



Zero Carbon Buildings Municipal Summit



Sponsored by





**Driving sustainable and regenerative
design, construction, and operations of the
built environment.**

education | community | advocacy | research/tools



bxp Boston
Properties



nationalgrid



PCA

**SHEPLEY
BULFINCH**

BURO HAPPOLD



ReSource Waste Services



-chargepoint+

LeMessurier.



Turner

DATA | BASED+
db.HMS



SASAKI



EVERSOURCE

ARUP

ELKUS | MANFREDI



SIMPSON
GUMPERTZ
& HEGER



Thornton
Tomasetti

Bruner/Cott
ARCHITECTS

Gensler



AHA

D/R/E/A/M
COLLABORATIVE
ARCHITECTURE | REAL ESTATE DEVELOPMENT

G|R|L|A
Gorman Richardson Lewis Architects

LDA
ARCHITECTURE & INTERIORS

NV5
BEYOND ENGINEERING



AKF

NYCBKUNN

HMFH
HMFH ARCHITECTS

LINNEAN
SOLUTIONS

PLA Paul Lukez
Architecture

SMMA

THE
TEAM
REAL ESTATE ADVISORS

ASSA ABLOY



REthink
39
ARCHITECTS

marguliesperruzzi

PERKINS —
EASTMAN



utile

CADMUS



Lam
Partners



SIENA
CONSTRUCTION



ZED

DIMELLA
SHAFFER



Why are we here?

Agenda

- **Overview** with Julie Janiski & Jacob Knowles
- **Panel Discussion**
 - a. Local Governmental / Municipal Leadership
- **Breakout 1** - What's Current?
- **Breakout 2** - What's Next?
- **Next Steps & Resources** with Eversource | Mass Save & MassCEC

Desired Outcomes

- 1 Inform Massachusetts's NZC efforts**
- 2 Hear from this Community**
- 3 Compile next steps**

Presenters



Julie Janiski

Partner | BuroHappold Engineering



Jacob Knowles

Director of Sustainable Design | BR+A

CODES + ZONING REGULATIONS

NET ZERO CODES

Seattle

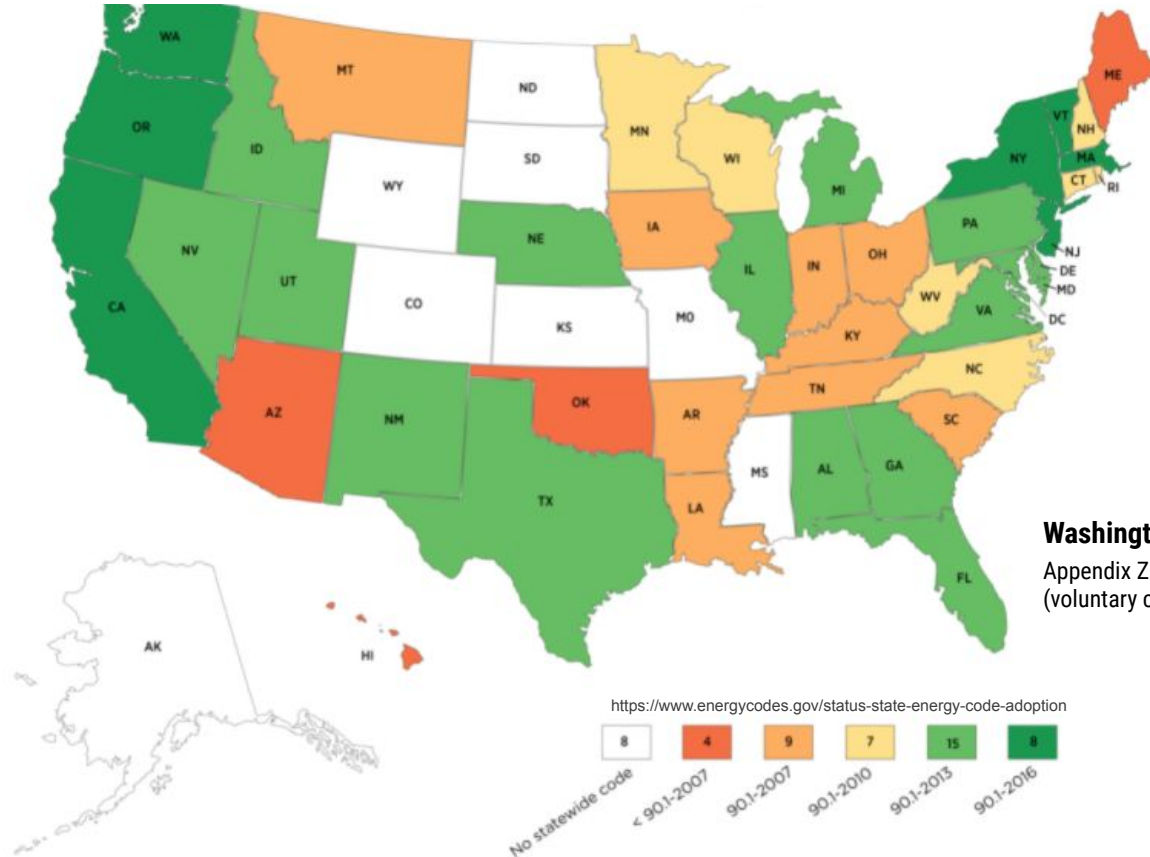
Energy Code is
Approaching Net Zero

California

Title 24-2019
(near residential NZE)
Zero Code
(commercial proposed)

National

IECC 2021
ZNE Appendix
IECC 2030 / ASHRAE
90.1-2031 = Approaching
ZNE



Massachusetts

Net Zero Stretch Code by 2022

Boston + Cambridge + Somerville

ZNE zoning regulations
in place or being developed

Washington, DC

Appendix Z
(voluntary compliance path)

MA CLIMATE BILL

MUNICIPAL LEADERS: NET ZERO STRETCH CODE SUPPORT LETTER

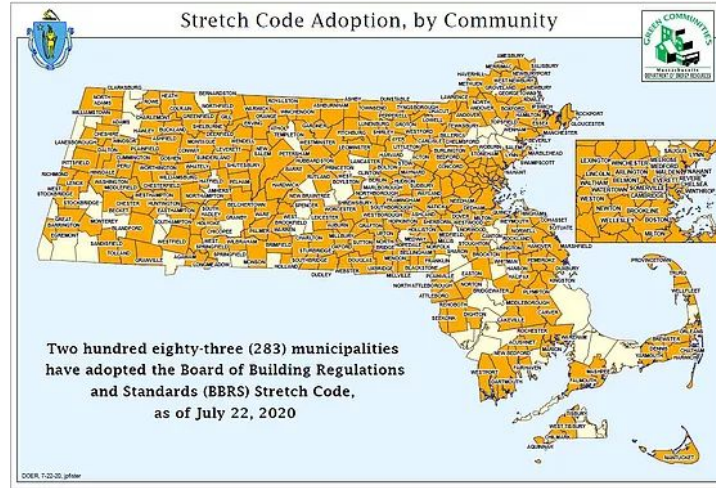
Acton
Amherst
Andover
Arlington
Ashland
Belmont
Becket
Beverly
Boston
Boxford
Brookline
Cambridge
Chelsea
Concord
Conway
Cummington
Dedham
Egremont
Everett
Framingham

Gill
Groton
Ipswich
Lancaster
Lexington
Lincoln
Malden
Marlborough
Medfield
Medford
Melrose
Montague
Natick
Newton
Northampton
Pittsfield
Salem
Saugus
Sharon
Sherborn

Shutesbury
Somerville
Springfield
Truro
Wakefield
Waltham
Warwick
Washington
Watertown
Wayland
Wellesley
Weston
Weymouth
Whately
Williamstown
Windsor
Winchester
Winthrop
Worcester

**Represents 40% of
the population of MA**

MA CLIMATE BILL: NET ZERO STRETCH CODE



TODAY
CURRENT
STRETCH
CODE

Late 2021 /
Early 2022

UPDATED STRETCH
CODE

MUNICIPAL OPT-IN NET ZERO STRETCH CODE

CARBON NEUTRAL ZONING + ORDINANCE

SOMERVILLE

ZONING
ORDINANCE



2020

BOSTON

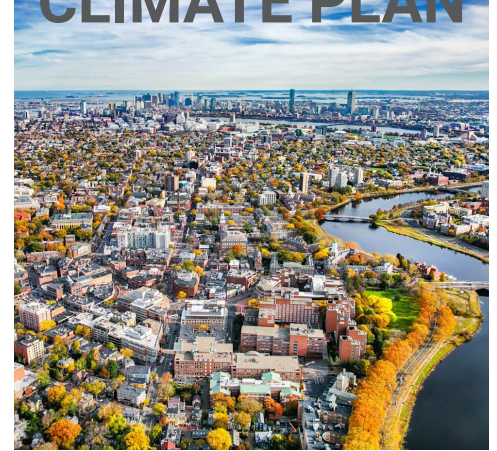
CO₂ NEUTRAL
ZONING



2021 / 2022

CAMBRIDGE

CLIMATE PLAN



2020 - 2030

WATERTOWN

SOLAR PV ORDINANCE

BROOKLINE

ELECTRIFICATION ORDINANCE

MANY OTHERS

SEEKING HOME RULE TO BAN GAS

WHAT IS NET ZERO?

