March 2024

EVERSOURCE

Utilities and Decarbonization: How It All Comes Together

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Agenda

A Roadmap for Decarbonization

Energy Performance Targets, New Construction & Decarbonizing the Built Environment

Decarbonizing Existing Buildings

A Roadmap for Decarbonization

In 2008, MA Legislature passed the Green Communities Act

- Made energy efficiency the first fuel
- Provided the legal and regulatory frameworks for Mass Save
- Challenged us to scale energy efficiency

We responded and delivered.

We have a lot to be proud of

Since 2012

3.7M Metric Tons CO_2 reduction

~15 TWH Saved

~Annual Output of 5 Brayton Points

~350,000

Homes weatherized

4.8¢ Per kWH

2021 Climate Act in MA, prioritizes Decarbonization (Electrification)

2030
50% below 1990

2040
75% below 1990

2050
Net Zero

2030 Goals

5.9 Billion Square Feet

~65% built before 1980

75%
RESIDENTIAL

25%
COMMERCIAL

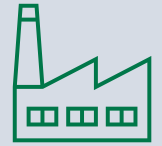
80-90%
USE FOSSIL FUEL FOR HEATING

Commercial Building Stock by Size

Very Small
[< 5k ft^2]

Small
[<5k-25k ft^2]

Medium
[25k-100k ft^2]



Large
[>100k ft^2]

~80% of Buildings:
~25% of sq. ft

~20% of Buildings:
~75% of sq. ft

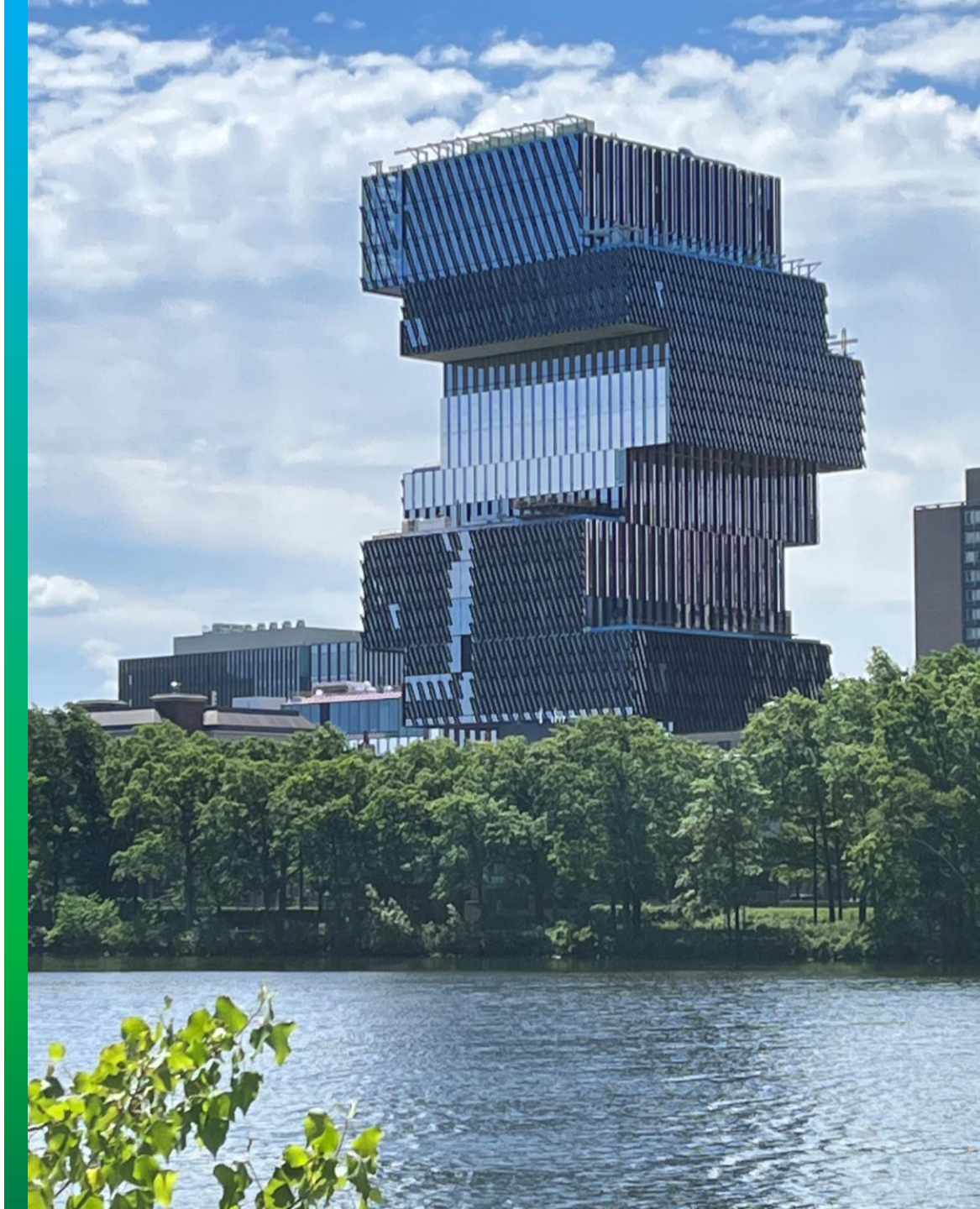
KEY QUESTIONS

1. What does this cost, and how do we pay for it?
2. What does a decarbonization roadmap look like?
3. What about rate design to send appropriate pricing signals
4. How do we ensure affordability?
5. Can the Electric Grid handle it?

