Creating A Clean, Affordable, Equitable and Resilient Energy Future For the Commonwealth

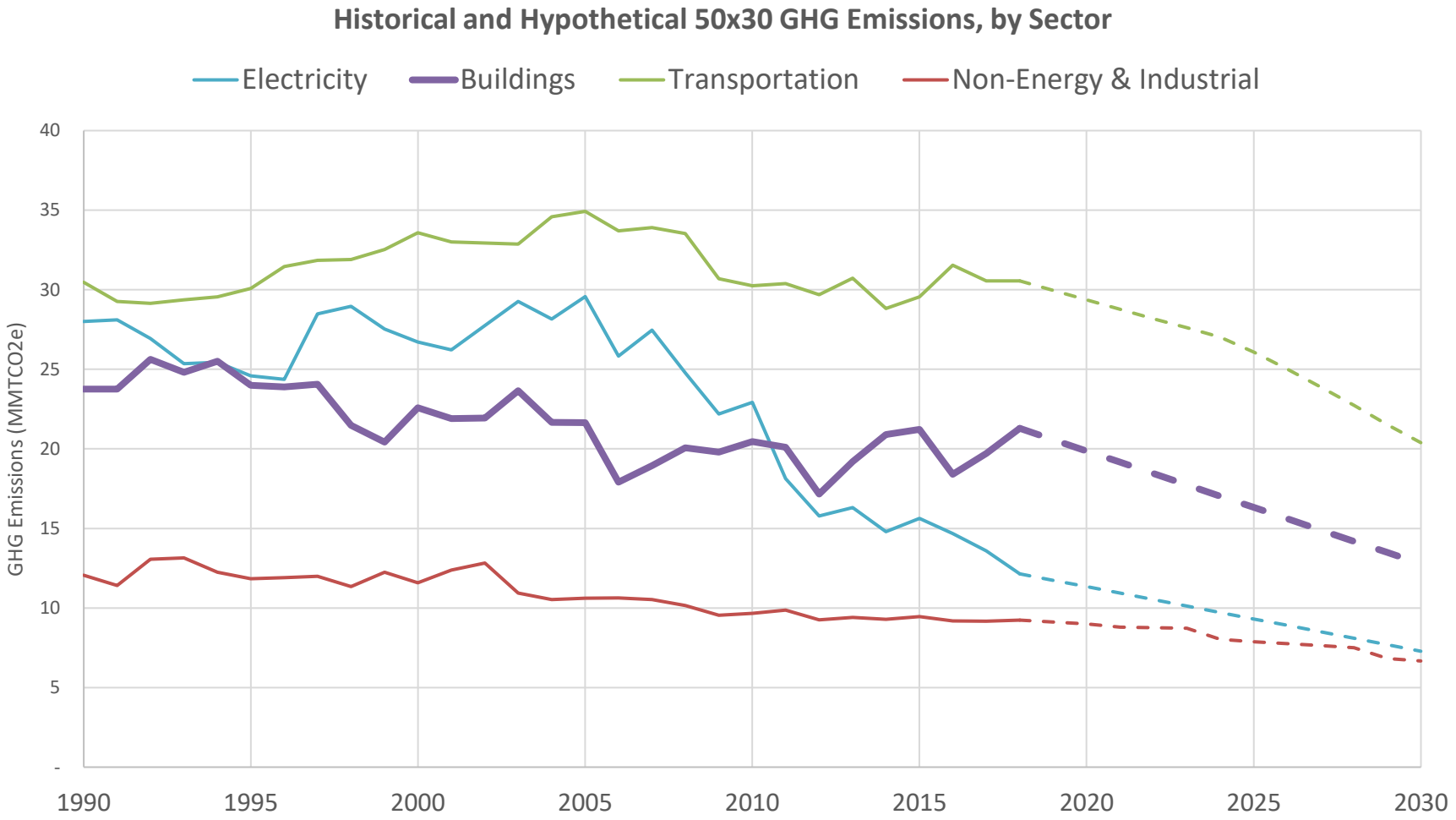
COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENERGY RESOURCES
Patrick Woodcock, Commissioner

Building Energy Code Straw Proposal: Updated Stretch Code & Specialized Opt-In Code

February 2022

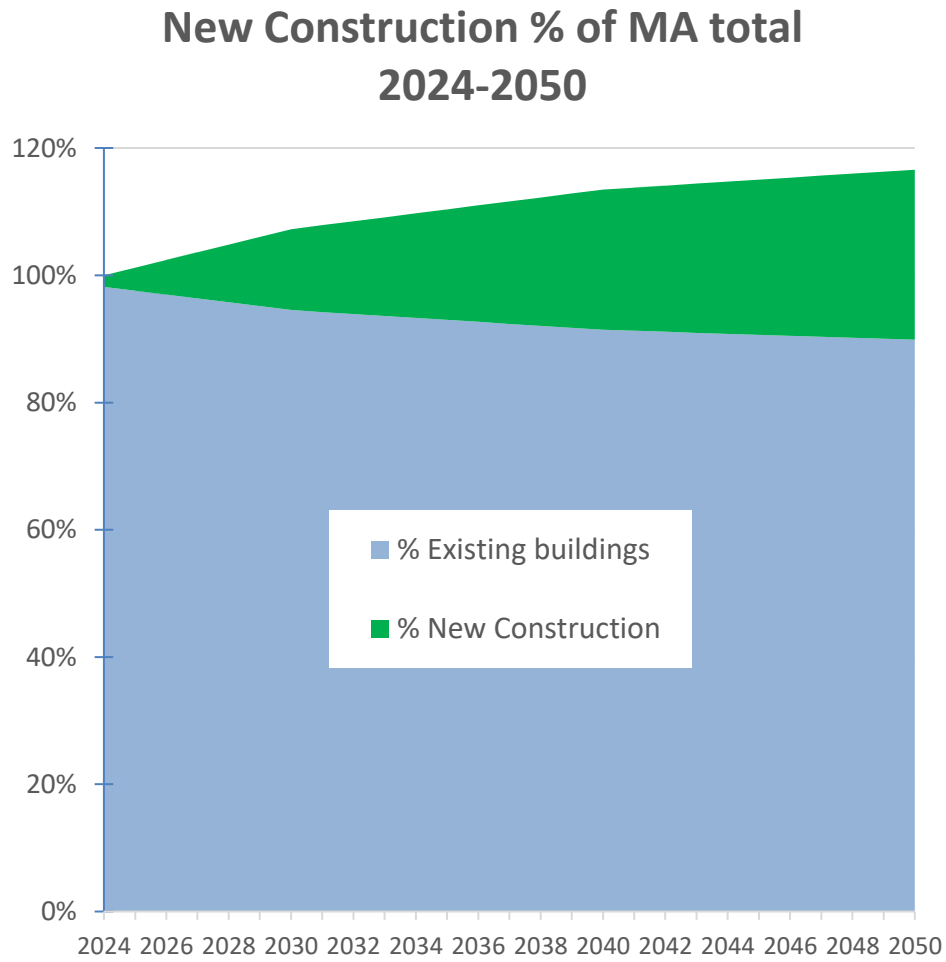
Climate context: MA Emissions by Sector

- **Historical:** Building sector emissions have made modest progress; electric sector has made most progress in decreasing emissions
- **Going forward**: Need reductions across all sectors by 2030 and beyond
- More than **50% of emissions reductions we need to cut by 2050** will come from personal vehicles and residential space heating



Building Energy Code role in reducing emissions

- Building code is the primary policy impacting new buildings.
- New buildings (built after 2023) ~27% of all building space by 2050
- New buildings are easiest and cheapest to make 2050-compliant
- New construction market helps drive cost reductions in building retrofits.



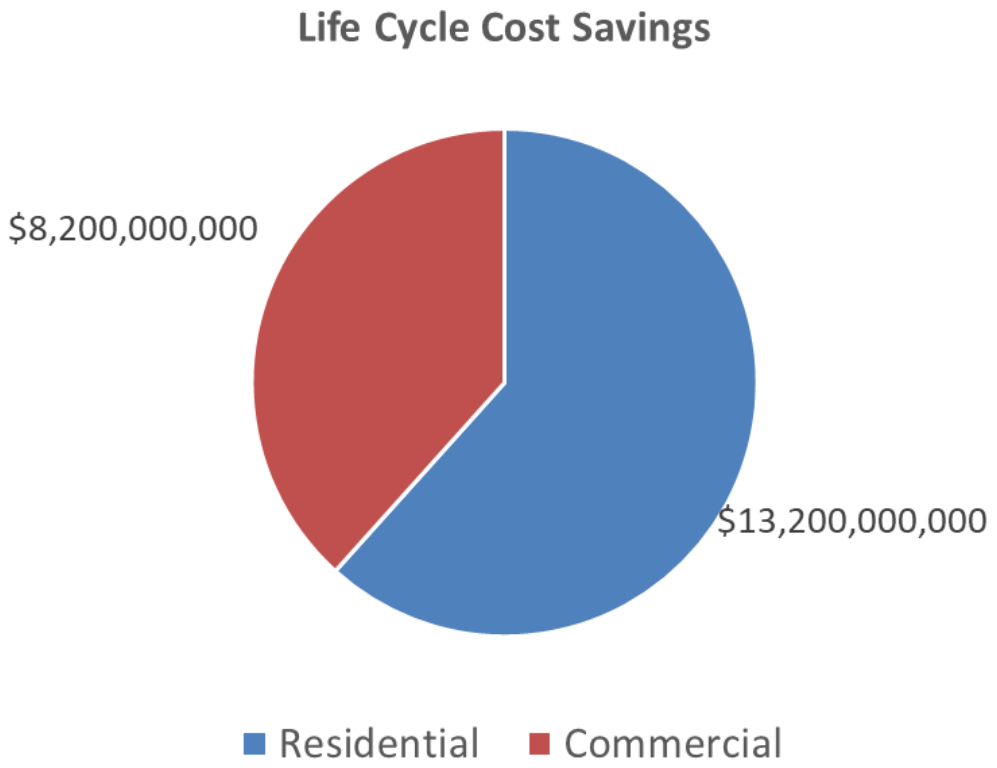
DOER Straw Proposal – Economic and Emissions Impact

