COMMERCIAL BUILDING ENERGY ASSET RATING WORKSHOP

December 8-9, 2011
Washington, D.C.

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Molly McCabe (Hayden Tanner, LLC)
Cody Taylor (Department of Energy)

PRE-DECISIONAL

Information included in this document is for discussion purposes and does not constitute the final program design.

FOR INFORMATION ONLY

Program Goals

- Facilitate cost-effective investment in energy efficiency and reduce energy use in the commercial building sector
- Establish a national standard for voluntary commercial building asset rating
- Create a tool to help building owners identify and implement actionable strategies to improve commercial building efficiency
  - Ensure that ratings are credible
  - Ensure that rating program is scalable

Project Timeline

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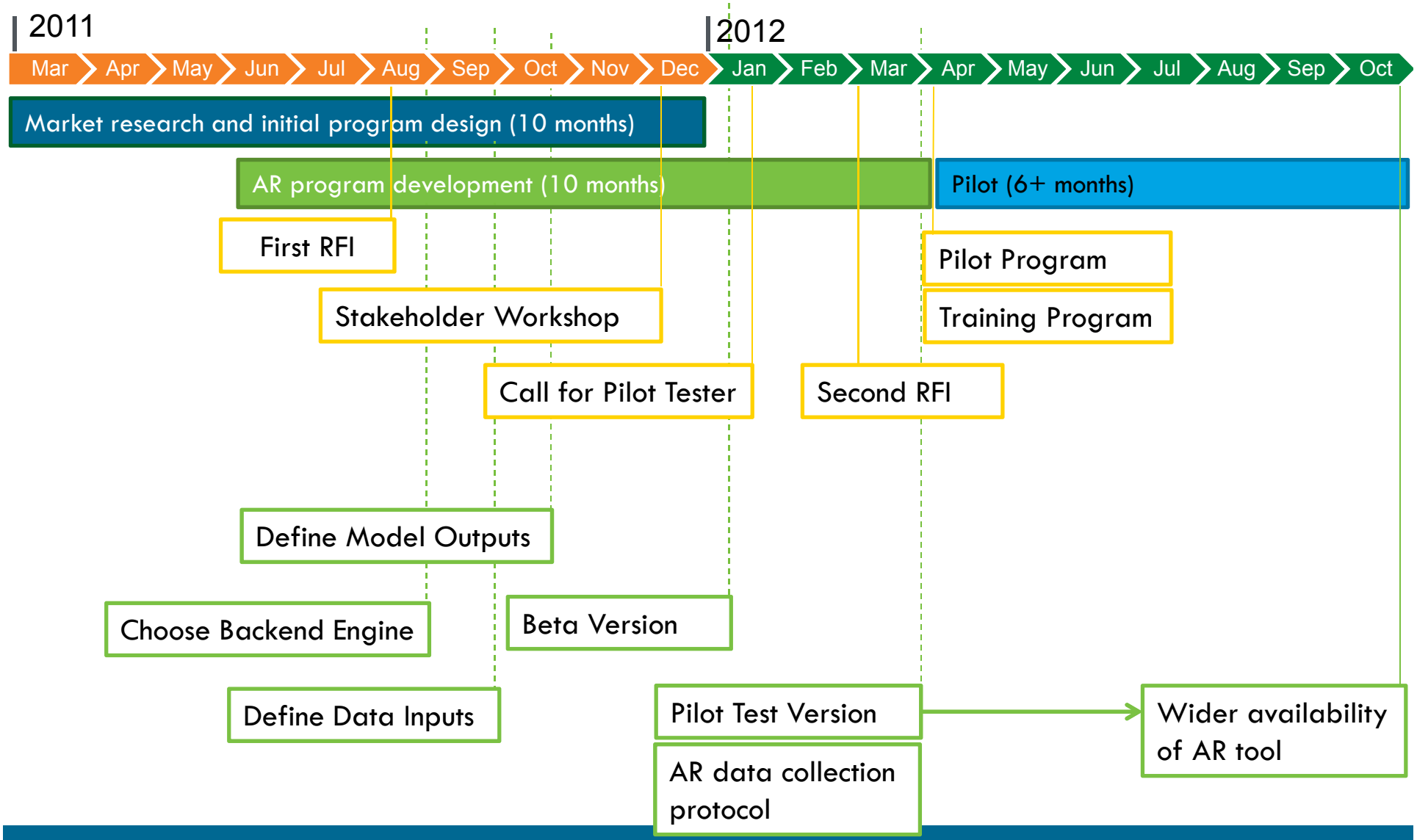

Workshop Objectives

- **Objectives:**
  - Engage stakeholders in the program design process and reach a common understanding
  - Share PNNL team's progress and findings to date
  - Collect direct feedback on the key program elements
  - Plan for the pilot test and engage early adopters

Agenda: Day 1 (Morning Session)

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- **9:00 – 9:30 a.m. Opening remarks**
  - Program overview
  - Project schedule
- **9:30 – 11:00 a.m. Key elements options of the Asset Rating program (PNNL Presentation)**
  - Market research and outreach (interviews, focus group study, and RFI)
  - Asset rating basic metrics
  - Asset rating scale
- **11:00 – 11:15 p.m. Break**
- **11:15 – 12:00 p.m. Questions and discussions**
- **12:00 – 1:00 p.m. Working lunch (discussions and summary)**

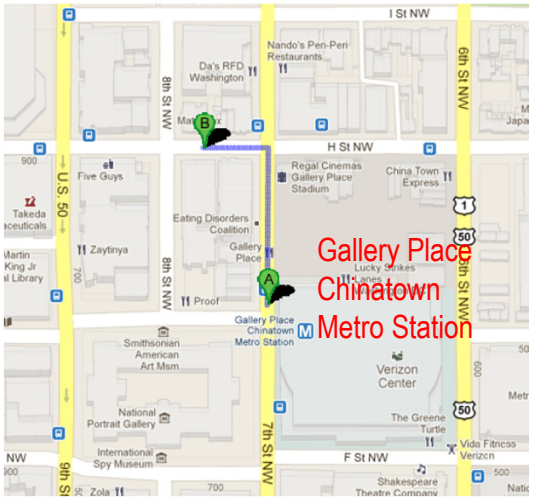
Agenda: Day 1 (Afternoon Session)

- **1:00 – 2:30 p.m. Asset rating tool (PNNL Presentation)**
  - Modeling methodology
  - Asset rating web tool (under development) demo
  - Data inputs
  - Model outputs
  - Asset rating certificate and report
- **2:30 – 2:45 p.m. Break**
- **2:45 – 4:00 p.m. Questions and discussions**
- **4:00 – 4:30 p.m. Summary**

- **6:00 – 8:00 p.m. No-host social dinner**

  Location: Asian Spice Restaurant

  717 H. Street, N.W. Tel: (202) 589-0900



Agenda: Day 2

- **8:30 – 9:00 a.m. Pilot project (PNNL Presentation)**
  - Pilot test plan
  - Quality assurance
- **9:30 – 10:00 a.m. Questions and discussions**
- **10:00 – 11:30 a.m. Unresolved questions or concerns from Day 1**
- **11:30 a.m. – 12:00 p.m. Summary and path forward**
- **12:00 p.m. Workshop adjourned**

- **1:00 – 5:00 p.m.** PNNL team is available to schedule individual meetings on related topics based on stakeholder's interest.

SESSION No. 1
Asset Rating Program Design
9AM-12PM, December 8, 2011

Market Research and Outreach

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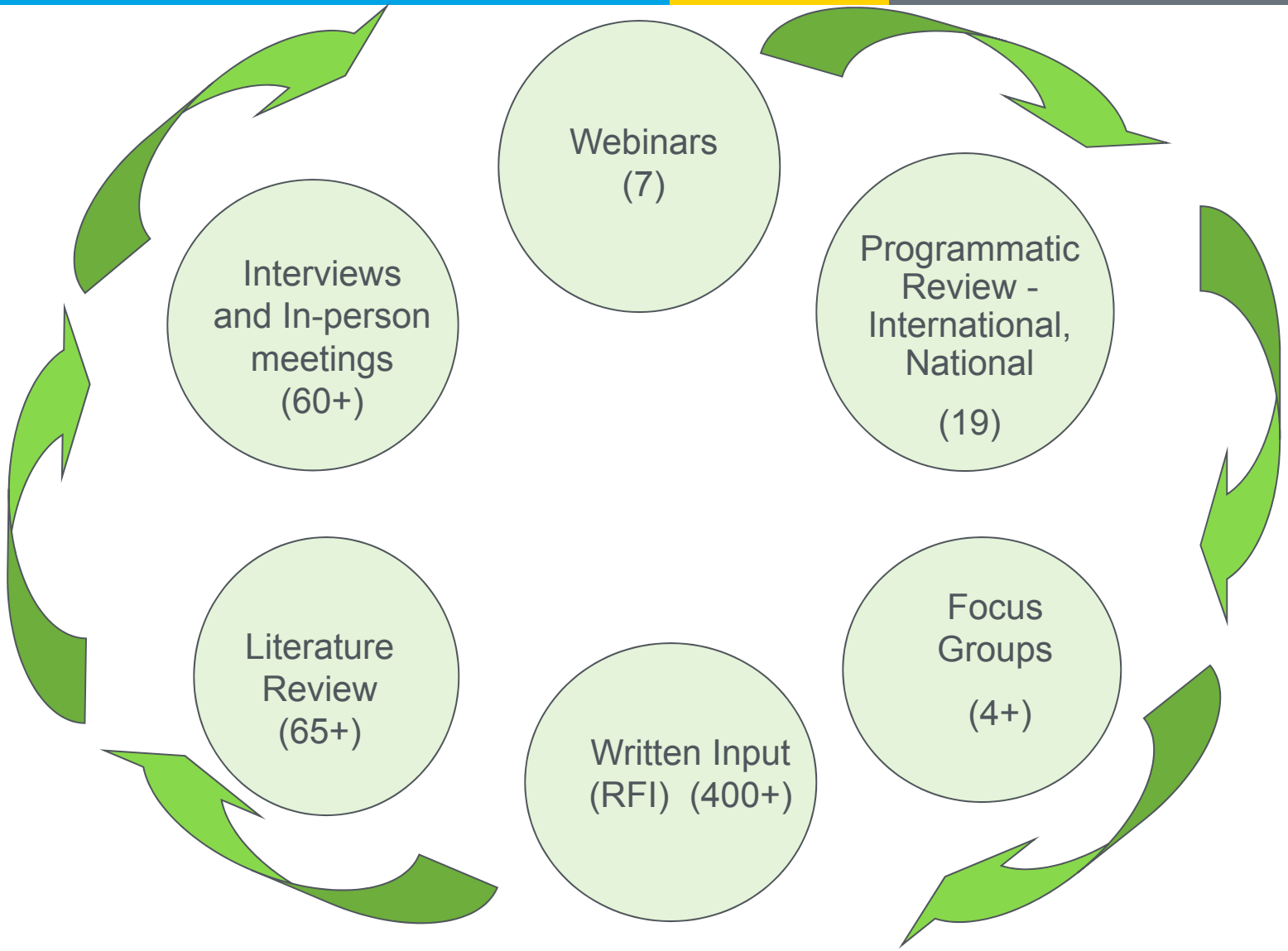
Abundant Power Acuity Brands, Inc. Advisory Council on Historic Preservation Air-Conditioning, Heating, and Regrigeration Institute Alabama Department of Economic and Community Affairs Alliance to Save Energy American Council for an Energy-Efficient Economy American Institute of Architects American Public Gas Association American Society of Heating, Refrigerating and Air-Conditioning Engineers Apartment Investment and Management Company Appraisal Institute Architectural Energy Corporation Argonne National Laboratory and Georgia Institute of Technology Arlington County Government Armstrong World Industries ASTM International Austin Energy Autodesk, Inc. Bank of America Bentall Kennedy Pension Fund Advisors Beth Shearer & Associates, Inc. Boston Boston Redevelopment Authority Bright Power BTC Credits Building Owners and Managers Association International, Building Owners and Managers Association International, Chicago California Energy Commission Cassidy Turley CB Richard Ellis Center for Environmental Innovation in Roofing City of Austin - Austin Energy City of Boulder CIty of Palo Alto City of Portland City of Seattle Clinton Climate Initiative CO Governor's Energy Office ComEd Comerica Commercial Buildings Consortium Commercial Energy Services Network Commercial Real Estate Development Association Consortium for Energy Efficiency CoStar Cushman and Wakefield Danfoss LLC Davis Langdon Seah Delaware Division of Energy and Climate Department of Natural Resources Department of Veterans Affairs DOE Building Energy Efficiency Hub DOE Federal Energy Management Program Dunn & Hobbes Earth Advantage Institute Ecology and Environment, Inc Edison Electric Institute Efficiency Maine Trust Efficiency Vermont/VEIC Elton Sherwin EMCOR Energy Servicves Emerald Cities Seattle Emerson Climate Technologies, Inc. Empire Comfort Systems Energy Center of Wisconsin Energy Foundation Energy Futures Group Energy Information Administration Energy Trust of Oregon EnergyRM EnergyScoreCards ENVINT Consulting Environmental Defense Fund Environmental Protection Agency Franklin Energy Services Furman University Gas Technology Institute GE Capital Real Estate General Services Administration George Butler Associates, Inc. Georgia Tech Gilbane Building Company Glenborough LLC Greater Boston Real Estate Board Greenprint Foundation GreenWorks Studio Group Energy Conservation, Institute for Environmental Research & Sustainable Development, NOA Hannon Armstrong Harvard Hines Honest Buildings ICF International ijkim architect Illuminating Engineering Society Innovologie LLC Institute for Market Transformation International Code Council International Facility Management Association Johns Manville Johnson Controls Building Efficiency Johnson Controls Inc Jones Lang LaSalle Kirksey Kohl's Kresge foundation Laclede Gas Company LORD Green Real Estate Strategies LordGreen Strategies Maastricht Univ/UC Berkeley Mach Energy Macy's Inc. Mammoth, Inc. Marriott International Massachusetts Department of Energy Resources McQuay International Metrus Energy MicroGrid Midwest Energy Efficiency Alliance Milton Bevington Minnesota Department of Commerce, Division of Energy Resources MKK Consulting Engineers, Inc. MO Dept of Natural Resources Mortenson Construction Munters National Association of Realtors National Association of State Energy Officials National Association of State Energy Officials National Building Operator Certification National Electrical Manufacturers Association National Grid National Institute of Building Sciences National Insulation Association National Multi Housing Council National Park Service National Propane Gas Association National Trust Preservation Green Lab Natural Resources Canada, Office of Energy Efficiency Natural Resouces Defense Council Navigant Navigant consulting Nevada State Office of Energy New Buildings Institute New York State Energy Research and Development Authority NOI Engineering North Carolina Energy Partners Northeast Energy Efficiency Partnerships Northwest Energy Efficiency Alliance Northwest Energy Efficiency Council NYC Energy Efficiency Corporation NYC Mayor's Office of Long Term Planning + Sustainability Oak Ridge National Laboratory Office of Energy Development OfficeMax, Inc. Opensourcegreen.Info Oregon Department of Energy PACE LLP Pacific Gas and Electric Company Parkhill, Smith, & Cooper, Inc. Parsons Partner Energy Pen State University PennDesign and TC Chan Center University of Pennsylvania PNC Bank Portland Sustainability Institute Purdue University Pythagoras Solar Ramsey County Assessor Real Estate Roundtable Ridgewood Capital, CA Rocky Mountain Institute Sage Energy San Francisco Dept of Environment Schneider Electric SCTE Seattle 2030 District Sempra Energy Simon Property Group Southeast Energy Efficiency Alliance Southwest Energy Efficiency Project State of Arkansas/ Energy Office Sustainability Roundtable, Inc. Sustainable Energy Partnerships Sustainable Real Estate Solutions, Inc. Target Corporation Taylor Engineering TEGNOS Research, Inc. The American Institute of Architects The Cadmus Group, Inc. The City of New York The Home Depot The JBG Companies The Kresge Foundation The Real Estate Roundtable The Weidt Group Tishman Speyer TRACO/Alcoa Trane/Ingersoll Rand Transcend Equity (Cycle 7) Transwestern Sustainability Services TRF Sustainable Development Fund U.S. Green Building Council United Technologies Research Center, UTC University of Arizona University of Illinois -- SEDAC Urban Green Building Council Urban Land Institute, London Urban Land Institute, New York US Bank US Department of Agriculture US Department of State US Green Building Council Utah Clean Energy Vermont Energy Investment Corporation Virginia Dept Mines, Minerals and Energy Vornado Realty Trust WA Dept of Commerce - State Energy Office Walgreens Company Waypoint Building Wells Fargo Bank - RETECHS LA William Boardass Associates WW Grainger, Inc. Wyoming State Energy Office Yum Brands YUM! BRANDS Zero Zone

Market Research & Outreach



Existing Building Stock

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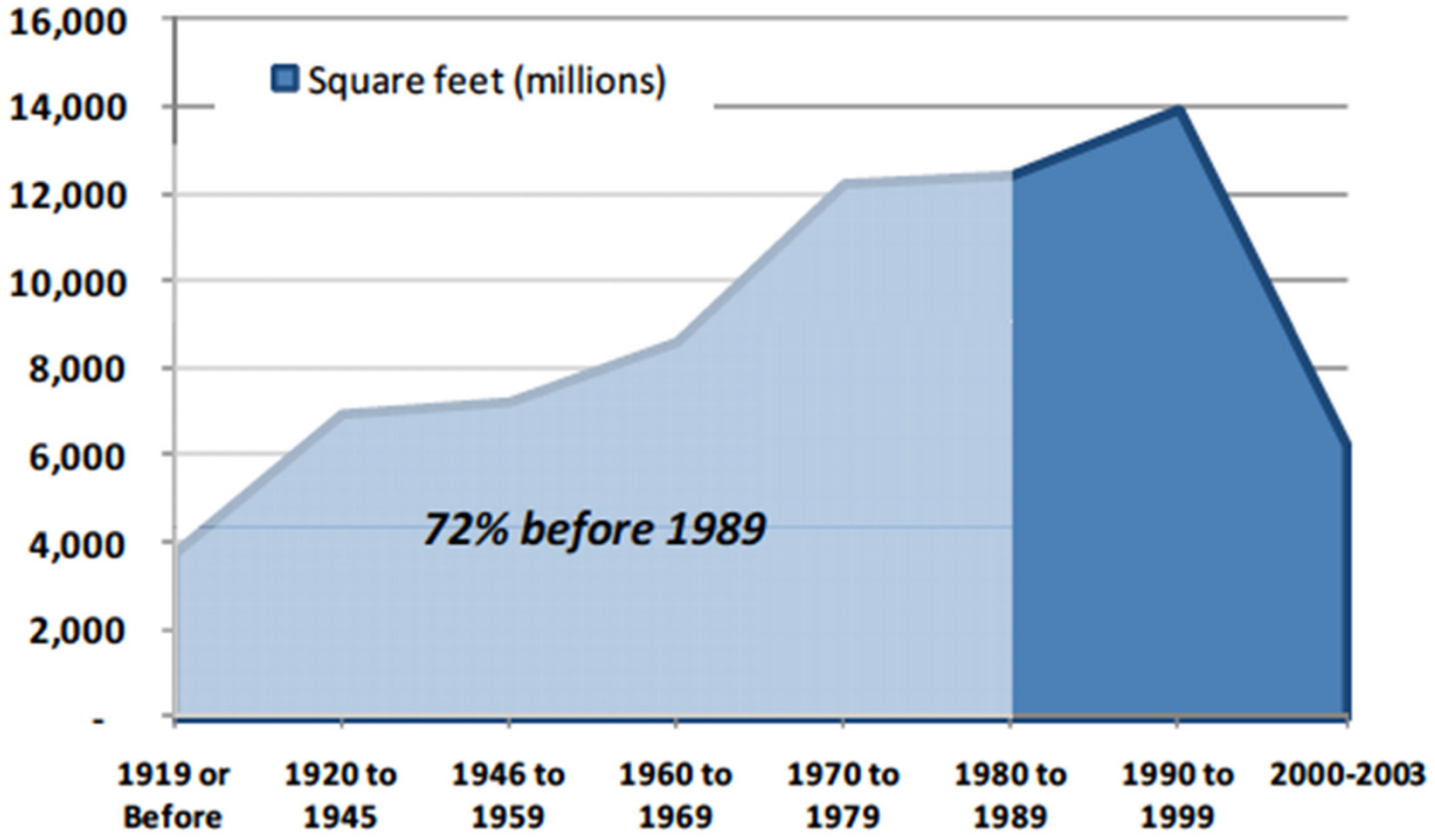
- The majority of the U.S. building stock was built prior to 1989.



