Pathways to Net Zero Outcomes

Mark Frankel
April 28, 2016

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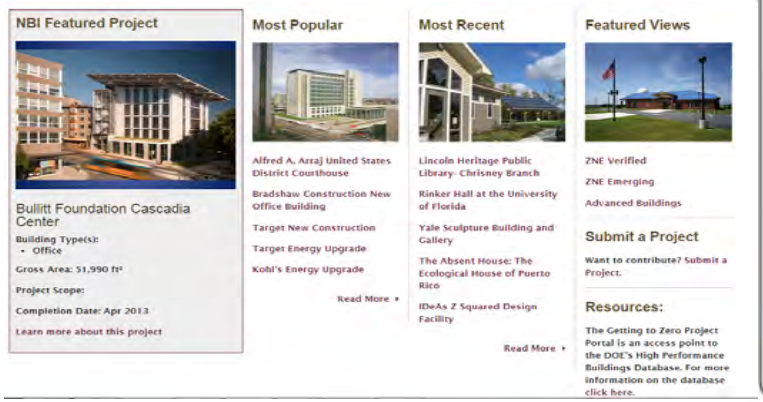

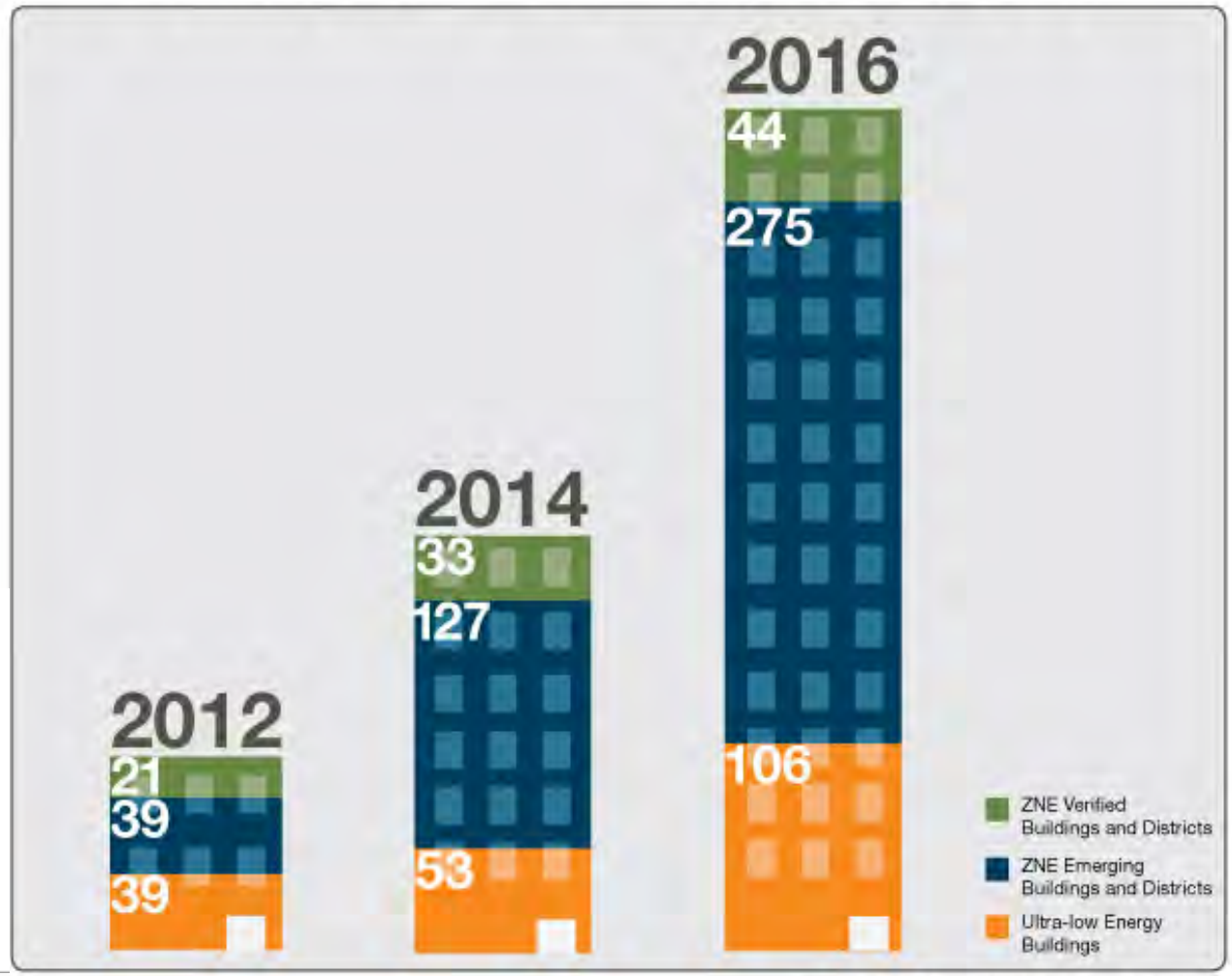

Courtesy of New Buildings Institute | newbuildings.org

ZNE and Ultra-Low Buildings are Possible in Many Building Types Across the US

Small-Med Commercial Offices

K-12 Schools

Large Office Facilities

Environmental Centers

Higher Education Institutions

Government Offices

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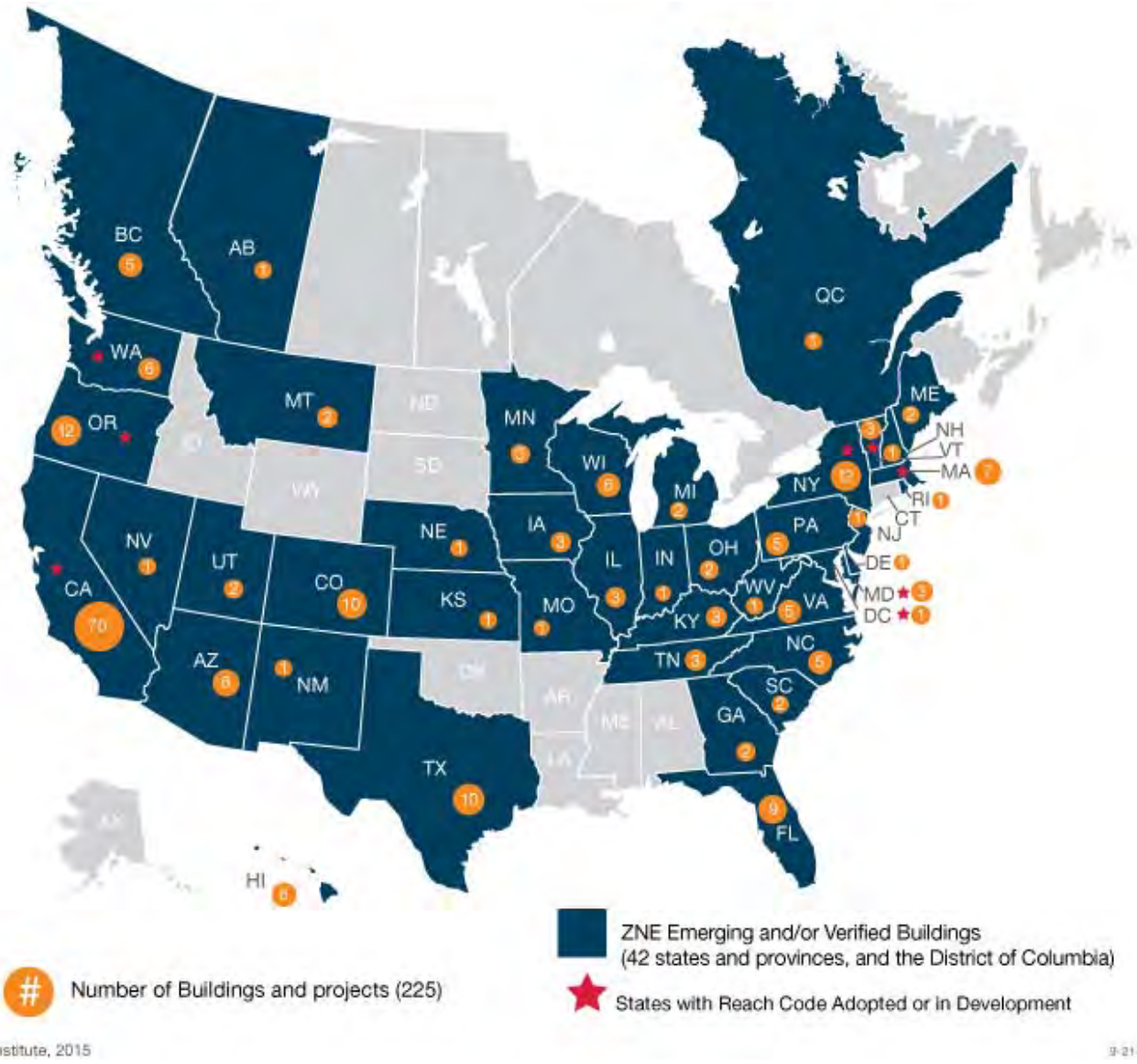
40 States with ZNE Buildings



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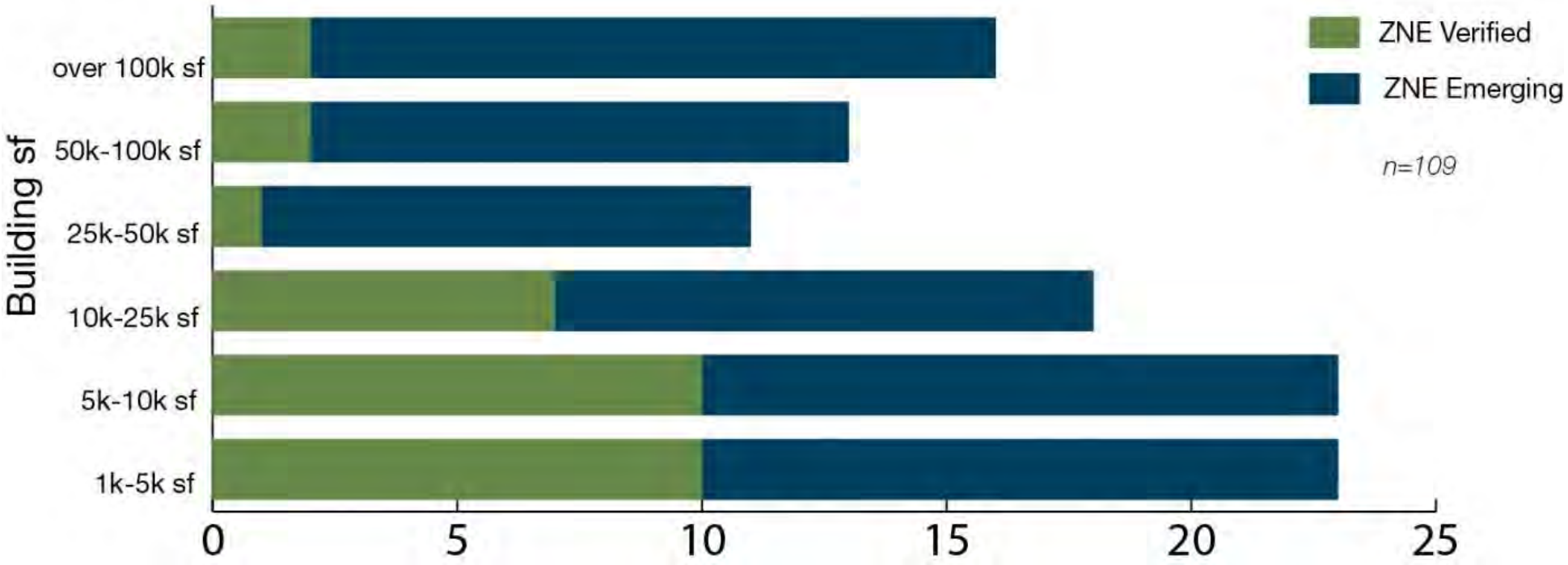
9-21-15

