

Building Asset Ratings to Enhance Energy Assessments and Increase Efficiency Investments

Facilitated by

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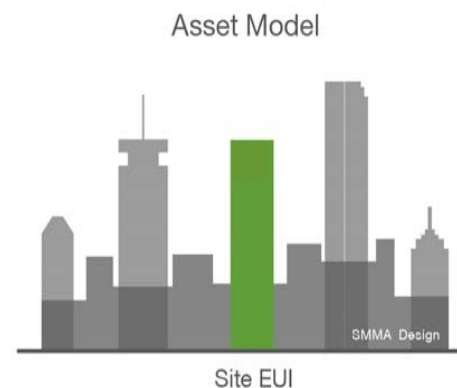
DOER

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SMMA / Symmes Maini & McKee Associates

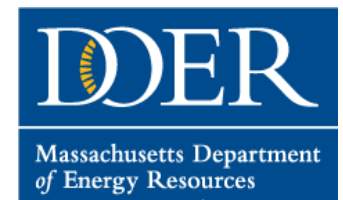


October 28th , 2014



Learning Objectives

1. Understand the distinctions and complementary elements of 'operational' (such as Energy Star) and 'asset' commercial building energy ratings;
2. Understand the value of enhanced access to information about commercial building energy performance as a means to encourage investment in energy efficiency improvements;
3. Understand the results and key findings of the Massachusetts Building Asset Rating pilot;
4. Understand the status, opportunities, and challenges of state and federal building asset rating initiatives and their implementation.

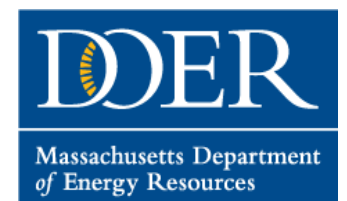


Agenda

- Introduction
- BAR Pilot Program
 - Goals and Objectives
 - Phase 1 & Phase 2: Overview
- Phase 2 Analysis and Evaluation Findings
 - Methodology
 - Evaluation
 - Recommendations
- Asset Ratings and local energy ordinances
 - Opportunities for Policies and Market Applications



BAR Pilot Program Funders



BAR Pilot Program Partners

ANALYST TEAMS

THE WEIDT GROUP®



FIRST FUEL
BUILDING ENERGY ANALYTICS

THE
CADMUS
GROUP, INC.

ARUP



Retroficiency

The Green Engineer, Inc.
Sustainable Design Consulting

TECHNICAL & PROCESS CONSULTANTS

SMMA

PEREGRINE

ENERGY GROUP



POLICY, PROGRAM & STRATEGIC DEVELOPMENT



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

SMMA



Pacific Northwest
NATIONAL LABORATORY



DOER

Massachusetts Department
of Energy Resources

BAR Pilot Program Snapshot

EUI (kBTU/sf)		
Calibrated	43	46
Operational	43	42
Asset	51	51

	Energy Star Score (0-100)	100	97
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BAR Pilot Program Goals

Office buildings are an efficiency resource : 38% electric and 55% gas savings potential for MA



- Identify **cost-effective**, scalable methods to assess existing buildings and systems
- “Apples-to-apples” **comparison** of building energy performance
- Connect owners with efficiency **programs**



BAR Pilot Program: Cost Effective Methods

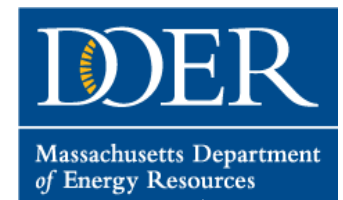
➤ Identify **cost-effective**, scalable methods to assess “as-built” building and systems

- Traditional ASHRAE Level 2 audit: \$20,000-\$25,000+
without comparable results
- BAR audits: \$6,000-\$8,000
with comparable results



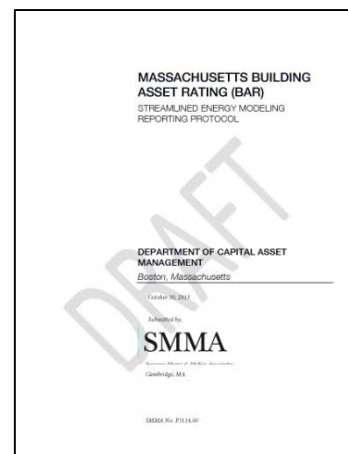
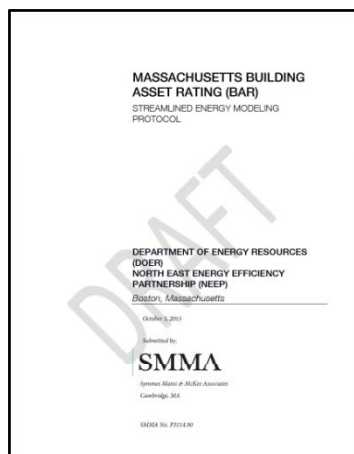
BAR Pilot Program: Asset Based Comparison

- **Compare** energy performance between office buildings independent of tenancy and weather
 - Provide whole building and end-use assessment numbers
 - BAR provides EUI comparison metrics for building owners
 - Asset score normalizes lighting schedules, plug loads, etc. to compare to other buildings



BAR Pilot Program Objectives

- **Develop protocols** for collecting building data, modeling and reporting for the final building level reports
- **Testing the efficacy** of streamlined audit tools
- **Document lessons learned** to accelerate development of market-ready solutions
- **Connect** buildings to utility incentives



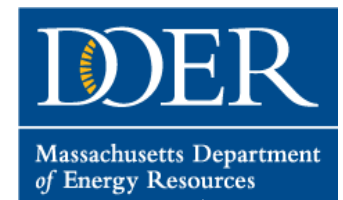
BAR Pilot Program Phase 1: Overview

- **11 buildings: ASHRAE Level 2 Audits + BAR analyses**
- Stress test across building types
 - Construction date: 1871 to 2010
 - Size: 32,000 to 1,025,000 sq ft
 - Height: 4 to 40 floors
 - Metering: Interval / monthly
- City Partners: Boston, Cambridge



BAR Pilot Program Phase 1: Findings

- Strong correlation between traditional [audit] and BAR analysis, while **new tools identified more opportunities**
- Analysis of building assets requires **clear, standardized guidelines** to generate consistent results
- **Site visits** validate modeling assumptions
- **Specialized areas** need particular attention (e.g. data centers, retail spaces)
- Building size and age alone do not appear correlated with energy consumption




BAR Pilot Program Phase 1: Findings

- Need for clear analysis and reporting protocols
Square footage.

Reported Sq Ft	768,054	580,000	602,000	793,168
Reported EUI	63	81	78	54
Common SF EUI	62	60	60	55

- **30+ office buildings**
 - varying size, type, age, location
- Streamlined Modeling & Reporting protocol
- Conducted Analysis
 - System-level analysis
 - ENERGY STAR Score
- Streamlined energy data-sharing
- Results: Fall 2014

