Creating A Cleaner Energy Future For the Commonwealth

Raising the BAR: Building Asset Rating in Massachusetts

January 29, 2013

Northeast Energy Efficiency Partnerships
&
Massachusetts Department of Energy Resources

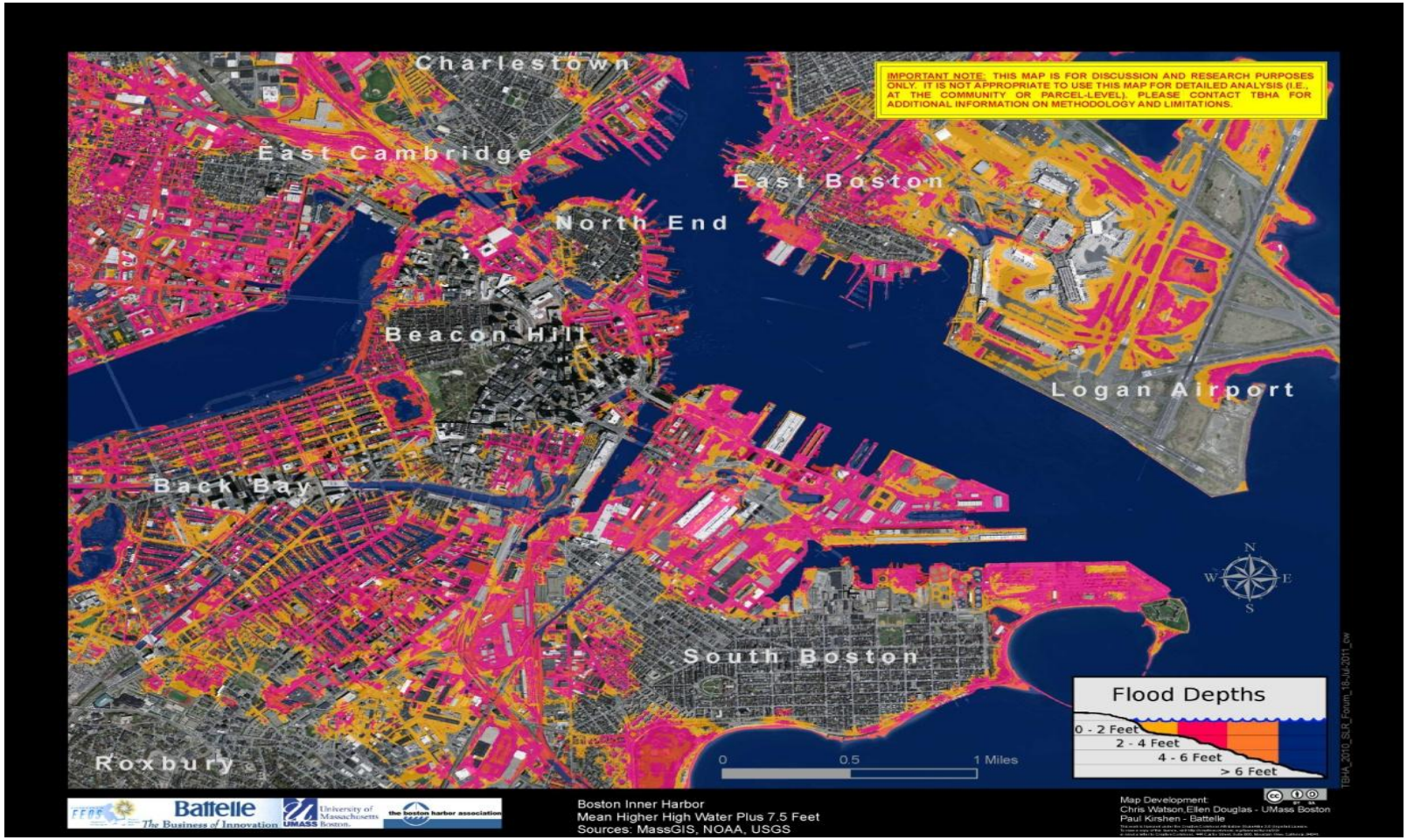
TODAY'S WEBINAR

- Background motivation for MA pilot
- Building Energy Rating Overview
- Phase I - Innovative Methods
- Phase I – Lessons learned
- Phase I – Findings
- Phase II – Scope and Goals

WHY RAISE THE BAR?

- MA Global Warming Solutions Act
  - 25% GHG reduction by 2020
  - 80% GHG reduction by 2050
- 2020 Clean Energy & Climate Plan

OTHER THINGS ARE RISING!



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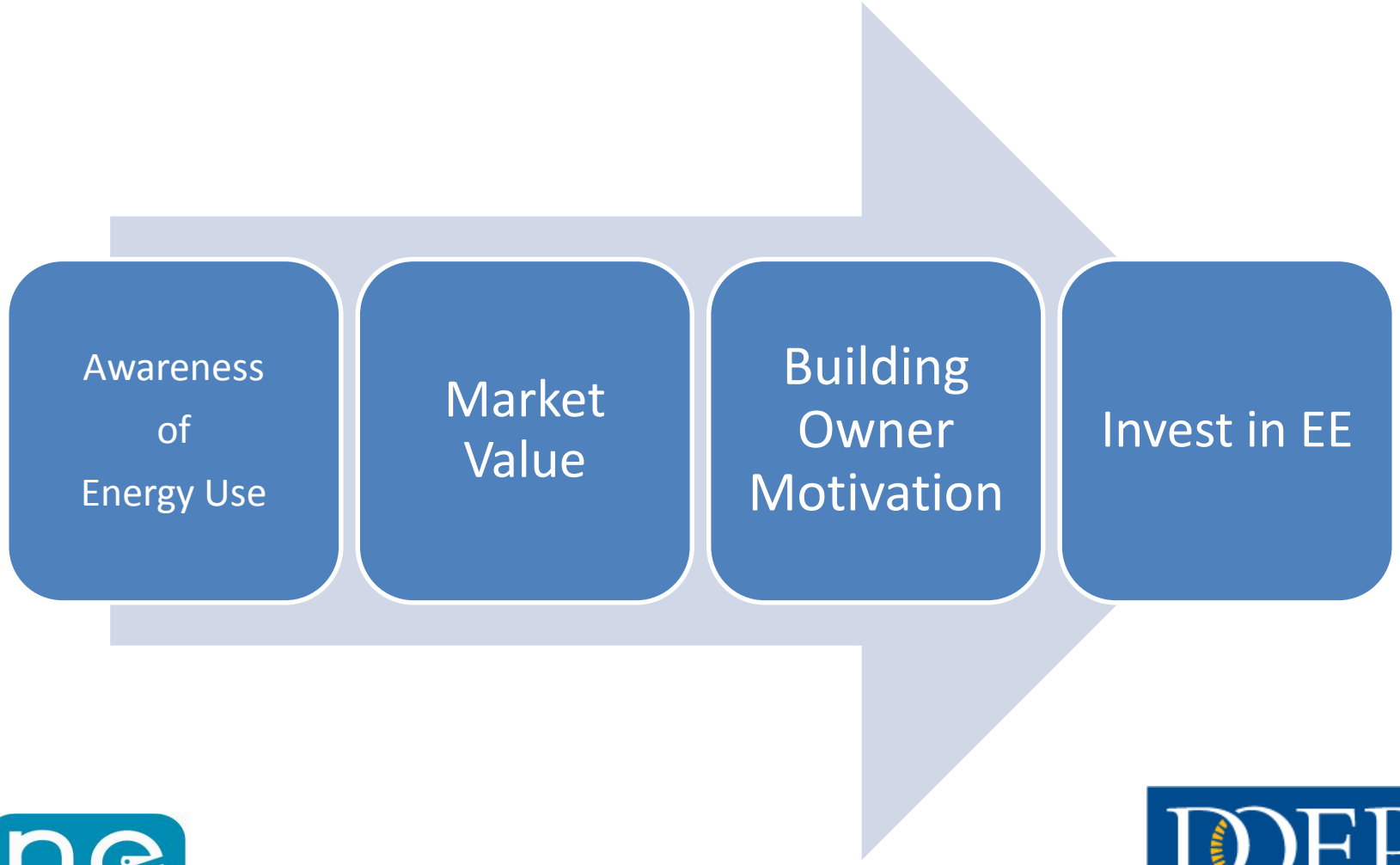
OPPORTUNITY

