Rewiring Model Energy Codes for Net Zero Carbon Buildings

Michael Waite

National Energy Codes Conference | Chicago, IL

May 3, 2023

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American Council for an Energy-Efficient Economy

Why Decarbonize Codes? Take your pick…

- The climate imperative
- Better indoor and outdoor air quality
- Reduced social costs
- Avoid upgrading or extending aged gas infrastructure
- Your state requires you to
- You're ASHRAE or ICC and have imposed your own targets
- There's a lot of federal funding available

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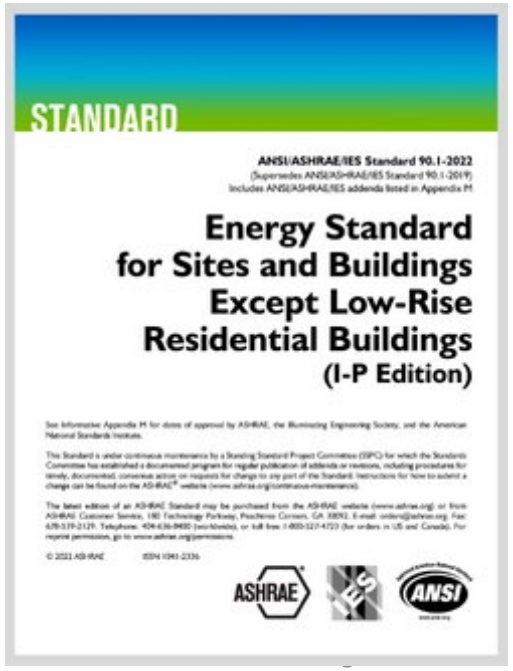
Why focus on the model energy codes?

- The vast majority of states and jurisdictions with energy codes adopt model codes
- They form the basis of stretch codes
- To meet climate goals, adoption needs to be widespread
- They should work everywhere



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Initial Forays and Current Attempts

- ”Zero Energy” optional appendices
- All-electric optional appendices
- ”Electric-Ready” provisions where combustion equipment installed
- Requiring more energy efficiency for fossil fuel buildings

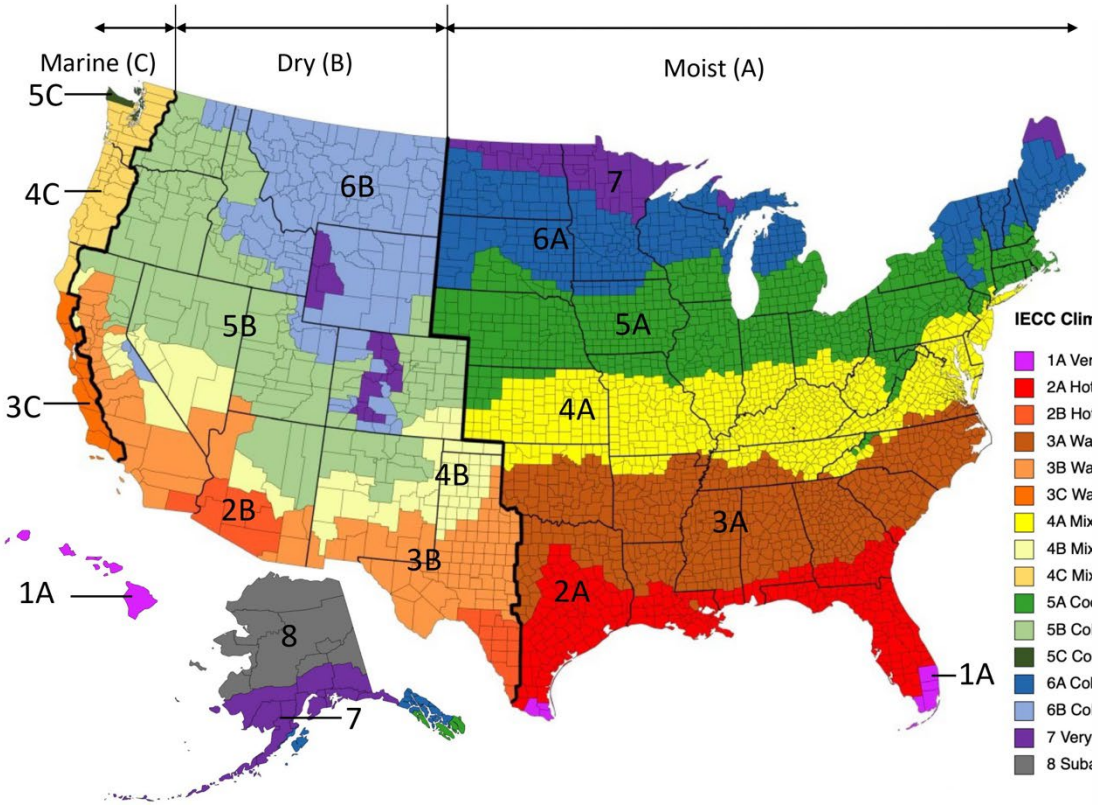
➢Energy focus needs to shift to a carbon/emissions focus