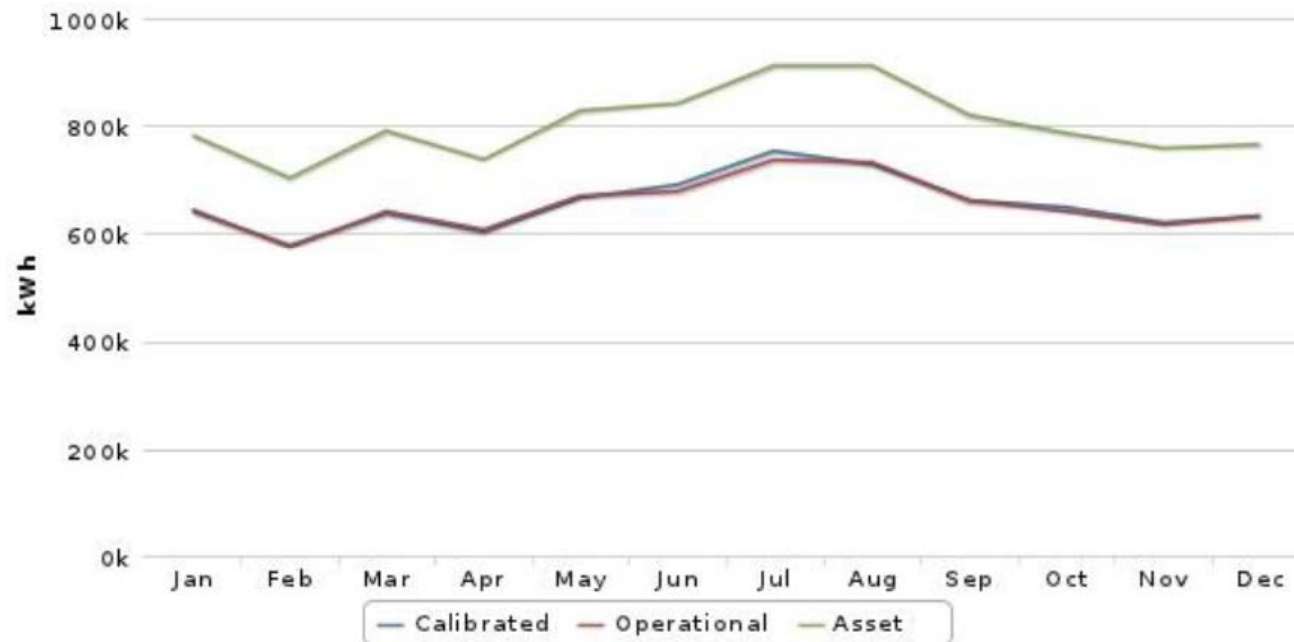


Massachusetts Department
of Energy Resources



BAR Pilot Program Phase 2: Approach

- **Calibrated** – Actual Modeled Energy Use
- **Operational** – Weather Normalized
- **Asset** – Occupancy Normalized

BAR Modeled Annual Energy Use By Fuel (Electricity)



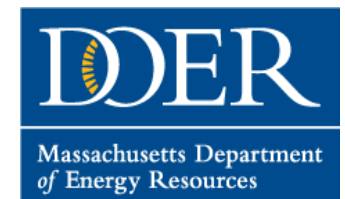
BAR Pilot Program Phase 2: Approach

EUI (kBTU/sf)		
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Operational	43	42
Asset	51	51

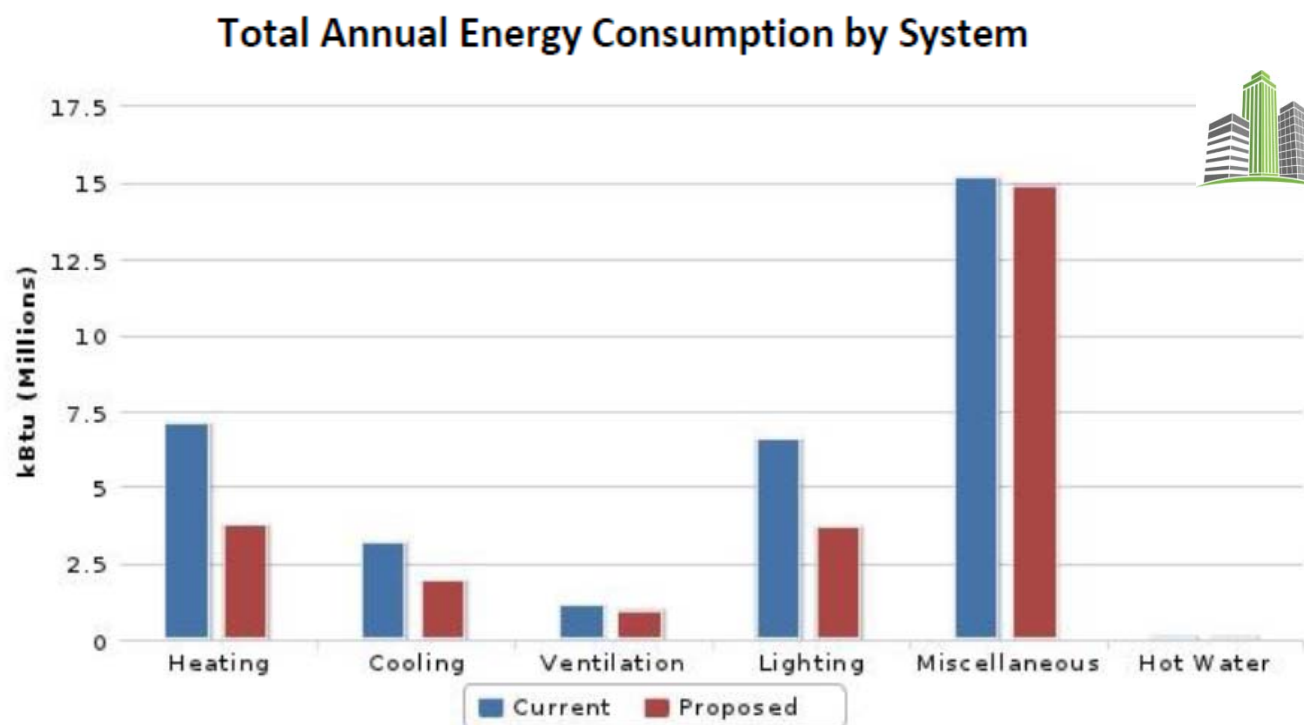
	Energy Star Score (0-100)	100	97
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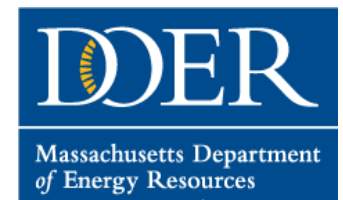
BAR Pilot Program Phase 2: Approach



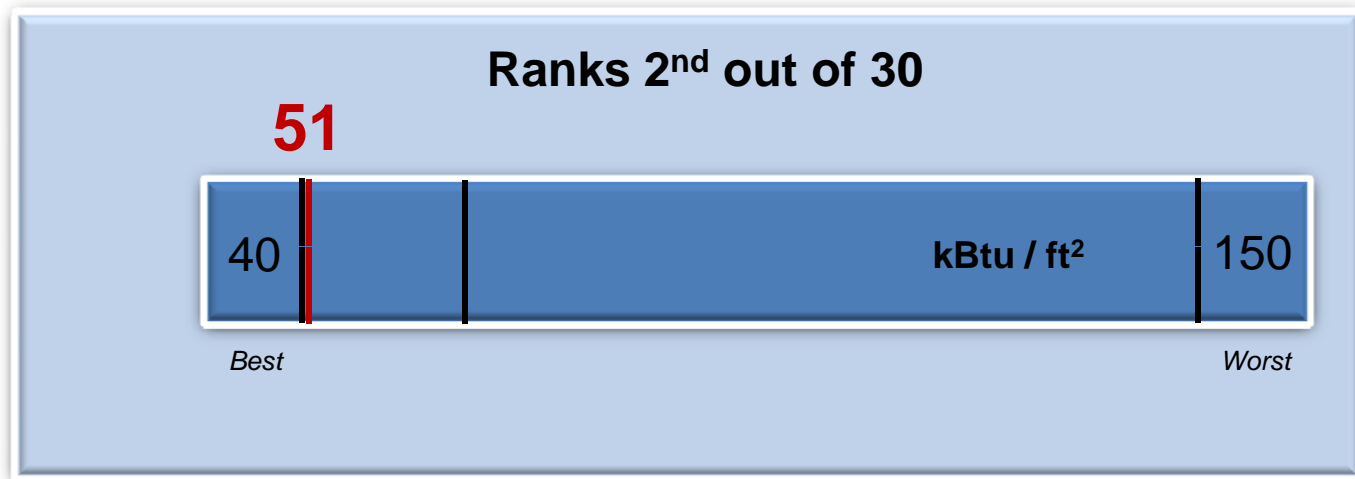
Cooling, heating, and lighting offer largest energy reduction potential