Building Size



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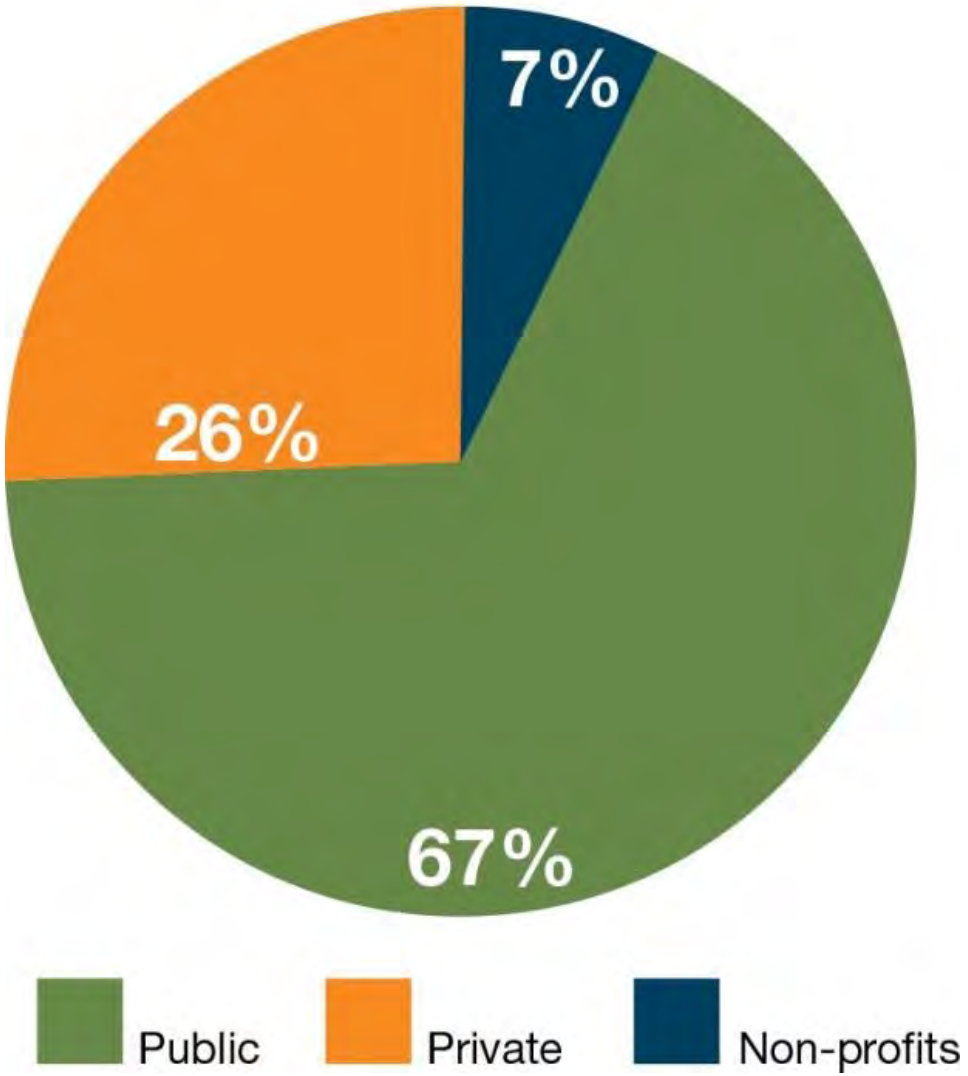
Ownership Type



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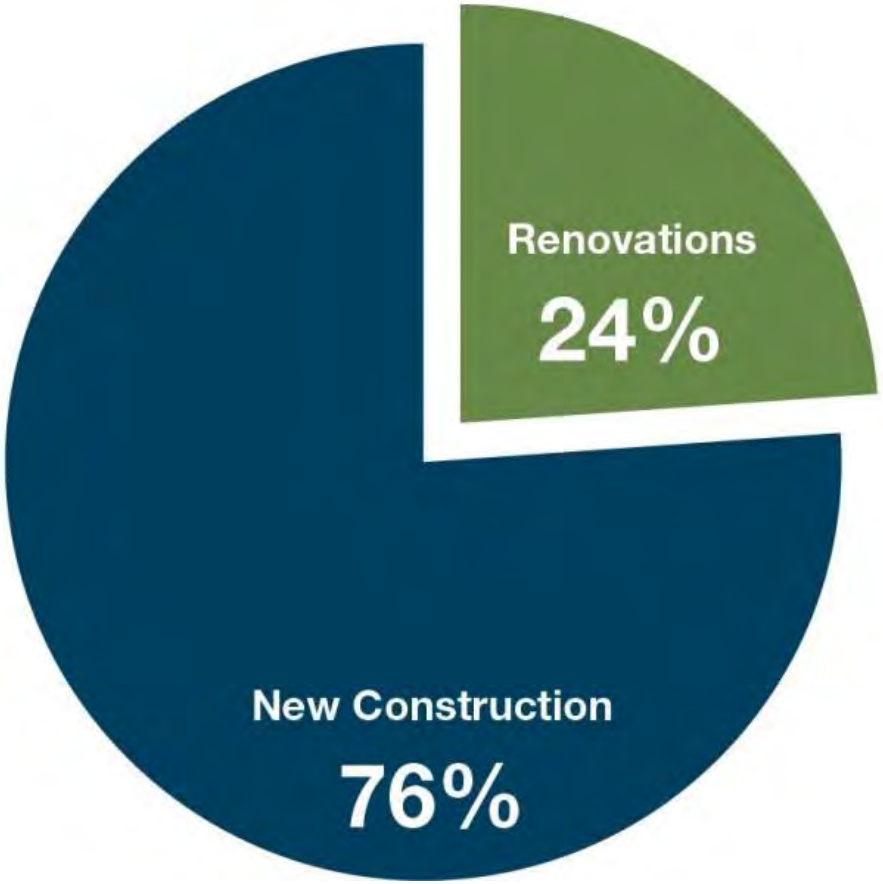
Existing Building Renovation



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Net Zero Spec Office

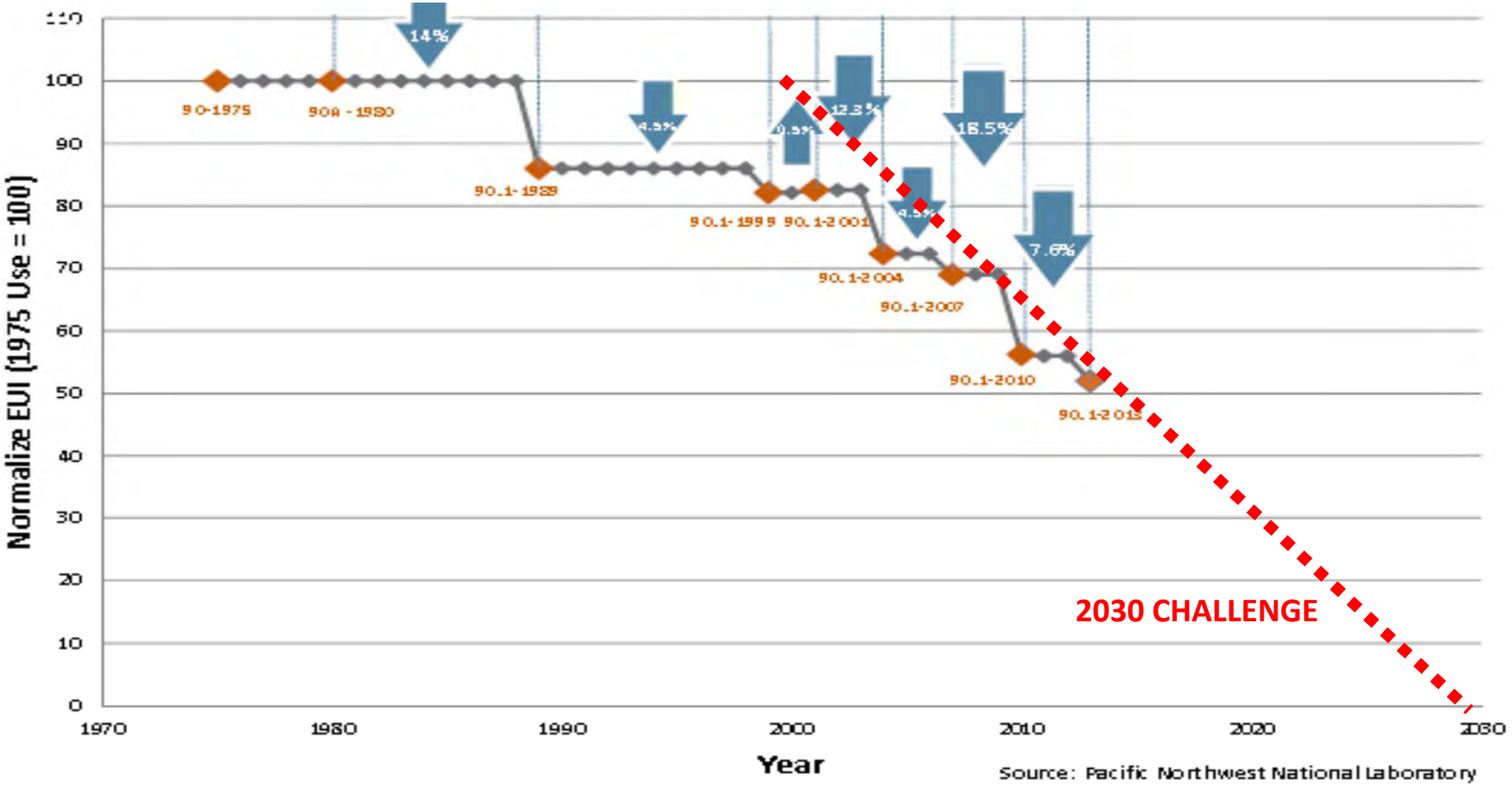
Code and Policy Goals

IBEW Local 595 Training Center, CA

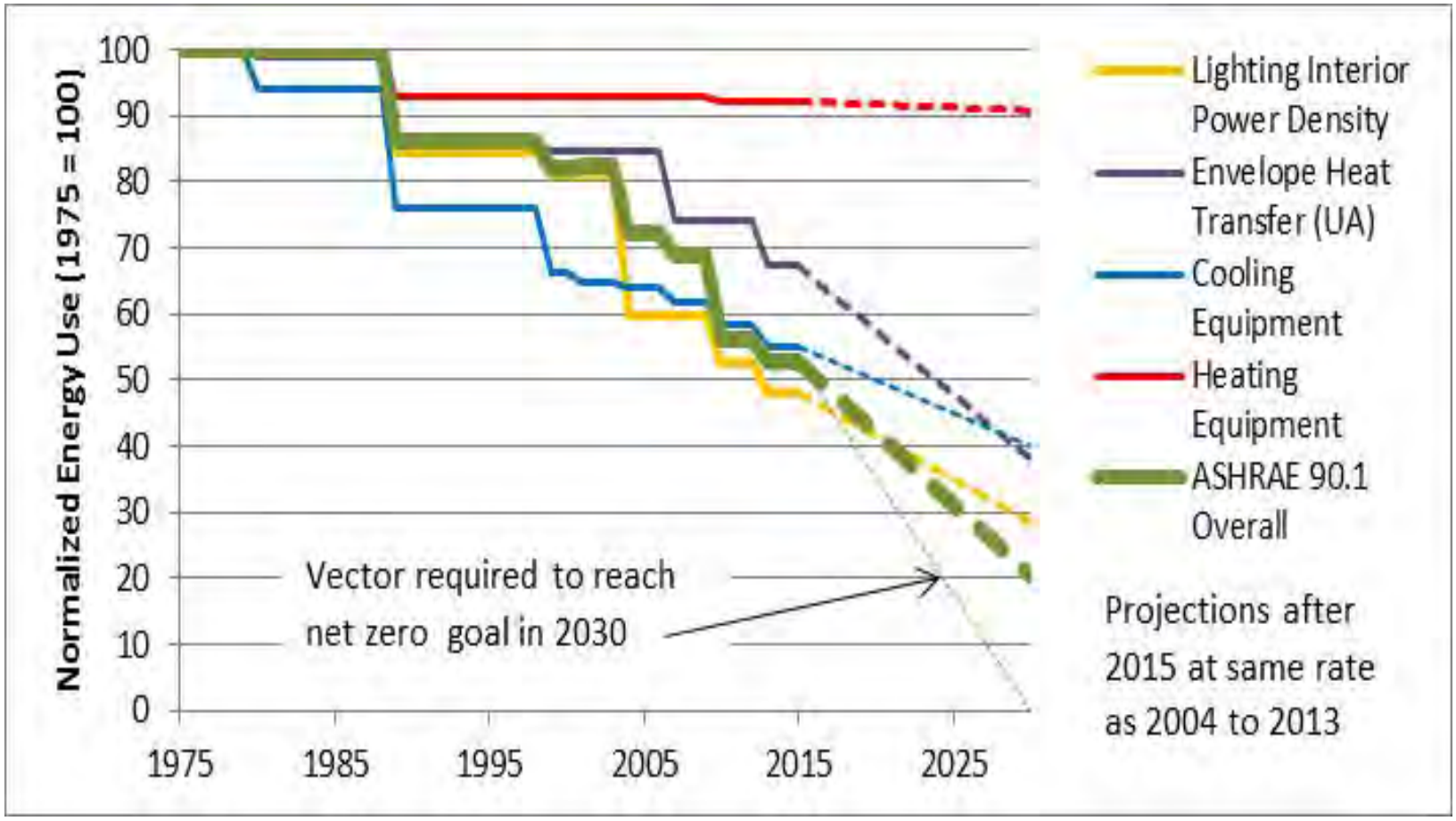
Aggressive Code/Performance Goals are Widely Adopted

- 2030 Challenge
- 2030 Commitment
- CA Big Bold Goals
- Carbon Neutral Cities Alliance/Urban Sustainable Directors Network
- Federal, State, and City Jurisdictions
- Paris Accord
- GSA

