



# Building Energy Literacy

Swiss-US Energy Innovation Days

August 20, 2015

**PAYETTE**

## PAYETTE | FACTS

150 People – Single Boston Office

Established In 1936, Fourth Generation of Leadership

Focus In High Technology Buildings for Healthcare and Science

Innovative Thinking & Design Excellence

Integrated:

ARCHITECTURE

MASTER PLANNING

LANDSCAPE

PROGRAMMING

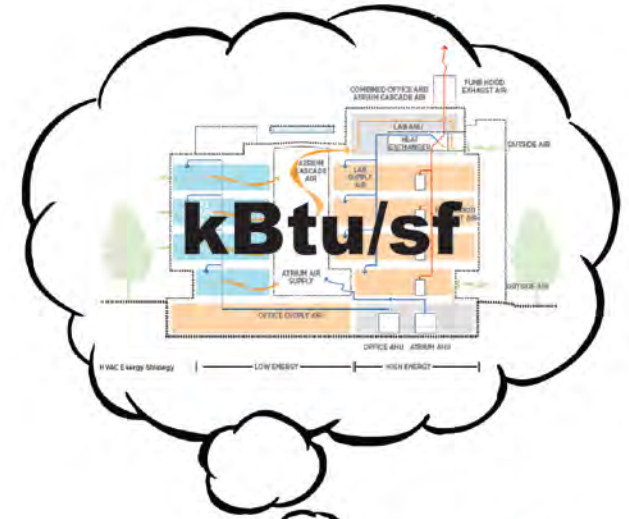
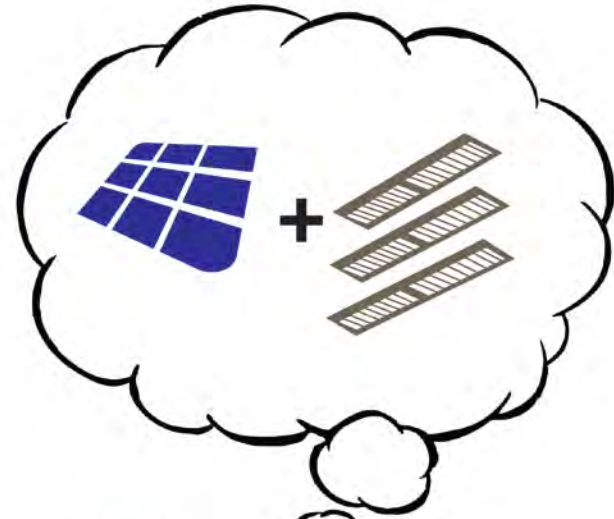
BUILDING SCIENCE



# TRANSFORMATION FROM DISCRETE ICONS OF SUSTAINABILITY



## TO SYSTEMS THINKING ABOUT PERFORMANCE





# COLLEGE AND UNIVERSITY ACADEMIC SCIENCE CLIENTS

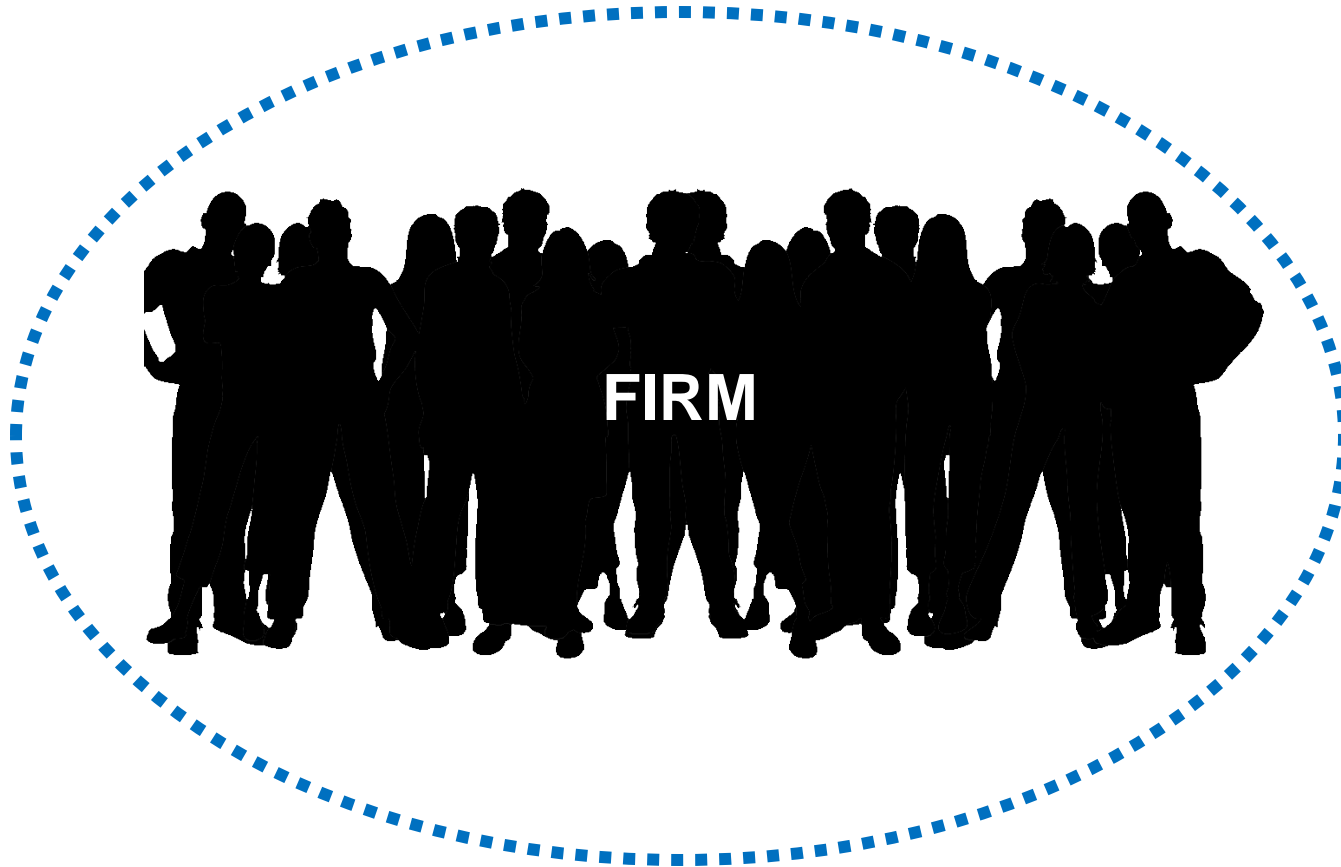
The Aga Khan University  
Albert Einstein College of Medicine  
Amherst College **EUI: 94 kBtu / SF**  
Boston College  
Boston University **EUI: 136 kBtu / SF**  
Bowling Green State University  
Brandeis University **EUI: 331 kBtu / SF**  
Bridgewater State College **EUI: 177kBtu / SF**  
Brock University **EUI: 166 kBtu / SF**  
Brown University  
Cape Cod Community College **net zero**  
Carnegie Mellon University  
Clemson University  
College of William and Mary  
Columbia University  
Connecticut College **EUI: 112 kBtu / SF**  
Cornell University **EUI: 141 kBtu / SF**  
Dartmouth College  
Drew University  
Drexel University  
Duke University **EUI: 59 kBtu / SF**  
Emory and Henry College  
Franklin and Marshall College  
George Washington Univ. **EUI: 67 kBtu / SF**  
Georgetown University **EUI: 220 kBtu / SF**

Gordon College  
Harvard University **EUI: 275 kBtu / SF**  
Houghton College  
Hudson Valley Community College **EUI: 166 kBtu / SF**  
Indiana University  
Johns Hopkins University  
Massachusetts Institute of Technology  
Middlebury College  
National University of Ireland, Galway **EUI: 142 kBtu / SF**  
Northeastern University **EUI: 131 kBtu / SF**  
Oberlin College  
Ohio Wesleyan University  
The Pennsylvania State University **EUI: 151 kBtu / SF**  
Polytechnic Institute of New York University  
Princeton University **EUI: 431 kBtu / SF**  
Radford University  
Roanoke College  
Rutgers University  
Salem State University  
Skidmore College **EUI: 182 kBtu / SF**  
Skolkovo Inst. of Science & Technology **EUI: 182 kBtu / SF**  
Smith College  
Tufts University **EUI: 95 kBtu / SF**  
Tulane University  
University of Alabama

The Univ. of Chicago  
Univ. of California, Los Angeles  
The Univ. of Chicago  
Univ. of Colorado  
Univ. of Indianapolis  
Univ. of Kentucky  
Univ. of Maine  
Univ. of Maryland  
Univ. of Mass. **EUI: 241 kBtu / SF**  
Univ. of Pennsylvania  
Univ. of Pittsburgh  
Univ. of Rhode Island **EUI: 159 kBtu / SF**  
The University of Texas  
University of Utah  
Utah State University  
Vanderbilt University  
Virginia Commonwealth University  
Washington and Lee University  
Wellesley College  
Wesleyan University  
West Virginia University  
Wheaton College, Illinois  
Williams College  
Worcester Polytechnic Institute  
Yale University



