THE ASHRAE BUILDING ENERGY LABELING PROGRAM

William P. Bahnfleth, PhD, PE, FASHRAE, FASME
The Pennsylvania State University

City of San Diego
Sustainable Energy Advisory Board
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ASHRAE Facts

- Founded in 1894
- 501(c)(3) non-profit
- Purpose – “promote the arts and sciences of HVAC&R and allied arts and sciences”
- 53,000 members in 130 countries
- Designers, manufacturers, contractors, architects, facility engineers and managers, students
- 20% of members outside North America
- ~100 technical committees
- ~100 standards and guidelines
- $5 million annual research program

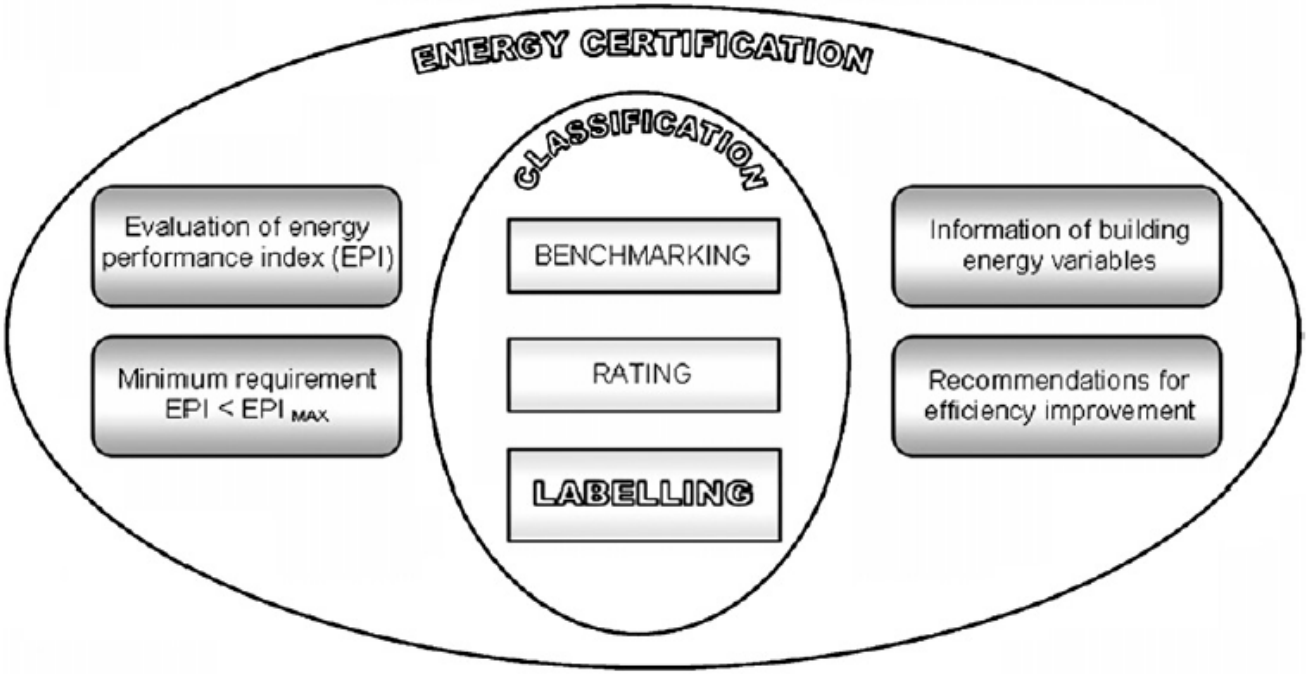
Outline

- Background
- ASHRAE's Labeling Program –Overview
- Qualifications for Performing Ratings
- Comparison with Other Ratings
- Current Status
- Case Study
- Summary
- Further Information

Background

Labeling = Energy Certification

- *Description of energy use characteristics*
- *Information for prospective users concerning efficiency*
- *Options for improvement*