Standard 90.1 Stringency Trend



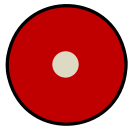
Technical Progress by Component



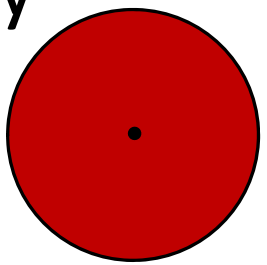
PNNL

Mechanical Systems:
Relative Cooling Efficiency

Conventional
7.5 kBtu/kWh



Direct Evap.
20 kBtu/kWh



Passive Evap.
88 kBtu/kWh

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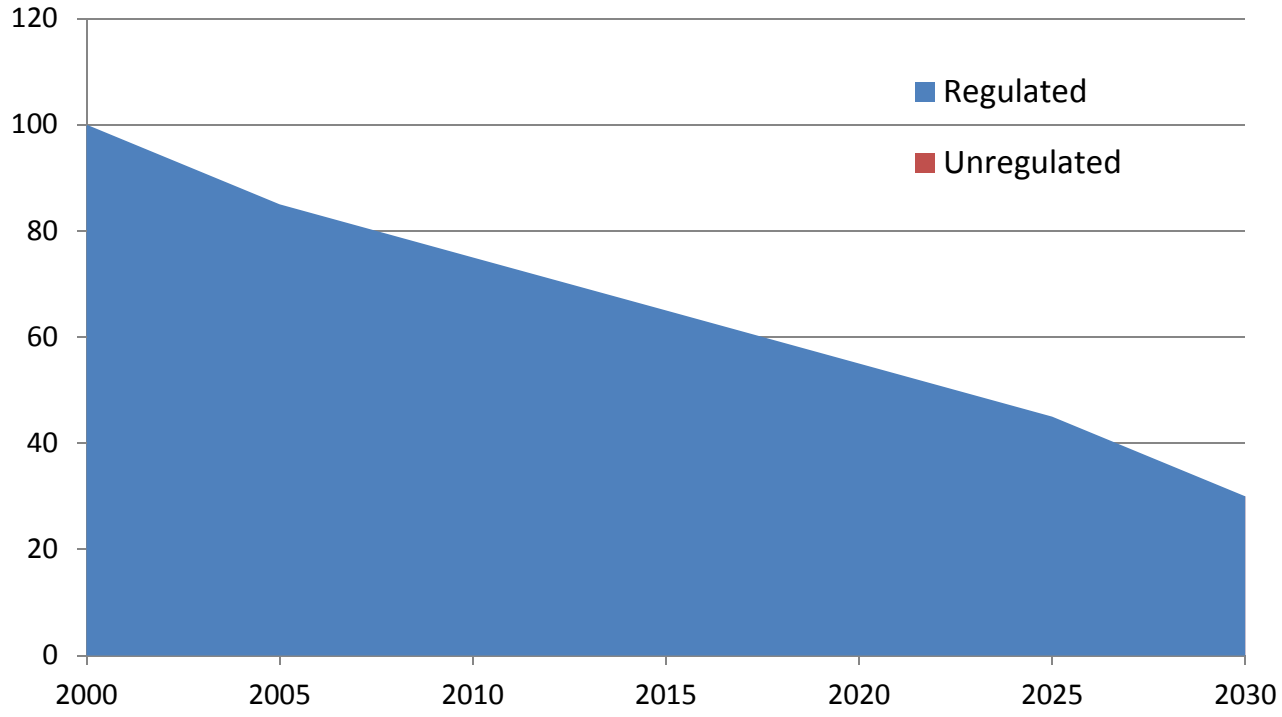
Regulated vs. Unregulated Loads

(conceptual relationship as codes evolve)



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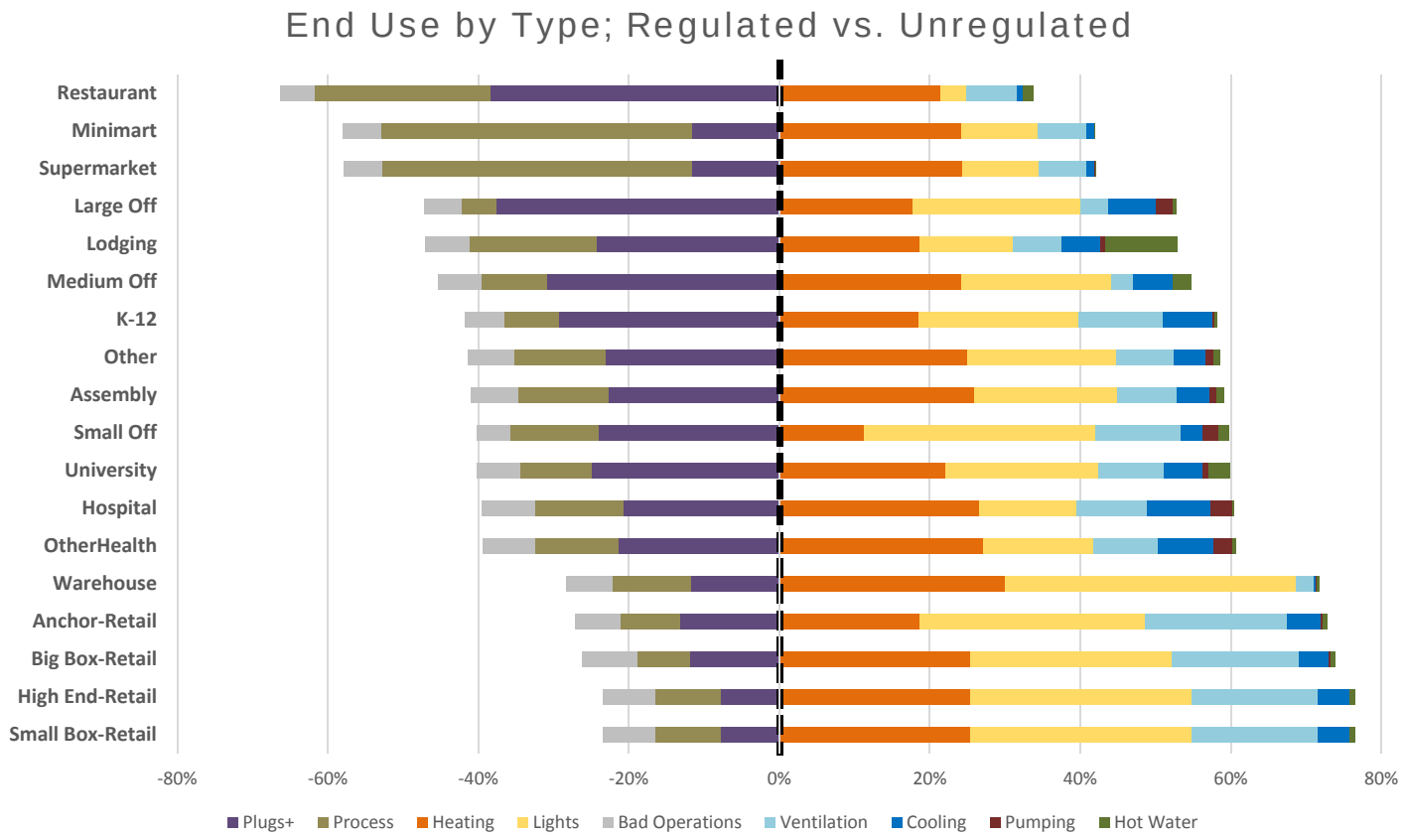
Energy End Use by Building Type
(new buildings in the Pacific Northwest)



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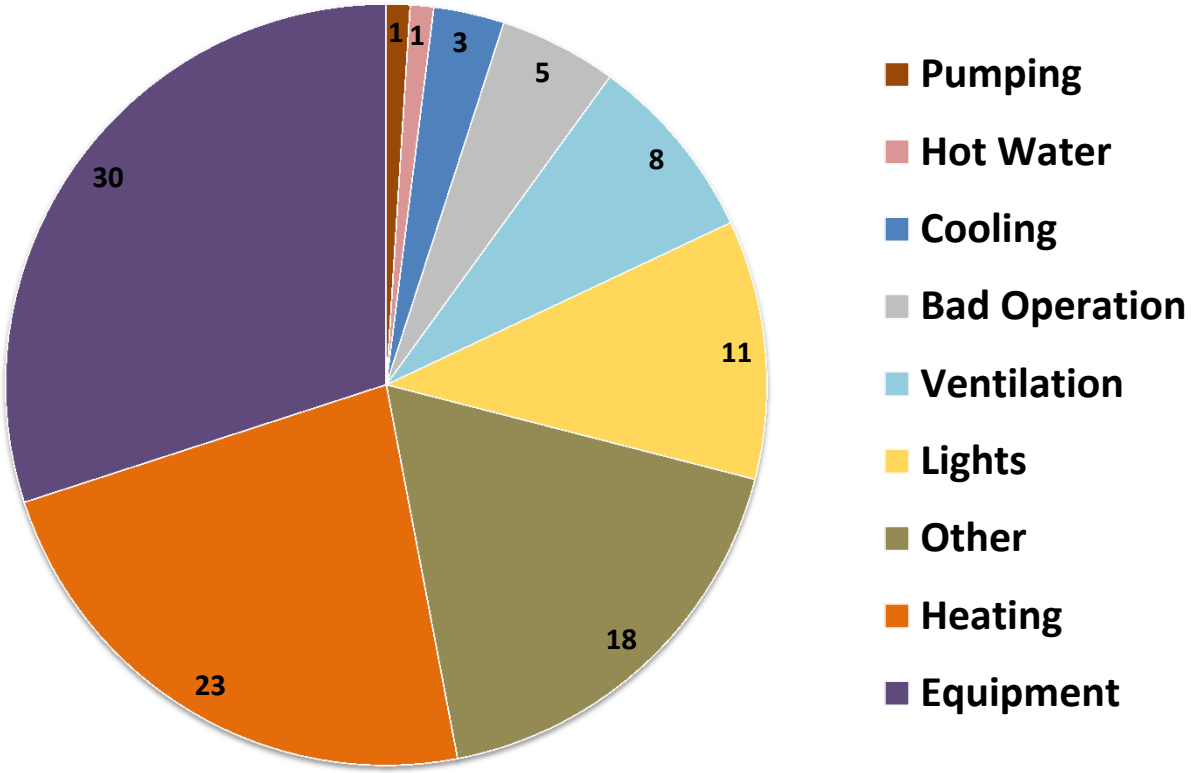
Weighted End Use Energy (across building types)



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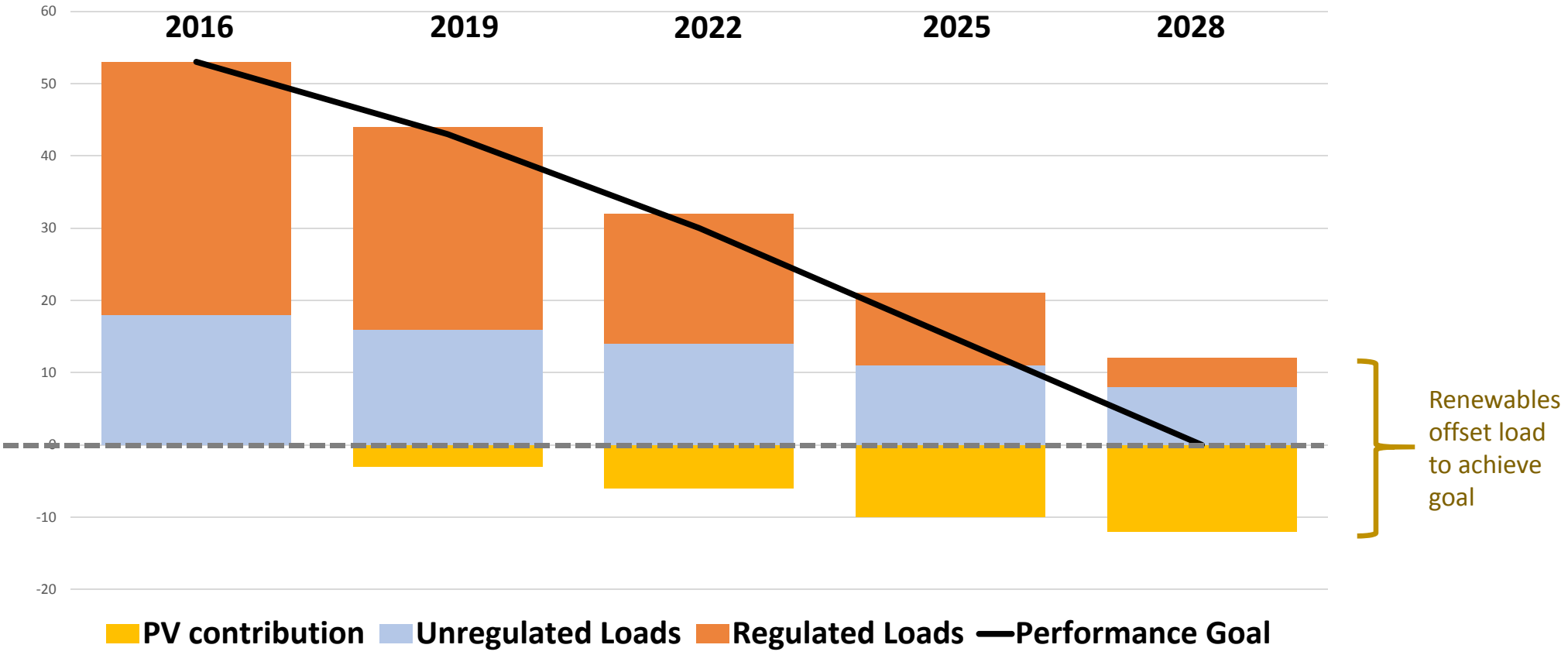
Data from the Pacific Northwest