## INTERNAL VS. EXTERNAL FORCES





## AGENDA

### National Influences

State Influences

Local Influences

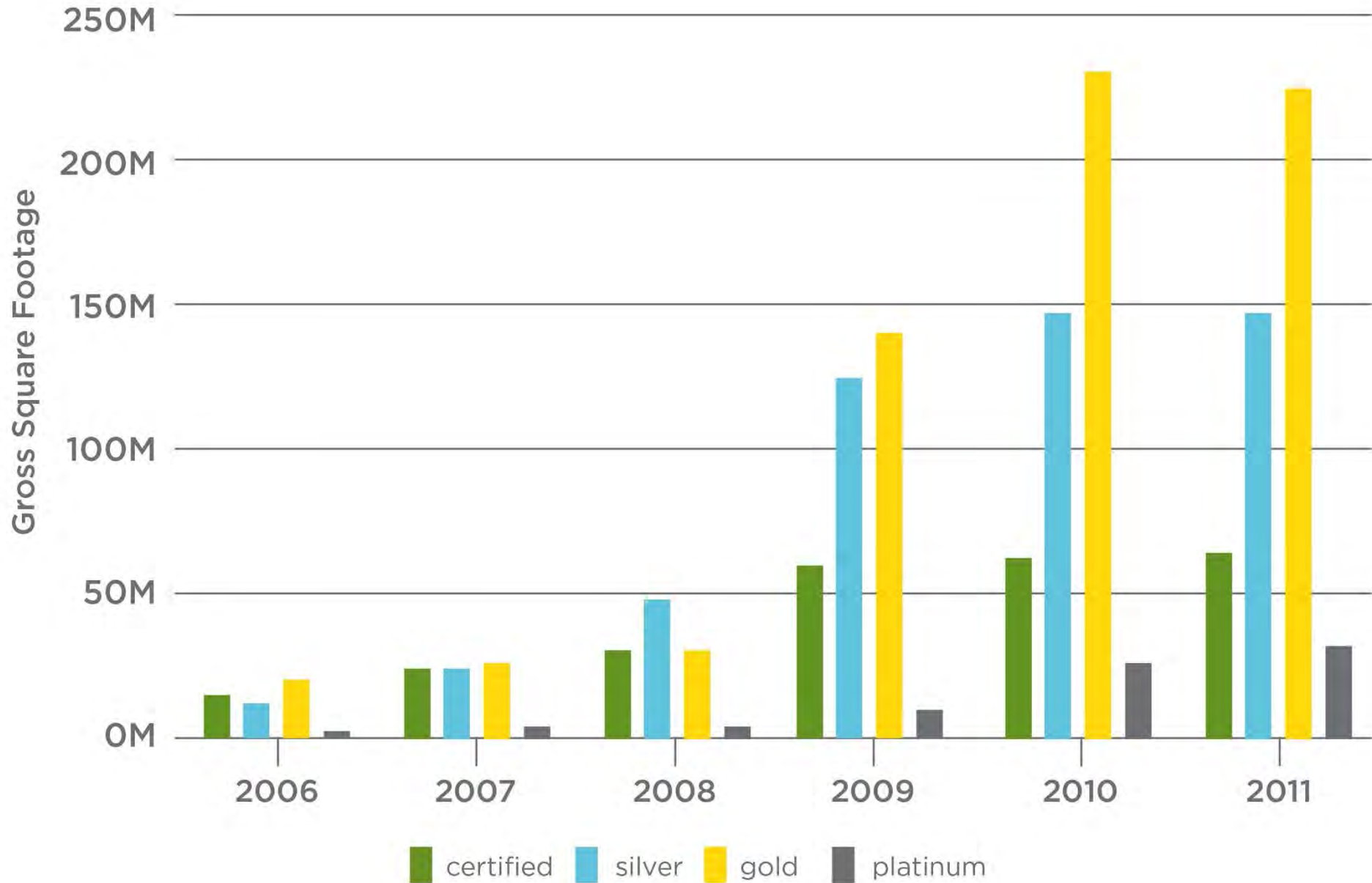
Internal Impacts

## IN THE BEGINNING . . .



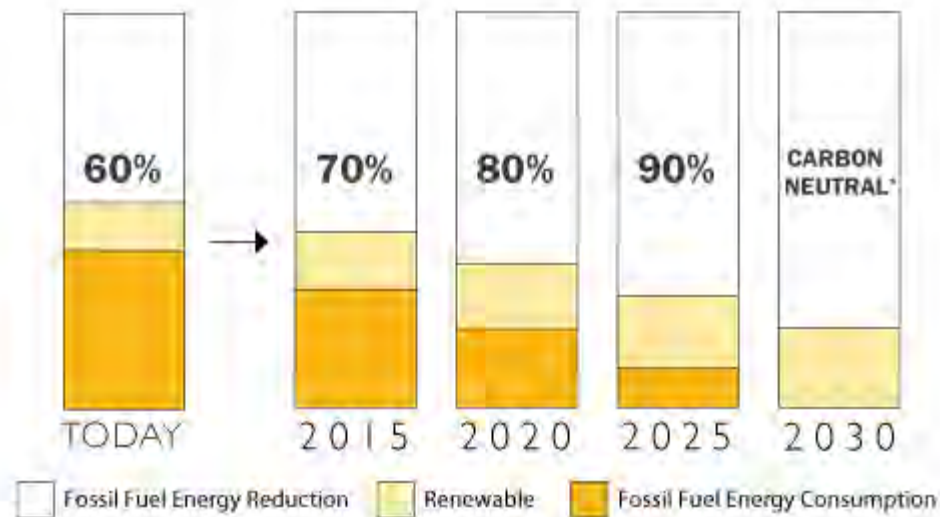


## LEED CERTIFICATION IN THE UNITED STATES BY SQUARE FOOTAGE



## AIA 2030 COMMITMENT

- All new buildings, developments and major renovations designed to be carbon neutral by 2030



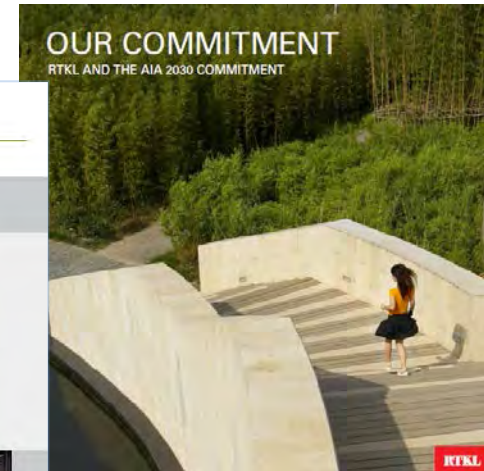
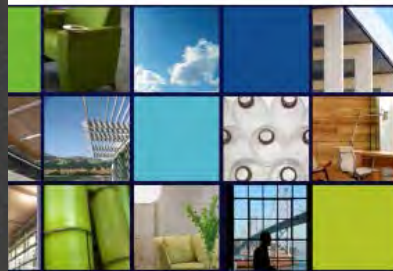
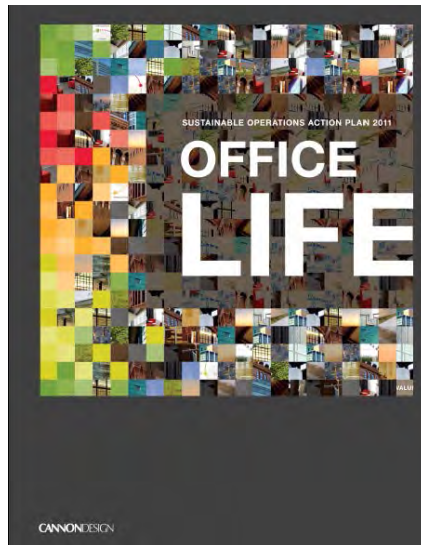
### The 2030 Challenge

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\*Using no fossil fuel GHG-emitting energy to operate

# OPERATIONAL EFFICIENCY

- Long range sustainability action plan that aligns with the stated 2030 benchmarks for achieving carbon neutrality.



AIA 2030 Commitment  
Sustainability Action Plan  
2012

## THE WORLD IS WATCHING



- *In those cases where reaching carbon neutral is not feasible or practical, plan and design cities, towns, urban developments, new buildings and renovations to be highly efficient with the capability to produce, or import, all their energy from renewable energy sources in the future.*
- *We commit to the principle of engaging in research and setting targets towards meeting the 2050 goal.*
- *Advocate and promote socially responsible architecture for the community, develop and deliver equitable access to the information and tools needed to:*
  - *plan and design sustainable, resilient, inclusive and low-carbon/zero carbon built environments.*
  - *design no-cost/low-cost on-site renewable energy and natural resources systems (e.g., passive heating and cooling, water catchment and storage, solar hot water, daylighting, and natural ventilation systems).*

Supporting Organization: Architecture 2030



## SWITZERLAND & THE UNITED STATES HAVE SIGNED ON

### Signatories:

UIA - International Union of Architects

UIA Young Architects

ARCASIA - Architects Regional Council Asia

AUA - Africa Union of Architects

ACE - Architects Council of Europe

FPAA - Federacion Panamericana de Asociaciones de Arquitectos

CAA - Commonwealth Association of Architects

UMAR - Union Mediterraneenne des Architectes

CIALP - Conselho Internacional dos Arquitectos de Lingua Portuguesa

DoCoMoMo - Docomomo International

ICOMOS International Council of Monuments and sites

FAU - Fondation des Architectes de l'Urgence

AHA - Active House Alliance

WGBC - World Green Building Council

Supporting Organization: Architecture 2030

  
FOR A BETTER URBAN FUTURE

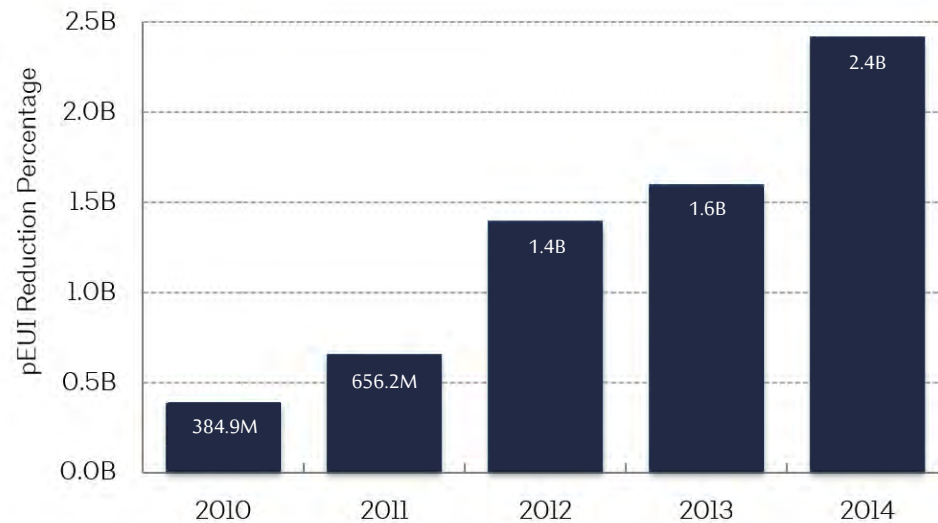


## ANNUAL REPORTING TO THE AIA

More projects than ever are being reported

- Building area reported increased to 2.4B GSF – 50% increase

**Total Area (GSF) of Projects in an Active Design Phase\***

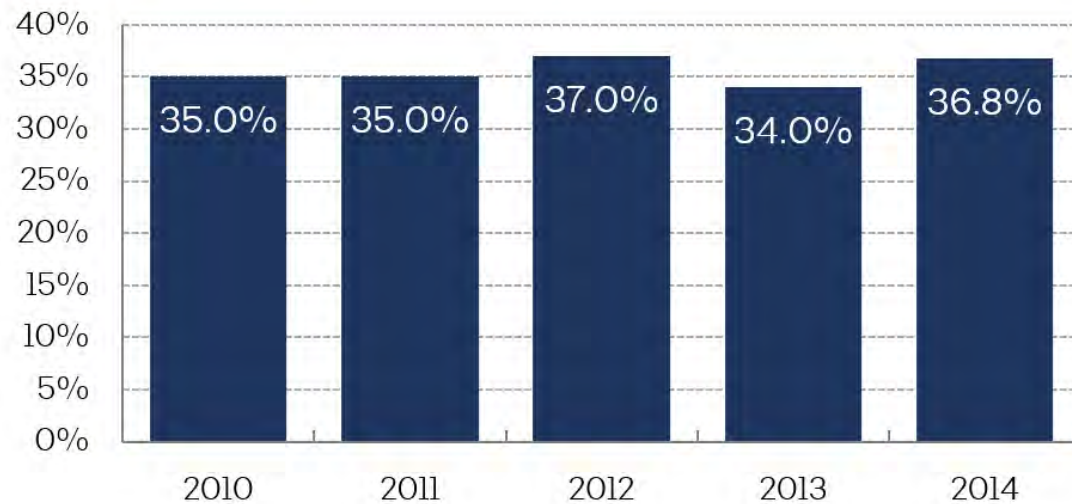


\*active design phase denotes conceptual, schematic, design development, or contract document

## ANNUAL REPORTING TO THE AIA

- Average pEUI increased by 3% but remained mostly flat across all reporting years