BAR Pilot Program Phase 2: Approach

- Each team provided a set of recommended Energy Conservation Measures (ECM) upgrades
- Utility representatives received reports and attended building meetings
- Commonly recommended ECMs:
 - LEDs (exit signs, stairwells)
 - Network lighting controls (incorporation into BAS)
 - Equipment upgrades, Cx
 - chiller plant optimization
 - VFDs



BAR Pilot Phase 2: Initial Findings



Common Modeling Challenges

- Special uses: data spaces, first floor retail, kitchens
- Aging mechanical systems / control deficiencies

Streamlined Energy Modeling Protocols

- Methodology and Normalization
 - Data Collection
 - Building Area
 - Parking lighting and HVAC
 - **Unique Spaces**
 - BAR Asset Defaults

TABLE 1 – BAR Energy Model Parameters Conceptual Framework

Input Parameters		Calibrated Model	Operational Model	Asset Model	
				Office Space	Unique Spaces: Data Centers Kitchens Pools
				[Converted Program Spaces and Unique Spaces are defined in Section 3.3.2]	
Schedules	Occupancy	Actual		BAR Default	
	Lighting	Actual		BAR Default	
	Plug Loads	Actual		BAR Default	BAR method 3.3.2
	HVAC Equipment	Actual		BAR Default	BAR method 3.3.2
	Service Hot Water	Actual		BAR Default	BAR method 3.3.2
Site Data	Building Orientation			Actual	
	Weather	Actual		TMY3	
Building Enclosure	Wall Assembly			Actual	
	Roof Assembly			Actual	
	Slab Assembly			Actual	
	Window Assembly			Actual	
	WWR			Actual	
	Infiltration			Actual	
Internal Loads	Occupancy	Actual		BAR Default	
	Lighting			Actual	
	Receptacle/Plug	Actual		BAR Default	BAR Method 3.3.2
	Service Hot Water	Actual		BAR Default	BAR Method 3.3.2
External Loads	Parking Lighting	Actual		BAR Default	
	Site Lighting (Building Façade, Building Grounds, Entrances, etc.; Not including parking)			Actual	
HVAC ²	Ventilation Air	Actual		BAR Default	BAR Method 3.3.2
	Heating			Actual	BAR Method 3.3.2
	Cooling			Actual	BAR Method 3.3.2
	Fans			Actual	BAR Method 3.3.2
	Pumps			Actual	BAR Method 3.3.2
	Heat Rejection			Actual	BAR Method 3.3.2
	Parking	Actual		BAR Default	

Key:	
Actual	Parameter(s) currently in place for the building
BAR Default	Default value(s) listed in Table 2, section 3.3.2
WWR	Window to Wall Ratio
TMY3	Weather data file, closest city location to the subject facility

² With the exception of ventilation air and parking, the subject facility's HVAC systems remain unchanged. However, the BAR energy models' outputs will vary due to model normalization.

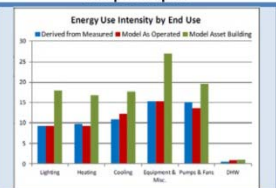
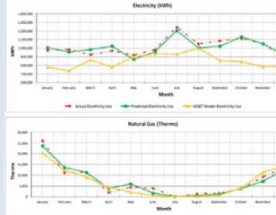
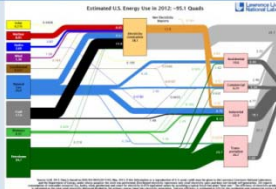
Streamlined Energy Reporting Protocols

➤ Reports Standards

- Format
- Graphics
- Consistency across teams

3 | BAR ANALYSIS REPORTING PROTOCOL GRAPHICS

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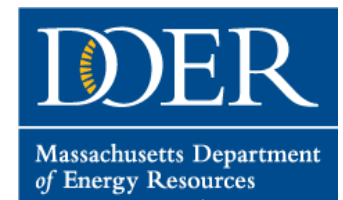
Graphic Number	Graphic Name	Type	Values	Other Content and Footnotes	Sample Graphic
3.	End Use Energy Performance	Suggested format: Bar Chart (Vertical)	EUI [kBtu/SF/yr] EUI for each end use as generated in Calibrated, Operational and Asset models	End use list per modeling protocol Comment on differences between 3 models in report narrative	
4.	Annual Energy Use Graph (By Fuel)	Line graph: time on x axis; fuel usage on y axis	One graph for each fuel kWh, therms, etc. One line for actual, calibrated, operational, asset	Include note that defines total energy used by fuel in study period Comment on peak and valleys; other notable trends	
5.	Fuel to End Use	Flow chart desired; information could also be presented in table format	EUI: kBtu/sf/yr	End use list per modeling protocol	

MASSACHUSETTS BAR – REPORTING PROTOCOL
DEPARTMENT OF ENERGY RESOURCES (DOER), BOSTON, MASSACHUSETTS

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BAR Methodology: Utility Data Collection



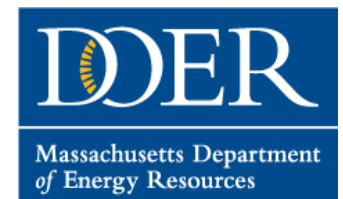
UTILITIES

DATA COLLECTION

ANALYST TEAMS



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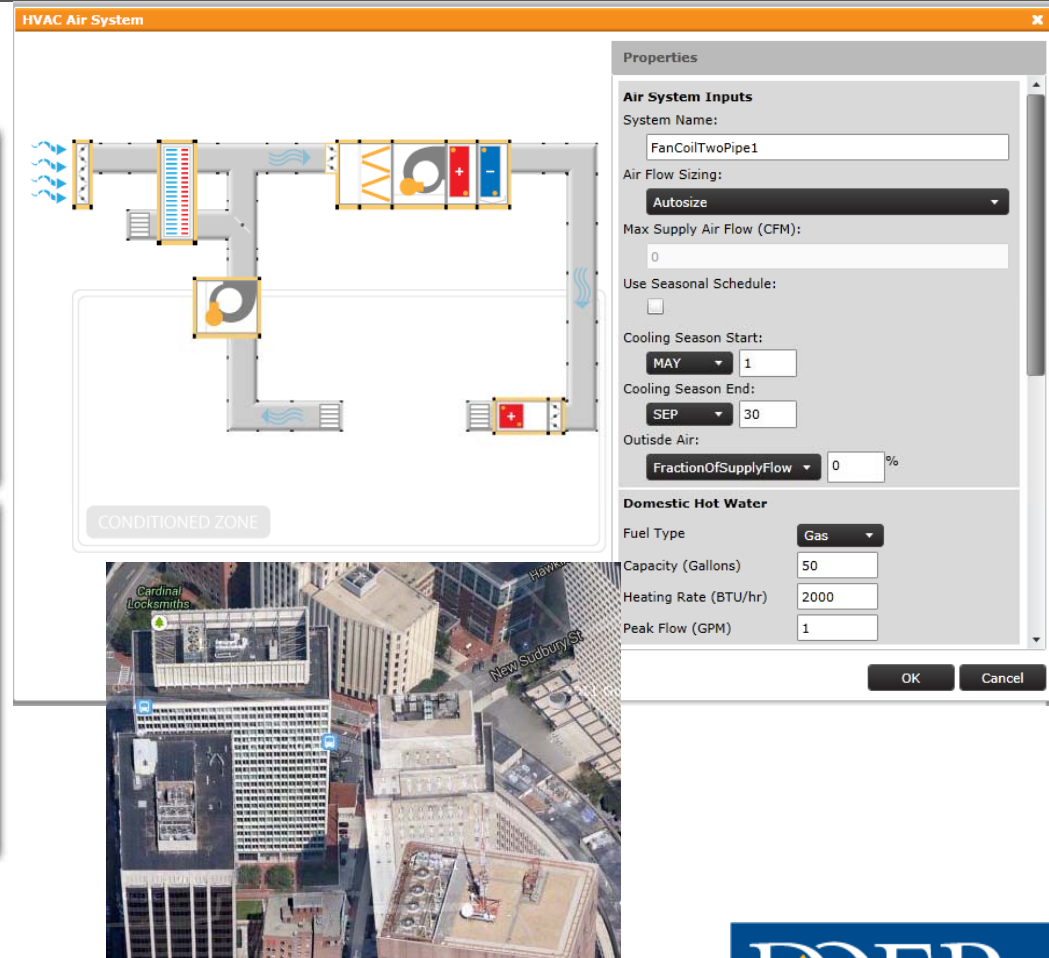
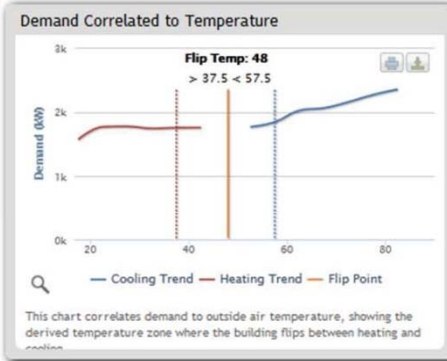
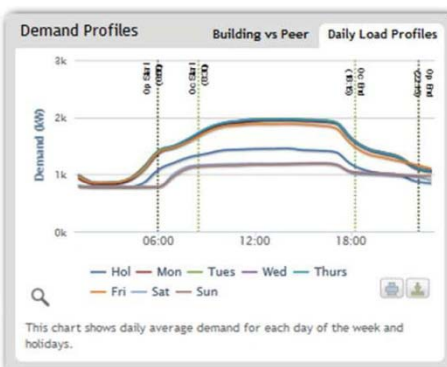
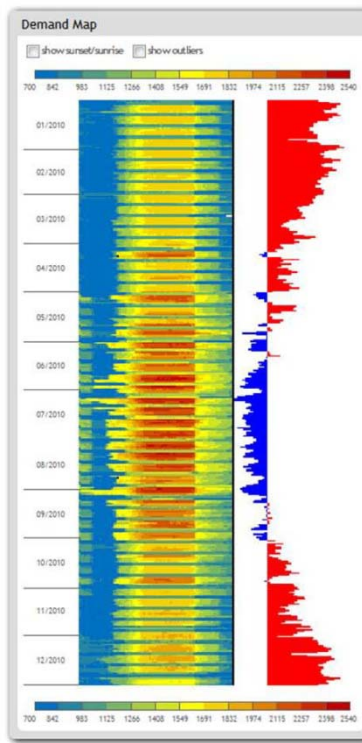
BAR Methodology: Building Data & Site Visit