Code Progression



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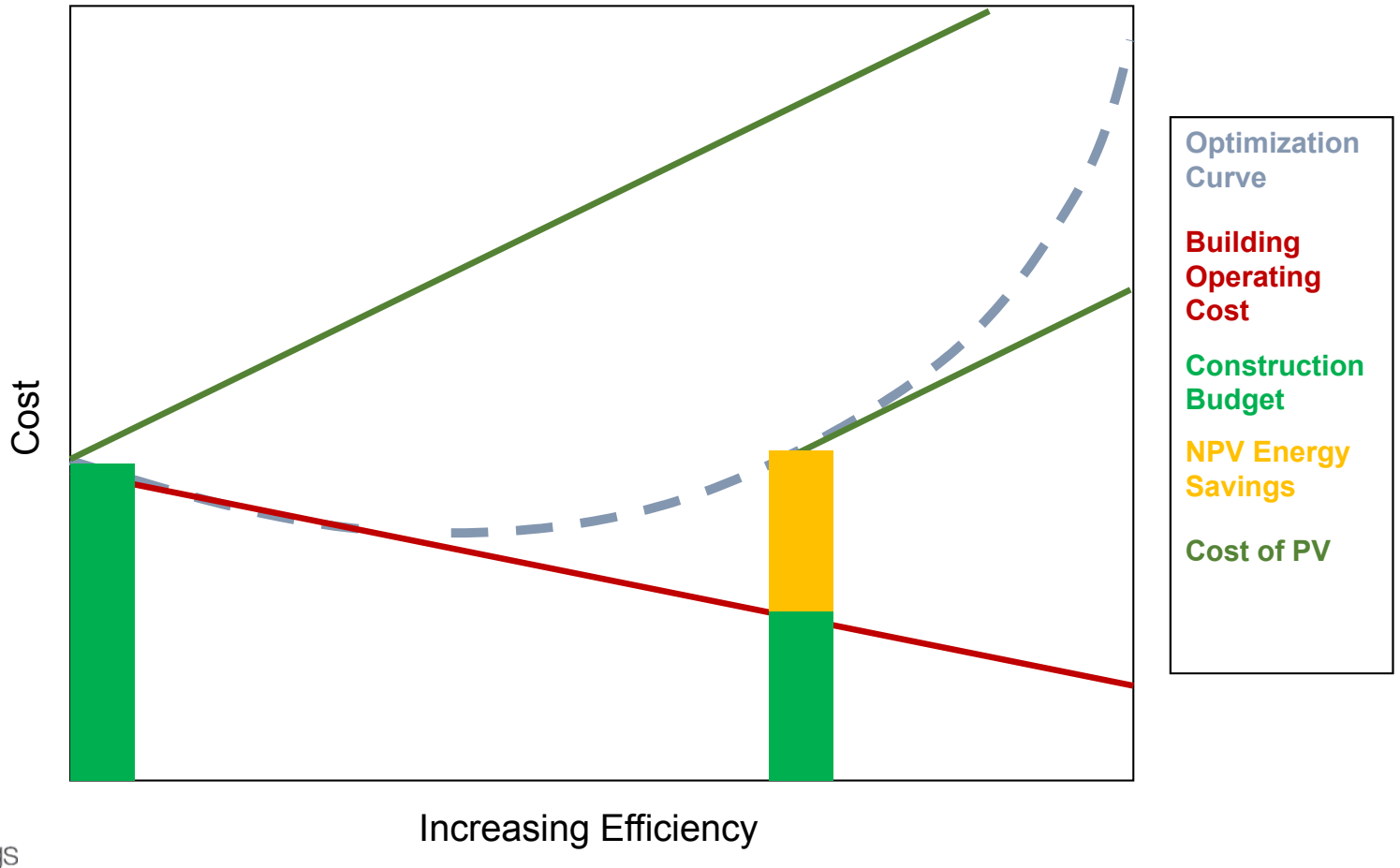
OPTIMIZING project costs and PV



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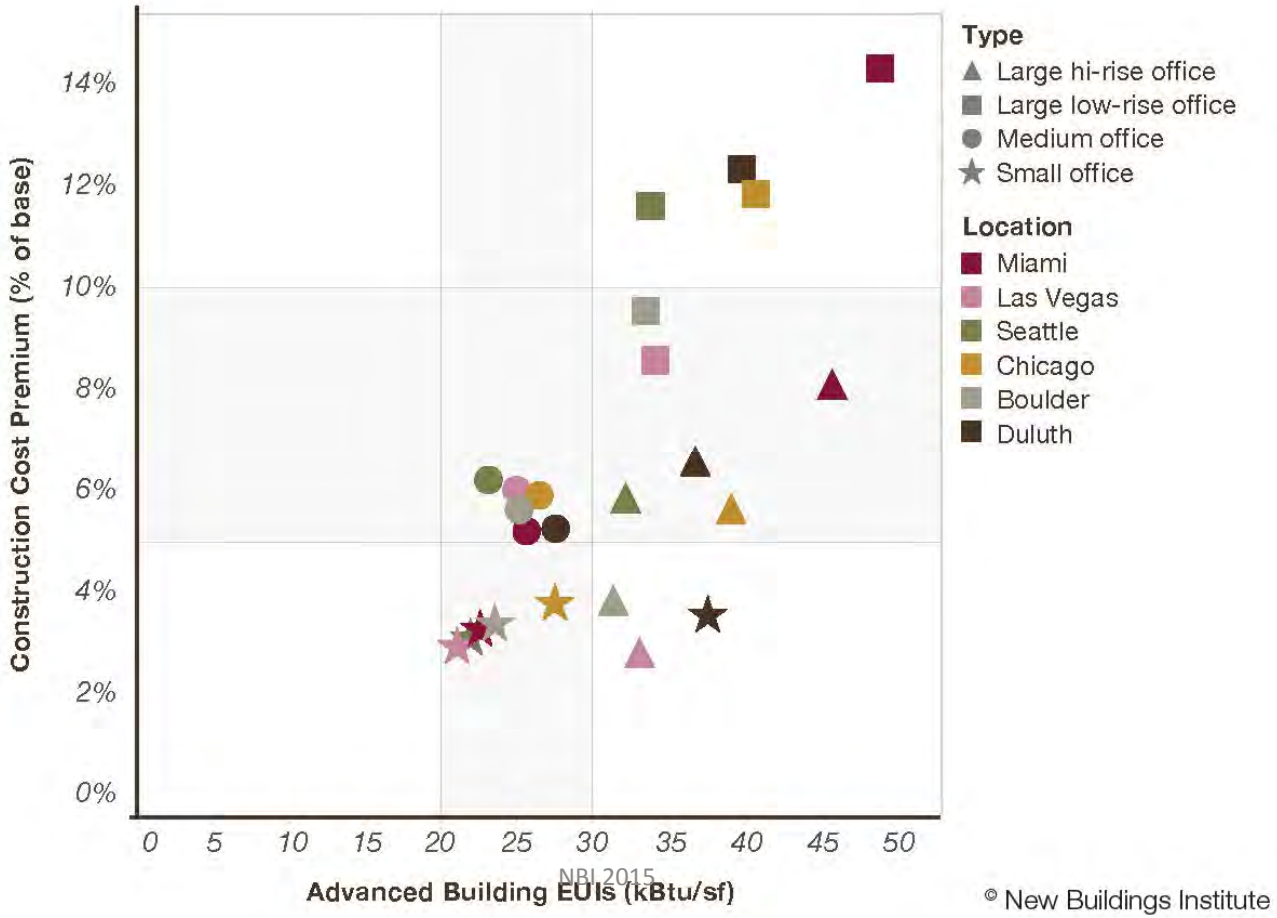
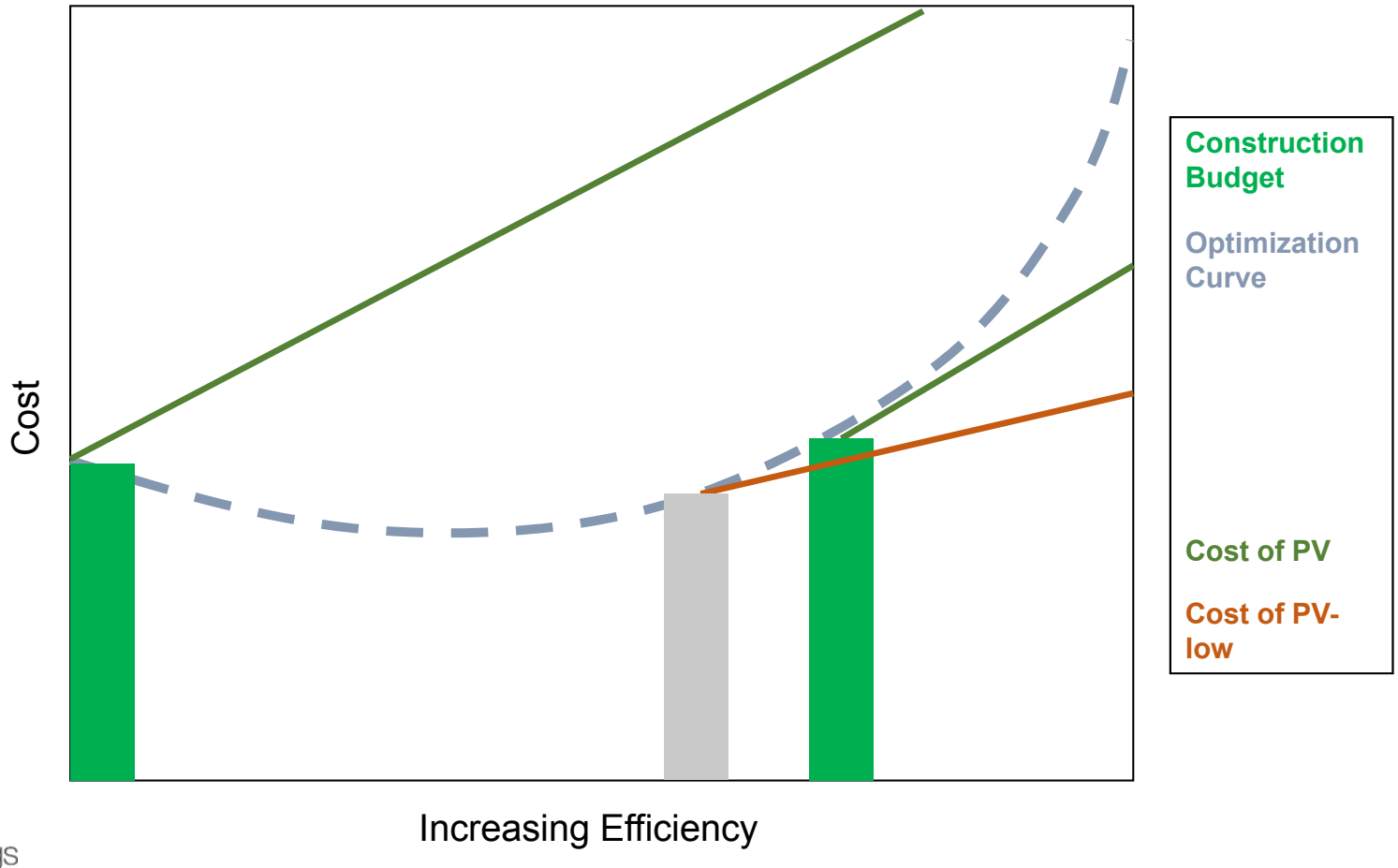
Net Zero Cost vs. Performance