Refocusing on carbon

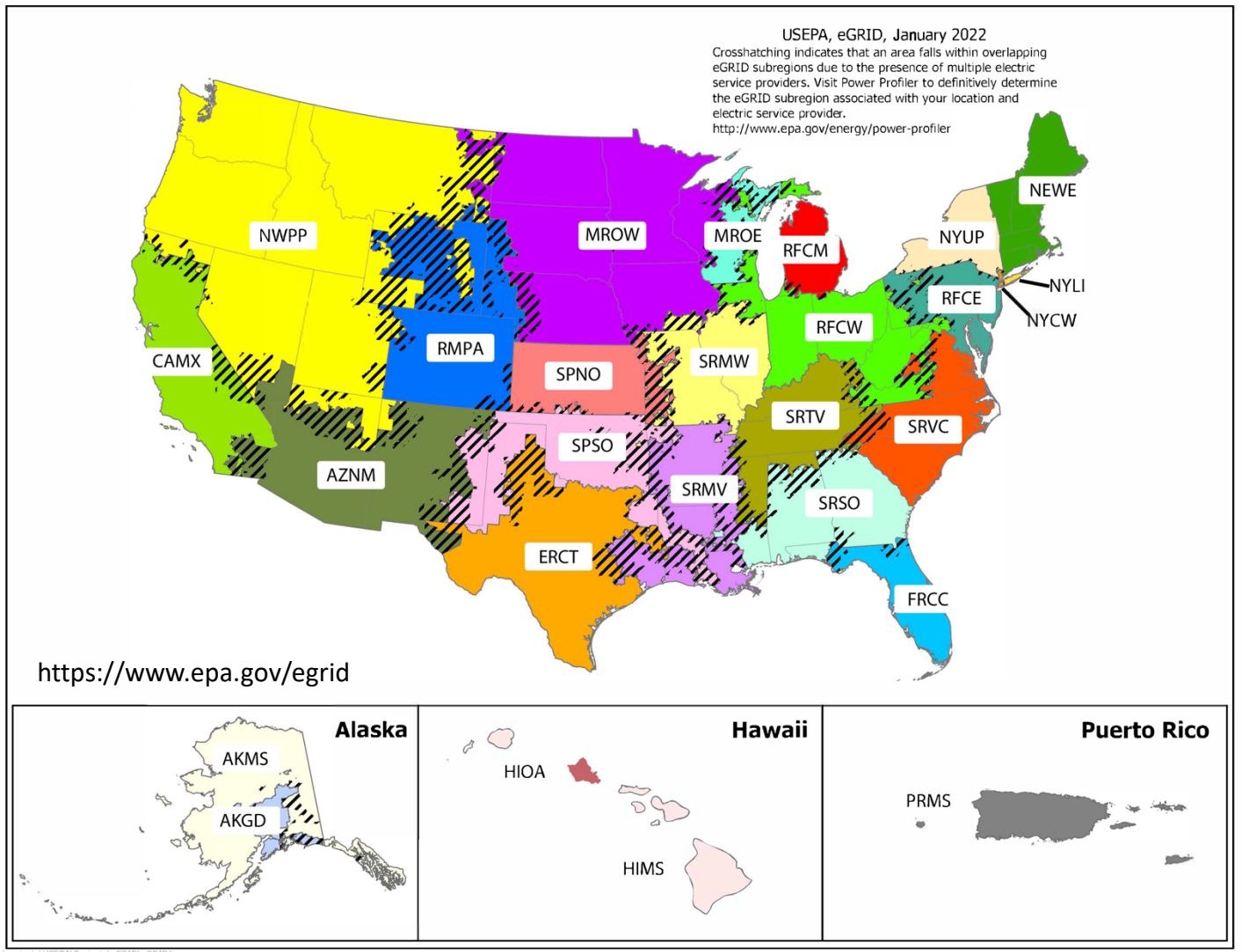
To decarbonize new construction, model energy codes must be:

Effective at reducing energy costs and emissions across climates and grid regions

Effective across climates and grid regions



https://basc.pnnl.gov/images/climate-zone-map-iecc-2021



https://www.epa.gov/egrid

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Refocusing on carbon

To decarbonize new construction, model energy codes must be:

Effective at reducing energy costs and emissions across climates and grid regions

Adoptable across diverse states and localities

Refocusing on carbon

To decarbonize new construction, model energy codes must be:

Effective at reducing energy costs and emissions across climates and grid regions