- **DOER is proposing two updates:**
  - Update Stretch Energy Code, align with timing of the base energy code update
  - Issue new Specialized Opt-in Code as required by 2021 Climate Roadmap legislation by Dec 2022

- **500,000* tons/year** of GHG reductions in 2030,
  - rising to 694,000 tons/year by 2035
  - Other economic, health, resiliency and grid benefits

- **Over $21 Billion** in life cycle cost savings (combined construction and operating costs)

*Note: Emissions reduction and cost savings forecasts are conservative as they currently do not account for any solar PV additions to new construction or methane leakage from natural gas supply and use.



Straw Proposal for Comment

DOER is seeking comments on its Straw Proposal updating the Stretch Energy Code and Proposing the new, Specialized Stretch Energy Code.

DOER highly encourages written comments be submitted electronically to **stretchcode@mass.gov** with the subject line “Stretch Code Straw Proposal Comments”. Responses will be accepted until 5 pm on **March 9, 2022**. Written comments may also be submitted via mail to the Department of Energy Resources, 100 Cambridge Street, Suite 1020, Boston, Ma 02114, attention Nina Mascarenhas.

ENERGY CODE BACKGROUND

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Building Energy Code in MA state law

2008 Green Communities Act

- **Base Energy Code**:

"To adopt and fully integrate the latest International Energy Conservation Code (IECC) and any more stringent amendments thereto as part of the state building code, in consultation with DOER."

MGL CH143, Section 94(o)

- Created DOER Green Communities Program and **Stretch energy code**:

"minimize, to the extent feasible, the life-cycle cost of the facility by utilizing energy efficiency, water conservation and other renewable or alternative energy technologies."

MGL CH25a. Section 10(c)

2021 Climate Act

- 50% emission reduction in 2030 (sub-limits to be established for buildings sector)
- DOER to **update the Stretch Code** from time to time, in consultation with BBRS
- DOER to develop: a **municipal opt-in specialized stretch energy code** that includes:
  - net-zero building performance standards
  - a definition of net-zero building
  - designed to achieve MA GHG emission limits and sub-limits.
  - may by phased in by building type

Session Laws of 2021 Chapter 8: Section 31

Statutory Timeline

- **July 2022**: EEA must establish specific 2025 and 2030 emissions reduction targets for the buildings sector
- **December 2022**: DOER must promulgate new specialized opt-in code
- **January 2023**: New Base Energy Code expected to go into effect
- **2030**: Massachusetts must achieve at least 50% reduction in GHG emissions

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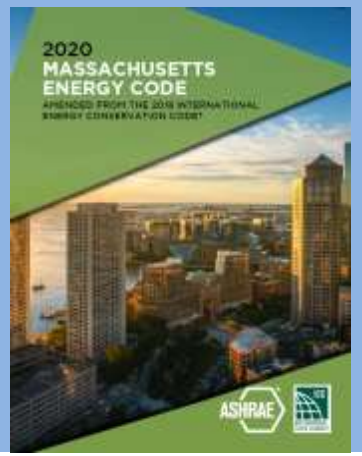
Today - two options for cities and towns:

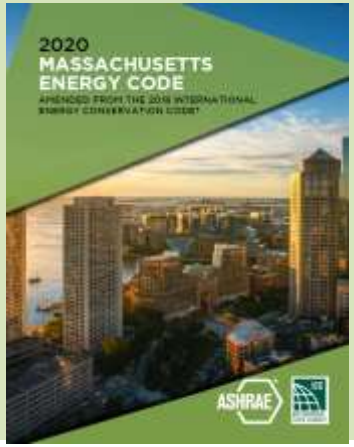
Base Energy Code

52 municipalities that are not designated Green Communities



Stretch Energy Code

299 municipalities that are or plan to become a Green Community



Base energy code last updated February of 2020, Stretch code last updated in January of 2017

One integrated MA energy code book viewable on the ICC website

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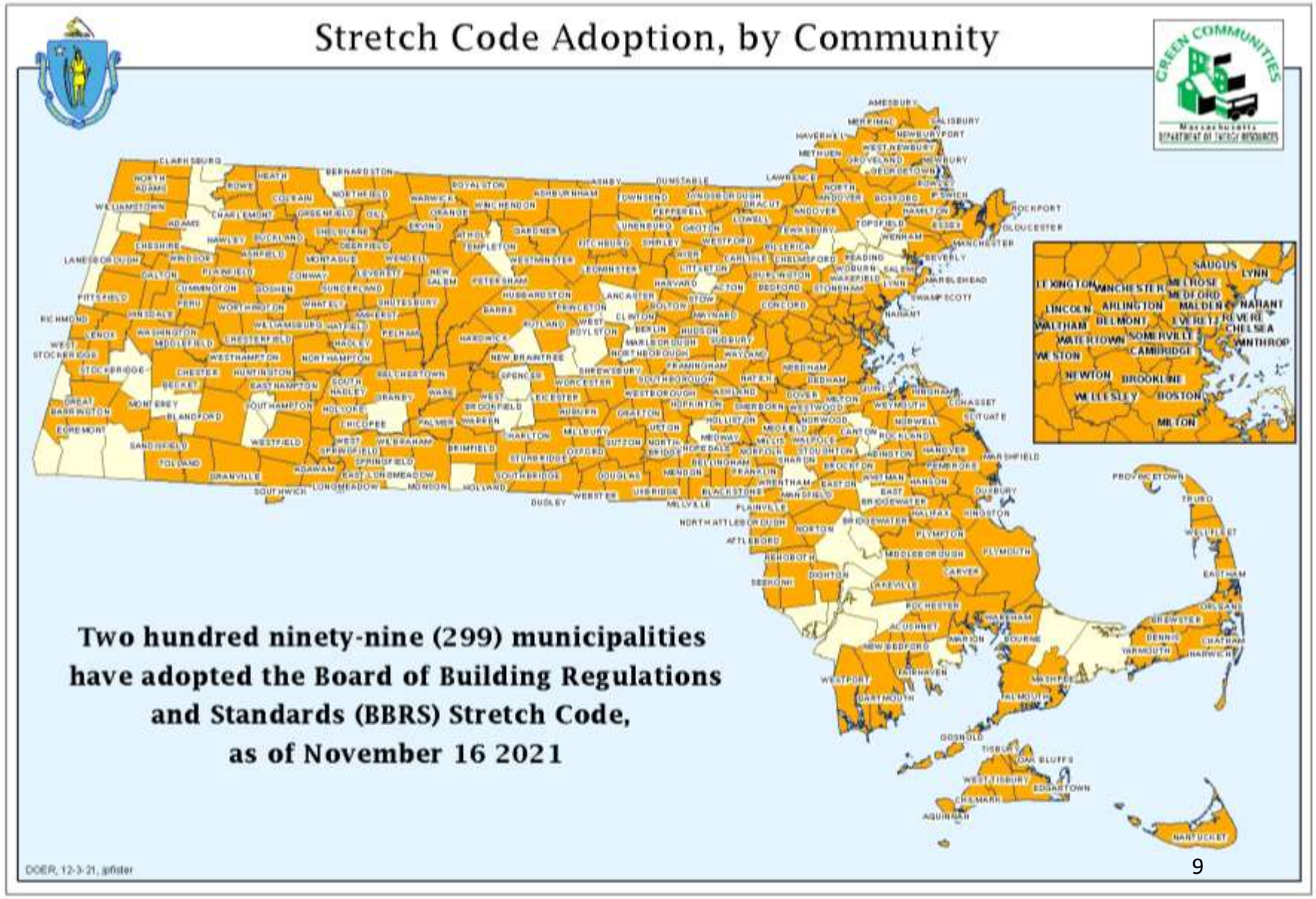
Today: Base code or Stretch code



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Starting in 2023 – 3 Energy Code options:

This straw proposal includes an update to the stretch code alongside the new specialized stretch option for Municipalities