L. Pérez-Lombard, et al. 2009. Energy and Buildings 41: 272-278.

Objectives/Benefits of Labeling

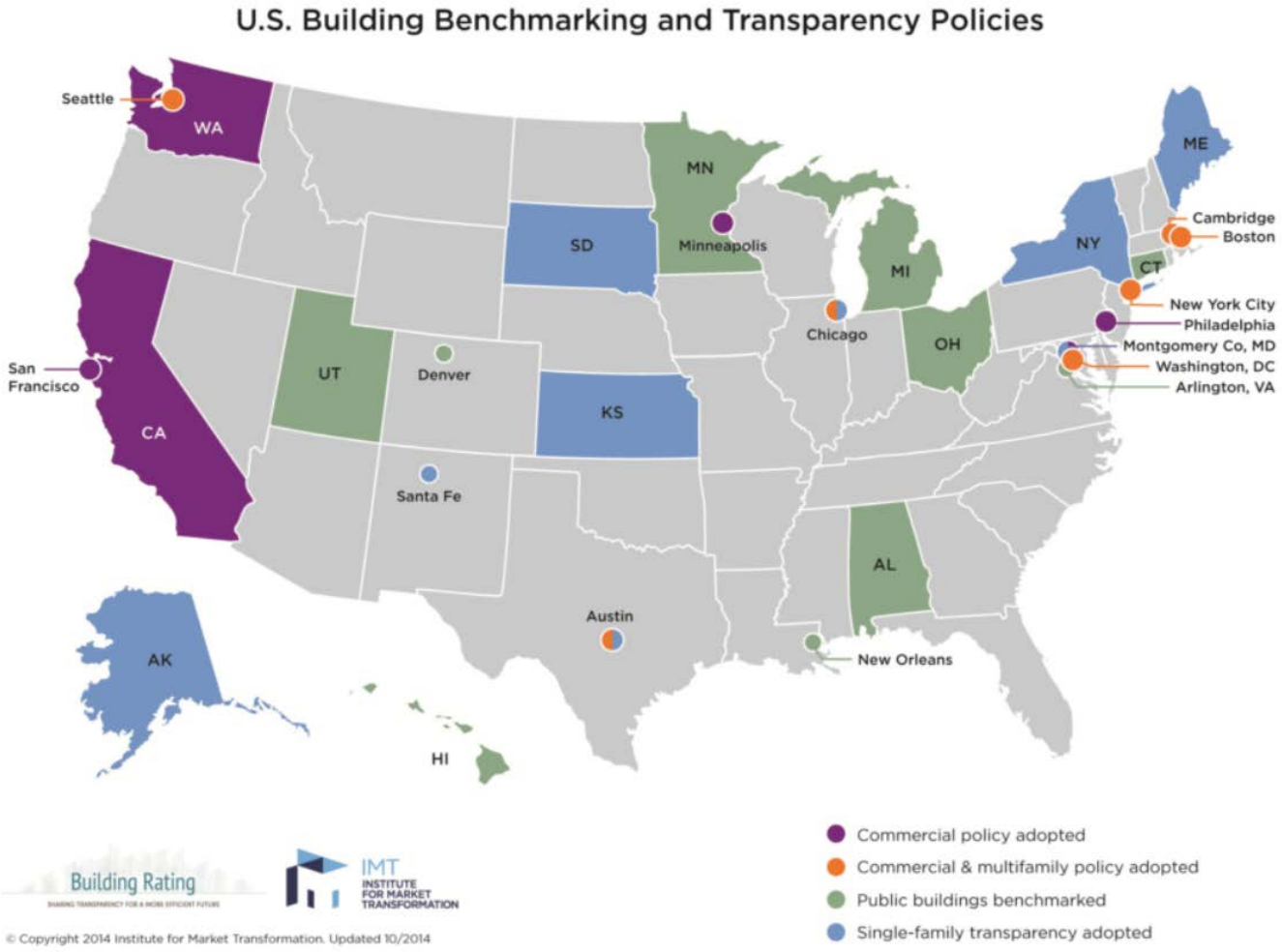
- Promote energy efficiency in real estate market
- Identify energy efficiency measures
- Support regulation of building efficiency
- Add to building performance database

ASHRAE's qualifications

- Credibility
  - Technical capability
  - Consensus standards developer
  - Growing focus on building performance
- Global reach
  - Access to international expertise
  - Ability to support programs anywhere

Energy labeling value

- Society
  - Reduced energy use
  - Reduced environmental impact
  - Economic benefit of re-directing resources to purchase and mitigate effects of energy use
- Owners
  - Benchmarking
  - Enhances image
  - Operating cost savings
- Professionals
  - A marketable service
  - Should stimulate retrofit market



51,000 properties, 5.8 billion sf covered by existing programs

Source: http://www.buildingrating.org/ updated 10/14

Key Issues

- Modeled or measured
- New or existing
- Performance index
- Energy labeling scale
- What data are modeled/collected and by whom
- Energy modeling/measurement methods
- Identification of energy efficiency measures
- Communication of data and results
- Implementation: voluntary vs. mandatory

ASHRAE's Labeling Program - Overview

Building Energy Quotient (bEQ)

- *As Designed* rating
  - New or existing building
  - Based on as-built conditions
  - Rates quality of building design
  - Based on energy model by certified modeler (BEMP or PE in jurisdiction)
- *In Operation* rating
  - Existing buildings
  - Based on metered energy use
  - Rates combined effect of design and operation
  - Requires at least 18 months of operation for new buildings
  - Includes ASHRAE Level 1 audit by certified assessor (BEAP or PE in jurisdiction)

Building eQ®
Powered by ASHRAE

Performance Index

- What is measured?
  - Site energy
  - Source energy
  - On-site renewables
  - Emissions
- What is the reference case?
  - Occupancy
  - Climate zone
- bEQ - Normalized Source Energy Use Intensity
  - Modeled (As Designed) or measured (In Operation) energy per unit of area
  - Includes on-site renewables
  - % of modeled or measured reference value

As Designed bEQ

- $EUI_{Standard}$
  - Source energy use of actual building design computed using standard occupancy and operational schedules
  - Site-source conversion based on typical conversion factors

