as valuation criteria.	N/A	For seven out of eight building owners and property managers, the policy did not influence their decision to make energy efficiency improvements. Six interviewees were "very likely" to invest in energy efficiency upgrades, though not necessarily due to the B&T policy. Demand for efficient or green-labeled buildings has increased, and building owners expect to see more investors requesting benchmarking data in the future. For most owners and managers, compliance with the ordinance was the most influential reason for benchmarking.
Long Term	Persistent energy savings and greenhouse gas reductions.	Building owners increasingly incorporate B&T data into energy management decisions. Building owners increasingly incorporate kWh and therm costs into expansion and retrofit design and construction practices. Building owners deliberately strive toward improved energy performance as a management metric.	Tenants require consistent energy improvements as a standard lease offering. Investors and underwriters include improving energy performance as a standard valuation metric.	N/A	Most interviewees have hired full-time staff or consultants dedicated to energy efficiency in their buildings, but have not quantified the benefits of their energy management efforts to date. Energy efficiency is not a large draw for tenants, but those that have drawn new tenants cited cost savings and public image as drivers.

The Handbook Provides Interview Guides, Surveys and Example Tables of Findings from Early Market (immediate and short-term) Interviews on MT progress.

Real Estate Professionals and Efficiency Administrator Illustrative Findings

Outcome	MTI	MTI Present?
Owners recognize opportunities for energy savings and begin to take operational actions and implement low-cost measures.	Building owners can identify specific energy savings opportunities in their own buildings.	Yes, but not necessarily due to policy
	Building owners can describe implementation of specific low-cost measures within their own buildings.	Yes, but not necessarily due to policy
Tenants, investors, and underwriters begin to incorporate energy performance into real estate decision making.	Tenants are increasingly aware of benchmarking disclosure information and their understanding of this information increases over time.	Yes
	Investors and underwriters are increasingly aware of benchmarking and transparency information.	Yes
Program administrators use insights from benchmarking to inform program design.	Energy-efficiency program administrators begin to include benchmarking and transparency information in their new program design.	Yes

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Primary Recommendation: Analysis of Iterative Energy Use Intensity (EUI) Outputs from ENERGY STAR Portfolio Manager®

- **High Level Overview of Approach:**
  - Isolate buildings that complied in years being compared (e.g., Year 1 & Year 2).
  - Remove outliers from data.
  - Calculate the change in source EUI between Year 1 & Year 2.
  - Multiply the change in source EUI by the building square footage for each building
  - Sum the source energy savings for all of the buildings (Savings = Δ Source EUI x Building Square Footage)

» **Basic Equation**

$$Gross\ Energy\ Savings = Baseline\ Energy\ Use\ - Reporting\ Period\ Energy\ Use$$
$$= (EUI_{Year\ 1} - EUI_{Year\ 2}) * Building\ Square\ Footage$$

Supplementary Recommendation: Augmented Analysis of Energy Use Intensity (EUI) Outputs from ENERGY STAR Portfolio Manager®