**Percent Average pEUI Reduction from the National Average**

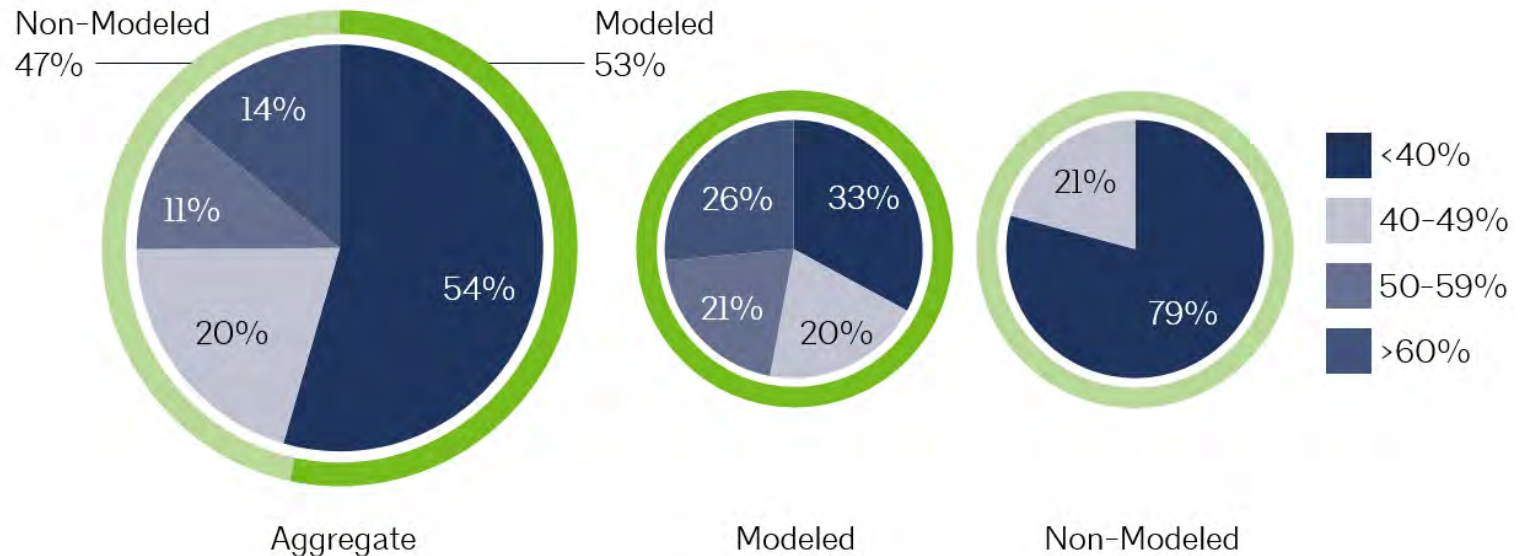


# ANNUAL REPORTING TO THE AIA

## Impact of Energy Modeling

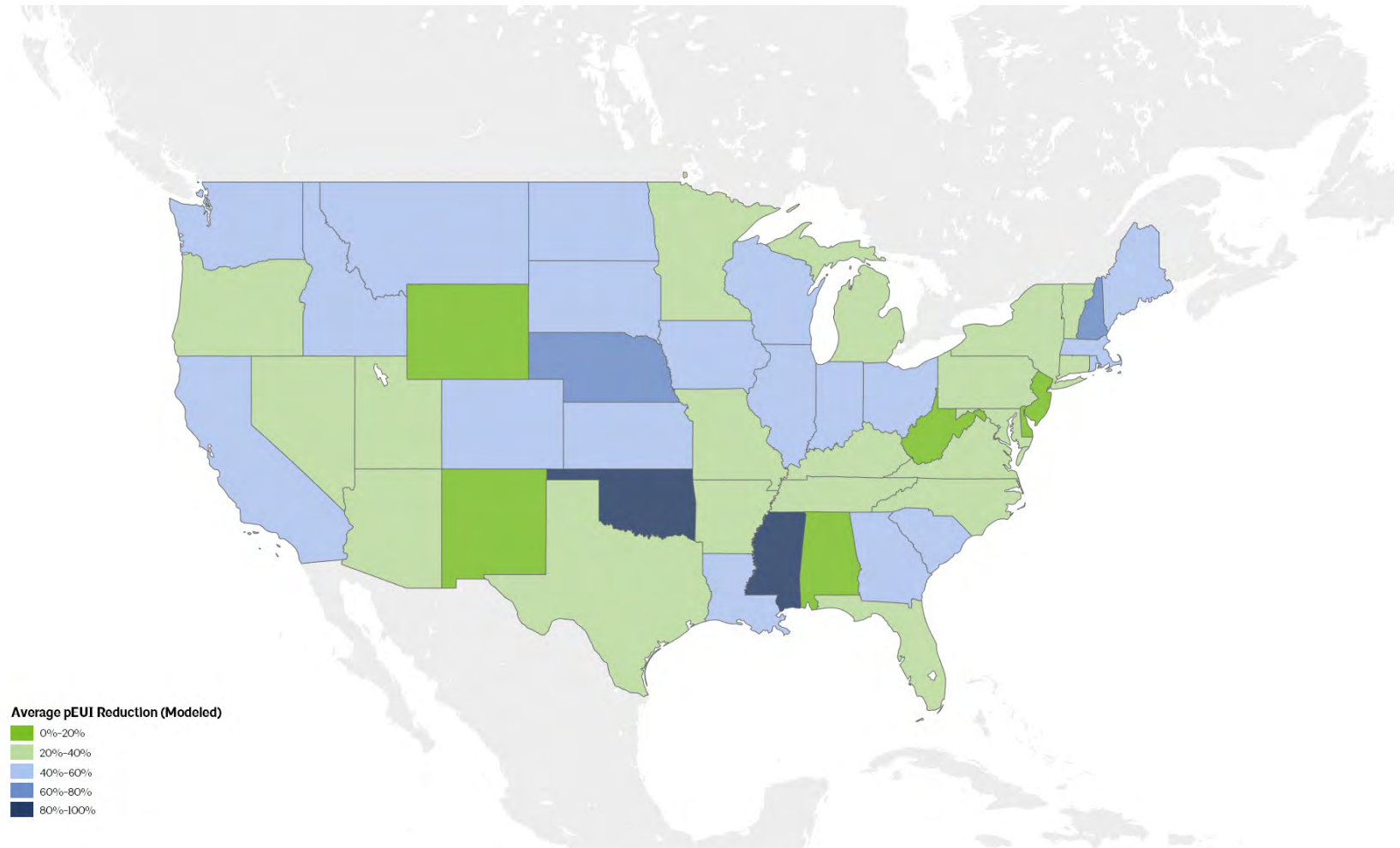
- 26% of modeled projects met the 60% reduction target with another 21% coming close by exceeding 50% pEUI reduction
- 79% of non-modeled projects fell below 40% reduction over the baseline