Source: 2003 CBECS

Building Demographics

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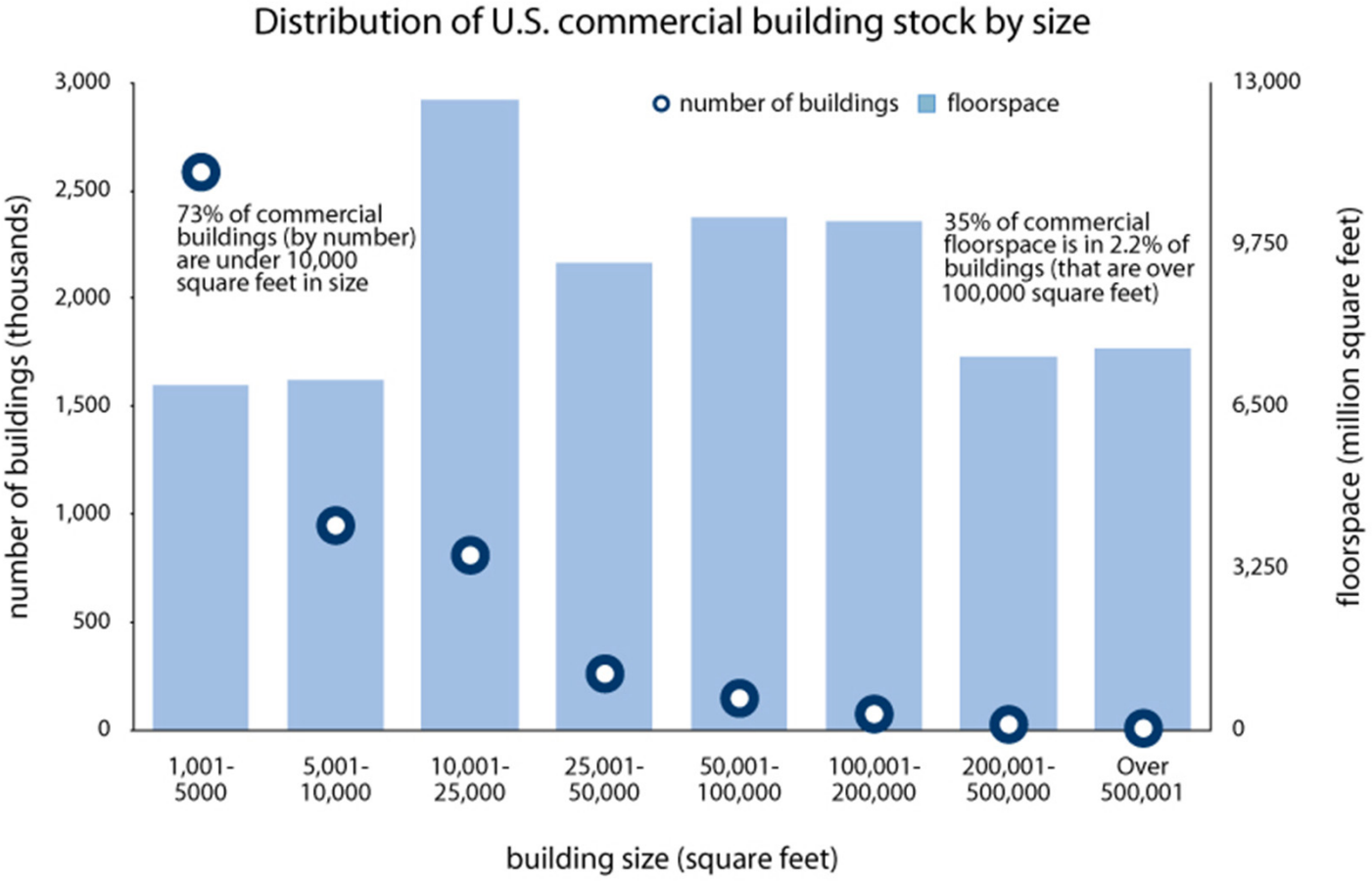
- Ninety percent of commercial structures are less than 50,000 s.f., encompassing 51% of the total commercial floorspace.



Source: http://www.rmi.org/RFGraph-distribution_US_commercial_building_stock

Owner Demographics

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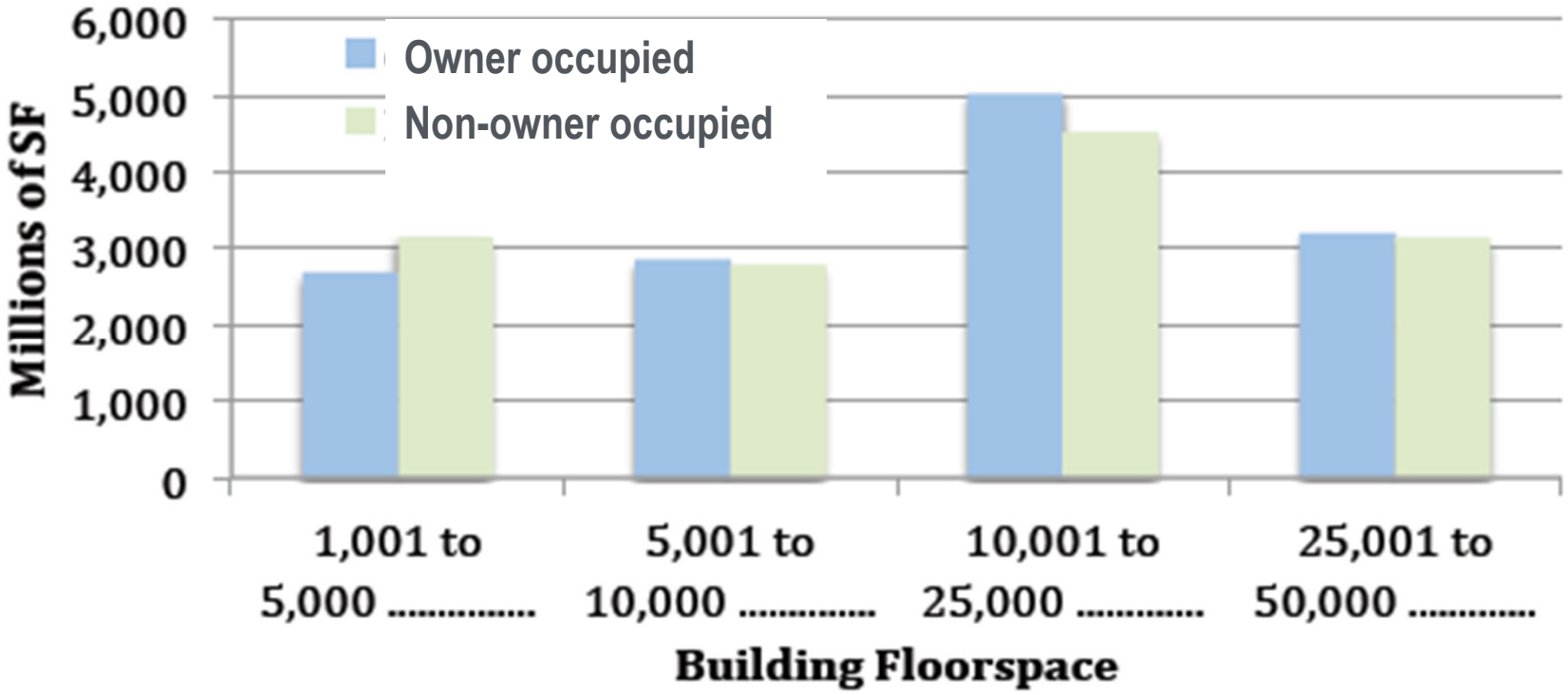
- Half of commercial buildings under 50,000 SF are owner occupied.



Source: 2003 CBECS Data, Chart: RMI/NEEA Financial Workshop April 2011

Uses of Asset Rating

- How do we expect the Asset Rating to be used?
  - Scenario 1: Owner occupied, Small buildings
    - A utility-based ranking alone does not identify the improvement opportunities.
    - Lack of resources for an advanced energy audit
  - Scenario 2: Owner occupied, large buildings
    - Be recognized for energy improvements and/or high performance features
  - Scenario 3: Nonowner occupied
    - Need to improve marketing value and stay competitive
  - Scenario 4: Building portfolio owners
    - Need to compare building values and identify portfolio strategies

Building Types

- The asset rating (AR) tool development will first focus on building types that do not have special internal load requirements and have adequate information sources to establish a reliable rating system. Building types would be included in the rating system beginning with simpler types and later including more complex types:
  - Tier 1: office, school, retail, warehouse, and assembly

    (adequate information resources from CBECS + inference data)
  - Tier 2: Mixed-use buildings, lodging, food service, food sales

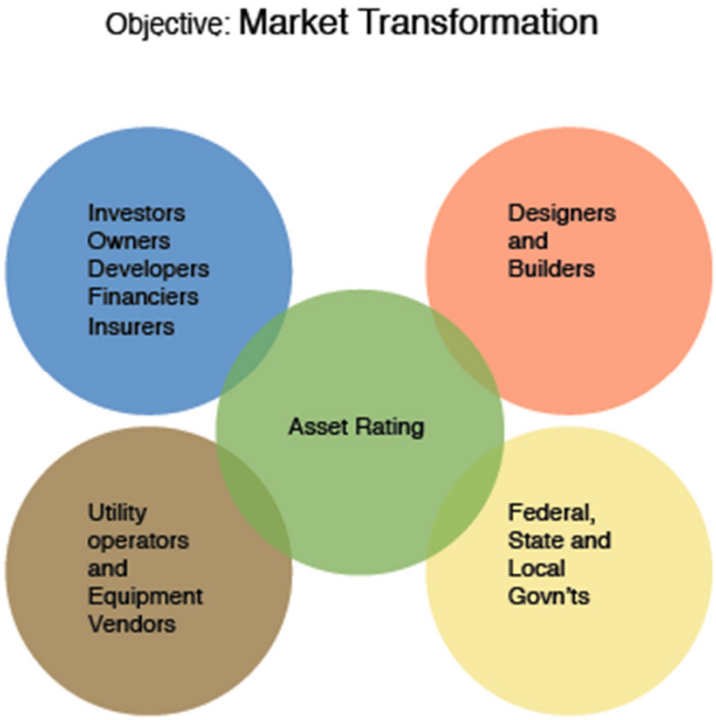
    (limited information sources from CBECS + inference data)
  - Tier 3: Data center, laboratory, refrigerated warehouse, and health care

    (very limited information sources + little inference data)

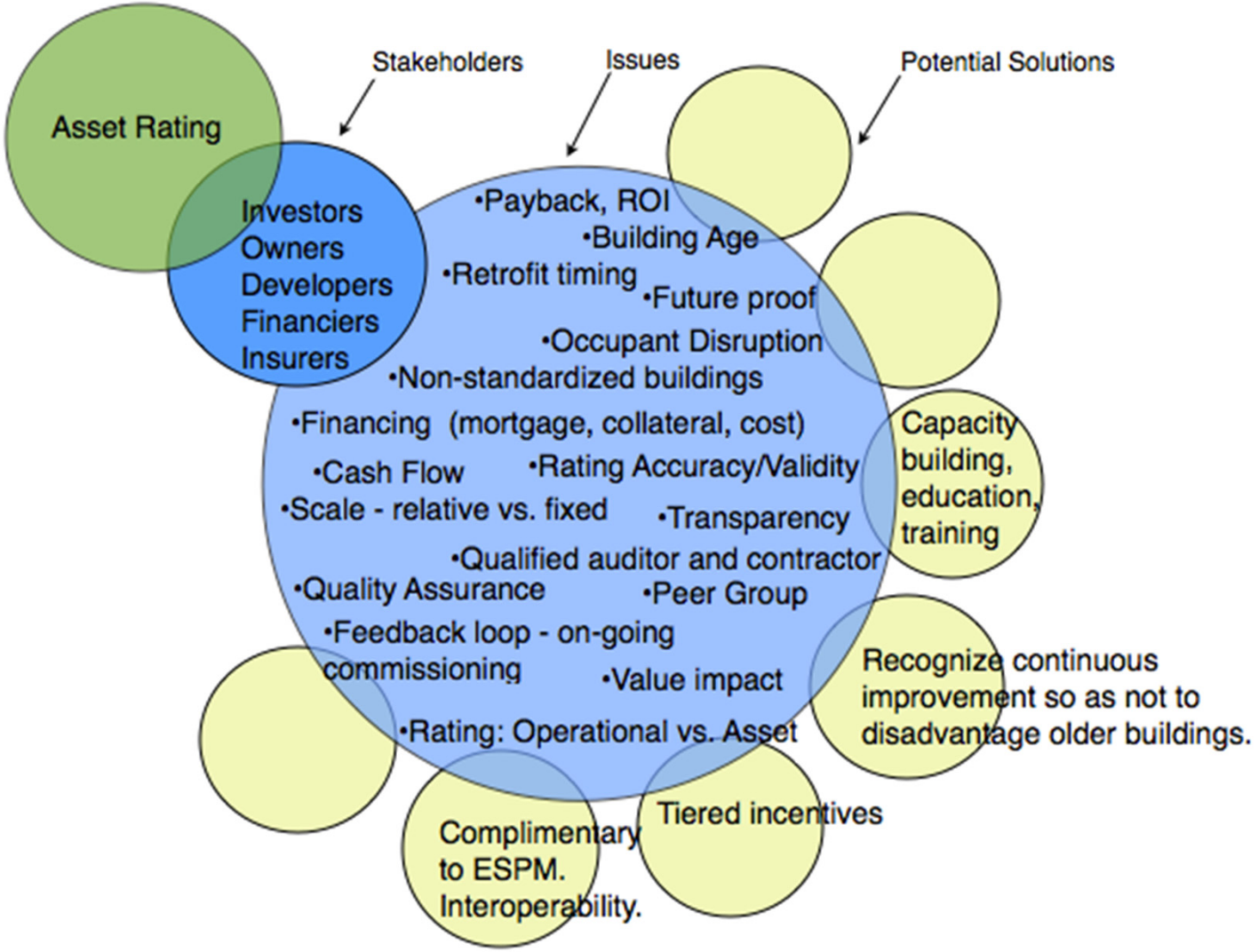
Target Audience

- Primary audience: Stakeholders with a direct interest in the efficiency of a building can use asset ratings:
  - Owners
  - Investors
  - Operators
  - Investors, lenders, and appraisers
  - Occupants

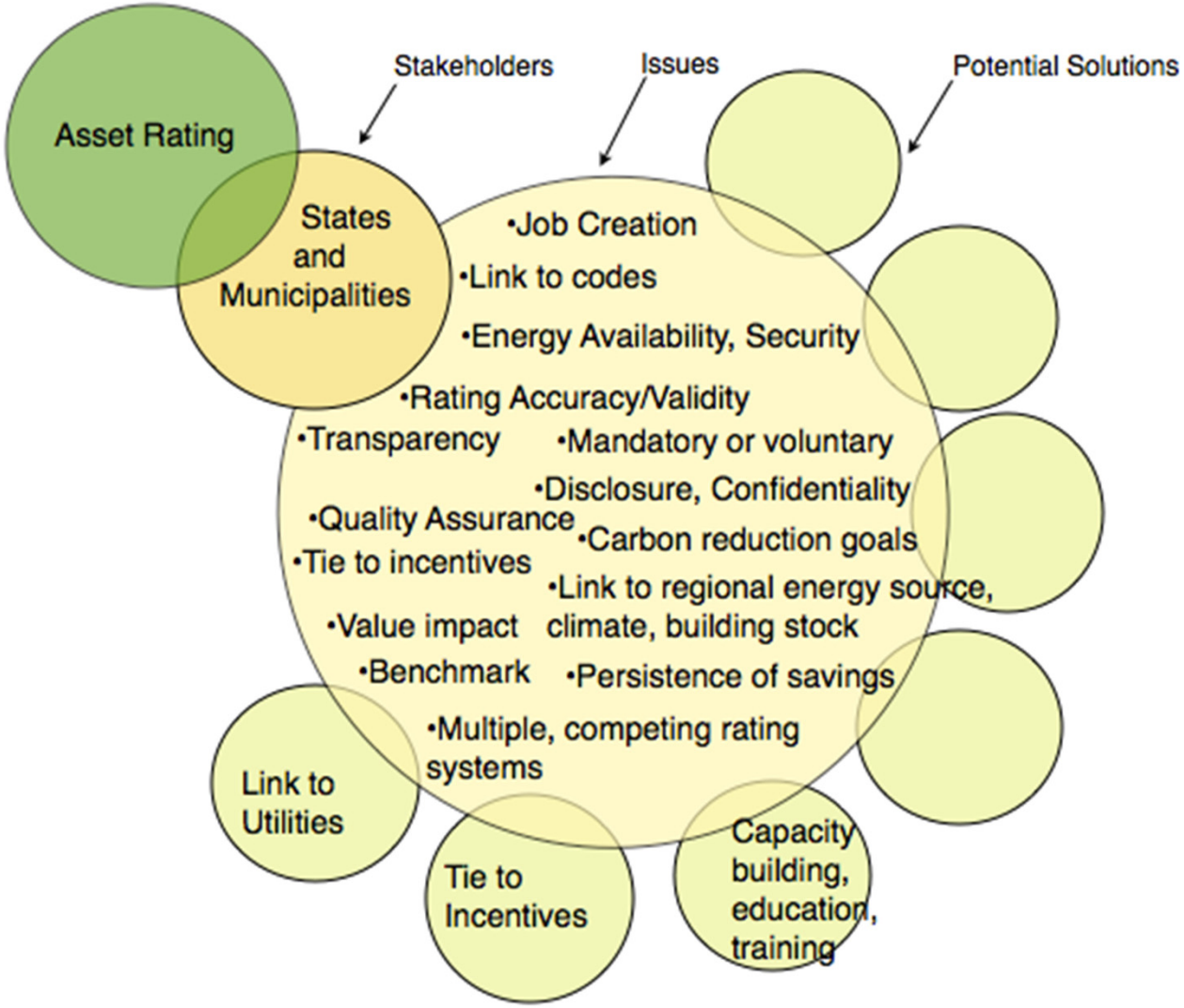
- Secondary audience: stakeholders who may wish to incorporate asset ratings into other programs:
  - Local governments
  - Utilities
  - Green building rating systems
  - Building designers



Target Audience



Target Audience



First RFI

- August 8 – September 22, 2011
- 52 unique respondents
- 400+ specific comments

Focus Groups

- Four held to date
- 166 people invited
- 6 – 8 participants per group

- Future locations?
  - Considerations: local utility cost and labor cost

Programmatic Review

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- Which programs
- Lessons Learned

Benefits of AR Program

WHAT WE HEARD…

- Owners and operators can benchmark their building against peers
  - Evaluate a building's installed systems with standardized operating assumptions
- Owners, lenders, and buyers gain insight into building's value
  - Distinct from maintenance and occupant behavior
- Owners gain insight into potential for capital improvements to increase energy efficiency & reduce costs
- Operators can better understand quality of operations (when asset rating is used in conjunction with operational rating)
- Operators gain insight into potential for operating improvements to increase energy efficiency & reduce costs (when asset rating is used in conjunction with operational rating)
- Potential tenants gain insight into relative long-term costs of buildings

Focus Group

- How do you currently evaluate the energy efficiency of your buildings?
  - Some buildings - not all - raw data
  - Energy Star Portfolio Manager as baseline
  - Compare to CBECS 2003
  - Year over year comparison
  - Cost per square foot

Focus Group

- When you decide to purchase, make capital improvements to, or divest of a property, in what way does its energy use and/or efficiency fit into your decision-making process?
  - Start with ES rating goal of at least 50, typically 75 or higher, as well as ability to move toward LEED status
  - Re-commission properties - look for low hanging fruit, then 5 and 10 year working plans
  - Historical operating expenses and physical plant (HVAC). More concerned about replacement costs than energy expenses
  - ROI of energy initiatives and payback period

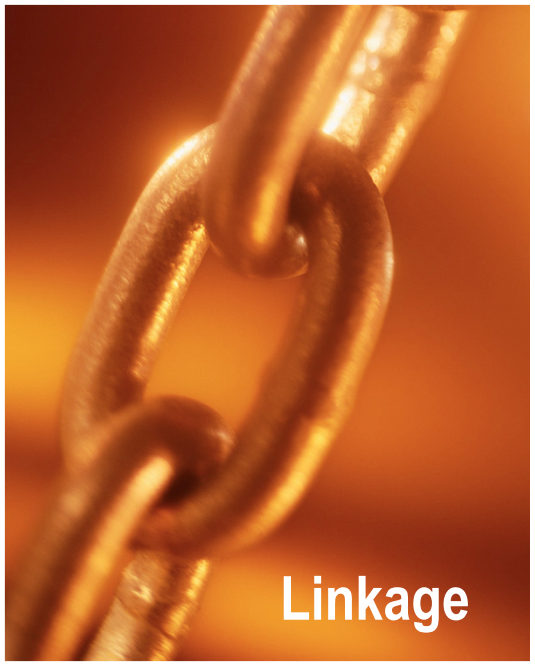
Focus Group

- When you're trying to invest capital into making improvements to improve the energy efficiency, what types of information would be helpful?
  - Energy audit
  - Cost benefit analysis
  - Payback period
  - Each building is unique - both in investment direction as well as in use.

Key Design Criteria - Input informs Output

- Rating validity must be ensured
  - Rigor must be balanced with cost
  - Clear reference points (sq. footage, building type classification, normalization factors)
  - Compliance (quality control, quality assurance - auditing, spot checks)
    - Competency of raters
    - Official rating requires sign-off by professional.
    - Enforcement likely to be at the State or Municipal level through their own rating and disclosure policies.
- Low cost (balanced with validity of results)
- Reflect Incremental improvement
- Actionable strategies
- Training, education and outreach necessary
- Integration with operational performance data (e.g. through linkage with Energy Star Portfolio Manager
- Linkage with existing systems (ESPM, LEED, ASHRAE bEQ, state programs, third party applications)

Key Findings



Business Model

Diagnostic

Key Findings

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"Our buildings have so many different tenants with different uses that it is difficult to sort out what is the occupant vs. the building."

Institutional Investor/Owner

"Energy Managers' Top Priority Is Benchmarking Facility Energy Performance."

"Tracking facility energy performance data on an increasingly granular level is a growing priority for energy managers."

E Source Energy Management Survey 2011

"Measure Understand Manage"

ESource Survey Respondent

Key Findings

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"An asset rating system would evaluate the existing building's potential performance. If that were available alongside an actual performance data point, the industry would have a very powerful tool to accelerate capital investment for financial and environmental returns."

"An AR Label is a reflection of modeled energy efficiency - how efficient, in this case, is a commercial property, on paper. The actual "in-use" performance of the building is strongly dependent on operations an maintenance as well as plug loads and occupant behavior. Ideally an AR energy label is accompanied by some kind of "in use" label like Energy Star."

Engineer

Key Themes

- Integration with Energy Star and other rating programs

"Given the extent of Portfolio Manager's market penetration, I think that first and foremost it is in the industry's interest that any new government programs leverage the existing web and information portal."

Asset Rating and ENERGY STAR

- Develop different scenarios to help AR users to understand how to use the information provided by the asset rating tool and ENERGY STAR Portfolio Manager.