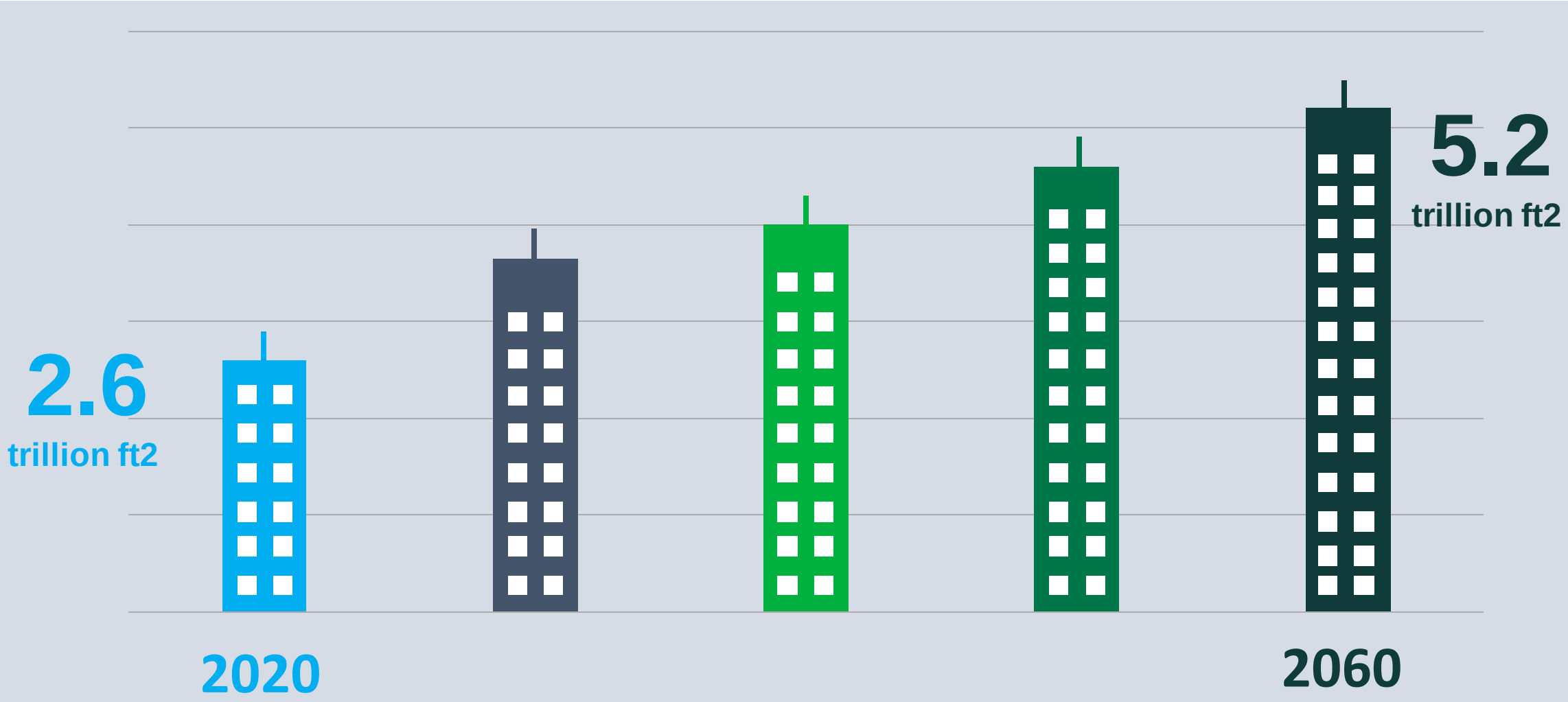
Energy Performance Targets, New Construction and Decarbonizing the Built Environment

Significant Strides in New Construction

- New homes and buildings **- all-electric** now required to qualify for Mass Save® support
- Nearly 15 million square feet of **Passive House Multi-Family** projects enrolled
- 5 million sf of net zero ready, ultra low energy **K-12 schools**, including 15 installing ground source heat pumps
- Numerous other **best-in-class buildings** – e.g., BU Data Science Center (right), DCAMM's Chelsea Soldiers' Home, Winthrop Tower



Global Building Floor Area to Double by 2060



Source: International Energy Agency, "Global buildings sector CO_2 emissions and floor area on the Net Zero Scenario, 2020-2050". 2060 floor area assumes projected trends would continue.

Drivers of Low Carbon Buildings

Incentive Programs

energize CONNECTICUT

mass save

NHsaves

Advancing Technologies

Heat Pumps

Induction Cooking

State & Local Policy

Energy Codes/ Stretch Codes

•

MA Climate Act and Other State Legislation

•

Building Perf. Standards

Federal Policy

INFLATION REDUCTION ACT OF 2022

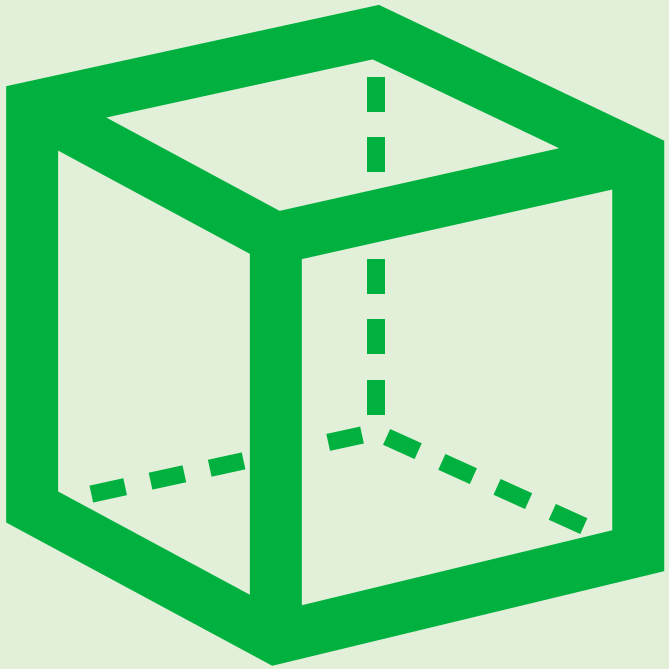
Biden's Goal: Net zero emissions economy by no later than 2050

Hurdle: Current Practice

STANDARDS
REGULATIONS
INCENTIVES
CERTIFICATIONS

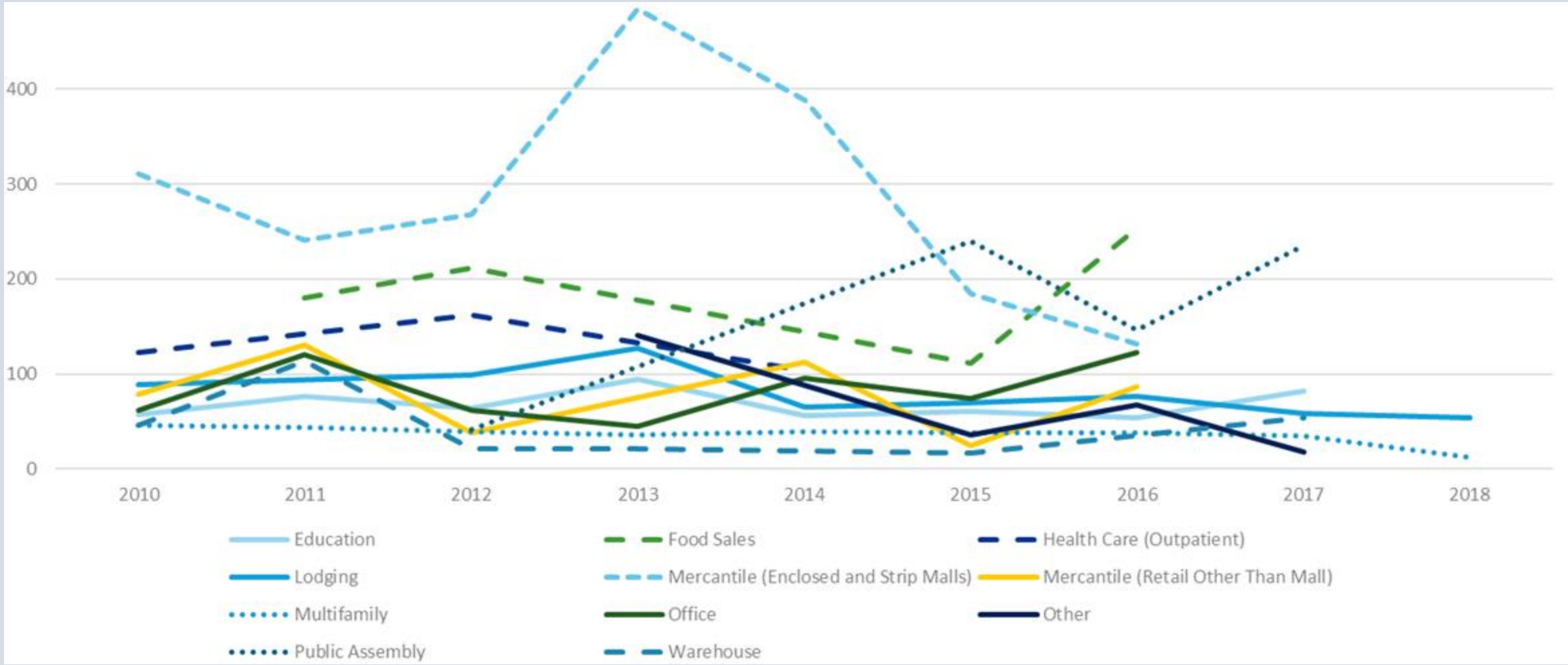
=

Energy Model



Percent reduction relative to a theoretical baseline

Average EUIs in Massachusetts for Building types Greater than 50,000 SF



Performance Targets Lead to Better Buildings

Set **clear expectations** among project team members

Drive **energy efficient and low carbon outcomes**:

- Load Reduction
- Energy efficiency and equipment optimization
- Efficient electrification of building systems

Align with **net zero and use of renewable energy sources**

Eversource Support Path 1: Net Zero & Low EUI Buildings

ACTON-BOXBOROUGH DOUGLAS-GATES ELEMENTARY SCHOOL
Opened Fall 2022 | All-electric

Intent: Focus On Performance

- Drive projects toward net zero, low carbon and low EUI in operation

Key Program Drivers: EUI And Low Carbon

- Target an ultra-low site EUI throughout design, construction and into first year of occupancy
- Building decarbonization

Net Zero Technical Support

- Net zero design support
- Mass Save Sponsors will pay 50% up to $10,000
- Mass Save Sponsors will pay for optional Verification Incentive - 50% of fee up to $10,000

Setting EUI Targets – Input

EUI by Building Type	
Building Type	**Net Zero Level EUI Targets**
Hotel	Tier 1: 35 or less Tier 2: 36-40
K-12 School	Tier 1: 25 or less Tier 2 (high schools only): 26-29
Library	Tier 1: 30 or less Tier 2: 31-35
Office	Tier 1: 30 or less Tier 2: 31-35
Fire/Police Station	Tier 1: 35 or less Tier 2: 36-40
Other Sectors	Use 25 or set unique target

Combined Knowledge and Experience

City of Boston Data

New Buildings Institute Data

Eversource Project Experience

Path 1: Zero Net Energy/Deep Energy Savings

Territory	Construction	Post Occupancy	Heat Pump Adder
	Up to $2.50/sf	$1.50/sf	Air Source Heat Pumps: $640/ton ($400,000 cap) Variable Refrigerant Flow (VRF): $1,000/ton ($500,000 cap) Ground Source Heat Pumps: $4,000/ton ($600,000 cap)
	Up to $2.00/sf	$1.50/sf	Air Source Heat Pumps: $800/ton Variable Refrigerant Flow (VRF): $1,200/ton Ground Source Heat Pumps: $4,500/ton
	Up to $1.50/sf	$1.00/sf	N/A

Results: Massachusetts Path 1 Projects by Type

Path 1 Projects	Project Count	Square Footage
K-12 Schools	30	4,988,653
Public Safety	3	68,145
Library	6	223,877
Office	2	114,280
College or University	2	217,000
Other	10	865,114
Total	**53**	**6,477,069**

Results

Five Path 1 projects through construction in MA; 1 in CT, 1 in NH

Early data suggest projects are tracking **at or under their target EUI** in operation

Where improvements are needed, troubleshooting and **corrective action are taking place early**

Advantages

Policymakers

More direct mechanisms to meet carbon goals

Future-proofing new construction

Designers

Streamlined design and analysis

Informs better designs through data

Owners

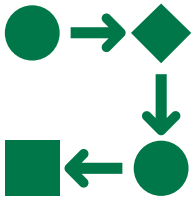
Sets clear expectations for the design team

Better building performance

Challenges

Less flexible for unique project types

More effort post occupancy



Accurately modeling occupancy and equipment schedules takes more effort

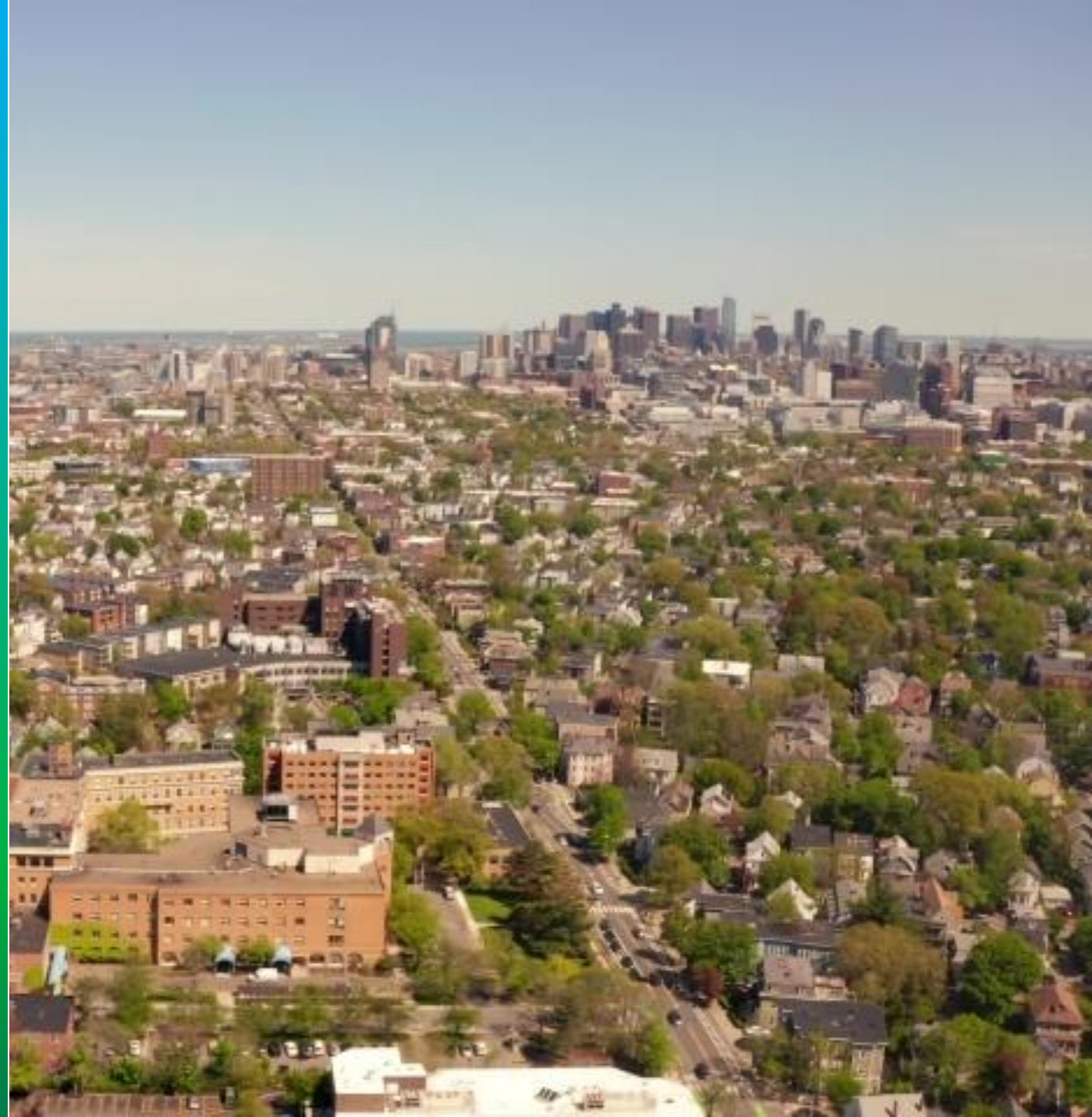
KEY TAKEAWAYS

- Set measurable energy or carbon intensity targets as early as possible in design process
- Track progress toward the targets throughout design
- Measure results post construction and take corrective action where needed
- Integrate lessons learned into future designs
- Fully train and engage building occupants and operators