OPTIMIZING project costs and PV



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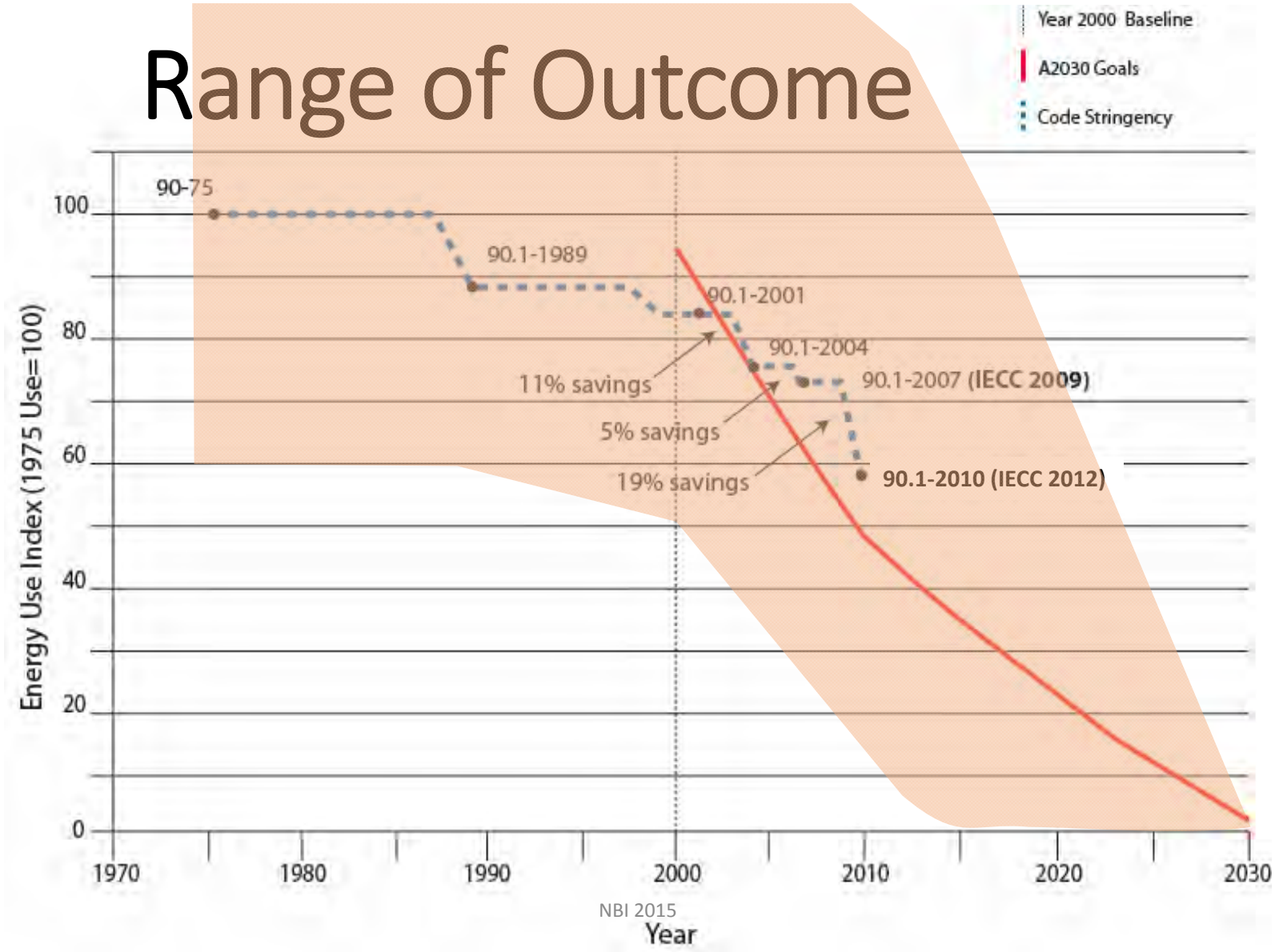
Range of Outcome

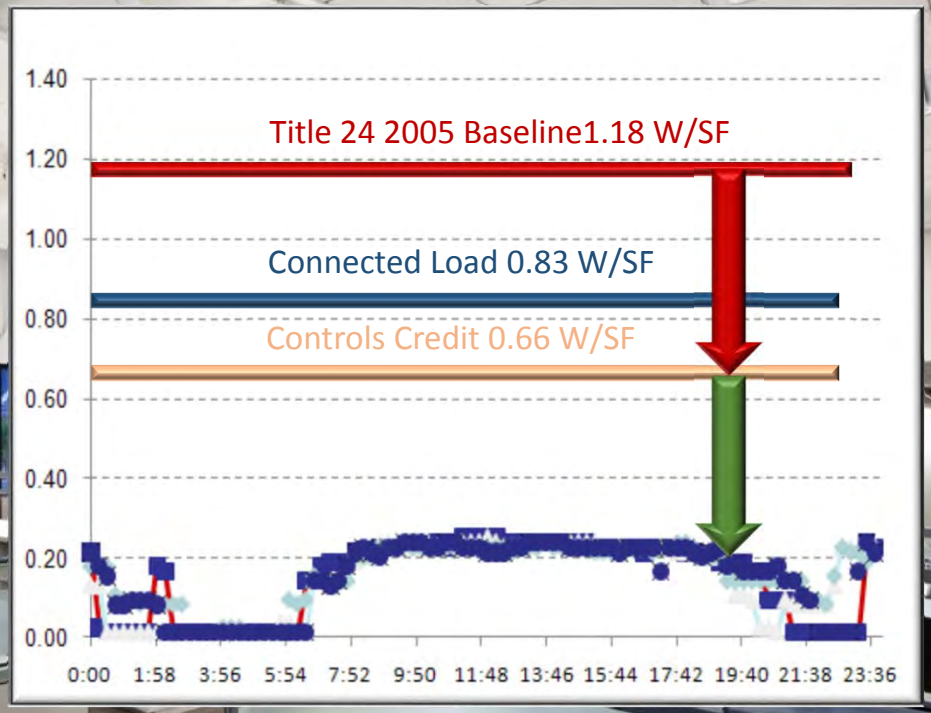


Create a Good Meal


NBI 2015

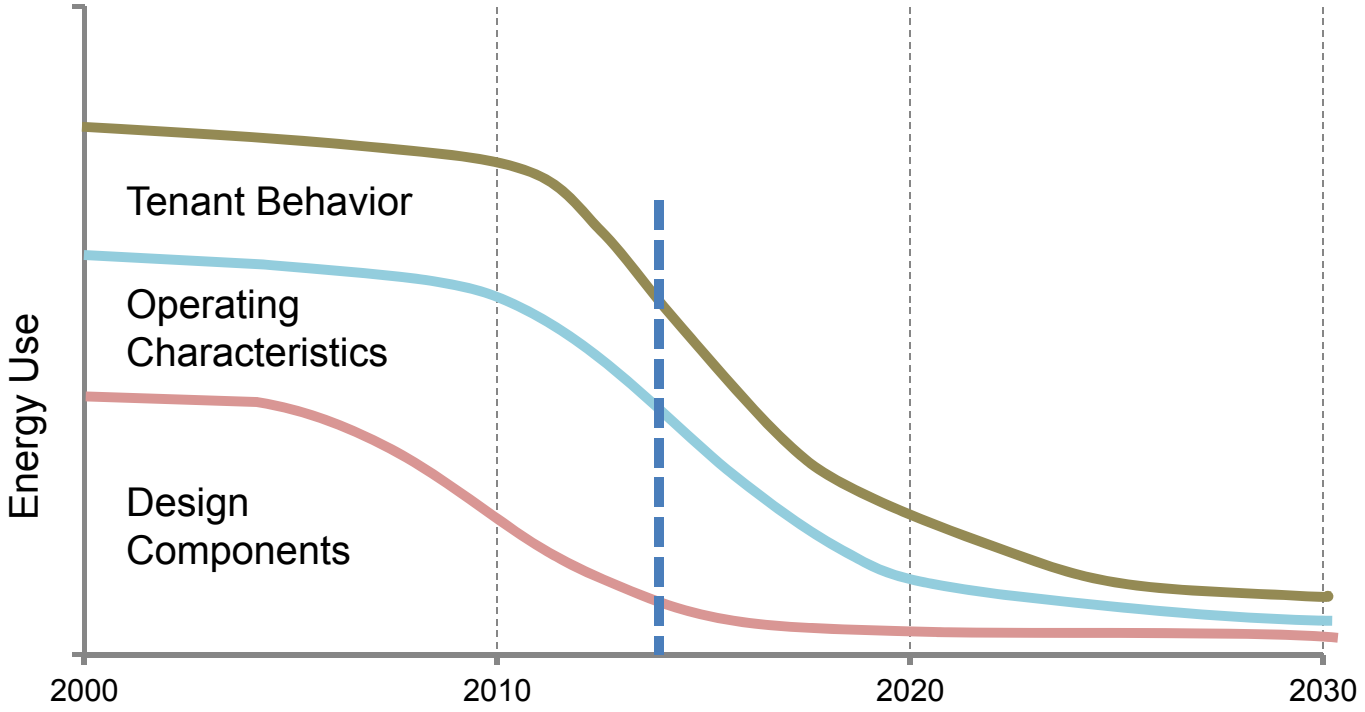
Design vs Operation

- **Single-Fixture Task-ambient (task light provides ambient)**
- **All building lighting on occupancy sensors**
- **Private offices 50% auto-on with occupancy sensors, all lights auto-off**



Courtesy of Glumac

Components of energy outcomes



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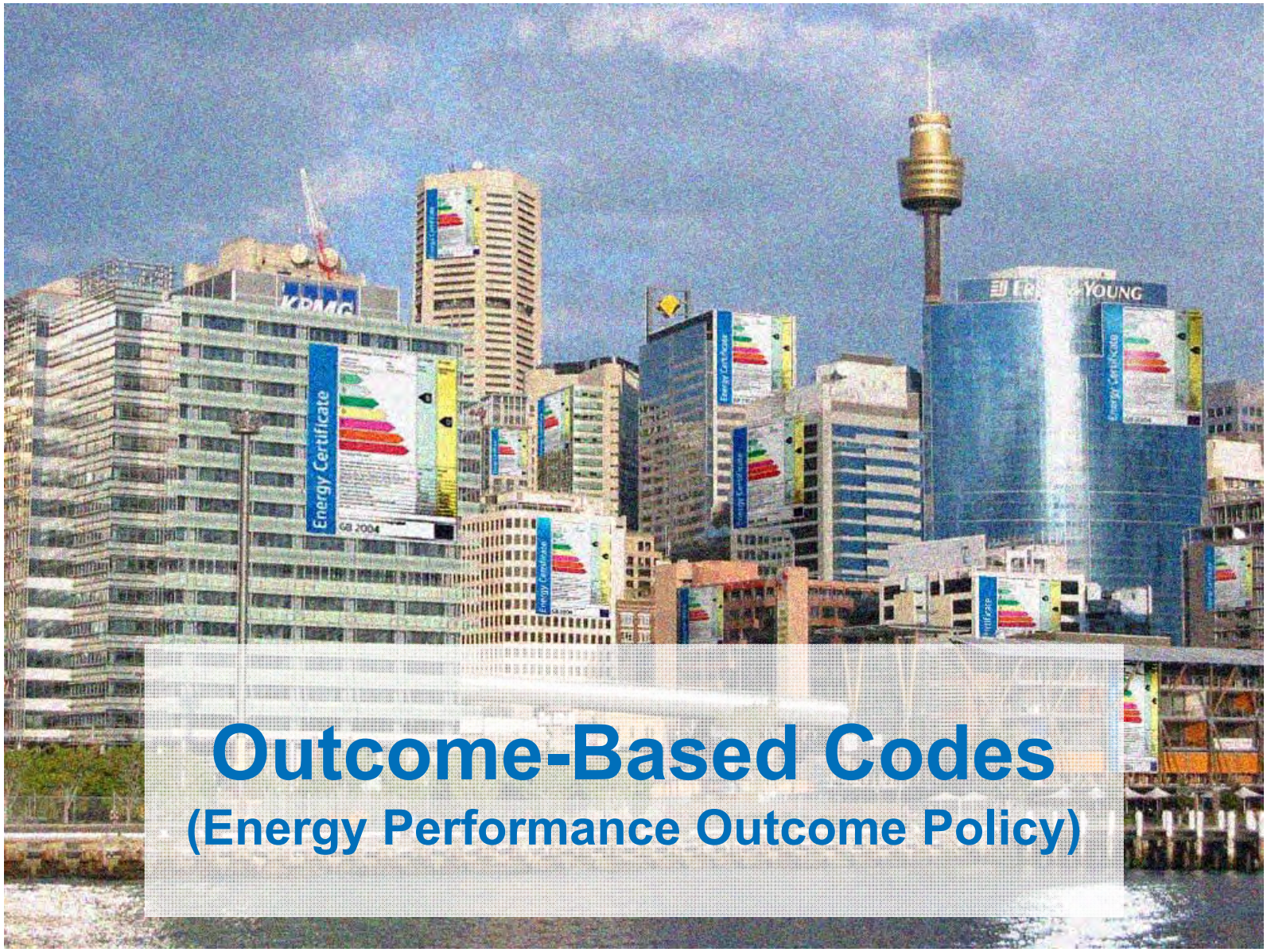