- Have to invest in upgrading our buildings
  - Owners/investors lack information on efficiency opportunities
  - Cost of comprehensive audits is ‘too high’
  - Custom audits currently not scalable

PATHWAY TO EE INVESTMENTS



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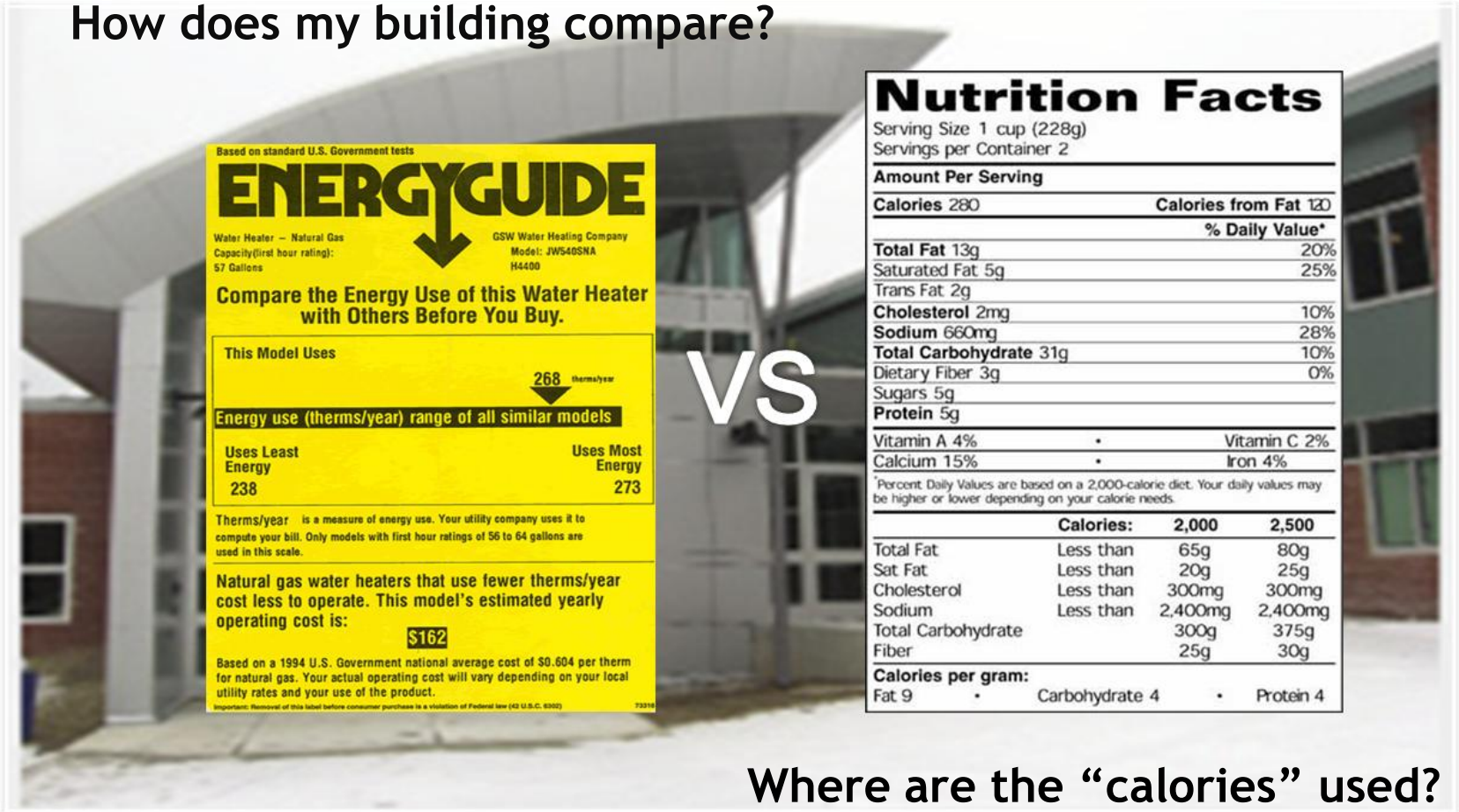
VALUE OF ASSET RATINGS

How does my building compare?



Where are the "calories" used?

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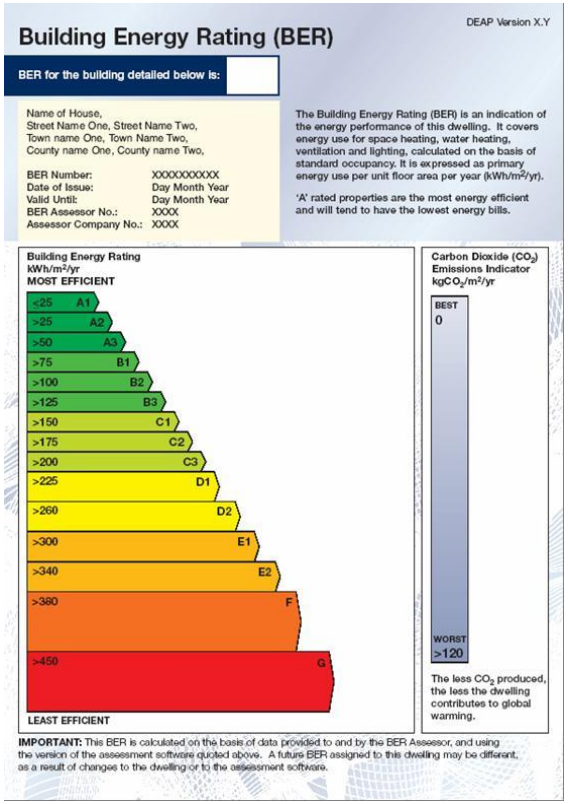
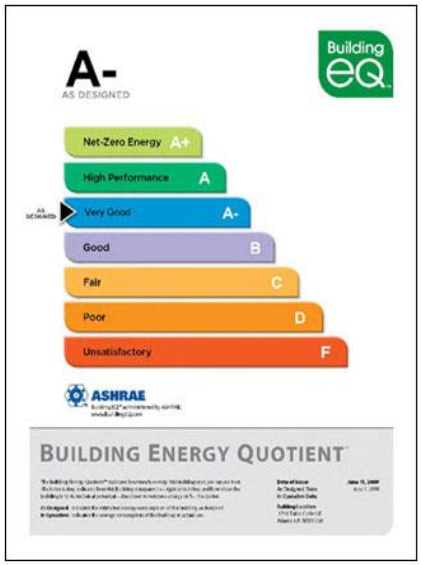
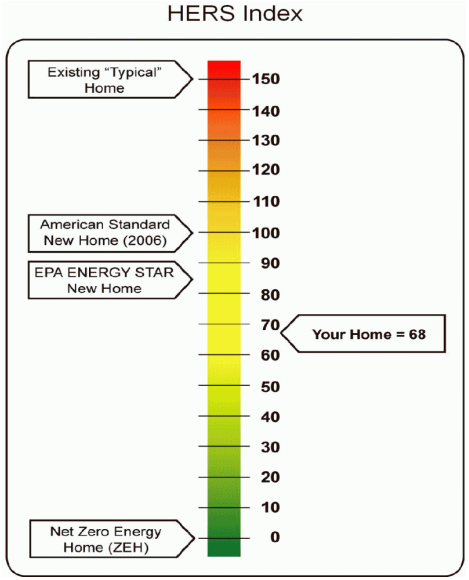
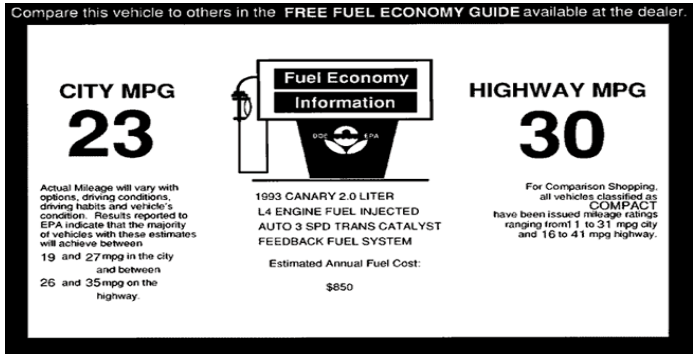
LABELS MATTER TOO
.....but not our focus









