



Sneak Peek! The Building Envelope Campaign

May 20, 2020

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#SneakPeek

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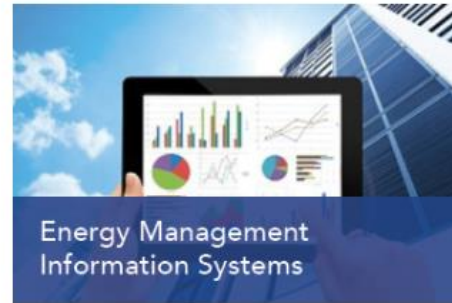
Poll 1



Better Buildings Alliance – Background

- The Alliance includes more than 230 organizations, representing over 11 billion commercial square feet across 5 key market sectors:
 - commercial real estate,
 - healthcare,
 - higher education,
 - hospitality, and
 - retail, food service, and grocery.
- Previous Alliance technology campaigns, led by DOE's National Labs, aim to accelerate the adoption of efficient building technologies by providing technical assistance, resources, and guidance on implementation best practices.

Better Buildings Alliance – Background



Envelope Technology Research Team (ETRT)

Connecting Better Buildings partners with advanced building envelope technology solutions

- ✓ Technology verification studies
- ✓ Specification documents
- ✓ Case studies and fact sheets
- ✓ Calculators and analytic tools

Envelope technologies account for approximately 30% of the primary energy consumed in commercial buildings, playing a key role in determining levels of comfort, natural lighting, ventilation, and how much energy is required to heat and cool a building.

Hayley McLeod, M.S.P.P.



**Building Envelope
Campaign Lead**

Simon Pallin, Ph.D.



**Building Envelope
Technical Lead**

Mahabir Bhandari, Ph.D.



**Building Envelope
Tech Team Support**

Jason DeGraw, Ph.D.



**Building Envelope
Tech Team Support**

Kita Cranfill



Full Stack Developer

Previous Better Buildings Alliance Campaigns

Campaign	Launch Year	Result
Lighting Energy Efficiency Campaign (LEEP)	2012	\$23.6 million in electricity cost savings through energy use savings of 227 million kWh annually across 560 million ft ² of parking facilities
Interior Lighting Campaign (ILC)	2013	\$24 million in electricity cost savings through energy use savings of nearly 229 million ft ² of building space
Advanced Rooftop Campaign (ARC)	2013	\$90 million in electricity cost savings through energy use savings of 903 million kWh annual from of 114,000 RTUs
Smart Energy Analytics (SEA)	2016	\$9 million in electricity cost savings through 400 billion Btu/year savings across 15 participants' portfolios with energy management and information systems (EMIS) installed

Building Envelope Campaign

- Thank you to our organizers, IIBEC and IFMA!

- Early Participants

- Mathis Consulting
- Engengineers
- Redhorse Corp
- Judicial Council of California
- Tenderloin Neighborhood Development Corporation
- Arlington County Department of Environmental Services



- Early Supporters

- Lawrence Berkeley National Laboratory
- Walter P. Moore
- Ghafari Associates
- NRG Insulated Block
- Arc Green Consultant

Building Envelope Campaign Goals

- **Motivate action and increase awareness** of the value of investing in high performance building envelope technologies for both new and existing commercial buildings
- **Recognize leaders** adopting and achieving high performing building envelope systems
- **Demonstrate and document** energy and cost savings with integrated design, construction, commissioning, and maintenance from implementation of high performing envelope systems

How are we going to achieve the goals?

- Work with a Technical Advisory Group
- Thank you!
 - Chris Mathis, Mathis Consulting
 - Liz Fischer, BCxA
 - Dean Stanberry, IFMA
 - Paul Romano, ConEd
 - Michael Loughlin, Eversource NH
 - Jonathan Flaherty (Chair LEED Steering Committee), Tishman-Speyer
 - Anica Landreneau, (LEED Advisory Committee Member), HoK



How are we going to achieve the goals?