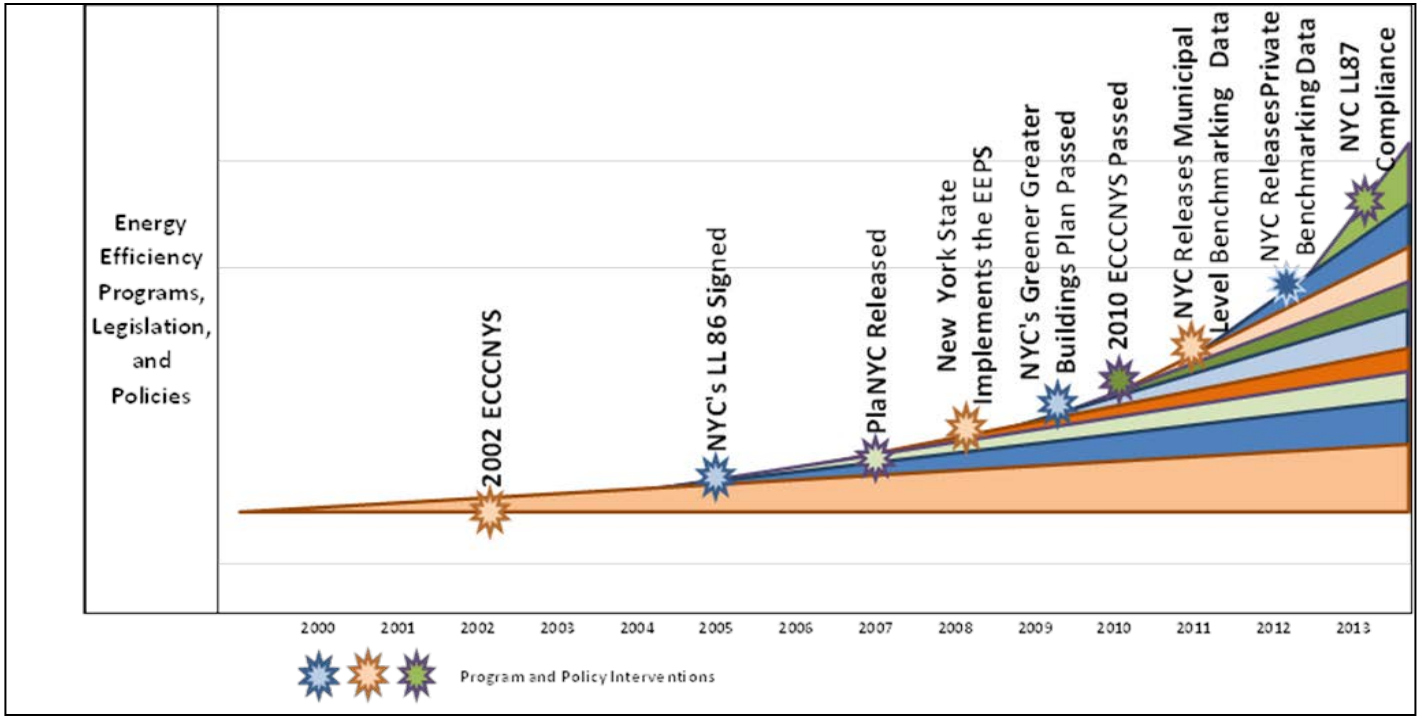
- **High Level Overview of Approach:**
  - This method is an extension of the primary recommendation, Analysis of Iterative EUI Outs from Portfolio Manager
  - There is an additional step to crosscheck the inputs entered into Portfolio Manager, which results in an adjustment factor, AF_{Audit}.
  - The benefit to going through this process is higher accuracy in the estimated gross energy impacts than just relying on what the building owners submitted in Portfolio Manager

- **Recommended Supplemental Quasi-Experimental Design Approaches*:**
  - Regression Discontinuity
  - Comparison City
  - Matching approaches

* These approaches requires specialized training in advanced econometrics, and energy consumption and building characteristics data for B&T and control group buildings.

Primary Recommendation:

- **Historical Tracing Analysis:** A structured process for attributing energy savings from various market interventions, programs, and legislation, and policies affecting a group of buildings energy use.



- **Structured Expert Judgement:** A panel of "experts" assembled to make final decisions on the evidence on the B&T policies potential energy savings impacts.

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Calculating GHG Emissions Reductions

» GHG emissions reductions are calculated from Portfolio Manager® outputs
  - Portfolio Manager returns emissions for each building in $MtCO_2e$ (metric tons of carbon dioxide equivalent)