Base Code
(10th Edition of MA Building Code)

- New Buildings in towns and cities that have not adopted a stretch code
- 52 communities
- BBRS update effective in 2023

Stretch Code
(Update)

- New Buildings in towns and cities that adopted, including all green communities
- 299 communities
- DOER update effective in 2023

Specialized Opt-in
(New Code Option)

- New Buildings in towns and cities that choose to opt-into this code
- Available for adoption Dec 2022

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Expected Timeline for code adoption

	Winter 2022	Spring 2022	Summer 2022	Fall 2022	Winter/Spring 2023	Summer 2023 and beyond
Updated Base Code	Draft on BBRS 10th edition code webpage		BBRS Public hearing on 10th edition	BBRS vote on final 10th edition	**Effective Jan. 2023** as part of 10th edition Code (MA IECC 2021)	
Updated Stretch Code	Outreach, public hearings, and comments on straw proposal	Draft code language available for public comment	Public hearings on draft code	Finalize code proposal & Publish Code	**Effective Jan. 2023** to align with 10th edition	Phase-in HERS requirements in Dec 2023
New Specialized Opt-in Code	Outreach, public hearings, and comments on straw proposal	Draft code language available for public comment	Public hearings on draft code	Finalize code proposal & Publish Code	**Finalized Dec. 2022 -** Municipal adoption begins	Likely effective dates - July 1, 2023, Jan 1, 2024

Goal of Analysis: Achieve Least-Cost Decarbonization

Energy Code Analysis

- In 2019, DOER commissioned analysis of different building code standards specific to the Massachusetts climate.
- Building Type Variety: 12 building use types and size-specific analysis to align with needs of different building types
- Analyzed up-front costs, operational costs, and total cost of ownership.

Residential Low-Rise Team

PERFORMANCE SYSTEMS DEVELOPMENT

NORESCO

Commercial & Large Multi-Family Team

Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

BRA+

BURO HAPPOLD

CONSIGLI
Est. 1905

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12 Building types for in-depth analysis

- Small office
- Large office
- Office-lab
- Elementary school
- High school
- High rise multi-family tower
- 4 story multi-family
- Multi-family mid-rise podium
- 6-unit multi-family
- Townhouse
- Single family Small
- Single family Large

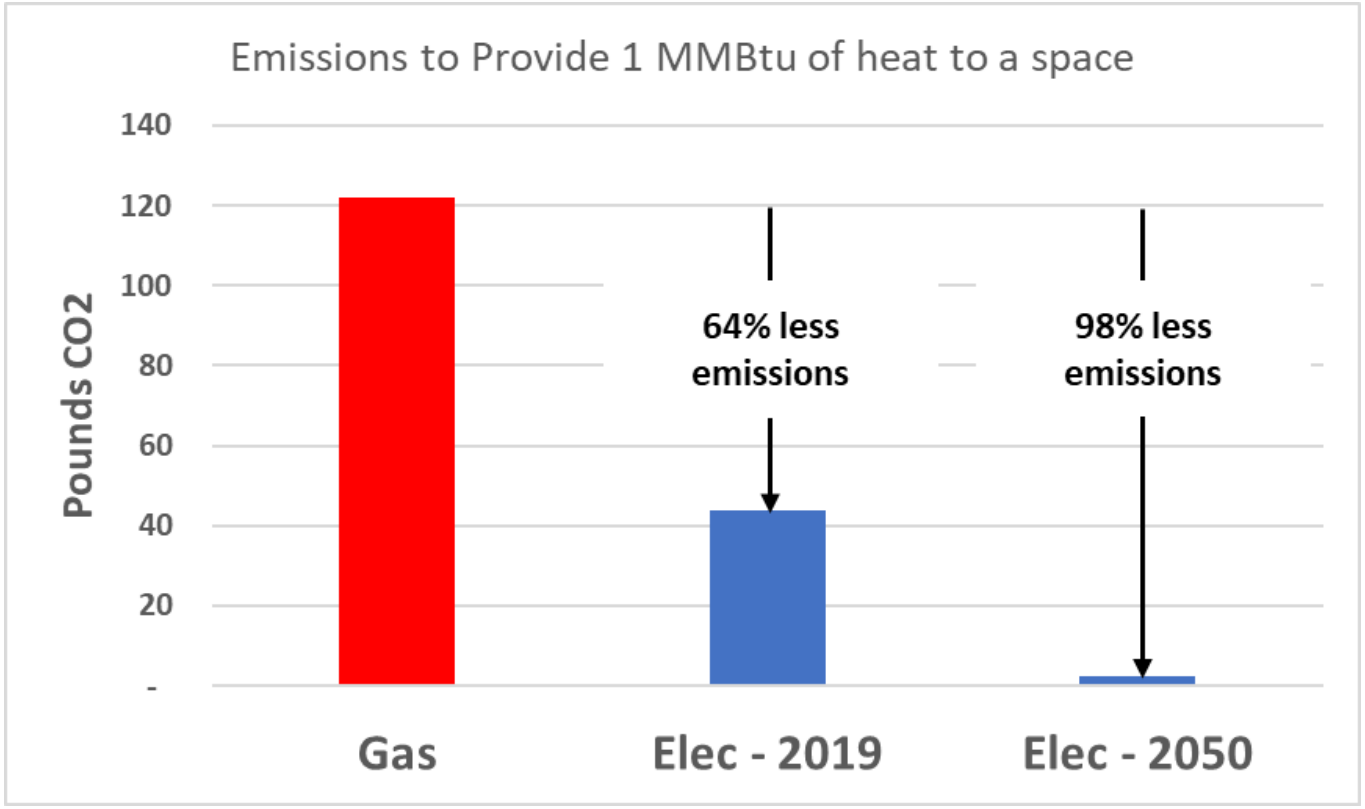





Key Consideration: Electrification in Residential & Commercial

- Electric heating compared to gas heating
  - 64% less emissions current
  - 98% less emissions in 2050

- Critical that buildings migrate toward electrification



Based on 95% efficient natural gas boiler vs. 320% efficient air source heat pump, 2019 emission rate of 478 lbs/MWh, 2050 emission rate of 27 lbs/MWh
https://www.mass.gov/doc/technical-support-document-draft-2019-ghg-emission-factors/download

Base Code
(10th Edition of MA Building Code)

Stretch Code
(Update)

Specialized Opt-in
(New Code Option)