Decarbonizing Existing Buildings

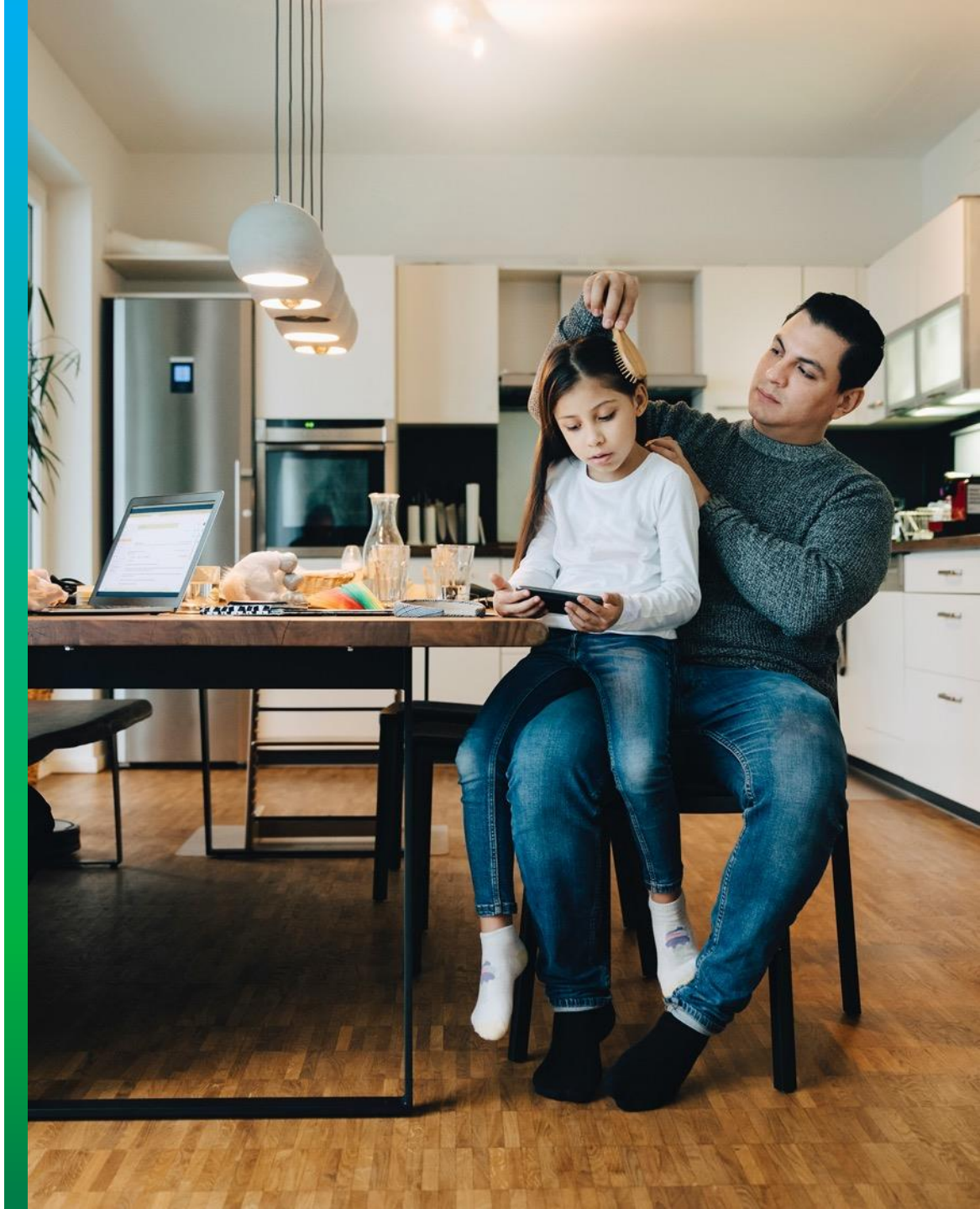
Existing Buildings Are Key

Over 80% of the current buildings will exist in 2050



We Have Begun Transforming the Residential Heating Market

- Established Heat Pump Installer Network with **1,500+ qualified HVAC companies** in Massachusetts
- Promoted network at approximately **100 in-person industry events**/trainings.
- **2,000 + customer consultations** completed.
- **4,000 + contractor trainings** through our eLearning Centers
- **1,500+ heat pump quality inspections** completed.