Building data and site visit

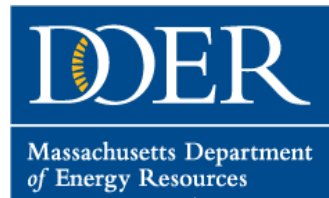
- Survey
- Pre-visit Meeting
- Site Visit



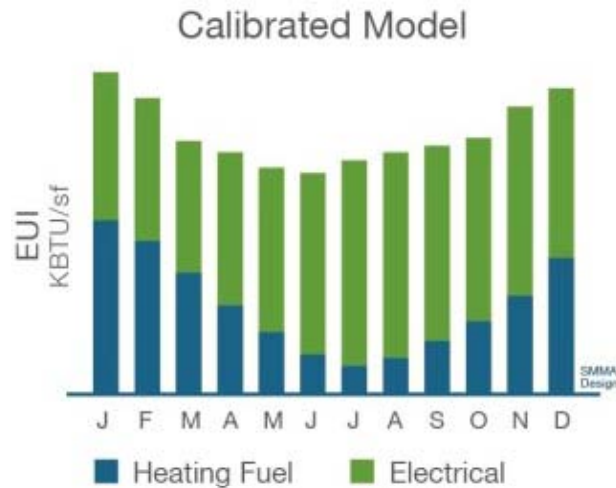
BAR Methodology: Analysis tools



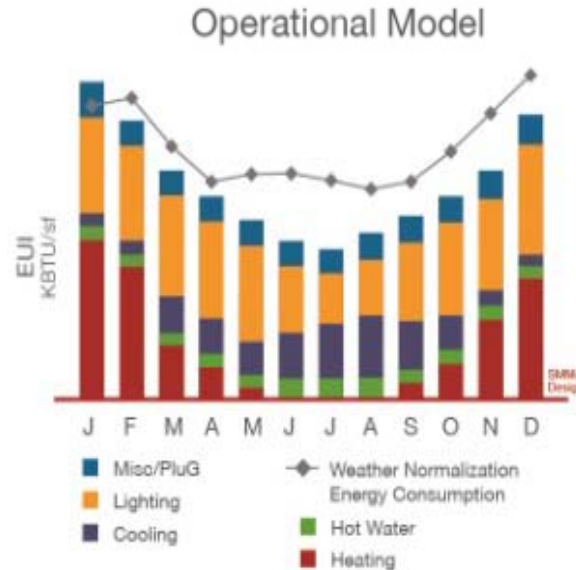
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BAR Methodology: Modeling Analysis



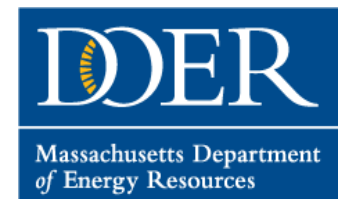
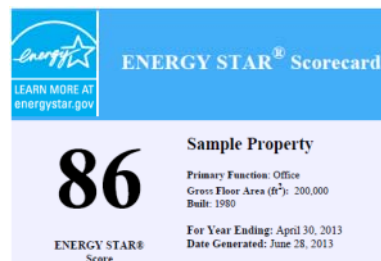
- Actual consumption
- Bill analysis



- Weather and Parking are normalized
- Compares to Portfolio Manager

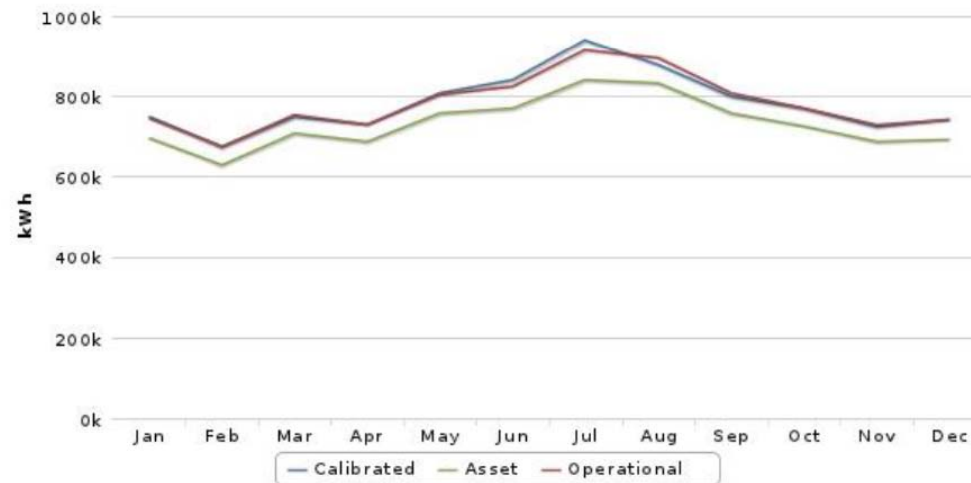


- Typical Occupant
- Operational Parameters are normalized
- DOE Asset rating tool