- EUI_{Median}
  - From EUI table in workbook or ENERGY STAR Target finder - but moving to Standard 100 methodology

$$bEQ_{As\ Designed} = \frac{EUI_{Standard}}{EUI_{Median}} \cdot 100$$

As Designed Median EUI Table

MEDIAN EUI LOOK-UP TABLE FOR AS DESIGNED RATING																
Building Use Description	**Median Source EUI (kBtu/ft²-yr) by ASHRAE Climate Zone:**															
	1A	**2A**	**2B**	**3A**	**3B Coast**	**3B Other**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**6A**	**6B**	**7**	**8**
Education																
K-12 Schools (EL-HI)	Not Available for the As-Designed Rating at this time															
College/university	Not Available for the As-Designed Rating at this time															
Preschool/daycare	Not Available for the As-Designed Rating at this time															
Food Sales																
Grocery store/food market	**Use ENERGY STAR Target Finder**															
Convenience store	527	571	529	595	468	543	521	612	552	578	658	596	697	646	719	888
Convenience store with gas station	425	461	428	480	378	439	421	493	444	467	529	480	563	520	579	716
Food Service																
Fast food	Not Available for the As-Designed Rating at this time															
Restaurant/cafeteria	Not Available for the As-Designed Rating at this time															
Health Care																
Hospital/inpatient health	Not Available for the As-Designed Rating at this time															
Senior Care	Not Available for the As-Designed Rating at this time															
Clinic/other outpatient health	Not Available for the As-Designed Rating at this time															
Medical office (diagnostic)	Not Available for the As-Designed Rating at this time															
Laboratory	Not Available for the As-Designed Rating at this time															
Lodging																
Hotel/Motel/Inn	Not Available for the As-Designed Rating at this time															
Dormitory/fraternity/sorority	Not Available for the As-Designed Rating at this time															
Office																
General office	**Use ENERGY STAR Target Finder**															
Bank/other financial	**Use ENERGY STAR Target Finder**															
Medical office (non-diagnostic)	**Use ENERGY STAR Target Finder for General Office**															
Data Center	Not Available for the As-Designed Rating at this time															
Mixed-use office	174	179	176	187	138	174	140	191	166	171	204	176	219	194	229	312
Public Assembly																
House of Worship	Not Available for the As-Designed Rating at this time															

In Operation bEQ

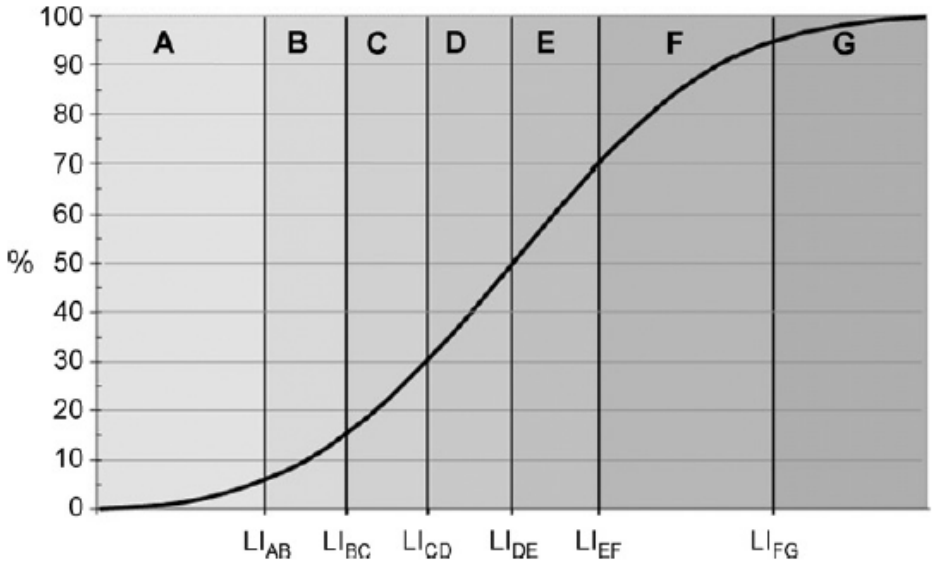
- $EUI_{Metered}$
  - Metered energy use intensity
  - Normalized for climate zone using HDD and CDD from data collection period

- EUI_{Median}
  - Based on methodology of ASHRAE Standard 100
  - Normalized for climate and operating hours
  - Calculated automatically in workbook based on user input