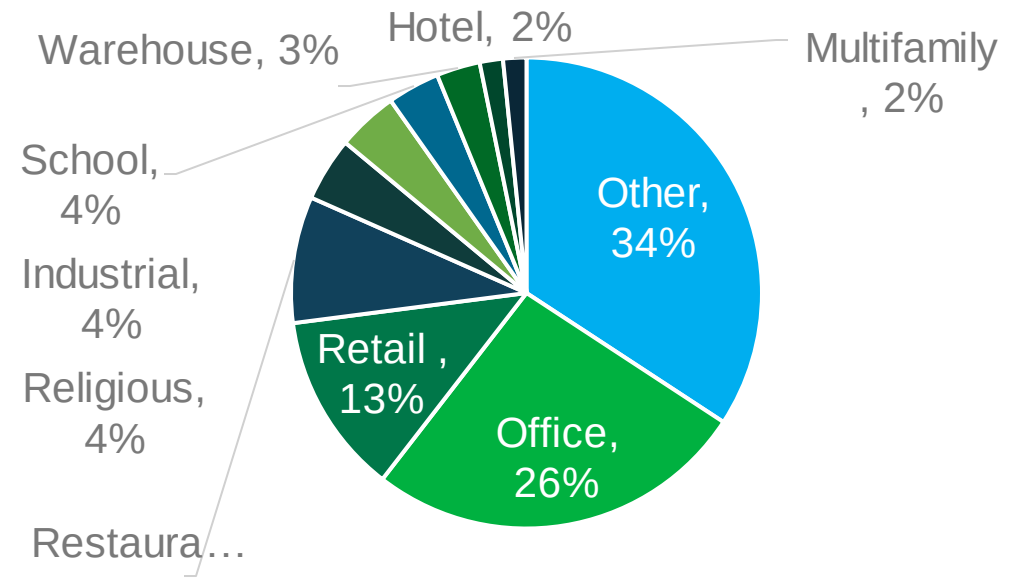
Small Commercial

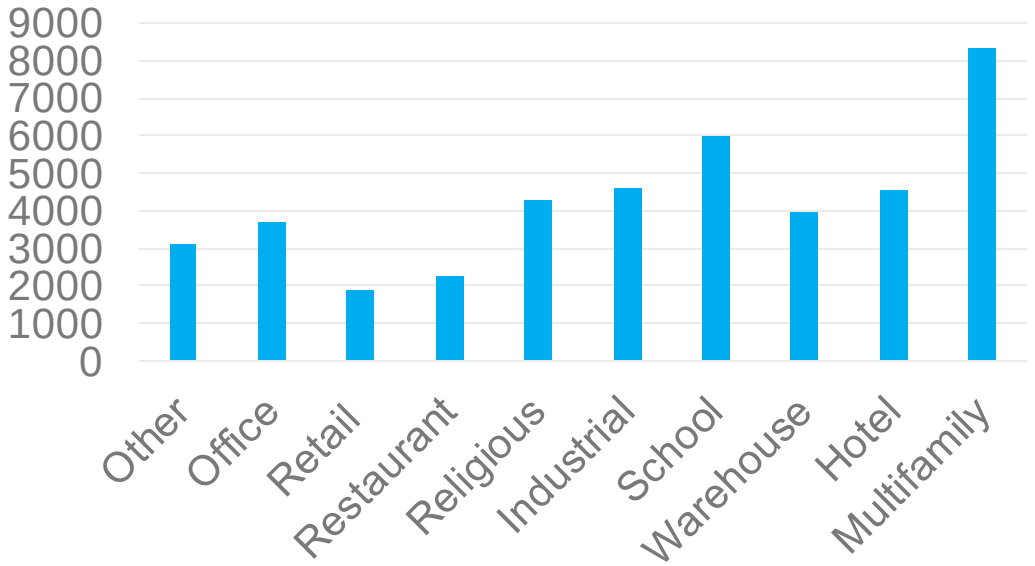
Lots of small, almost residential scale buildings – small offices, restaurants, religious, retail, service






Prescriptive HP Projects by Building Type





Avg HP Project SqFt by Building Type

Large Commercial

Small number and **large footprint**

Complex systems, **pre-defined workspace**

Internal and external **motivation**

Energy Efficiency

Reducing waste is the most effective decarbonization tool

Lower loads = less clean energy needed

Strong value proposition (R.O.I.)

Common HVAC Configurations

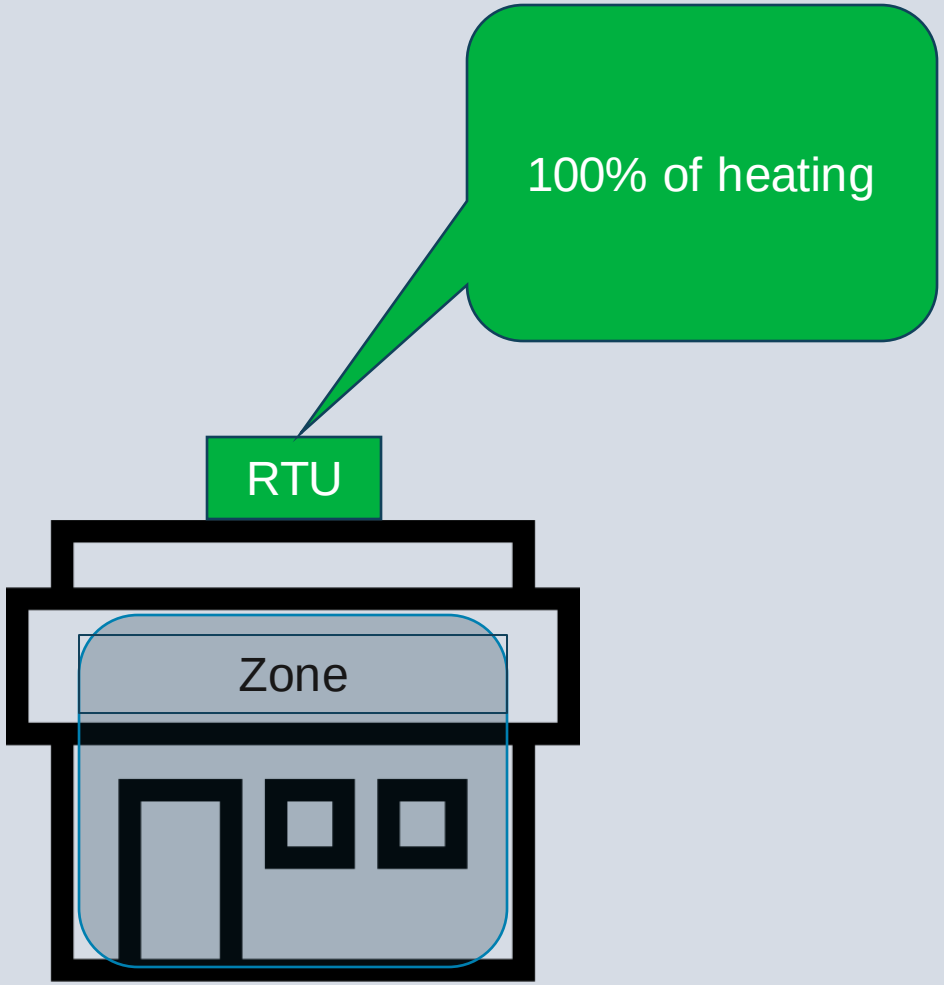
Roof Top Units (RTU) single-zone

Building Types

- Big Box Stores
- Retail
- Restaurants
- Strip Malls
- Warehouses

Considerations for Electrification

- Hybrid solutions only
- Align with replacement timeline
- Electrical infrastructure