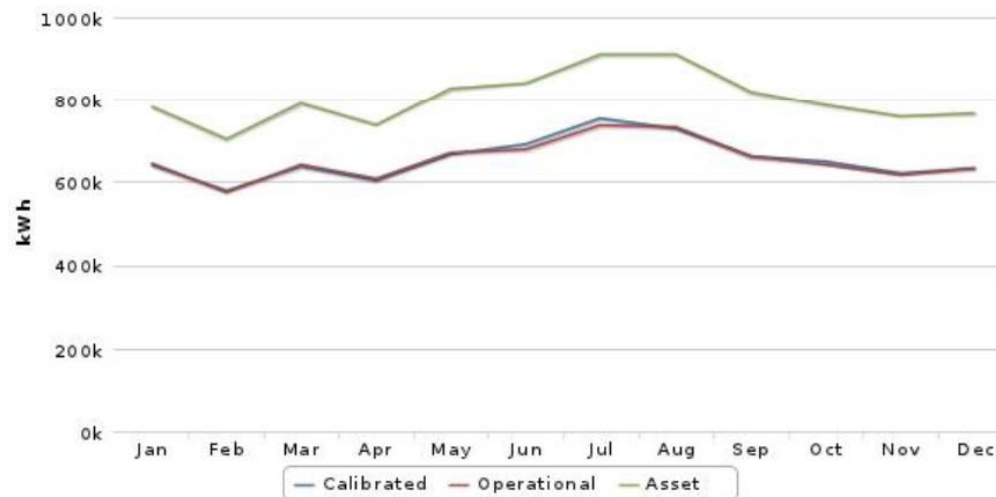


BAR Evaluation: Energy Use Analysis

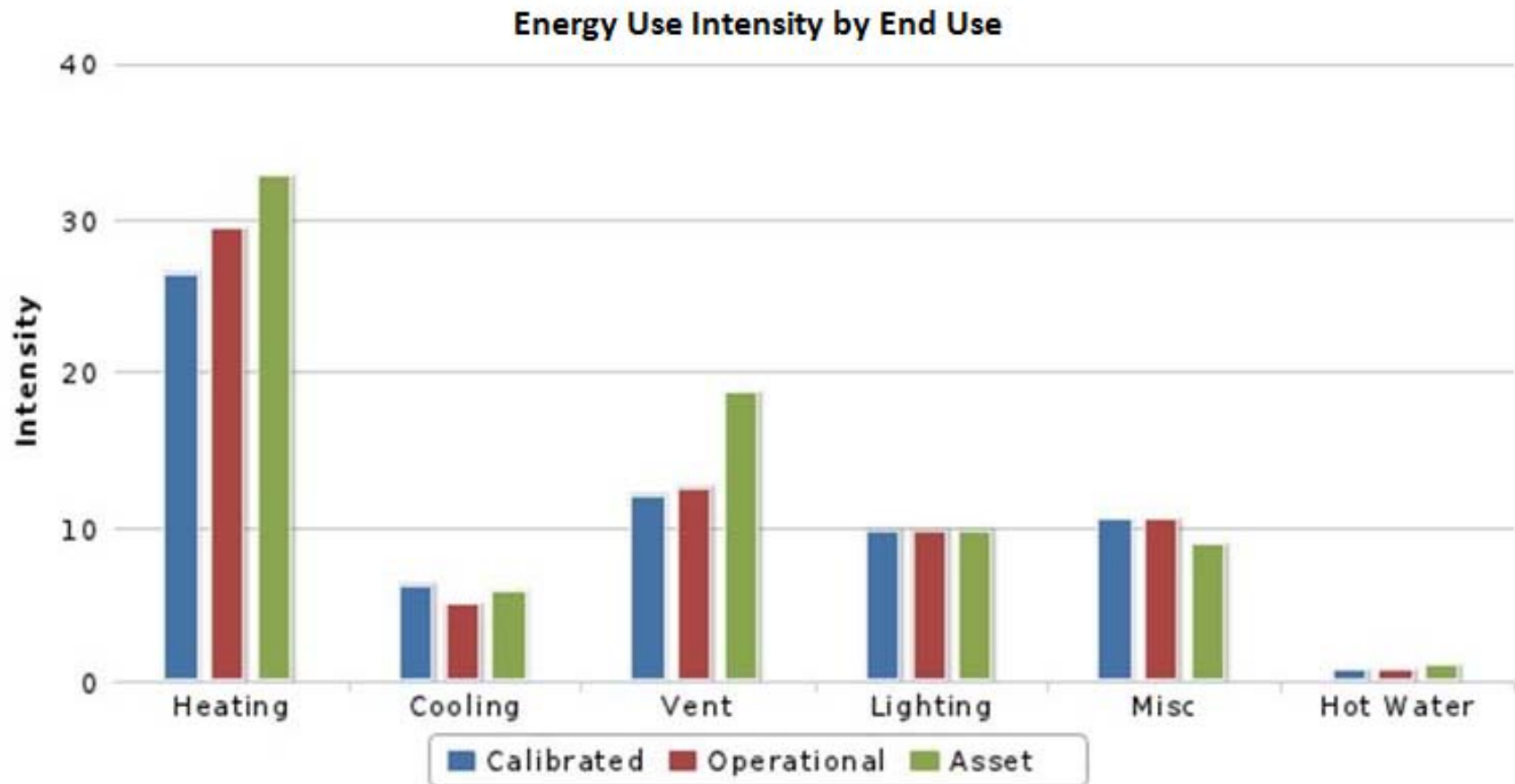
BAR Modeled Annual Energy Use By Fuel (Electricity)



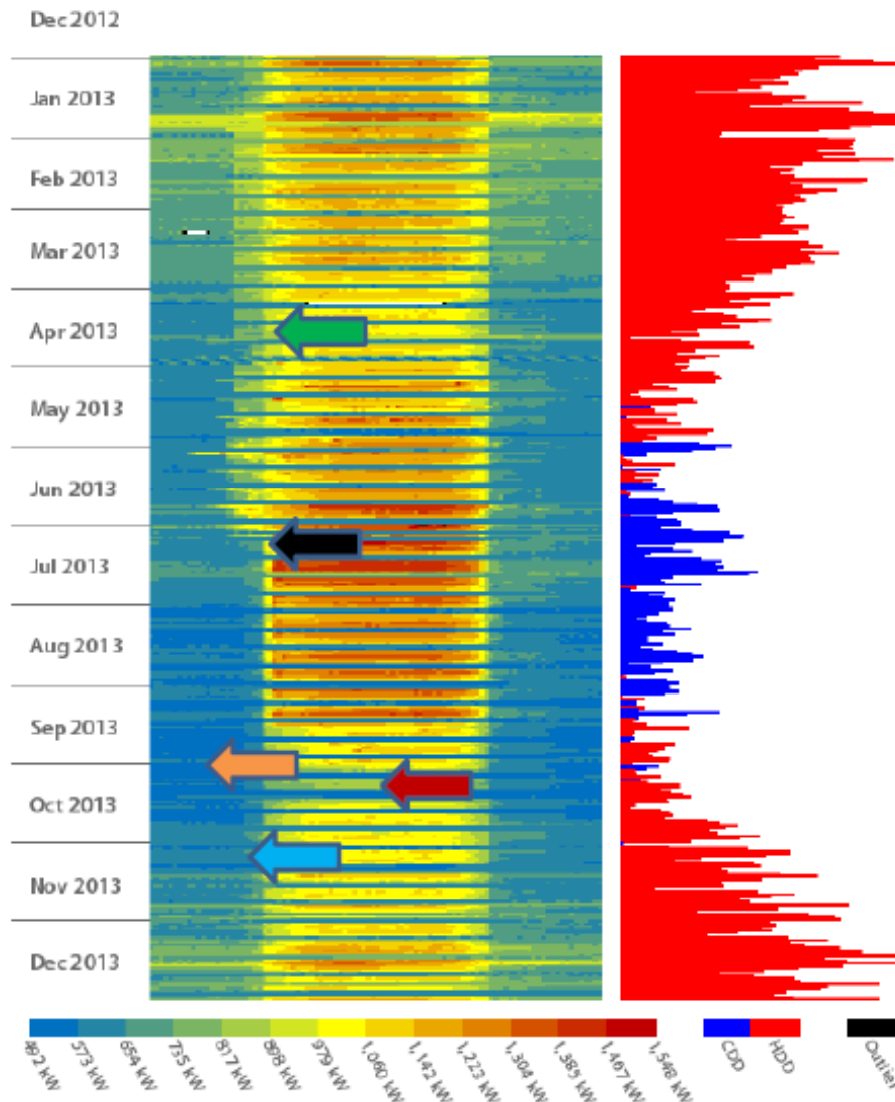
BAR Modeled Annual Energy Use By Fuel (Electricity)