RESIDENTIAL LOW-RISE PROPOSAL

One and two family homes, town homes, and low-rise multi-family up to 3 stories

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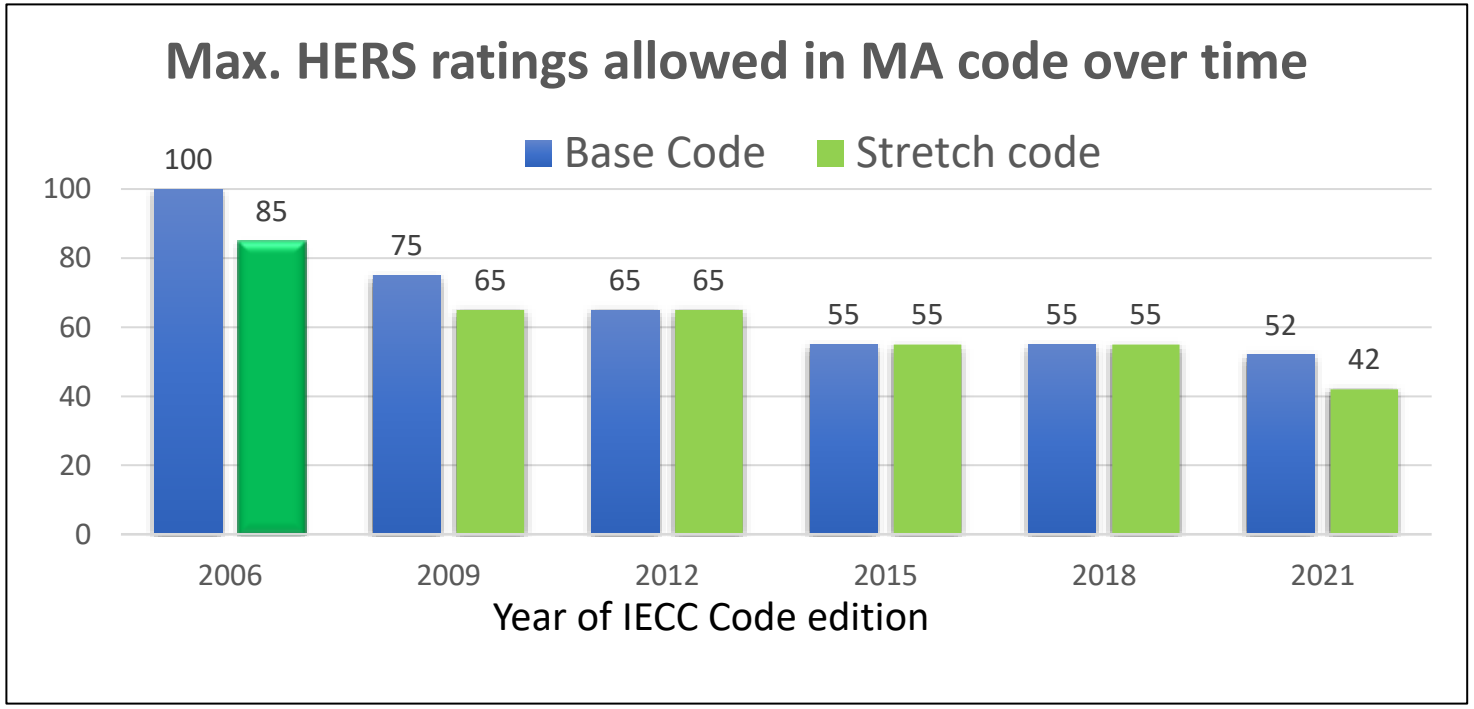
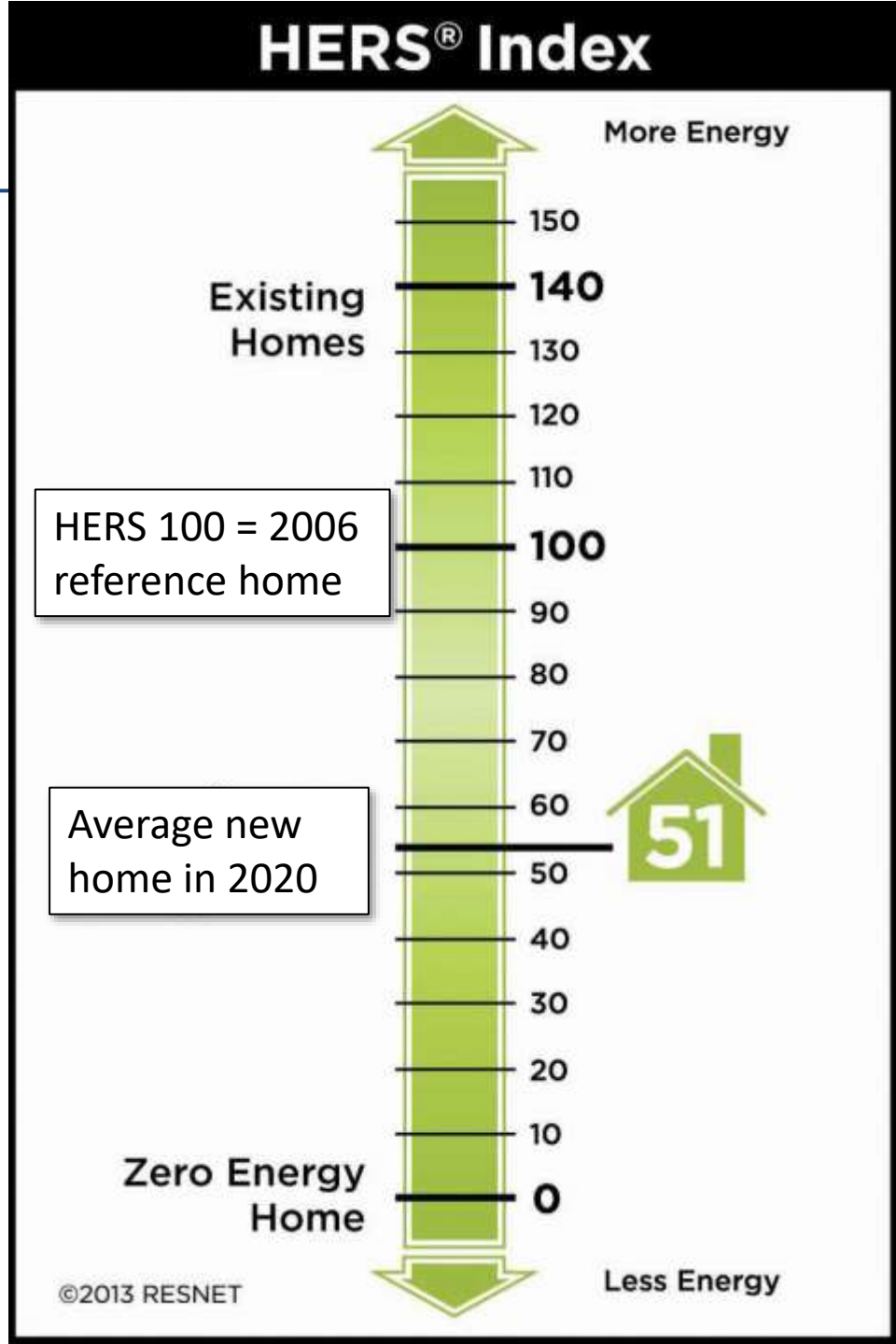
What is HERS?

- HERS (Home Energy Rating System) used in MA energy code since IECC 2006 edition
  - HERS 51 = Average in MA in 2020
  - 87% of new homes used HERS in 2020
  - HERS ratings qualify for Mass Save incentives & Federal tax credits





Stretch Code Update – Residential low rise

Proposing 3 Options for Code Compliance:

- **HERS 42** for fossil fuel heating (each unit)

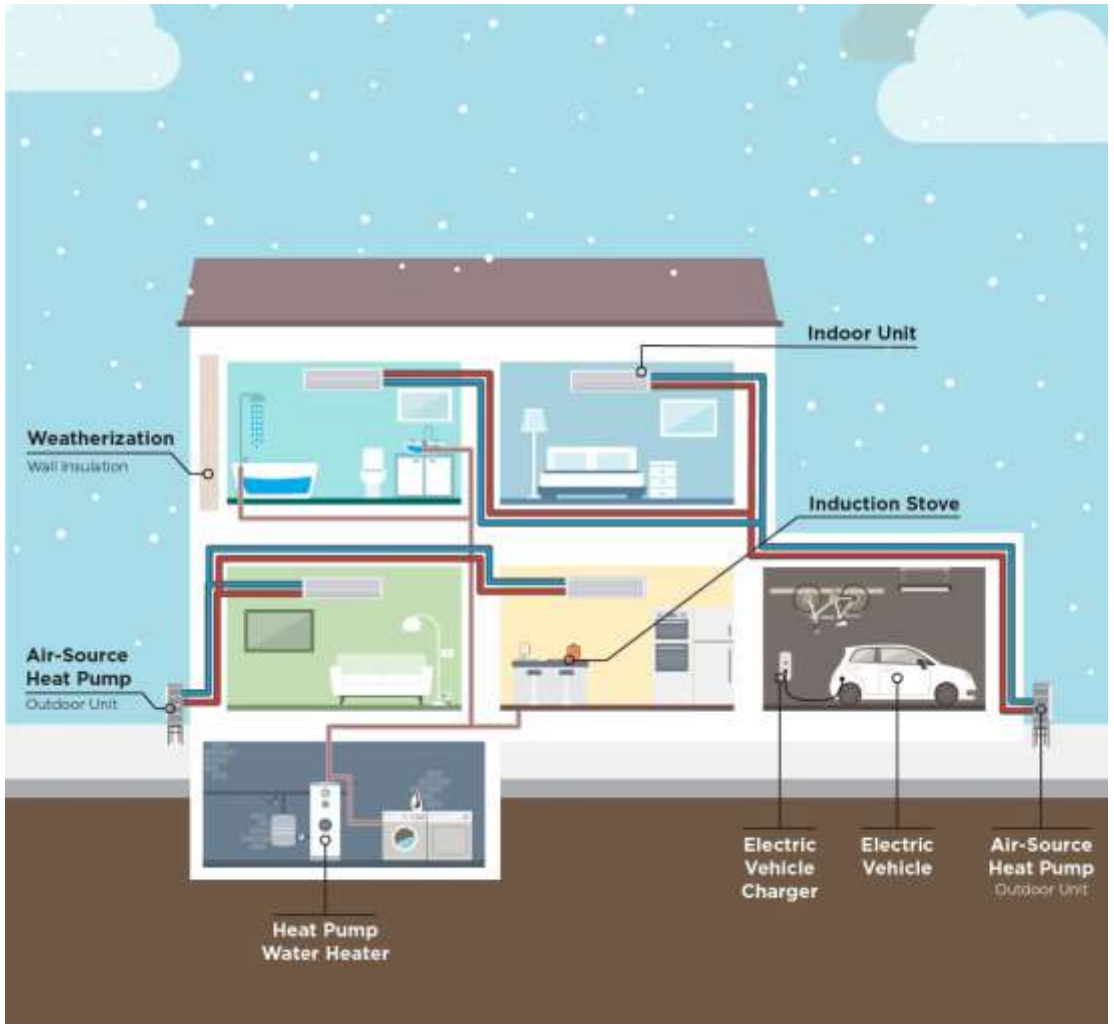
or

- **HERS 45** for electric heating (each unit)

or

- **Passivehouse** (whole building)

- Jan-Dec 2023 transition year with HERS 52/55
- Effective December 2023 HERS 42/45



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Residential Analysis Approach