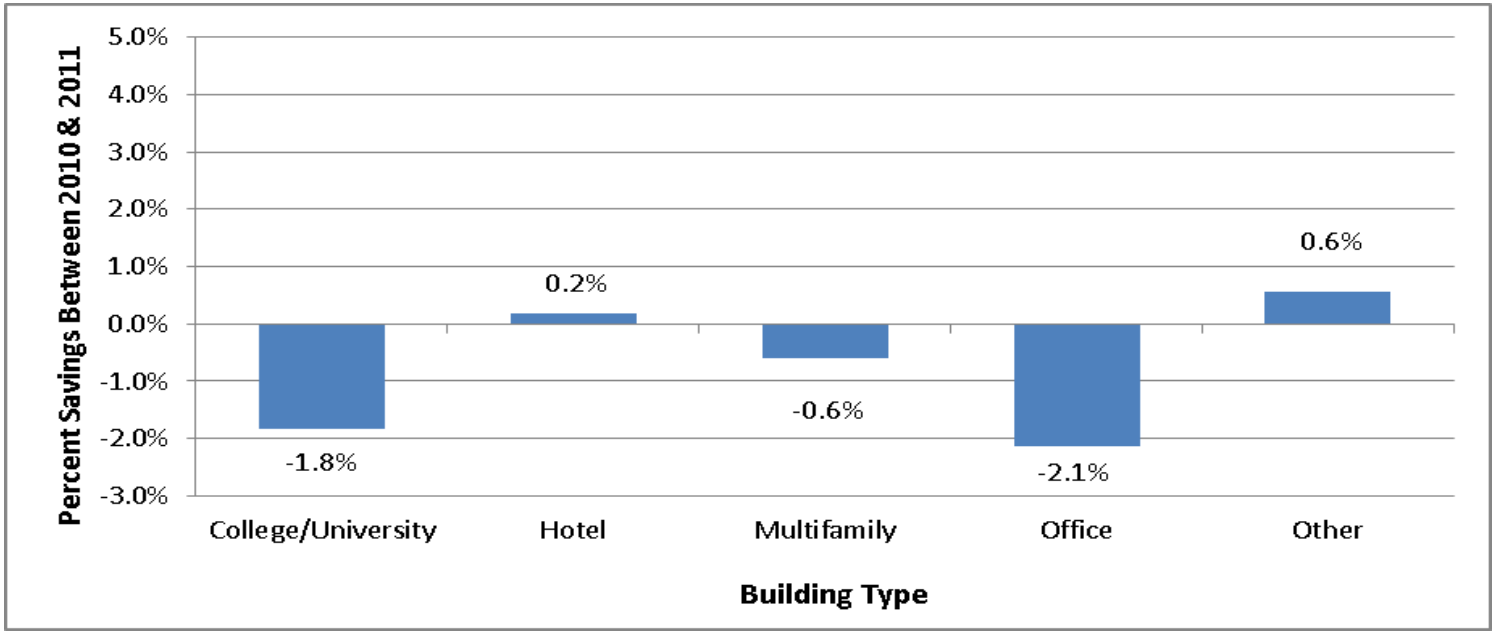
» **Approach**
  - Identify buildings to include in dataset
    - Dataset should be identical to set used for energy savings calculations
  - Collect emissions data for each building from Portfolio Manager for baseline year and current year
  - Normalize emissions data by building area for each year
    - $MtCO_2e$/sq. ft.
  - Adjust emissions baseline for total building area reported in current year
    - $Adjusted\ building\ emissions\ baseline(MtCO_2e) = [Normalized\ GHG\ emissions_{Year\ 0}] \times [Citywide\ gross\ floor\ area_{Year\ x}]$
  - Calculate difference between adjusted emissions baseline and current year emissions

Summarizing GHG Emissions Results

» Follow method used for summarizing energy savings results

- Group GHG emissions reductions into the same categories used for energy savings: building type, building floor area, building vintage, etc.