### Percent Improvement by pEUI Reduction Bins

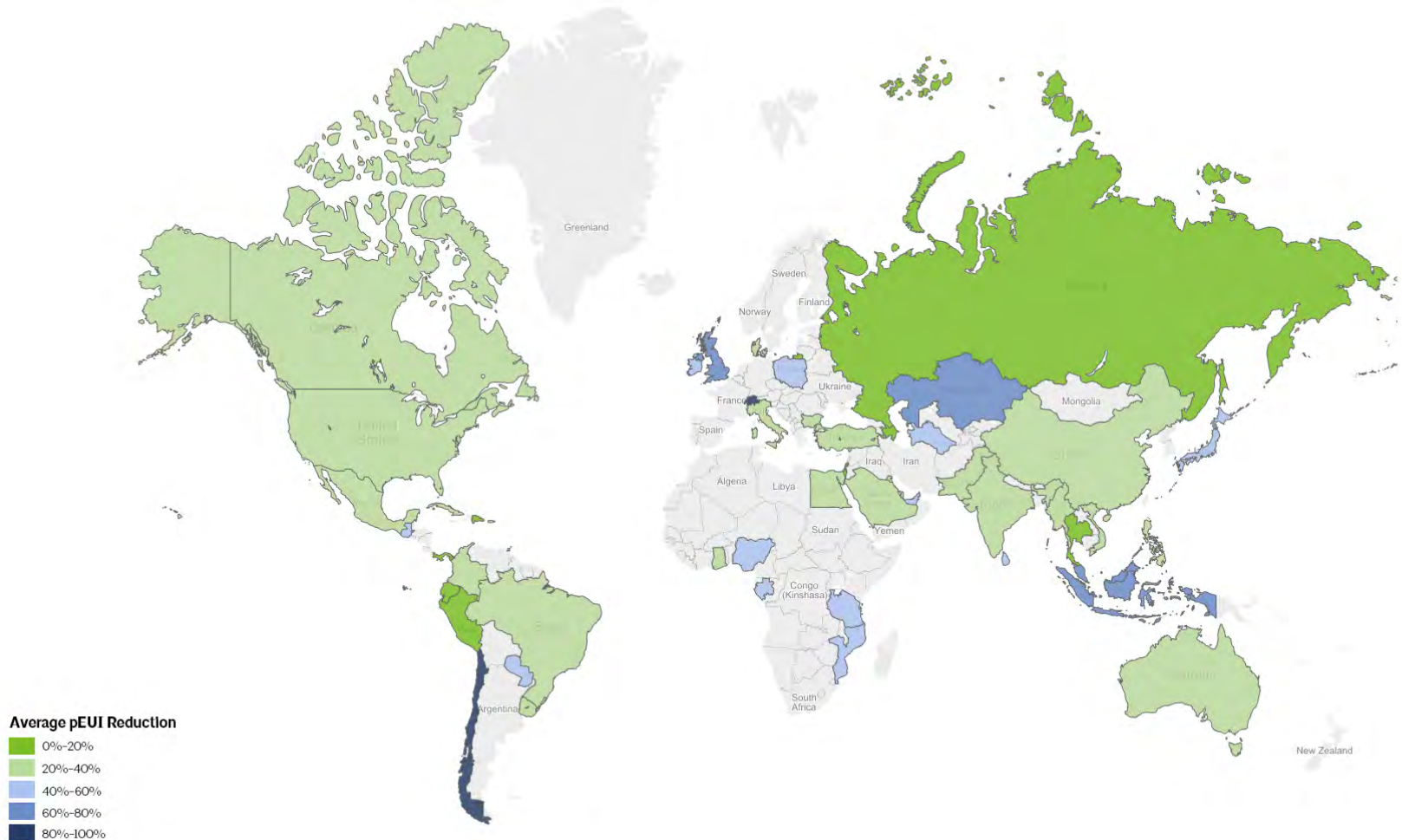


# ANNUAL REPORTING TO THE AIA

## Predicted Performance by State



## Predicted Performance by Country



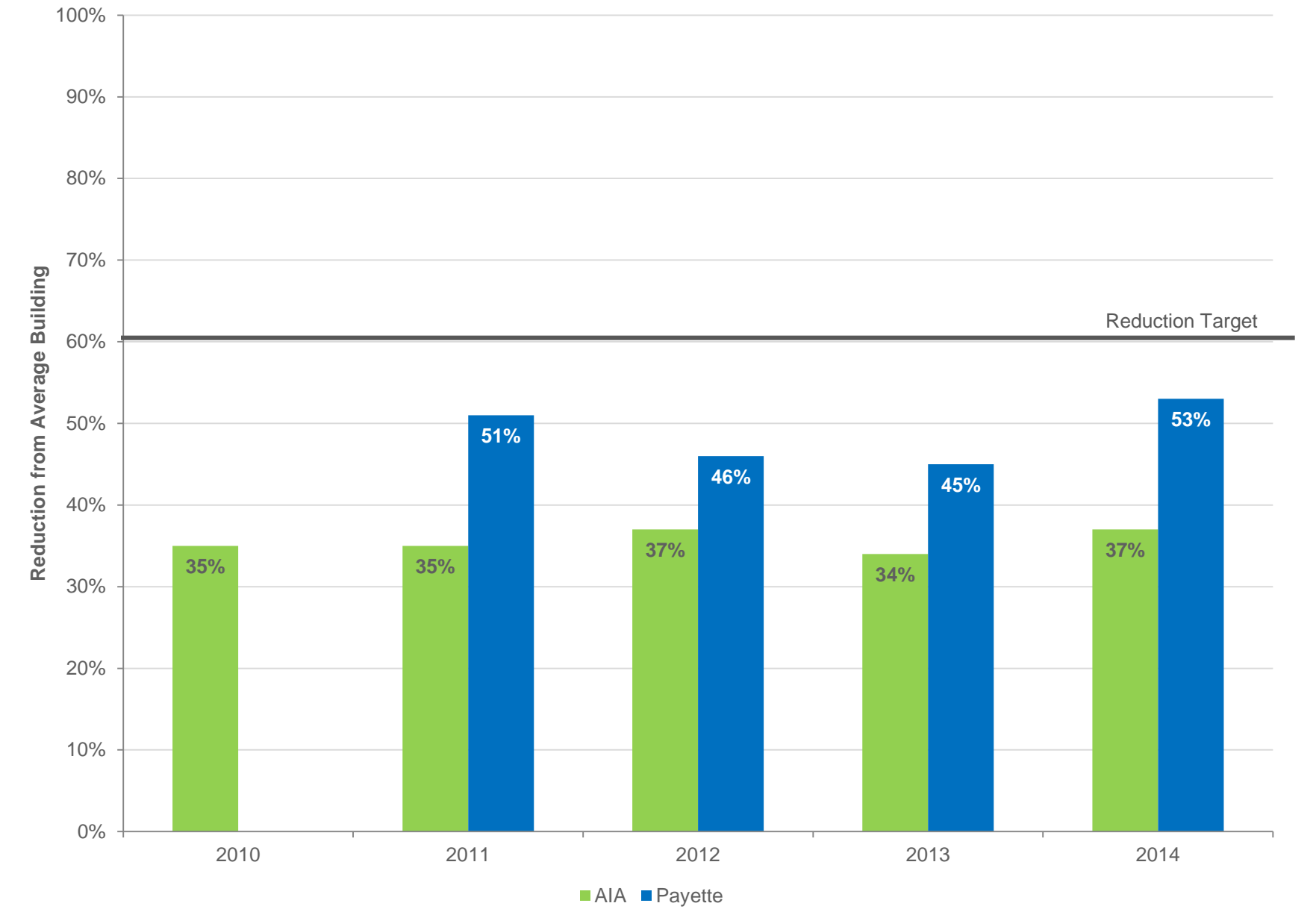


# ANNUAL REPORTING TO THE AIA

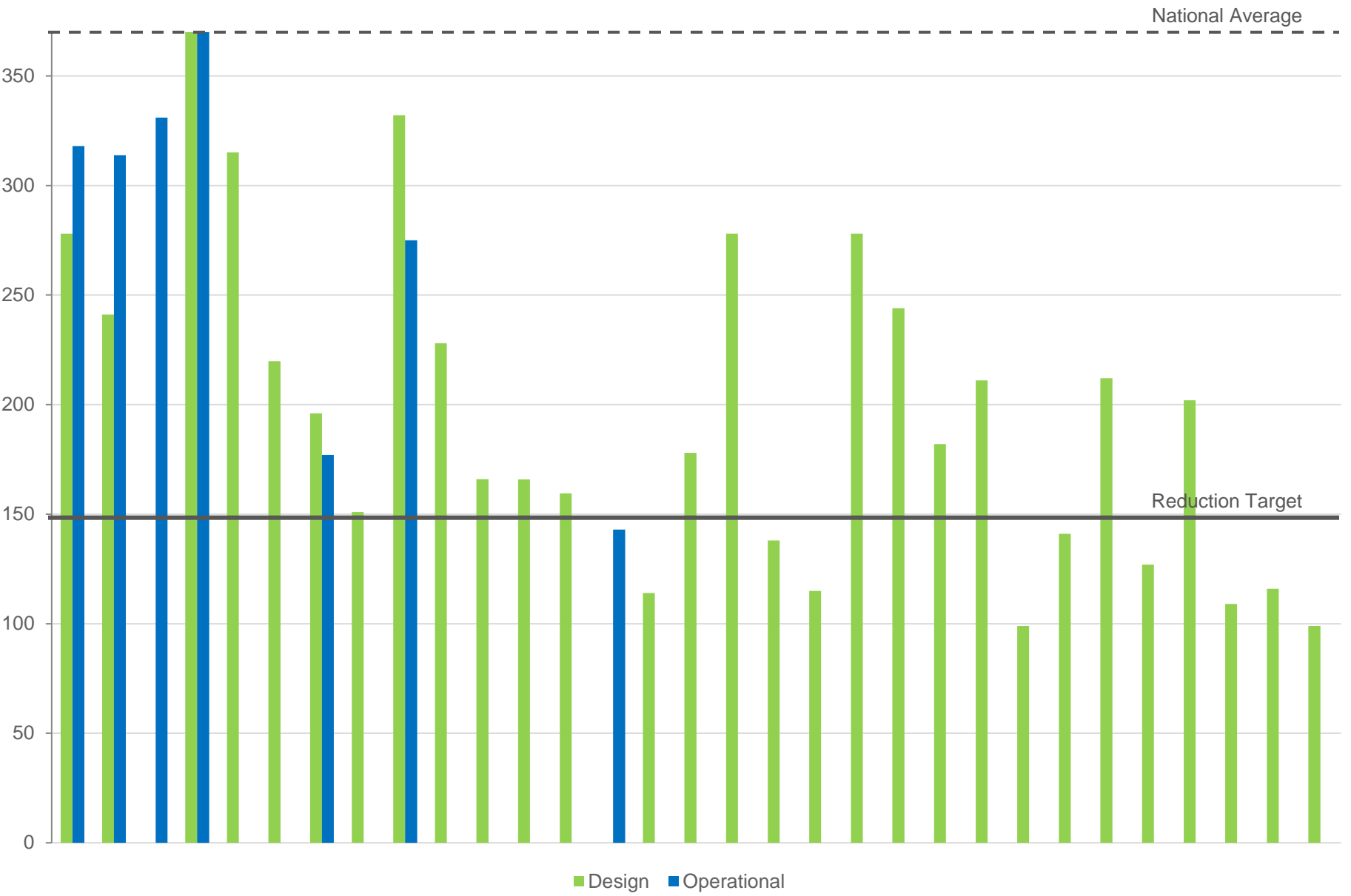
## 2014 Summary: AIA Aggregated Program Data

2.4 BILLION.....total amount of gross square feet (GSF)..... 50% increase  
4,362 ..... number of projects reports ..... 77% increase  
37% ..... average Predicted Energy Use Intensity (PEUI) reduction ..... 2% increase  
14%..... percent of total GSF meeting the current 60% reduction target .....4% increase  
53%..... percent of total GSF using energy modeling to predict energy consumption .....13% decrease  
3,837 ..... number of interiors only projects ..... < 1% decrease  
22%..... average Lighting Power Density reduction for interiors projects ..... 3% increase

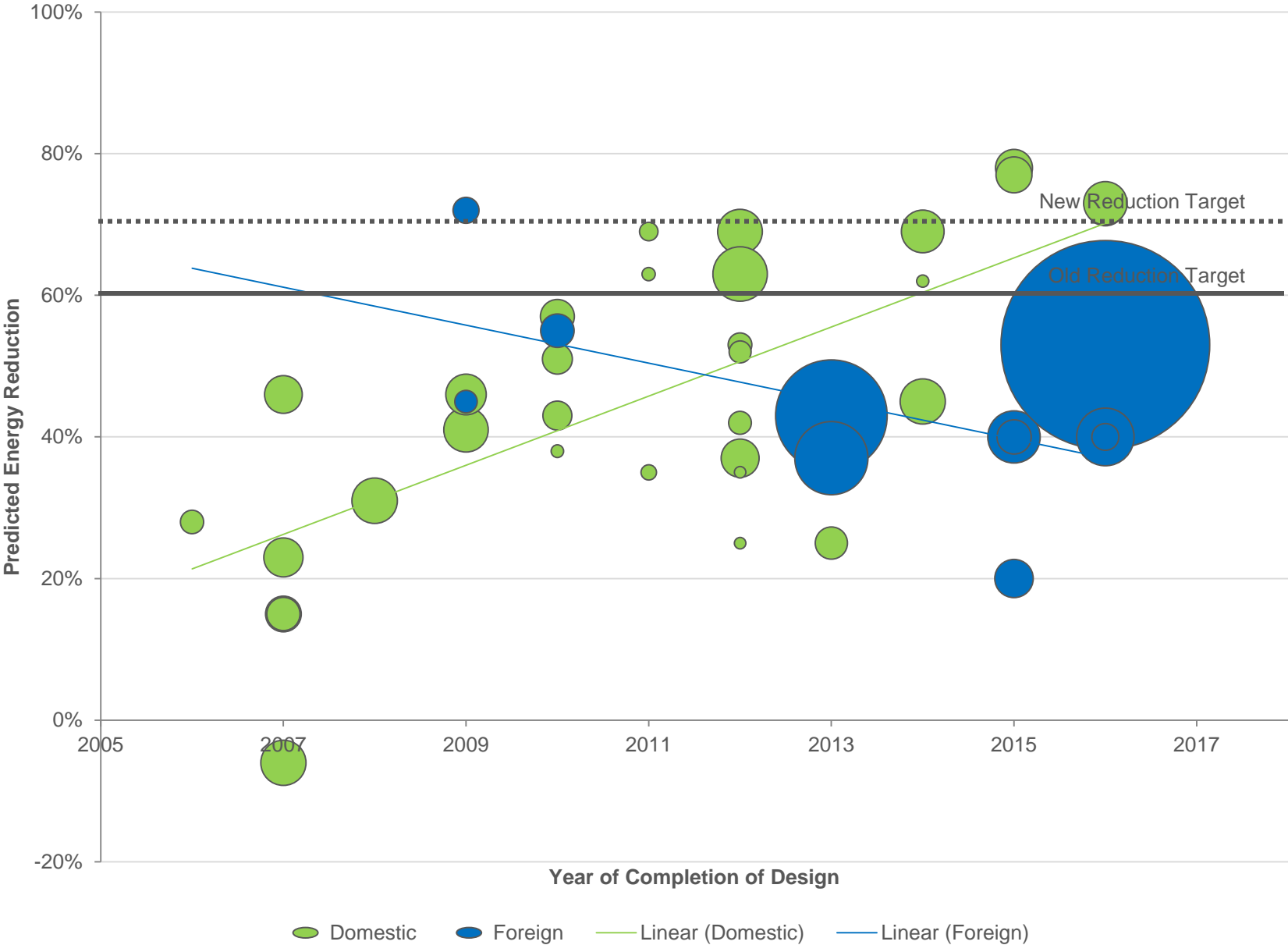
# FIRM PROGRESS – AVERAGE EUI REDUCTION



# PROJECT PROGRESS OVER TIME - LABS



# FIRM PROGRESS – IMPACT OF INTERNATIONAL WORK



# SUSTAINABILITY ACTION PLAN – PROJECT GOALS

- Design Principles
  - Reduce Excess Capacity
  - Study Building Operation
  - First Principle Engineering
  - Harnessing Available Resources
  - Adoption of Technological Solutions
- Integrated Design Charrettes
- Energy Benchmarks & Targets
- Basis of Designs
- Shadow Studies
- Site Analysis
- Energy & Performance Modeling
- Life Cycle Cost Analysis
- Embodied Energy
- POEs

## PAYETTE SUSTAINABILITY ACTION PLAN



*Payette's open studio, in a LEED Platinum Certified building, fosters collaboration.*