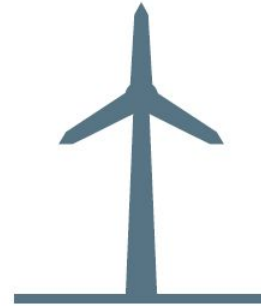
CARBON NEUTRAL: OPERATION



**ENERGY
EFFICIENCY**



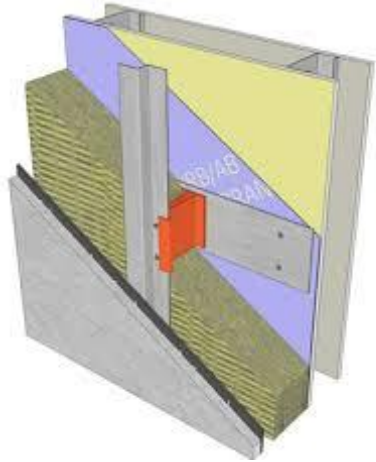
**ELECTRIC
HEAT PUMPS**



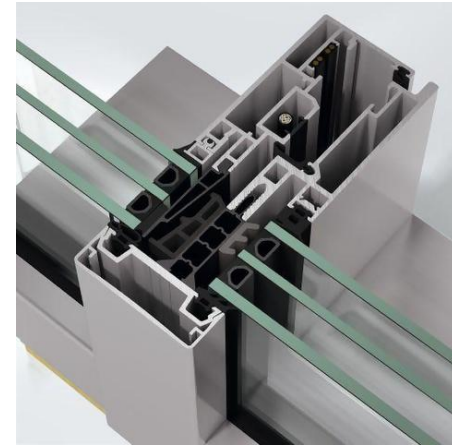
**ON + OFF-SITE
RENEWABLE ENERGY**

= 0

ENERGY EFFICIENCY: ENVELOPE

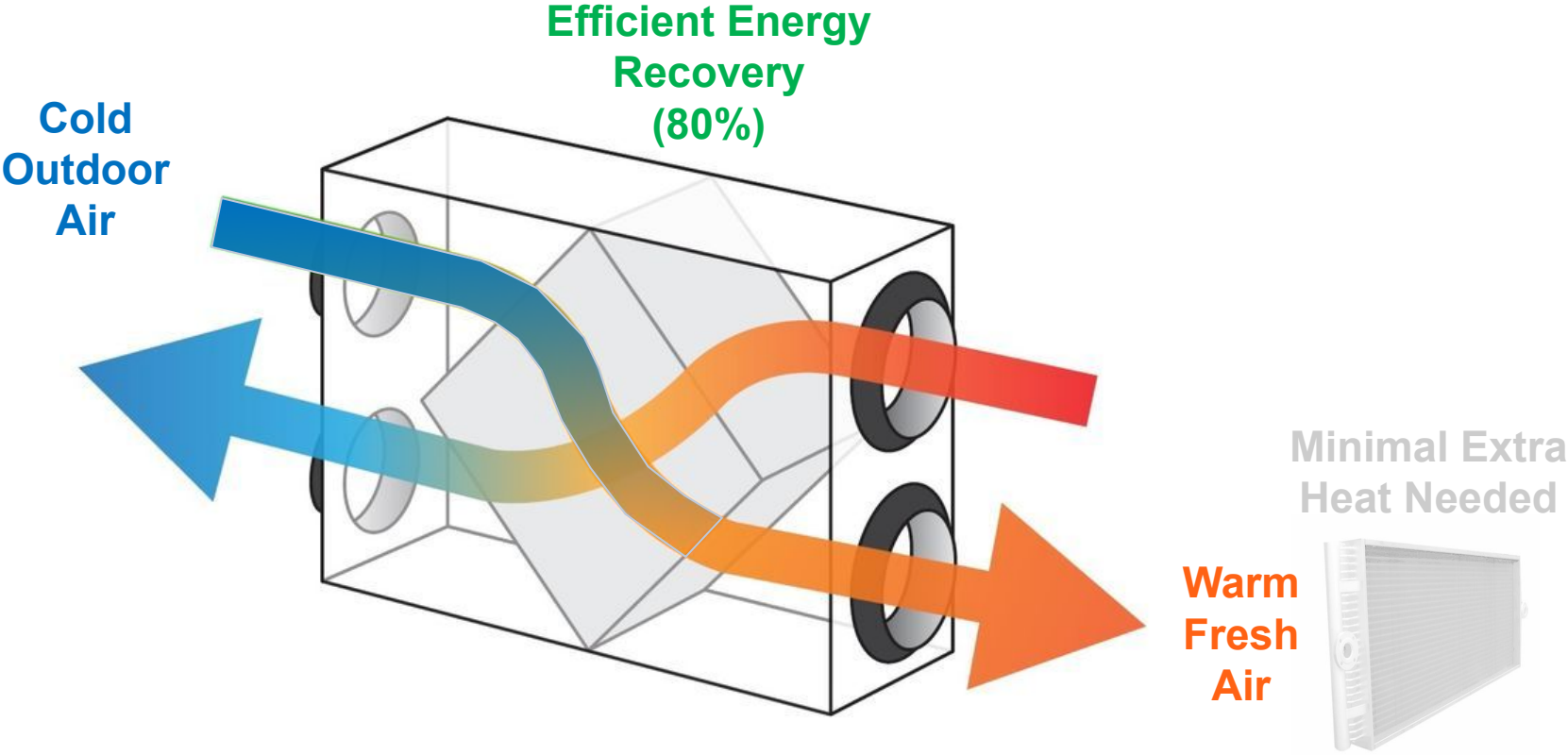


Thermally Broken
+ Highly Insulated Envelope

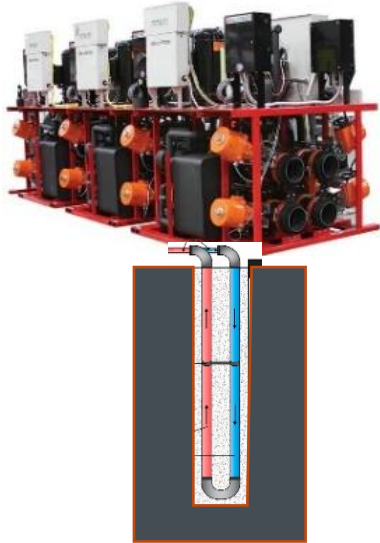


Triple Glazing
+ High Performance Frame

ENERGY EFFICIENCY: HVAC



ELECTRIC HEAT PUMPS

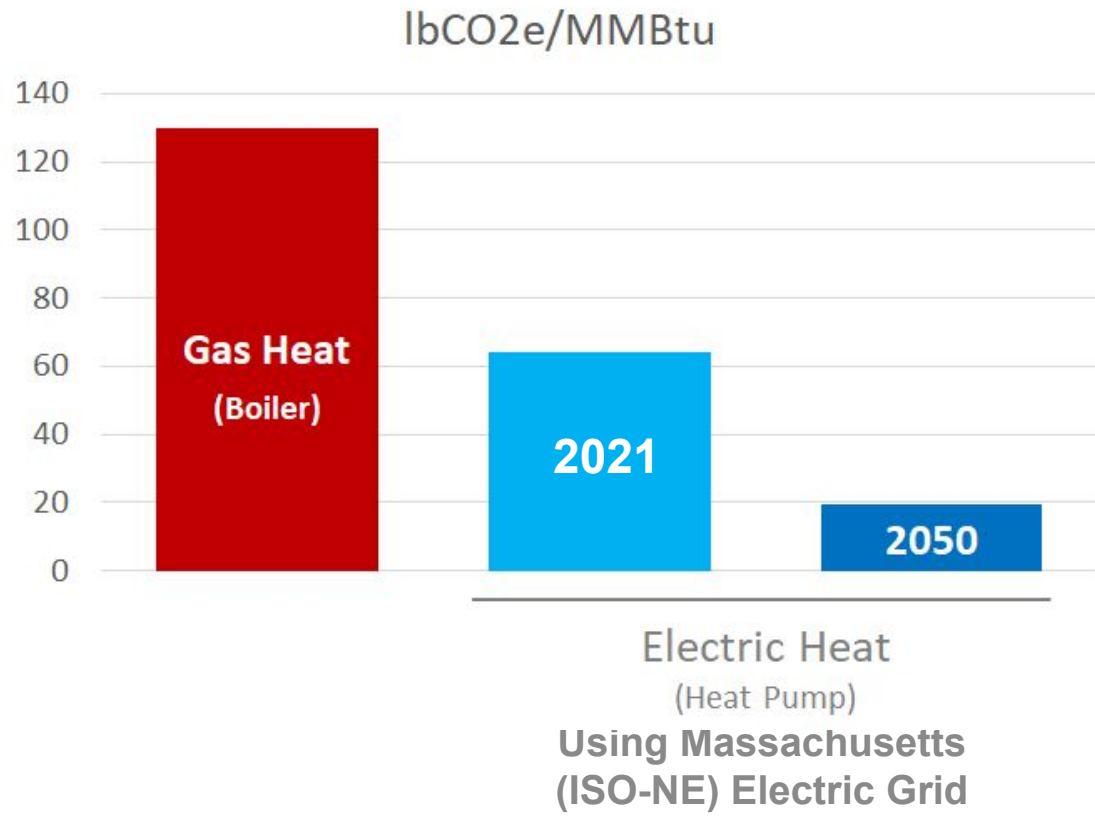


GROUND-SOURCE



AIR-SOURCE

GAS vs. HEAT PUMP: CO2 EMISSIONS



RENEWABLE ENERGY



ON-SITE RENEWABLES
Prioritized as primary



OFF-SITE RENEWABLES
Supplement as necessary

= *100% of the
building's
annual energy
consumption*

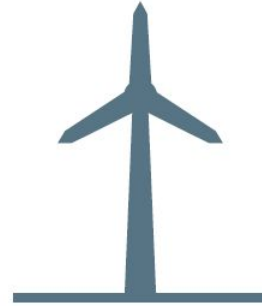
CARBON NEUTRAL



**LOW
EMBODIED
CARBON**



**LOW
OPERATIONAL
CARBON**



**CARBON CREDITS
+
RENEWABLE ENERGY**

= 0

CASE STUDY:
BRISTOL SBREGA BUILDING



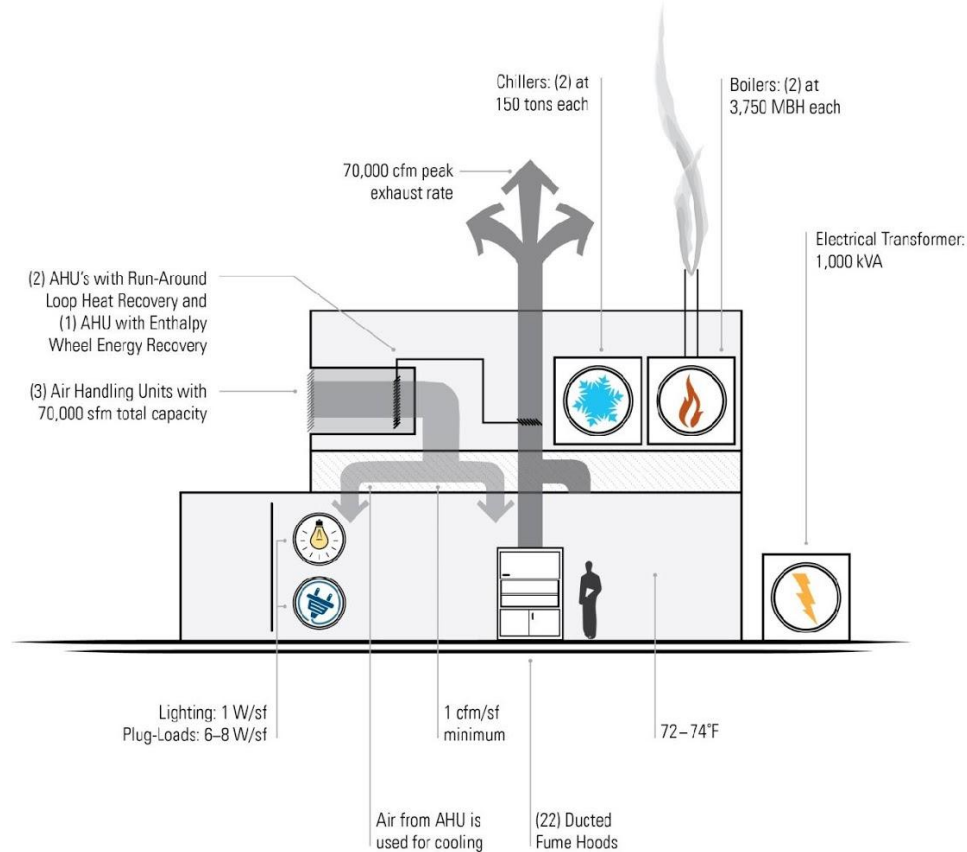
JOHN J. SBAGA
HEALTH & SCIENCE BUILDING

BRISTOL COMMUNITY COLLEGE



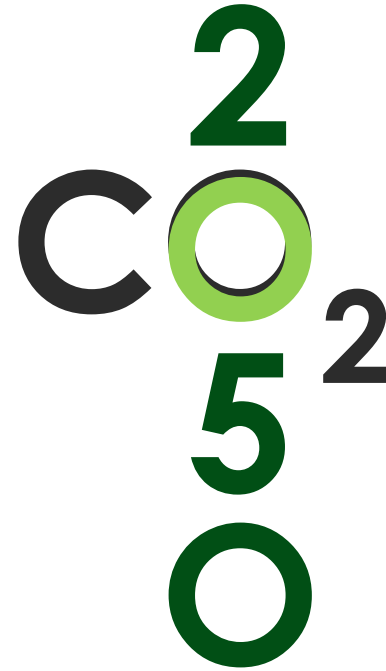


Original Design: High Performance





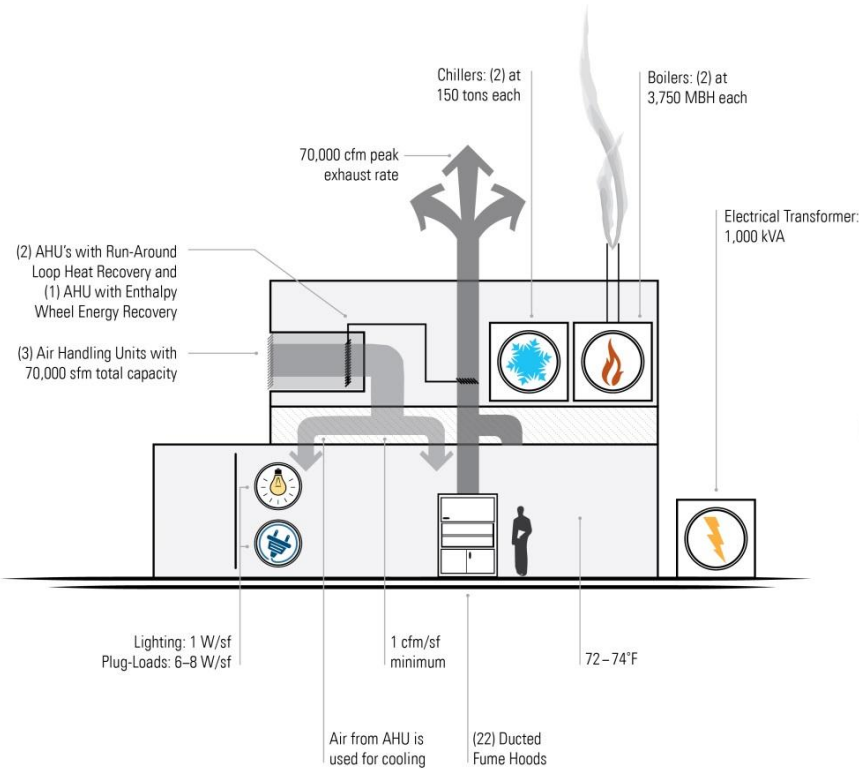
through night and day and in and out of weeks and almost over a year