Adoptable across diverse states and localities

Enforceable through verification and ease of compliance

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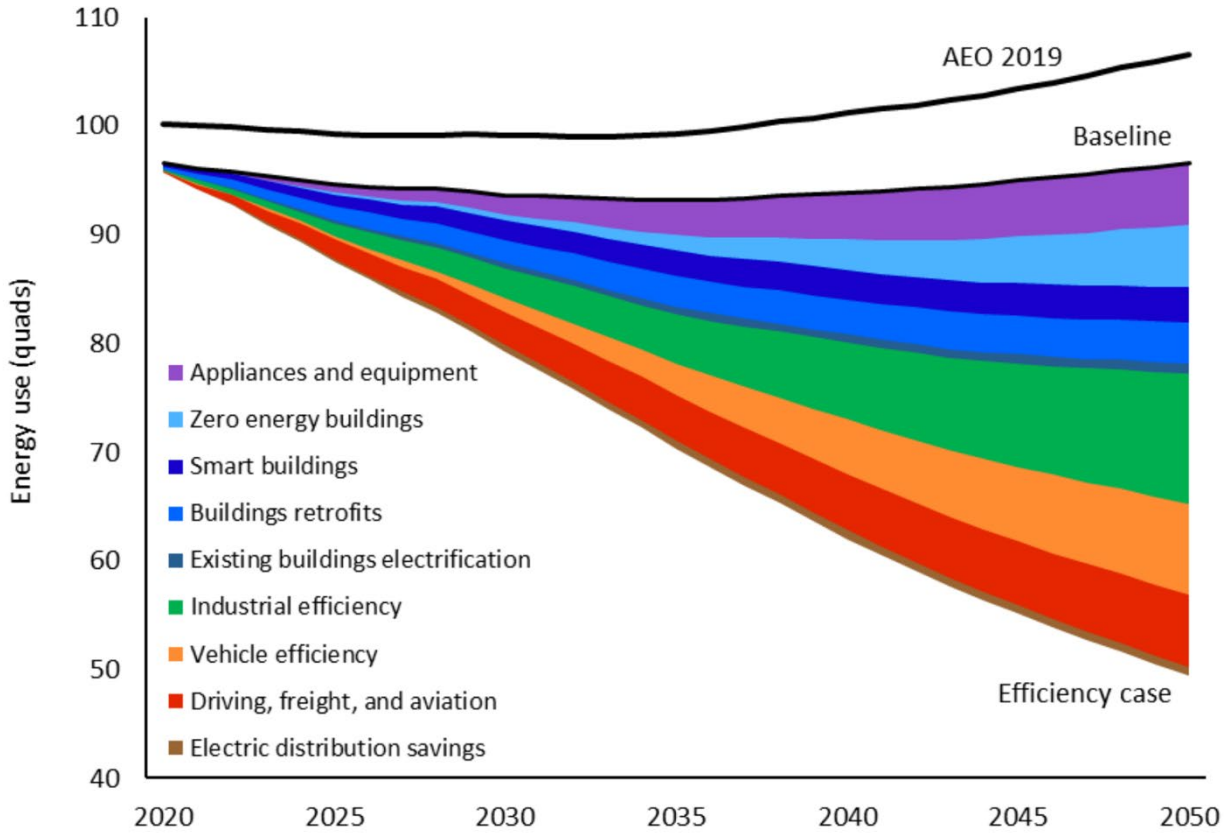
Principles to achieve net zero carbon codes

- Efficiency First
- Beneficial Electrification is Efficient Electrification
- Provide Flexibility
- Effectively Offset Remaining Emissions

Efficiency First

- Maintain original intent of energy codes: reduce energy costs
- Proven emissions reductions and much more possible
- Reduces:
  - **HVAC equipment size**
  - **New heating-driven electricity peaks**
  - **New generation, storage, and delivery infrastructure capacity**



ACEEE: "Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050"
https://www.aceee.org/research-report/u1907

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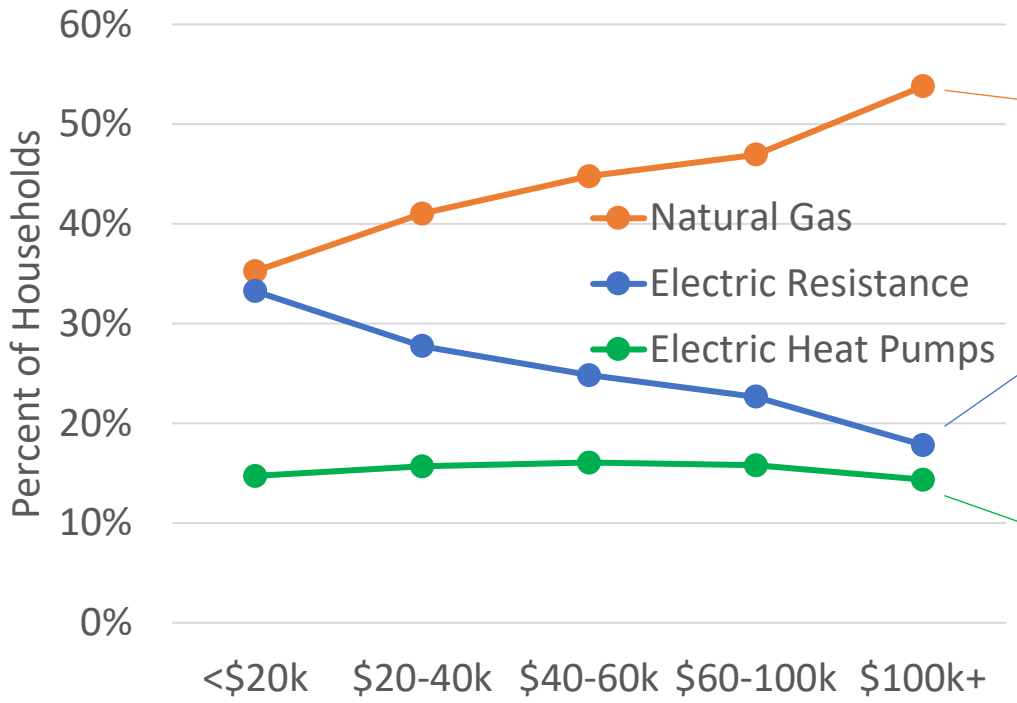
Beneficial Electrification is Efficient Electrification