BAR Evaluation: End Use Analysis



BAR Evaluation: Reports Observations



Operational changes made in July are noticeable



Operational or controls improvements in the shoulder seasons are noticeable



Most of the building lighting is not controlled by occupancy sensors



Early start up time can be revised





High pump-related energy during unoccupied hours should be investigated in the data areas



BAR Evaluation: Analysts' reports review

Legend		Model Data									Uniques Spaces				Fuel Use		Renos	WWR	Notes	kWh/sq. ft.	therms/sq. ft.			
<div></div> = +/-15% VARIANCE		Actual	Metered EUI	Modeled EUI - Calibrated	Modeled EUI - Operational	Modeled EUI - Asset	ESPM - EUI	ESPM - Score	DOE Asset Rater	Data Quality	Data Center	Cafeteria	Pool	Parking Garage	Retail	Electric (kWh)	Gas (Therms)	Steam						
Building 1 Sq. Ft. - 152,136 Waltham, MA Built: 2003	TWG		82	82	90	85.6	63	0								2,782,859	30,136		No	43%	18% WWR Variance	18.29	0.20	
	Retro	82	89	86	72	n/a	89	0	1							2,782,859	30,136		No	43%				
	% Gap		-9%	-5%	20%																			
Building 2 Sq. Ft. - 249,600 Woburn, MA Built: 2000	TWG		80	82	74	84	72	0								4,127,440	68,425		No	40%	Gym/Fitness Center	16.54	0.27	
	Retro	84	85	84	48	n/a	69	0	3							4,127,440	68,425		No	40%				
	% Gap		-7%	-2%	35%																			
Building 3 Sq. Ft. - 222,622 Andover, MA Built: 1960	TWG		143	146	145	none	none	0								8,850,592	0		Multiple	0.39		39.76	n/a	
	Retro	136	137	137	137	n/a	83	0	1							8,850,592	0		Multiple	0.39				
	% Gap		4%	6%	6%																			
Building 4 Sq. Ft. - 136,638 Andover, MA Built: 1984/85	TWG		0	0	0	62	71	0								2,489,911			Lighting and HVAC	0.3		18.22	n/a	
	Retro	62	62	62	42	n/a	75	0	3							2,489,911			Lighting and HVAC	0.3				
	% Gap		2%	6%	9%																			
Building 5 Sq. Ft. - 673,914 Boston, MA Built: 1965	TWG		68	67	58	70.9	67	0								14,992,650	29,658		2004	0.67		22.25	0.04	
	Retro	80	79	80	68	n/a	84	0	1							14,992,650	29,658		2004	0.67				
	% Gap		-25%	-19%	-16%																			
Building 6 Sq. Ft. - 40,883 Boston, MA Built: 1904	TWG		115	138	149	109	58	0								508,093	27,634		Multiple	0.2	21% WWR Variance TWG has a lower total SF (didn't include the retail spaces) - may impact the EUI gap between the 2 teams	12.43	0.68	
	Retro	110	111	122	100	n/a	50	0	1							508,093	27,634		Multiple	0.2				
	% Gap		3%	12%	33%																			
Building 7 Sq. Ft. - 175,436 Boston, MA Built: 1902	TWG		76	80	75	79	72	0								2,872,505	35,012		1999	36%		16.37	0.20	
	Retro	76	77	82	66	n/a	77	52	1							2,872,505	35,012		1999	36%				
	% Gap		-1%	-2%	12%																			
Building 8 Sq. Ft. - 224,426 Boston, MA Built: 1911	TWG		53	53	59	51.5	87	0								3,243,034	5,567		Multiple	35%	Questionable source data may affect EUIs - outlier/flag	14.45	0.02	
	Retro	52	51	51	48	n/a	84	45	1							3,243,034	5,567		Multiple	35%				
	% Gap		3%	4%	18%																			

BAR Evaluation: Analysis Review– Building 28

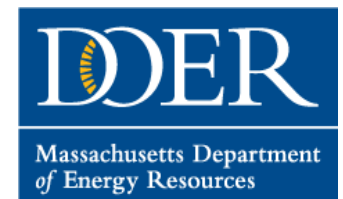
kBtu / ft ²		
Calibrated	84	88
Operational	99	112
Asset	94	140



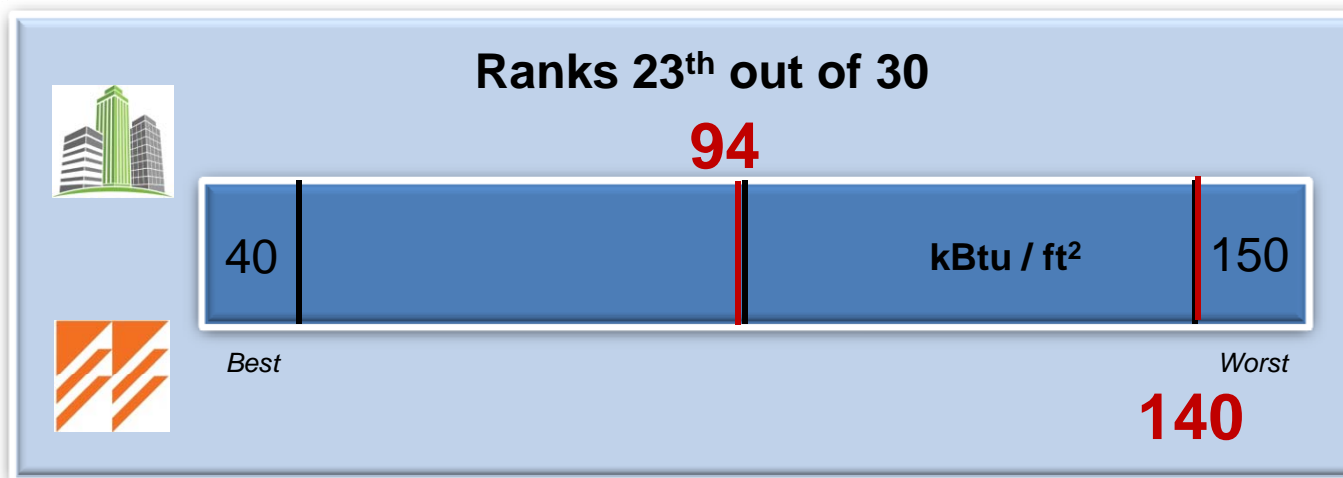
Energy Star Score (0-100)	82	88
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BAR Evaluation: Analysis Review – Building 28



Modeling Challenges

- Joined buildings & varying envelopes
- HVAC systems calibration

BAR Evaluation: Analysis – Building 9

kBtu / ft ²		
Calibrated	154	149
Operational	150	155
Asset	130	154

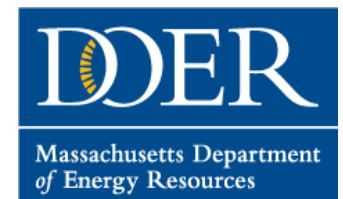


Energy Star
Score
(0-100)