Asset Rating

- Modeled EUI

ENERGY STAR

- Predicted EUI
- Measured EUI

ENERGY STAR Portfolio Manager		Asset Rating Tool	What does it mean?
Measured EUI	Predicted EUI (Normalized EUI)	Modeled EUI	
A ≈ B	A ≈ B	A ≈ B	
		A > B	
		A < B	
	A > B	A ≈ B	
		A > B	
		A < B	
	A < B	A ≈ B	
		A > B	
		A < B	
A > B	A ≈ B	A ≈ B	
		A > B	
		A < B	
	A > B	A ≈ B	
		A > B	
		A < B	
	A < B	A ≈ B	
		A > B	
		A < B	
A < B	A ≈ B	A ≈ B	
		A > B	
		A < B	
	A > B	A ≈ B	
		A > B	
		A < B	
	A < B	A ≈ B	
		A > B	
		A < B	

Themes

- Confidentiality of Information
- Building Type
  - Start with subset that has simple building systems
  - Expand to include historic, mixed-use, public housing, and federal buildings
  - Distinguish between new construction, existing buildings, and historic buildings
- Quality Assurance - Credentials, Data, Modeling
- Data Gathering
- Efficiency Recommendations

Themes

The most popular topics:

- Site vs. Source
- Rating Scale
- Simulation Method

Themes

- Metrics: Energy / Greenhouse Gas Emission / Cost
  - Cost - favor inclusion, preferred metrics vary
  - Site vs. Source (slight favoring of source)
  - Conversion factor (comments favor national)
  - Greenhouse gas emissions (favor inclusion, but as a secondary metric)
  - Renewables - some interest in including energy use information with and without renewables

RFI Comments: Asset Rating Metrics

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	Summary of comments	Count
Site (12)	Use site energy use intensity	9
	Use site and source energy usage and peak demand intensity	1
	Use site energy use intensity and cost per sq.ft.	2
Source (20)	Use source energy use intensity	17
	Use total source energy	3
Conversion Factor (15)	Use regional or sub-regional (eGRID) conversion factor	4
	Use national conversion factor	8
	Use full fuel cycle	3
GHG (7)	Include GHG	7
Cost (18)	Include cost information	13
	Exclude cost information	5

Site vs. Source Energy

- **Source Energy:** Maintains alignment with Energy Star Portfolio Manager and avoids unintentional favoring of a fuel type.
- **Site Energy:** Simpler, more transparent, and easier to measure with units that are easily replicated.

Site vs. Source Energy

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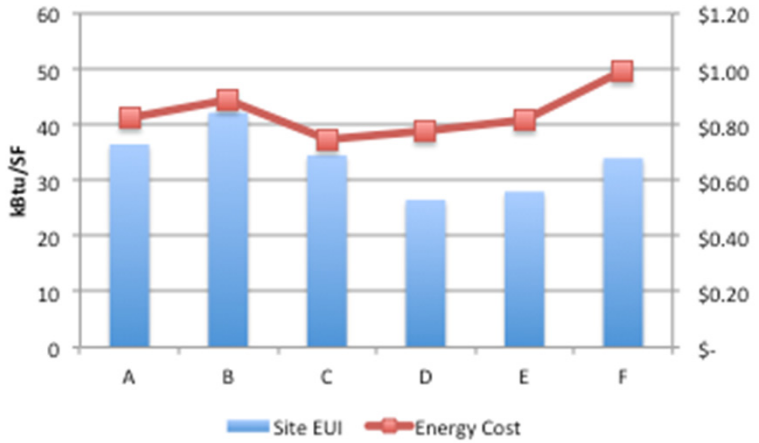
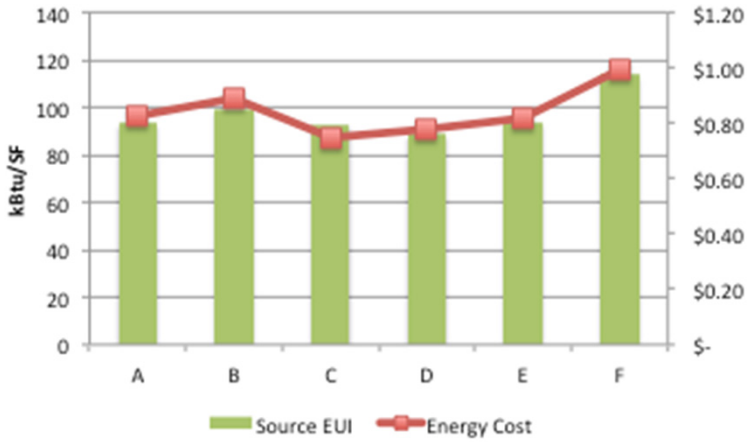
Comparison of Site and Source EUI of identical buildings with different heating systems

	Building A	Building B	Building C	Building D	Building E	Building F
Heating System	NG Boiler 80% system efficiency	NG Boiler 55% system efficiency	District Steam 95% system efficiency	Geothermal COP=4.0	Air Source Heat Pump COP=2.5	Electric Resistance Heat COP=1
Heating Fuel	Natural Gas	Natural Gas	District Steam	Electric	Electric	Electric
Site EUI	37	42	35	27	28	34
% reduction compared to B	13%	0%	18%	37%	34%	19%
Source EUI	93	99	93	89	94	114
% reduction compared to B	6%	0%	6%	11%	6%	-14%





Assumption:
$0.10/kWh
$1.00/therm

Source EUI better reflects energy cost per sq.ft.

Site vs. Source Energy

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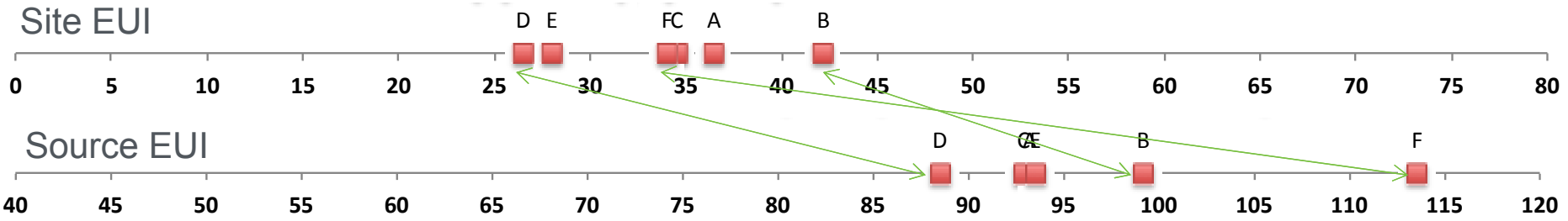
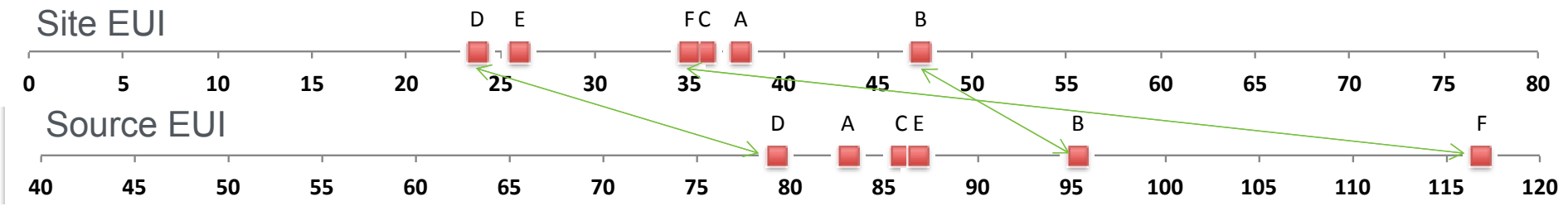
- The overall site/source relationships among buildings appear similar although source energy has greater impact on heating-dominated area.

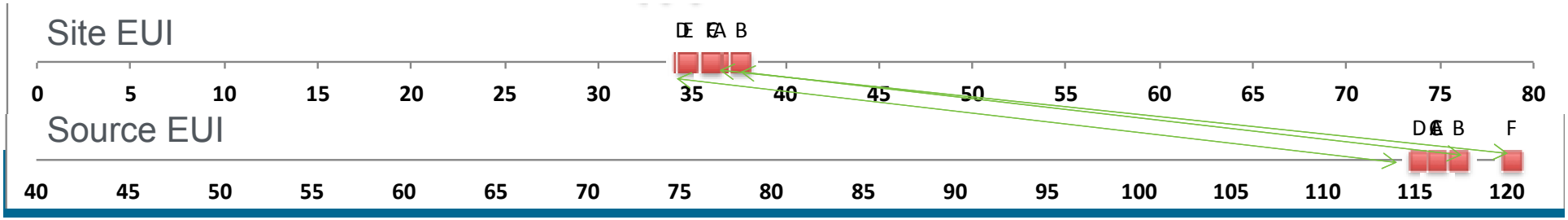
Moderate heating and cooling

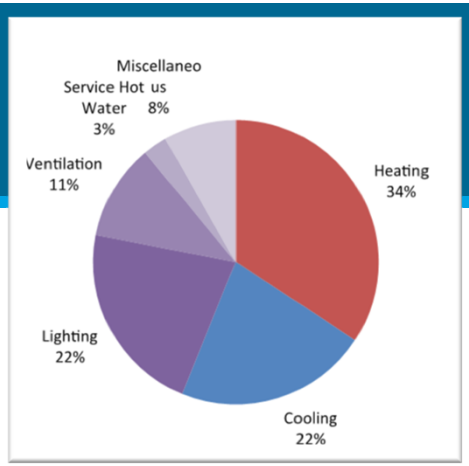


Heating dominated area



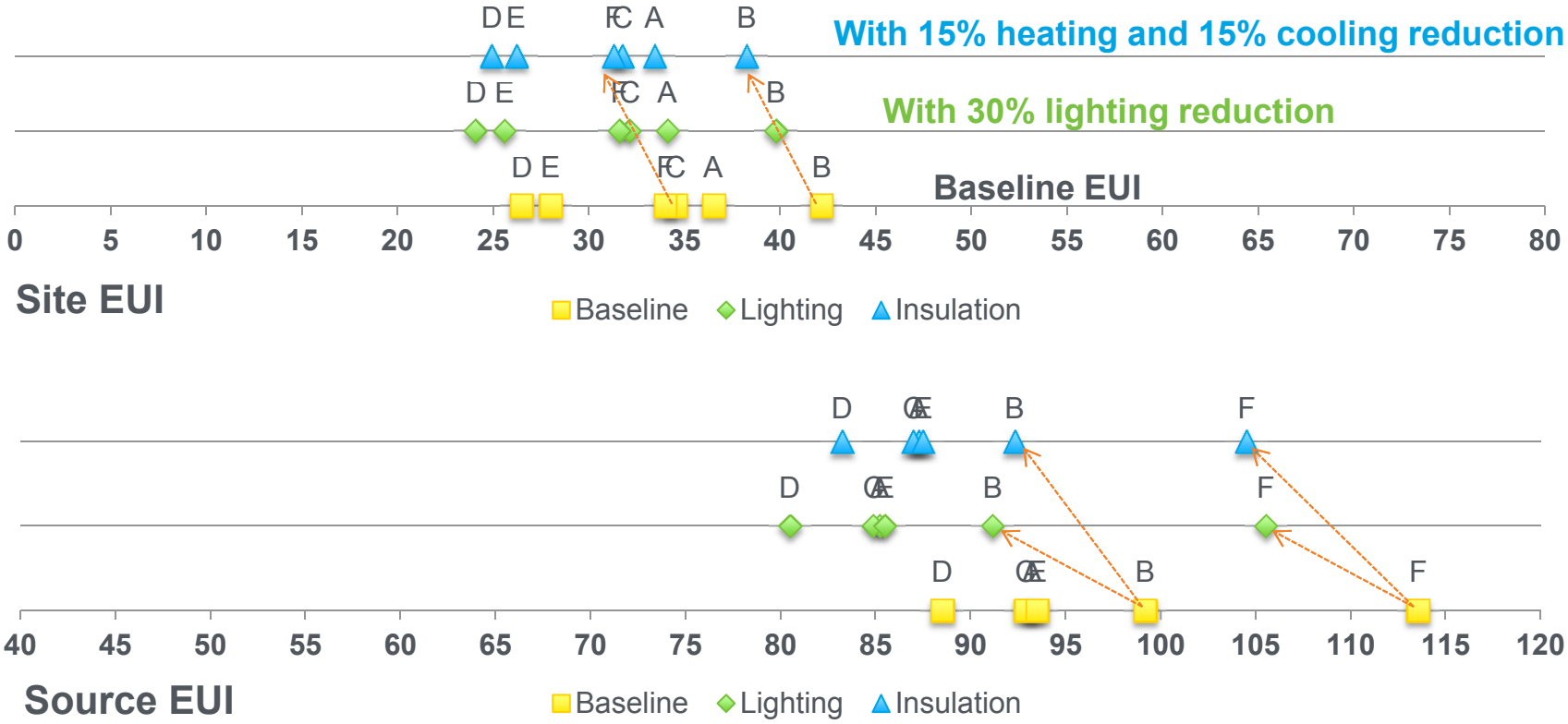
Cooling dominated area

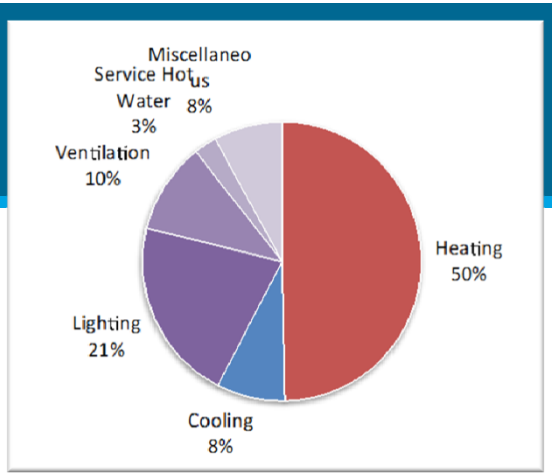




- Site: 30% lighting saving ≈ 15% HVAC saving
- Source: 30% lighting saving > 15% HVAC saving

Moderate heating and cooling





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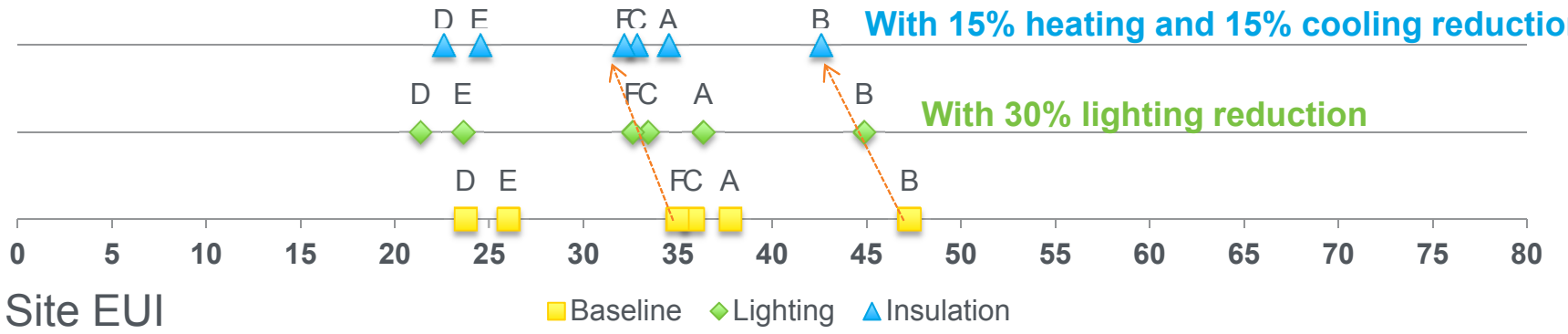
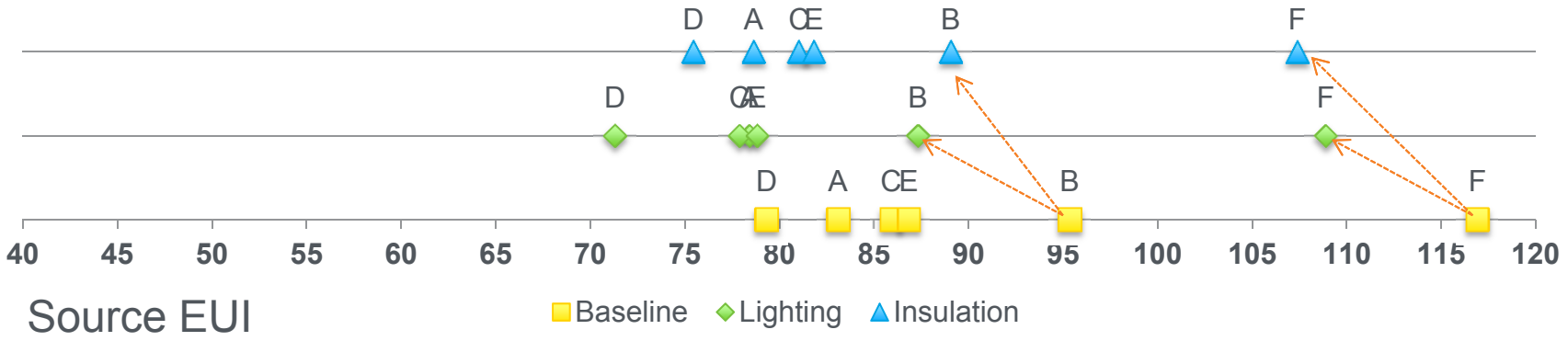
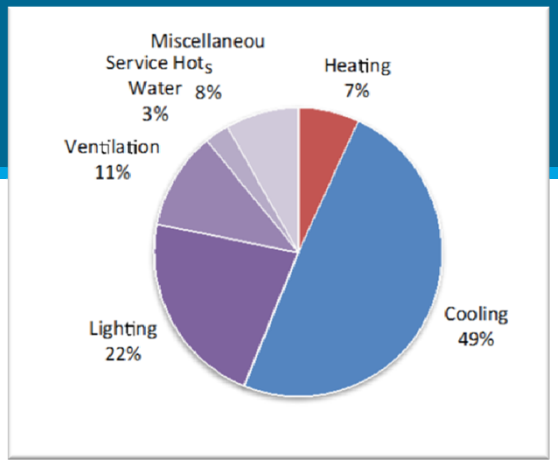
Heating dominated area

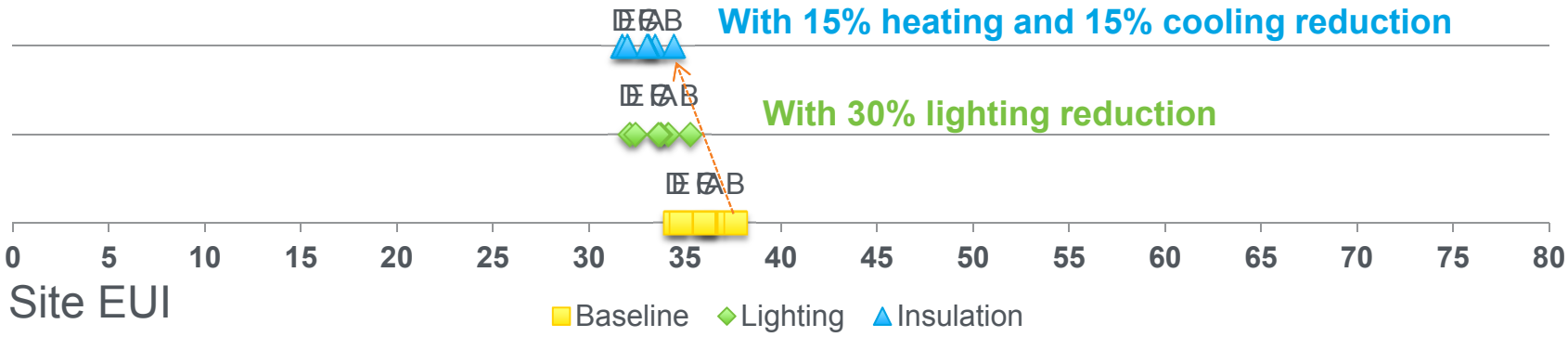


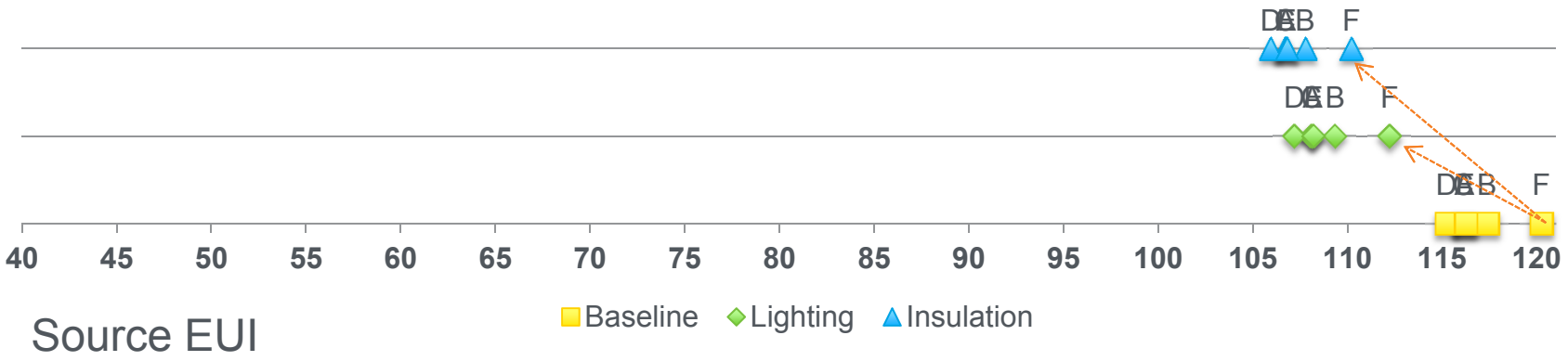




- Site: 30% lighting saving ≈ 15% HVAC saving
- Source: 30% lighting saving > 15% HVAC saving

Cooling dominated area



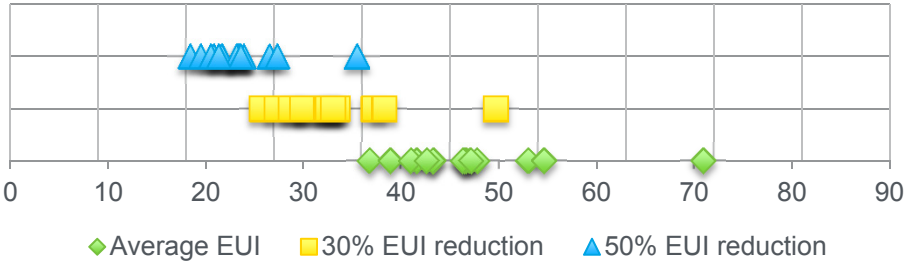


Site vs. Source Energy

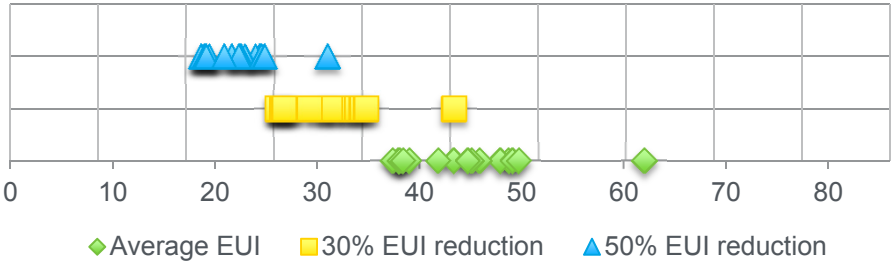
- When source energy scale is used, the variations across climate zones tend to be smaller.