- Make use of the greening grid and high efficiency electric heat
- Electric heat pumps are the most cost-effective way to decarbonize
- Cannot saddle lower income homes with electric resistance



Natural Gas: $700/year, 4.6 tCO2e/year

Electric Resistance: $2000/year, 8.5 tCO2e/year

Electric Heat Pump: $800/year, 3.4 tCO2e/year

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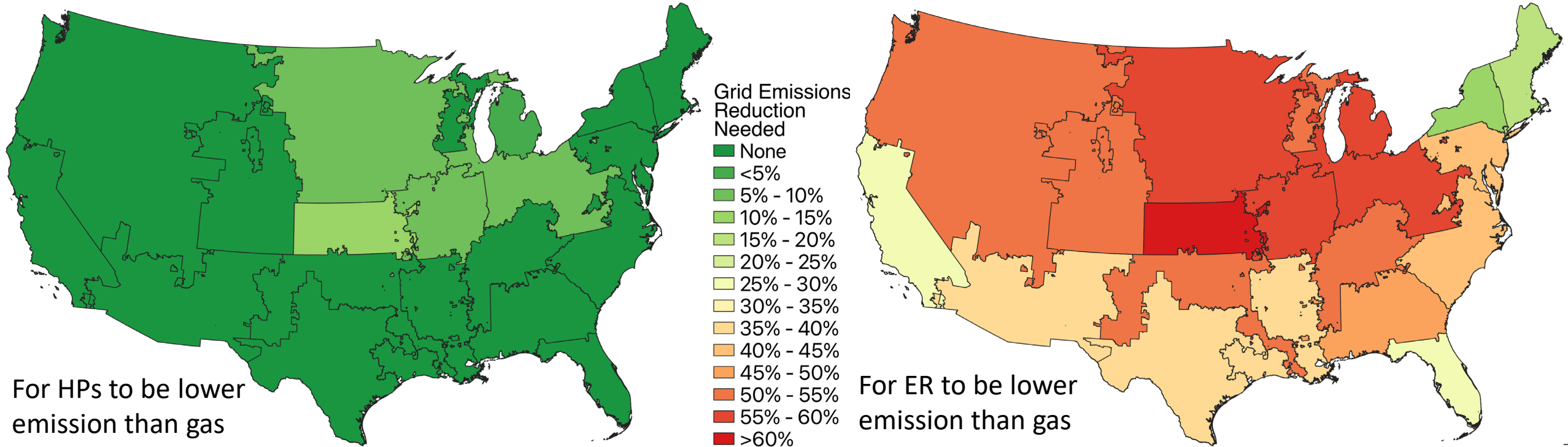
Figure based on 2020 RECS: https://www.eia.gov/consumption/residential/
Calculations based on 2015 RECS, Energy Star equipment, average 2022 residential prices (EIA), and us avg non-baseload emissions rates (2021 eGRID)