$$bEQ_{In\ Operation} = \frac{EUI_{Metered}}{EUI_{Median}} \cdot 100$$

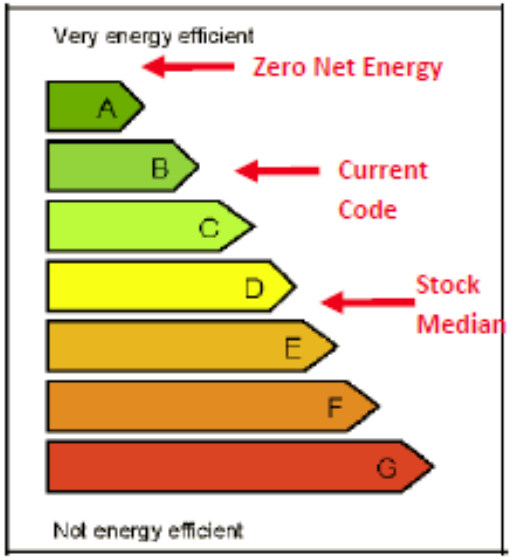
Rating Scale Approaches

Statistical



Compare value to mean of actual distribution

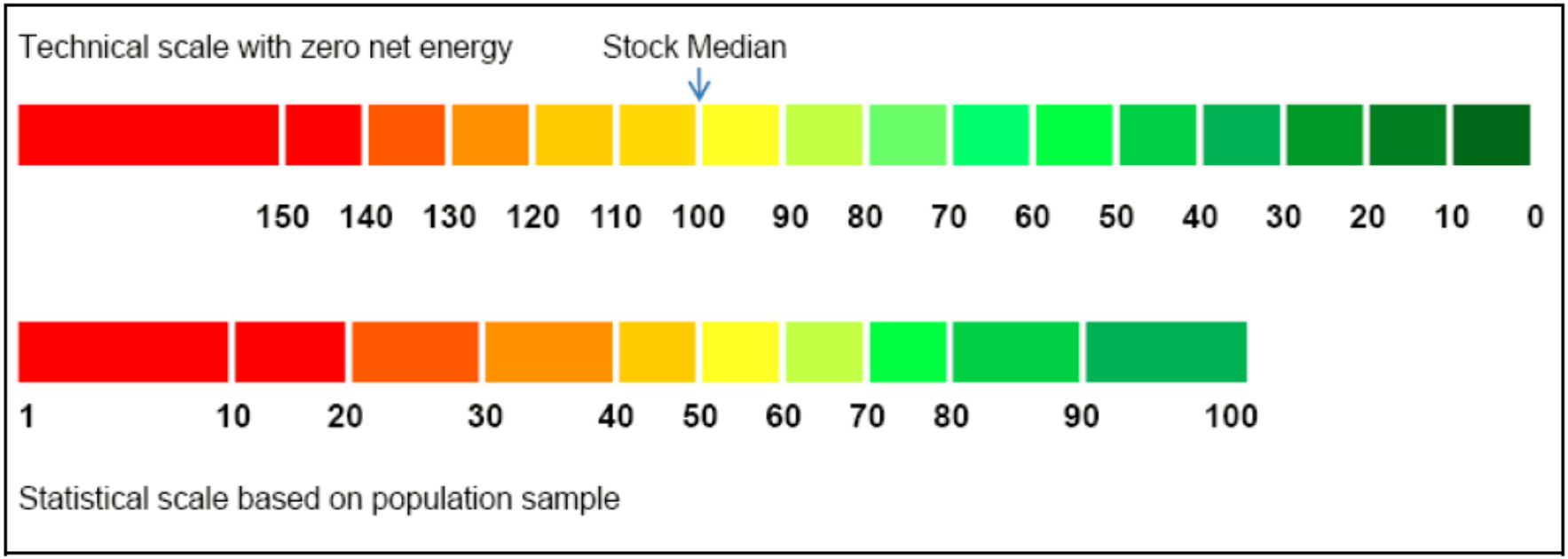
Technical Potential



Compare to what is possible, practical, typical as defined by codes

Technical potential scales can rate performance that falls outside the current distribution, like net zero or net positive buildings

Technical Potential vs. Statistical Scale



bEQ Scale Definitions

Rating Scale	Rating	Description
≤0	A+	*Zero Net Energy*
1-25	A	High Performance
26-55	A-	Very Good
56-85	B	*Efficient*
86-115	C	*Average*
116-145	D	*Inefficient*
>145	F	Unsatisfactory

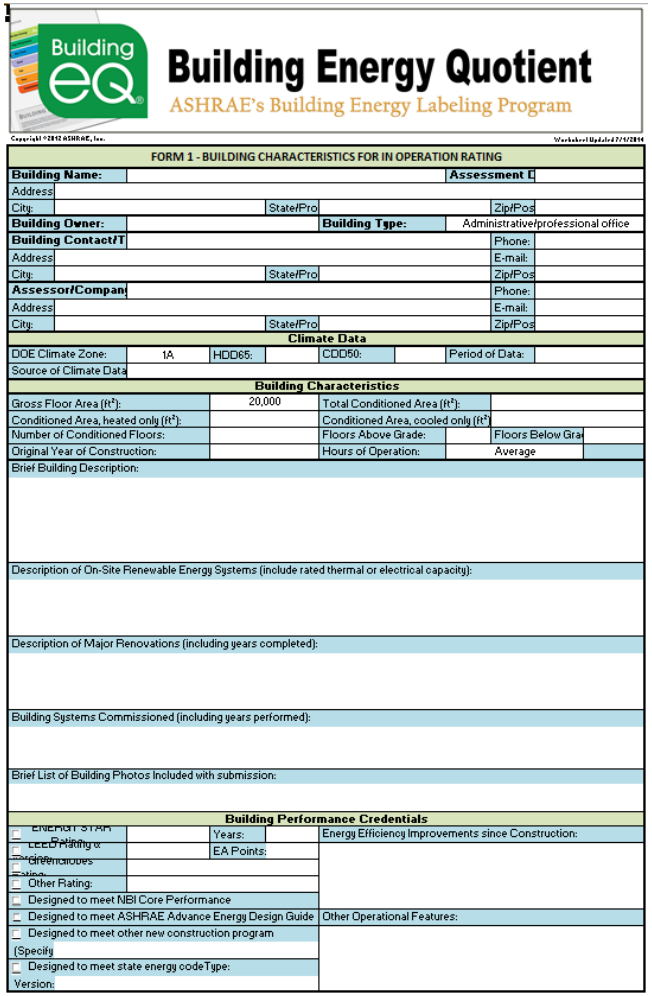
Original descriptions and scale ranges have been adjusted based on pilot results.