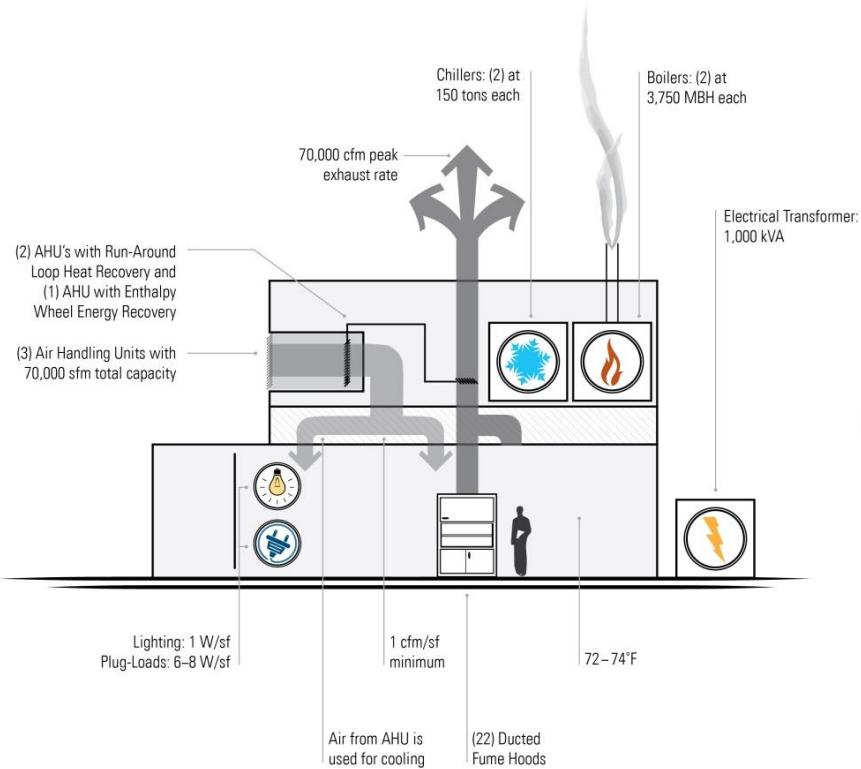
High Performance

Zero Net Energy

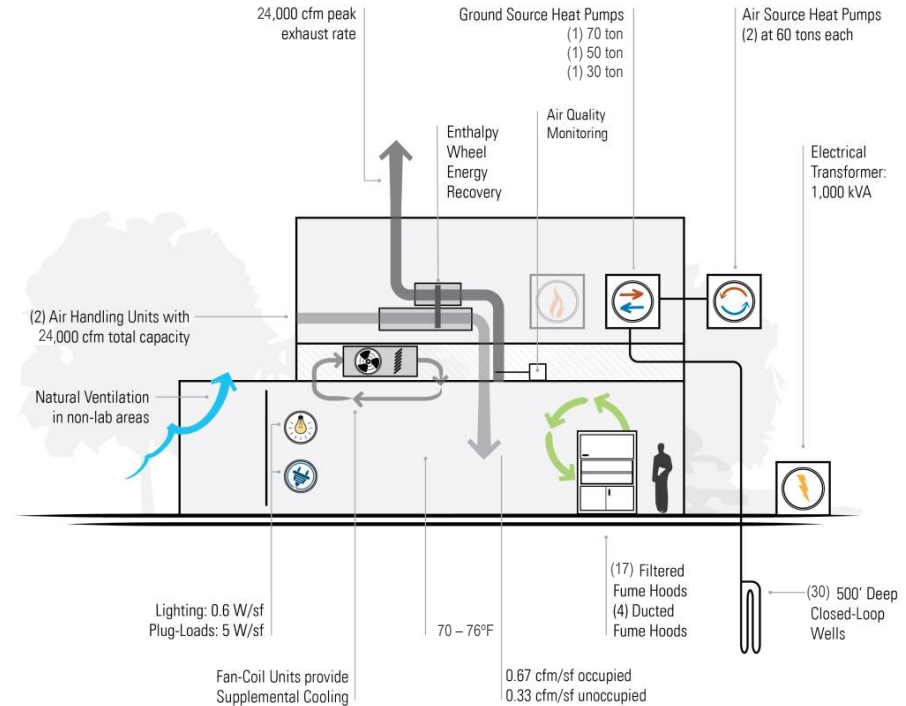


?