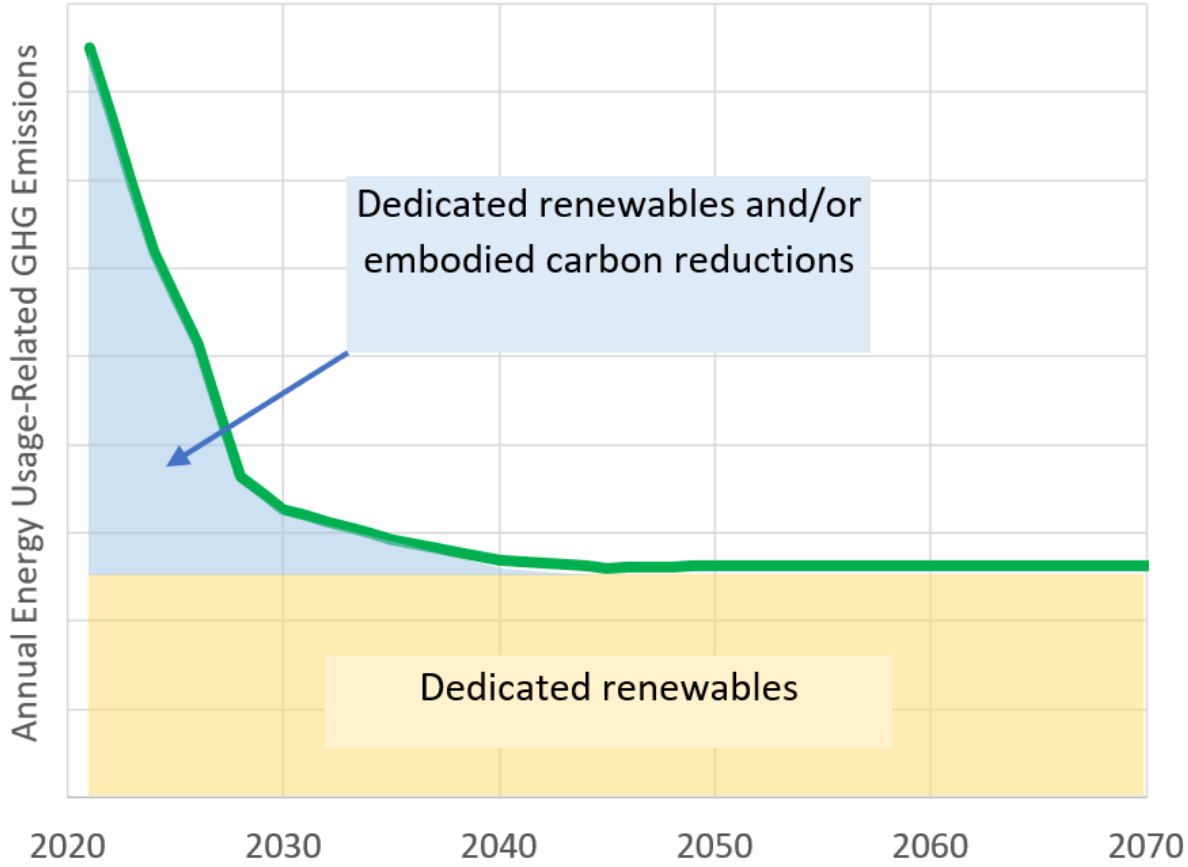
Flexibility

- Maintain minimum efficiency requirements
- Flexibility in how to decarbonize – including prescriptive and performance
- Example: Grid-interactive technology and controls to utilize VRE
- Example: Peak space heating in cold climates
  - **Cold-climate HPs, electric resistance, supplemental fuels, thermal energy storage**



Effectively Offsetting Remaining Emissions

- After achievable efficiency and electrification
- Remaining emissions reductions primarily from renewables
  - **On-site or very robust offsite contracts**
- Consider a role for reductions in embodied carbon



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Are the model energy codes ready?

Need: Standardized carbon quantification

- ASHRAE alone has different approaches in 90.1, 189.1, 105, 228
  - **IECC has not included emissions metrics**
- And there are many, many others…
- Historical emissions >>> forward-looking grid emissions rates
- Promising: ASHRAE/ICC Standard 240P under development
  - **"Quantification of Life Cycle Greenhouse Gas Emissions of Buildings"**

Drafts are posted and comments can be made until May 21st at: osr.ashrae.org.

Need: Expanded Prototype Building Models

- Developed to assess energy savings of different code versions

Current	Needed
One heating, cooling and water heating system for each building type (*residential has more*)	Multiple common systems for each building type
Some mix of fuels for heating, water heating, cooking and cooling.	Minimum: One fossil fuel, one all-electric
Representative cities by Climate Zone (16 in U.S.)	Representative cities by Climate Zone *and* Grid Region (74 in U.S., based on eGRID subregions)
Base code equipment and systems	Additional technology (e.g. storage, grid controls)

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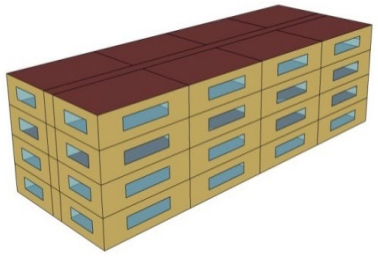
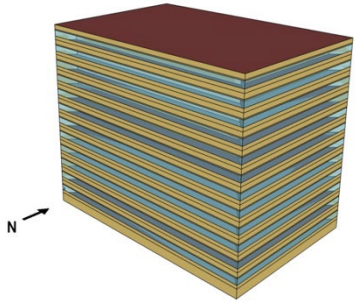
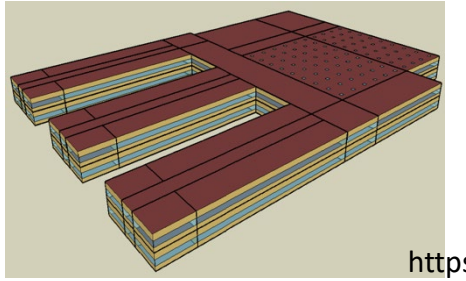
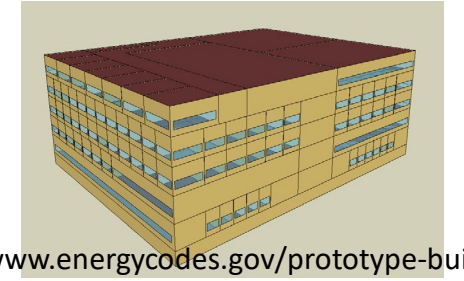








https://www.energycodes.gov/prototype-building-models

Need: Energy Credits >>> Carbon Reduction Credits

ID	Energy Credit Measure	Section	0A	0B	1A
E01	Envelope Performance	C406.2.1.1			
E02	UA reduction (15%)	C406.2.1.2	8	13	7
E03	Envelope leak reduction	C406.2.1.3	15	10	12
E04	Add Roof Insulation	C406.2.1.4	1	1	1
E05	Add Wall Insulation	C406.2.1.5	10	10	6
E06	Improve Fenestration	C406.2.1.6	7	7	4
H01	HVAC Performance	C406.2.2.1	20	19	16
H02	Heating efficiency	C406.2.2.2	x	x	x
H03	Cooling efficiency	C406.2.2.3	7	6	4
H04	Residential HVAC control	C406.2.2.4	9	10	8
H05	DOAS/fan control	C406.2.2.5	32	31	27
W01	SHW preheat recovery	C406.2.3.1 a	61	63	74
W02	Heat pump water heater	C406.2.3.1 b	50	52	62
W03	Efficient gas water heater	C406.2.3.1 c	38	39	46