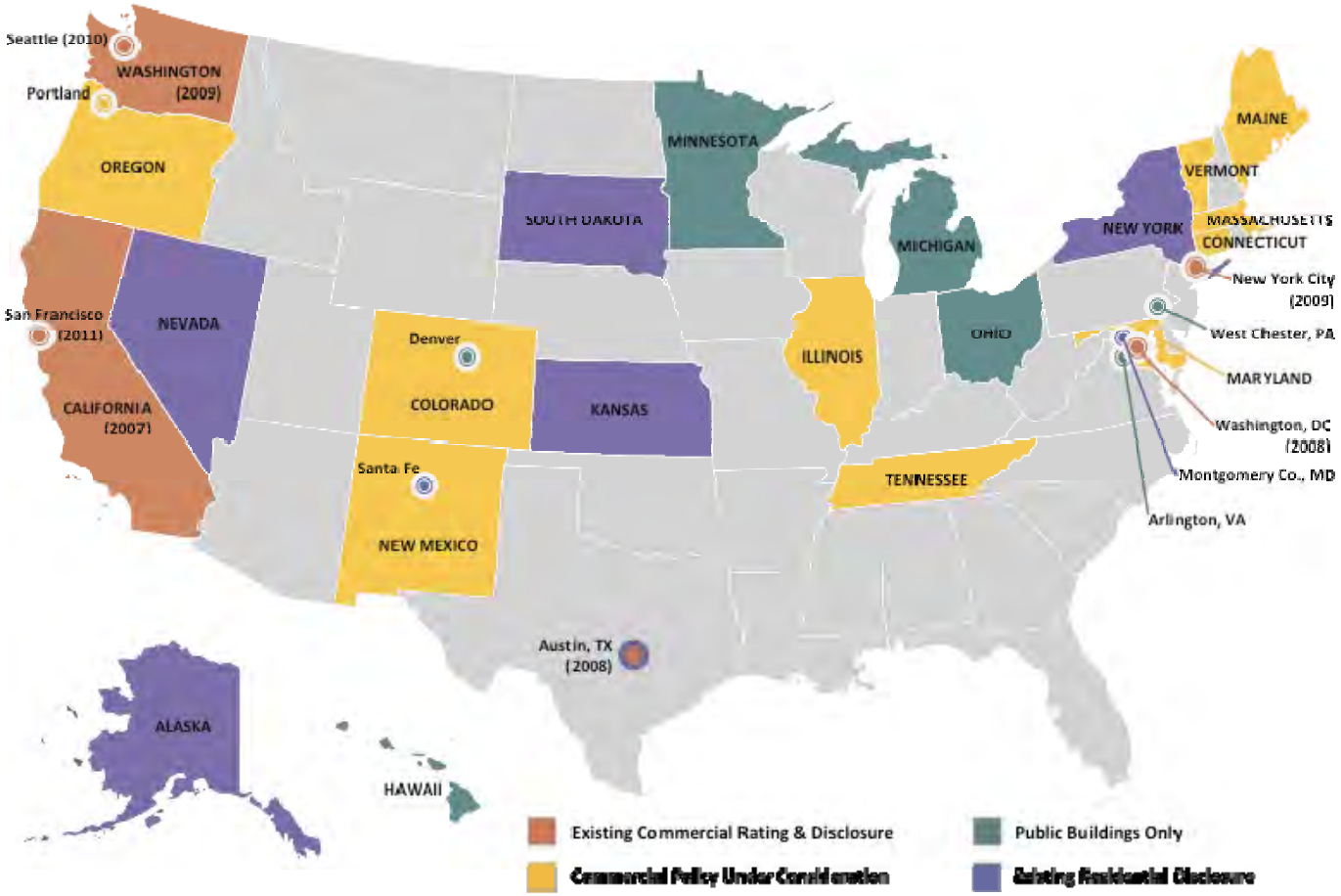
Outcome-Based Codes

(Energy Performance Outcome Policy)

Outcome Project Examples

- Edith Green Wendell Wyatt Federal Building; Portland -SERA
- George Deukmejian Courthouse, Long Beach –AECOM/Clark
- Federal Center South; Seattle -ZGF

Building Energy Disclosure



City of Seattle: Outcome Code Pathway

Demonstrate EUI of 40 or less within 3 years of building completion

City of Vancouver, BC: Annual Thermal Energy Demand Intensity (TEDI)

Envelope/Infiltration-driven heating load limits (Similar to Passive House)

IGCC Language

- **Section 612, Outcome-Based Pathway Requirements**

  612.1 Outcome-based requirements. Compliance for buildings and their sites to be designed on an outcome basis shall be determined by actual measurement of all energy being used once the building and the energy using elements associated with the building site are in full operation…

  …Buildings and building sites complying with this section shall also comply with the IECC. Compliance shall be based on a determination of actual energy use in accordance with this section.

  'Post-Occupancy Verification Permit'

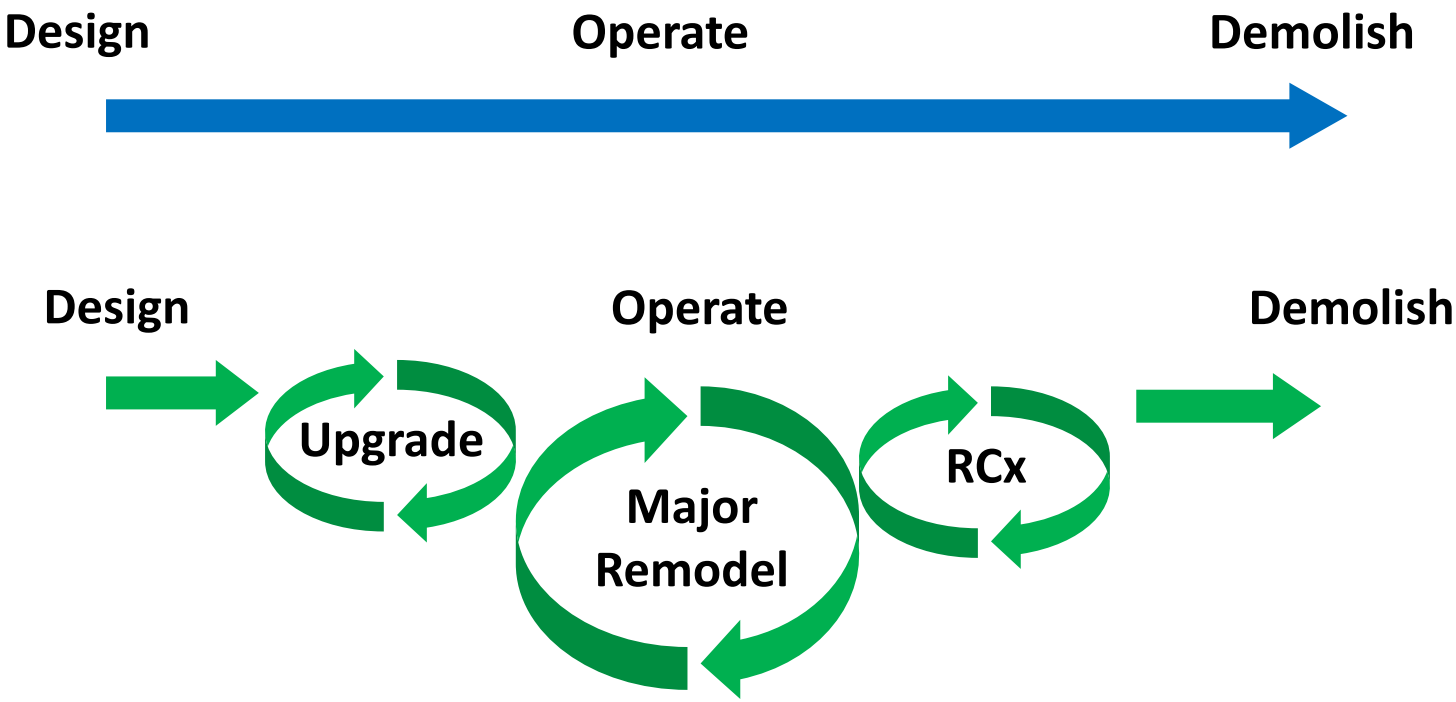
Portfolio Evaluation

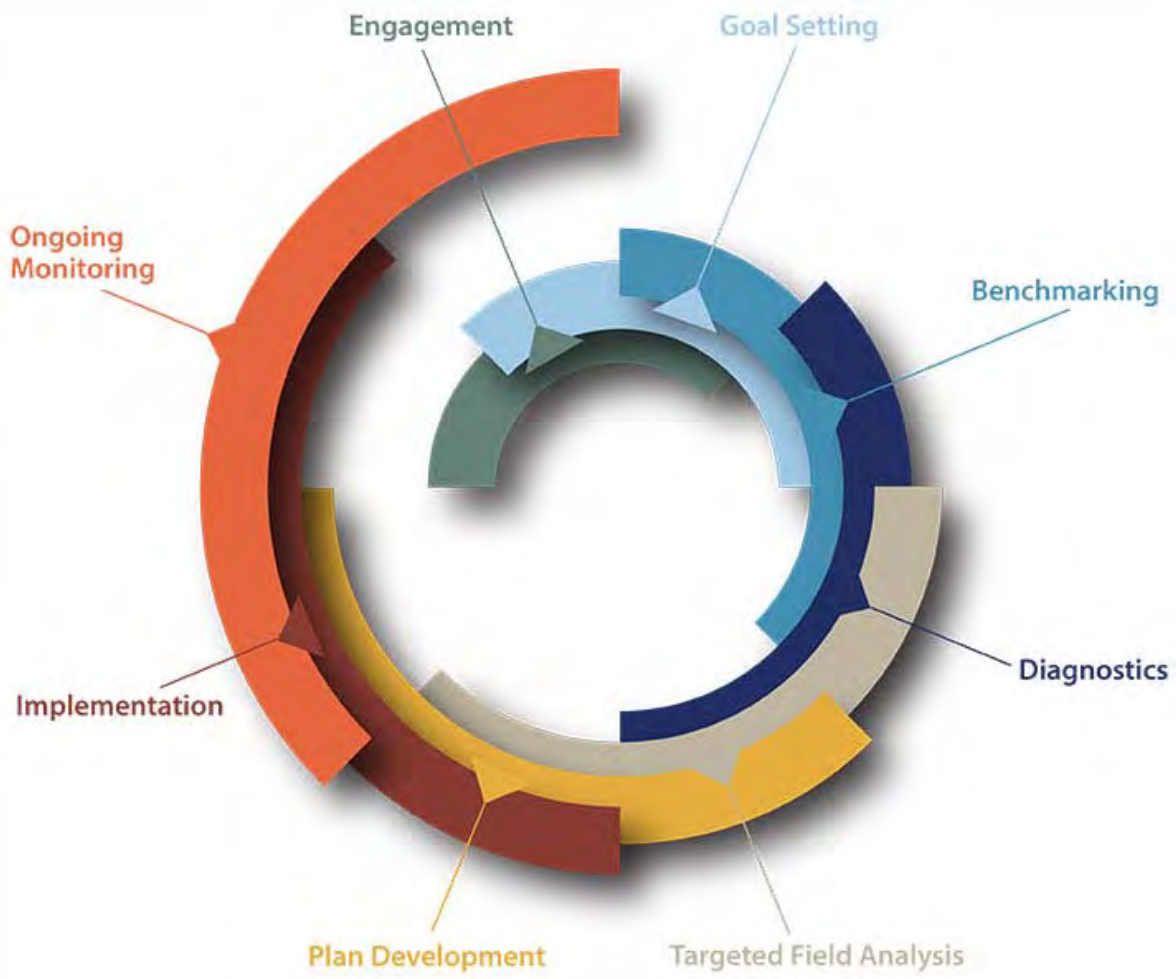
Hood River Middle School
Photo:Michael Mathers

City Portfolio Approach

- **Portfolio Benchmarking**
- **City Engagement**
- **Analysis and Prioritization**
- **SEMP**
- **Integration in City Policy**
- **Tool for On-Going Performance Tracking and Management**
- **Project Financing Plan**
- **Implement Upgrades**

Building Life-Cycle Opportunities




Engagement
Goal Setting
Ongoing Monitoring
Benchmarking
Diagnostics
Implementation
Plan Development
Targeted Field Analysis

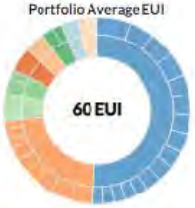
EUI Report

The EUI Report allows you to instantly identify under-performing buildings and departments. Using the powerful filters below you can easily compare building performance across portfolios and identify trends year over year.

Fire Station × Ice/Curling Rink × Library × Lifestyle Center × Museum × Office × Other - Education × Other - Entertainment/Public Assembly × Social/Meeting Hall × Transportation Terminal/Station ×

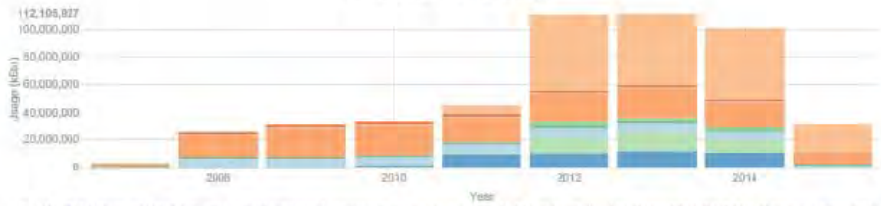
2007 × 2008 × 2009 × 2010 × 2011 × 2012 × 2013 × 2014 × 2015 ×

Portfolio Average EUI



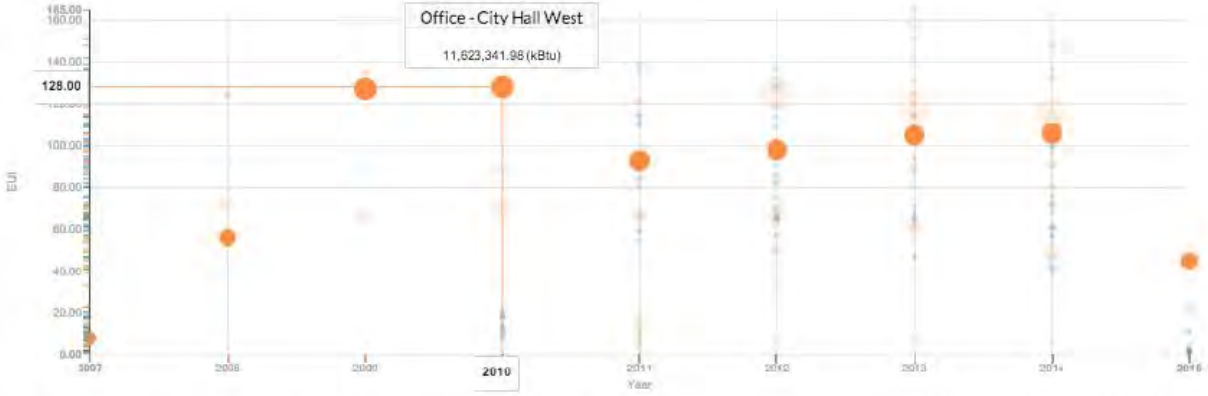
The EUI 'Eye' provides a powerful visualization of how the energy-use intensity of whole portfolios (e.g. departments), as well as how buildings within each portfolio, compare to one another.