Newly constructed medium or large office buildings energy use in 16 climate zones

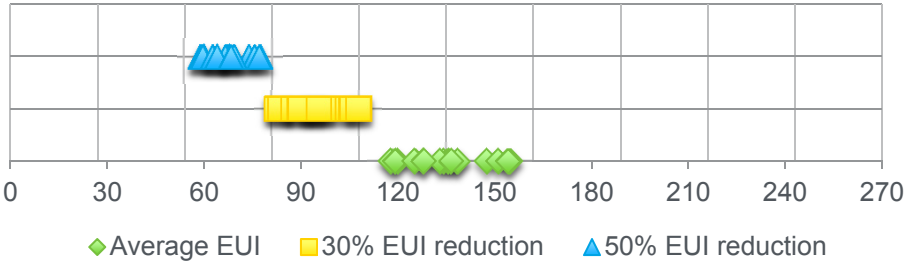
Medium Office Building Site EUI



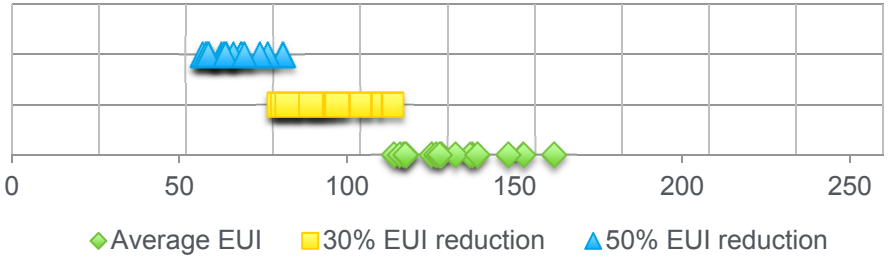
Large Office Building Site EUI



Medium Office Building Source EUI



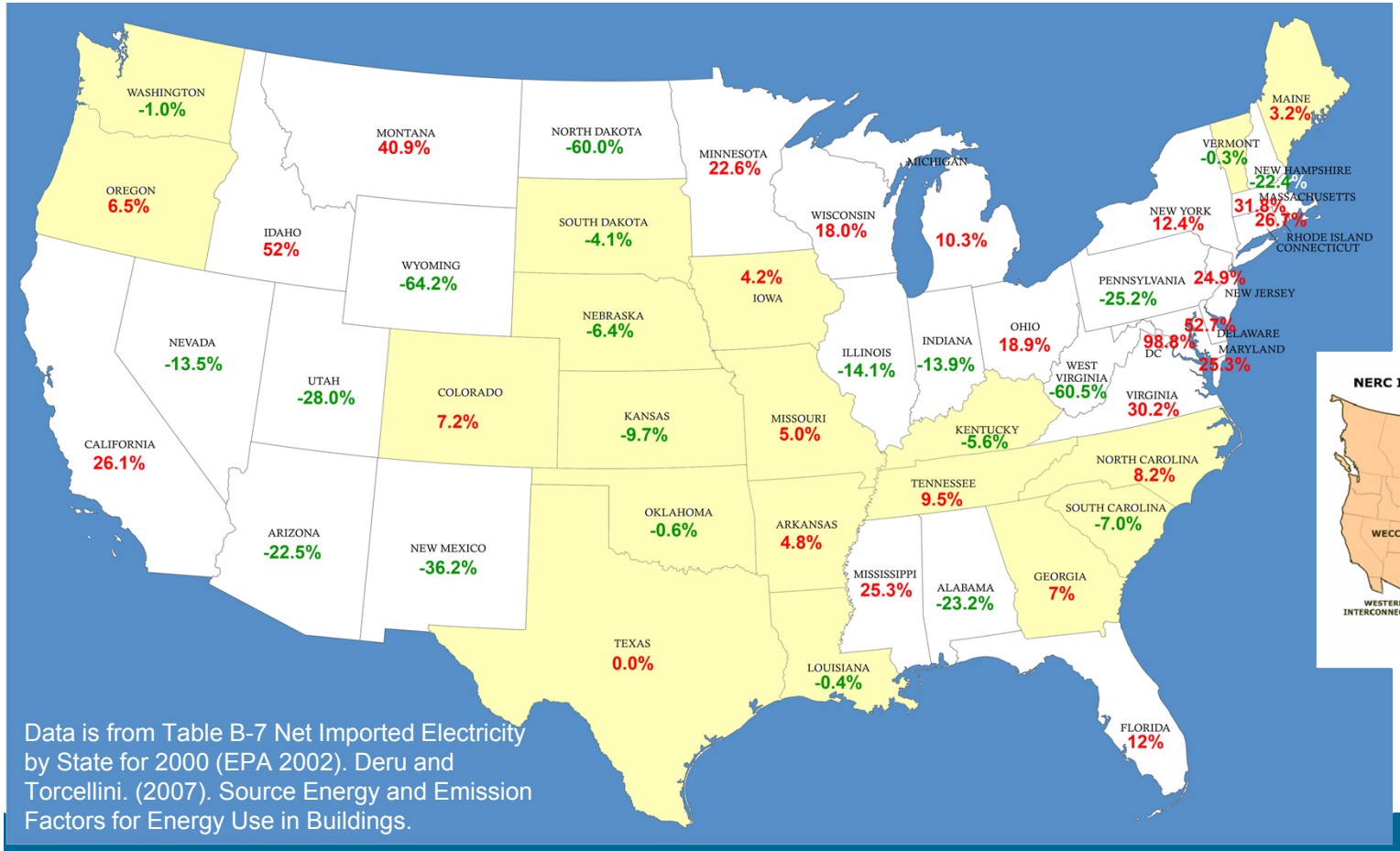
Large Office Building Source EUI

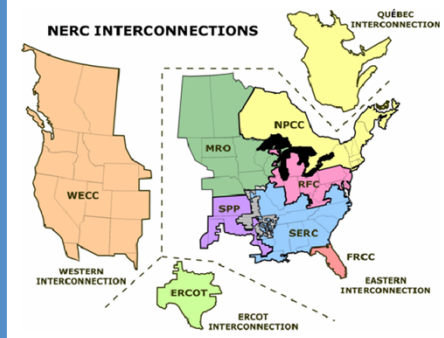


Data from Buildings Energy Data Book: 3.6 Office Building Markets and Companies

Conversion Factor: State Level

- State-level conversion factors are not good indicators.
  - Significant energy transfer between some states.
  - The source of the imported energy is difficult to account for.

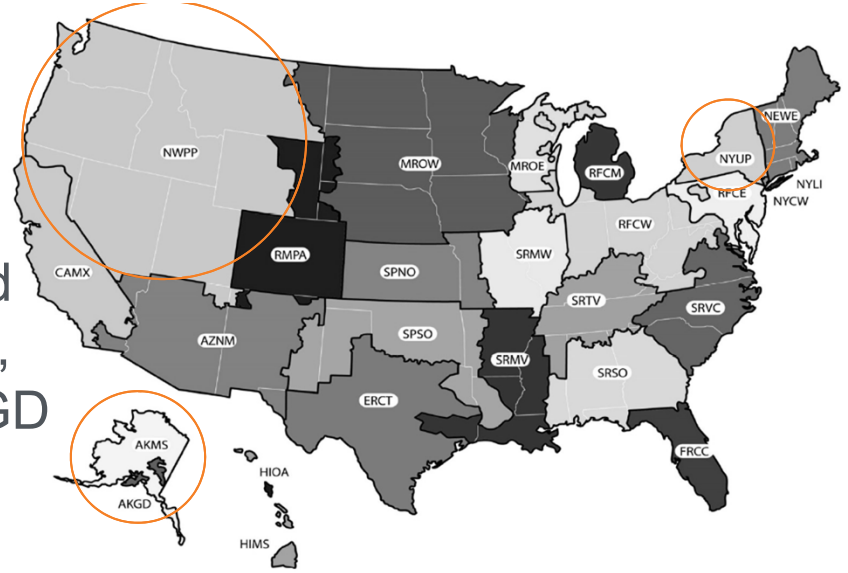


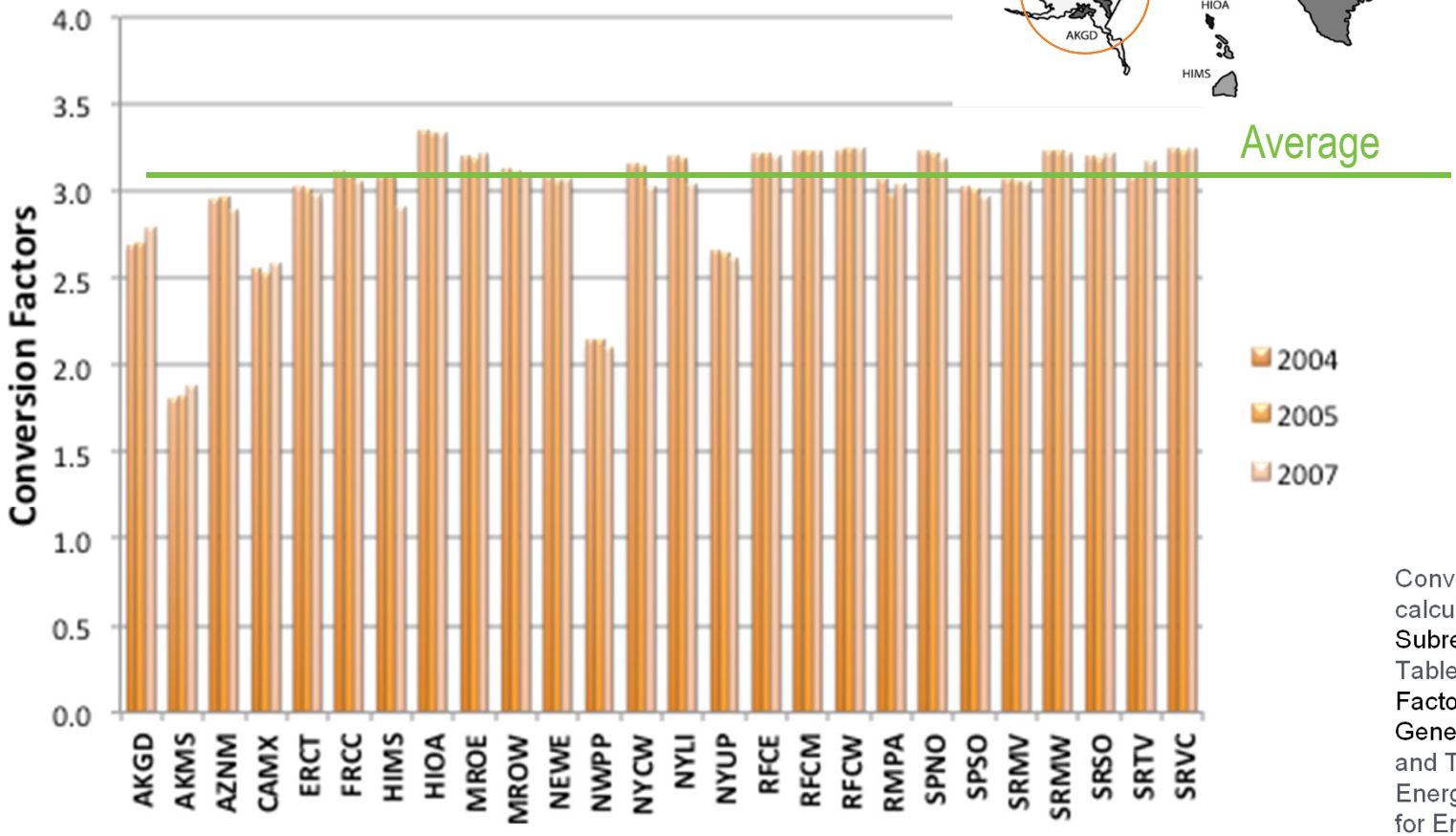


Data is from Table B-7 Net Imported Electricity by State for 2000 (EPA 2002). Deru and Torcellini. (2007). Source Energy and Emission Factors for Energy Use in Buildings.

Conversion Factor: e-Grid

- The conversion factors of most e-Grid regions are close to national average, except for AKMS, NWPP, NYUP, AKGD





Conversion factors are calculated based on eGRID Subregion Resource Mix and Table B-1 Source Energy Factors by Fuel Type for Generating Electricity. Deru and Torcellini. (2007). Source Energy and Emission Factors for Energy Use in Buildings.

Site vs. Source Energy

- **Conclusions:**

Source Energy Use Intensity calculated from National Conversion Factor is recommended to be the main metric for energy asset rating.

Other metrics may also be valuable to include as outputs to users of the rating tool.

RFI Comments: Asset Rating Scale

- Support 1-100 point scale:
  - It is similar to Portfolio Manager, familiar to people, and easily interpreted.
  - A 100-point scale provides sufficient granular data so buildings can show improvements over time as upgrades are made.
- Oppose 1-100 point scale:
  - A 100-point interval scale will appear similar to the ENERGY STAR scale, when in fact they represent fundamentally different methodologies and scopes. This lack of alignment between the two scales will make it difficult to communicate the meaning of each rating to commercial users and could cause confusion in the marketplace.

RFI Comments: Asset Rating Scale

- Support bin system:
  - A 10-point scale may be the best for asset rating, as it is intended to be a preliminary analysis
  - A significant benefit to an alphabetical rating system is a decreased need for educating the public and others on the meaning of various letter ratings.
- Support ratio scale (like zEPI):
  - The asset values of the same building characteristics should be judged differently in each location. This issue is resolved eloquently by setting the rating metric to be the ratio of the rated building's energy use to that of the same building designed to meet energy efficiency code requirements.

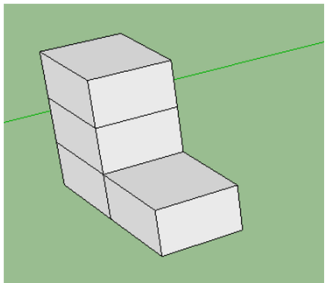
RFI Comments: Asset Rating Scale

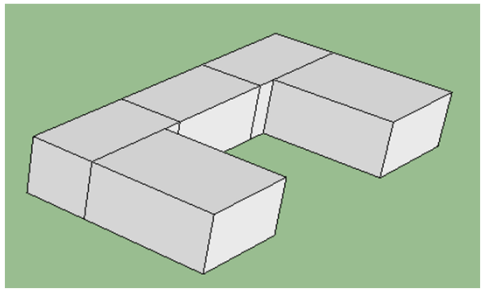
- Support net-zero:
  - The rating scale should be singular and fixed for all buildings.
- Oppose net-zero:
  - Zero-net energy would likely cause a concentration of existing building toward the middle of the scale. It could prove beneficial to use a scale that adjusts over time, with buildings competing for the top position.
  - Zero-net energy buildings are not prevalent in today's building stock, nor can they be expected in the near future. As a consequence, very high-performing buildings may not achieve the highest ratings.
- Other issue: the orientation of the scale
  - If the Asset Rating went from 100 down to 0 for net-zero, it may be confusing for people to remember if they wanted a high or a low number.
  - For the HERS scale, zero indicates a net zero energy use home, a great home. In contrast, an ENERGY STAR benchmarking rating of "1" indicates the worst possible performance.

Ratio Based Scale (NOT recommended)

Given two identical buildings except for geometry

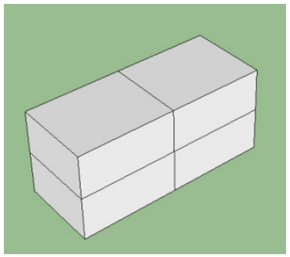
Building A: 45 kBtu/sqft
(Gas Heating)





Building B: 50 kBtu/sqft
(Gas Heating)

Compare to a standard reference building

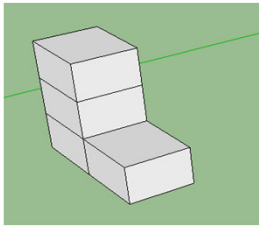


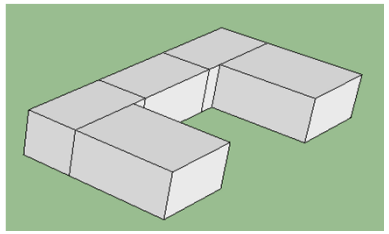
Reference building uses gas as heating fuel and EUI
45 kBtu / sqft

Building A Score: 45 / 45 = 1.00
Building B Score: 50 / 45 = 1.11

- Influence of geometry considered.
- Issue of selecting the proper reference building.
- Limited fuel type in reference buildings.

Compare to a code compliant version of itself





Code compliant version of both buildings use same fuel

Building A Code Complaint: 45 kBtu / sqft (Gas Heating)
Building B Code Complaint: 50 kBtu / sqft (Gas Heating)

Building A Score: 45 / 45 = 1.00
Building B Score: 50 / 50 = 1.00

- Influence of geometry not considered

Weather Normalization (for 100pt scale)

Given the modeled EUI a candidate building of Type A located near Weather Station Site B

$$\text{Weather Normalized EUI}_{\text{Building1, Type A, weather Site B}} = \text{Modeled EUI}_{\text{Building1, Type A , Weather Site B}} \times \text{Normalization Coefficient}_{\text{Type A, Weather Site B}}$$

The normalization coefficient for a given Weather Station Site is calculated by dividing the average of the modeled EUI of all DOE Reference Buildings modeled using weather data from the station by the average of EUIs obtained by modeling all DOE Reference Buildings in all Weather Station Sites.

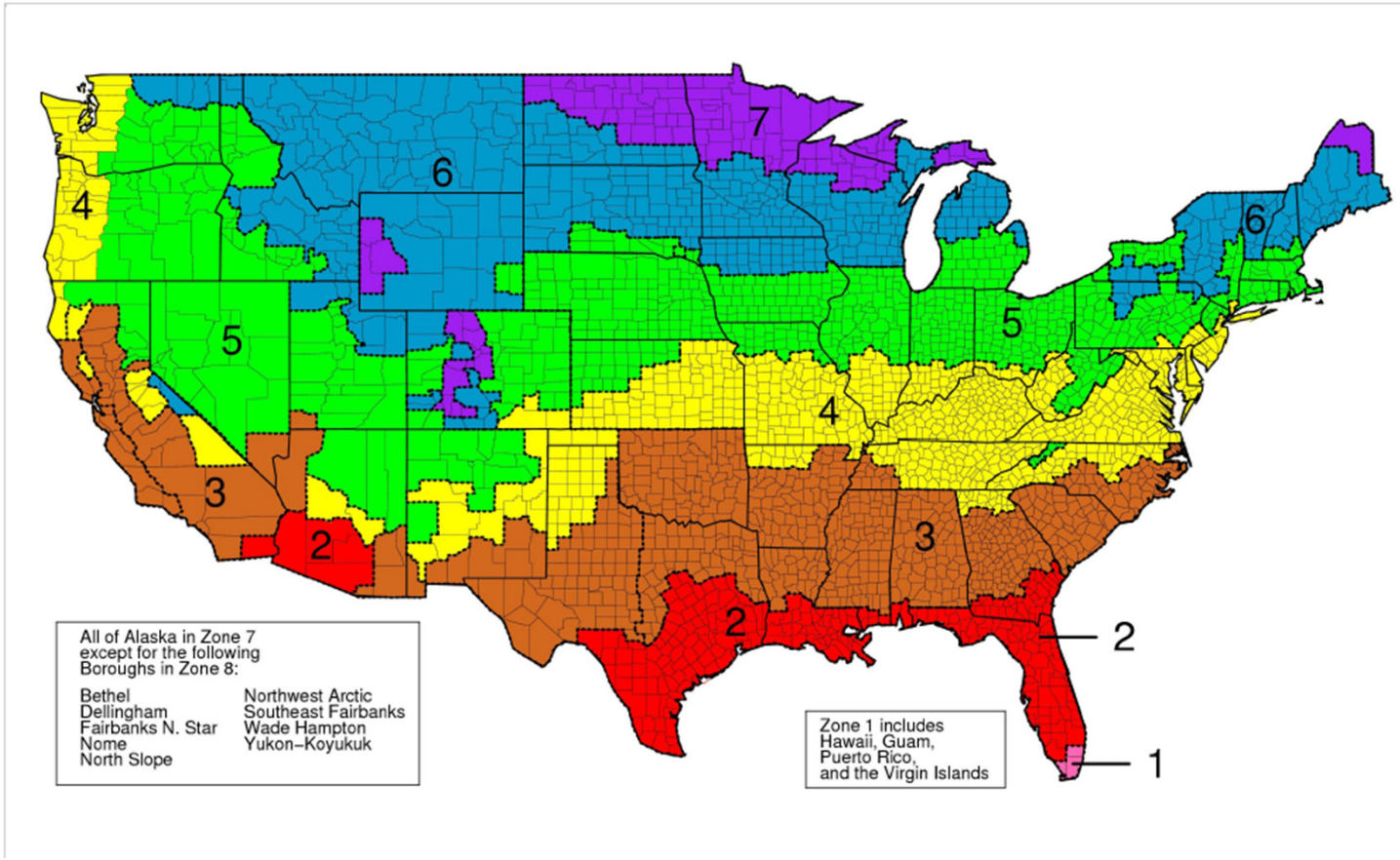
$$\text{Normalization Coefficient}_{\text{Type A, Weather Site B}} = \frac{\text{EUI}_{\text{Reference Building Type A, Weather Site B}}}{\text{AVG EUI}_{\text{Reference Building Type A , All Weather Sites}}}$$

Assumptions

- The response of all buildings to weather is similar
- Even though the response is not identical, it will be in the same direction
- The normalized EUI is only used to develop a 100 point scale, not to represent the building energy use, which should be the modeled EUI.