1. HERS 52 base code baseline cost & efficiency

2. Ran 10,000 home scenarios to evaluate emissions and cost impacts

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

3. Representative homes selected for detailed analysis

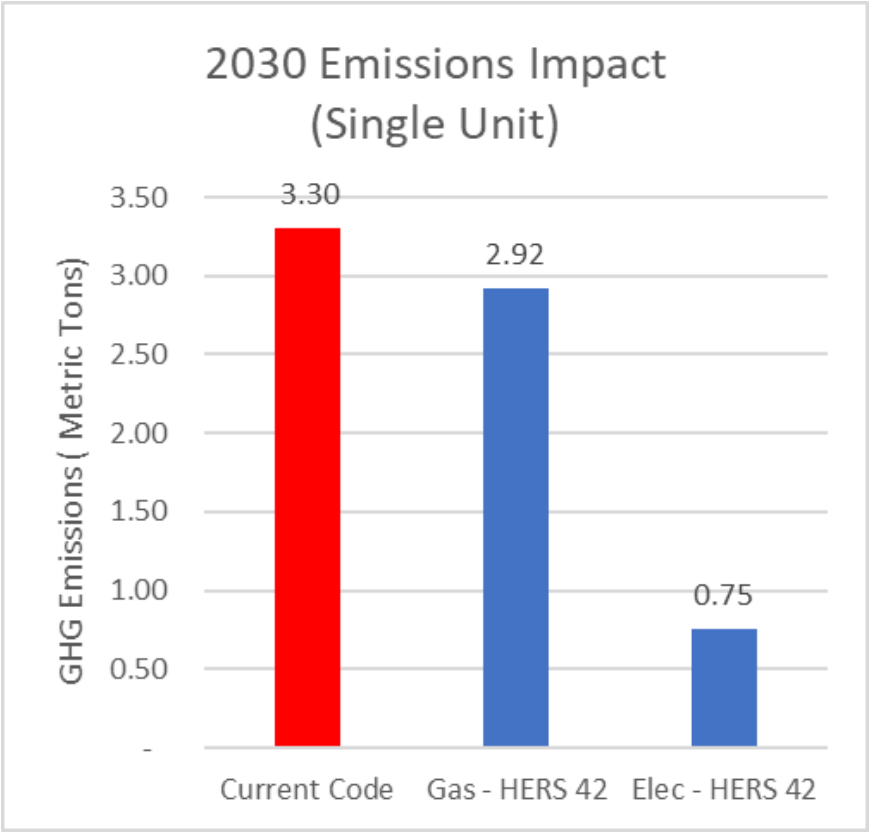
ekotrope
REM/Rate™

4. Detailed cost-benefit building case studies

Results of Residential Analysis

Why HERS 42?

- At HERS 42, both gas and electric heat are cost-effective to build and cheaper to operate.
- At or below HERS 42, most homes will choose electric heat because heat pumps can lower construction costs for builders and lower ownership costs for buyers.
- Heat pumps are more efficient and save significant GHG emissions compared to gas or propane heating.



Switching from gas heat to electric heat pump saves 75% of the GHG emissions in 2030, more in 2050

Results of Residential Analysis

What does HERS 42 mean for builders?

- **Electric-heated homes:** heat pumps significantly improve efficiency; better air sealing and ventilation is all that is needed to reach HERS 42-45
  - Incremental costs savings range from $11,938 to $28,597 after incentives

- **Gas-heated homes:** HERS 42 requires some combination of triple-glazed windows, improved insulation, better air sealing and heat recovery ventilation
  - Incremental costs for these improvements range from cost savings of $570 to an increase of $7,900 after incentives

Building with heat pumps will be lower-cost for builders but gas or propane heating is still permitted

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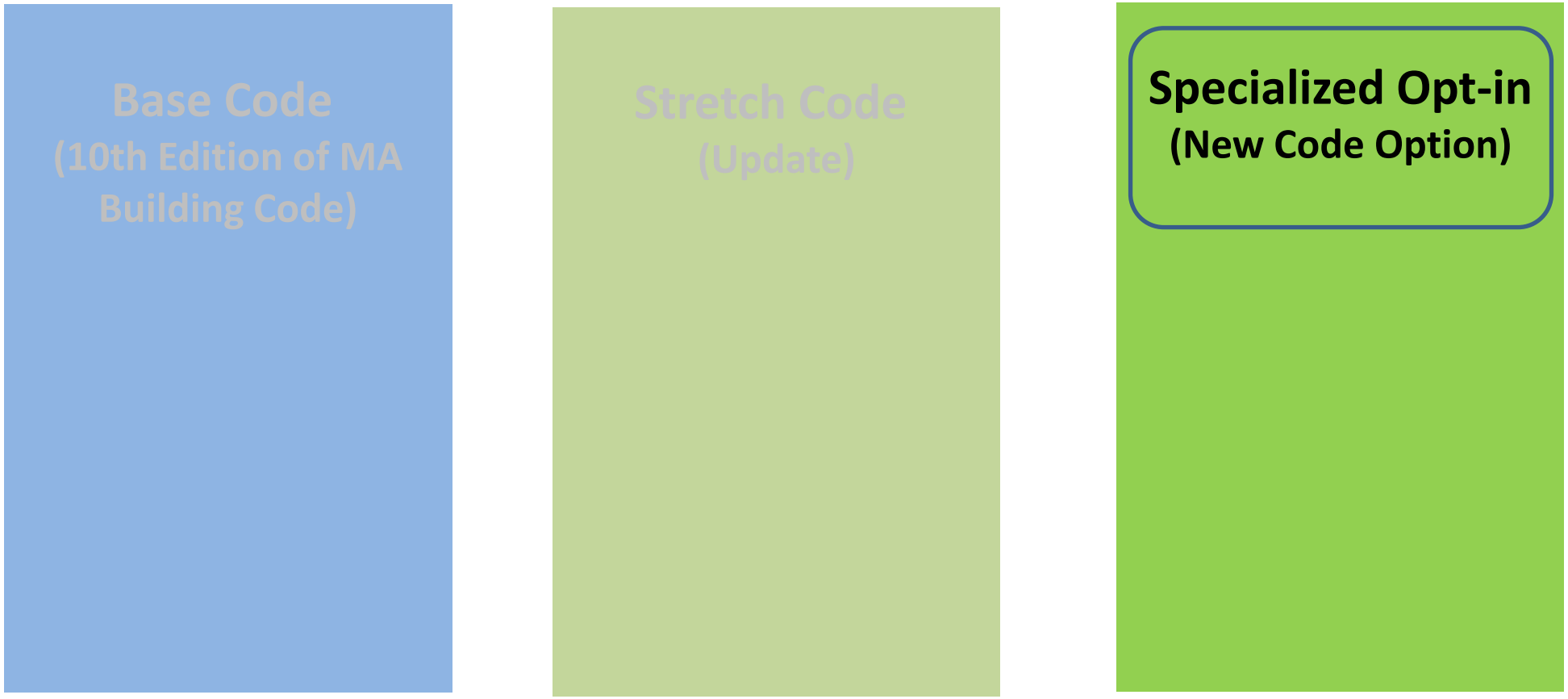
Coordination with Mass Save® 1-4 unit Incentives

- New Mass Save incentives for 2022-2024
  - ➢ $15k For All-Electric homes below HERS 45 and $25k below HERS 35 / Passivehouse

Figure 2-29: All-Electric Initiative (1-4)

Target (% savings over baseline or HERS score)	Tier 2: ≤ HERS 45 or ≥ 30% savings	Tier 1: ≤ HERS 35 or ≥ 50% savings
Incentive	$15,000 per home + $2,500 for each additional unit	$25,000 per home + $5,000 for each additional unit
Infiltration rate	≤1.5 ACH50	≤1.0 ACH50
Balanced Heat Recovery Ventilator/Energy Recovery ventilator (HRV/ERV)	Required	Required
EV-ready check list	Required	Required
Continuous envelope insulation	Optional	Required
Heat pumps for space heating	Required	Required
Domestic hot water	Electric DHW required, heat pump water heater optional	Heat pump water heater required

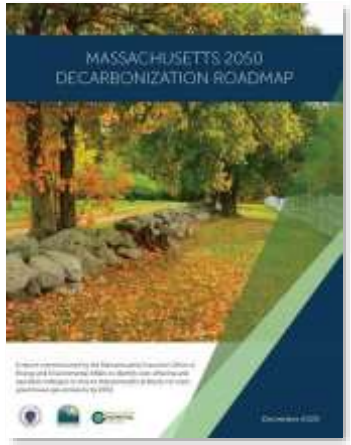


RESIDENTIAL SPECIALIZED OPT-IN CODE

Specialized Code: Proposed Net Zero Definition

Net-Zero new construction is compatible, as-built, with the Commonwealth's net-zero emissions economy in 2050.