Building Description

Name or description of building:

My Building

Building Type

Is this a new construction or a retrofit?

Approximate year of building construction:

New Construction **Retrofit**

1990

Climate

Select the climate zone where building is located

4A - Mixed-Humid

Select the built environment

Rural

Geometry

Select the type of building

Hospital

Conditioned Floor Area

24140 ft²

Building Height

70 ft

Building Floors

5

Building Rotation (Deviation from North)

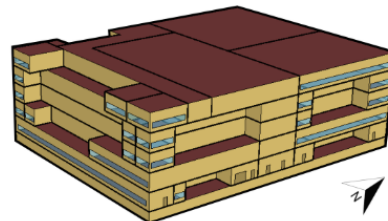
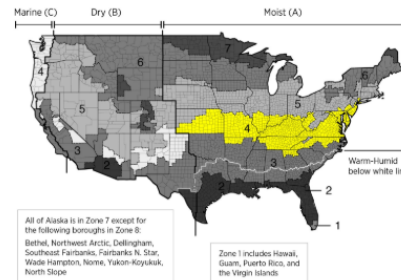
0 °D

Total Surface Area of the Walls (including windows)

North	South	East	West
10839 ft ²	11130 ft ²	14015 ft ²	12239 ft ²

Window Area

North	South	East	West
1475 ft ²	1959 ft ²	2088 ft ²	3864 ft ²



By determining your Building Envelope Performance (BEP) metric

- Basic building information
- Slightly different for new construction vs retrofit

Building Components/Material Properties

Existing Building

Wall R-value

7.5

Predominant Wall Facade Material

Painted Surface - Dark

Roof R-value

16.1

Roof Surface Material

Gravel

Window U-factor

0.6

Window SHGC

0.36

Yes **No** Have you performed building envelope commissioning or conducted a blower door test?

Building Airtightness Value

1.070

scfm/ft²

Yes **No** Have you taken any additional steps to improve the airtightness of your building?

Planned Retrofit

Wall R-value

7.5

Predominant Wall Facade Material

Painted Surface - Dark

Roof R-value

16.1

Roof Surface Material

Gravel

Window U-factor

0.6

Window SHGC

0.36

Building Airtightness Value

No improvement.

How are we going to achieve the goals?

■ Results

- If satisfied, great! Time to submit!
- If dissatisfied, your building has been saved and information can be edited.
- The building characteristic with the most room for improvement has been identified.

■ Resources

- Commercially available technologies
- Case studies
- Additional resources



Building Envelope Performance (BEP)
🎉 Congratulations! you meet the requirements to receive the Retro 30 award.

34% Improvement

Toggle: Retrofit New Construction

Filters: Window U-factor Window SHGC Wall Roof Airtightness

Recognition Tiers and Categories

Existing Building – Envelope Retrofit

Recognition Tiers

Retro 30

Building envelope heat loss/gain reduction of 30%^a,
due to implementation of building envelope improvements

Retro 50

Building envelope heat loss/gain reduction of 50%^a,
due to implementation of building envelope improvements

(a) Reduction may consist of any energy retrofit measure that involve the building envelope thermal performance (R-value, Air leakage, Attachments, etc.)

Recognition Tiers and Categories

New Construction

Recognition Tiers

Novel 20

Building envelope heat loss/gain reduction of 20%^a over code^b,
due to incorporation of emerging high-performance envelope technologies

Novel 40

Building envelope heat loss/gain reduction of 40%^a over code^b,
due to incorporation of emerging high-performance envelope technologies

(a) Follow ASHRAE Advanced Energy Design Guides Reduction

(b) Most recent national energy code (ASHRAE 90.1 - 2016)

Recognition Tiers and Categories

Possible Additional Recognition

Role Models

An additional level of recognition will be available to those buildings which meet a campaign recognition tier and *also* incorporate an additional advanced strategy or technology into their building envelopes, serving as role models within the industry.