### History

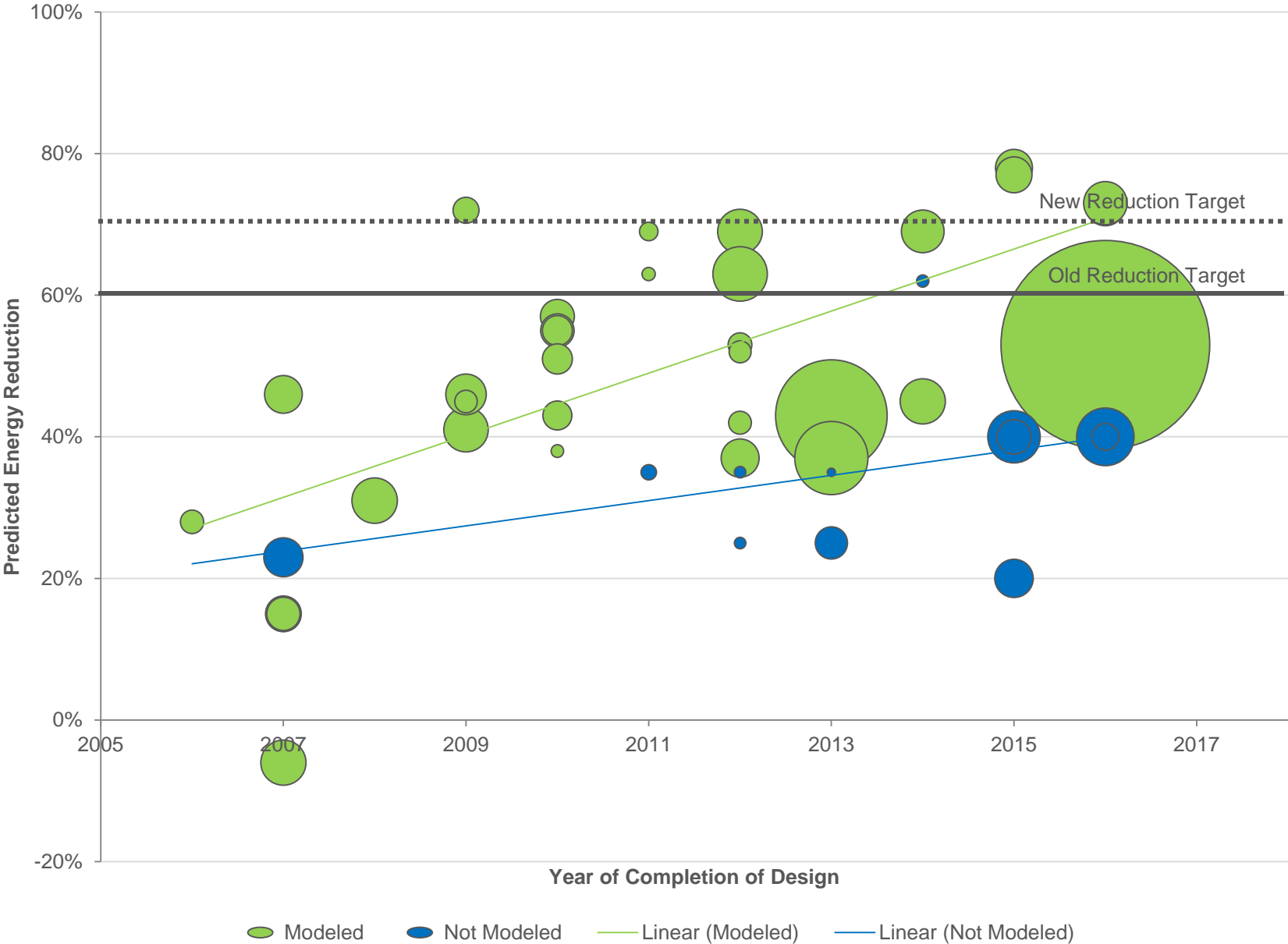
Three generations, many voices, one practice. In 1932, Fred Markus and Paul Nocka started a small design firm in Boston. Using pioneering time-and-motion studies, they helped hospitals throughout New England take apart and retool complex, mission-critical processes including nursing units, kitchens and pharmacies. In 1960, Tom Payette joined the firm, adding a modern design philosophy to the firm's innovative process. Tom led the firm in designing a series of New England hospitals that were centered on the experience of the patient, manifested by an intimate connection to the landscape, abundant use of color and natural light to help orient patients and visitors.

Through the promotion of the same humanistic values and fundamental design approach, the firm broadened its focus in the following decades to include high technology buildings, bringing deep technical expertise, commitment to rigorous research and dedication to beauty to a new class of projects. Today, the practice has advanced as an international leader by providing planning and design services to leading institutions across the country and abroad.

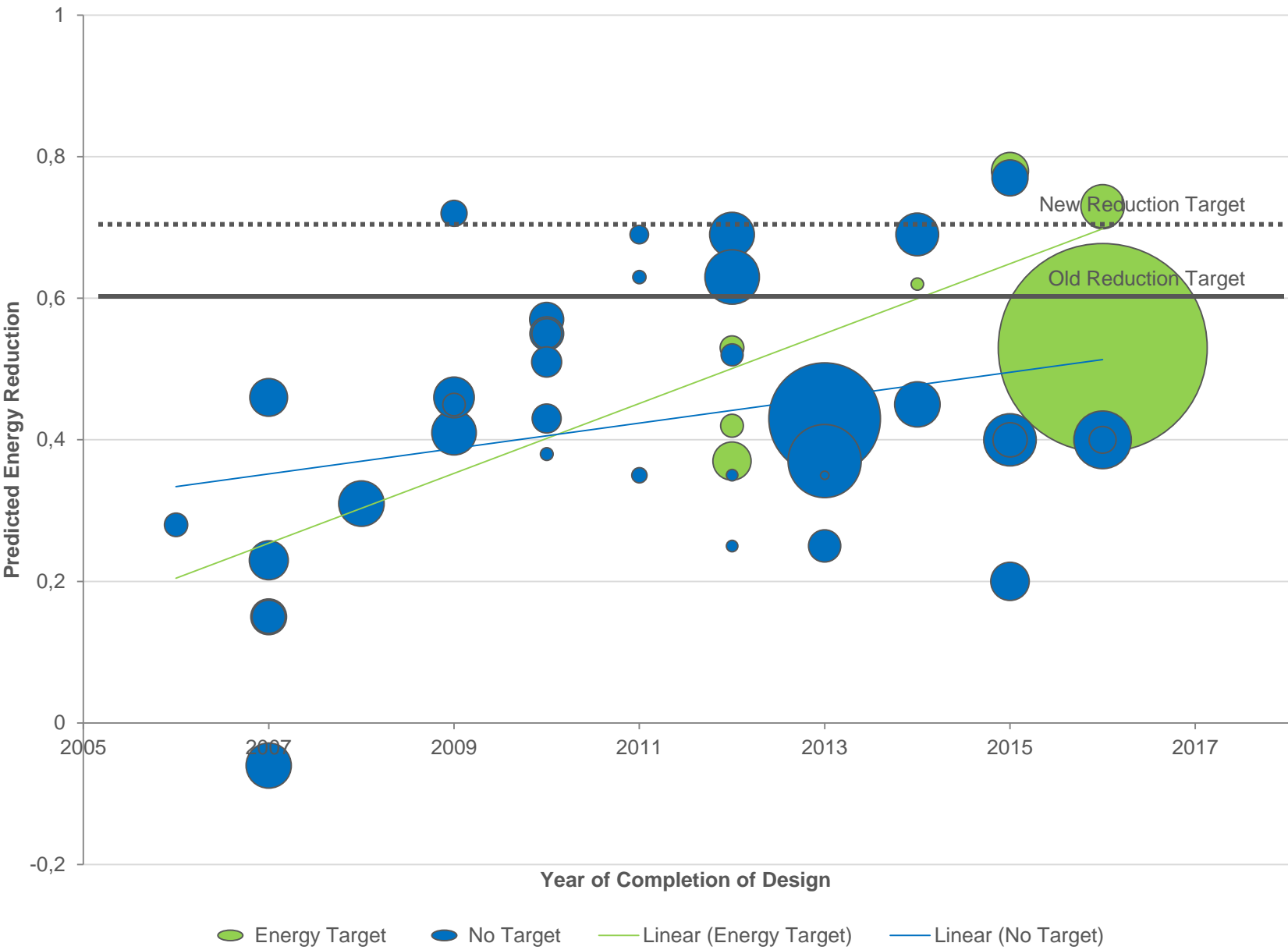
We approach design as a process that combines problem-solving, research and invention. The architecture we practice is inherently multidisciplinary. Our definition of architecture embraces planning, programming, landscape architecture and interior design as being intimately intertwined in producing our work.



# FIRM PROGRESS – IMPACT OF ENERGY MODEL



# FIRM PROGRESS – IMPACT OF SETTING AN EARLY ENERGY TARGET



## Sorted %

Sorted %



[illegible]

- Minimize Ventilation Air
- High Performance Lighting
- Heat Recovery
- Sun Shading & High Performance Envelope
- Natural Ventilation

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- High Performance Lighting
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## AGENDA