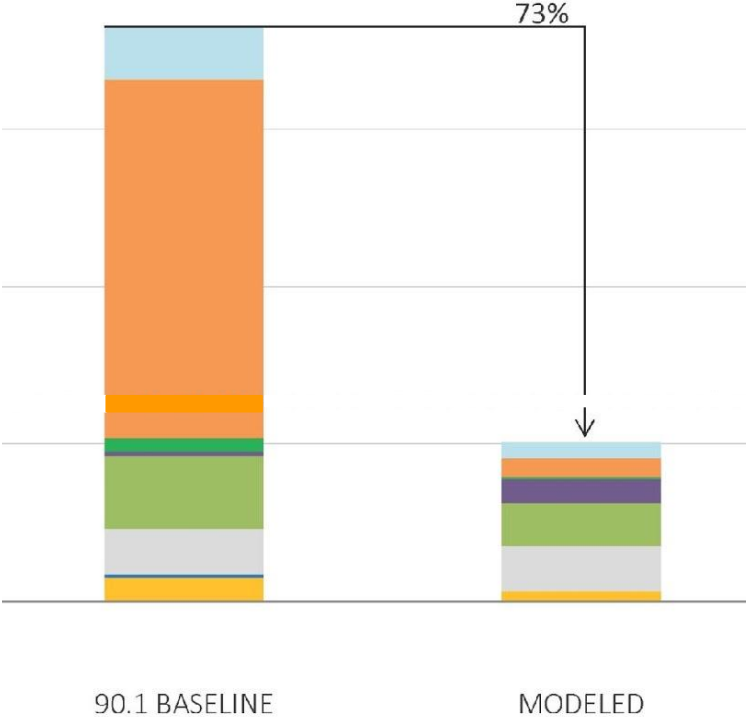
High Performance



Zero Net Energy

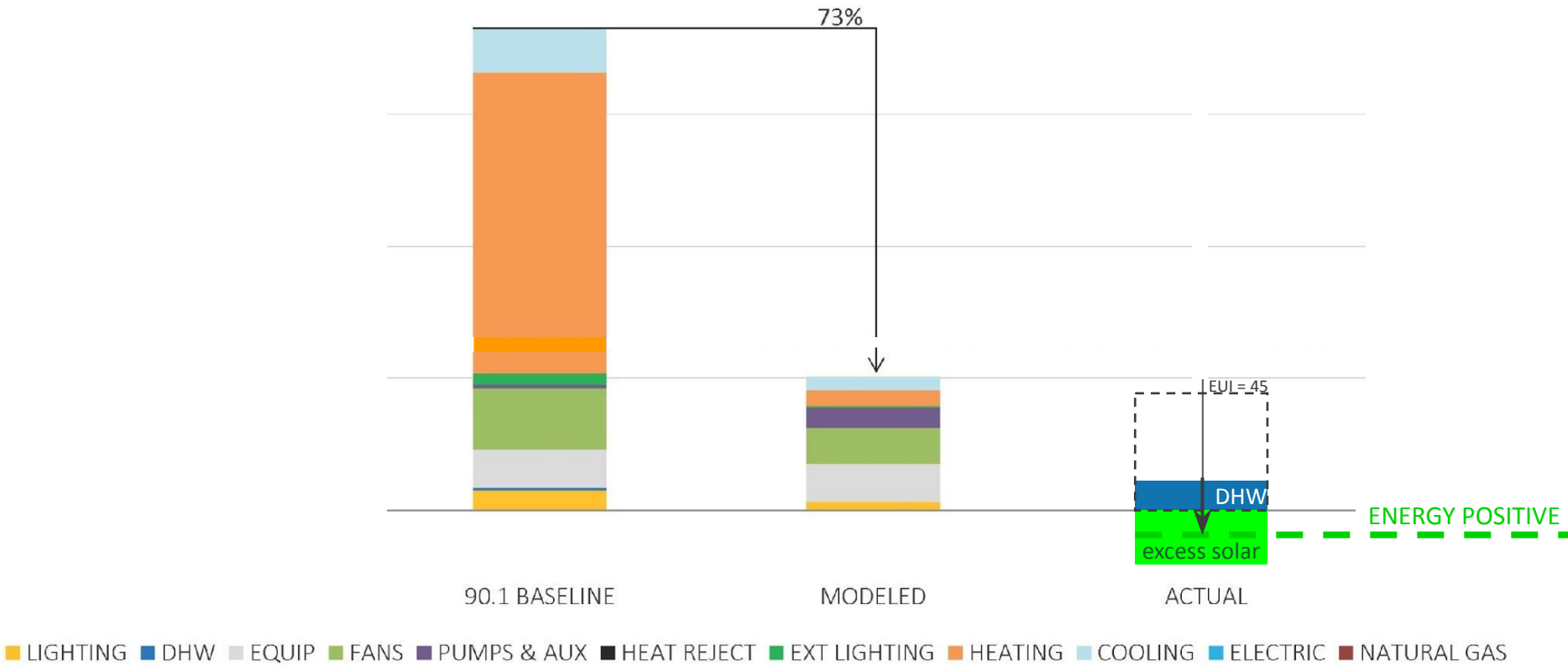


Energy Consumption

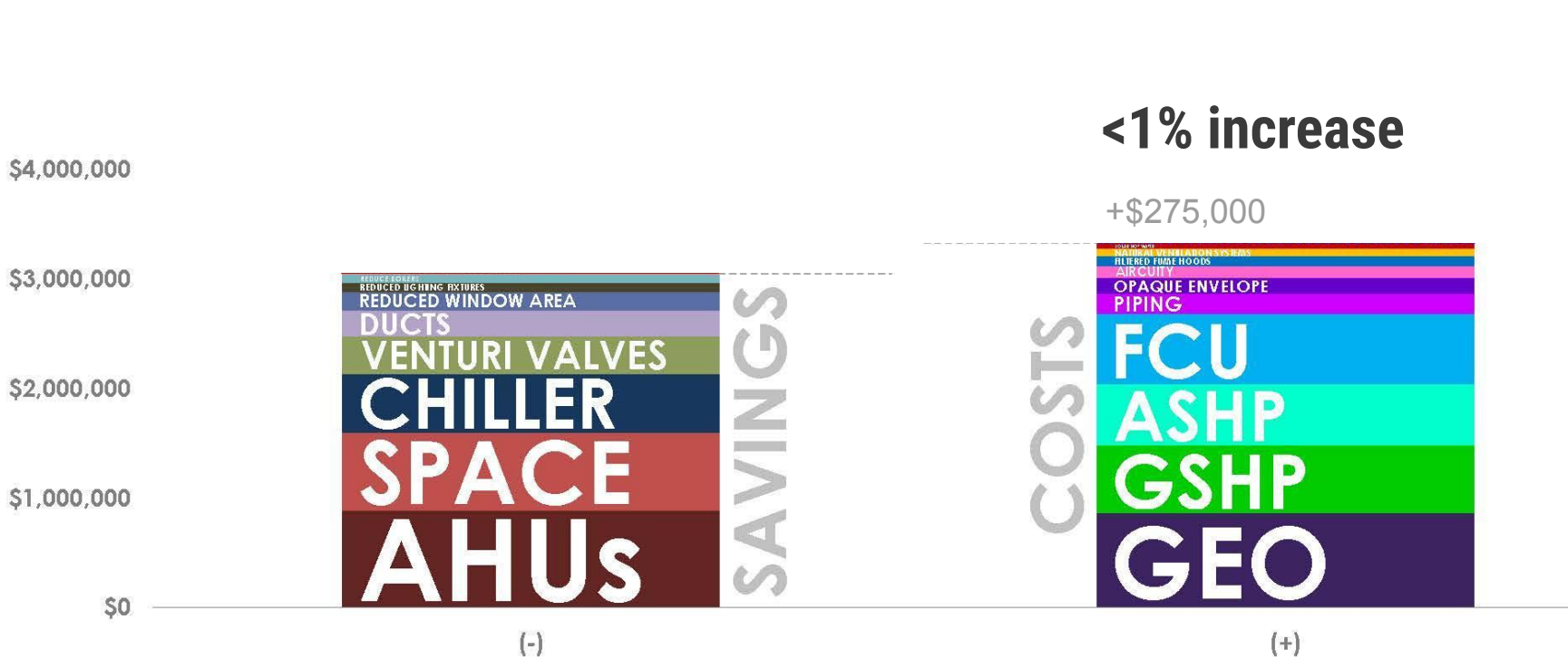


LIGHTING DHW EQUIP FANS PUMPS & AUX HEAT REJECT EXT LIGHTING HEATING COOLING ELECTRIC NATURAL GAS

Measured Performance

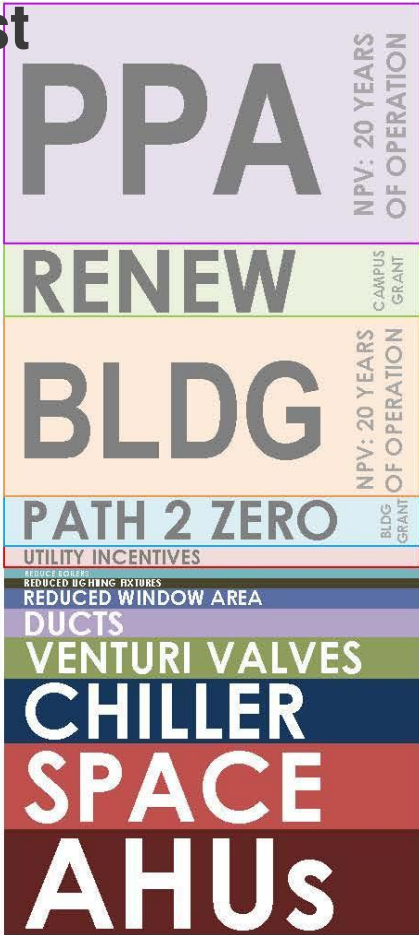


Construction Cost



Life Cycle Cost

\$7,000,000
\$6,000,000
\$5,000,000
\$4,000,000
\$3,000,000
\$2,000,000
\$1,000,000
\$0



NPV: 20 YEARS
OF OPERATION

CAMPUS
GRANT

NPV: 20 YEARS
OF OPERATION

BLDG
GRANT

REVENUE +

ZNE GRANT
+ INCENTIVES

SAVINGS

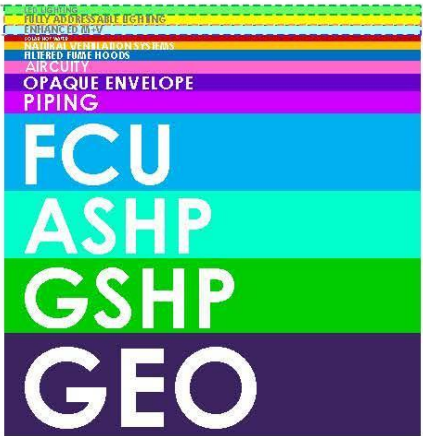
(-)

\$4,150,000
Net Present Savings

\$230,000/yr
Operational Savings
(annual tuition for 50 students)

ALTERNATES*
*(GRANT-FUNDED)

COSTS



(+)

CASE STUDY: BELMONT MIDDLE + HIGH SCHOOL



Bond Payments
Solar Maintenance Premiums
REC Purchases

Utility Cost Savings
Geothermal Maintenance Savings
AEC Incentives

Geothermal

Rooftop Solar

REC

Geothermal

Rooftop Solar

AEC

\$0 (Cost Neutral)

\$>5M Net
Present Savings

**NET ZERO = READILY ACHIEVABLE
BY ALL BUILDING TYPES**




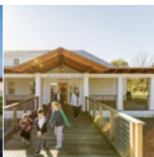


NET ZERO READY DATABASE SNAPSHOT

7.2 Million Sq Ft in Massachusetts Currently Documented. More Pending...

(select examples shown below)

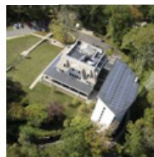


Assembly

76,899
GSF

					
Lexington Visitor's Center	Walden Pond Visitor Center	Eastham Public Library	MA Audubon Broad Meadow Brook	786 Belmont Public Library	Old Oak Dojo
Lexington 6,700	Concord 5,575	Eastham 17,500	Worcester 6,200	Belmont 40,000	Jamaica Plain 924












Office

505,200
GSF

		
Woods Hole Research Center	Div of Fisheries & Wildlife Field HQ	11-21 Bromfield
Falmouth 19,200	Westborough 45,000	Boston 441,000















Education: K-12

1,927,400
GSF

										
Douglas & Gates Schools	King Open/Cambridge St Upper Schools Complex	Annie E. Fales Elementary School	Lexington Children's Place	Tobin Montessori Vassal Lane Upper Schools Project	608-Hastings School-DDP	Belmont Middle and High School	Cunniff Elementary School	Dr. Martin Luther King, Jr. School	Hosmer Elementary School	Lincoln School
Acton 174,000	Cambridge 243,000	Westborough 70,000	Lexington 18,945	Cambridge 275,000	Lexington 110,000	Belmont 445,100	Watertown 82,355	Cambridge 168,500	Watertown 142,500	New Bedford 100,000





Residential: Affordable

1,070,483
GSF

						
402 Rindge Ave / Ringe Commons (B - Residential Portion)	402 Rindge Ave / Ringe Commons (Building B)	Finch Cambridge	1005 Broadway	Harbor Village	31 Tufts	191 Talbot
Cambridge 27,600	Cambridge 74,848	Cambridge 100,000	Chelsea 44,150	Gloucester 35,000	Somerville 13,800	Dorchester 14,195
						
Hyde Park LGBTQ Senior Housing	Clarendon Hill Redevelopment	2072 Mass Ave. Apartments	Linnean Apartments	152-154 Highland	226 Highland	246 Norwell
Boston 90,000	Somerville 497,493	Cambridge 65,710	Cambridge 15,000	Roxbury 4,640	Roxbury 7,200	Dorchester 5,847

Lab / Tech / Science

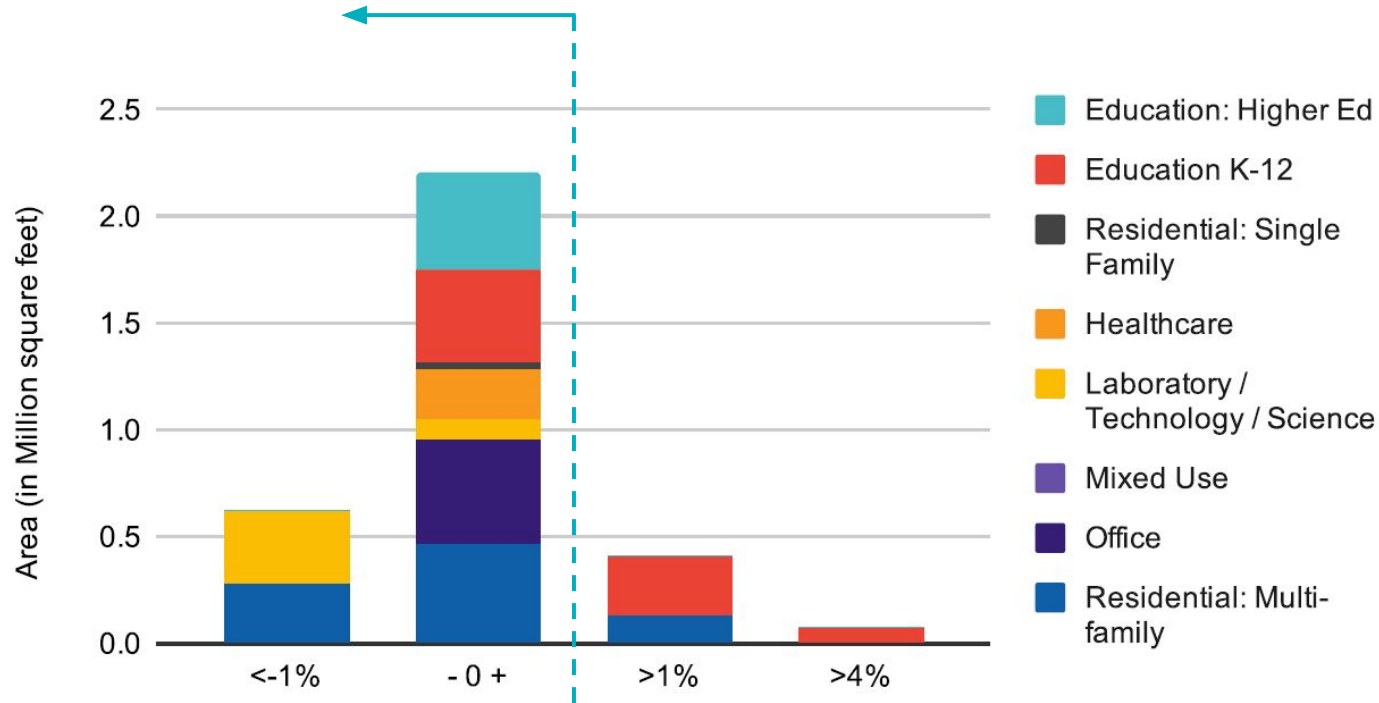
899,100
GSF

	
Cape Cod Community College Science and Engineering Center	Bristol Community College Sbraga Health & Science Building
Barnstable 38,500	Fall River 50,600
	
University of Massachusetts Medical School	325 Binney Street
Worcester 335,000	Cambridge 475,000

HOW MUCH DOES IT COST TO BUILD NET ZERO READY?