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FOCUS OF MA BAR PILOT

- **Existing buildings**
  - Vast majority of building stock
  - Have usage data to calibrate
  - Major energy efficiency retrofit opportunities
- **Commercial office use type**
  - Significant % of C&I buildings
  - Competitive market for tenants
- Building on LEED and ENERGY STAR rating
- **Building Energy Rating coming soon to ???**

CAN WE IMPROVE BUILDING ANALYSIS?

BAR Pilot tests new methods:

1. Streamlined modeling tools
2. Prioritization of key data inputs requires less reliance on building plans & schedules
3. Use new data sources: satellite imagery; interval meter analysis
4. Modeling inferences based on previous building analysis

RAISING THE BAR: GOAL

- **Goal:** *Identify cost-effective, scalable methods to assess "as-built" buildings and systems*
  - Compare energy use intensity between buildings, independent of tenancy
  - Enable market valuation
- Scope: Commercial office buildings
- Two phases
  - Phase 1: Testing innovation (2011-2012)
  - Phase 2: Scale Demonstration (2012-2013)

BAR PILOT – PHASE 1

- 11 office buildings modeled by 4 teams
- Stress test across building types
  - Construction: 1871 to 2010
  - Size: 32,000 to 1,025,000 sq ft
- Funding:
  - Barr Foundation
  - ARRA
  - US DOE SEP competitive award
- National Partners: US DOE, PNNL, CA CEC
- Local Partners: Boston & Cambridge

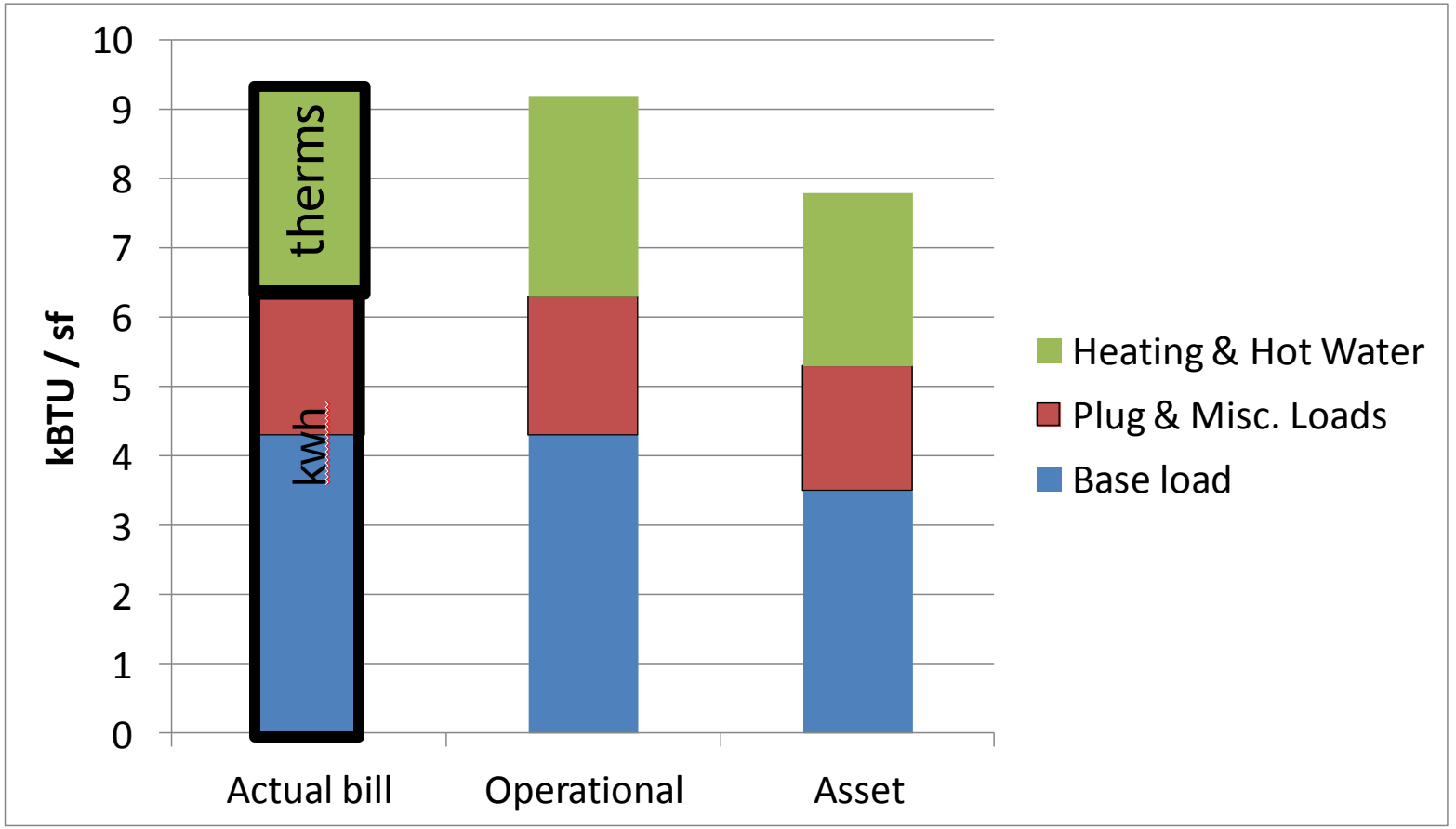
METHODOLOGY
- Ian Finlayson

MA BAR METHODOLOGY

3 step energy modeling process:

- Data collection: energy use data, building drawings, site visit, etc.
- Calibrate energy model: develop energy model calibrated to prior year usage data
- Generate asset model: normalize calibrated model parameters to neutralize impact of tenant operations

ADJUSTING FOR 'NORMAL' TENANTS



NORMALIZATION:
operational > asset

Operational Model	Asset Model
Heating: Boiler X	Heating: Boiler X
Cooling: Chiller Y	Cooling: Chiller Y
Lighting: 100% T8s	Lighting: 100% T8s
Occupant Density: 300 sf / person	Occupant Density: typical
Occupancy Schedule: 8 am – 7 pm	Occupancy Schedule: typical
Plug Loads: 0.8 w / sf	Plug Loads: typical