ID	Energy Credit Abbreviated Title	Section	0A	0B	1A
R01	Renewable Energy	C406.3.1	9	15	11
G01	Lighting load management	C406.3.2	16	7	9
G02	HVAC load management	C406.3.3	42	41	21
G03	Automated shading	C406.3.4	11	x	7
G04	Electric energy storage	C406.3.5	10	10	10
G05	Cooling energy storage	C406.3.6	28	6	31
G06	SHW energy storage	C406.3.7	17	17	19
G07	Building thermal mass	C406.3.8	7	2	11

Snapshots from 2024 IECC Public Comment Draft #1: https://www.iccsafe.org/wp-content/uploads/IECC2024P1CE-UPDATE-110122.pdf

- Menu of options beyond minimum requirements
- Must attain a total amount by building type and climate zone

➢Translate to emissions reduction basis

➢Incorporate decarbonization-specific measures

➢Develop packages that meet emissions reduction target levels
  - **E.g. all-electric, dual fuel, net zero carbon, X% reduction vs. reference year**

➢Provides framework for states and jurisdictions to transition

Need: Rethinking cost-effectiveness

Current Approach

$$\frac{Upfront\ Costs}{Annual\ Energy\ Cost\ Savings} \leq Maximum\ Simple\ Payback\ (years)$$

Incorporating Greenhouse Gas Emissions

Option 1: Social Cost of Carbon

Decide on and incorporate a social cost of carbon

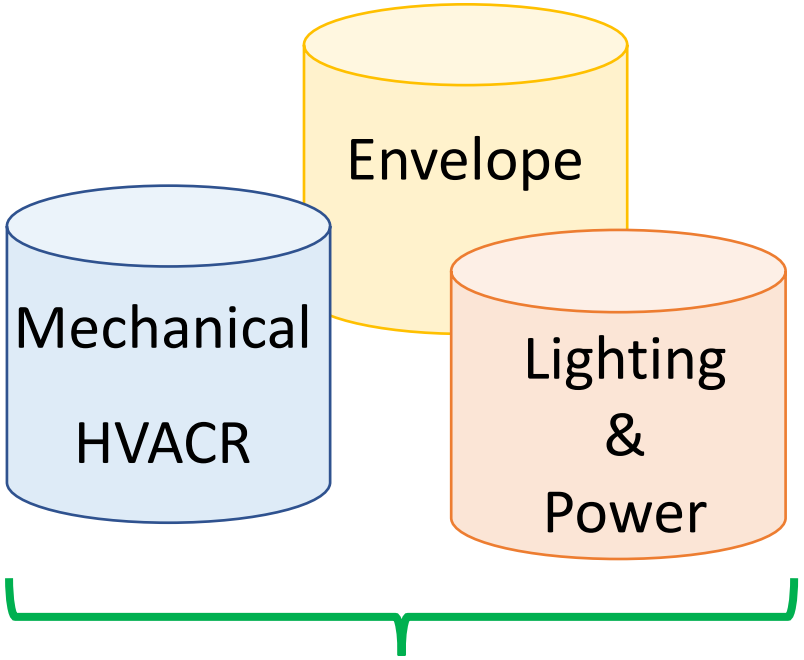
- And hope it works to reach carbon reduction goals

Option 2: Emissions Target

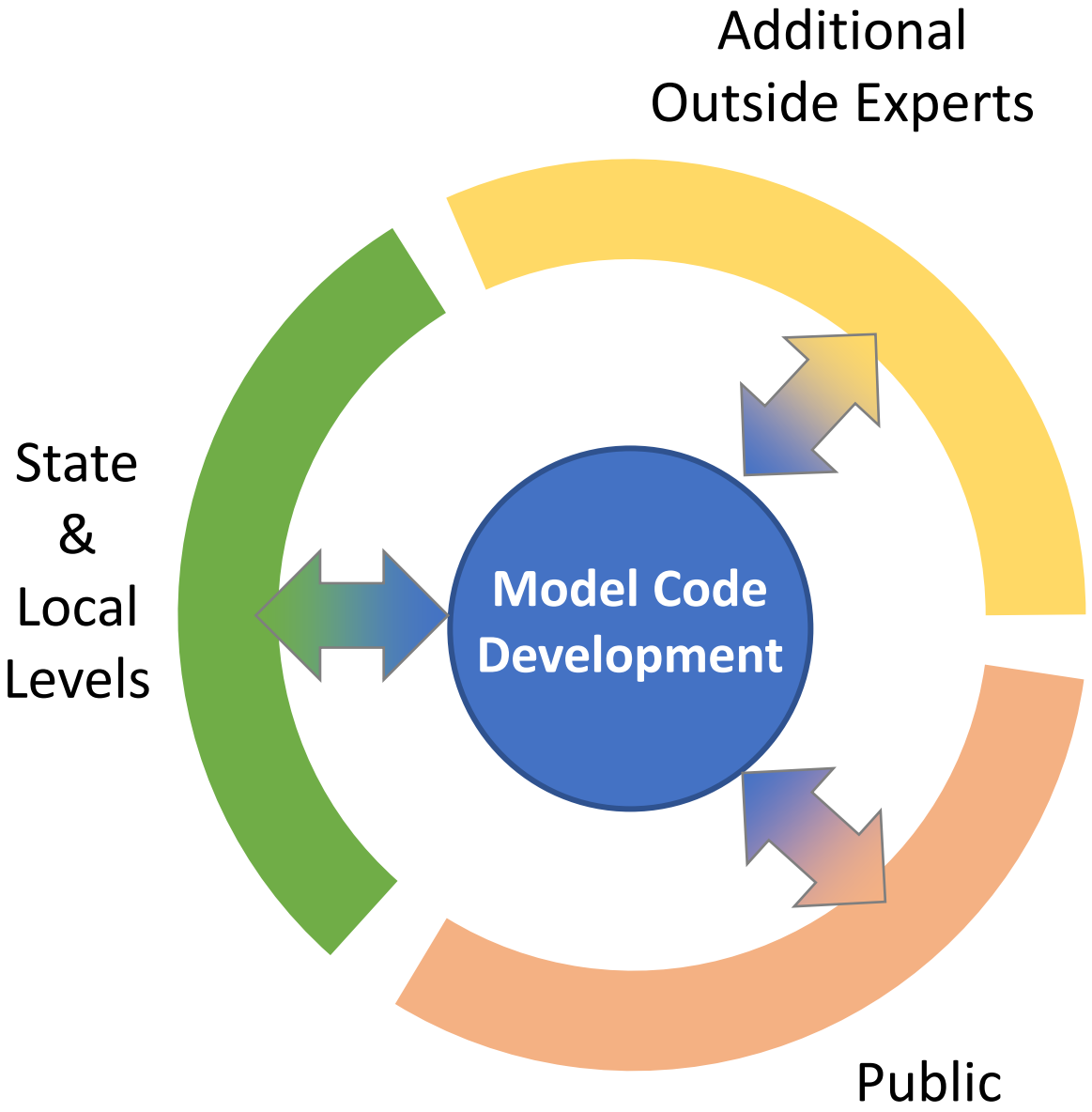
Set an emissions reduction target and evaluate the most cost effective way to reach it