*47% OF GSF REPORTED ON % COST DIFFERENCE

85% OF RESPONSES: <1% PREMIUM



Percent Change in Construction Cost due to Net Zero Ready in MA

WHOLE-BUILDING CARBON EMISSIONS

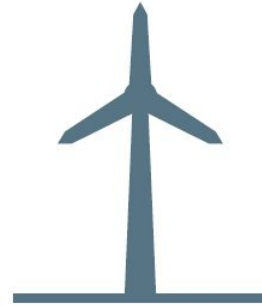
CARBON NEUTRAL



**LOW
EMBODIED
CARBON**



**LOW
OPERATIONAL
CARBON**



**CARBON CREDITS
+
RENEWABLE ENERGY**



0

OPERATIONAL + EMBODIED CARBON



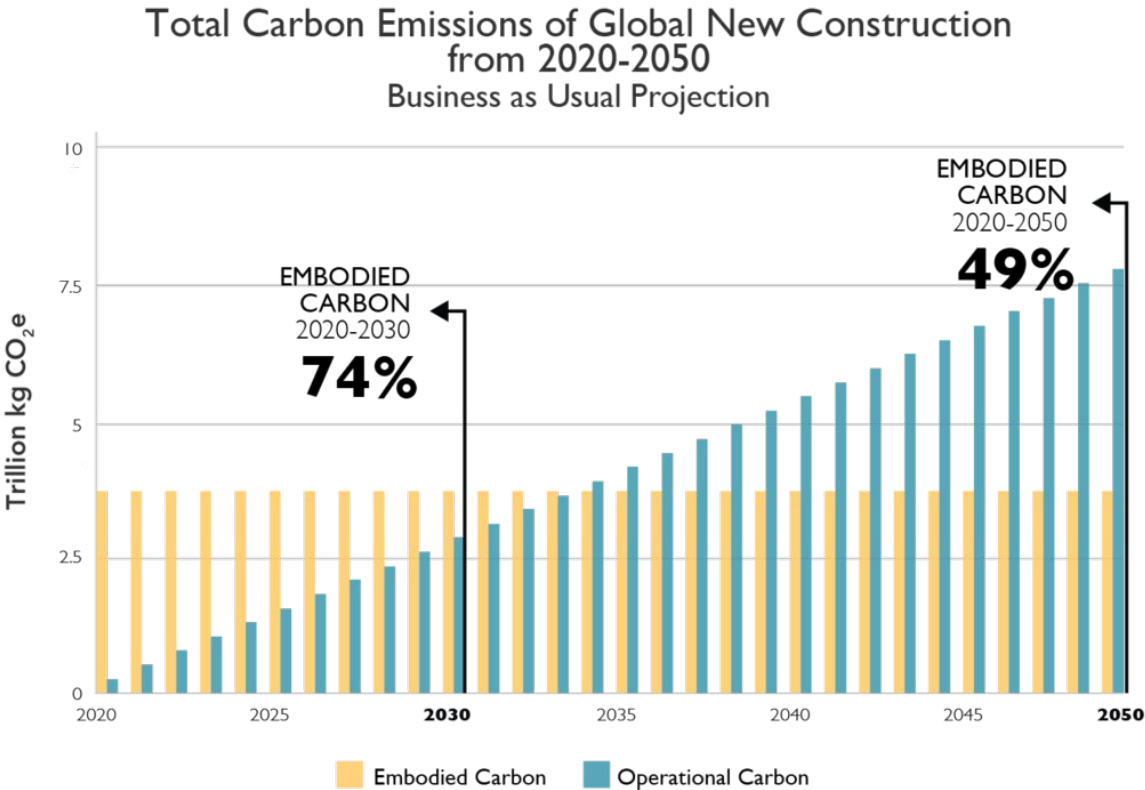
MATERIAL SELECTION & PROCUREMENT

- Regional extraction/manufacture
- Less resources used to manufacture
- Industrial best practice for reuse and recycle
- High quality offsets

BUILDING PERFORMANCE

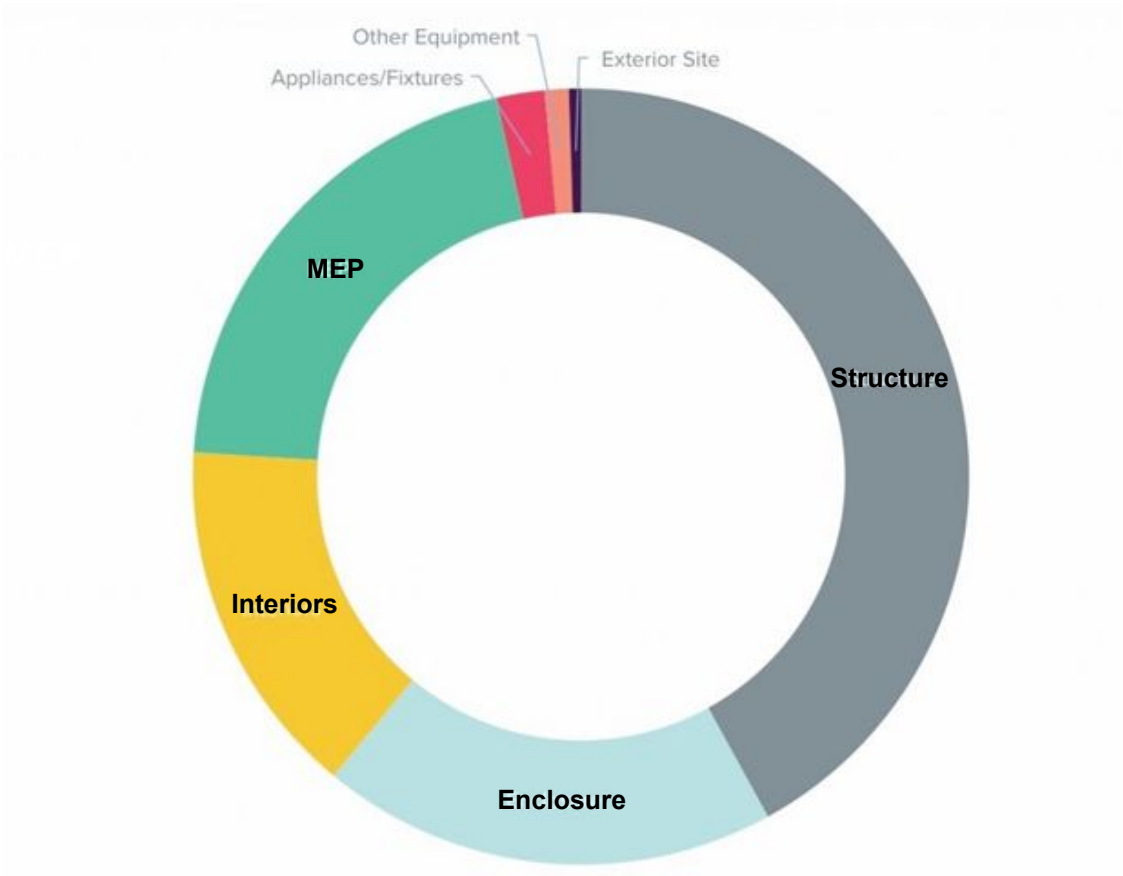
- High-Performance Envelope
- Efficient, Electric Systems
- Renewable Energy, incl. high quality offsets

GLOBAL CARBON EMISSIONS: NEW CONSTRUCTION (2020-2050)



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Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

EMBODIED CARBON / WHOLE BUILDING



EMBODIED CARBON / EXAMPLE - STRUCTURE

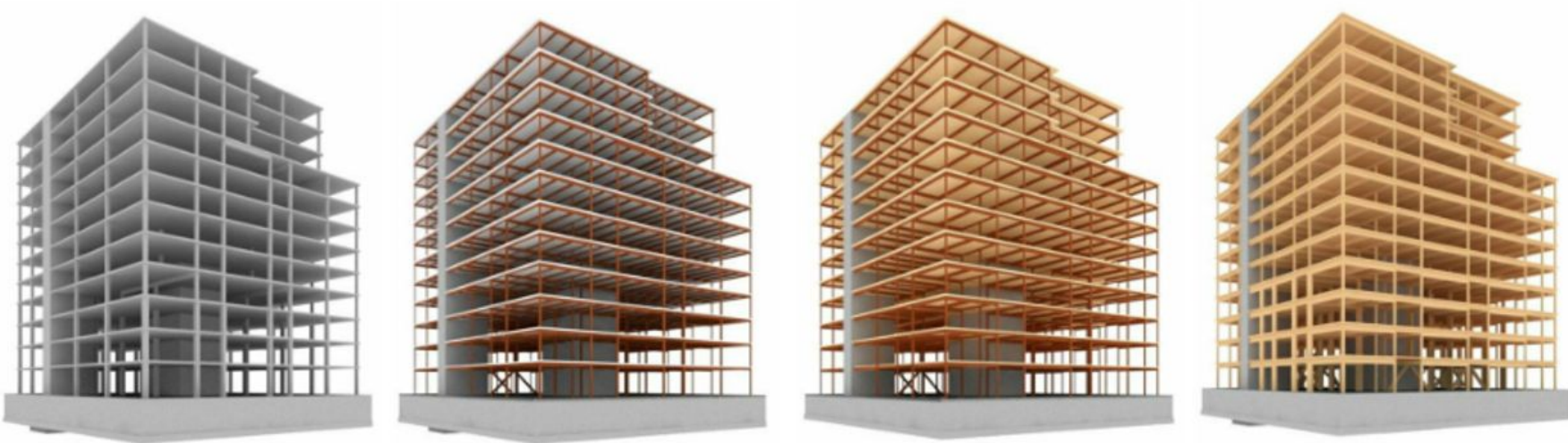
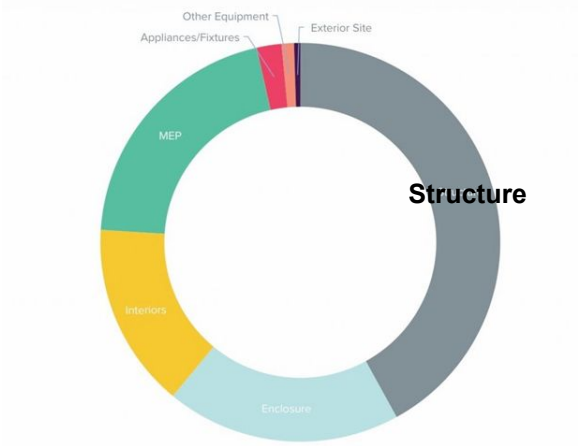
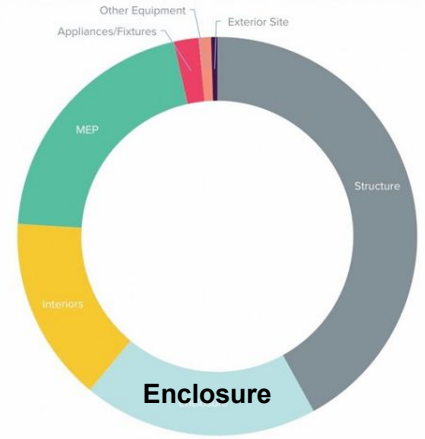
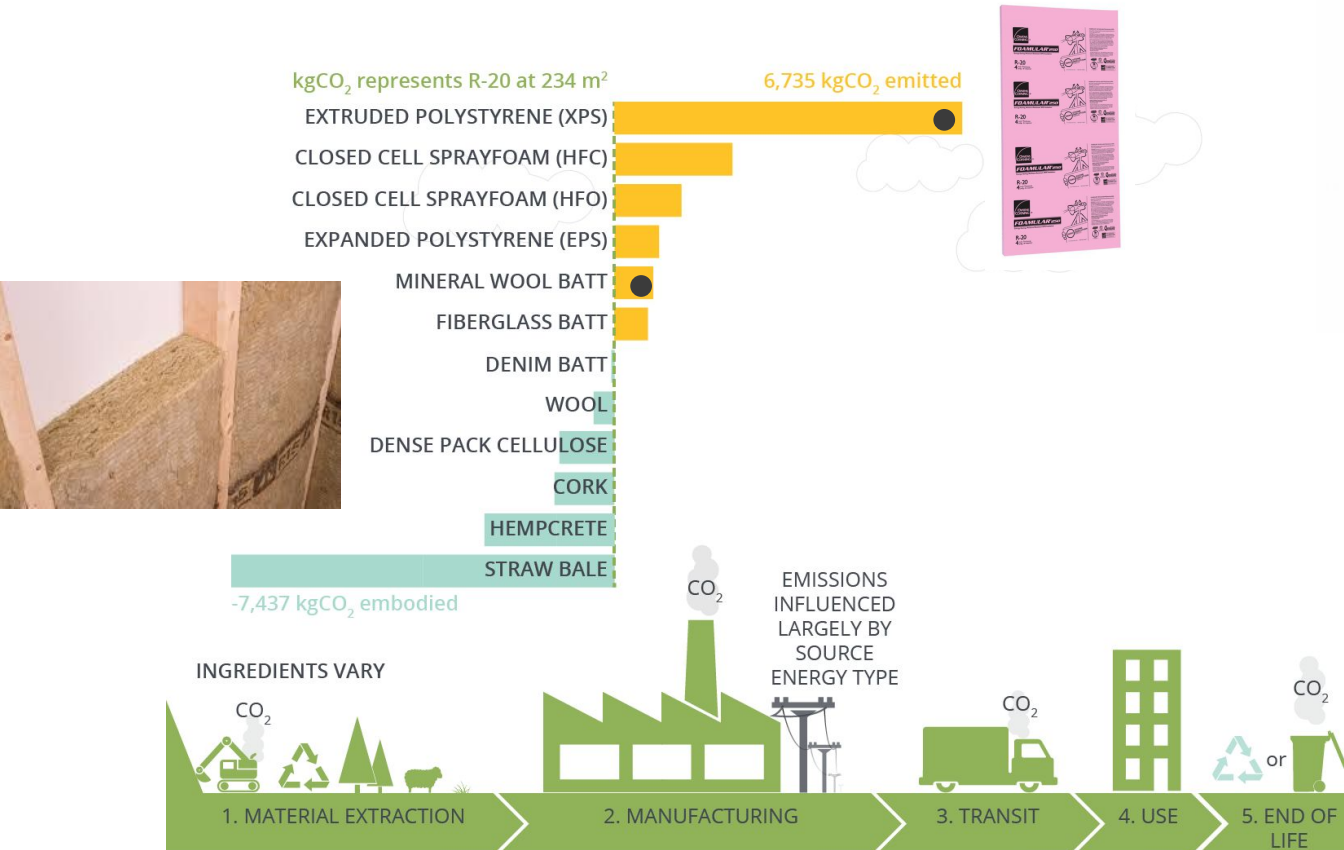
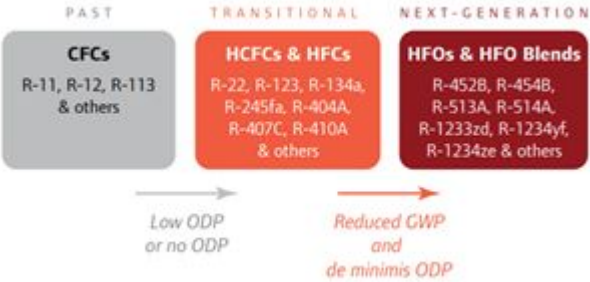