OPERATIONAL TO ASSET:
End Use Changes

Operational factors

- Long hours
- Process loads
- Data centers
- Operational inefficiencies (long start-up time)

Asset normalization

- Lighting down (schedule)
- Plug load up
- Process load removed
- Occupancy up
- Heating up
- Cooling down

TRADITIONAL APPROACH - PHASE 1

- ASHRAE level II Audit - *lite*
- Typically 1 day site visit
- Developed e-Quest or Trane Trace energy models
- Calibrated models generate Operational EUIs
- Substitute reference loads for Asset Rating EUIs
- Cost range $15k - $30k per building

ARUP

The Green Engineer, Inc.
Sustainable Design Consulting

ALTERNATE METHODOLOGIES

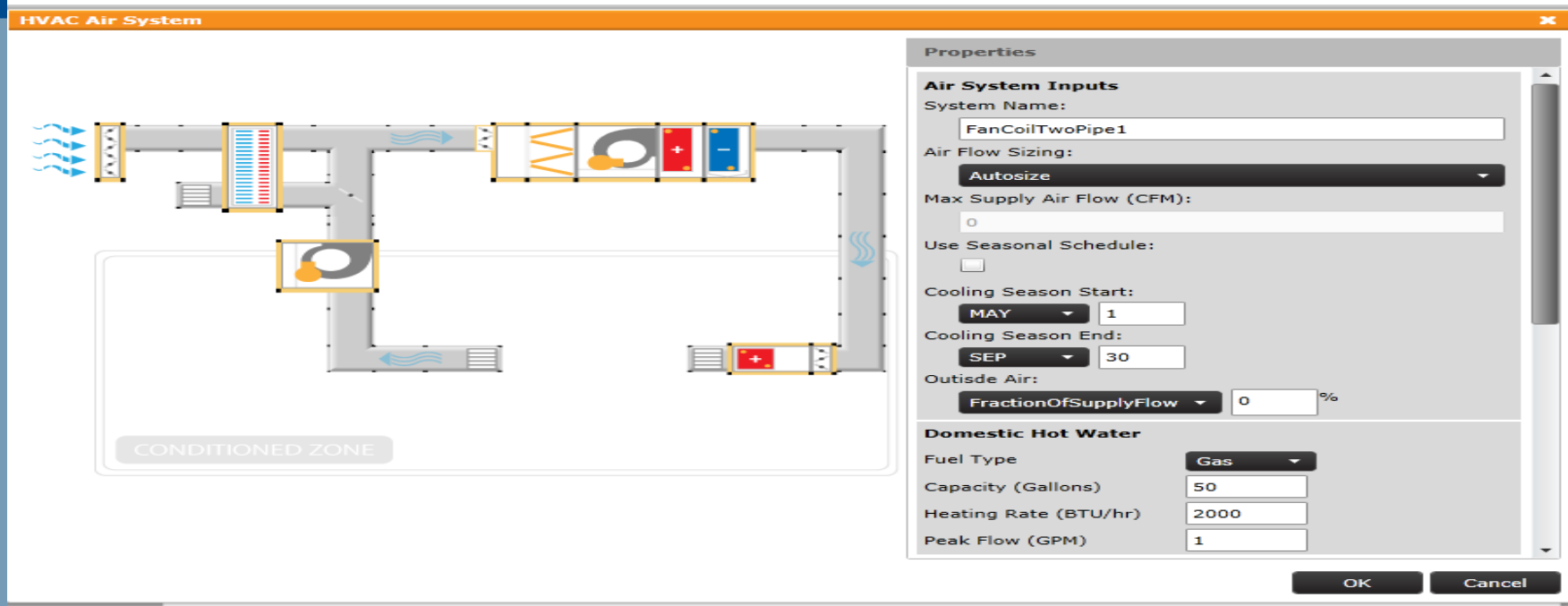
1. Streamlined building energy model
2. Streamlined building energy model + time-of-use meter analysis
3. Operational focused rating using time-of-use meter analysis

US DOE / PNNL Asset Rating Pilot:

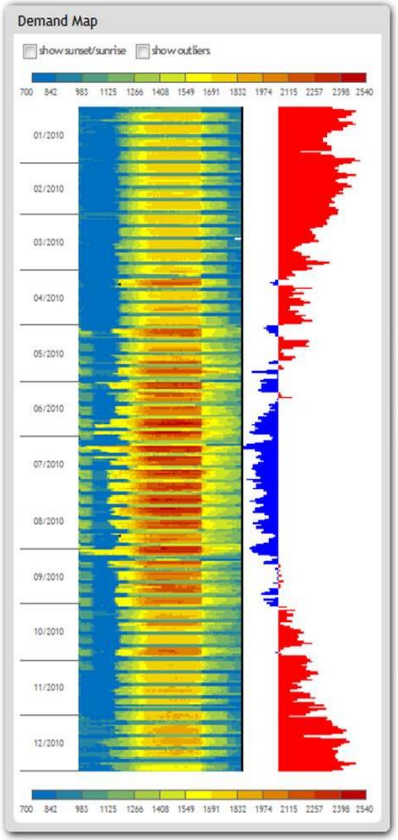
4. Streamlined building energy model with minimal calibration

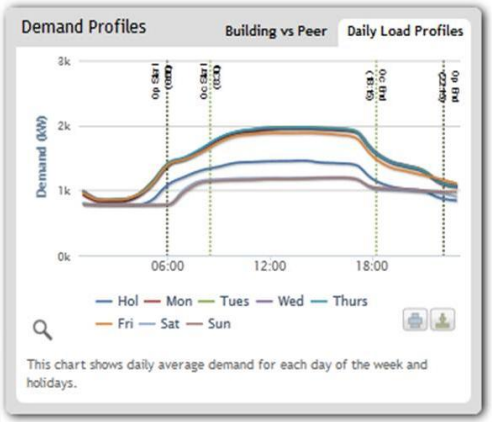
1. STREAMLINED BUILDING ENERGY MODEL

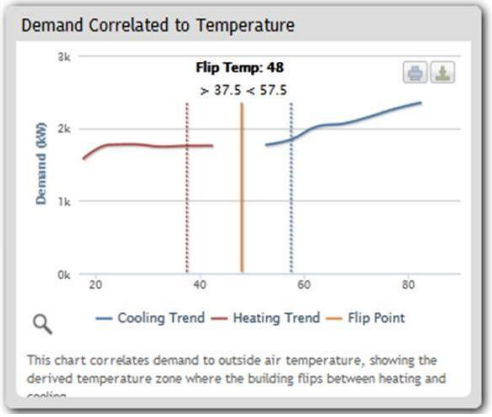
- Inputs – same set of visit data, building documentation and energy billing data as for ‘traditional approach’
- Streamlined energy model coupled with the team’s existing database of buildings
- PRISM approach to calibrating using all fuels