Climate Zone and Weather Location

Energy Code Climate Zones



Weather Normalization

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

1. Modeled EUI for 9 DOE Reference Buildings in 15 weather station sites

		Miami	Houston	Phoenix	Atlanta	Los Angeles	San Francisco	Baltimore	Albuquerque	Seattle	Chicago	Denver	Minneapolis	Helena	Duluth	Fairbanks	
	Climate Zone	**1A**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**6A**	**6B**	**7**	**8**	**Average**
Pre 1980	Large Office	69	69	65	69	58	54	73	58	61	64	55	69	60	71	90	65.31
Pre 1980	Medium Office	73	70	76	70	56	53	71	67	61	71	66	78	72	83	112	71.94
Pre 1980	Small Office	77	79	83	82	64	66	92	85	80	99	90	112	101	126	180	93.69
Post 1980	Large Office	65	65	62	63	57	51	64	54	55	63	55	67	58	69	89	62.13
Post 1980	Medium Office	66	63	65	60	55	51	63	58	57	66	59	71	64	74	98	64.50
Post 1980	Small Office	70	67	69	66	57	55	67	64	60	72	66	78	72	82	109	69.94
New Construction	Large Office	56	55	53	50	44	44	52	43	44	51	44	55	48	55	67	50.38
New Construction	Medium Office	51	51	51	47	41	43	50	46	45	52	47	57	51	59	75	50.81
New Construction	Small Office	52	51	53	47	41	41	51	47	47	54	49	59	54	61	83	52.25
		1.06	1.06	1.00	1.06	0.89	0.83	1.12	0.89	0.93	0.98	0.84	1.06	0.92	1.09	1.38	
		1.01	0.97	1.06	0.97	0.78	0.74	0.99	0.93	0.85	0.99	0.92	1.08	1.00	1.15	1.56	
		0.82	0.84	0.89	0.88	0.68	0.70	0.98	0.91	0.85	1.06	0.96	1.20	1.08	1.34	1.92	
		1.05	1.05	1.00	1.01	0.92	0.82	1.03	0.87	0.89	1.01	0.89	1.08	0.93	1.11	1.43	
		1.02	0.98	1.01	0.93	0.85	0.79	0.98	0.90	0.88	1.02	0.91	1.10	0.99	1.15		
		1.00	0.96	0.99	0.94	0.82	0.79	0.96	0.92	0.86	1.03	0.94	1.12	1.03	1.17		
		1.11	1.09	1.05	0.99	0.87	0.87	1.03	0.85	0.87	1.01	0.87	1.09	0.95	1.09		
		1.00	1.00	1.00	0.92	0.81	0.85	0.98	0.91	0.89	1.02	0.92	1.12	1.00	1.16		
		1.00	0.98	1.01	0.90	0.78	0.78	0.98	0.90	0.90	1.03	0.94	1.13	1.03	1.17	1.59	
		1.03	1.01	1.01	0.95	0.84	0.82	0.99	0.89	0.88	1.02	0.91	1.11	0.99	1.14	1.48	
	Average	1.010	0.993	1.001	0.956	0.824	0.799	1.004	0.896	0.880	1.018	0.911	1.108	0.993	1.158	1.525	

3. Coefficient for each building obtained by dividing its EUI, by (2)

4. Normalization Coefficient for each Climate Zone (average of coefficient of 9 buildings)

2. Average EUI of the same building in all climate zones

Calculated for 15 Climate Zones based on EUI (kBtu/ft2/yr) from DOE Commercial Reference Buildings, September 2010

Example: Medium office (new construction)

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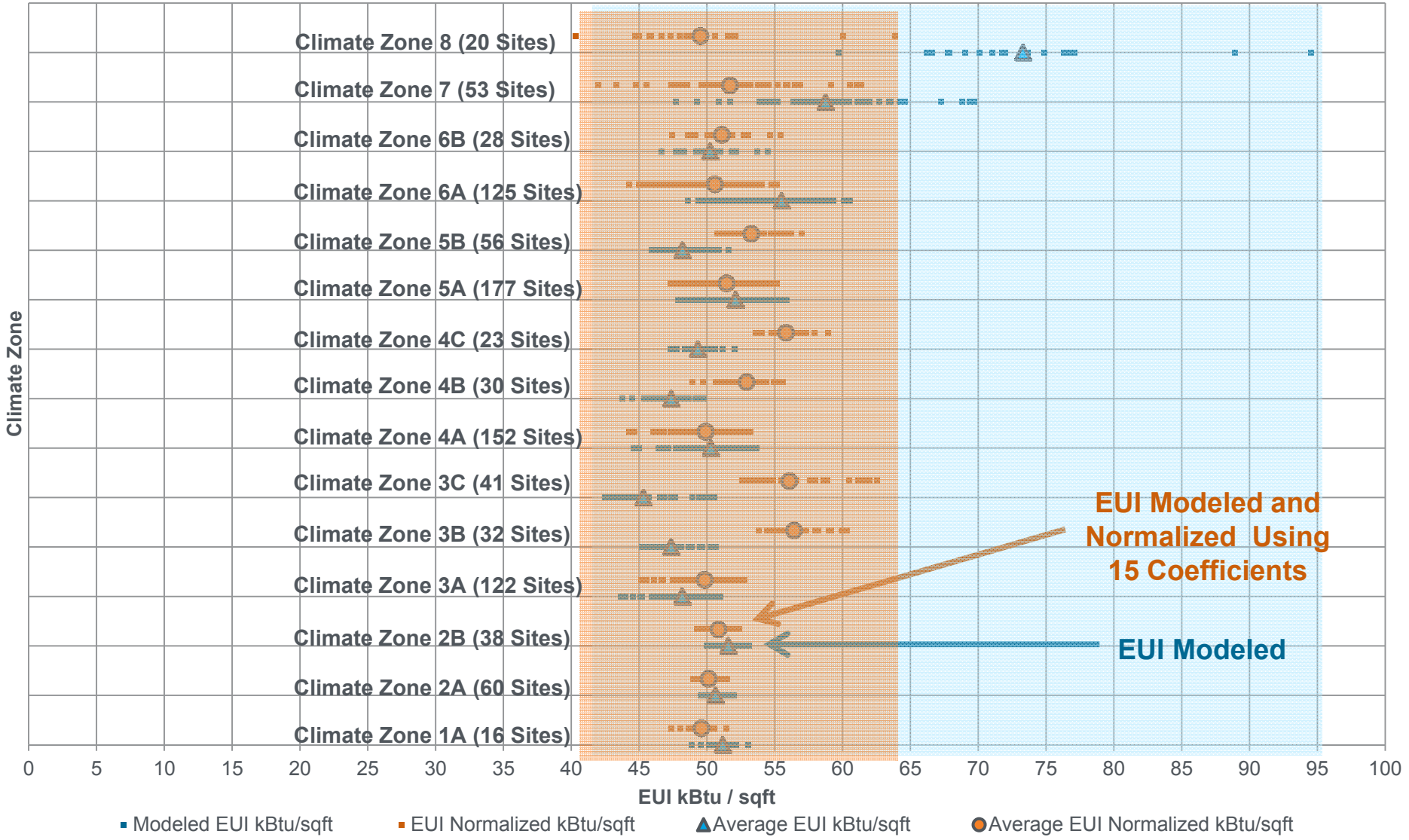


Weather Normalization

- Weather normalization reduces the standard deviation of modeled EUI.

Descriptive Statistics: DOE Reference Building Medium Office Modeled EUI and Modeled EUI Normalized using 15 coefficients

	All EUI	All EUI Normalized (15 Coefficients, one per Climate Zone)	All EUI Normalized (973 Coefficients, one per Weather Site)
Mean	51.50	51.33	
Standard Error	0.16	0.09	
Median	50.64	50.99	
Mode	46.95	46.59	
Standard Deviation	**5.01**	**2.79**	
Sample Variance	25.06	7.79	
Kurtosis	13.17	2.22	
Skewness	2.64	0.69	
Range	52.02	23.53	
Minimum	42.52	40.35	
Maximum	94.54	63.88	
Sum	50114.05	49946.43	
Count	973.00	973.00	
Coefficient of Variation	9.72	5.44	

Weather Normalization

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

1. Modeled EUI for 9 DOE Reference Buildings (local code compliant) in 973 weather station sites

DOE Reference Building (Offices) Modeled EUI																														
	Climate zone	**1A**				**2A**				**2B**	**3A**	**3B**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**6A**	**6B**	**7**	**8**	
	Weather Station	Site 1	Site 2	…	Site 16	Site 1	Site 2	…	Site 60															
Pre 1980	Large Office																							
	Medium Office																							
	Small Office																							
Post 1980	Large Office																							
	Medium Office																							
	Small Office																							
New Construction	Large Office																							
	Medium Office																							
	Small Office																							
Average EUI for each station		1A AVG Site 1	1A AVG Site 2	…	1A AVG Site 16	1A AVG Site 1	1A AVG Site 2	…	1A AVG Site 60															Average EUI for all Buildings
Normalization Coefficient (Average EUI for each station / Average EUI for all buildings)		(1A AVG Site 1 / AVG all Bldgs)																						

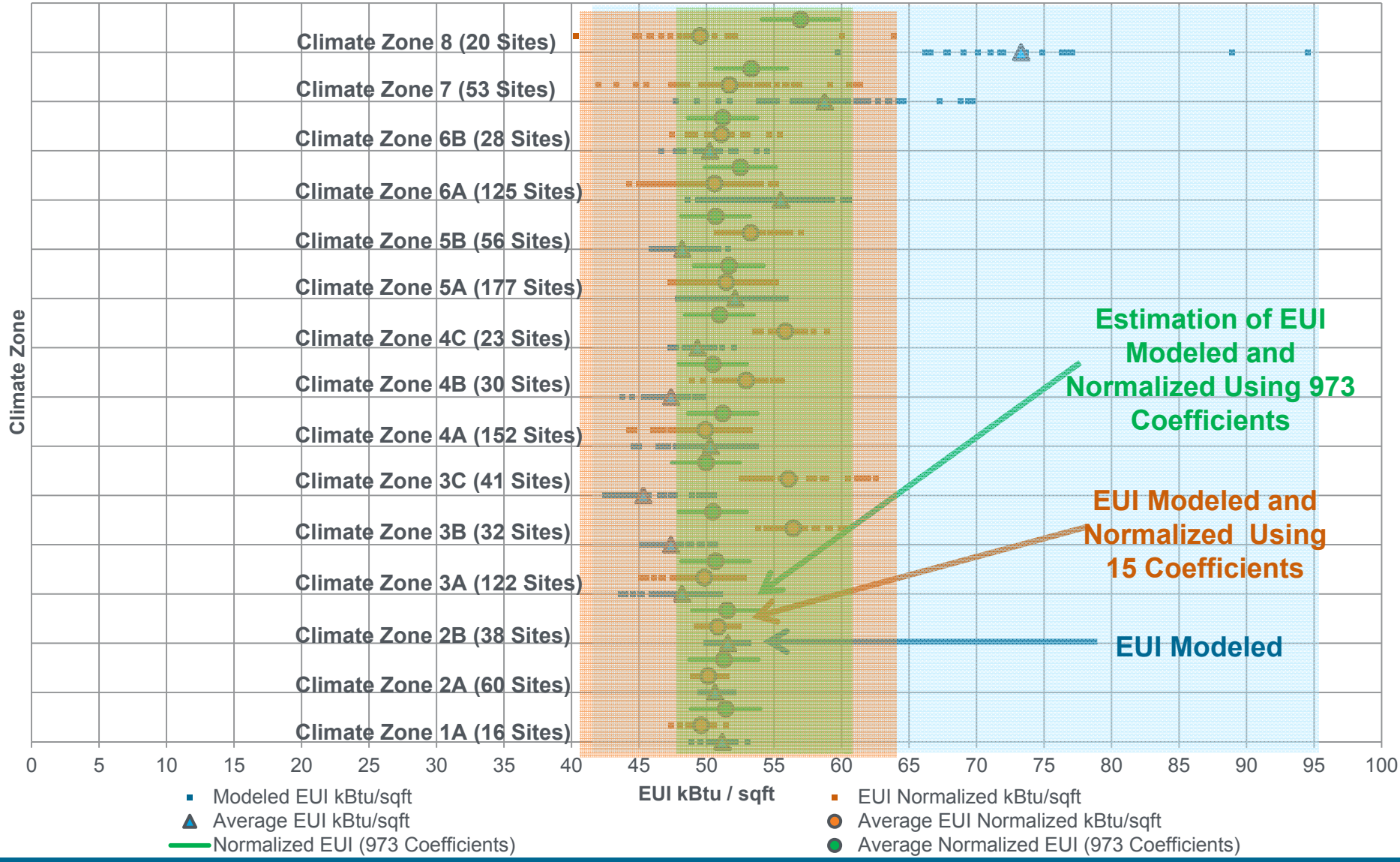
2. Average EUI for 9 buildings in each weather site

4. Normalization coefficients for each weather site: (2) divided by (3)

3. Average EUI for 8757 buildings

Example: Medium office (new construction)

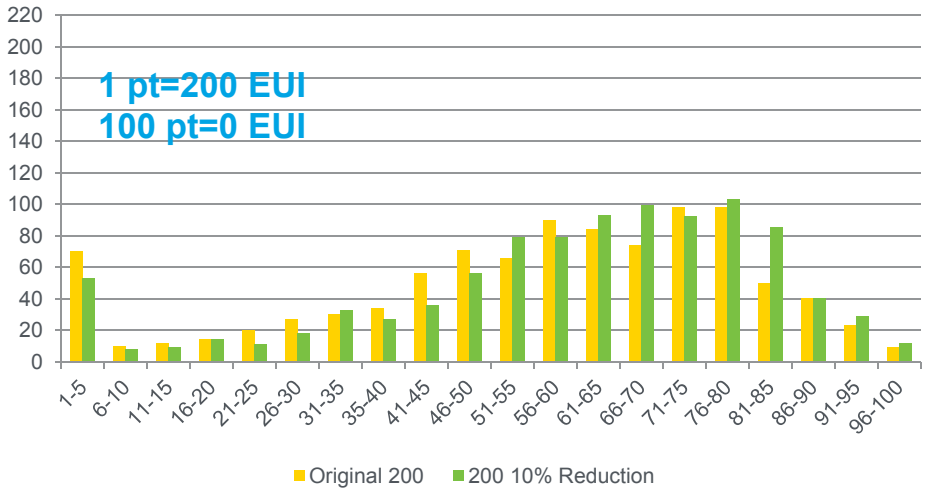
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

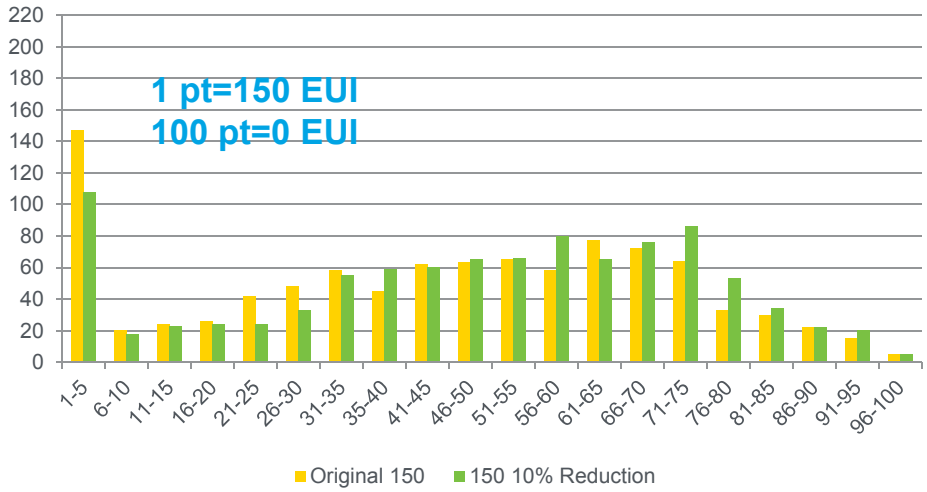


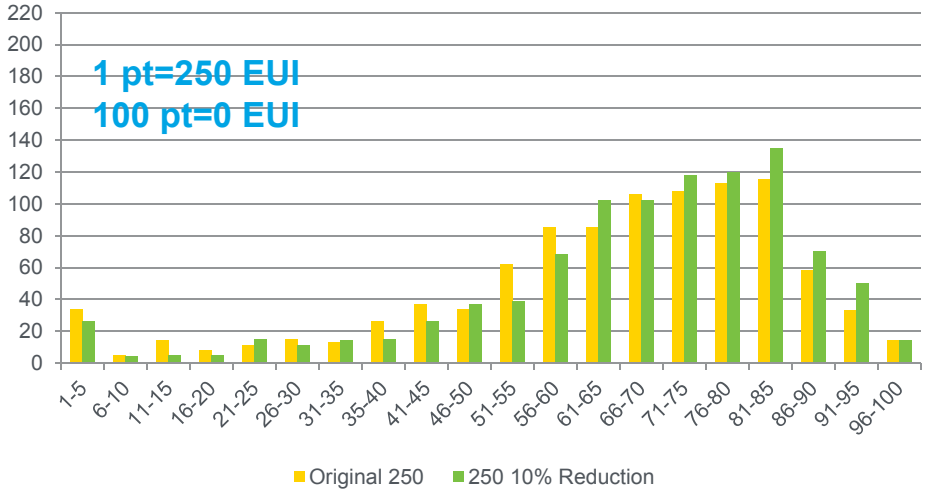
Setting the width of scales

- Use CBECS measured data to test how the distribution of scores is changed when different EUI values are selected for the non-zero end of the scale.
- The diagrams show scales using several different EUI values for the endpoint.
- CBECS data is NOT used to create asset rating.

Office buildings







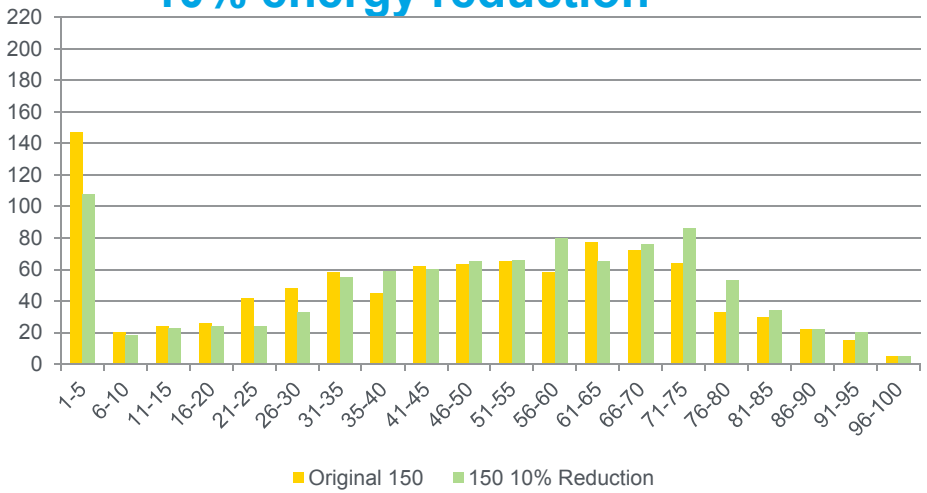
1-100 Point Scale

- Asset rating scale should reflect building energy improvement overtime.

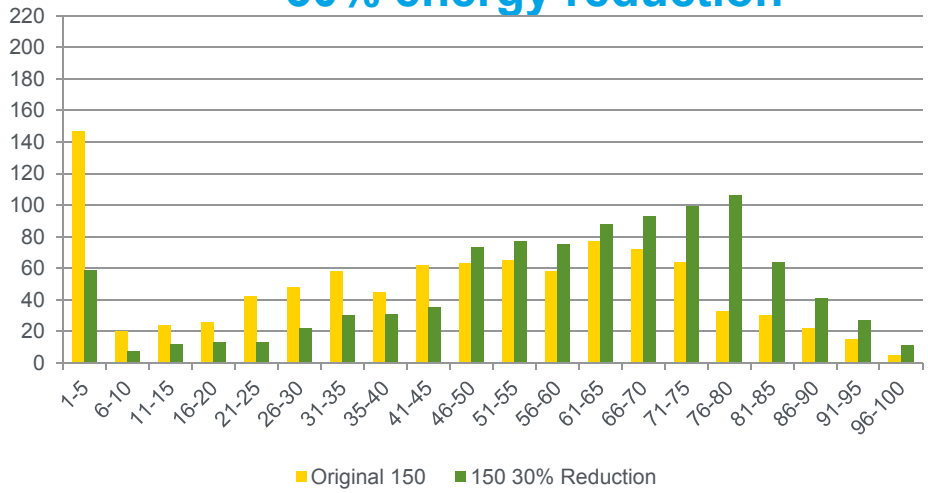
Office buildings

1 pt=150 EUI
100 pt=0 EUI

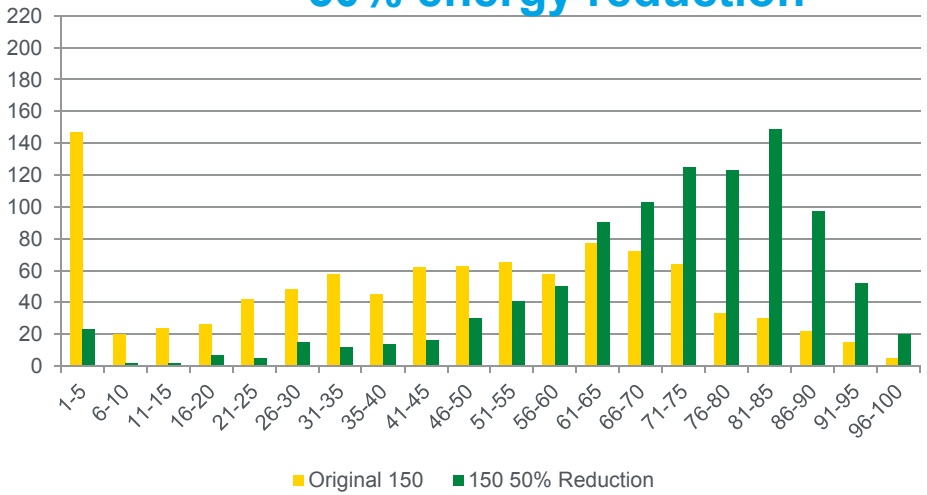
10% energy reduction



30% energy reduction

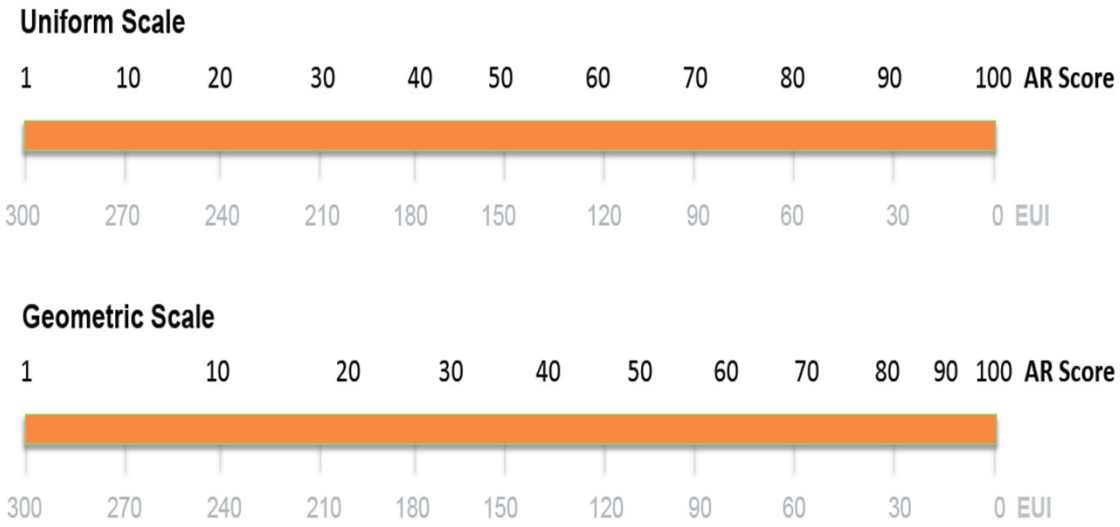


50% energy reduction



Uniform Scale vs. Geometric Scale

- Different levels of upgrades are reflected in the potential AR score for all levels of building efficiency.