Image: Buro Happold

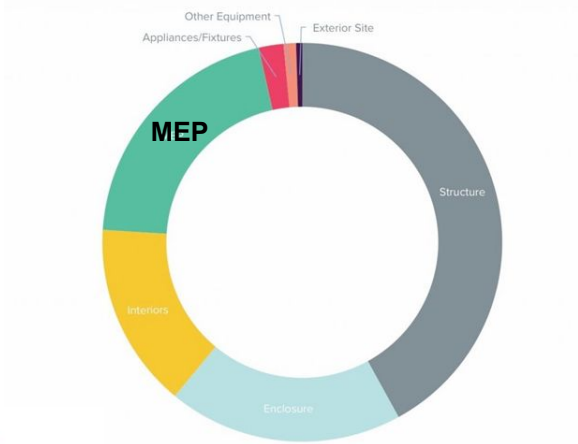
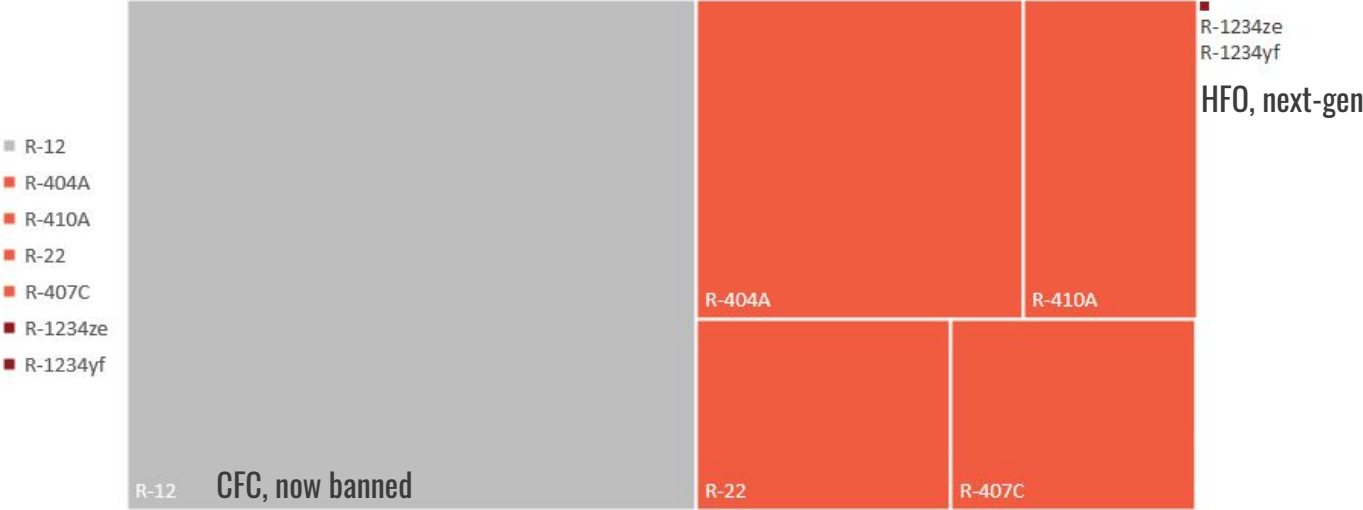
EMBODIED CARBON / EXAMPLE - INSULATION



EMBODIED CARBON / EXAMPLE - REFRIGERANTS



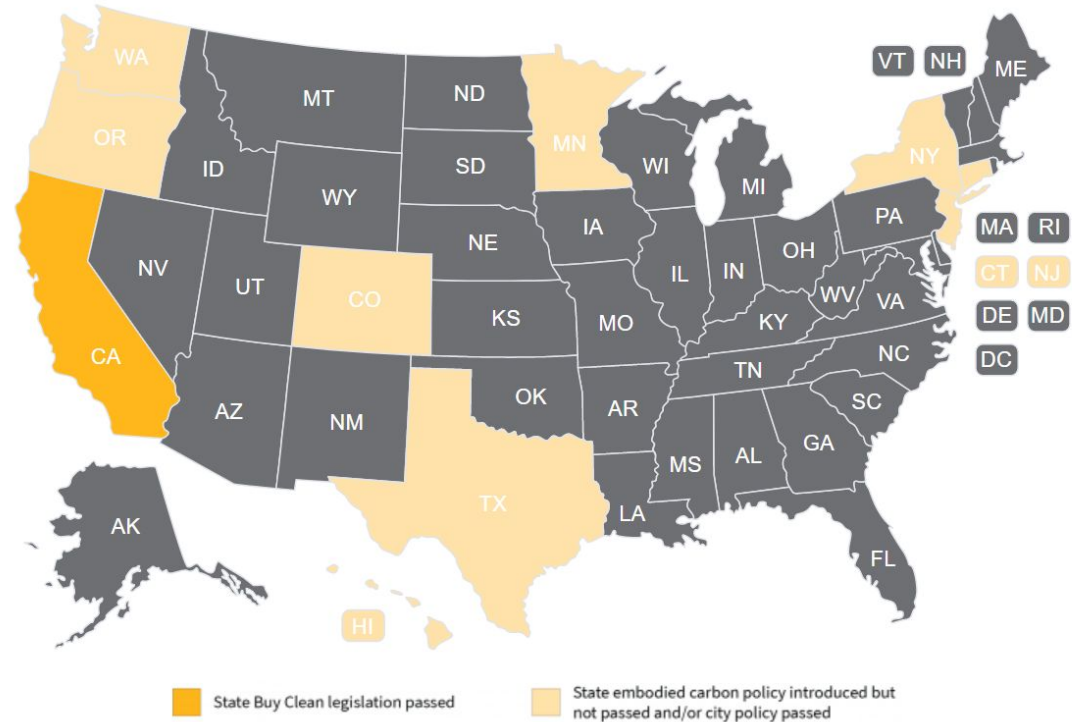
Global Warming Potential (kg CO₂e)



EMBODIED CARBON - POLICY - NORTH AMERICA

Policy Options

1. Prescriptive
2. Adopt other green building certification requirements
3. Performance targets or limits



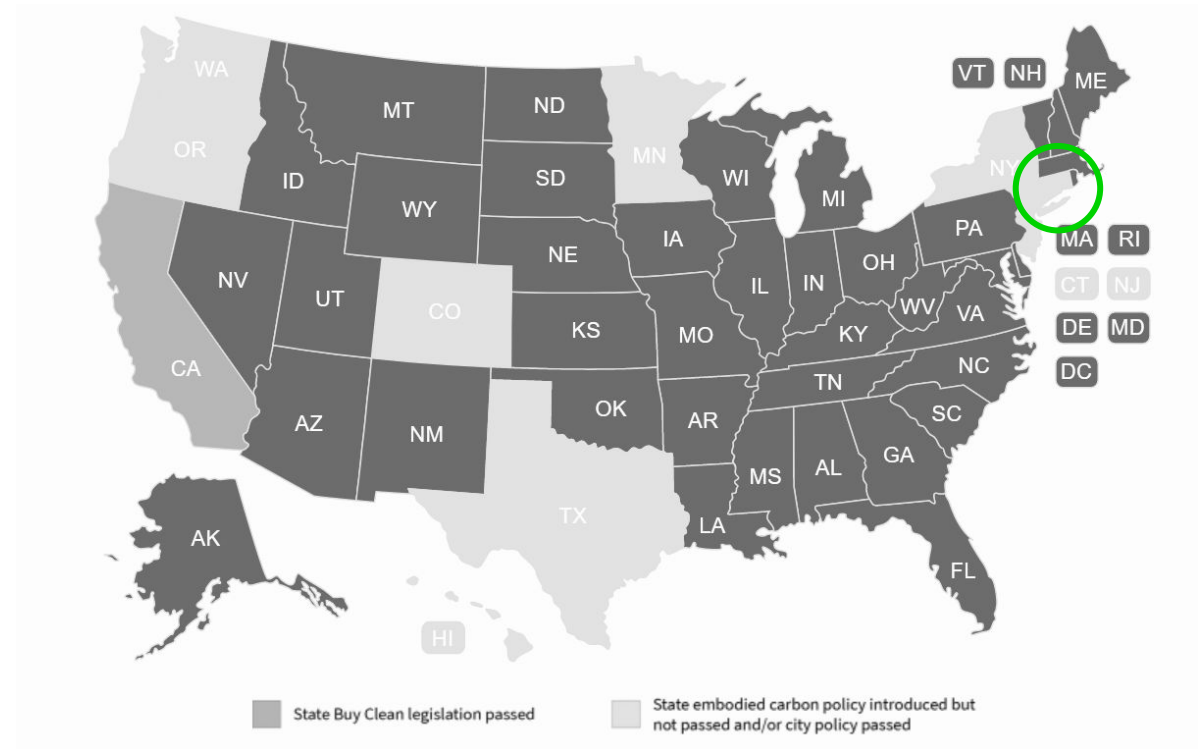
EMBODIED CARBON - POLICY - MASSACHUSETTS