2. STREAMLINED BUILDING ENERGY MODEL +TIME-OF-USE ANALYSIS



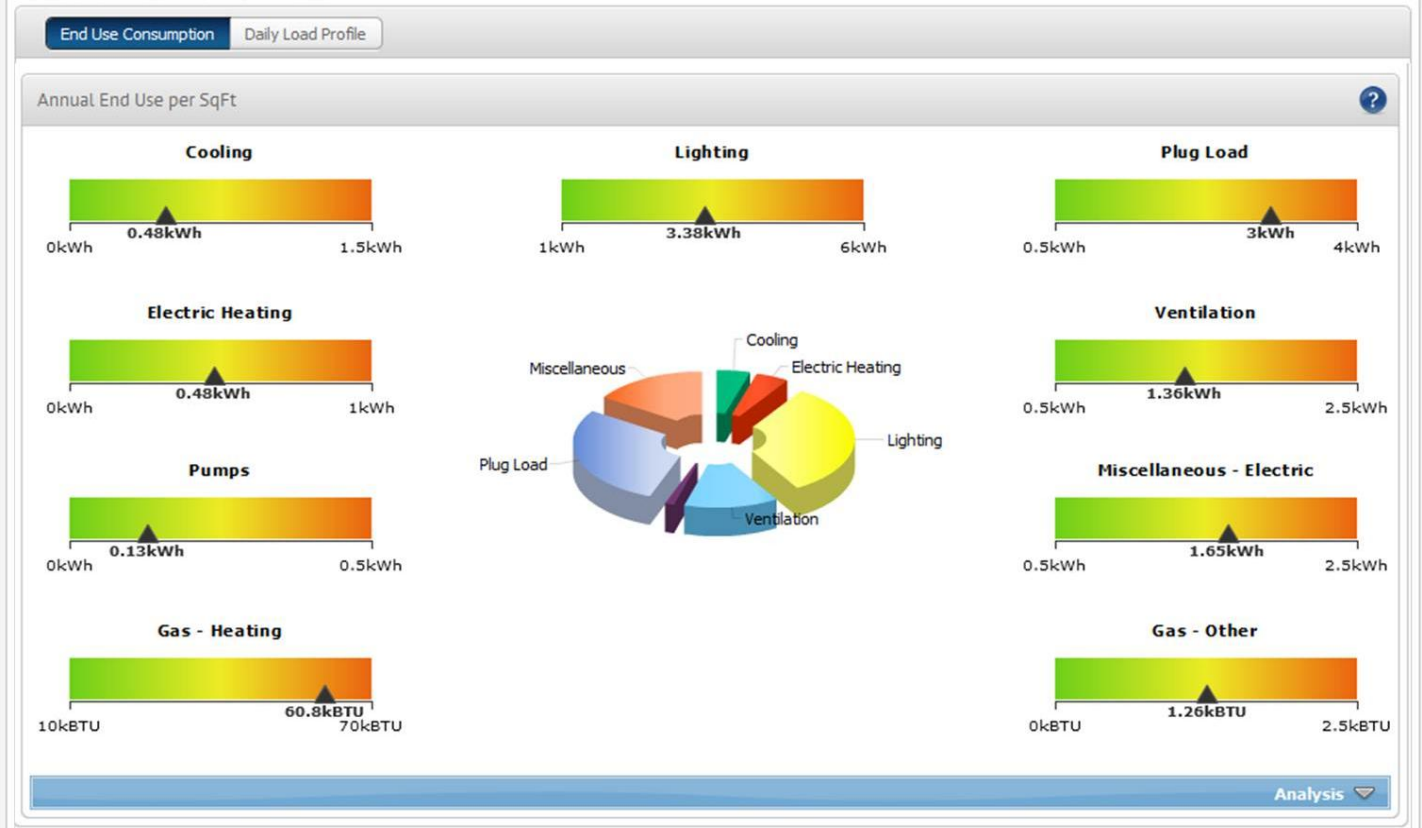




- Streamlined energy model coupled with the team's existing data base of buildings
- Analysis of electric interval meter data
- Additional use of online data

3.OPERATIONAL FOCUSED RATING WITH TIME-OF-USE ANALYSIS

- Analysis of time-of-use meter data and online data



4. US DOE/ PNNL: Streamlined energy model without operational calibration

- Detailed hourly energy simulation coupled with a simplified user interface and informed building data defaults
- Easy to use online interface for rapid modeling and cloud based data management
- Multiple building types: office, school, retail, mixed use, etc.

PHASE ONE FINDINGS
- Pat Coleman

BAR PHASE 1 – BOTTOM LINE

- Assessment of building performance achieved at lower cost – especially with TOU data
  - "Innovative" methods ID efficiency opportunities missed by "traditional" methods
- Average cost of traditional method: $25k
- Average cost of "innovative" methods <$8k
  - Opportunities to reduce cost with scale

BAR PHASE 1 – LESSONS LEARNED

1. **Comprehensive energy usage data is critical to MA pilot approach**
    - The methodology relies on utility and fuel data to calibrate models
    - Incomplete utility data resulted in inconsistent modeling outcomes
- DOE / PNNL tool can handle buildings without annual energy data

BAR PHASE 1
Lessons Learned

2. Definition of building area (Sq ft) is critical

- Defining the "building" can be challenging
- Similar issue faced by Portfolio Manager

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

BAR PHASE 1
Lessons Learned

3. Building drawings of limited use

- Plans & elevations useful but imagery can often replace
- Modern buildings have 1,000s of files
- Older buildings have incomplete drawings
- Equipment schedules frequently out of date

BAR PHASE 1
Lessons Learned

4. Tenants vary – TOU data highlights operations

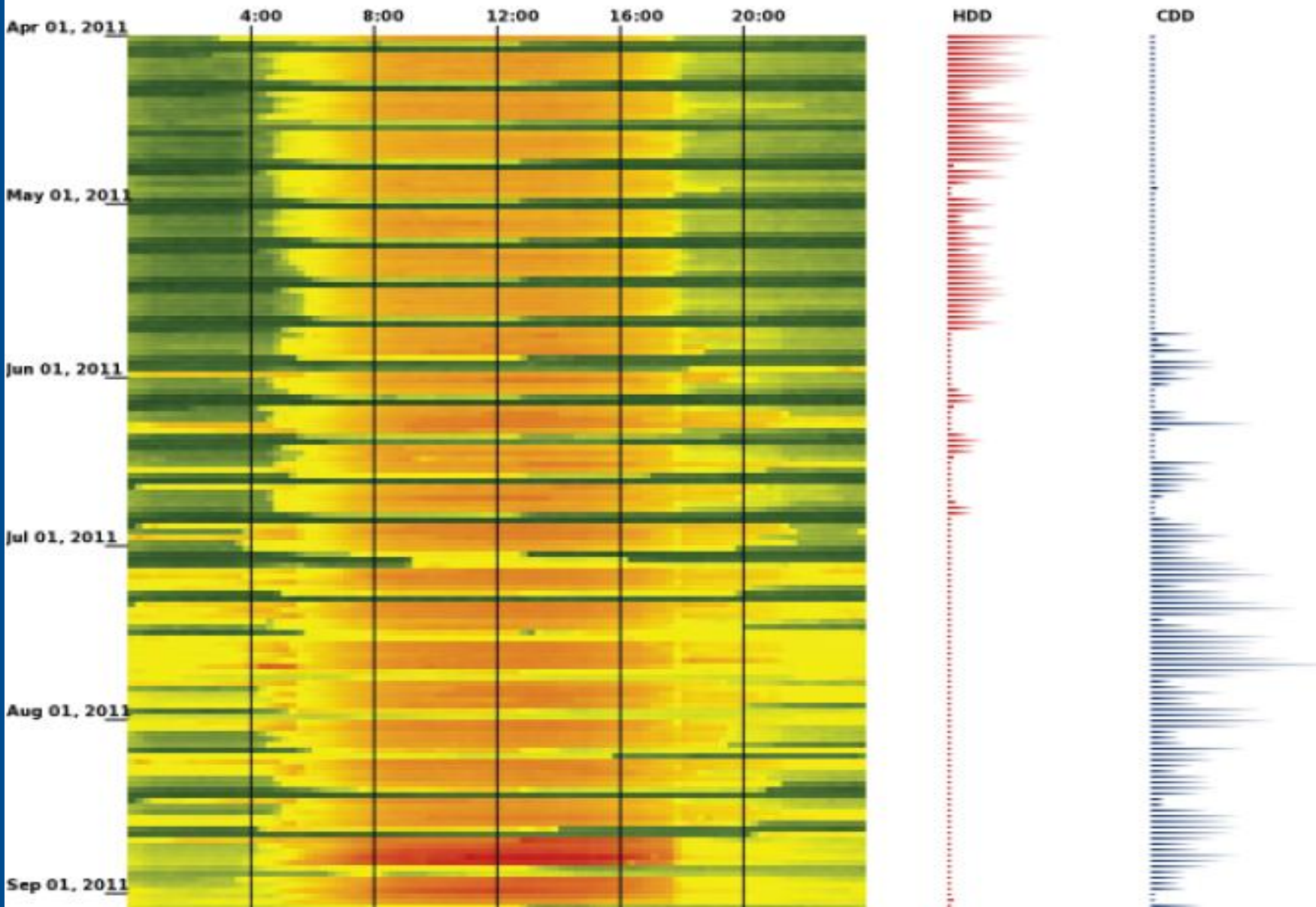
- Occupancy is not just 9-5
  - E.g. after hours events
- Interval data analysis can pick up unexpected hours and loads
  - Data centers and process loads
  - Tenants augment HVAC
    - Personal heaters, opening windows