Communication

- bEQ Workbook
  - Documents Rating Calculation
  - Provides Supplemental Information
- bEQ Certificate
  - Contains Key Building Information
  - Satisfies Disclosure Requirements
  - Provides Info for Tenants & Governments
- bEQ Dashboard
  - Illustrates Level of Performance
- bEQ Plaque
  - Public Display of Building's Rating

Communication- Workbook

- Completed by the professional
- Submitted electronically to ASHRAE for rating



Building eQ

Building Energy Quotient

ASHRAE's Building Energy Labeling Program

FORM 1 - BUILDING CHARACTERISTICS FOR IN OPERATION RATING

Building Name:				**Assessment D**	
Address					
City:		State/Pro		Zip/Pos	
Building Owner:			**Building Type:**	Administrative/professional office	
Building Contact/T				Phone:	
Address				E-mail:	
City:		State/Pro		Zip/Pos	
Assessor/Compan				Phone:	
Address				E-mail:	
City:		State/Pro		Zip/Pos	

Climate Data

DOE Climate Zone:	1A	HDD65:		CDD50:	Period of Data:
Source of Climate Data					

Building Characteristics

Gross Floor Area (ft²):	20,000	Total Conditioned Area (ft²):	
Conditioned Area, heated only (ft²):		Conditioned Area, cooled only (ft²)	
Number of Conditioned Floors:		Floors Above Grade:	Floors Below Gra
Original Year of Construction:		Hours of Operation:	Average

Brief Building Description:

Description of On-Site Renewable Energy Systems (include rated thermal or electrical capacity):

Description of Major Renovations (including years completed):

Building Systems Commissioned (including years performed):

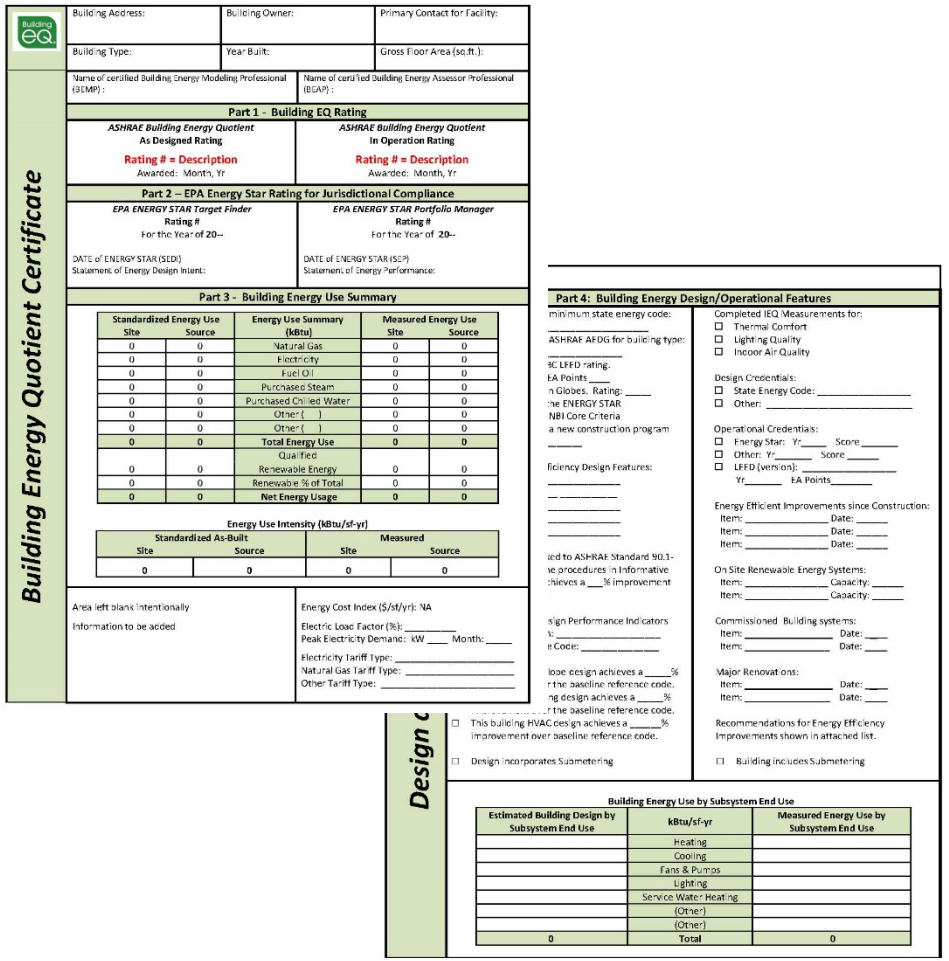
Brief List of Building Photos Included with submission:

Building Performance Credentials

☐ ENERGY STAR Rating		Years:	Energy Efficiency Improvements since Construction:
☐ LEED Rating & Level		EA Points:	
☐ Green Globes Rating			
☐ Other Rating:			
☐ Designed to meet NBI Core Performance			
☐ Designed to meet ASHRAE Advance Energy Design Guide			Other Operational Features:
☐ Designed to meet other new construction program (Specify)			
☐ Designed to meet state energy code Version:	Type:		

Communication – bEQ Certificate

- More detailed documentation including,
  - Site/source use by energy source type
  - Electric demand
  - Energy cost
  - Energy saving features
  - Subsystem energy use
  - IEQ screening
  - …



Building Energy Quotient Certificate

Building Address: | Building Owner: | Primary Contact for Facility:

Building Type: | Year Built: | Gross Floor Area (sq.ft.):

Name of certified Building Energy Modeling Professional (BEMP): | Name of certified Building Energy Assessor Professional (BEAP):

Part 1 - Building EQ Rating

ASHRAE Building Energy Quotient As Designed Rating	*ASHRAE Building Energy Quotient* In Operation Rating
Rating # = Description Awarded: Month, Yr	Rating # = Description Awarded: Month, Yr

Part 2 – EPA Energy Star Rating for Jurisdictional Compliance

EPA ENERGY STAR Target Finder Rating # For the Year of 20--	*EPA ENERGY STAR Portfolio Manager* Rating # For the Year of 20--
DATE of ENERGY STAR (SEDI) Statement of Energy Design Intent:	DATE of ENERGY STAR (SEPI) Statement of Energy Performance:

Part 3 - Building Energy Use Summary

Standardized Energy Use Site	Standardized Energy Use Source	Energy Use Summary (kBtu)	Measured Energy Use Site	Measured Energy Use Source
0	0	Natural Gas	0	0
0	0	Electricity	0	0
0	0	Fuel Oil	0	0
0	0	Purchased Steam	0	0
0	0	Purchased Chilled Water	0	0
0	0	Other ( )	0	0
0	0	Other ( )	0	0
0	0	**Total Energy Use**	0	0
0	0	Qualified Renewable Energy	0	0
0	0	Renewable % of Total	0	0
0	0	**Net Energy Usage**	0	0

Energy Use Intensity (kBtu/sf-yr)

Standardized As-Built Site	Standardized As-Built Source	Measured Site	Measured Source
0	0	0	0

Area left blank Intentionally

Information to be added

Energy Cost Index ($/sf/yr): NA

Electric Load Factor (%): _____

Peak Electricity Demand: kW ____ Month: ____

Electricity Tariff Type: _____

Natural Gas Tariff Type: _____

Other Tariff Type: _____

Part 4: Building Energy Design/Operational Features

minimum state energy code: _____

ASHRAE AEDG for building type: _____

BC LEED rating.

EA Points ____

n Globes. Rating: ____

he ENERGY STAR

NBI Core Criteria

a new construction program

_____

ficiency Design Features:

_____

_____

_____

_____

_____

ed to ASHRAE Standard 90.1-

e procedures in Informative

hieves a ___% improvement

sign Performance Indicators

: _____

e Code: _____

lope design achieves a ____%

the baseline reference code.

ng design achieves a ____%

the baseline reference code.

☐ This building HVAC design achieves a _____% improvement over baseline reference code.

☐ Design Incorporates Submetering

Completed IEQ Measurements for:

☐ Thermal Comfort

☐ Lighting Quality

☐ Indoor Air Quality

Design Credentials:

☐ State Energy Code: _____

☐ Other: _____

Operational Credentials:

☐ Energy Star: Yr_____ Score _____

☐ Other: Yr_____ Score _____

☐ LEED (version): _____ Yr_____ EA Points_____

Energy Efficient Improvements since Construction:

Item: _____ Date: _____

Item: _____ Date: _____

Item: _____ Date: _____

On Site Renewable Energy Systems:

Item: _____ Capacity: _____

Item: _____ Capacity: _____

Commissioned Building systems:

Item: _____ Date: ____

Item: _____ Date: ____

Major Renovations:

Item: _____ Date: ____

Item: _____ Date: ____

Recommendations for Energy Efficiency Improvements shown in attached list.