Example Graph: GHG Emissions Impacts by Building Type



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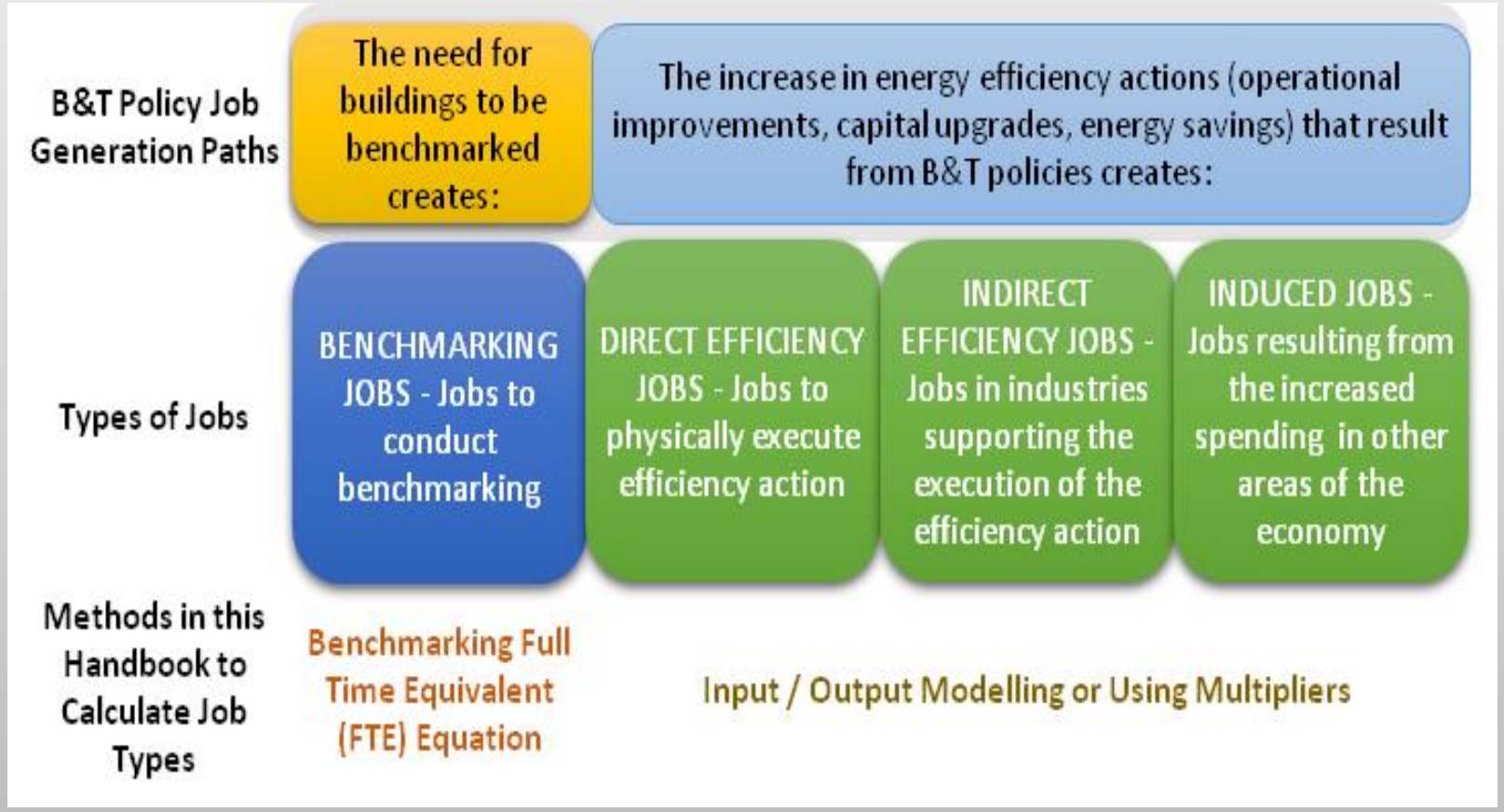
Job creation estimates can be derived from the economic activity generated due to the B&T policy.



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Primary Method: Category 1: Calculating Employment From Benchmarking

A function of the labor required to benchmark the properties. Benchmarking is done in-house by owners and managers or by third party consultants

- **Identify number of buildings benchmarked**
- **Determine time needed to benchmark a building**
- **Calculate Full-Time Equivalent (FTE).**

$$\textit{Direct Benchmarking FTE} = \frac{\textit{(Number of Buildings Benchmarked * Y Hours of Benchmarking Per Building)}}{\textit{2080 – Hours Unavailable for Analysis (Holidays, Vacation, etc)}}$$

Primary Method: Category 2: Calculate I-O Model Job Creation

An input-output analysis (I-O modeling) can estimate the direct and indirect economic impact of energy savings The sq. ft. of buildings saving energy are compiled, multiplied against assumed cost/ sq. ft. figures to achieve the level of savings, then multiplied against standard multipliers to result in job estimates.

Three types of jobs are studied:

» **Direct Jobs:** Jobs generated from a change in spending patterns

» **Indirect Jobs:** Jobs generated in the supply chain and supporting industries

» **Induced Jobs:** Jobs generated by the spending of received income resulting from direct and indirect job creation

Which result from three energy efficiency activities:

» **Operational Expenditures and Improvements:**

» **Capital Upgrades**

» **Spending Shifts from Energy to Non-Energy Goods and Services**

Supplementary Recommendation:

Survey Owners -- This approach requests direct feedback from the firms and building owners about staffing, energy actions, costs, etc.

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Primary Method: Evaluating Real Estate Value in Relation to Policy Generated Energy Efficiency Value

-- **Real estate comparative sales analysis:** Real estate valuations commonly apply a qualitative sales comparison approach to valuing buildings based on individual building and local jurisdictional characteristics such as distance to the city center, construction attributes, building size, occupancy rate, building class, lease type, and other characteristics.