- But this requires a whole building approach and a lot of coordination

Need: Collaboration



- IECC Advisory Groups?
- ASHRAE 90.1's "Net Zero Operational Carbon" Working Group???



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Summary

- Some initial forays into decarbonizing the model energy codes
- Need to rethink structures and processes if focusing on carbon
- Efficiency, beneficial electrification, flexibility, robust offsets
- Several changes are needed to support focus on emissions and to get us on a path net zero carbon model energy codes
- Let's get going!

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Thank you!

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See more here: https://www.aceee.org/blog-post/2023/04/rethinking-model-energy-codes-net-zero-carbon-buildings

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Decarbonizing Energy Codes:
Weighing Effectiveness, Adoptability, and Enforceability

Cornelia Wu
Senior Manager, Codes & Standards
May 3, 2023

About NEEP

A Regional Energy Efficiency Organization

One of six REEOs funded in-part by U.S. DOE
to support state and local efficiency policies and programs.

Northeast Energy Efficiency Partnerships

"Assist the Northeast and Mid-Atlantic region to reduce building sector energy consumption by at least 3% per year and carbon emissions by at least 40% by 2030 (relative to 2001)"

Mission

We seek to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities.

Vision

We envision the region's homes, buildings, and communities transformed into efficient, affordable, low-carbon, resilient places to live, work, and play.

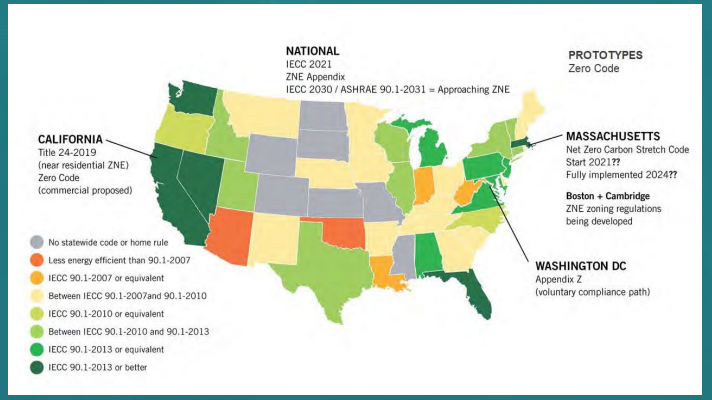
Approach

Drive market transformation regionally by fostering collaboration and innovation, developing tools, and disseminating knowledge

Policies for Energy and Emissions Reduction

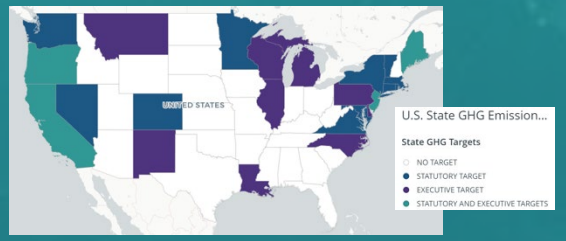
Commitments

- Local, State and Regional Emissions Reduction
- Renewables



Existing Buildings

- Benchmarking
- Building Performance Standards (BPS)
- Clean Heating Standard
- Appliance Standards



New Buildings / Major Renovation

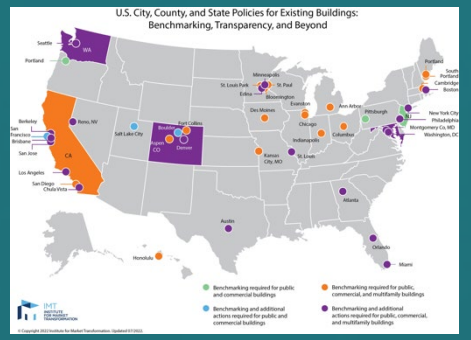
Building Energy Codes: Base Codes, Stretch Codes, Renewables Codes, Zero Codes, and more