AR score	Modeled EUI (Uniform)	Modeled EUI (Geometric)
100	0	0
99	3	1
98	6	2
97	9	3
96	12	4
…		
52	156	100
51	153	105
50	150	110
49	147	115
48	143	120
…		
5	285	260
4	288	270
3	291	280
2	294	290
1	300	300

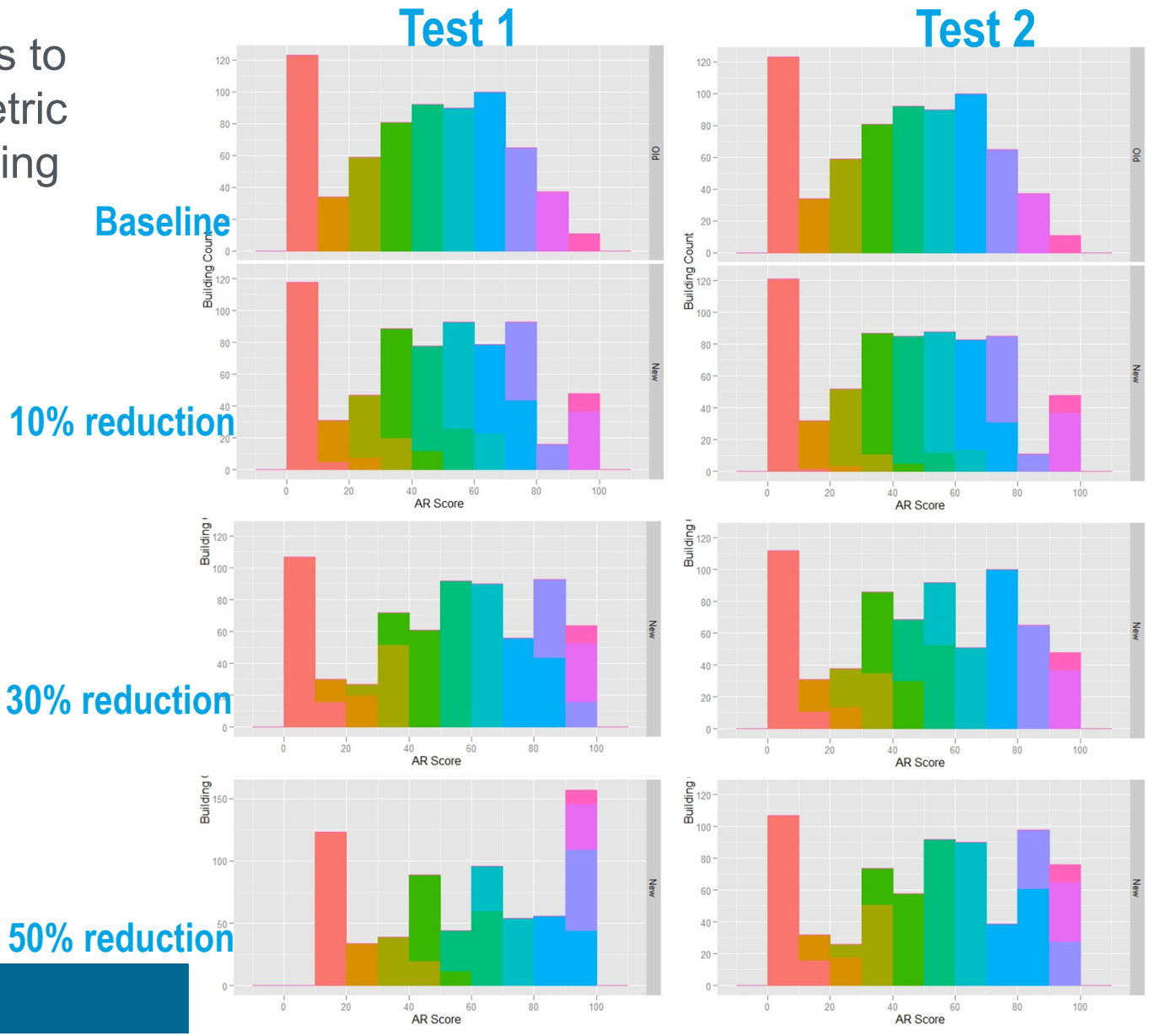
Uniform Scale vs. Geometric Scale

- **Uniform Scale**
  - Easy to understand.
  - Relatively easy for buildings at the low end to move up along the scale.
  - Does not accurately value improvements of high-performance buildings.
- **Geometric Scale**
  - Value high-performance buildings more accurately.
  - Difficult for a first-time user to understand.
  - Less transparent.

Buildings	EUI	EUI after 20% reduction	Uniform Scale		Geometric Scale	
			AR before upgrades	AR after upgrades	AR before upgrades	AR after upgrades
Low end	300	240	1	20	1	9
Mid end	150	120	50	60	38	45
High end	12	10	96	97	90	93

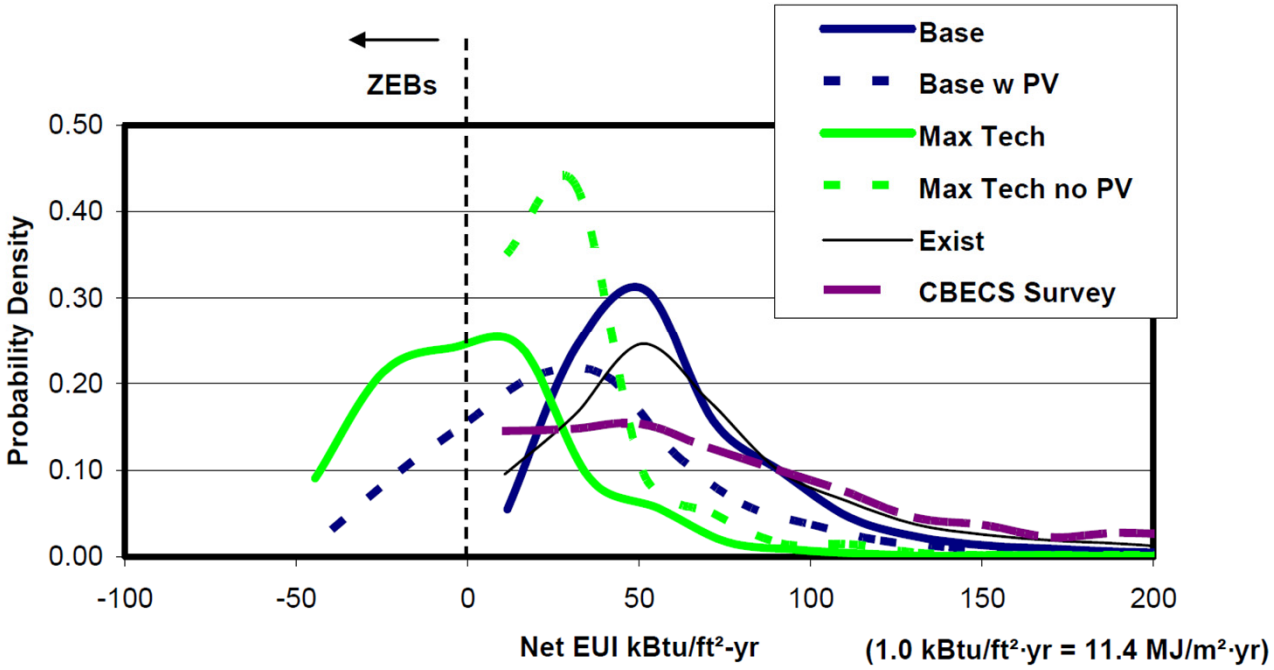
Evaluation of Geometric Scale

- Different ways to create geometric scales are being evaluated.



Net Zero

- How low can buildings practically go in terms of energy use?
- How to consider renewable? (Asset Rating is about building energy efficiency. Zero-end is used as a reference point.)



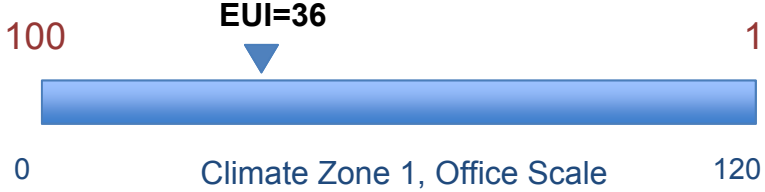
" The results show that the addition of energy efficiency decreases the amount of spread in EUIs and the addition of on-site PV increases the spread. "

Source: NREL/TP-550-41957, December 2007

Mixed-Use Buildings

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building A (100% Office)
AR=70
EUI=36



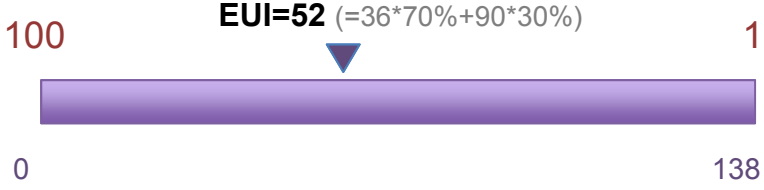
Basic Building Type: Office

Building B (100% Retail)
AR=50
EUI=90

Basic Building Type: Retail

Mixed-use building Option 1 (Prorated EUI)

Building C (70% Office, 30% Retail)
AR=62
EUI=52 (=36*70%+90*30%)



A new scale for Climate Zone 1
70% Office + 30% Retail

Step 1: Model the whole building EUI
Step 2: Construct a new scale weighing each space type
Step 3: Compare the EUI against the new scale

Mixed-use building Option 2 (Prorated Score)

Building C (70% Office, 30% Retail)
AR=64 (=70*70%+50*30%)

Climate Zone 1, No need to build a new scale

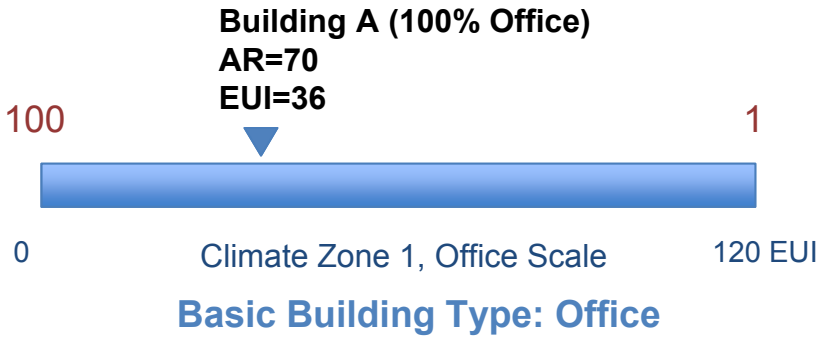
Recommended

Step 1: Model EUI for each space type
Step 2: Compare each EUI against the corresponding scale of the basic building type
Step 3: Calculate the new rating weighing the individual ratings

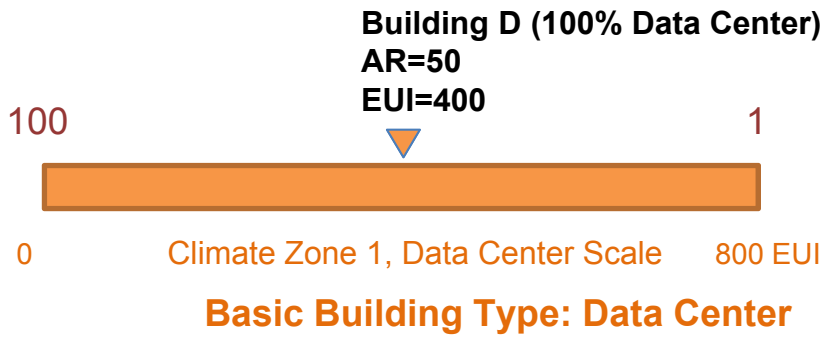
Consider pro-rating based on energy rather than square footage.

Mixed-Use Buildings

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

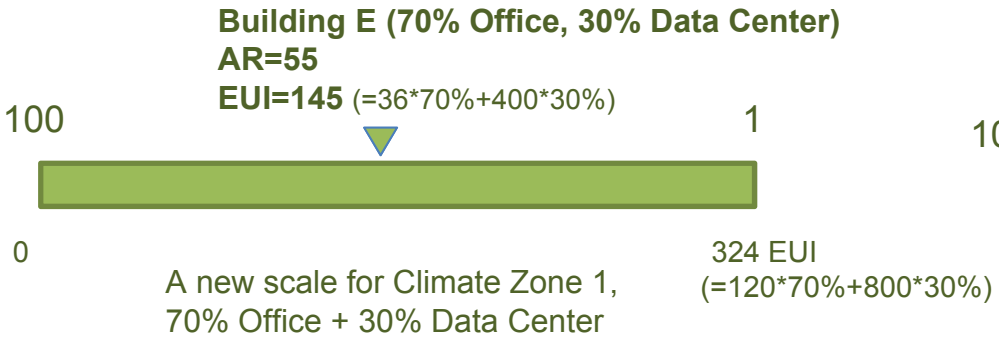


Basic Building Type: Office



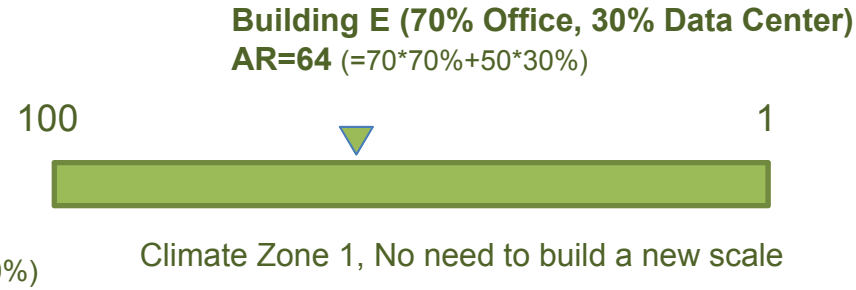
Basic Building Type: Data Center

Mixed-use building Option 1 (Prorated EUI)



When one basic building type has much larger EUI range than the other(s) (e.g. 800 EUI of data center compared with 120 EUI of office), the rating of the mixed-use building is heavily influenced by the building type with large EUI range.

Mixed-use building Option 2 (Prorated Score)



With this method, the main space type and its rating is better reflected. However, the EUI of each space type needs to be calculated separately.

Recommended

Questions and Discussions

AFTER 15 MINUTES BREAK

SESSION No. 2
Asset Rating Tool Development
1-4:30PM, December 8, 2011

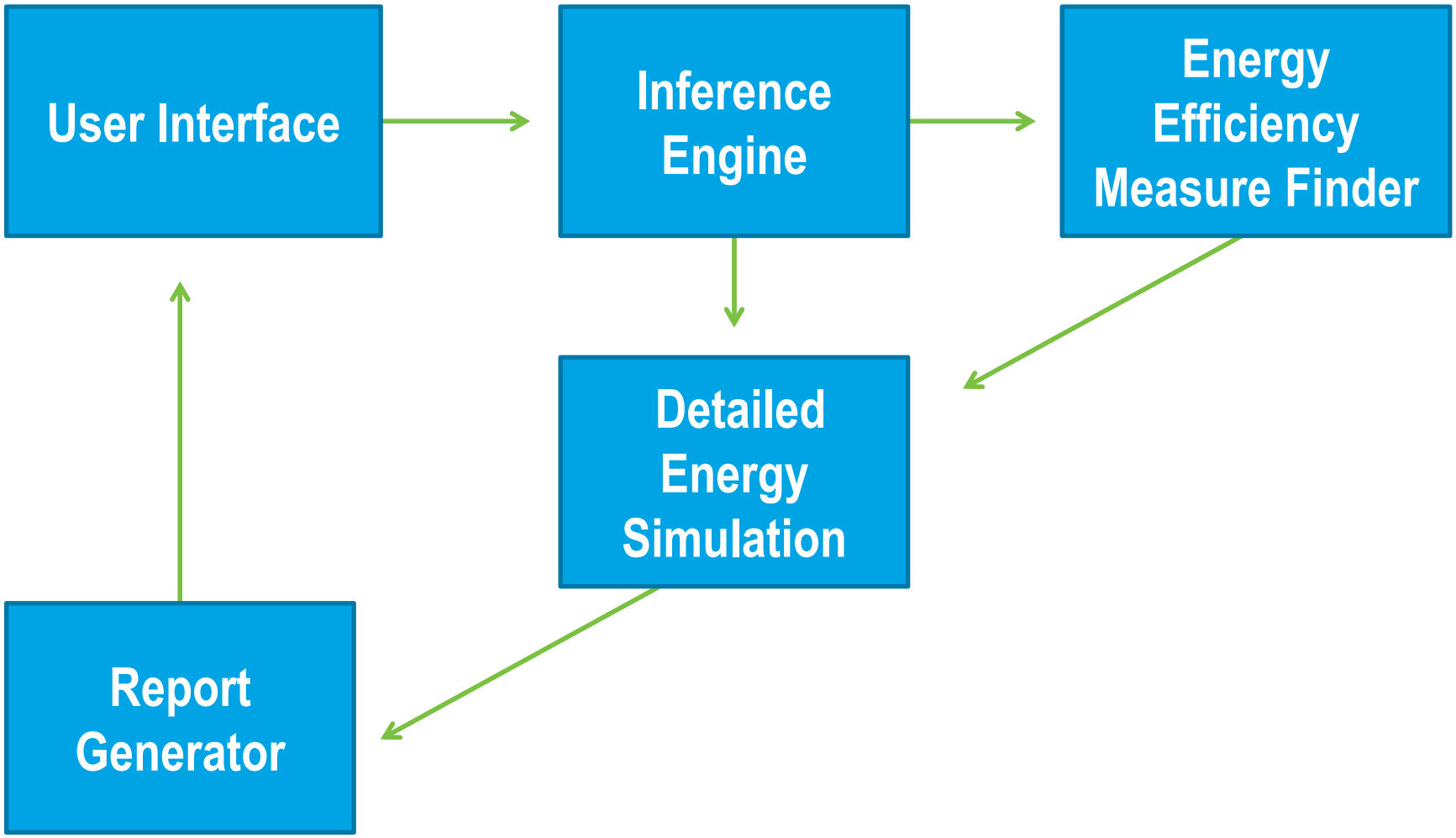
Options Considered

- Building Energy Model Pre-Simulation
  - Divide the likely range of variables of interest into steps and simulate the resulting feasible combinations of variables
  - Predict energy use through regression or interpolation of pre simulated model results
- Utility Data Disaggregation
  - Use utility data patterns to identify the issues with individual assets
- Simplified Energy Model
  - Use simplified energy modeling approach to predict and compare the energy use of a particular asset configuration
- Detailed Energy model
  - Use detailed, first principals energy model to rate asset performance

Options Considered, Findings

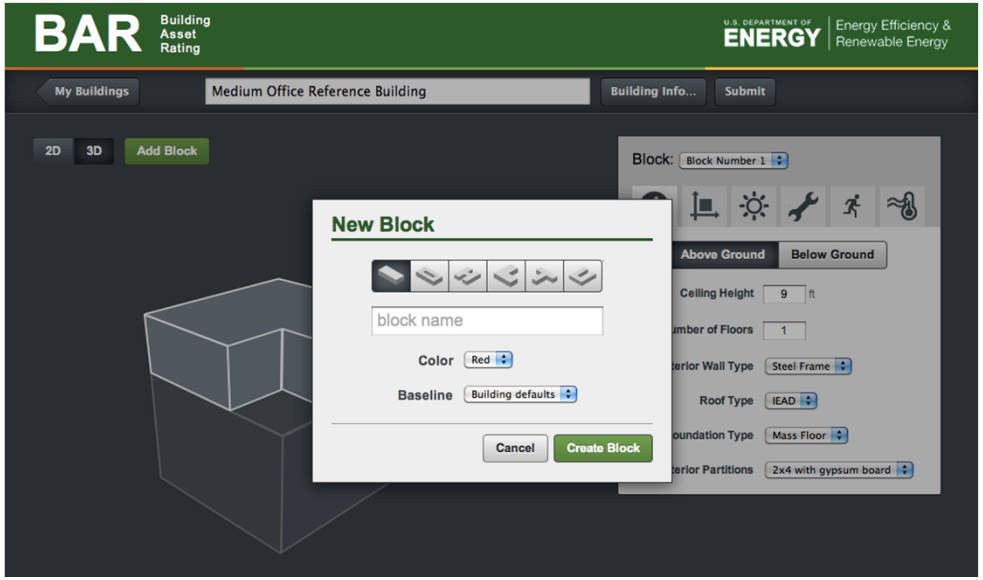
- Building Energy Model Pre-Simulation
  - Lacked flexibility and extensibility desired
- Utility Data Disaggregation
  - Generally more useful as an operational performance assessment tool
  - Requires higher level of energy consumption data detail than is typically available
- Simplified Energy Model
  - Discomfort with the simplifications required could hinder buy-in
  - Level of input detail required in line with expected user effort
- Detailed Energy model
  - Approach would provide the confidence in results required to make tool viable
  - Level of input detail required would likely make tool cumbersome to all but the most experienced users

AR Tool Overview



Data Collection and Input

- Users can enter varying amounts of data and receive results of varying degrees of specificity to their building. Two key levels:
  - Level 1 user
    - Basic minimum input set
    - A user must have at least this much data to begin using the tool
  - Level 2 user
    - More detailed minimum input set
    - Suitable for making public statements about a building's rating



Data Collection and Input

- Level 1 input set
  - Required for level 1 report
  - Simple to find, highly variable building characteristics
    - Floor area, building age, heating fuel type, etc.
  - Moderately difficult to collect, impactful variables
    - Cooling technology, heating technology, window wall ratio, etc.
  - Any other known values can be entered to improve accuracy
  - Remaining building characteristics inferred based on the minimum set

Data Collection and Input

- Level 2 input set
  - Required for level 2 report
  - Consists of minimum set plus all moderately difficult to obtain characteristics
    - Air distribution type, equipment efficiency, etc.
  - Any other known values can be entered to improve accuracy
  - Remaining building characteristics inferred based on the required variable set, only highly difficult to obtain variables will be inferable for official report
    - Infiltration, fan blade efficiency, etc.