- Consistent with electrification and deep efficiency approach in EEA's 2050 Roadmap
- Does not necessitate onsite or offsite renewables, nor the assumption that an individual building is net-zero energy
- A building becomes net zero energy when MA electric grid is net zero



All-Electric:
no additional requirements, compliant as-built with net-zero in 2050

Fossil Fuel used:
Required solar PV and pre-wire for future electric heating, drying and cooking

Specialized Opt-in Code – Residential low rise

Proposing 3 Options for 'net zero' Code Compliance:

- **HERS 42** for gas/propane heating (each unit)

+ Rooftop solar (where unshaded)

+ pre-wired for electrification

or

- **HERS 45** for electric heating (each unit)

or

- **Passivehouse** (whole building)

+ wired for electrification

And in all cases

EV ready wire to parking spaces (20% of spaces)

Specialized Stretch Code (Net Zero) - Residential

Residential (1-2 family, townhouse & small multi-family)

- HERS 45: All - Electric home
  - All stretch code efficiency requirements
- HERS 42 Gas/propane or other fossil fuel
  - All stretch code efficiency requirements
  - Solar **on roof where feasible**
  - **Electrification-ready** (pre-wiring for stoves, dryers, hot water, heating)
- Passive House
  - Electric heat or electrification ready

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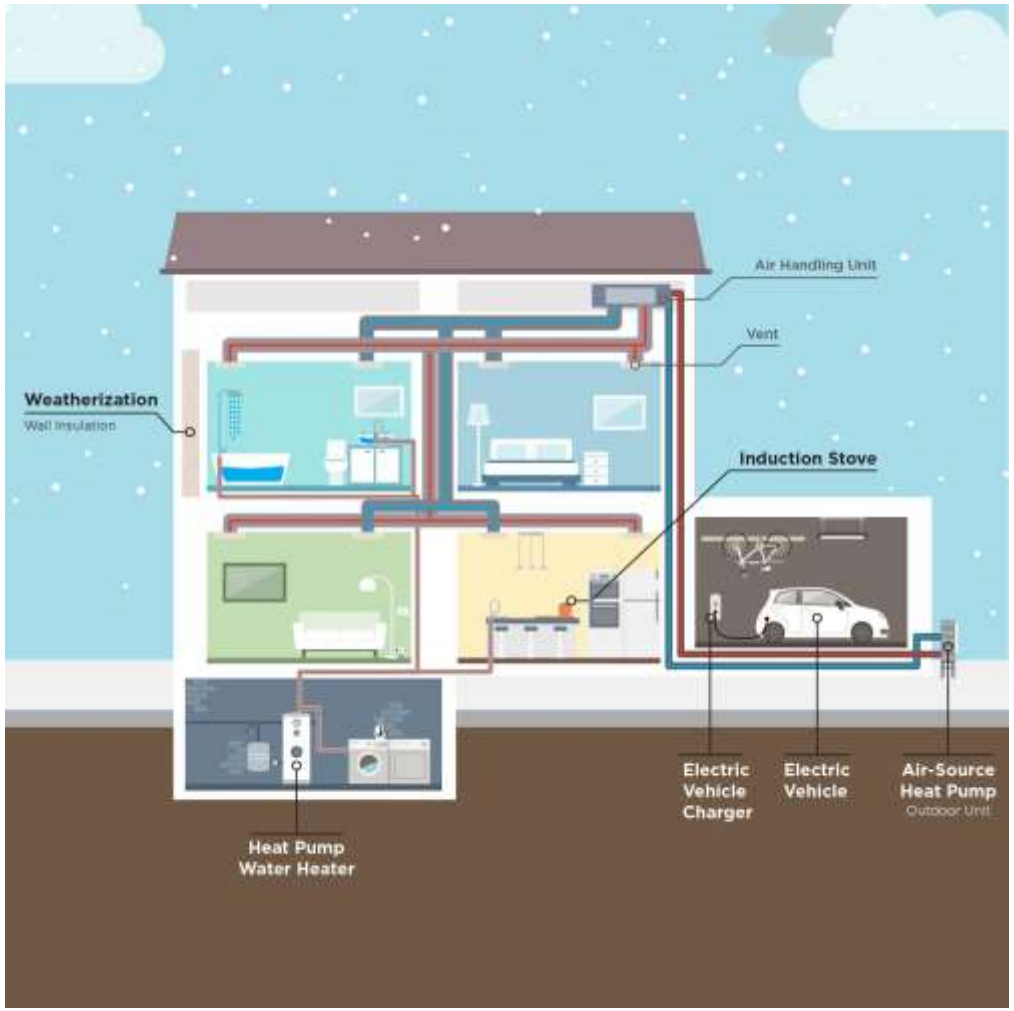
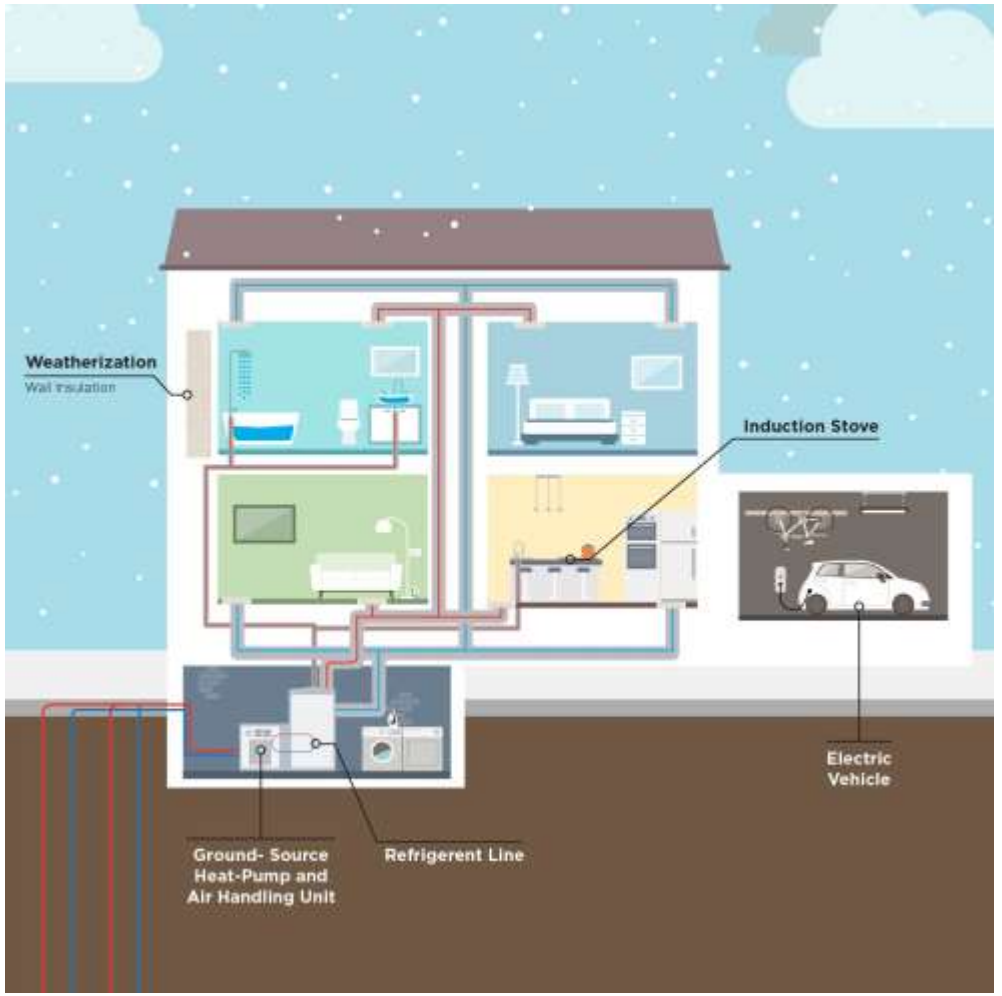
Net zero for all-electric homes: Solar ready – PV optional

Air source heat pumps



Ground-source heat pumps



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Net-zero requirements for homes with fossil fuels

- Solar PV requirement
  - Required solar PV installation on all unshaded roof with good solar access
  - Solar PV production may not meet full load

- Pre-wiring for future electrification
  - To be 2050 net-zero ready homes required to size electric panel and prewire to appliances for future electric conversion
  - E.g. install 240volt wire to cooking and dryer appliances, and adjacent to furnace & water heater

Base Code
(10th Edition of MA Building Code)

Stretch Code
(Update)

Specialized Opt-in
(New Code Option)

COMMERCIAL STRETCH CODE UPDATE

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Commercial Stretch Code

- Key considerations during evaluation (4 slides)
- Key findings from evaluations (1 slide)
- Proposed Stretch Code (6 slides)

Key Consideration: Optimization

Improved envelope + heat recovery

COST ADD

- Reduced air infiltration
- Wall “R” values
- Window “U” values
- Ventilation heat recovery

Reduced HVAC

COST DEDUCT

- Less distribution systems
- Smaller equipment
- Less rooftop equipment

Key consideration: Curtain walls

- A “curtain wall” is
  - All glass (vision and opaque)
  - Much lower insulation performance
    - R-5 vs R-16 wall
- Often, the preferred approach
  - Aesthetics
  - Flexibility
- Created 2 versions of ‘optimized’ design
  - Curtainwall
  - Traditional, non-curtainwall