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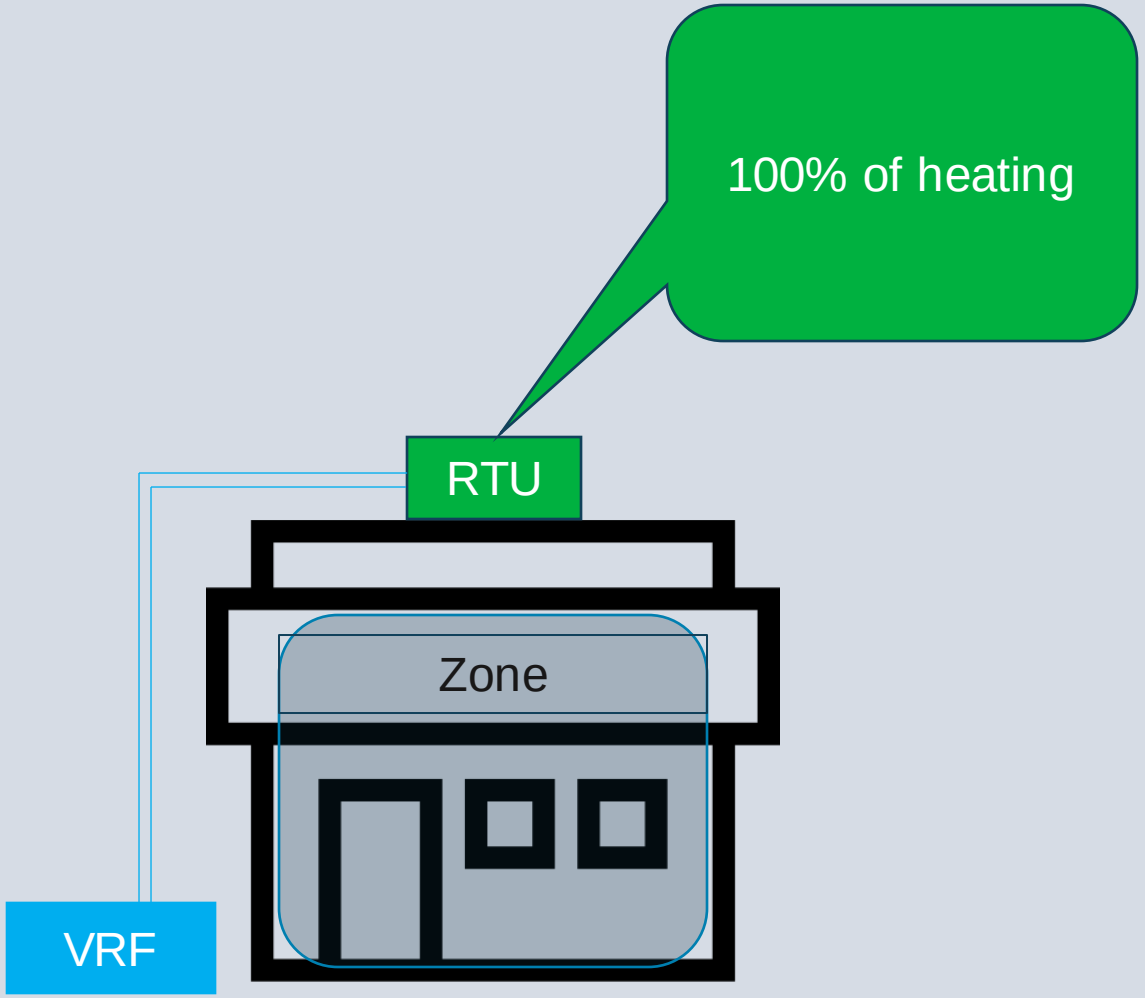


Common HVAC Configurations

Roof Top Units (RTU) & Terminal Units (TU)

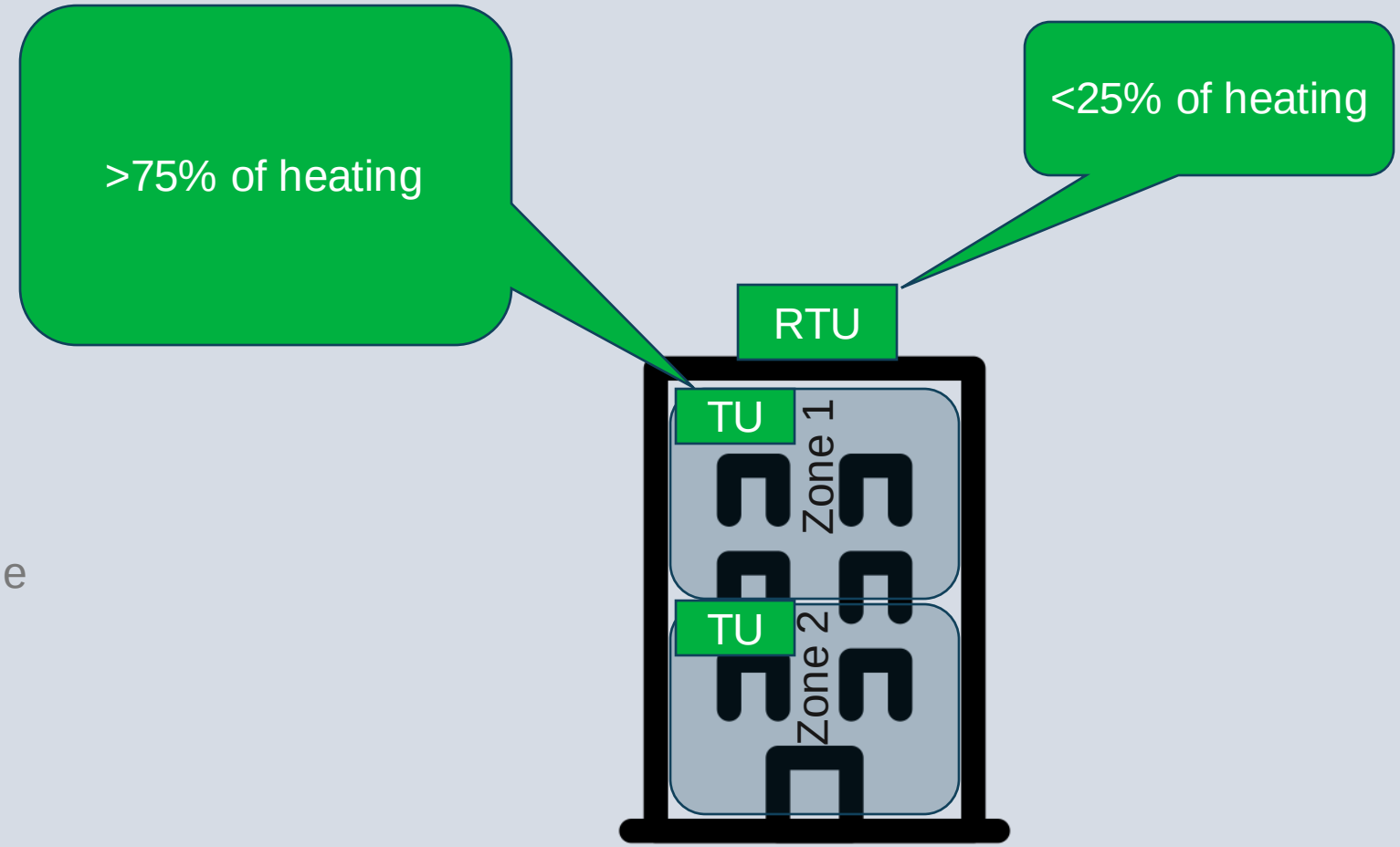
Building Types

- Office Buildings
- Hospitals
- Municipal Buildings

Considerations for Electrification

- Roof Top Unit
  - Hybrid solutions only
  - Align with replacement timeline
  - Electrical infrastructure

- Terminal units
  - Disruptive and costly retrofit
  - Electric resistance heating