BAR PHASE 1
Lessons learned

5. Important to reconcile all fuels

- Electric data – requires complete set of accounts
- Gas data – including onsite CHP
- Other fuels
  - Steam data
  - Onsite solar PV or geothermal systems
  - Back-up generation (load shaving)

LOAD SHAVING



BAR PHASE 1
Lessons learned

6. Heating & cooling: not just weather dependent

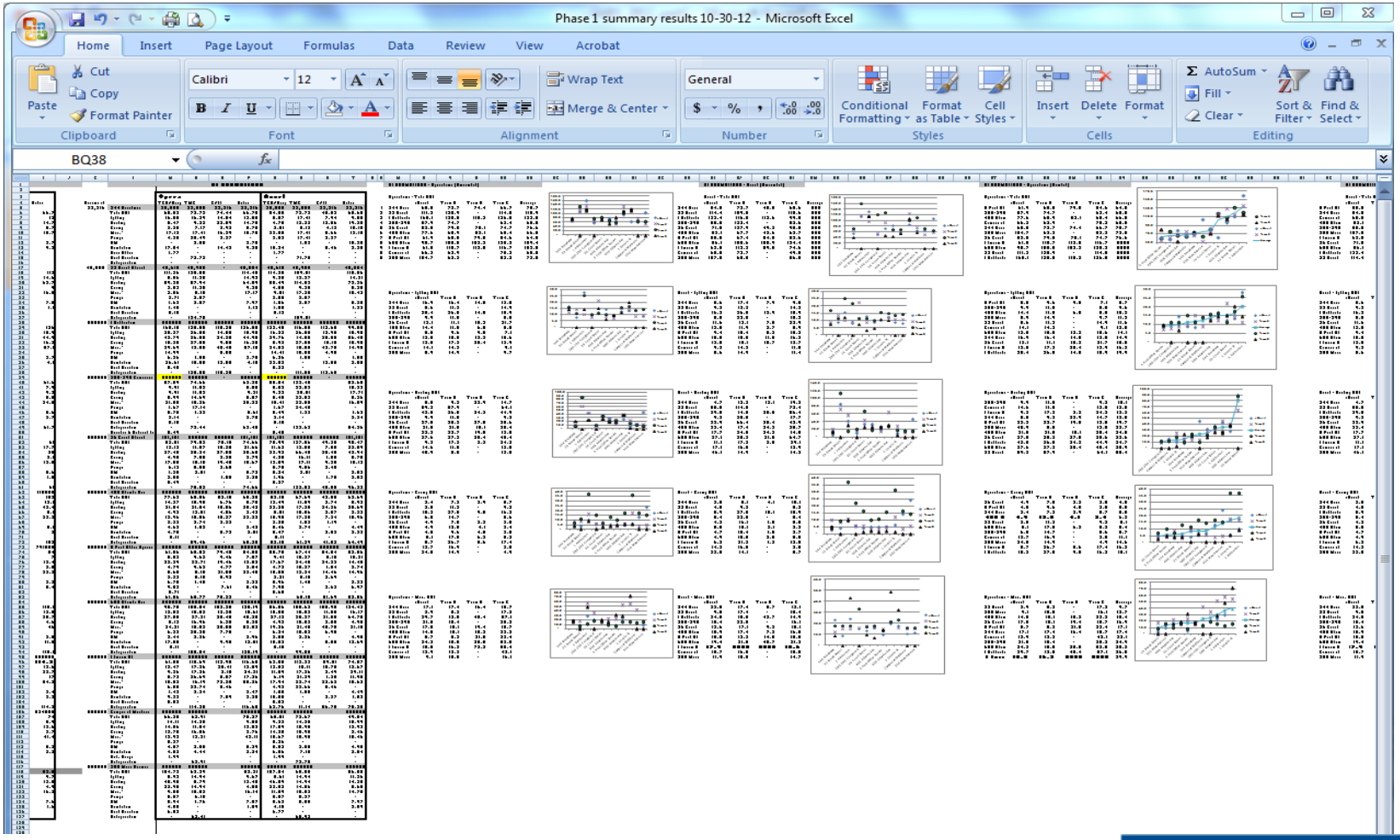
- Undersized systems
  - E.g. underperforming geothermal
- Oversized systems
  - E.g. oversized chillers or boilers without modulating controls
- Simultaneous heating & cooling
  - Major impact on building performance – not captured by all models

BAR PHASE 1
Lessons learned

7. Need to address inadequate ventilation

- Older buildings sometimes have undersized systems
  - ➢ Dependent on operable windows
- Low mechanical ventilation load, but is building space conditioned adequately?