Supplementary Recommendation:

-- **Real estate hedonic regression modelling:** The hedonic regression model utilizes more of the data and variables employed in qualitative comparison sales approaches. Although the hedonic technique is relatively sophisticated, it has been used extensively in real estate economics.

In the context of the non-energy impacts of B&T policies, the hedonic regression model is a supplementary method that may be employed to measure the impacts of the policy on the change in real estate valuations over time.

Questions

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Key Considerations

- **Source Energy**: Use the source energy use intensity (kBtu/square foot) for the gross energy impacts, as compared to the site energy use intensity.
  - ***Source energy***: the raw amount of fuel required to operate a building, including the amount of energy lost through transmission, distribution, and production losses.
  - ***Site energy*****:** the amount of fuel consumed by a building as reflected in the utility bills.
- **Weather Adjustment:** When possible, use the weather-normalized outputs from ENERGY STAR Portfolio Manager®.
- **Building Mix:** Account for the variation in gross energy impacts across the population by breaking out the buildings into different building segments, such building type, vintage, or size.
- **Outliers**: Remove buildings with extraneous values that might skew the data.

Issues and Challenges

- **Bad Data**: Building owners may submit bad data which could skew the gross energy impacts.
- **Inconsistent Compliance Rates:** Buildings may comply in Year 1 and Year 2, not comply in Year 3, then comply again in Year 4. This could skew the trend in gross energy impacts.

Insight and Advice

- Use the primary recommendation, Analysis of Iterative EUI Outputs from Portfolio Manager, unless there is additional budget to crosscheck the inputs to Portfolio Manager. If so, use the supplementary recommendation.
- Establish a set of data cleaning steps and consistently follow them so that there is no bias in the types of buildings that are included in the savings analysis.
- Consistently reach out to building managers to ensure that they are complying so that their gross energy savings can be accounted for.

Appendix -- Section 4: Non-Energy Benefits: GHG Reductions

Issues and Challenges

» **Bad data and inconsistent compliance rates:** Similar to the challenges faced when calculating energy savings, poor data quality and inconsistent compliance rates can skew impact trends
  – Solution: data cleaning
  – Solution: follow up with building owners, penalty for failure to comply

» **Renewable energy:** renewable energy sources with no GHG emissions (e.g. PV arrays) are not always captured by Portfolio Manager and may incorrectly appear in the data as sources of emissions
  – Solution: Cities with substantial renewable energy systems can request avoided emissions data from Portfolio Manager and subtract avoided emissions from total emissions.

Insights and Advice

» **Keep evaluation approach uniform**

- When evaluating GHG emissions impacts, keep the method consistent with the method used for energy savings evaluations

» **Keep scope of results in mind**

- Remember that GHG emissions reported in the benchmarking analysis are emissions from buildings only – not total emissions
  - Not included are emissions from transportation, landfills, etc.
  - Cities interested in analyzing total emissions should consider performing a GHG emissions inventory

Employment From Benchmarking – Issues and Challenges

- **The labor required to benchmark properties may vary by building type, provider, and over time**
  - **Different owners and consultants may operate more efficiently or more accurately**
  - **Some buildings are more complex than others**
  - **Updating Portfolio Manager accounts may move more quickly over time**

- **It is difficult to precisely determine to whom owners, managers, and consultants assign the work**
  - **Existing staff may given additional work, or additional staff may be hired**

Insights and Advice

Consider Outreach to Actual Practitioners for Feedback

- **Jurisdictions likely track who submits benchmarking data**
- **A small number of large property owners or consultants may be submitting the majority of reports, minimizing the amount of outreach**

I-O Model Job Creation – Issues and Challenges

- **No Absolute Way to Understand if Energy Savings Results from O&M Work or Capital Work**
  - The decision in this study was to attribute savings past a certain percentage to capital work
- **Energy Usage in Portfolio Manager is Not Weather-Normalized**
  - Without weather normalization it is difficult to understand the end use of fuel types

Insights and Advice

- **Consider Outreach to Actual Practitioners for Feedback**
  - Same as the previous section, interviews and feedback with consultants and owners can help understand the type of work actually underway in buildings
  - Municipalities may be able to share work permit records

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