Common HVAC Configurations

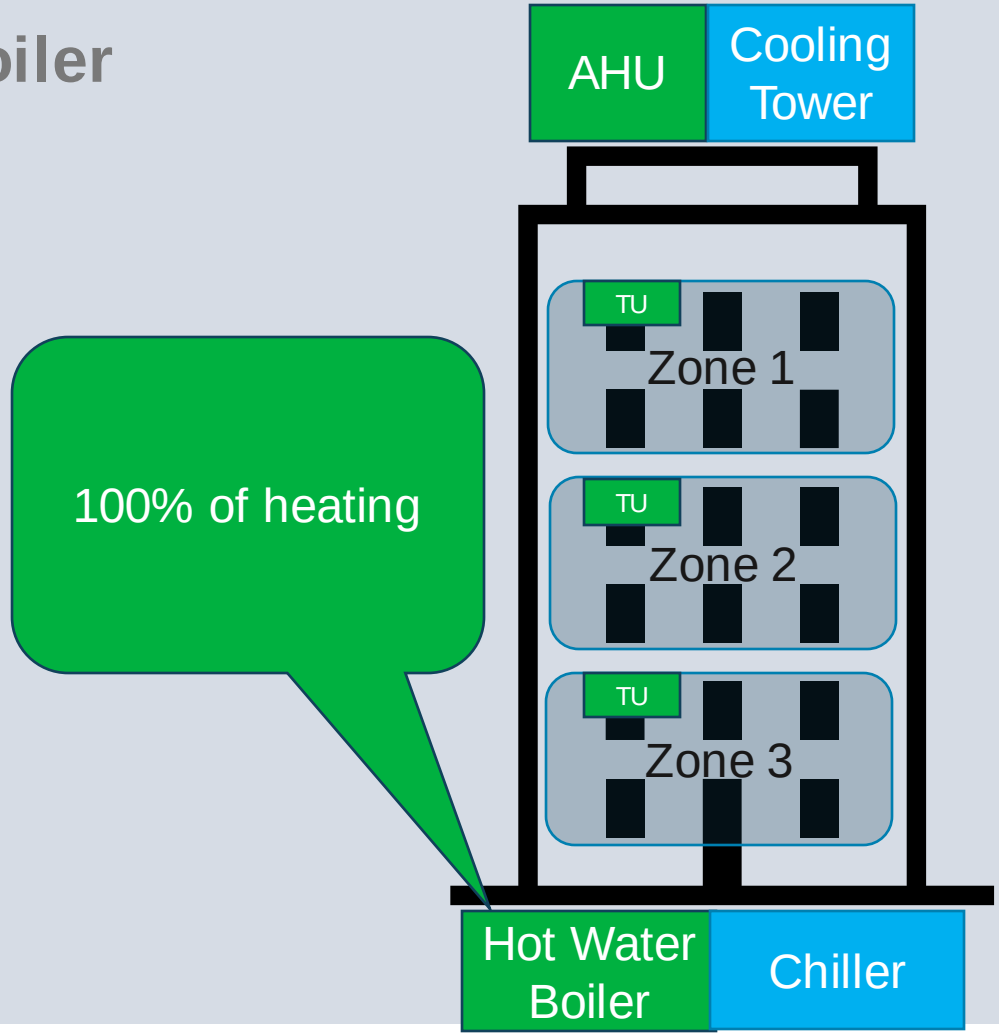
Air Handling Unit (AHU) with chiller and boiler

Considerations for Electrification

- System design parameter
  - 180F hot water supply
- Must align with replacement schedule
- Heat recovery
  - Exhaust air
  - Chiller waste heat

Building Types

- Large Office Buildings
- Hospitals
- Labs
- Schools*
- Public Buildings*
- Dormitory*



*may be heating only

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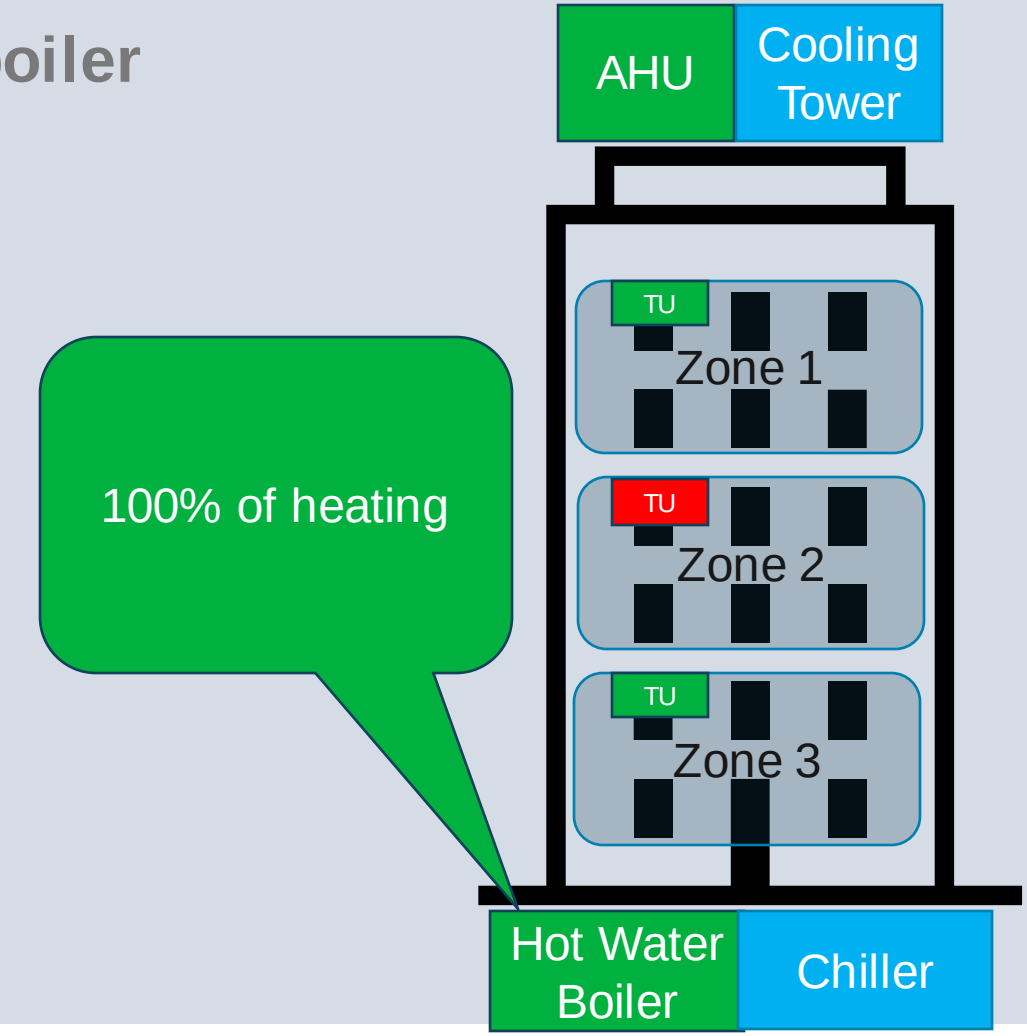


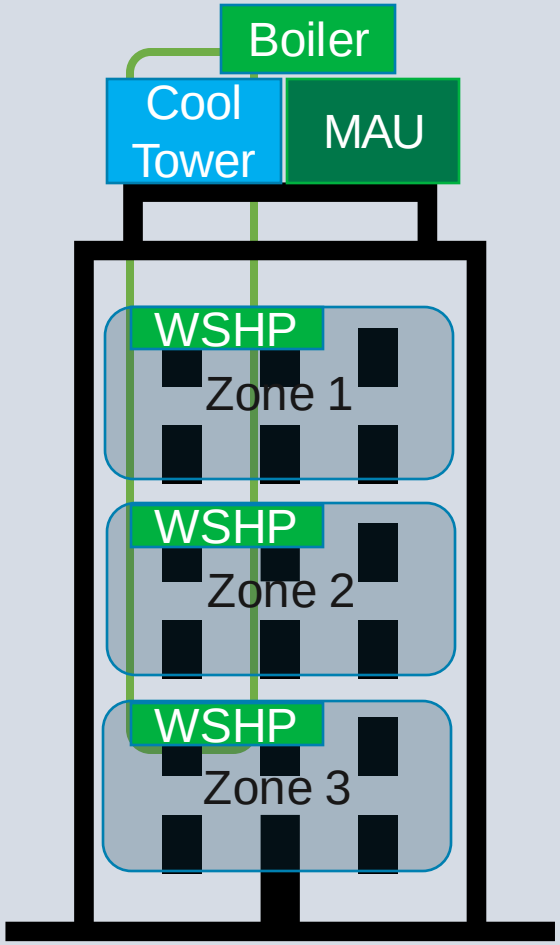
*may be heating only

Common HVAC Configurations

Water source heat pumps (WSHP) and Make up air unit (MAU)