Data Input

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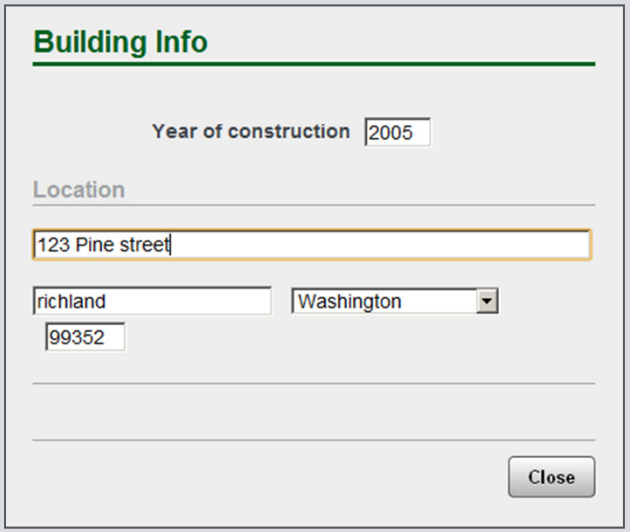

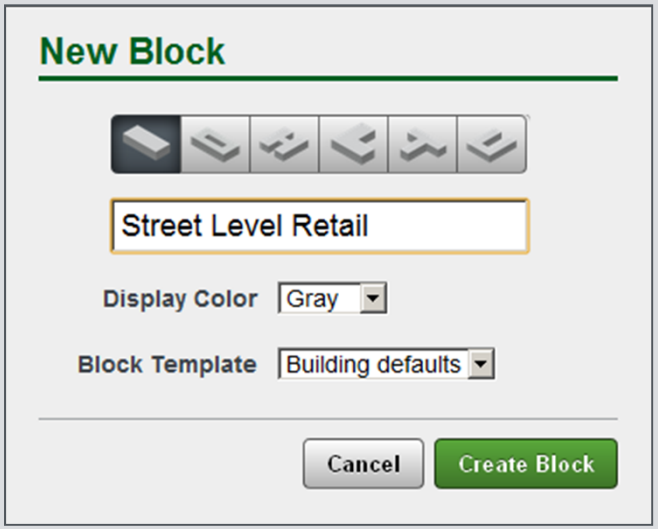

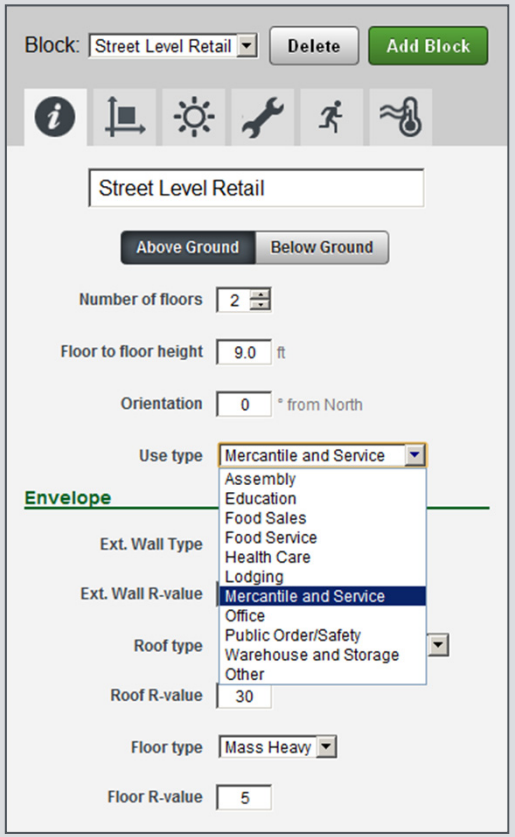

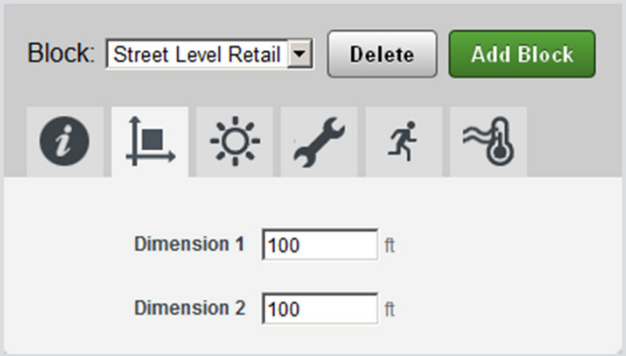

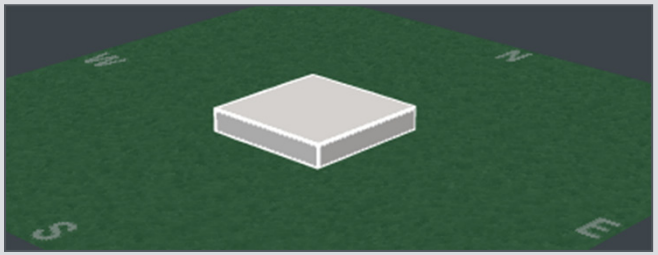

Input Data Overview

Variable Type	Description	Inferable For Level 1	Inferable For Level 2
1	Simple to obtain with low variability/Simple to obtain with low impact and medium variability	Yes	No
2	Simple to obtain with high variability/Simple to obtain with medium or high impact and medium variability	No	No
3	Moderately difficult to obtain with low variability and medium or high impact/Moderately difficult to obtain with moderate variability and medium impact	Yes	No
4	Moderately difficult to obtain with high variability and high or medium impact/Moderately difficult to obtain with medium variability and high impact	No	No
5	Moderately difficult to obtain with low variability	Yes	No
6	Highly difficult to obtain with low variability/Highly difficult to obtain with high or medium variability and low impact	Yes	Yes
7	Highly difficult to obtain with high or medium impact	Yes	Potentially

AR Tool Demo (under development)

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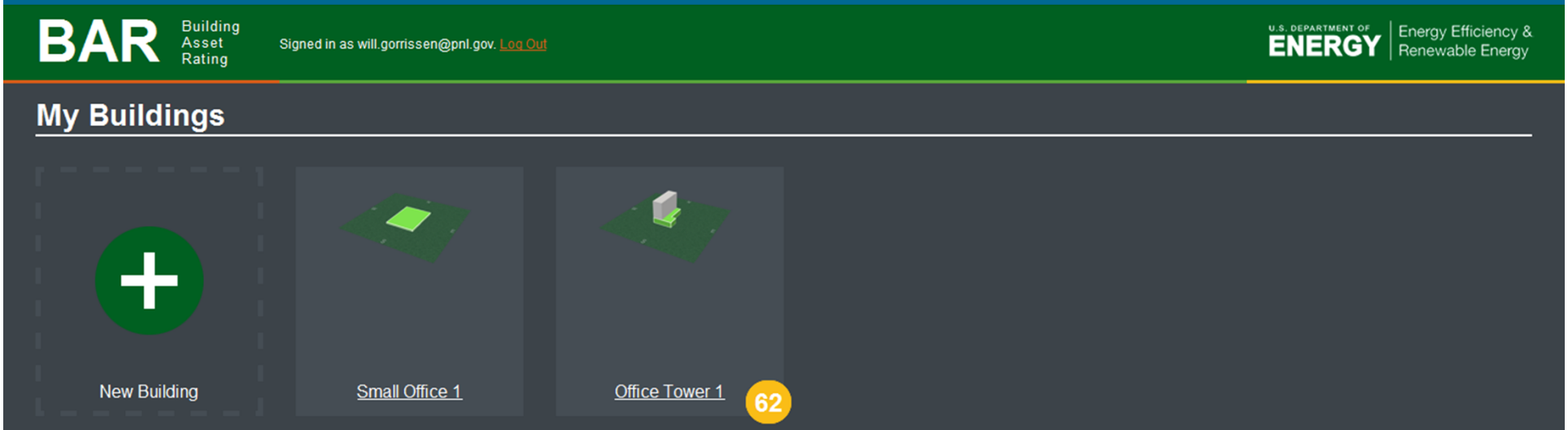
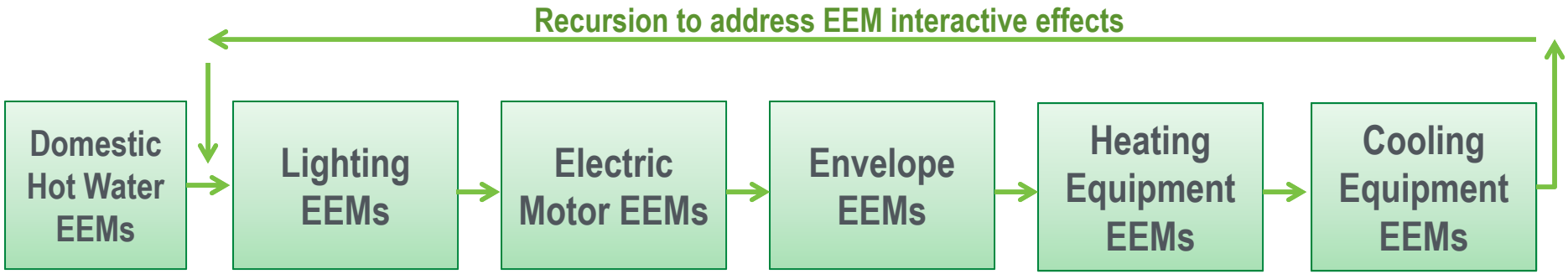


Inferences

- Inferences derived from multiple data sources and techniques
  - Dummy variable OLS regression of CBECS data, variables based on: Age, Use Type, Size, Climate.
  - Equipment efficiency standards
  - Building energy codes and adoption rates
  - ASHRAE handbooks
    - Fundamentals
    - HVAC Systems and Applications
  - Energy model internal system sizing algorithms
  - Pervious research

Opportunity Identification

- AR tool will provide building specific, potential energy efficiency measure (EEM) opportunities.
  - EEMs will be calculated based on life cycle cost (LCC) optimized simplified energy model
    - Recursive optimization, repeats until convergence to minimum LCC package

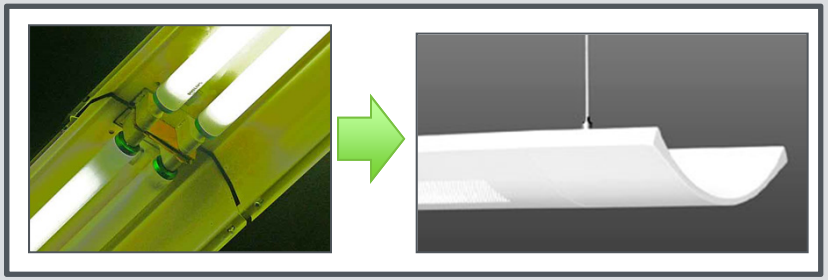


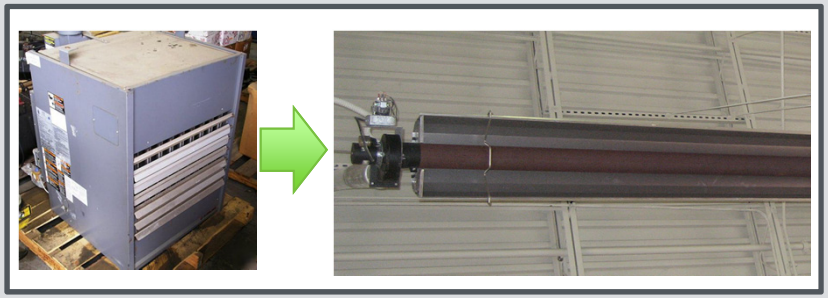
Opportunity Identification

- Simplified energy model used for EEM energy savings estimation
  - Simplified energy model based on CLTD/CLF method outlined in ASHRAE fundamentals
- NIST Building Life-Cycle Cost (BLCC) analysis algorithms used to rank EEMs
  - Regional energy and equipment costs will be used
    - Energy costs based on COMNET default TOU energy costs
    - Material and labor costs adjusted for state level differences

Example EEM Opportunities

- Domestic Hot Water
  - Up grade existing gas hot water heater to 94% efficient unit
- Lighting
  - Replace Existing T12 lighting with HO T8 luminaires
- Heating
  - Replace gas unit heaters with gas infrared heating
- Cooling
  - Upgrade air cooled chiller to high efficiency water cooled chiller





Asset Rating Energy Model

- Modeling approach
  - Environmental conditions for simulation based on TMY3 weather file developed fro the nearest available weather station to the candidate buildings.
  - Detailed model inputs automatically tailored to candidate buildings
  - User inputs and inferences auto generate energy model input file, user never interacts with energy model inputs

Asset Rating Energy Model

- EnergyPlus used to simulate the asset performance of as-is and EEM user building cases
  - State of the art, sub-hourly timestep first principals energy model
  - Capabilities far greater than currently required by AR tool, allowing future expansion in response to user needs
  - Long-term external support available for EnergyPlus
  - Growing suite of tools built for EnergyPlus allows for future external interaction with AR tool
    - OpenStudio
    - BIM

AR Tool Model Results

- AR modeling tools to produce:
  - Annual energy consumption normalized by floor area for asset as specified by user
  - Energy end use break down given asset operating conditions
  - Asset tailored EEM opportunities
- Above results will be then used to generate either a precertification report or a certification report, based on user credentials.

AR Certificate

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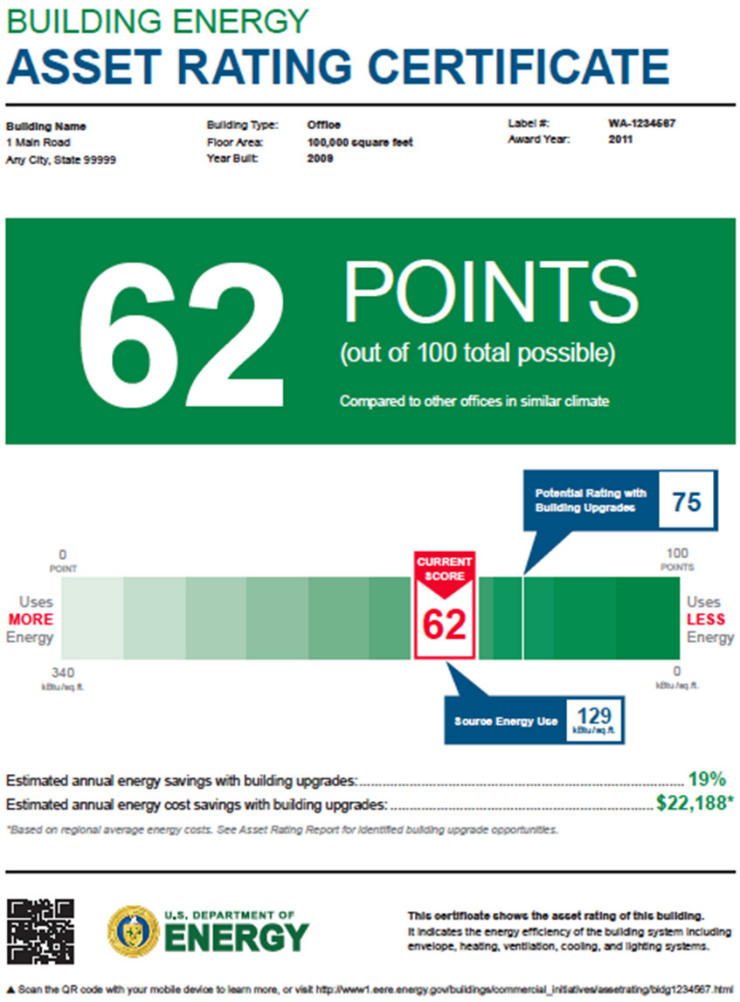
- Two labels were shown to focus groups



BUILDING ENERGY
ASSET RATING CERTIFICATE

Building Name
1 Main Road
Any City, State 99999

Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009

Label #: WA-1234567
Award Year: 2011

62 POINTS
(out of 100 total possible)
Compared to other offices in similar climate

Potential Rating with Building Upgrades 75

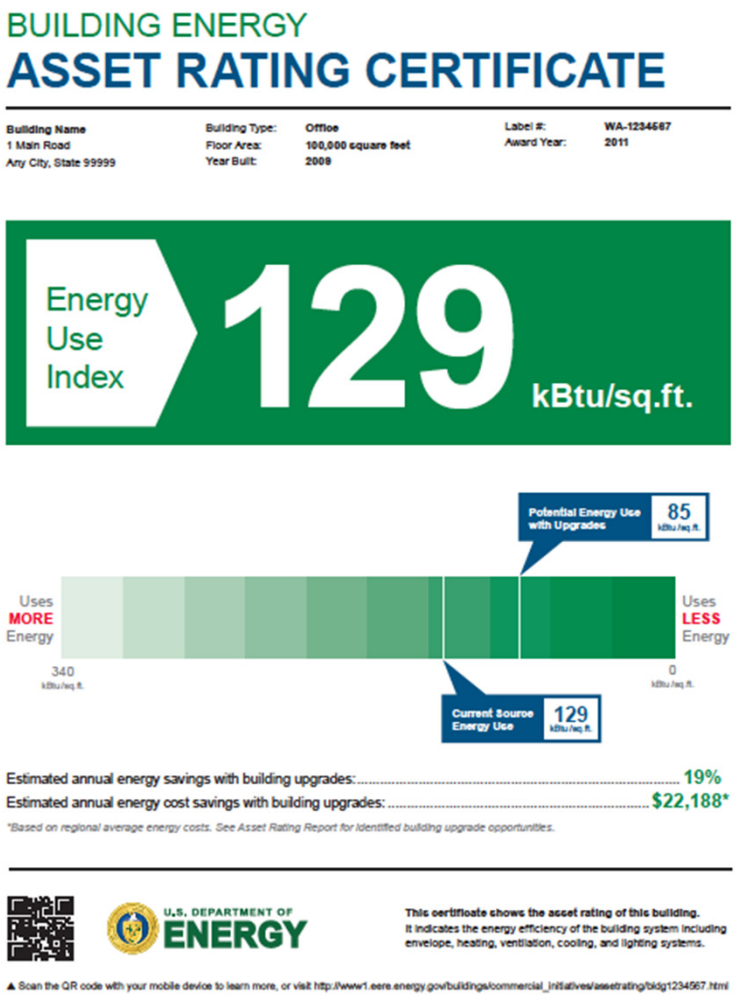
0 POINT
100 POINTS
CURRENT SCORE 62
Uses MORE Energy
Uses LESS Energy
340 kBtu/sq.ft.
0 kBtu/sq.ft.
Source Energy Use 129 kBtu/sq.ft.

Estimated annual energy savings with building upgrades: 19%
Estimated annual energy cost savings with building upgrades: $22,188*
*Based on regional average energy costs. See Asset Rating Report for identified building upgrade opportunities.

U.S. DEPARTMENT OF ENERGY

This certificate shows the asset rating of this building. It indicates the energy efficiency of the building system including envelope, heating, ventilation, cooling, and lighting systems.

▲ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating/bldg1234567.html



BUILDING ENERGY
ASSET RATING CERTIFICATE

Building Name
1 Main Road
Any City, State 99999

Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009

Label #: WA-1234567
Award Year: 2011

Energy Use Index 129 kBtu/sq.ft.

Potential Energy Use with Upgrades 85 kBtu/sq.ft.

Uses MORE Energy
Uses LESS Energy
340 kBtu/sq.ft.
0 kBtu/sq.ft.
Current Source Energy Use 129 kBtu/sq.ft.

Estimated annual energy savings with building upgrades: 19%
Estimated annual energy cost savings with building upgrades: $22,188*
*Based on regional average energy costs. See Asset Rating Report for identified building upgrade opportunities.

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Focus Group - Labels

- What information do you get from the labels shown?
  - The measure of kBtu is easily applied and could make some easy calculations when reviewing the certificate - as opposed to the point system that would require a deeper look at data. (owner/investor)
  - It will take more more education and background to understand kBtu/per sq. ft. and EUI in order to explain it to a potential buyer or tenant
  - Concern that “estimated annual energy savings” for building upgrades that are not well-defined or easily understood by general public.
  - Concern over how the energy costs measurements relate on a regional basis (say cost per kilowatt hour)

Focus Group - Scale Design

- We should be moving towards zero as moving up towards 100. A lot of people don't know what the 50, 75, 100 score system really means.
  - E.g. When you move from 97 to 98 on Energy Star - you need to improve by something like 10% - it is not well understood how much different a 98 is to an 88. Need a spatial description for reference.
- People respond more to zero on the left on an X-axis of scoring.
- Show some spatial reference to regional comps.
- Makes more sense to me to actually have a number that says there is so much energy used vs. a rating.
- Show current building performance, potential performance AND reference for typical building (baseline).

"I would prefer the design which shows that I can go from 129 kBtu per square foot down to 85. It seems a lot more concrete."