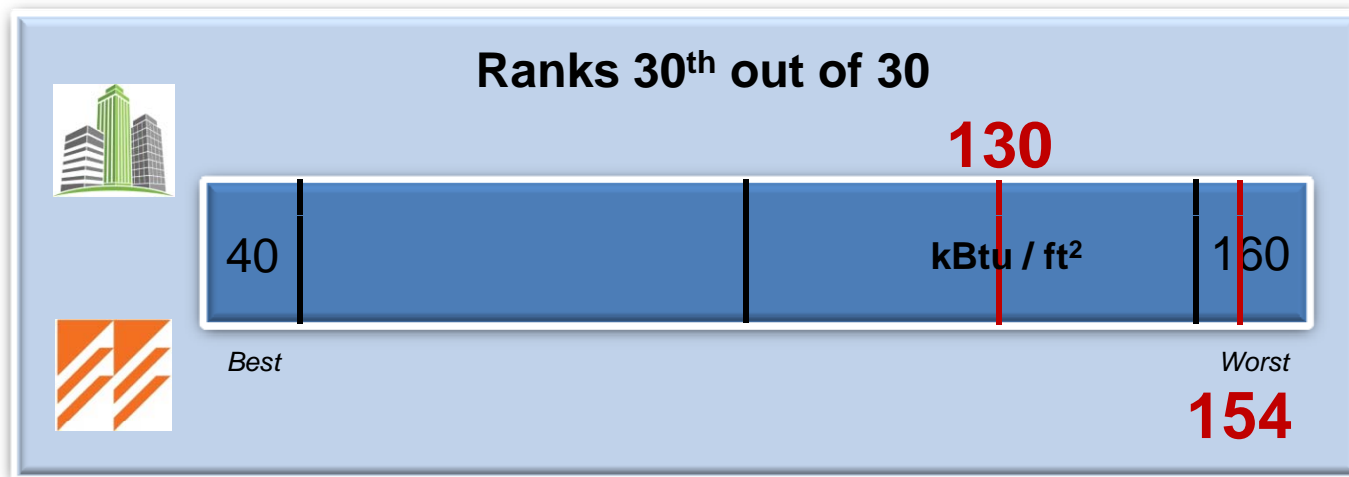
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BAR Evaluation: Analysis – Building 9



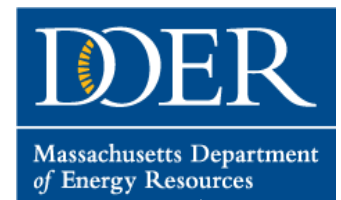
Modeling Challenges

- Data center & kitchen

BAR Evaluation: Findings and Recommendations

➤ Protocols Enhancements

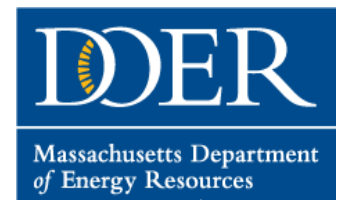
- Impacts of low performing systems
- Meter data quality
- Modeling input methodology and unique spaces
- Renewable energy use
- Site visits
- Study Period



BAR Evaluation: Findings and Recommendations

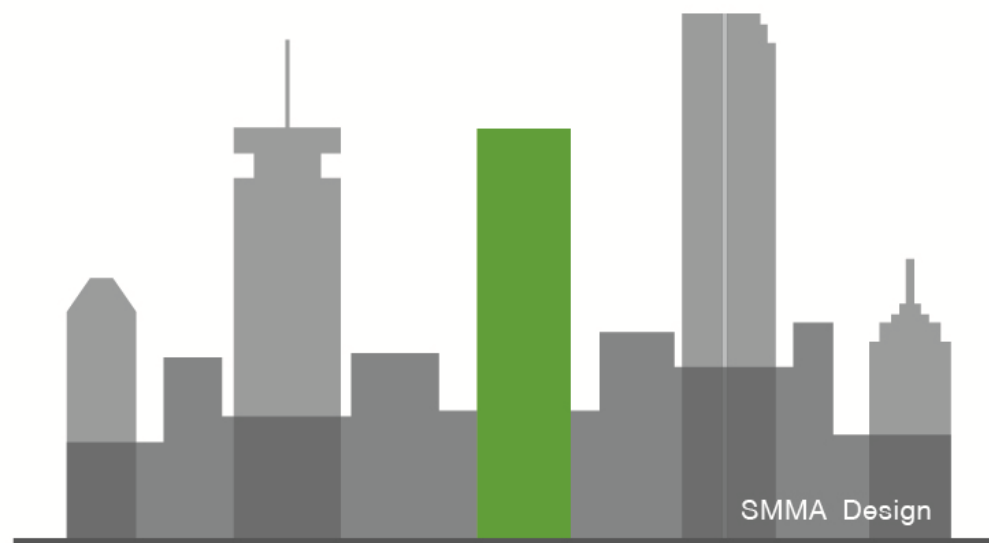
➤ Analysts teams Approach

- Modeling tools
 - Input interpretation
 - Output and automated reports
- Analysts team experience and methods (individual & combined)
 - LPD calculation
 - Recommended ECMs
 - Reported schedule
 - Reported end use granular data (owner friendly)



BAR Pilot Program: Next Steps & Phase 3

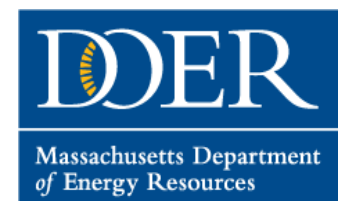
Asset Model



Site EUI



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BAR Pilot Program: Phase 2 Closeout

- **On-site report presentation meetings** with building/facilities team and energy efficiency investment decision-maker
- Include **Utility energy efficiency program staff**
 - 19/31 willing to share reports with PAs
- Follow-up **survey** to learn of participant experience and reaction to asset rating reports



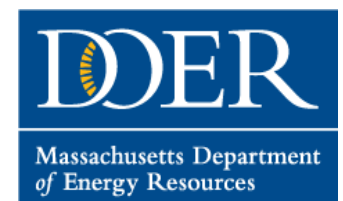
BAR Pilot Program: Phase 2 & 3 Final Reports

- Peregrine Energy - **Utility energy meter data**
 - Best practices on meter data collection
- SMMA – **Evaluation report of Phase 2 teams**
 - 2 Protocols: Modeling and Reporting
 - Evaluation of Phase 2 results
- DOER & NEEP – **Final Report**
 - Phase II Results and findings
 - Best practices



BAR Pilot Program: Phase 3 - Massachusetts & Beyond

- Inform national conversation around asset rating design standards
 - Industry and market drivers
- Protocols for audit and reporting



BAR and US DOE Asset Rater Pilot

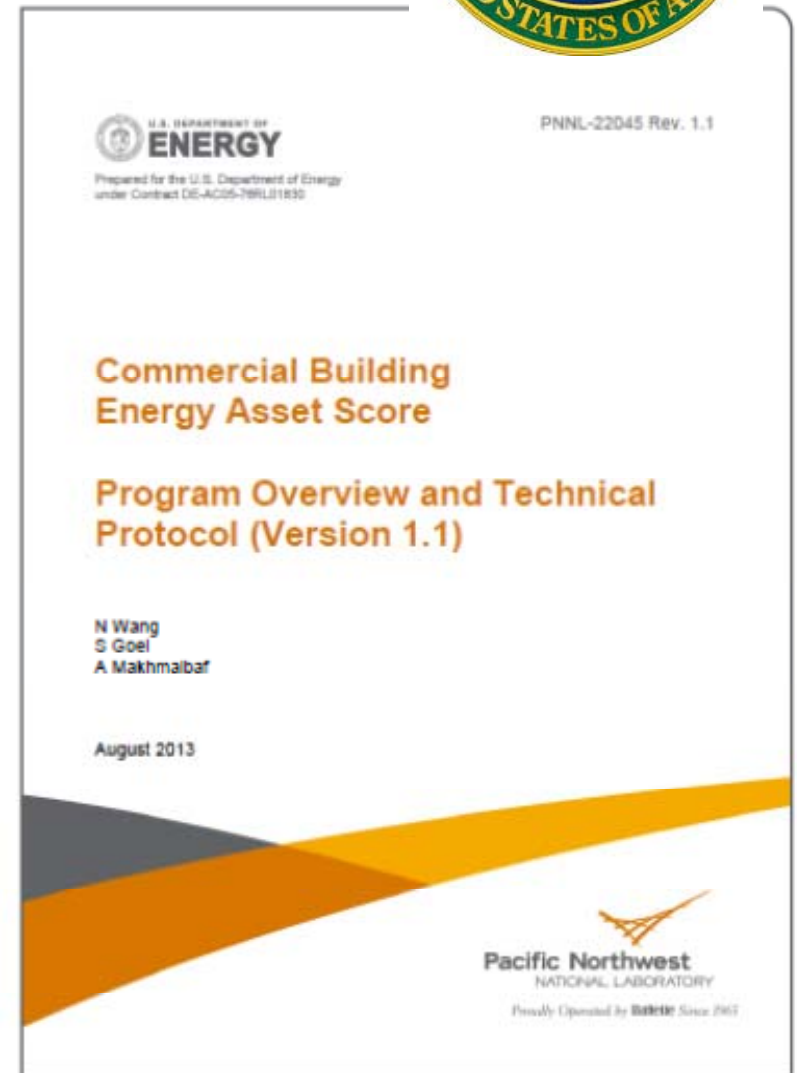


Ongoing Collaboration

- 10 buildings in DOE Asset Rater phase 1
- 20 buildings in DOE Asset Rater phase 2
- Sharing findings and building analysis