Portfolio Year over Year average



The Portfolio Resource Plot provides insight into yearly aggregate resource-use trends. The default view is a stacked bar chart that displays yearly whole portfolio resource-use broken down by building type or department. Mouseovers enable quick insights into how much of a given resource each department has consumed in a given year.

Building Year over Year EUI



The EUI Bubble Chart enables instant, powerful insights into when buildings were added to portfolios, the relative aggregate resource consumption by building and department, and year over year energy-use intensity trends.

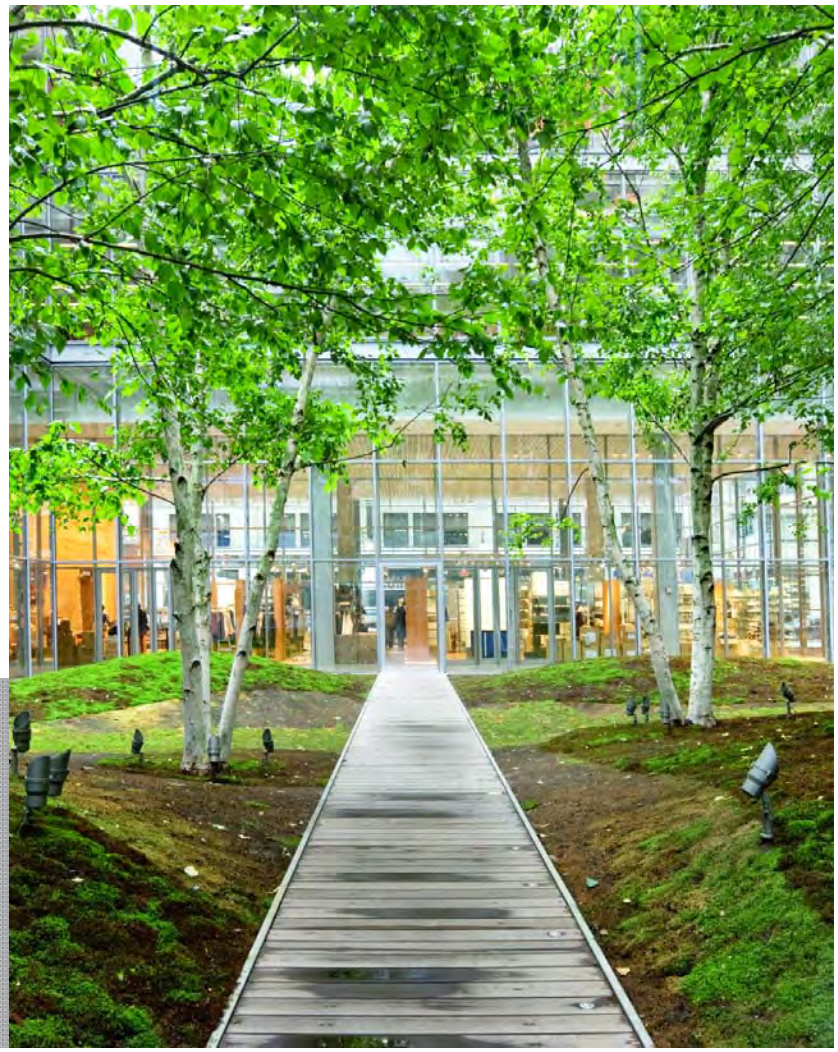
Properties

Airport Terminal PW
Black History Museum
Boise Art Museum
Boise Depot
CITY HALL
City Hall West
Community Center
Fire Station 1
Fire Station 10
Fire Station 11

+ Collaborators

FirstView®

An honest look at building performance



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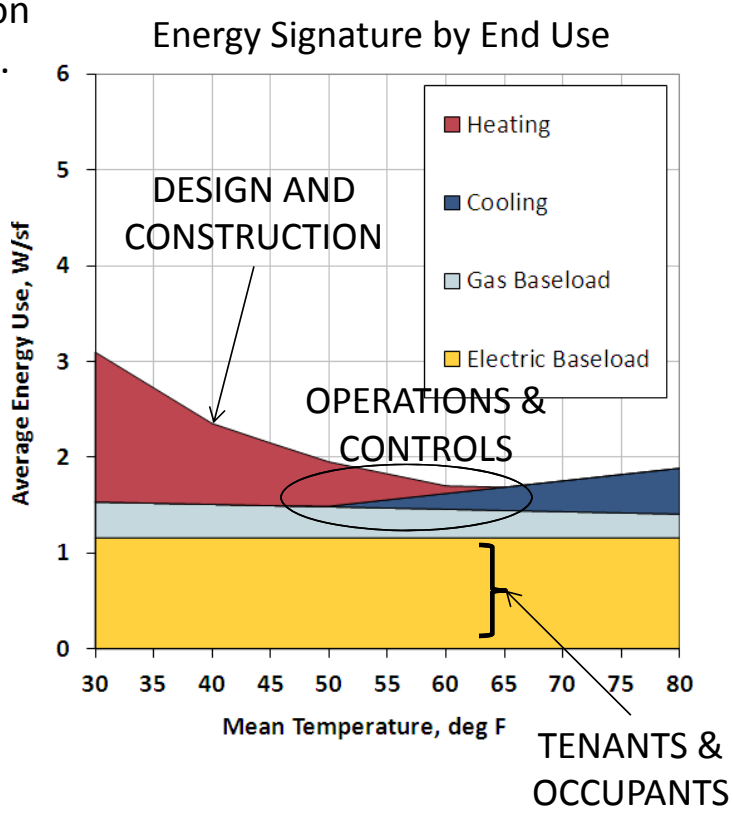
Simple Inputs for Deep Insight

- Inputs:
  - 1 year of monthly utility bills
    - All fuels – electric, gas, other
  - Basic Building Info:
    - Location
    - Building size
    - Building type
- Automatic disaggregation of end uses into:
  - Heating
  - Cooling
  - Thermal baseload (gas/steam)
  - Electric baseload

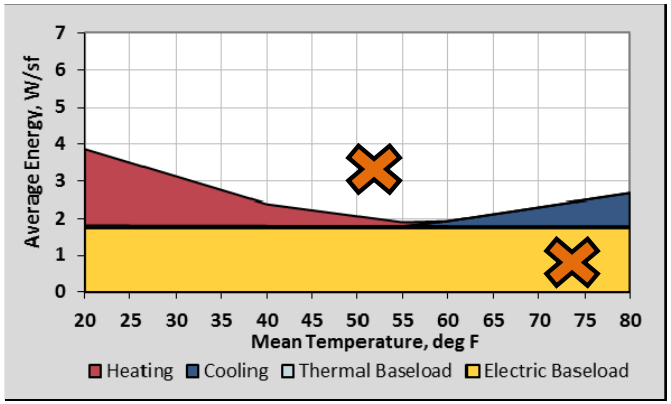
Energy Signature Diagnostics

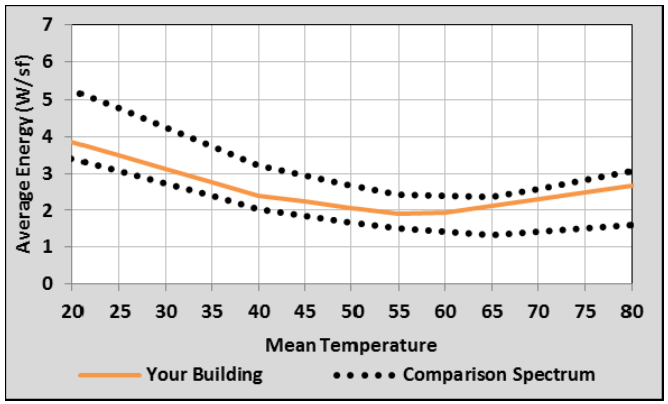
FirstView automates diagnostics based on specific patterns in the energy signature.

Diagnostic Category	Observation
Occupant Load	Low
Heating Impact of Shell and Ventilation	Typical
Cooling Efficiency	Good
Control Inefficiencies	Moderate
Reheat	None
Gas Baseload	High