National Influences

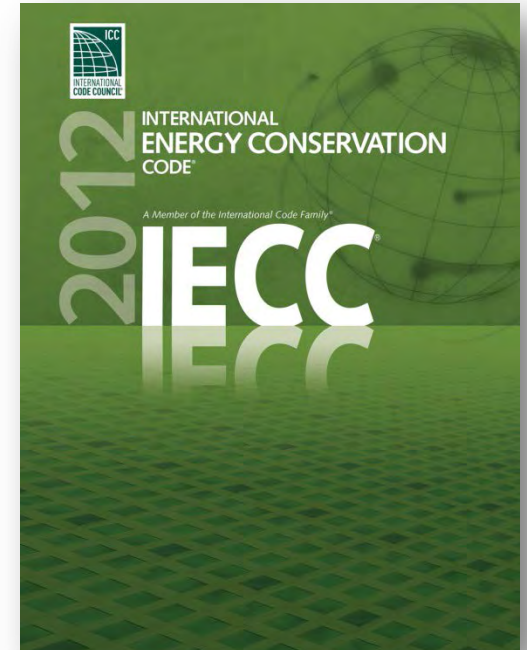
**State Influences**

Local Influences

Internal Impacts

## ENERGY CODES

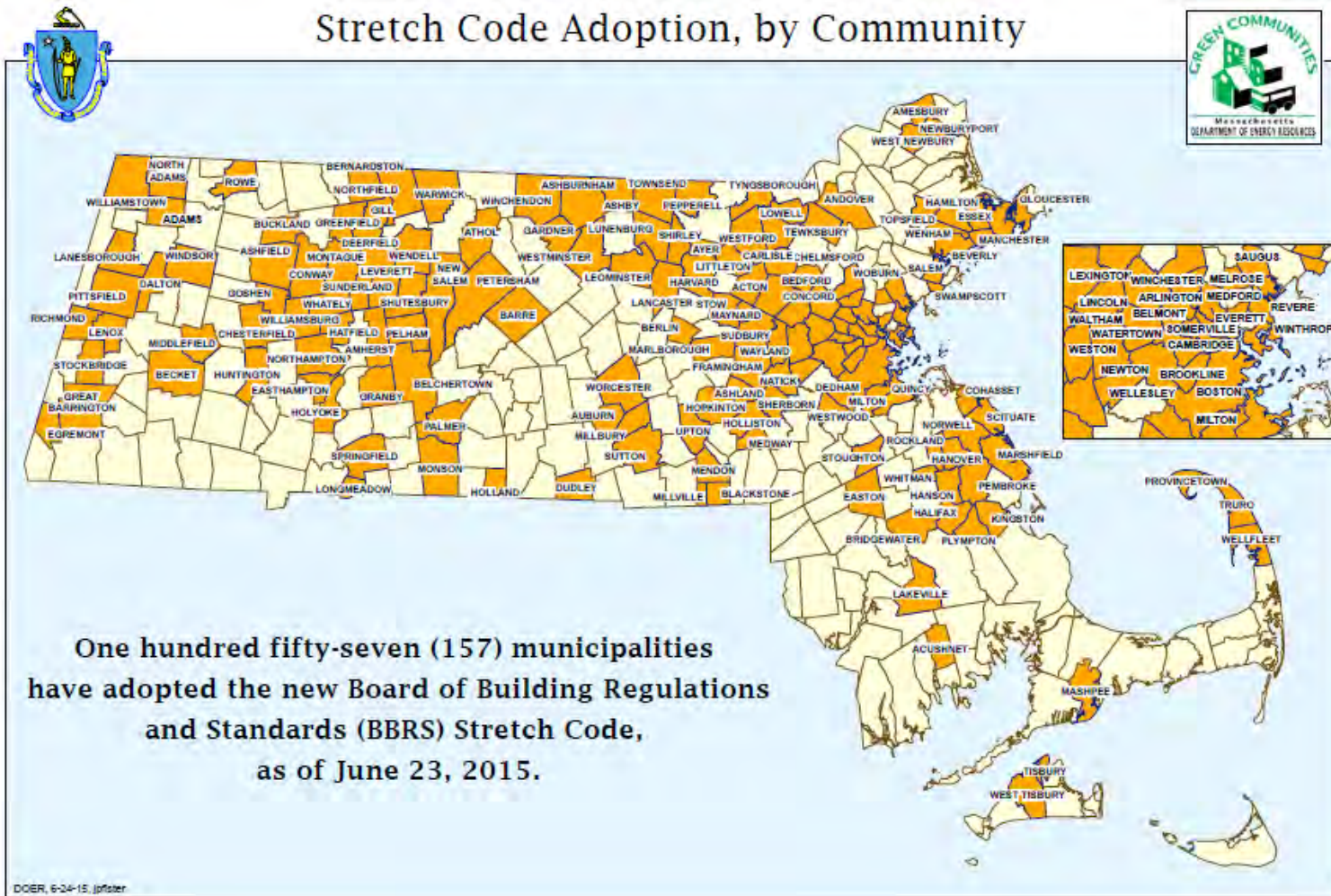
- ASHRAE 90.1 updated every 3 years
- IECC updated 3 years after the release of an updated ASHAE 90.1
- LEED & Stretch Code not currently updated on regular cycle
- ASHRAE 90.1, IECC and LEED developed, revised and adopted in public forums
- 90.1 Based on return on investment of first costs and operational savings
- Balance of market impact and performance
- Massachusetts Green Communities Act requires adoption of most recent IECC within 1 year of release





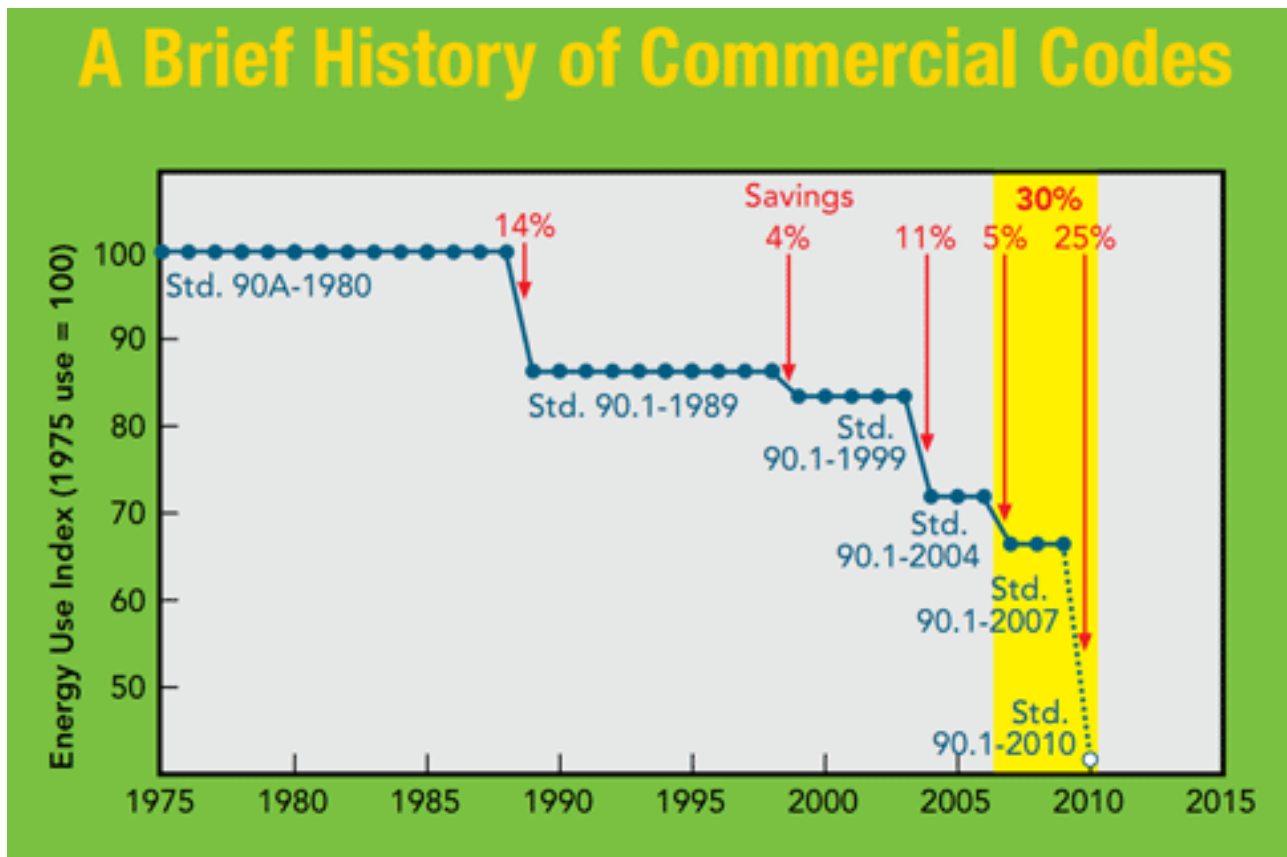
# ADOPTION OF THE “STRETCH CODE”

- Basis for Massachusetts’ “Stretch Code”
- Requires 20% less energy than ASHRAE 90.1-2007