MA Municipalities - Examples

- Somerville, Zoning Ordinance; Density increase
- Newton, Zoning Ordinance; 20,000sf+ special permit

In development:

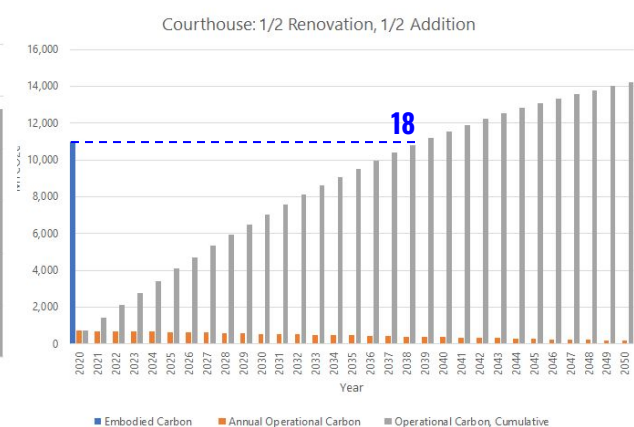
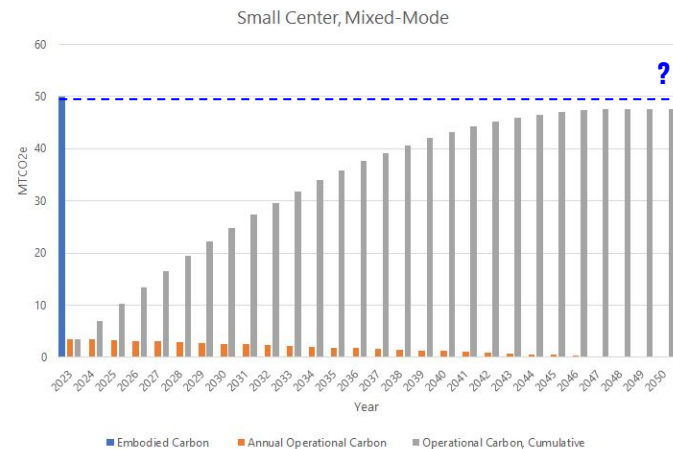
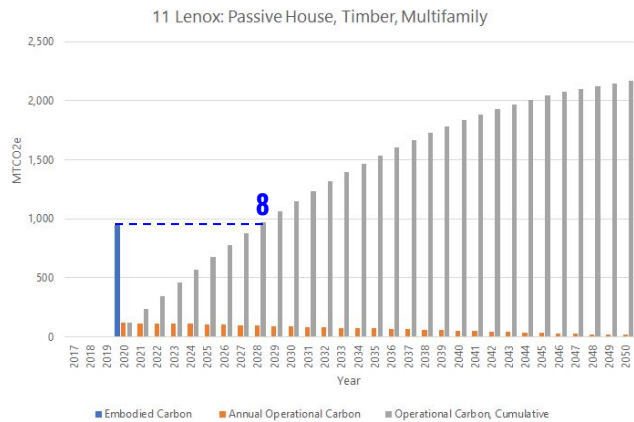
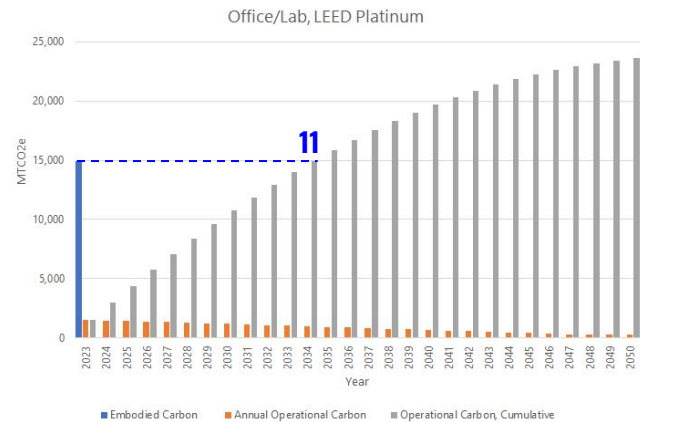
- Cambridge: Reporting, Re-use, Thresholds
- Boston: Zero Net Carbon Zoning, Exploratory



EMBODIED CARBON - POLICY - PERFORMANCE-BASED, CERTIFICATION/COMMITMENT EXAMPLES



WHOLE BUILDING CARBON EMISSIONS: OPERATIONAL + EMBODIED



11 LENOX STREET, BOSTON, MA



- 7 Stories
- 37,500 sf
- Multi-family
- 34 units
- \$14m Cost



STRATEGIES

Operational Carbon

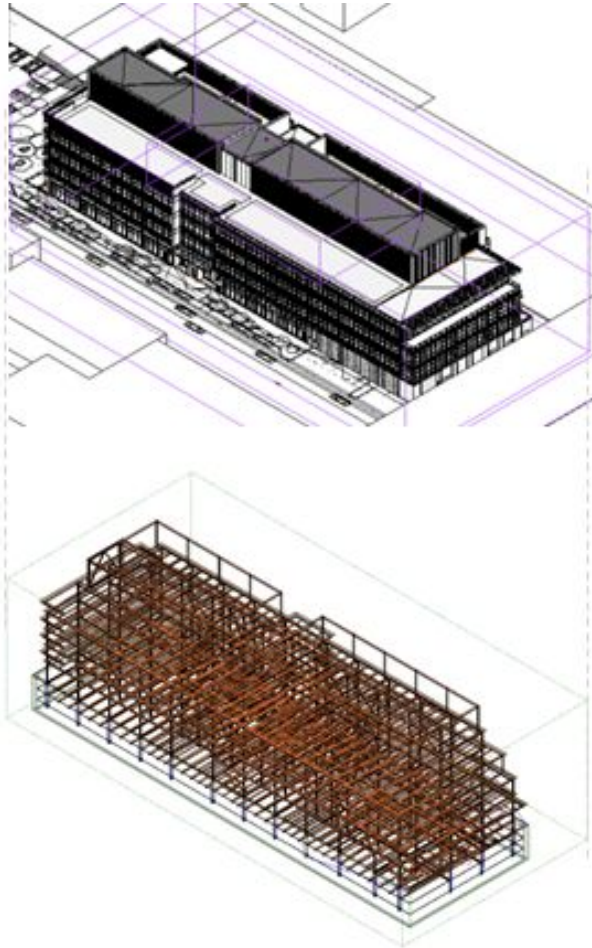
- Passive House (PHIUS), Triple-Pane Windows, Robust Insulation
- Ventilation: Energy Recovery
- Heating/Cooling: Daikin VRF (heat pumps)
- Hot Water: Heat Pump Hot Water Heater
- All-Electric
- Rooftop Solar PV (40kW)
- EV Charging

Embodied Carbon

- FSC Timber (Nordic); glulam post and beam, CLT floors
- Lightweight recycled insulated fill
- Prefab modular concrete cores

OFFICE/LAB, SOMERVILLE, MA

- 4 Stories
- Speculative



STRATEGIES

Operational Carbon

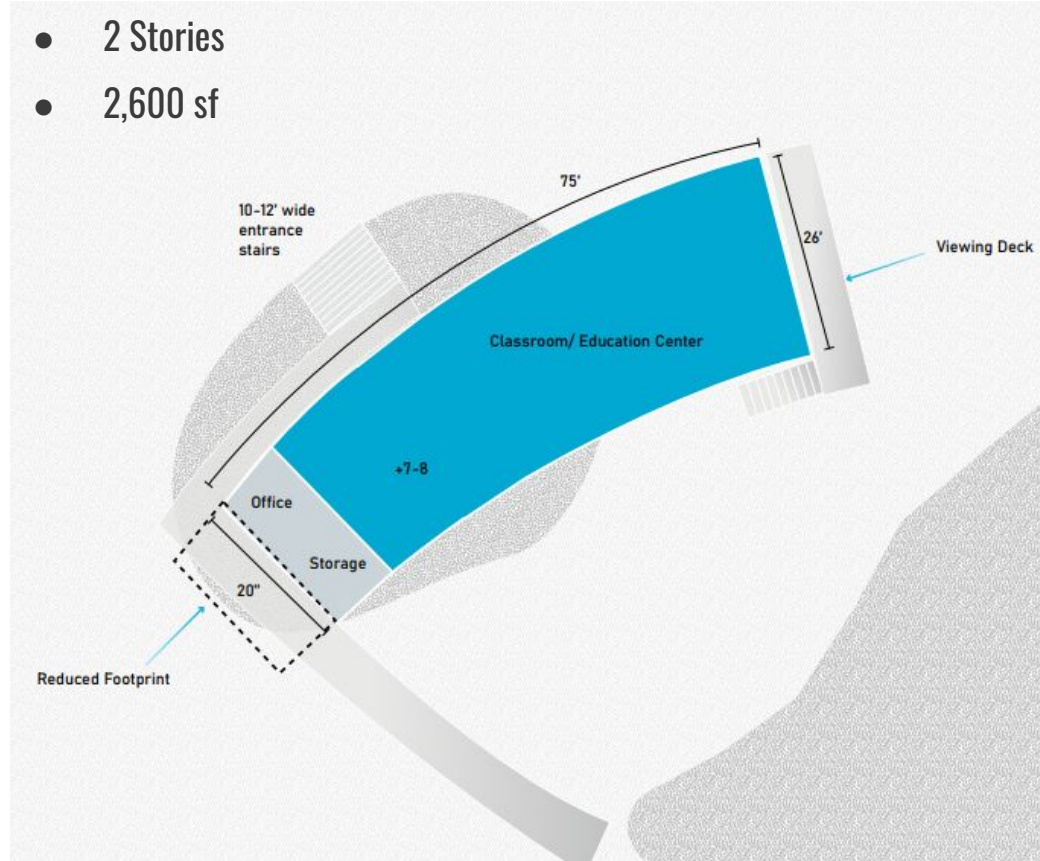
- High-performance envelope: triple-pane windows, external sun shading
- Ventilation: Heat recovery
- Heating/Cooling: Heat pump chiller to maximize heat recovery for heating
- All-Electric Ready
- 100% LED lighting design
- LEED Platinum

Embodied Carbon

- Structural concrete mix
- Low-carbon steel, rebar, decking
- Mineral wool insulation
- LEED Platinum