BAR PHASE 1 - FINDINGS



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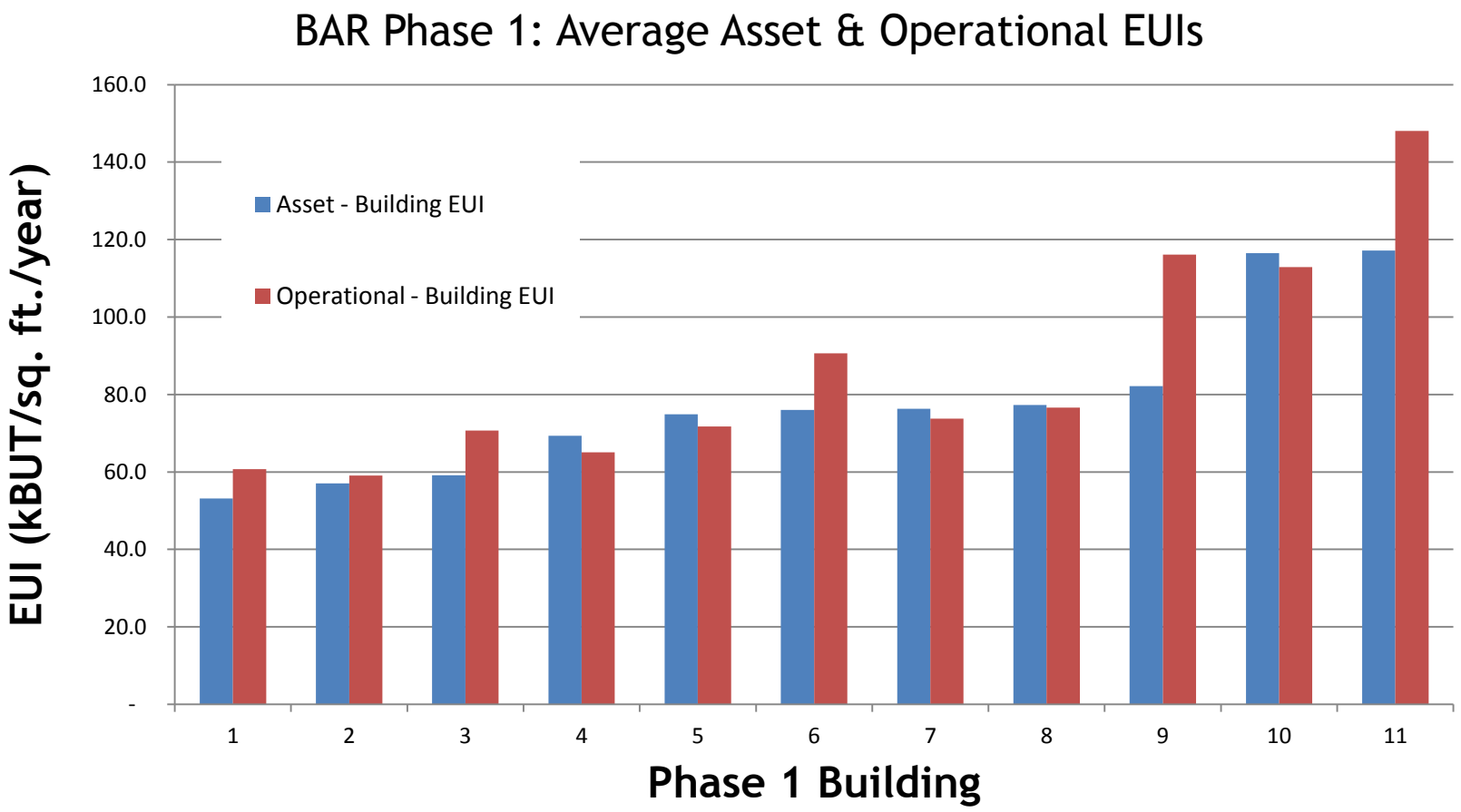
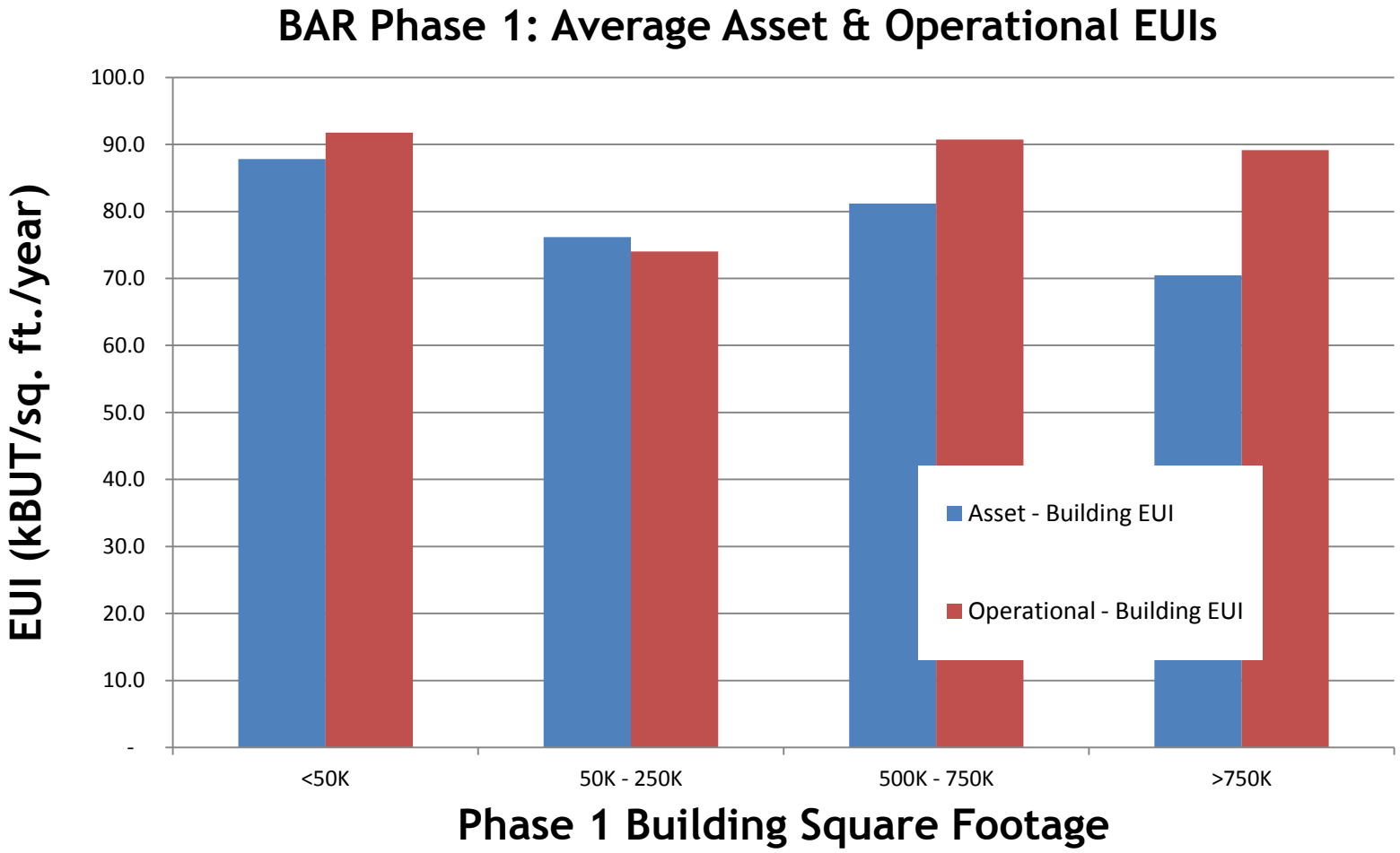
BAR PHASE 1 - FINDINGS