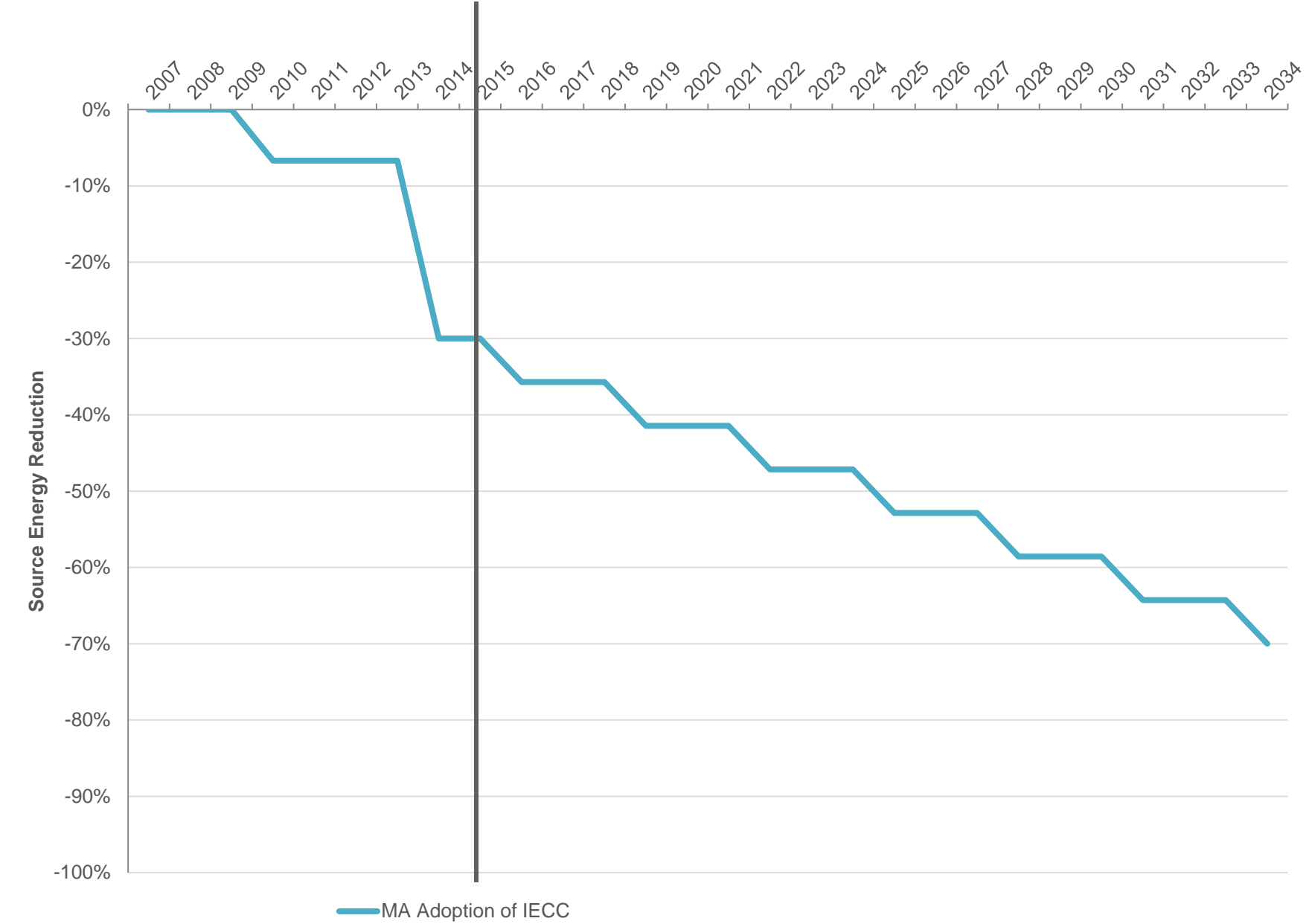


## ASHRAE REDUCTION TARGETS

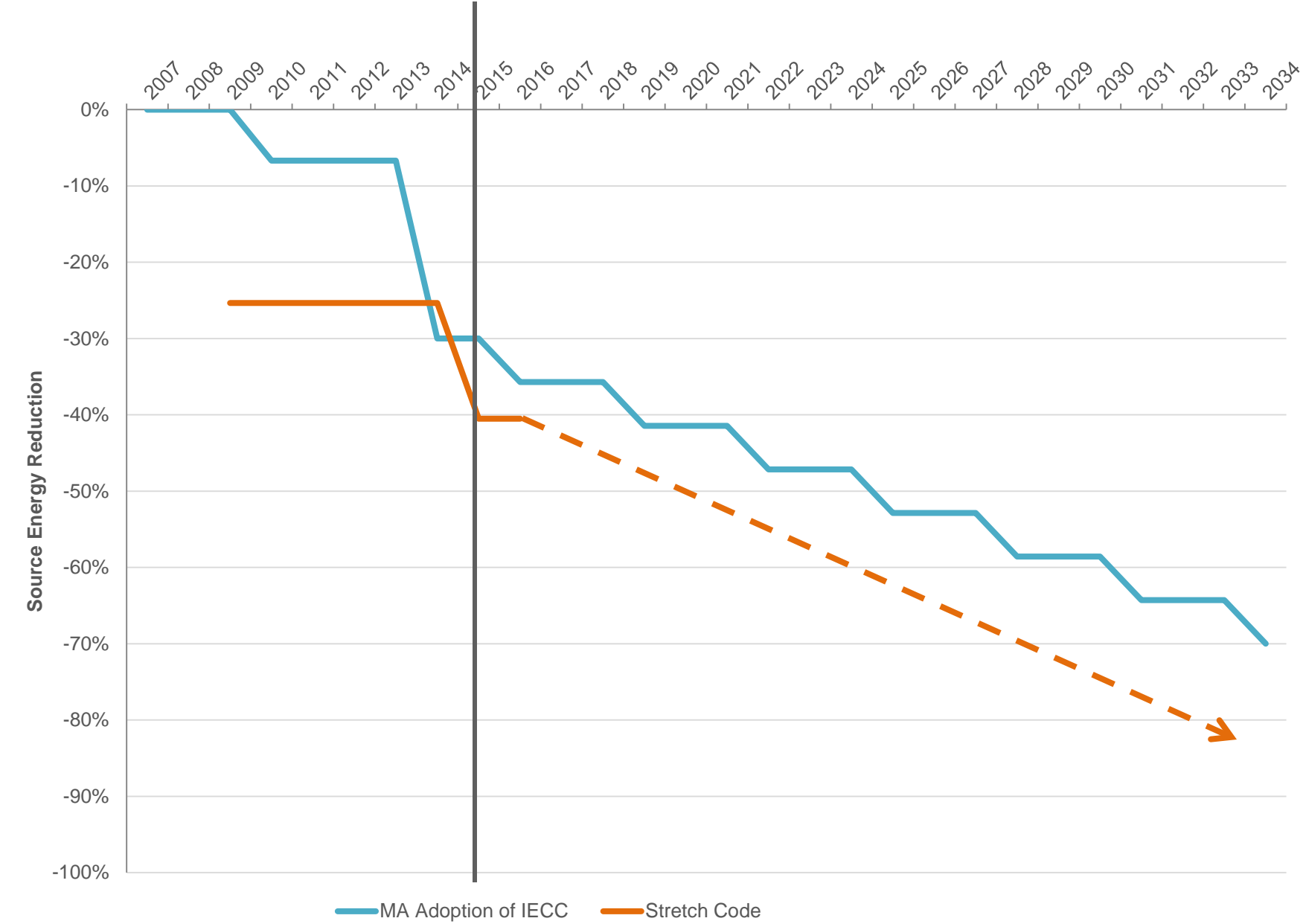
- In 2007 ASHRAE's Board set out requirements for net zero energy buildings for their Standards by 2031.
- Minimum energy standards like ASHRAE 90.1 need to be “Net Zero Ready” (IE very low energy without the renewables)



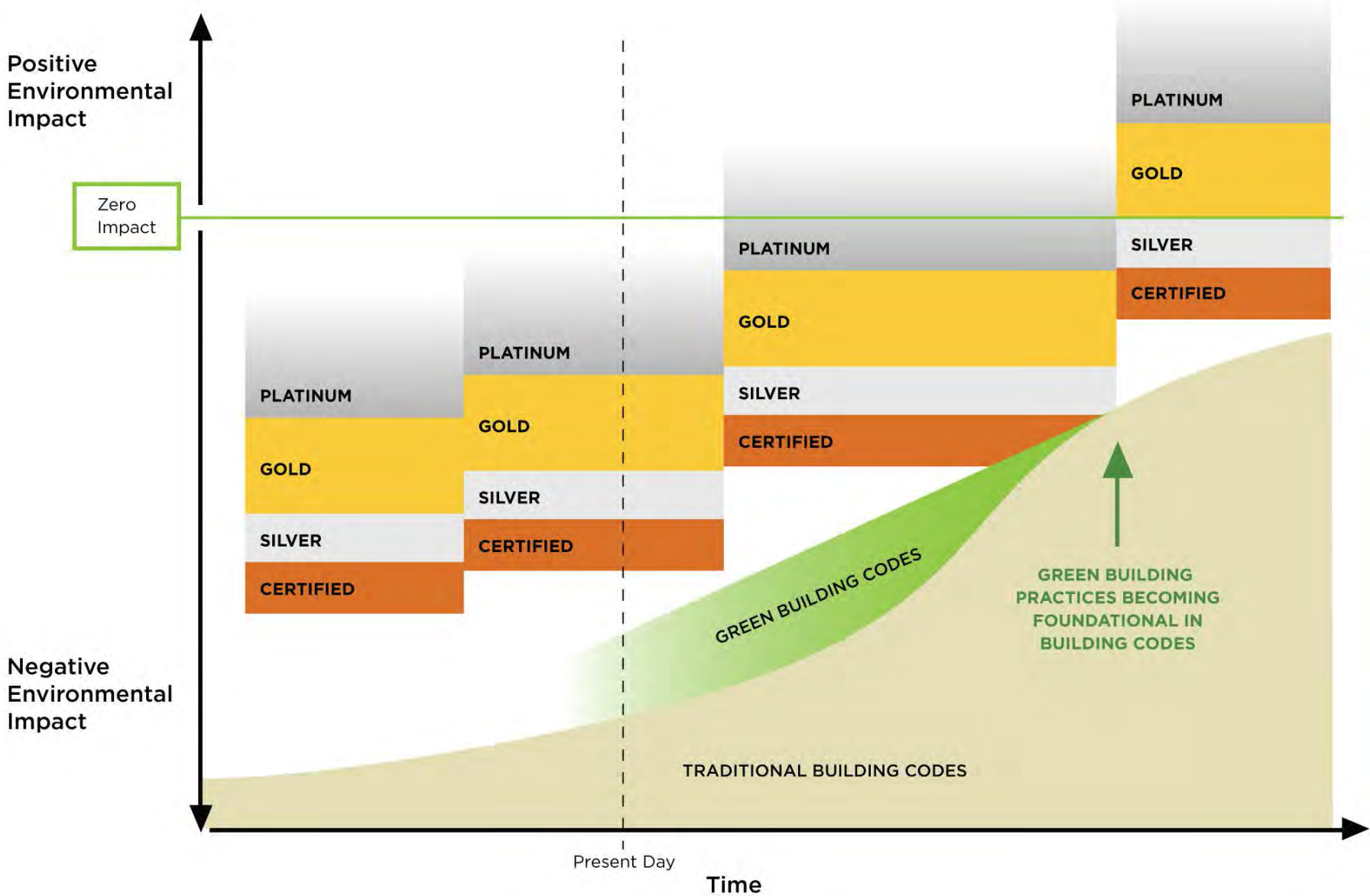
# FUTURE OF ENERGY CODES IN MASSACHUSETTS



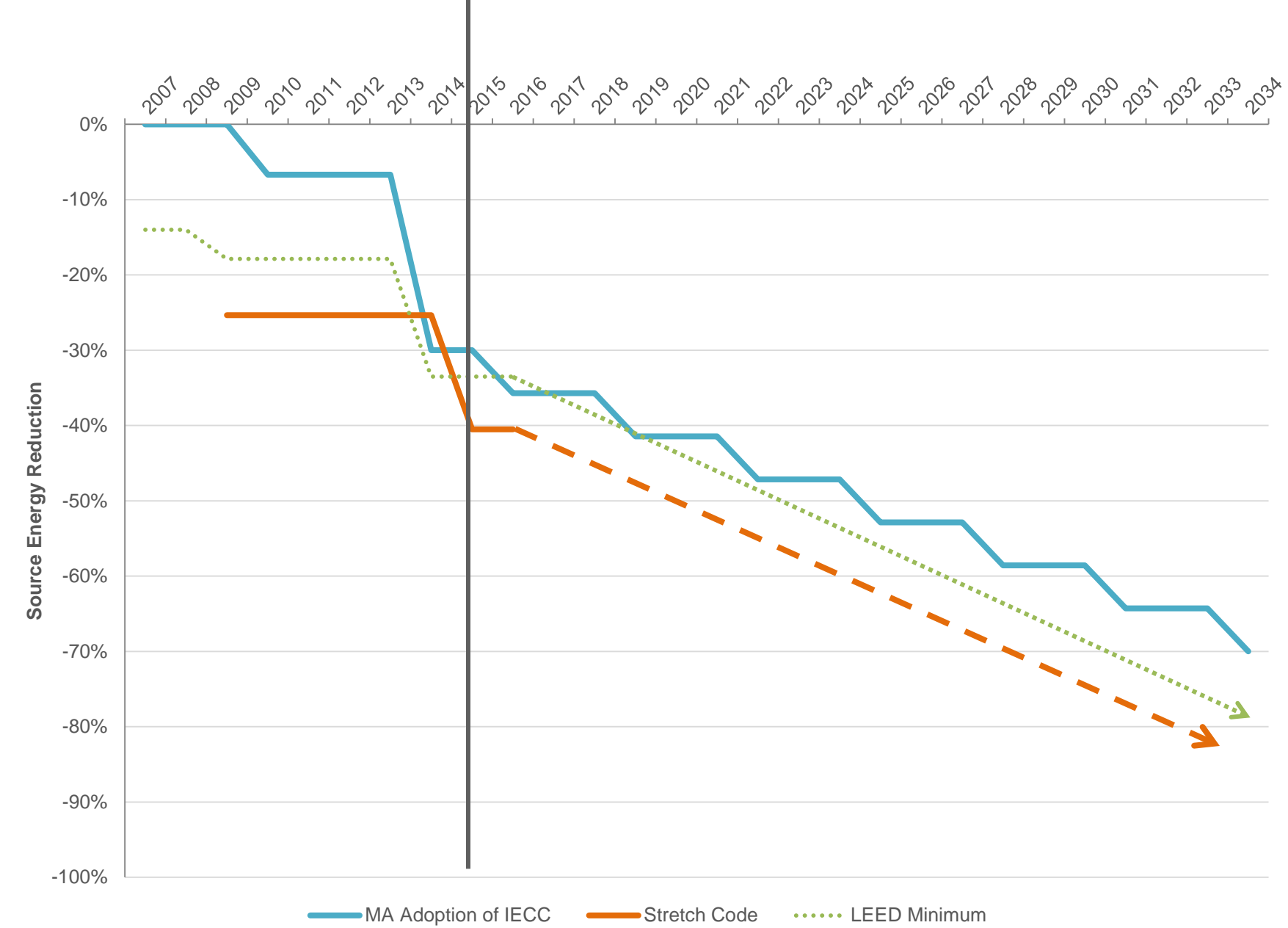
# FUTURE OF ENERGY CODES IN MASSACHUSETTS



# LEED REDUCTION TARGETS



# FUTURE OF ENERGY CODES IN MASSACHUSETTS







## AGENDA

National Influences

State Influences

**Local Influences**

Internal Impacts

2

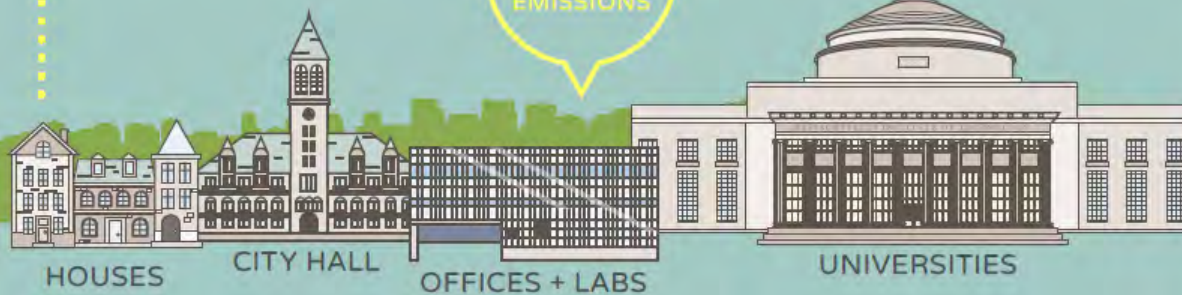
## WHAT IS NET ZERO?