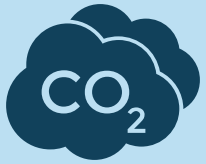
Considerations for Electrification

- Water loop temperature < 100F
- Limited decarbonization potential
- Electrical infrastructure



Elementary School
Electrification Opportunities Beyond Space Heating

Full Electrification
1 School



2,678 tons

$2.45M installed cost

Two measures:

Energy recovery on ventilation air ($0.85M)

Space conditioning ($1.6M)

VS

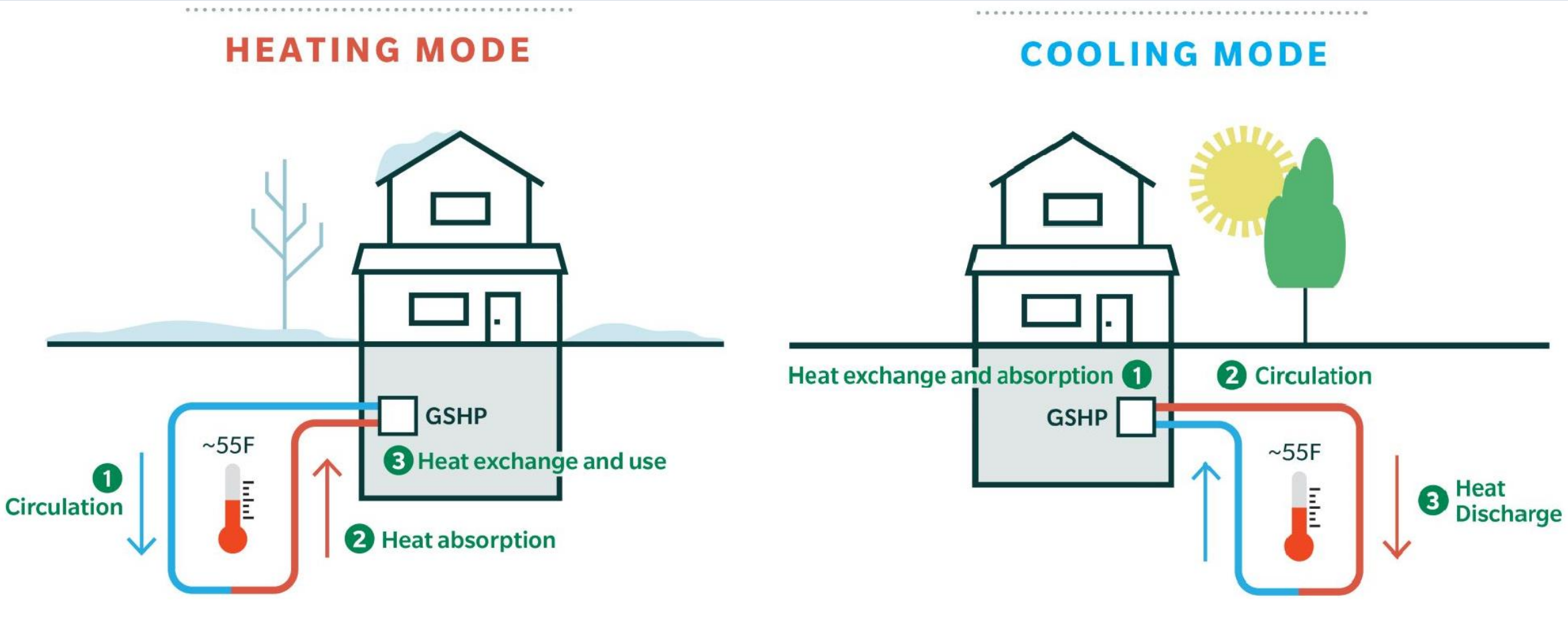
Selective Electrification
3 Schools

3,666 tons

$2.55M installed cost

Energy recovery on ventilation air

Geothermal: Ground Source Heat Pump



School HVAC Replacement

Option	Estimated Gross Install Cost	Estimated Utility Incentives	Estimated Federal Incentives	Estimated net install cost
Replace in-kind (oil boiler)	$1.15M	$0	$0	$1.15M
Ground-source heat pump	$3.65M	$0.962M	$1.825M	**$0.863M**

Non-Energy GHG Reducing Measures

Decarbonize Today – **Carbon Capture and Sequestration (CCUS)**

CHP market potential

- ~125 CHPs in the MA
  - emitting ~4M metric tons CO_2e annually
- Customers with newer systems unlikely to abandon them so early
- Reducing thermal load via partial electrification reduces efficiency

Non-Energy GHG Reducing Measures

Decarbonize Today **CCUS example (CHPs)**

CAPTURE
carbon from CHP exhaust

TRANSPORT
liquified carbon
< 200 miles

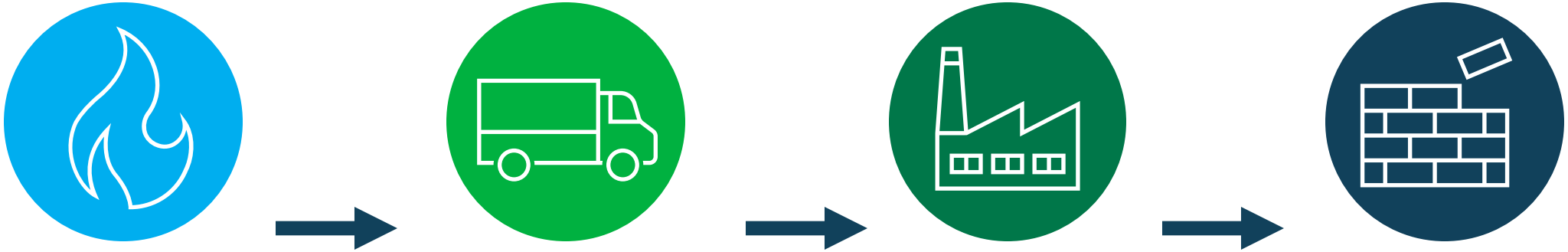
UTILIZATION
in concrete manufacturing at local plant

Carbon Capture, Utilization and Sequestration (CCUS)

- Target “hard to electrify” uses → CHPs and fuel cells
- Market in infancy; scalability TBD

Non-Energy GHG Reducing Measures

Decarbonize Today **CCUS example (CHPs)**



CAPTURE
carbon from CHP exhaust

TRANSPORT
liquified carbon < 200 miles

UTILIZATION
in concrete manufacturing at local plant

EMBODIED CARBON
reduction in construction materials

Carbon Capture, Utilization and Sequestration (CCUS)

- Target “hard to electrify” uses → CHPs and fuel cells
- Market in infancy; scalability TBD

Non-Energy Reducing GHG Measures

- Carbon capture, sequestration, and utilization
- Embodied carbon of building materials
- Gas leak mitigation
- Refrigerant leak mitigation and swap out

Questions