BAR PHASE 1 - FINDINGS



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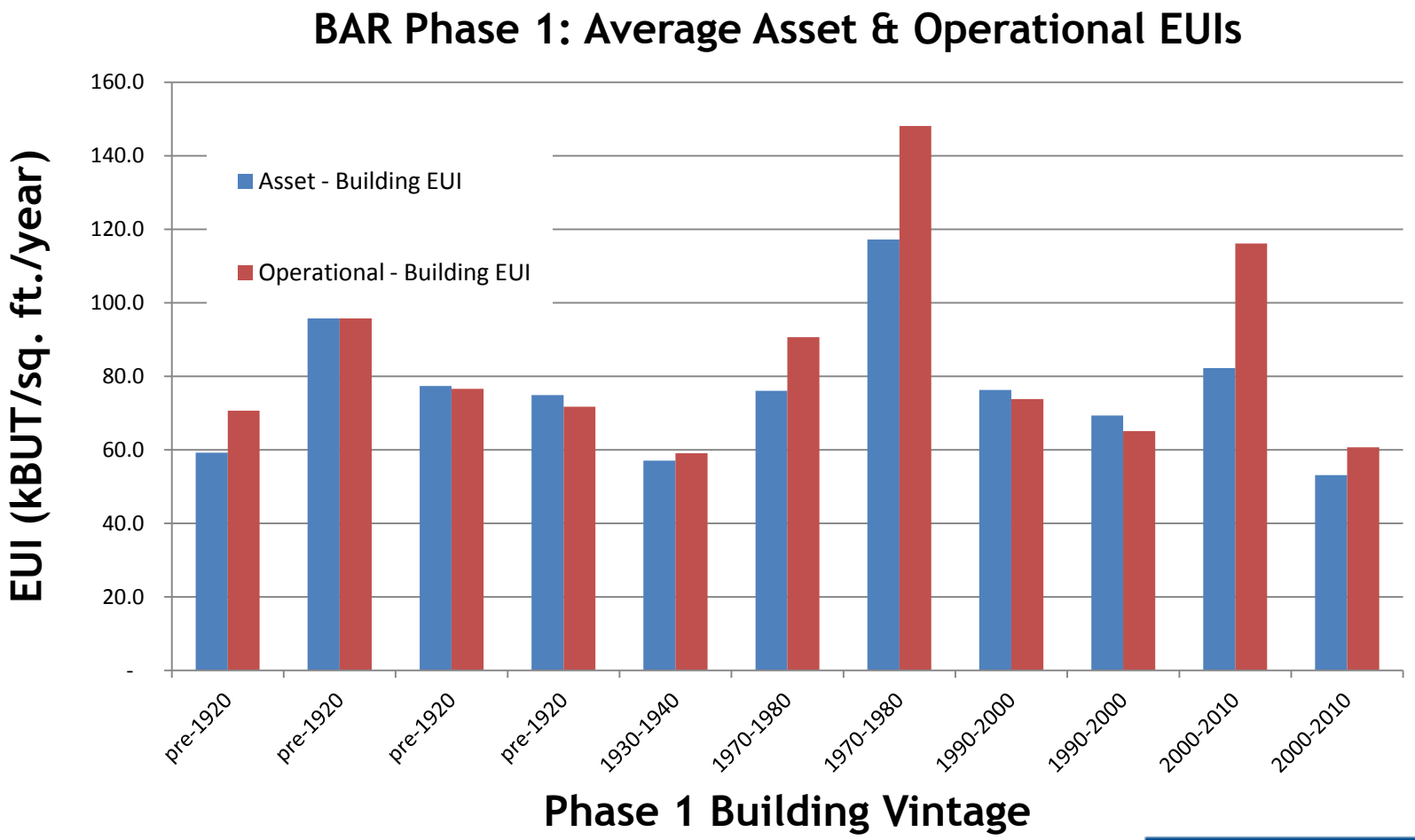
BAR PHASE 1 - FINDINGS



BAR PHASE 1 – EVALUATION

Three-step process:

1. Comparison of modeled EUIs by fuel with metered consumption
2. Disaggregation of end-use consumption in operational model logically explained by report narrative and model inputs
3. Normalization to asset EUIs logically explained by report narrative and model inputs

LESSONS LEARNED AND PHASE II - Carolyn Sarno

LESSONS LEARNED

- Critical elements:
  - Full set of consumption data
  - Site visits key to validate building inputs
- Clear modeling guidelines
- Important to reconcile all fuels
- HVAC sizing matters
- Tenant usage varies

BAR PILOT – PHASE 2

- **Deeper test of promising methodologies**
- 40-50 buildings
  - Statistically useful sample
  - Streamlined implementation
  - Interval / non-interval meters
  - Class A and Class B

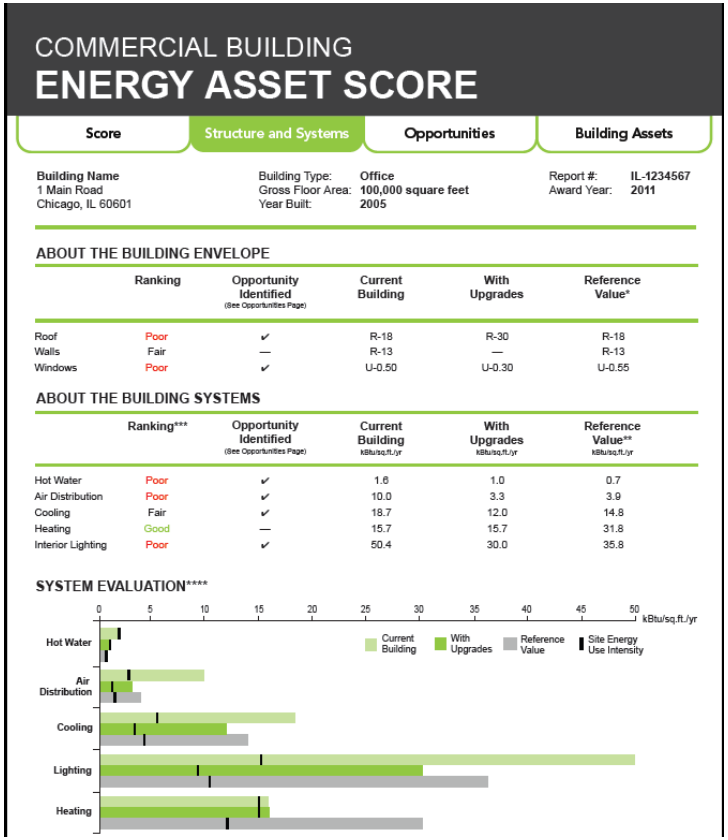
BAR PILOT - PHASE 2

- Key questions for phase 2:
  - How do BAR results compare with ESPM scores?
  - Trends based on building size, age, location?
  - How available is interval meter data?
- Greater Boston and the Merrimack Valley
- **Recruiting now!**

US DOE / PNNL Pilot #2

Second pilot round to test:

- Simple vs. advanced score
- Energy efficiency recommendations
- 100 point scale values
- Greater variety of building types (e.g., multi-family, courthouses, retail, mixed use)



COMMERCIAL BUILDING
ENERGY ASSET SCORE

Score | Structure and Systems | Opportunities | Building Assets

Building Name
1 Main Road
Chicago, IL 60601

Building Type: Office
Gross Floor Area: 100,000 square feet
Year Built: 2005

Report #: IL-1234567
Award Year: 2011

ABOUT THE BUILDING ENVELOPE

	Ranking	Opportunity Identified (See Opportunities Page)	Current Building	With Upgrades	Reference Value*
Roof	Poor	✔	R-18	R-30	R-18
Walls	Fair	—	R-13	—	R-13
Windows	Poor	✔	U-0.50	U-0.30	U-0.55

ABOUT THE BUILDING SYSTEMS

	Ranking***	Opportunity Identified (See Opportunities Page)	Current Building kBtu/sq.ft./yr	With Upgrades kBtu/sq.ft./yr	Reference Value** kBtu/sq.ft./yr
Hot Water	Poor	✔	1.6	1.0	0.7
Air Distribution	Poor	✔	10.0	3.3	3.9
Cooling	Fair	✔	18.7	12.0	14.8
Heating	Good	—	15.7	15.7	31.8
Interior Lighting	Poor	✔	50.4	30.0	35.8

SYSTEM EVALUATION**

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RESOURCES

MA DOER

http://www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/building-labeling/building-rating-and-labeling-commercial-buildings.html

NEEP

http://neep.org/public-policy/building-energy-codes/building-energy-rating

DOE Energy Asset Score website

http://www1.eere.energy.gov/buildings/commercial/assetscore.html

THANK YOU!

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