Regular wall: R-16

Curtain wall: R-5 to R-9

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Key consideration: Glazing

- Office and Lab/Office evaluated two levels of glazing:
  - High glazing (50% window)
  - Normal glazing (30-40% window)

- 50% window (measured on exterior):
  - 60-70% of all perimeters floor to ceiling height is window
  - Near “floor to ceiling” window from inside the building

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Key consideration: Air infiltration & Thermal bridging

Controlling air infiltration and thermal bridges - significant efficiency improvement

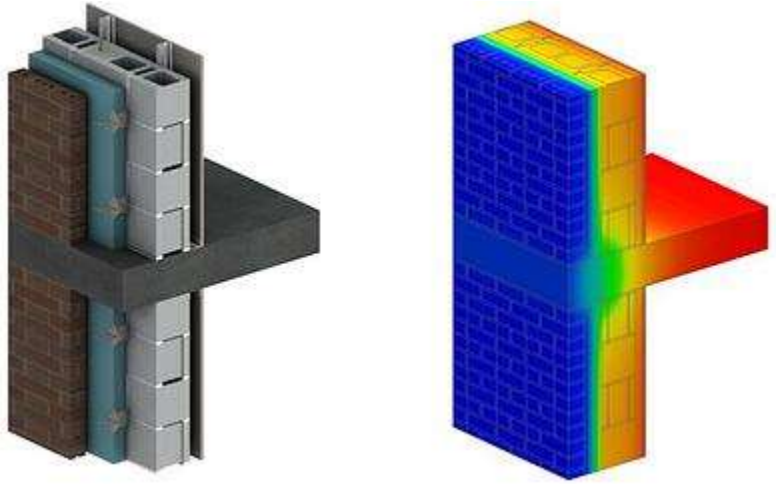
Credit: Steven Winters Associates

Air infiltration

- Testing required in updated base code to be effective Jan 2023 (IECC 2021)
- Optimized design lowers air leakage rate to 0.25 cfm/sf

Thermal bridging

- Accounting for thermal bridging
- Thermal breaks optimize insulation



Credit: Morrison Hershfield

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Key Findings: Cost & GHG Results for key Building Types

Increases efficiency requirements based on what is most **cost-effective by building type** to yield **optimized** proposal for gas and electric heated buildings.

Proposed code:

- Costs less upfront for office and office/lab.
- Lowers life cycle cost - all buildings
- Accommodates glass and curtain wall buildings preferred by developers
- Encourages, but does not, require electrification
- Allows flexibility for labs, hospitals
- Customizes heating limits based on building type

	Improves Life Cycle Cost?	Incremental Cost to Build	GHG Reduction
Primary School	✓	1.1 to 2.8%	26 to 39%
Secondary School	✓	0 to 0.5%	34 to 39%
Small office	✓	3.4 to 4.5%	25 to 50%
Large Office	✓	-4 to -4.6% **less**	31 to 33%
Lab/Office	✓	-0.7 to -1.2% **less**	29 to 67%
Multi-family	✓	< 1.9 to 2.9%	45% +/-

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Proposed Stretch Code: Pathways

DOER PROPOSAL: Five Pathways for Code Compliance depending on building use type:

- Prescriptive Pathway (Small buildings <20,000 sf only)
- Targeted Performance Pathway (Required for Offices & Schools, Option for Multi-family)
- Relative Performance Pathway (High ventilation and other buildings)
- Passivehouse (Option for all building types)
- HERS (Option for Multi-family)

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Proposed Stretch Code: Current/Proposed

Pathway	Current	Proposed
Prescriptive	IECC 2018 (MA amended)	IECC 2021 plus MA **additional commercial requirements**: air tightness, windows, ventilation, thermal bridging
Targeted Performance	Not an option	TEDI – Thermal Energy Demand Intensity limits by building type and size for Schools, Offices and Option for Multi-family. **Add'l commercial requirements** re: air tightness and widows/walls
Relative Performance	2013 ASHRAE (mandatory over 100,000 sf)	2019 ASHRAE App G plus MA **additional commercial requirements** (air tightness, etc) allowed for a) complex, high ventilation buildings and b) buildings not required to follow TEDI
Passivehouse	Optional for all types	Optional for all types
HERS	Option for Multi-family (HERS 55)	Option for Multi-family (HERS 42/45) effective in Dec 2023

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Proposed Stretch Code: Add'l Requirements

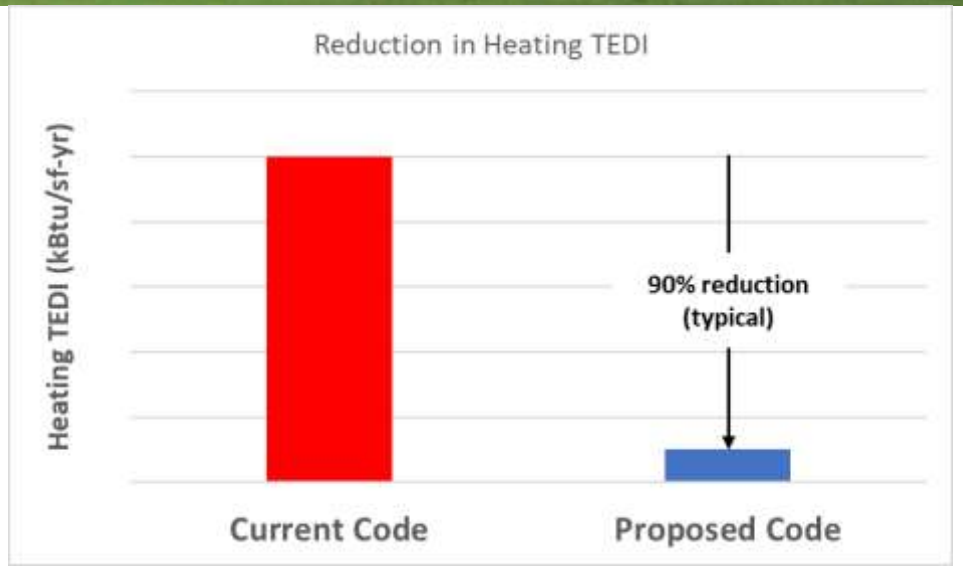
	Current Base & Stretch	Updated Stretch & Specialized
Envelope UA maximum	Mandatory – all commercial buildings	Improved for buildings with regular walls and accommodation for curtainwall buildings
Air infiltration	0.4 cfm/sf at 75 Pa	0.25 cfm/sf at 75 Pa
Ventilation Energy Recovery	Many exceptions which allow no energy recovery, otherwise up to 50% effectiveness	Largely reduces exceptions, generally 80% effectiveness
Electrification of space heating	Optional	High ventilation buildings: Partial electrification mandatory, all other buildings: optional

Proposed Stretch Code: Targeted Performance Path

- What is heating "TEDI":
  - **T**hermal **E**nergy **D**emand **I**ntensity
  - Amount of heating needed over 1 year

- Benefits to low TEDI
  - Easy to electrify
  - Cost effective
  - Low emissions

- Effective pathway to Zero Energy



The proposed code reduces heating TEDI by 90% for most buildings

Proposed Stretch Code: TEDI Limits

- **When TEDI applies**
  - Schools
  - Office (including town hall, courthouse, etc)
  - Multifamily (including dormitory)

- **Heating TEDI limits (kBtu/sf-yr)**

K-12 School < 100,000-sf	2.4
K-12 School >= 100,000-sf	2.2
Office < 100,000-sf	2.4
Office >= 100,000-sf	1.5
Multifamily	TBD

- **Plus**
  - Cooling TEDI limits
  - Vertical envelope UA backstop
  - Thermal bridge accounting
  - Infiltration limits and testing