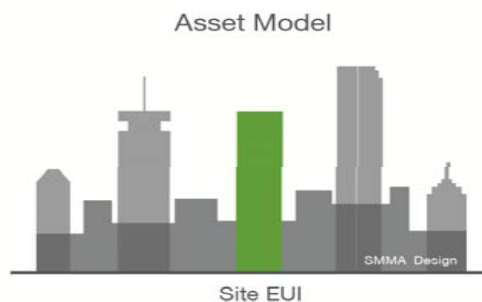


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BAR Pilot Program & Other States

- Massachusetts – Office BAR pilot
- California – Building Energy Asset Rating System (BEARS)
- New York – Multi-Family Asset Rating



BAR & Building Disclosure Ordinances

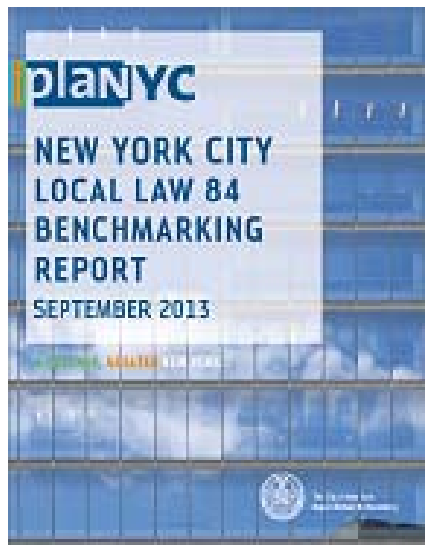
San Francisco Existing Commercial Building Energy Ordinance



	Energy Benchmarking	Audit/Retrocommissioning
Applies to	Non-residential buildings with $\geq 10,000$ square feet of conditioned space	
Requires	All energy used by the building, and basic descriptive characteristics. May be performed in-house.	Assessment by a qualified professional identifying cost-effective opportunities to save energy.
Tool	ENERGY STAR Portfolio Manager	ASHRAE Procedures for ...Audits "Level 2" for $\geq 50k$ sq ft "Level 1" for $< 50k$ sq ft (Alternative: retrocommissioning)
Frequency	Annually, starting:	
	<div>>50k sqft 2011</div> <div>25k-50k sqft 2012</div> <div>10k-25k sqft 2013</div>	After binning into groups by size, due dates within a 3 year period were randomly assigned
Exemptions	New or vacant buildings, (Administrative: Whole building transaction or change of separately metered tenant in prior calendar year)	New or vacant buildings, financial distress, or excellence (LEED EB certification, or ENERGY STAR certified 3 of prior 5 years)



Building Energy Disclosure and Reporting Ordinance



SMMA



BAR Pilot Phase 3 - Market opportunity in MA

➤ BERDO (Boston)

- Requirement for highest 25% energy users to have ASHRAE Level II or equivalent audit within 5 years.

➤ BEUDO (Cambridge)

- No Requirement as yet, but voluntary market need to improve building Energy Star Portfolio Manager score

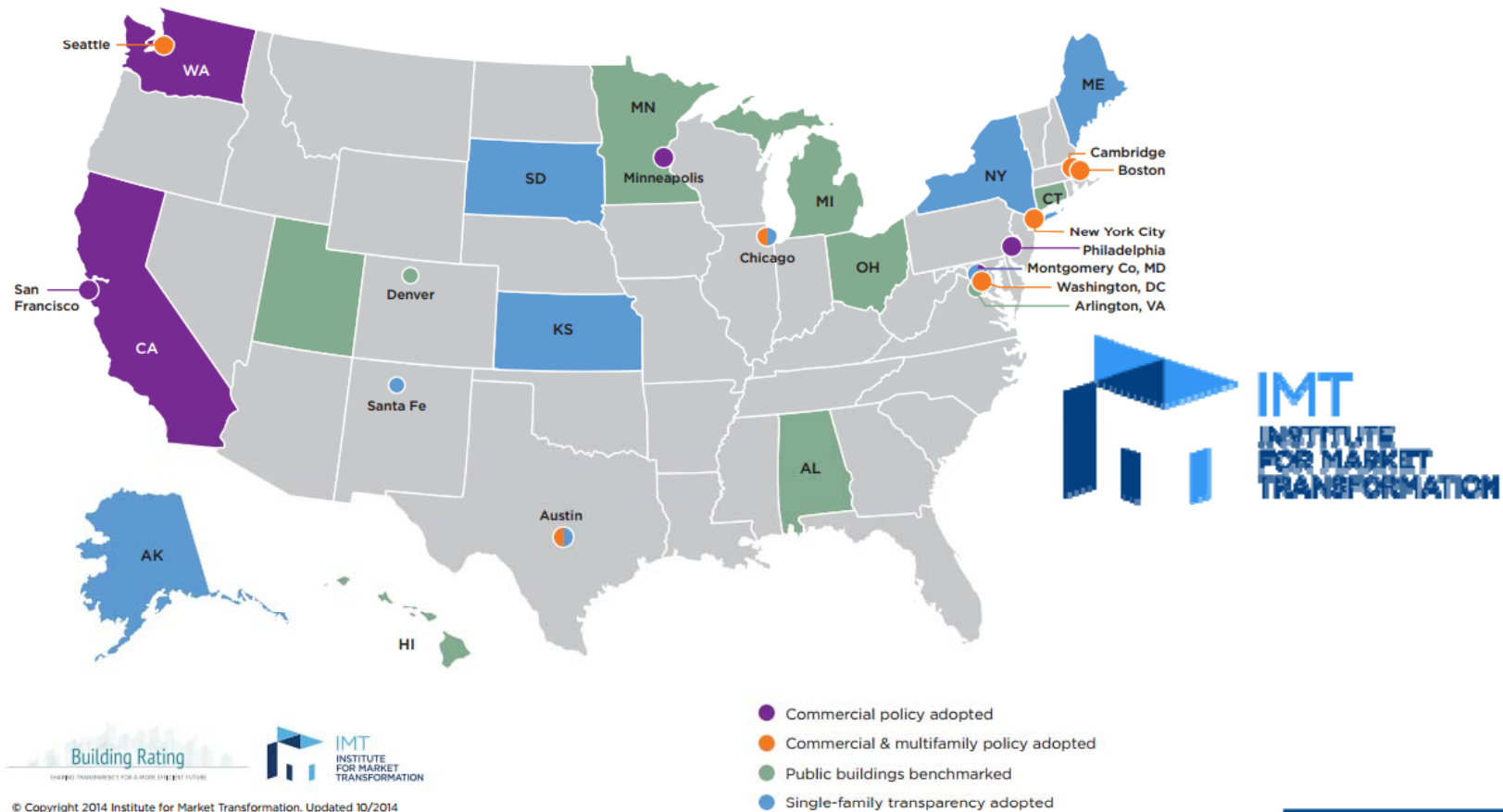


Building Energy
Disclosure and
Reporting Ordinance



Energy Star Disclosure - US Market is Growing

U.S. Building Benchmarking and Transparency Policies

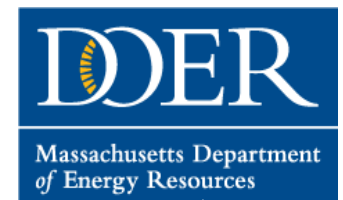


Building Rating
SHAPING TRANSPARENCY FOR A MORE EFFICIENT FUTURE

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BAR Pilot Program

Thank you!