SMALL EDUCATION CENTER, MA

- 2 Stories
- 2,600 sf



STRATEGIES

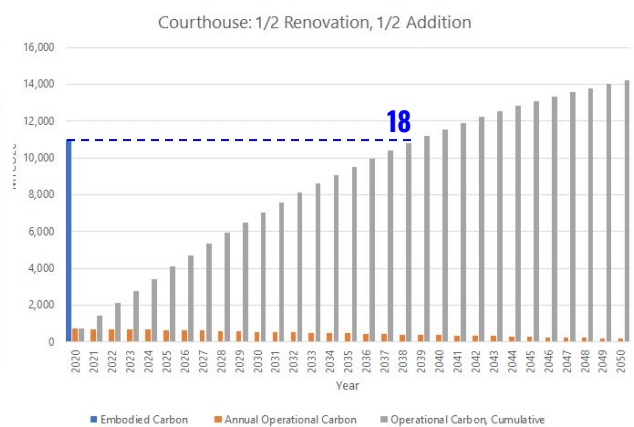
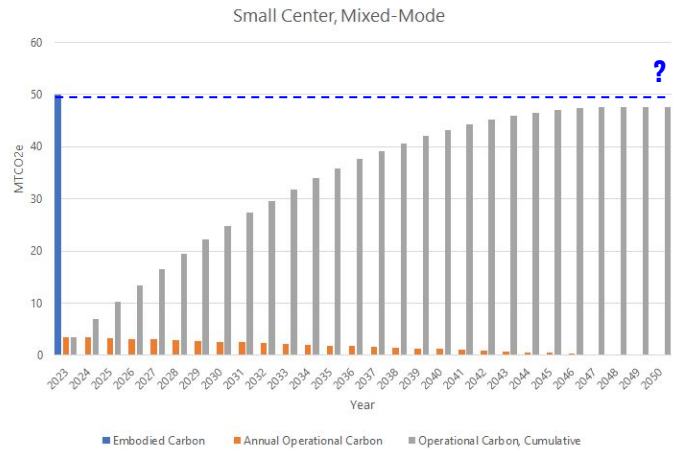
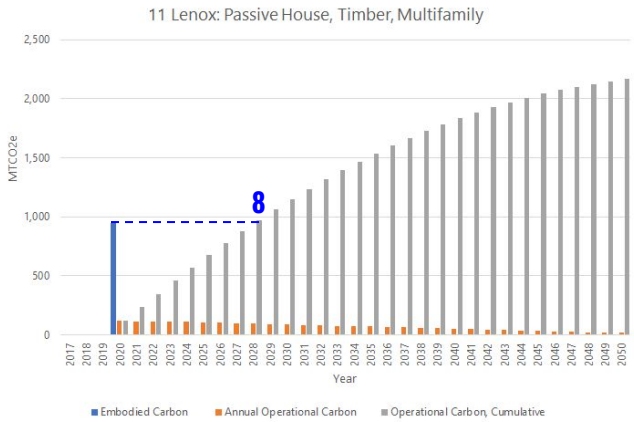
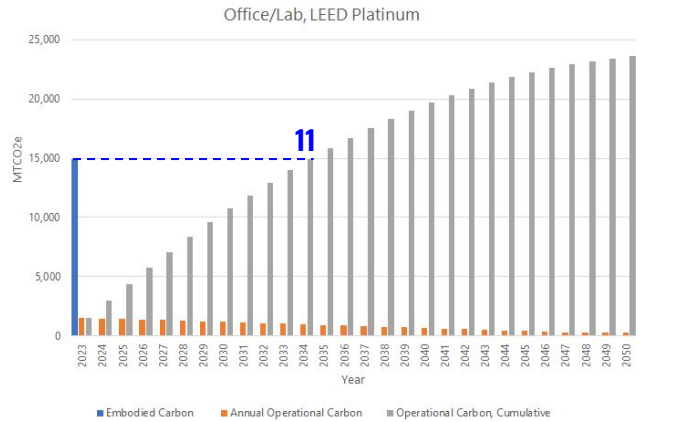
Operational Carbon

- High-performance envelope: robust insulation, external sun shading
- Natural ventilation strategies
- All-Electric: Heat pumps
- Energy Star appliances
- Rooftop Solar PV
- ILFI Zero Carbon

Embodied Carbon

- Timber structure, FSC
- Mineral wool insulation
- Design for disassembly
- Less aluminum extrusion profiles
- Concrete: CarbonCure, Maximum SCMs
- ILFI Zero Carbon

WHOLE BUILDING CARBON EMISSIONS: OPERATIONAL + EMBODIED



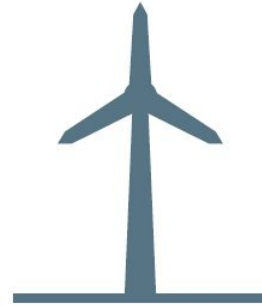
CARBON NEUTRAL



**LOW
EMBODIED
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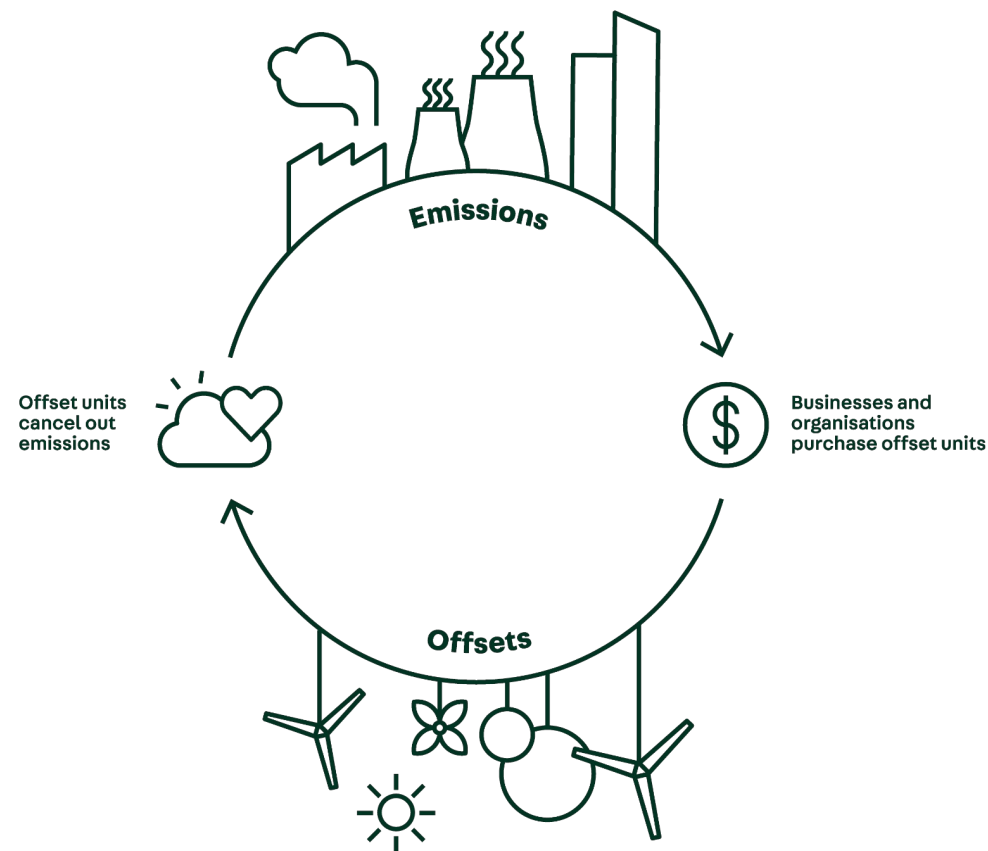


**CARBON CREDITS
+
RENEWABLE ENERGY**



0

HIGH QUALITY OFFSETS

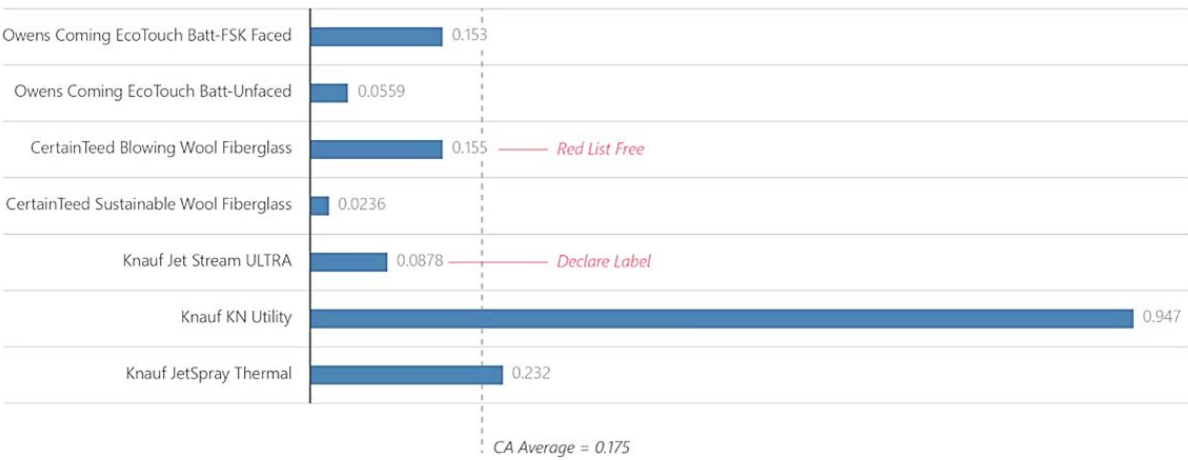


BUILDING DESIGN & HEALTH / WELLBEING

THEN

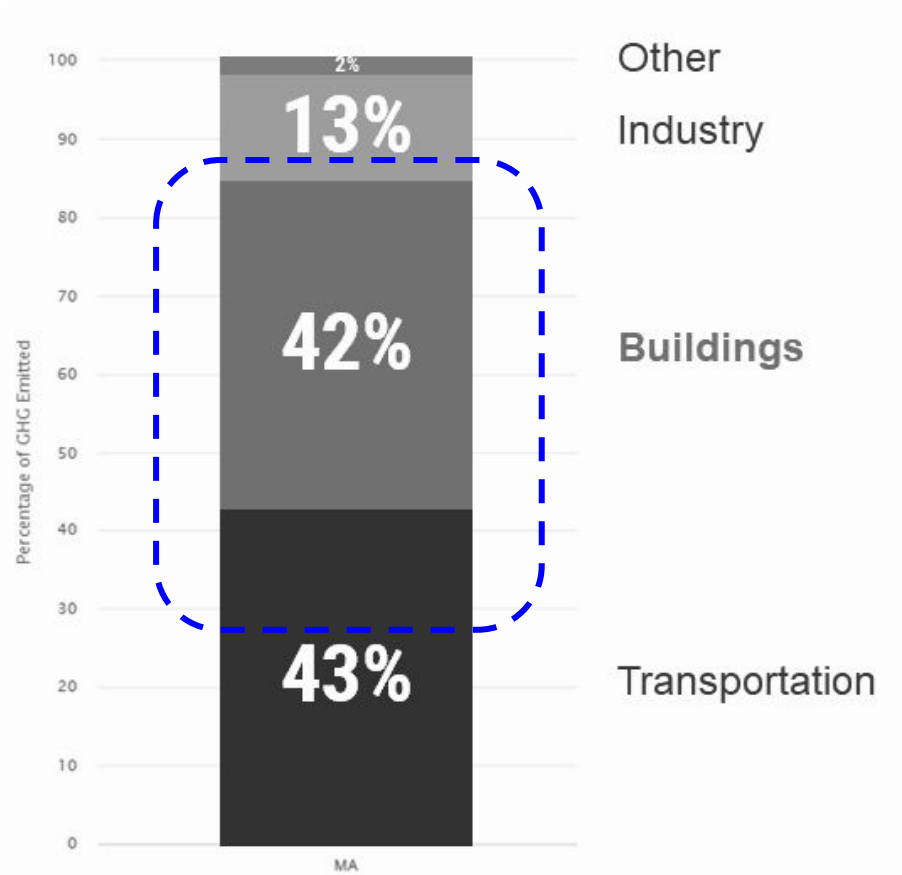


NOW



CARBON EMISSIONS: MASSACHUSETTS

OPPORTUNITY
FOR IMPACT



PANEL



Joseph Curtatone

Mayor of Somerville



Stephanie Ciccarello

Town of Amherst



Andrea Love

Cambridge Net Zero Task Force

EVERSOURCE



Kimberly Cullinane



Lisa Dobbs



Zero Carbon Buildings Municipal Summit



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