Old Colony - affordable Multi-family - Boston

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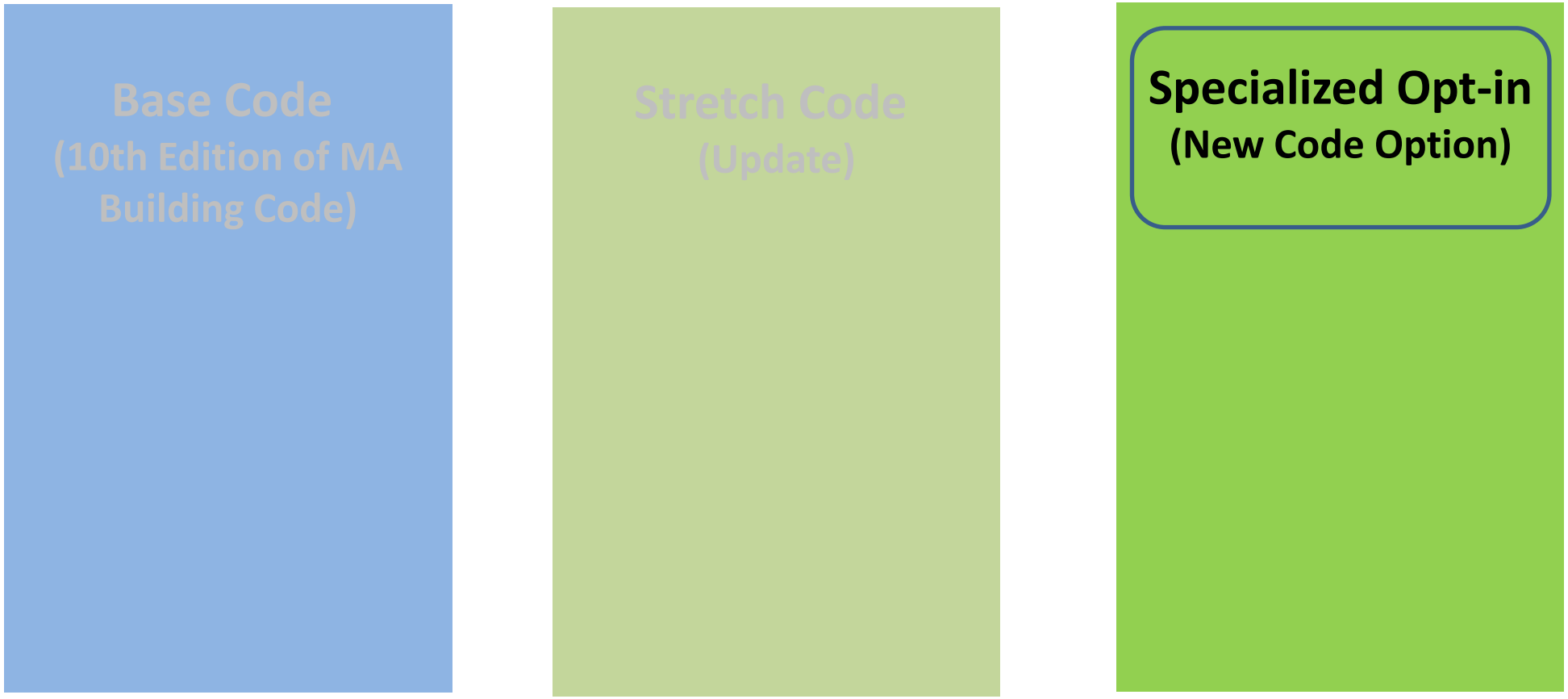
Proposed Stretch Code: Accommodation for Curtain wall

- Envelope performance backstop
  - Will be somewhat strengthened from current code
  - However, for curtain wall construction – will maintain about current level to accommodate builder preference

- Additional requirements if using curtainwall - demonstrate embodied carbon reduction from a choice of options
  - Low carbon concrete
  - Carbon sequestering materials (e.g. wood fibre-board, mass timber)
  - Recycled materials (e.g. Foamglass)
  - Reused materials/building reuse



COMMERCIAL SPECIALIZED OPT-IN CODE

Specialized Opt-in Code (Net Zero) - Commercial

Large Multi-Family → Passive House → Electric Heat or Electrification ready

All other Commercial Building Types →

- Passive House → All Electric or Electrification ready
- Gas or other fossil fuel → All stretch code efficiency requirements → Solar on roof where feasible → Electrification-ready (pre-wiring)
- All-Electric → All Stretch code efficiency requirements

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Specialized Opt-in Code – Commercial Requirements

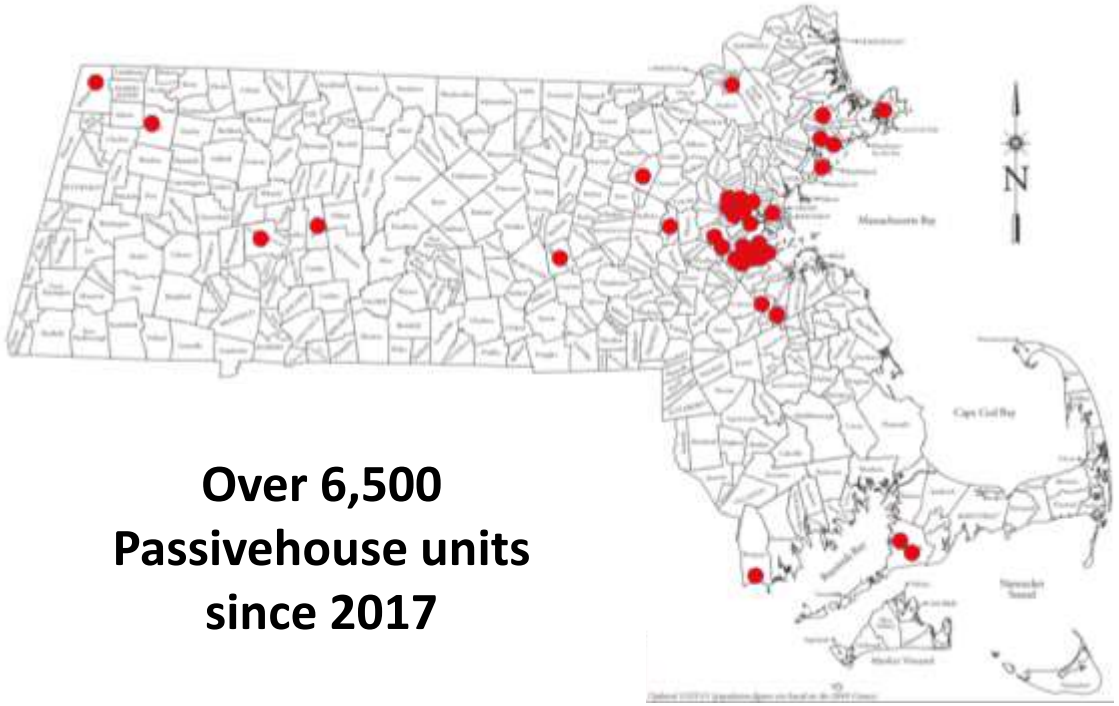
Pathway	Efficiency improvements – Same as Stretch code	Additional Requirements
Prescriptive	IECC 2021 plus MA additional commercial requirements: air tightness, windows, ventilation, thermal bridging	Additional EV ready wiring; & Buildings with fossil fuels must also add: • Solar PV on available roof space • Pre-wiring for future electrification
Targeted Performance	TEDI – Thermal Energy Demand Intensity limits by building type and size for Schools, Offices	
Relative Performance	2019 ASHRAE App G (site energy) plus MA additional commercial requirements allowed for a) complex, high ventilation buildings and b) buildings not required to follow TEDI	

Specialized Opt-in Code: Multi-family Requirements

- Passivehouse for Multi-family (6+ units):
  - Low-rise (up to 5 stories) required from Jan 2023
  - Mid-rise (6-9 stories) and high-rise (10+ stories) required from Jan 2024
- Targeted Performance Path (TEDI) in 2023 transition year for mid-rise and high-rise

Harbor Village – Affordable housing - Gloucester

Passivehouse & Multi-family – Recent Success



Over 6,500 Passivehouse units since 2017

Winthrop Center
Boston, MA

The Distillery
Boston, MA

Bunker Hill
Boston, MA

North Commons
North Hamptons, MA

Harbor Village
Gloucester, MA

Depot Village
Hanson, MA

What is Passivehouse? A building standard that includes:

- Super-efficient building envelope (approx. HERS 34)
- Improved indoor air quality with high performance ventilation

Net impact: Improved health, comfort, resiliency, and building quality, reduced HVAC equipment sizing, and low cost to maintain and operate

- **Passivehouse Growth**. Passivehouse is rapidly growing in 6+ unit multi-family with over 6,500 units in the Mass Save® incentive program pipeline versus less than 20 in 2018.
- 133 MA firms have Certified Passivehouse consultants, $1.7m for Mass Save training of 3,600 people in 2022-2024.
- **Multi-Family.** Passivehouse becomes most cost-effective for multi-family buildings, but standard can be used for all buildings

Passive House Costs for Multi-Family Low/High Rise

Passive House Challenge (2019)

1.4 to 2.8%

Actual costs (not estimates) from 8 low and mid-rise PH projects around Massachusetts

DOER Energy Code Analysis (2019)

1.9 to 2.9%

Detailed cost estimate by Consigli technical consultant

Pennsylvania Housing Authority (2015-2018)

-1.1% less

Actual costs (not estimates) from 74 PH projects and 194 non-PH projects

Since 2019, Mass Save provides technical assistance, training and $3,000/unit in incentives for multi-family Passive House construction

DOER
Massachusetts Department of Energy Resources

Summary – 3 Energy Code options:

This straw proposal includes an update to the stretch code alongside the new specialized stretch option for Municipalities

Base Code
(10th Edition of MA Building Code)

- New Buildings in towns and cities that have not adopted a stretch code
- 52 communities
- BBRS update effective in 2023

Stretch Code
(Update)

- New Buildings in towns and cities that adopted, including all green communities
- 299 communities
- DOER update effective in 2023

Specialized Opt-in
(New Code Option)

- New Buildings in towns and cities that choose to opt-into this code
- Available for adoption Dec 2022

Next Steps

- 4 Geographically targeted public meetings between February 28th and March 8th
- DOER webpage for stretch code development to sign up for outreach list
- Deadline for 1st round of public comments March 9th, 2022 submitted to: stretchcode@mass.gov