A community of buildings for which, annually, all greenhouse gas emissions produced through building operations are offset by carbon-free energy production.

### THE TARGET:

Net zero annual emissions from buildings citywide.

0  
TOTAL  
EMISSIONS



THE PATH TO A  
**NET ZERO  
CAMBRIDGE**

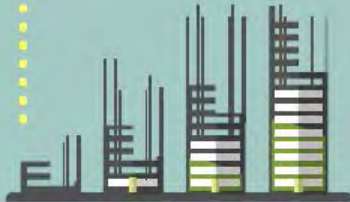


3

## HOW TO ADDRESS CARBON REDUCTION

There are **3** ways to  
reduce emissions from  
buildings:

EFFICIENT DESIGN  
& RETROFITS



IMPROVED  
OPERATIONS



RENEWABLE  
ENERGY SUPPLY



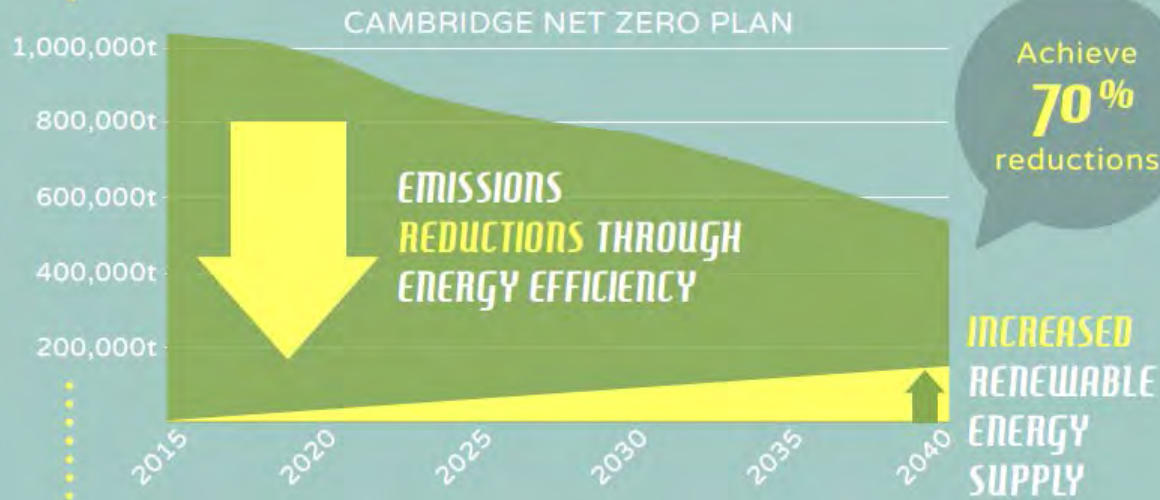
THE PATH TO A  
**NET ZERO**  
**CAMBRIDGE**



4

## THE 25-YEAR NET ZERO STRATEGY

The net zero action plan aims to cut energy demand significantly, and replace fossil fuels with renewable energy.



THE PATH TO A  
**NET ZERO**  
**CAMBRIDGE**





5

## ACTION PLAN

### ENERGY EFFICIENCY IN EXISTING BUILDINGS:

Reduce energy use in buildings through retrofits and improved operations.

### NET ZERO NEW CONSTRUCTION:

Require low carbon new construction.

### LOCAL CARBON FUND:

Option to invest in a net zero community.

### RENEWABLE ENERGY SUPPLY:

Replace fossil fuels with low carbon energy.

### ENGAGEMENT AND CAPACITY BUILDING:

Industry training and community involvement.



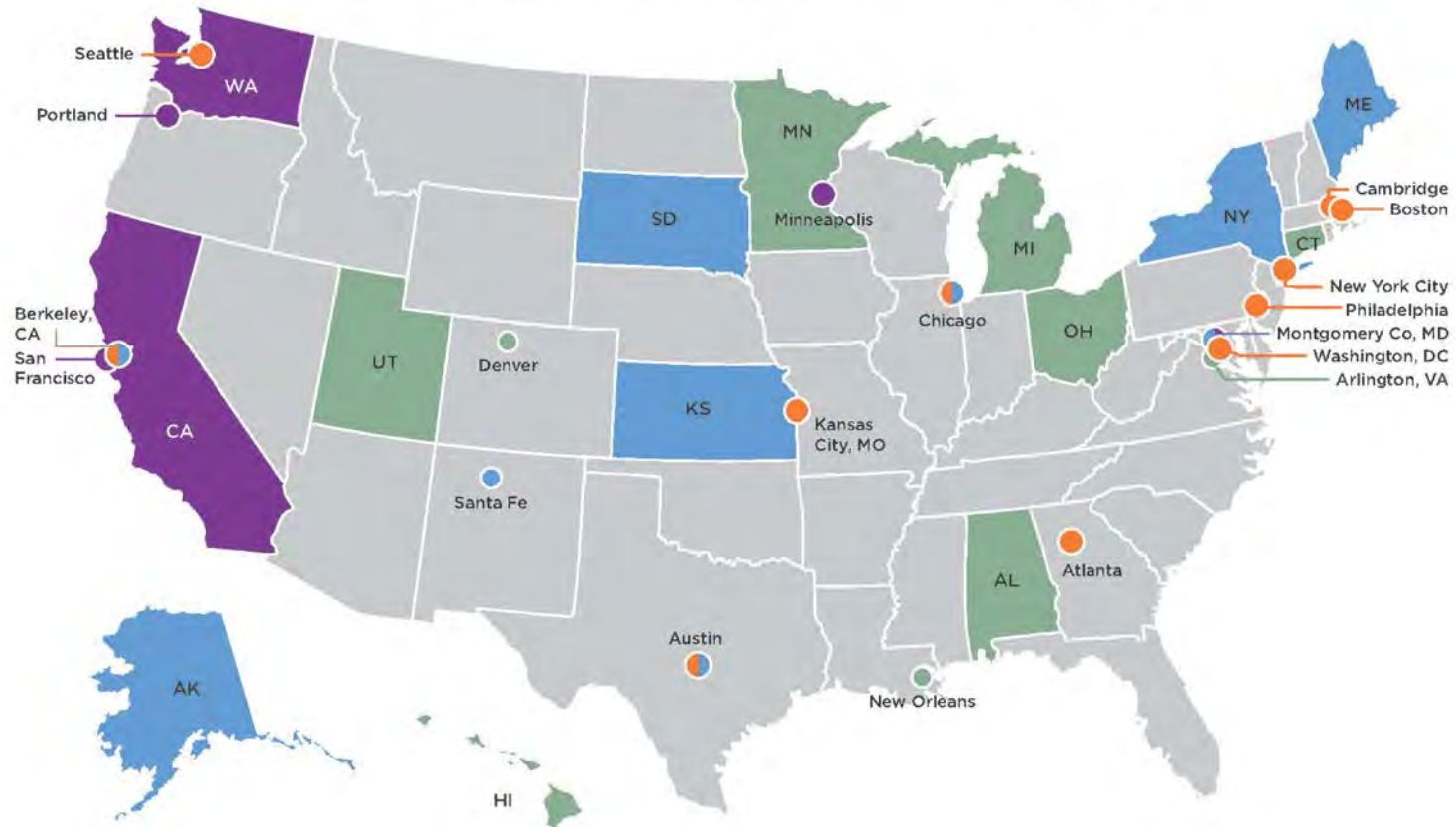
THE PATH TO A  
**NET ZERO**  
**CAMBRIDGE**



# BUILDING ENERGY DISCLOSURE ORDINANCES

- Public disclosure of annual energy usage for commercial and residential buildings over a certain size (in Boston it is commercial buildings over 2,350 m<sup>2</sup> or more than 25 residential units)

U.S. Building Benchmarking and Transparency Policies





# BUILDING ENERGY DISCLOSURE ORDINANCES

- Tie predicted performance to actual performance





## AGENDA

National Influences

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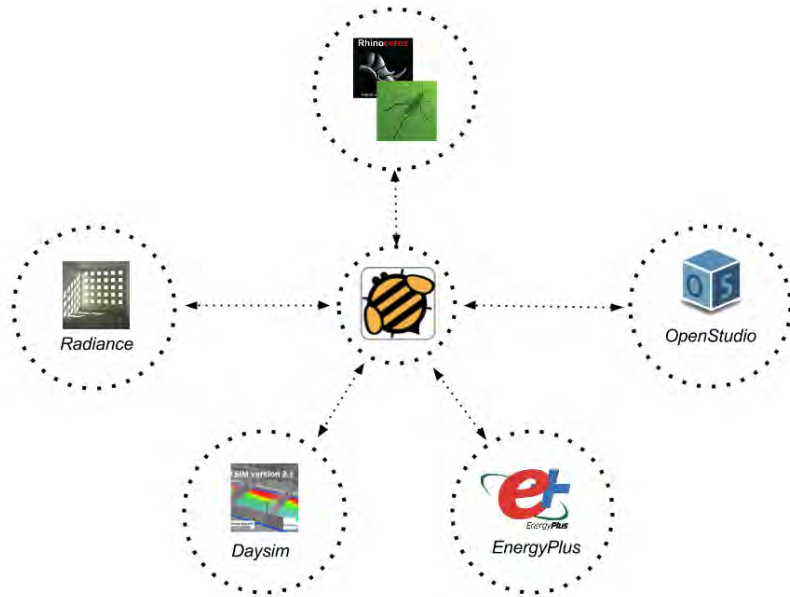
**Internal Impacts**

## FRIENDLY COMPETITION – INTERNAL DISCLOSURE

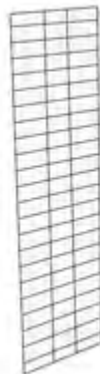
- Energy Use Intensity for every project posted publicly in the office



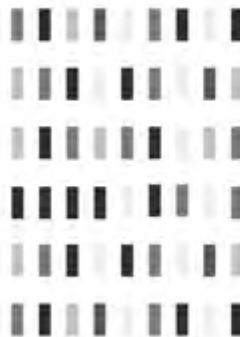
# INCREASED INTEGRATION OF MODELING



baseline



permutations

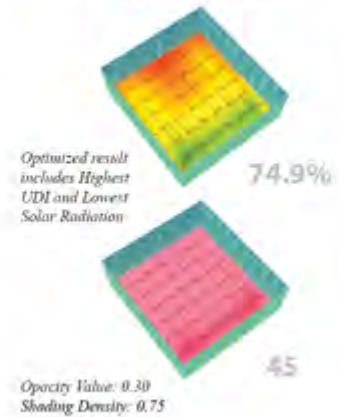


simulations



Useful Daylight Index (UDI)  
Solar Radiation (KWh/m<sup>2</sup>-yr)

optimization



result





QUESTIONS?