☐ Building Includes Submetering

Design

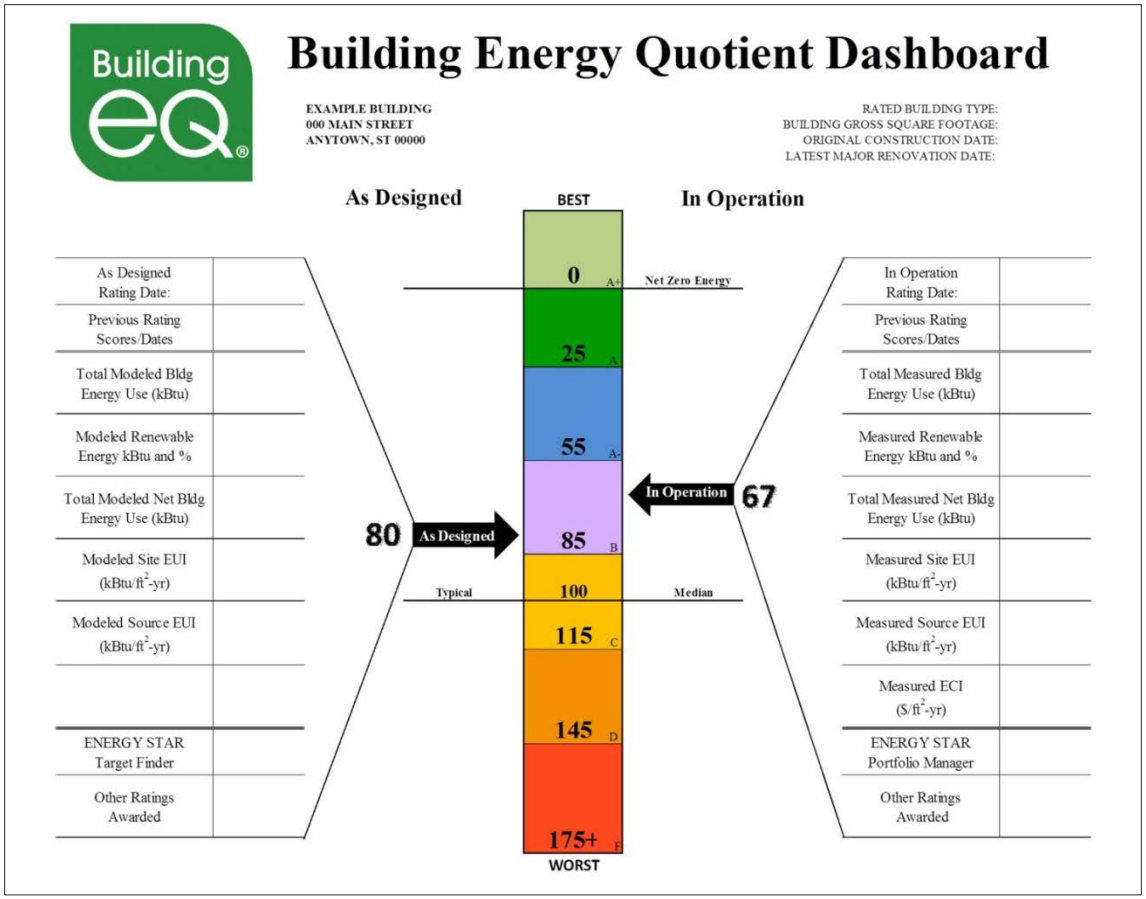
Building Energy Use by Subsystem End Use

Estimated Building Design by Subsystem End Use	kBtu/sf-yr	Measured Energy Use by Subsystem End Use
	Heating	
	Cooling	
	Fans & Pumps	
	Lighting	
	Service Water Heating	
	(Other)	
	(Other)	
0	Total	0

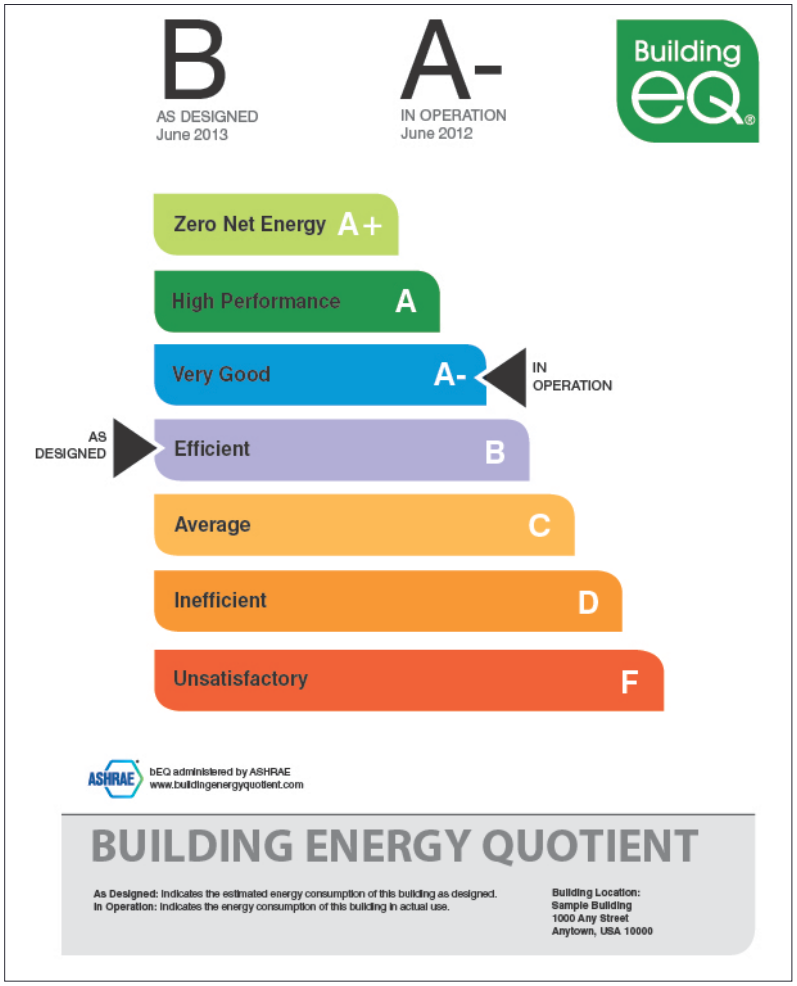
Intended to satisfy mandatory disclosure compliance requirements