Focus Group - Label Information

- What would make labels better?
  - Total cost of improvements and realized or anticipated payback period
  - Color coding - so it is easy to see how the building is stacking up
  - Date of analysis (vs. “award year”)
  - Retrofit year
  - Additional information on building type (e.g. two - story suburban office vs. high-rise)
    - Layers of data within the asset class - I.e. low rise; suburban two-story; high rise; parking structure.
  - Look beyond just building and include information on the asset that includes traffic management, parking, multimodal type of transit, emissions
  - Linkage to intensity of use “[The] key piece of an asset rating is its intensity of use”

AR Certificate

- Revised version based on collected comments

Differentiate preliminary rating from official rating

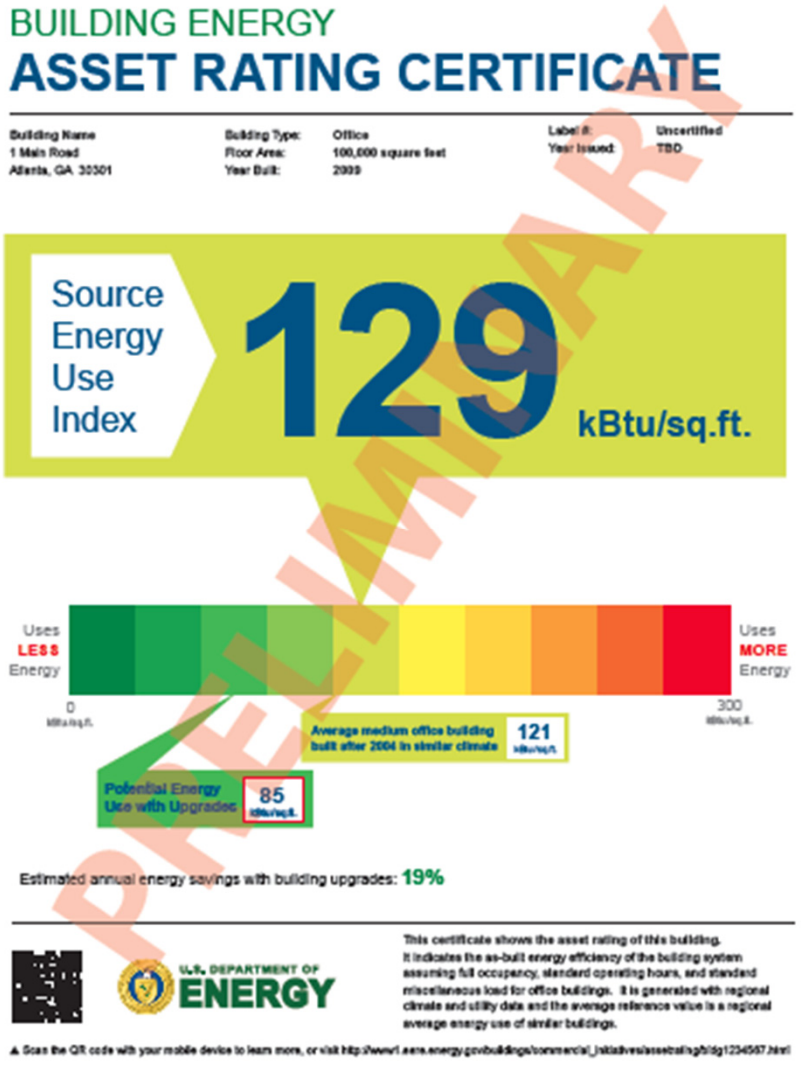
Change color

Move zero to the left

Add typical/regional comparison

Remove cost information

Add assumptions



AR Report

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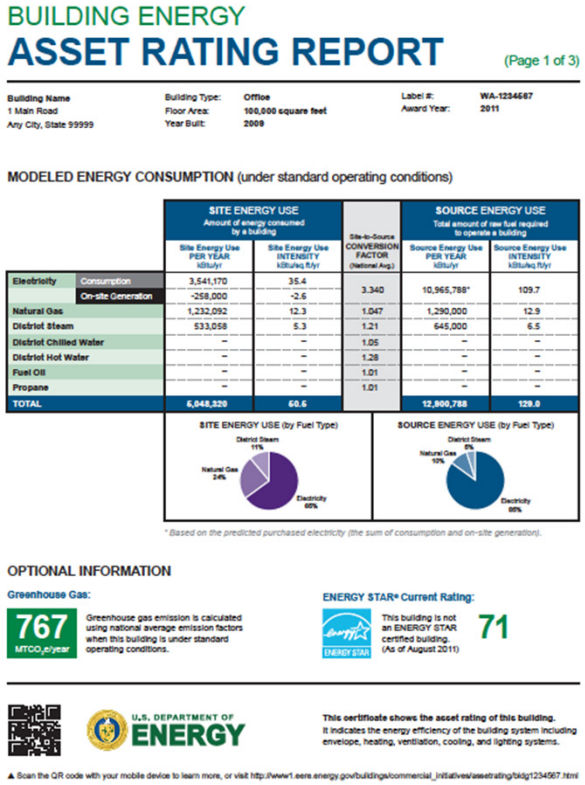
- Three pages of report were shown to focus groups

Most useful information



BUILDING ENERGY
ASSET RATING REPORT (Page 1 of 3)

Building Name: 1 Main Road, Any City, State 99999
Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009
Label #: WA-1234567
Award Year: 2011

MODELED ENERGY CONSUMPTION (under standard operating conditions)

		SITE ENERGY USE: Site Energy Use PER YEAR (kBtu/yr)	SITE ENERGY USE: Site Energy Use INTENSITY (kBtu/sq ft/yr)	Site-to-Source CONVERSION FACTOR (National Avg.)	SOURCE ENERGY USE: Source Energy Use PER YEAR (kBtu/yr)	SOURCE ENERGY USE: Source Energy Use INTENSITY (kBtu/sq ft/yr)
Electricity	Consumption	3,541,170	35.4	3.340	10,965,788*	109.7
	On-site Generation	-258,000	-2.6			
Natural Gas		1,232,092	12.3	1.047	1,290,000	12.9
District Steam		533,058	5.3	1.21	645,000	6.5
District Chilled Water		–	–	1.05	–	–
District Hot Water		–	–	1.28	–	–
Fuel Oil		–	–	1.01	–	–
Propane		–	–	1.01	–	–
TOTAL		6,048,320	60.6		12,900,788	129.0

SITE ENERGY USE (by Fuel Type) — District Steam 11%, Natural Gas 24%, Electricity 65%
SOURCE ENERGY USE (by Fuel Type) — District Steam 5%, Natural Gas 10%, Electricity 85%

* Based on the predicted purchased electricity (the sum of consumption and on-site generation).

OPTIONAL INFORMATION

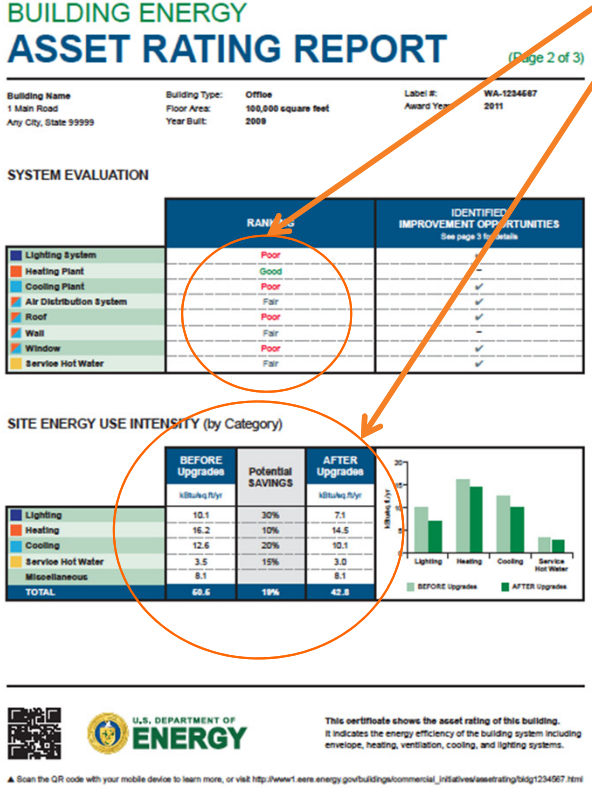
Greenhouse Gas: 767 MTCO2e/year — Greenhouse gas emission is calculated using national average emission factors when this building is under standard operating conditions.

ENERGY STAR® Current Rating: 71 — This building is not an ENERGY STAR certified building. (As of August 2011)

U.S. DEPARTMENT OF ENERGY

This certificate shows the asset rating of this building. It indicates the energy efficiency of the building system including envelope, heating, ventilation, cooling, and lighting systems.

▲ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating/bldg1234567.html



BUILDING ENERGY
ASSET RATING REPORT (Page 2 of 3)

Building Name: 1 Main Road, Any City, State 99999
Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009
Label #: WA-1234567
Award Year: 2011

SYSTEM EVALUATION

	RANKING	IDENTIFIED IMPROVEMENT OPPORTUNITIES (See page 3 for details)
Lighting System	Poor	✓
Heating Plant	Good	–
Cooling Plant	Poor	✓
Air Distribution System	Fair	✓
Roof	Poor	✓
Wall	Fair	–
Window	Poor	✓
Service Hot Water	Fair	✓

SITE ENERGY USE INTENSITY (by Category)

	BEFORE Upgrades (kBtu/sq ft/yr)	Potential SAVINGS	AFTER Upgrades (kBtu/sq ft/yr)
Lighting	10.1	30%	7.1
Heating	16.2	10%	14.5
Cooling	12.6	20%	10.1
Service Hot Water	3.5	15%	3.0
Miscellaneous	8.1		8.1
TOTAL	60.6	19%	42.8

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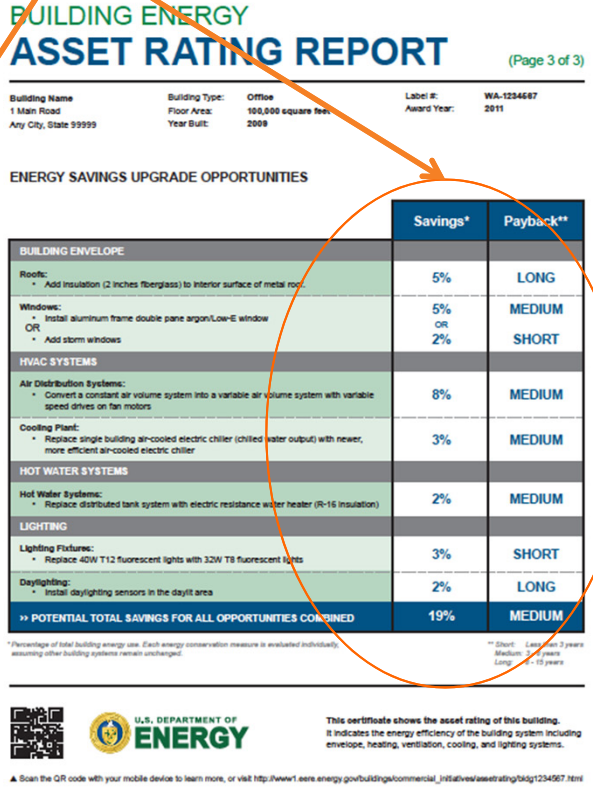


BUILDING ENERGY
ASSET RATING REPORT (Page 3 of 3)

Building Name: 1 Main Road, Any City, State 99999
Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009
Label #: WA-1234567
Award Year: 2011

ENERGY SAVINGS UPGRADE OPPORTUNITIES

	Savings*	Payback**
BUILDING ENVELOPE		
Roofs: • Add insulation (2 inches fiberglass) to interior surface of metal roof.	5%	LONG
Windows: • Install aluminum frame double pane argon/Low-E window OR • Add storm windows	5% OR 2%	MEDIUM SHORT
HVAC SYSTEMS		
Air Distribution Systems: • Convert a constant air volume system into a variable air volume system with variable speed drives on fan motors	8%	MEDIUM
Cooling Plant: • Replace single building air-cooled electric chiller (chilled water output) with newer, more efficient air-cooled electric chiller	3%	MEDIUM
HOT WATER SYSTEMS		
Hot Water Systems: • Replace distributed tank system with electric resistance water heater (R-16 insulation)	2%	MEDIUM
LIGHTING		
Lighting Fixtures: • Replace 40W T12 fluorescent lights with 32W T8 fluorescent lights	3%	SHORT
Daylighting: • Install daylighting sensors in the daylit area	2%	LONG
>> POTENTIAL TOTAL SAVINGS FOR ALL OPPORTUNITIES COMBINED	19%	MEDIUM

* Percentage of total building energy use. Each energy conservation measure is evaluated individually, assuming other building systems remain unchanged.

** Short: Less than 3 years; Medium: 3 - 8 years; Long: 8 - 15 years

U.S. DEPARTMENT OF ENERGY

This certificate shows the asset rating of this building. It indicates the energy efficiency of the building system including envelope, heating, ventilation, cooling, and lighting systems.

▲ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating/bldg1234567.html

Focus Group - Report

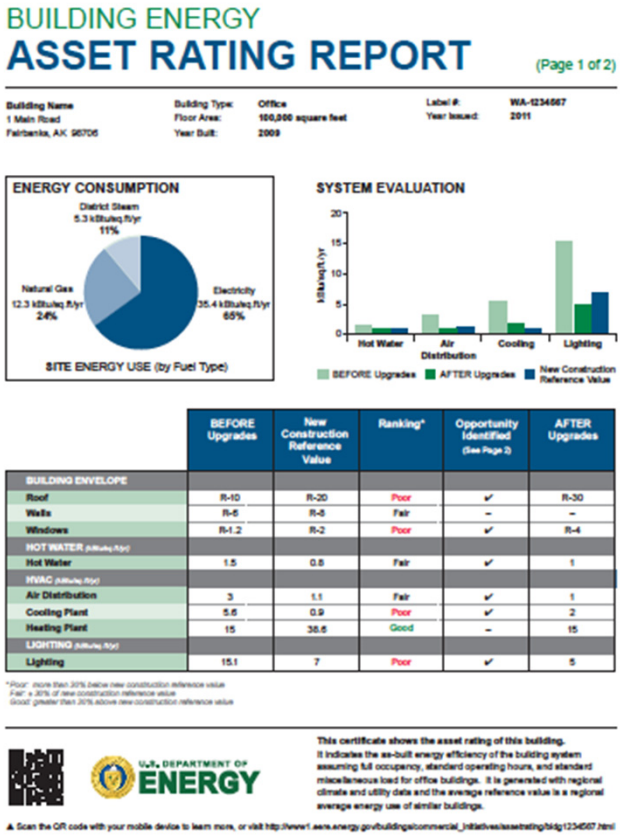
- Would you use this information, and how do you think that the information could be used?
  - Needs more detail
  - If a building I'm going to acquire shows a lot of short term payback items - then, I'd see I might be able to add value by doing that.
  - Skip labeling "terms" use time ranges: 0-2 years, 2-5 years, 5-10 years and 10+
  - Specify energy savings table reference (e.g. ASHRAE, etc.)

Asset Rating Report (continued)

- Additional information may be provided to help the user understand the building compared to important benchmarks.
  - A reference point to help users understand how their building scores compare to a chosen energy code.
  - Indication of whether the building has systems to provide a certain amount of energy from on-site renewables.
  - Indication of a building's past score
  - Possibly split upgrade measures into "basic" and "advanced" packages of recommendations.

AR Report

- Revised version based on collected comments
  - Concise
  - Less technical and self explanatory
  - Relevant to local market
  - Confidential
  - Financial assumptions



BUILDING ENERGY
ASSET RATING REPORT (Page 1 of 2)

Building Name
1 Main Road
Fairbanks, AK 98705

Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009

Label #: WA-1234567
Year Issued: 2011

ENERGY CONSUMPTION

SITE ENERGY USE (by Fuel Type)

SYSTEM EVALUATION

	BEFORE Upgrades	New Construction Reference Value	Ranking*	Opportunity Identified (See Page 2)	AFTER Upgrades
BUILDING ENVELOPE					
Roof	R-10	R-20	Poor	✔	R-30
Walls	R-6	R-6	Fair	–	–
Windows	R-1.2	R-2	Poor	✔	R-4
HOT WATER (kBtu/sq.ft/yr)					
Hot Water	1.5	0.8	Fair	✔	1
HVAC (kBtu/sq.ft/yr)					
Air Distribution	3	1.1	Fair	✔	1
Cooling Plant	5.6	0.9	Poor	✔	2
Heating Plant	15	38.6	Good	–	15
LIGHTING (kBtu/sq.ft/yr)					
Lighting	15.1	7	Poor	✔	5

*Poor: more than 30% below new construction reference value
Fair: ± 30% of new construction reference value
Good: greater than 30% above new construction reference value

U.S. DEPARTMENT OF ENERGY

This certificate shows the asset rating of this building. It indicates the as-built energy efficiency of the building system assuming full occupancy, standard operating hours, and standard miscellaneous load for office buildings. It is generated with regional climate and utility data and the average reference value is a regional average energy use of similar buildings.

▲ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating/bldg1234567.html

BUILDING ENERGY
ASSET RATING REPORT (Page 2 of 2)

Building Name
1 Main Road
Fairbanks, AK 98705

Building Type: Office
Floor Area: 100,000 square feet
Year Built: 2009

Label #: WA-1234567
Year Issued: 2011

ENERGY SAVINGS UPGRADE OPPORTUNITIES

	Savings*	Payback**
BUILDING ENVELOPE		
Roofs: • Add insulation (2 inches fiberglass) to interior surface of metal roof.	5%	> 10 yrs
Windows: • Install aluminum frame double pane argon/Low-E window OR • Add storm windows	5% OR 2%	1.5 - 5 yrs 1.5 - 5 yrs
HOT WATER SYSTEMS		
Hot Water Systems: • Replace distributed tank system with electric resistance water heater (R-16 insulation)	2%	1.5 - 5 yrs
HVAC SYSTEMS		
Air Distribution Systems: • Convert a constant air volume system into a variable air volume system with variable speed drives on fan motors	3%	5 - 10 yrs
Cooling Plant: • Replace single building air-cooled electric chiller (chilled water output) with newer, more efficient air-cooled electric chiller	2%	1.5 - 5 yrs
LIGHTING		
Lighting Fixtures: • Replace 40WT12 fluorescent lights with 32W T8 fluorescent lights	3%	< 1.5 yrs
Daylighting: • Install daylighting sensors in the daylit area	2%	5 - 10 yrs
>> POTENTIAL TOTAL SAVINGS FOR ALL OPPORTUNITIES COMBINED	19%	1.5 - 5 yrs

*Percentage of total building energy use. Each energy conservation measure is evaluated individually, assuming other building systems remain unchanged.

U.S. DEPARTMENT OF ENERGY

This certificate shows the asset rating of this building. It indicates the as-built energy efficiency of the building system assuming full occupancy, standard operating hours, and standard miscellaneous load for office buildings. It is generated with regional climate and utility data and the average reference value is a regional average energy use of similar buildings.

▲ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating/bldg1234567.html

Questions and Discussions

AFTER 15 MINUTES BREAK

SESSION No. 3
Asset Rating Pilot Project
8:30AM-12:00PM, December 9, 2011

Pilot Test Questions

- Q1: How easy is it to collect the required data?
  - Level 1 data
  - Level 2 data
- Q2: How accurate is the collected data?
  - Level 2 data
- Q3: How accurate is the AR model?
- Q4: How useful are the AR recommendations?
  - Audience appropriate phrasing
  - Applicability to building
- Q5: How useful is the AR report?
  - Relevance of rating
  - Energy use details provided
- Q6: What else?

Pilot building types:
Office, School, Retail

Pilot Test

How easy is it to collect the required data?

- **Pilot Activity 1a: Data Collection Questionnaire (100 Participants)**
  - Collect general feedback through questionnaires. The key questions to be answered are:
    - What data can or cannot be collected?
    - Where is the necessary data?
    - What is the average data collection time?
  - Pilot participants: Level 1 and 2 users of AR tool
  - Pilot participants' responsibility: complete the questionnaire

Pilot Test Methodology

How easy is it to collect the required data?

- **Pilot Activity 1b: Data Collection and Input Assessment (25 Participants)**
  - Document data input through case studies.
  - Selection criteria:
    - Scenario 1: owner/property manager operated building
    - Scenario 2: facility manager/building engineer operated building
    - Vintage: <5 years old, 10–20 years old, >50 years old.
  - Pilot participants: Level 1 and 2 users of AR tool
  - Pilot participants' responsibility: collect data, input into the AR tool, and complete questionnaire (from 1a)

Pilot Test Methodology

How accurate is the collected data?

How useful are the AR recommendations?

- **Pilot Activity 2: Data Accuracy and Usefulness of Recommendations (25 case studies)**
  - Compare the AR inputs with the building characteristics from previous energy audit.
  - Compare the AR recommendations with the previous energy audit results.
  - Selection criteria: Pilot participants need to have a recent energy audit within the last 5 years and agree to provide their energy audit report.
  - Pilot participants' responsibility: input building data into the AR tool, provide the energy audit report

Pilot Test Methodology

How accurate is the AR model?

- **Internal Test: Model Accuracy Test (before pilot test)**
  - Enter the characteristics of DOE reference buildings (total 336) into AR tool and compare results.

- **Pilot Activity 3: AR Tool and Detailed Energy Model Results Comparison (10 Participants)**
  - Compare the predicted energy use calculated using the AR tool with the predicted energy use calculated using a conventional audit and modeling method.
  - Selection Criteria: buildings with full-scale energy models
  - Pilot participants' responsibility: use AR tool, provide existing energy model and building data

Pilot Test Methodology

How useful is the AR report?

- **Pilot Activity 4a: Relevance of the Rating (25 Participants)**
  - Examine the correlation between AR and ENERGY STAR.
  - Pilot participants' responsibility: use the AR tool to obtain an asset rating and provide 12 months of energy bills and other operations data required to obtain an ENERGY STAR score.
- **Pilot Activity 4b: Usefulness of the Report Details (25 Participants)**
  - Collect feedback from all pilot users of the tool (via telephone or email).
  - Pilot participants' responsibility: provide feedback

Pilot Project

No.	Questions	Participant's Tasks	Expected Time Input	High-level (10 case studies)	Medium-level (15 case studies)	Low-level (75 case studies)
1a	Data collection questionnaire (100)	Complete questionnaire	30 mins	x	x	x
1b	Data input (25)	Collect building data	4–12 hrs	x	x	
2	Data accuracy test (10)	Use AR tool, provide energy audit report	4–12 hrs	x		
3	Model accuracy test (10)	Use AR tool, provide existing energy model	4–12 hrs	x		
4a	Rating relevance (25)	Use AR tool, provide utility data	4–12 hrs	x	x	
4b	Report detail relevance (25)	Provide feedback	30 mins	x	x	
			Total	16-32hrs	8–16 hrs	30 mins

Pilot Test Discussion

- Are the participant numbers high enough?
- Are participant numbers achievable?
- How do we test the relevance of the rating?
- How do we examine the relationship of AR and ENERGY STAR?

- **Who is interested in participating?**

AR Tool Discussion

- Discussion topics:
  - Minimum allowable input requirements
  - Suitable existing credential regimes
  - Approach to impactful, difficult to obtain variables
    - Ex: Infiltration, Wall R-Value
  - High performance building EEMs that should be included
  - Length of validity for AR
  - Tool release frequency (w/ constant AR)

Further Discussion/Summary

- Other metrics you'd like to see on the report?
- How to deal with the peak demand and/or time of use?
- How important to include code information? at which level? how?
- How to connect users to local incentive programs and industry service providers?
- Potential to provide EEMs based on different use intensities?
- Best way to convey uncertainty of results?
- Ways to assess building system efficiency?

Thank you

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Please contact us if you are interested in piloting the Asset Rating tool