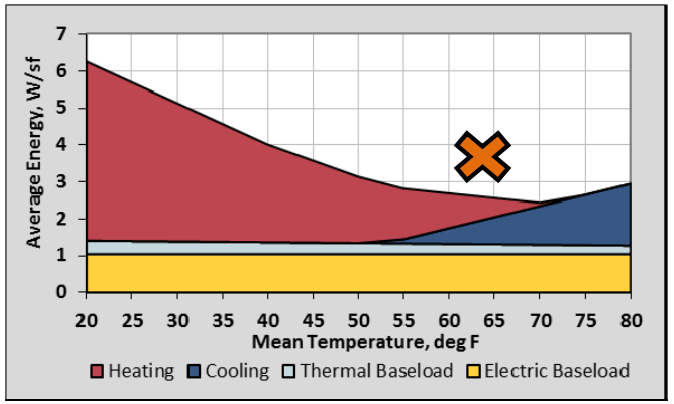


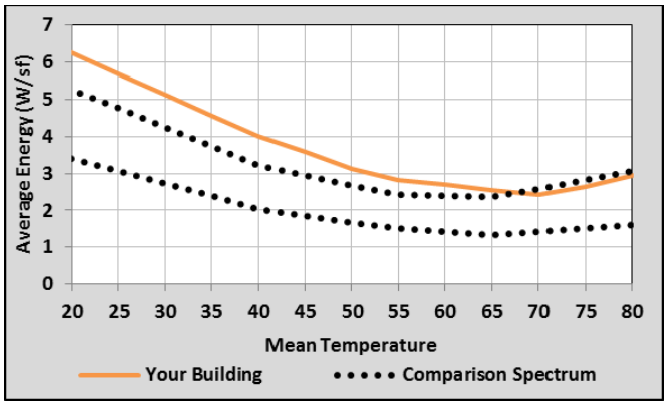
A City Hall

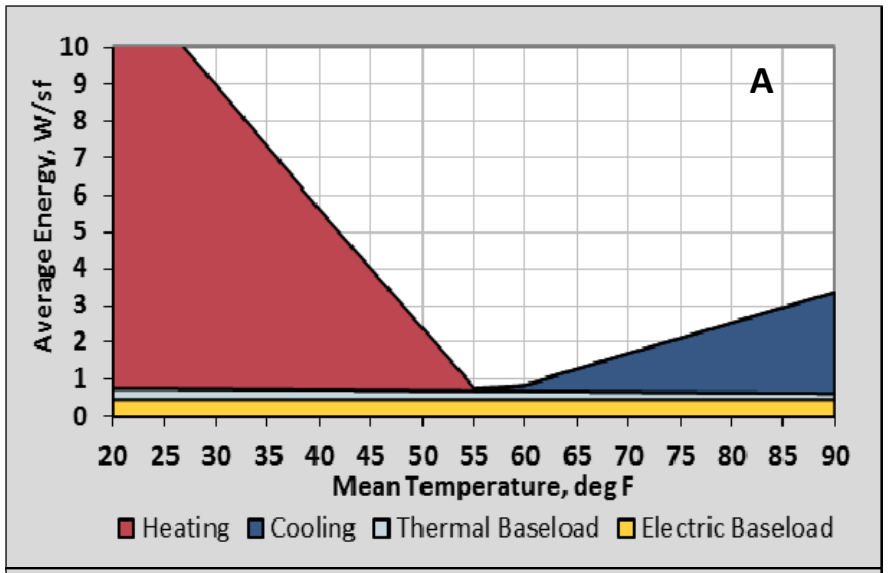


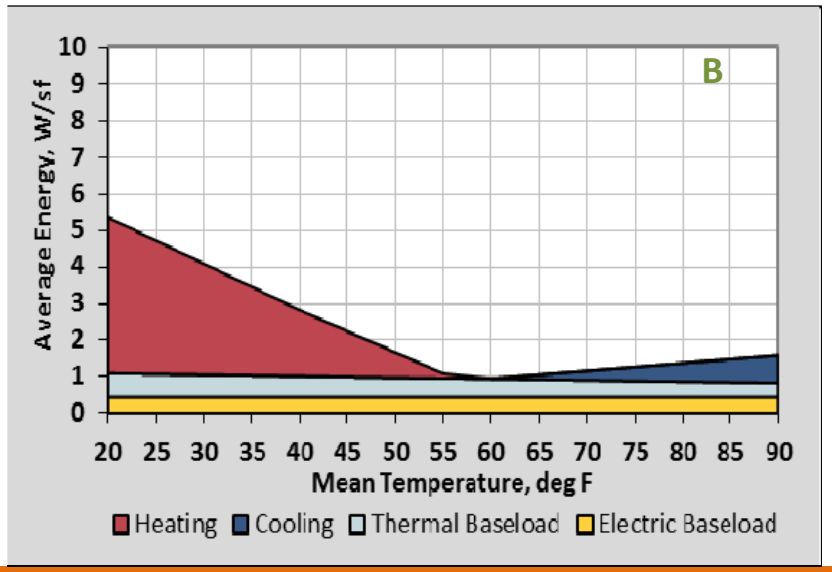


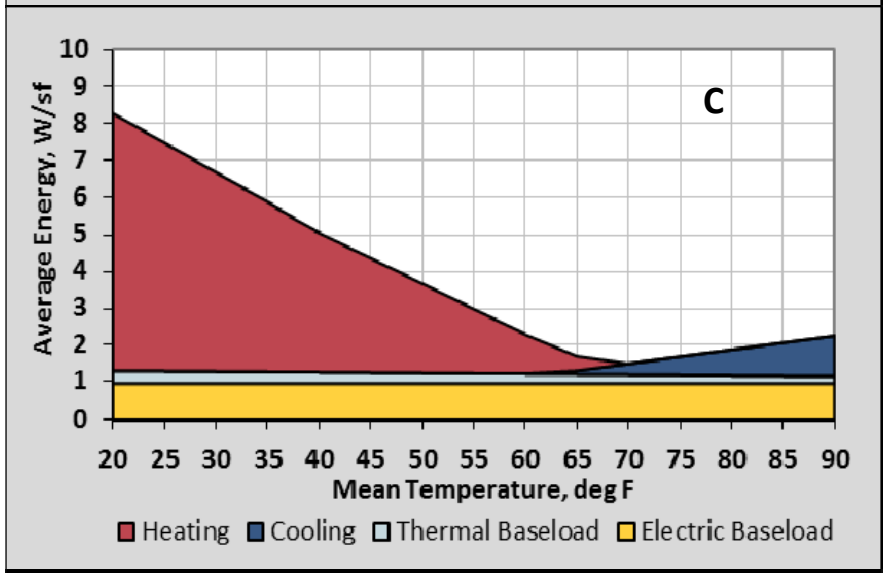
A Different City Hall






A
Average Energy, W/sf
10
9
8
7
6
5
4
3
2
1
0
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Mean Temperature, deg F
Heating
Cooling
Thermal Baseload
Electric Baseload


B
Average Energy, W/sf
10
9
8
7
6
5
4
3
2
1
0
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Mean Temperature, deg F
Heating
Cooling
Thermal Baseload
Electric Baseload


C
Average Energy, W/sf
10
9
8
7
6
5
4
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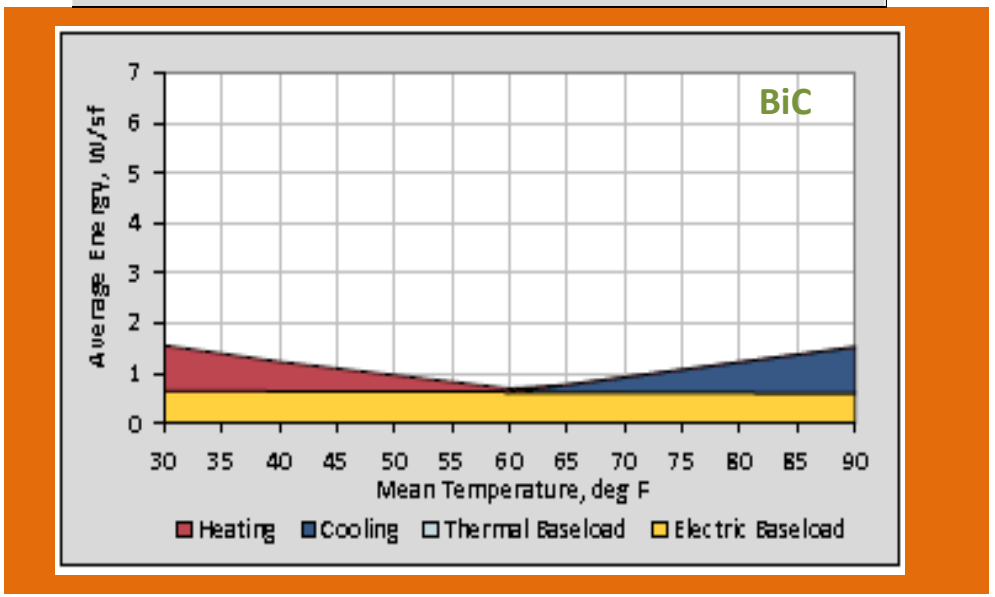
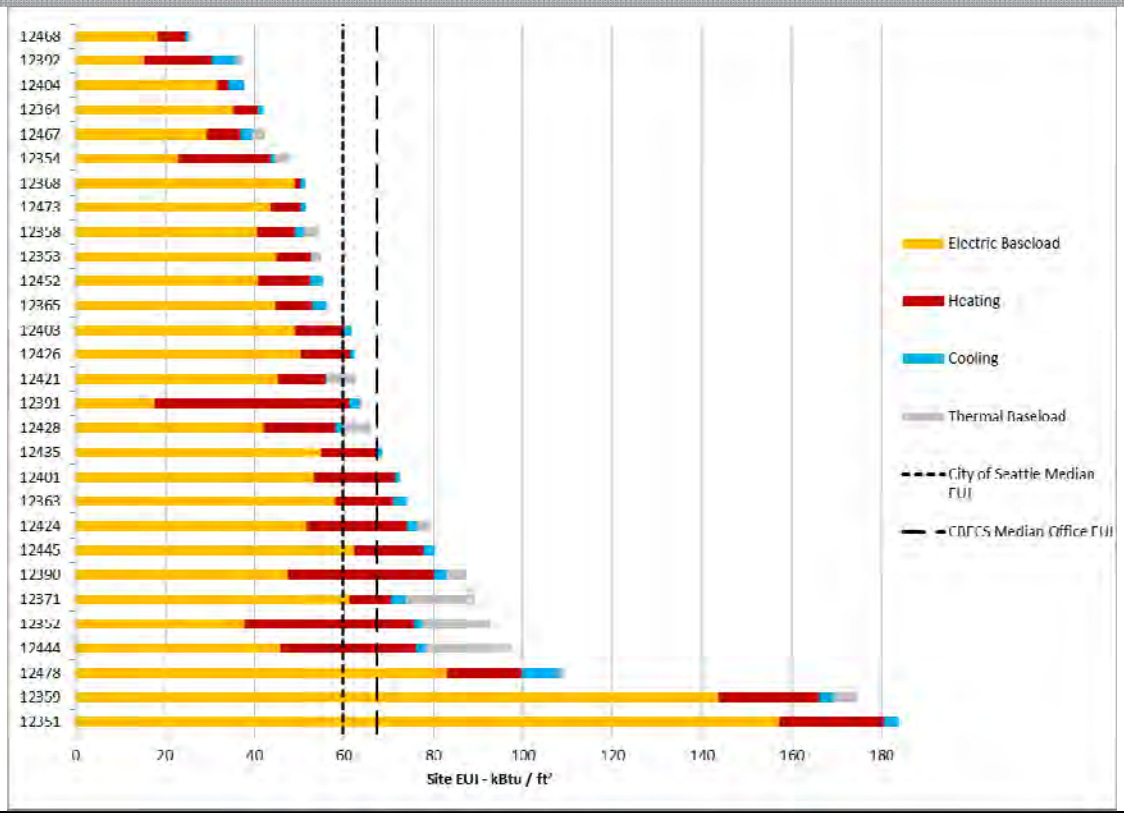
2
1
0
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Mean Temperature, deg F
Heating
Cooling
Thermal Baseload
Electric Baseload


BiC
Average Energy, W/sf
7
6
5
4
3
2
1
0
30 35 40 45 50 55 60 65 70 75 80 85 90
Mean Temperature, deg F
Heating
Cooling
Thermal Baseload
Electric Baseload

Portfolio Diagnostics: Prioritization

Building #	Areas to Investigate
xxxxx	Heating Equipment & Controls, Ventilation Rates & Schedules, Infiltration
xxxxx	Heating Equipment & Controls, Ventilation Rates & Schedules, Infiltration
xxxxx	Domestic Hot Water Setpoint & Recirculation, Steam Reheat, Steam Traps
xxxxx	Domestic Hot Water Setpoint & Recirculation, Gas Reheat, Gas Process Load
xxxxx	Plug Loads, Lighting Power Density, Lighting Controls, 24 Hour Fan Operation

EUI by End Use



Portfolio Analysis (NBI, 2014)

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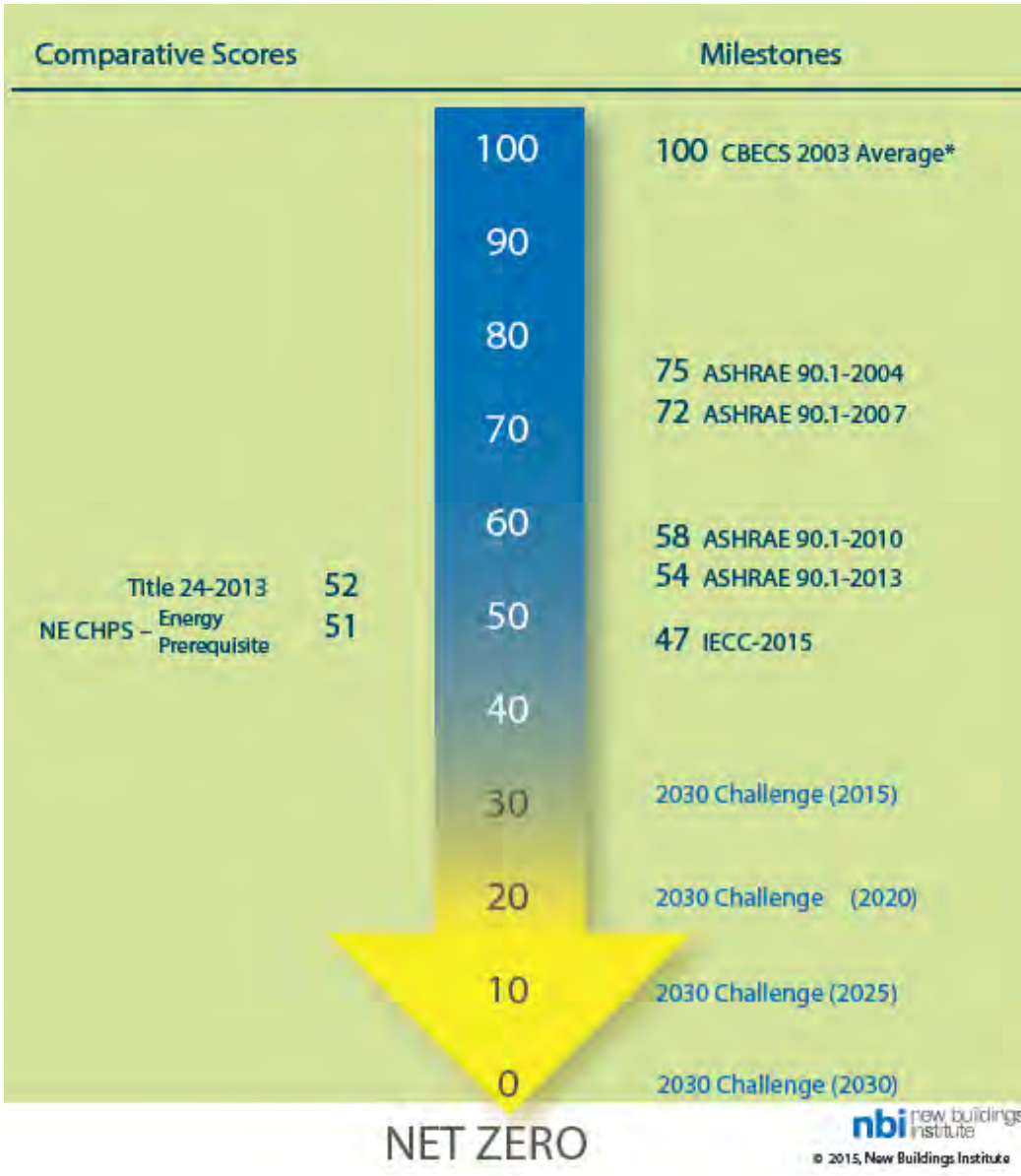
Comparing Building Performance at the Leading Edge

zEPI

Zero Energy Performance Index



Some Opportunities

- Market uptake on ZNE is broadening
- Cities are leading on energy/climate policy
- Codes are moving aggressively, but are running out of scope
- Operations and occupancy are major opportunity areas for energy performance
- Building performance data is influencing performance outcomes
- Energy Performance Outcome policies (outcome-based codes) are starting to get traction conceptually

Pathways to Net Zero Outcomes

Mark Frankel
April 28, 2016

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