Honorable Mentions

Buildings which do not meet a campaign recognition tier but still make a noteworthy impact on the campaign (e.g., substantial square footage) may apply for an Honorable Mention.

Campaign Process

Participant Milestones



Team Responsibilities



The Building Envelope Performance (BEP) Metric



The Building Envelope Performance (*BEP*) Metric

Target - Fuel Economy



Variables

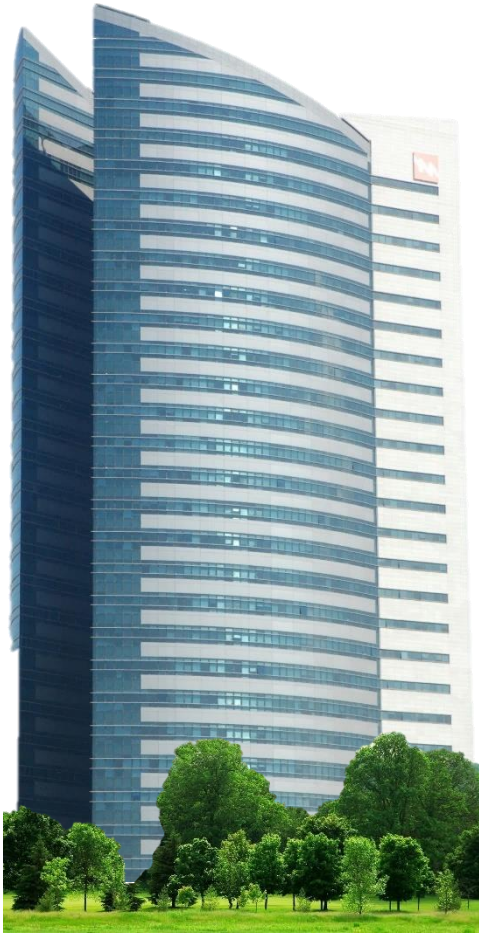
- Engine
 - Size
 - # of Cylinders
 - Valve resistance + timing
 - Combustion time
 - etc.
- Fuel System
- Air Supply
- Shape (aerodynamics)
- ...

Performance Indicator



The Building Envelope Performance (*BEP*) Metric

Target – Energy Efficiency



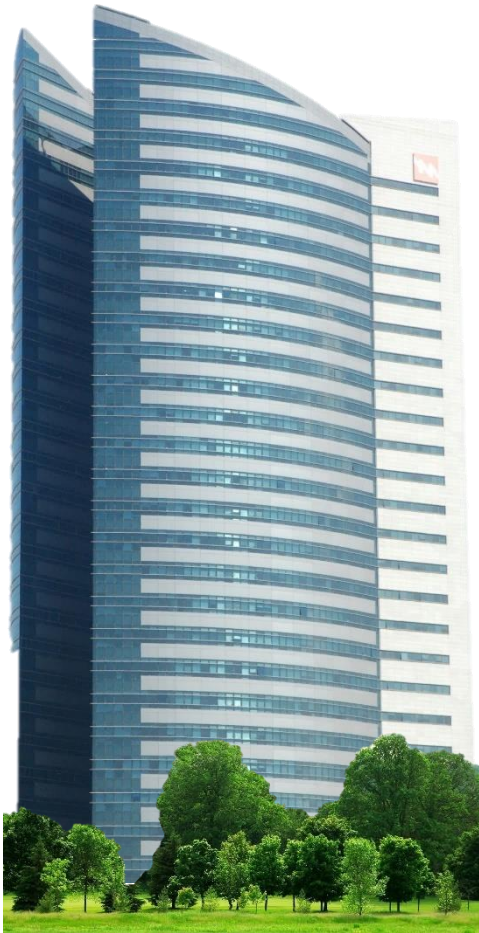
Variables

Performance Indicator



The Building Envelope Performance (*BEP*) Metric

Target – Energy Efficiency



Variables

- R-value
 - Walls
 - Roof
 - Foundation
 - Fenestration
- Thermal Bridges
- Installation Quality
 - Joints
 - Penetrations
 - Perforations
- Airtightness
- Building Type
- Thermostat Setpoints
- HVAC Characteristics
- User Behavior
- Indoor Climate
- Outdoor Climate
- ...