Communication – bEQ Dashboard

Illustrates level of performance



Communication - bEQ Plaque



One label for both ratings

Qualifications to Perform Ratings

ASHRAE certification or PE required

- As Designed rating – Building Energy Modeling Professional (BEMP) www.ashrae.org/BEMP
- In Operation rating – Building Energy Assessment Professional (BEAP) www.ashrae.org/BEAP
- Alternatively, PE in jurisdiction of rating
- ASHRAE Certification information web page

  http://www.ashrae.org/education--certification/certification

  ASHRAE certifications require
  - Combination of education and experience
  - Mastery of specified body of knowledge (pass exam)
  - Periodic renewal

Comparison with Other Programs

Comparison with Other Programs

- Main alternatives
  - EPA ENERGY STAR – In Operation
  - DOE Energy Asset Score (under development) – As Designed
  - ASHRAE emphasizes depth of detail, rigor
  - Alternatives emphasize ease of use, broad adoption
- Can be seen as complementary

Current Status

As of February 2015

- In-Operation Rating (since March 2012)
  - 26 submissions, 18 labels (1 A, 3 A-, 7 B, 7 C, 1 pending, 4 in process, 1 on hold, 2 withdrawn)
  - 3.3 million sf (330,000 m^2) rated
- As-Designed Rating (since May 2013)
  - Three categories – Food Sales, Office, Retail – 8 types covered
  - No buildings submitted to date

Case Study

Putting bEQ in Practice

R. Montgomery and T. Wentz, ASHRAE Journal (May 2014)

- Four fire stations
  - Sarasota County, FL, USA
  - Climate zone 2B, “hot &humid”
  - One LEED Silver, two LEED certified, one not rated
  - Solar thermal systems at 3 stations
  - Similar design but 3 architects
  - EUIs
    - 31-72 kBTU/sf range
    - 50 kBTU/sf overall
  - In operation bEQs
    - 45 (A-, Very Good)
    - 72 (B, Efficient)
    - 86 (C, Average)
    - 103 (C, Average)

Building Assessment

- Audit results identified multiple items missed in LEED commissioning
  - Malfunctioning dehumidifier
  - Improper OA ducting of DX air conditioner
  - Missing toxic gas monitoring system
  - Missing solar water heating system
  - Abandoned grey water system

Energy Efficiency Measures, Economics

- EEM cost - $39,300
- Elec svgs - 119.2 MWh/yr
  9 – 30% svgs per bldg,
  21% overall
- Elec cost svgs $9588/yr @ $0.08/kWh
- 0.6 – 12.5 yr EEM SPB
  4.1 yr overall EEM SPB
- bEQ costs, 4 buildings - $7820 ($0.21/sf)
- 4.9 year overall SPB
- All buildings increased to A-rating if implemented

TABLE 1 Fire station 3, 4, 10, 15 EEM summary (minus PV or LED).

MEASURE NUMBER	DESCRIPTION OF MEASURE	ELECTRICITY SAVINGS (KWH)	TOTAL COST SAVINGS ($)	MEASURE COST ($)	PAYBACK (YEARS)
4a	New programmable thermostats, general area temperature setbacks and rescheduling of OA units	28,750	2,300	8,000	3.5
4b	Add solar hot water panels	11,250	900	4,000	4.4
4c	Add thermostat and timer To SF-2; add timer and thermostat to SF-1	2,500	200	2,000	10
4d	Add occupancy timers to selected light fixtures	2,500	200	2,000	10
3a	General area temperature setbacks and re-configuration/re-distribution	28,750	2,300	8,000	3.5
3b	Stairwell lighting reduction and occupancy sensing	4,375	350	1,700	4.9
3c	General control system re-programming of setpoints	1,250	100	250	2.5
3d	Retrofit solar water heater, thermostatic mixing valve, and electric booster heater	5,000	400	250	0.6
10a	West area thermostat setbacks	8,750	750	2,000	2.7
10b	East area temperature setbacks	2,500	200	2,500	12.5
15a	General area temperature setbacks, CO_2/ OA unit changes, and re-programming	11,250	900	5,000	5.6
15b	Add motion sensor to EF-4 exercise room	1,100	88	600	6.8
15c	SF-2, EF-5 and SF-1 changes to operations	11,250	900	3,000	3.3
TOTALS		119,225 kWh	$9,588	$39,300	4.10

Summary

Summary

- ASHRAE's bEQ labelling program...
  - voluntary building energy certification program (to date)
  - *technical potential* rating that draws on successful features of other US and European building certifications
  - tool to stimulate adoption of high performance building techniques and cost-effectively save energy and energy cost
  - complements other green building rating systems and energy certification programs

Further Information

- ASHRAE bEQ web site: http://www.buildingenergyquotient.org/
- General Questions: info@buildingenergyquotient.org
- Technical Questions: assessment@buildingenergyquotient.org
- Background
  - Pérez-Lombard, L., J. Ortiz, R. González, I. Maestre. 2009. A review of benchmarking, rating and labelling concepts within the framework of building energy certification schemes. Energy and Buildings 41: 272-278.
- Bill Bahnfleth wbahnfleth@psu.edu

Q & A

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