Performance Indicator

- EUI [kBtu/ft²]
- Predicted EUI (Simulations)
- ...

The Building Envelope Performance (*BEP*) Metric

Variables

- R-value
 - Walls
 - Roof
 - Foundation
 - Fenestration
- Thermal Bridges
- Installation Quality
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- Airtightness
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- ...

Performance Indicator

- EUI [kBtu/ft²]
- Predicted EUI (Simulations)
- ...

- **Only Applicable to Existing Buildings**
- **One-way Connection**
- **Highly Influenced by Building Usage**

The Building Envelope Performance (*BEP*) Metric

Variables

- R-value
 - Walls
 - Roof
 - Foundation
 - Fenestration

Performance Indicator

- EUI [kBtu/ft²]
- Predicted EUI
(Simulation)

EUI is not equivalent to “mpg”!

- Air-tightness
- Building Type
- Thermostat Setpoints
- HVAC Characteristics
- User Behavior
- Indoor Climate
- Outdoor Climate
- ...

- **Complicated**
- **Time Consuming**

The Building Envelope Performance (*BEP*) Metric



Energy Usage

Building Envelope
Energy Demand

$$\frac{Q_{HVAC}}{\eta} = Q_{net}^{env} + Q_{in}$$

$$Q_{net}^{env} = BEP \cdot A_{tot}^{env}$$



Building Envelope Performance [kBtu/ft²]

The Building Envelope Performance (*BEP*) Metric

Overall Building Thermal Resistance

$$\mathcal{R} = \frac{1}{\frac{1}{\sigma \cdot R_{env}} + \frac{1}{R_{air}} + \frac{1}{R_{gain}}}$$

R_{env} = Building envelope conductive thermal resistance, *R*-value ((m²·K)/W [(°F·ft²·hr)/Btu]),

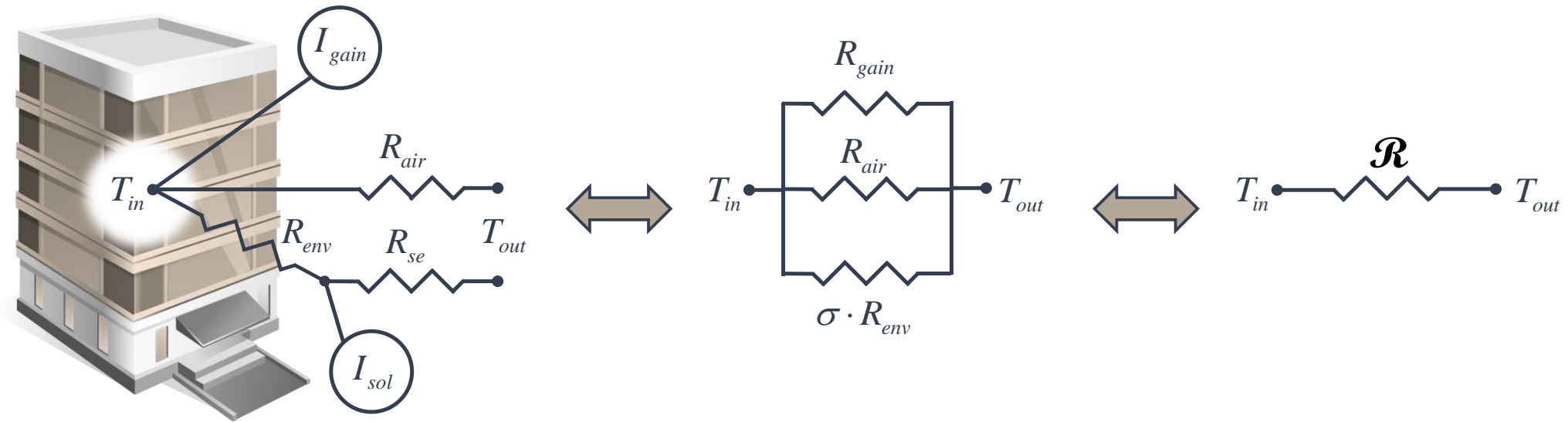
σ = Opaque envelope solar and thermal radiation correction factor (-),

R_{air} = Air leakage resistance ((m²·K)/W [(°F·ft²·hr)/Btu]),

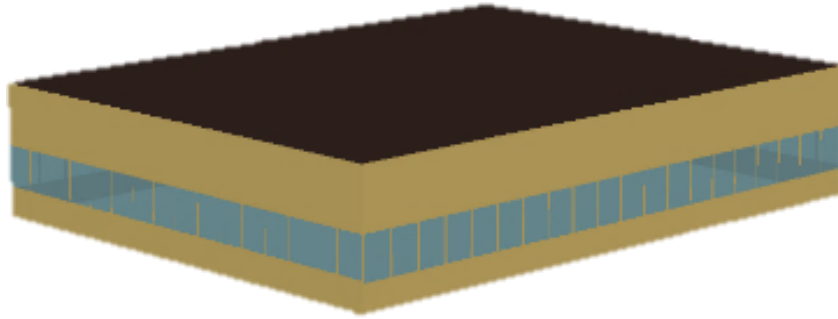
R_{gain} = Window solar internal heat gain resistance ((m²·K)/W [(°F·ft²·hr)/Btu]),

I_{gain} = Window solar internal heat gain (W/m² [Btu/(hr·ft²)]),

I_{sol} = Opaque envelope exterior solar heat gains (W/m² [Btu/(hr·ft²)]),

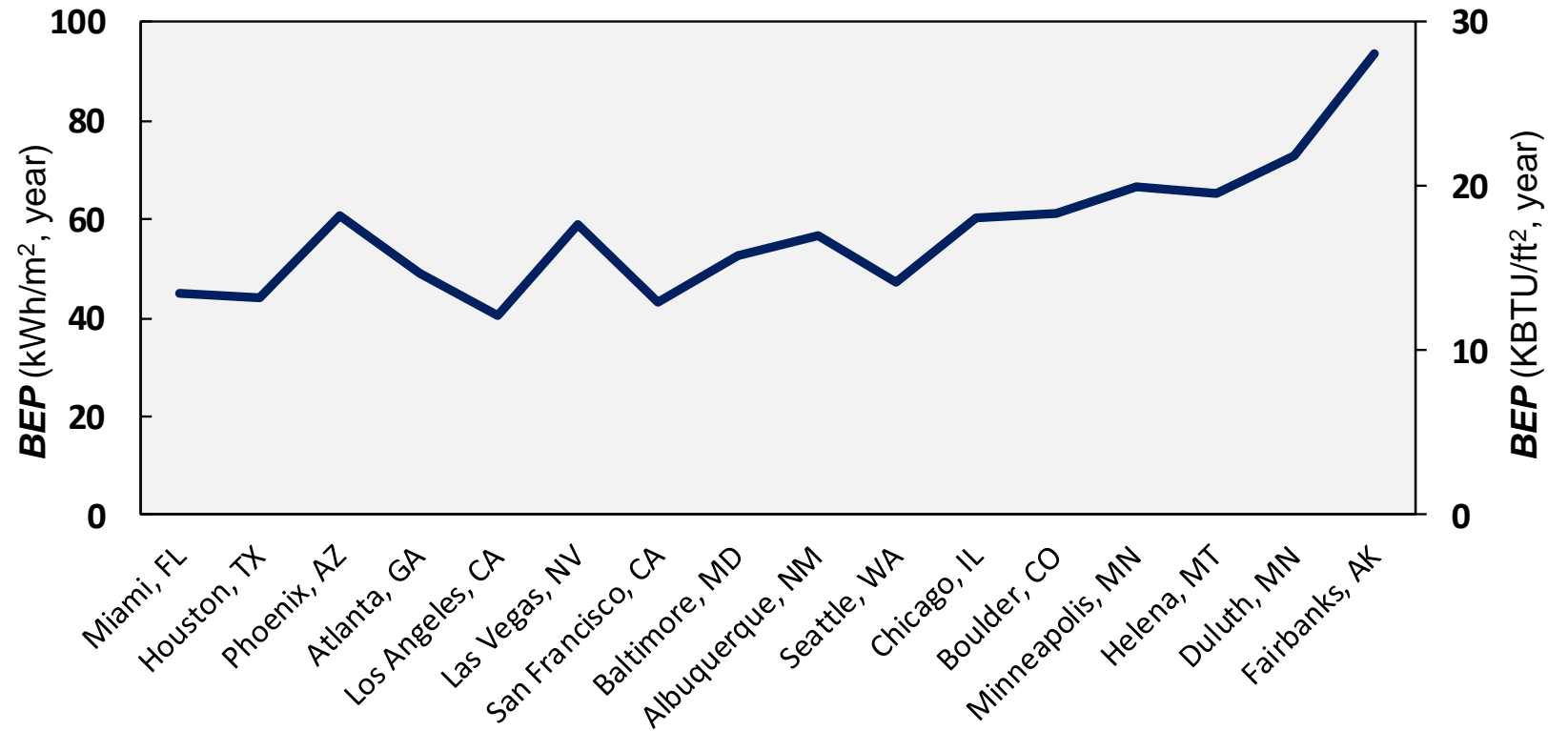
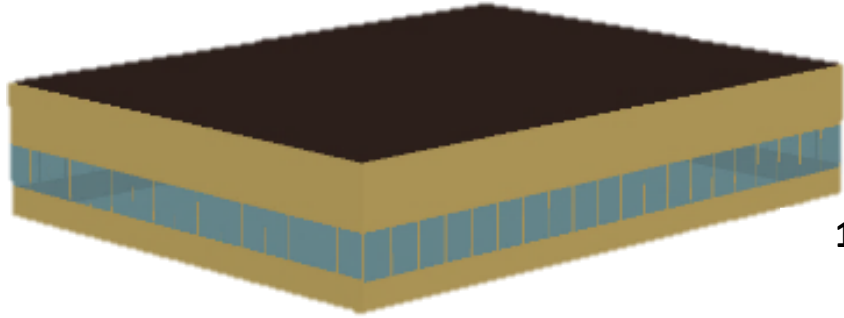


The Building Envelope Performance (*BEP*) Metric



Length x Width x Height	20 x 15 x 4 m [65.6 x 49.2 x 13.1 ft]
Window Area	84 m ² [275.6 ft ²]
SHGC	0.352 (-)
R-value Wall/Roof/Window/Slab	1.013/3.509/0.391/adiabatic (m ² ·K)/W
Solar absorptance Wall/Roof	0.92/0.7
Surface heat transfer coefficient Interior/Exterior	8/25 W/(m ² ·K)

The Building Envelope Performance (*BEP*) Metric





ec.ornl.gov





Polls 2 and 3



Q&A

Join Us!

Unsealed! The Envelope Campaign



2020 SUMMIT
JUNE 8-10 | ARLINGTON, VA



Workshop scheduled for
11:00 am – 12:30 pm,
Wednesday morning,
June 10th

Thank you!

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- Hayley McLeod, ORNL, mcleodhd@ornl.gov
- envelopecampaign@ornl.gov