Carbon Neutral Zoning and Ordinances

Zero Emissions/Electric Ordinances

Clean Heating Standard

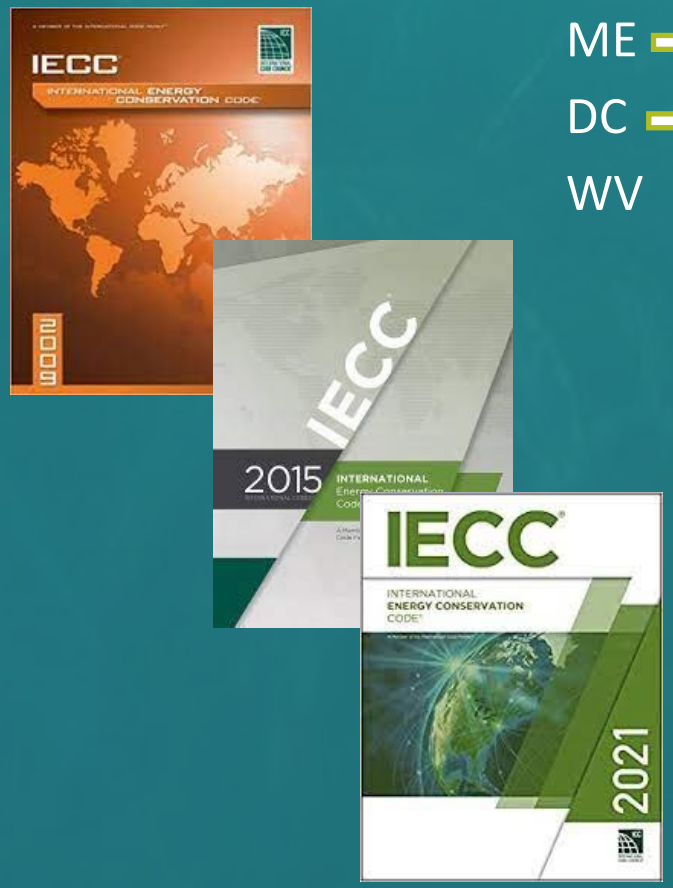
Appliance Standards



State and Regional Emissions Commitments

NEEP Region State Climate Goals				
State	**Baseline Year**	**Near-term Goal**	**Interim Goal**	**Long-term Goal**
Connecticut	2001	10% by 2020	45% by 2030	80% by 2050
Delaware	2005*	45% by 2020*	30% by 2030*	
Maine	1990	10% by 2020	45% by 2030	80% by 2050
Maryland	2006	25% by 2020	40% by 2030	recommends 80% - 95% by 2050
Massachusetts	1990	50% by 2030	75% by 2040	85% by 2050
New Hampshire	1990	10% by 2020	20% by 2035	80% by 2050
New Jersey	2006	1990 emissions level by 2020		80% by 2050
New York	1990	40% by 2030		85% by 2050
Pennsylvania	2005	26% by 2025		80% by 2050
Rhode Island	1990	10% by 2020	45% by 2035	80% by 2050
Vermont	1990	40% by 2030		75% by 2050
Washington D.C.	2006	50% by 2032		100% by 2050
West Virginia				

Building Energy Base Code Adoption
NEEP Region



2015

ME → 2021*

DC → 2021*

WV

2018

MA → 2021*

NY → 2024*

MD → 2021

VT → 2021*

DE → 2021*

RI → 2021*

PA → 2021

NH → 2021

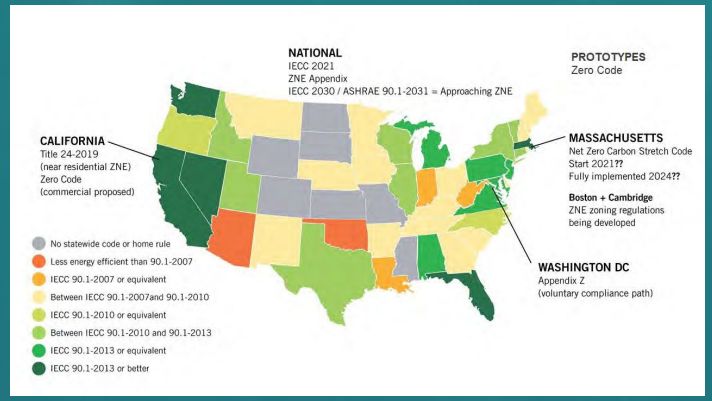
2021

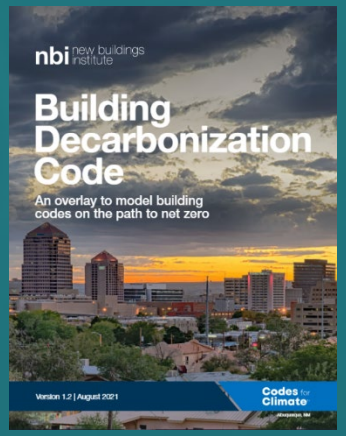
CT

NJ

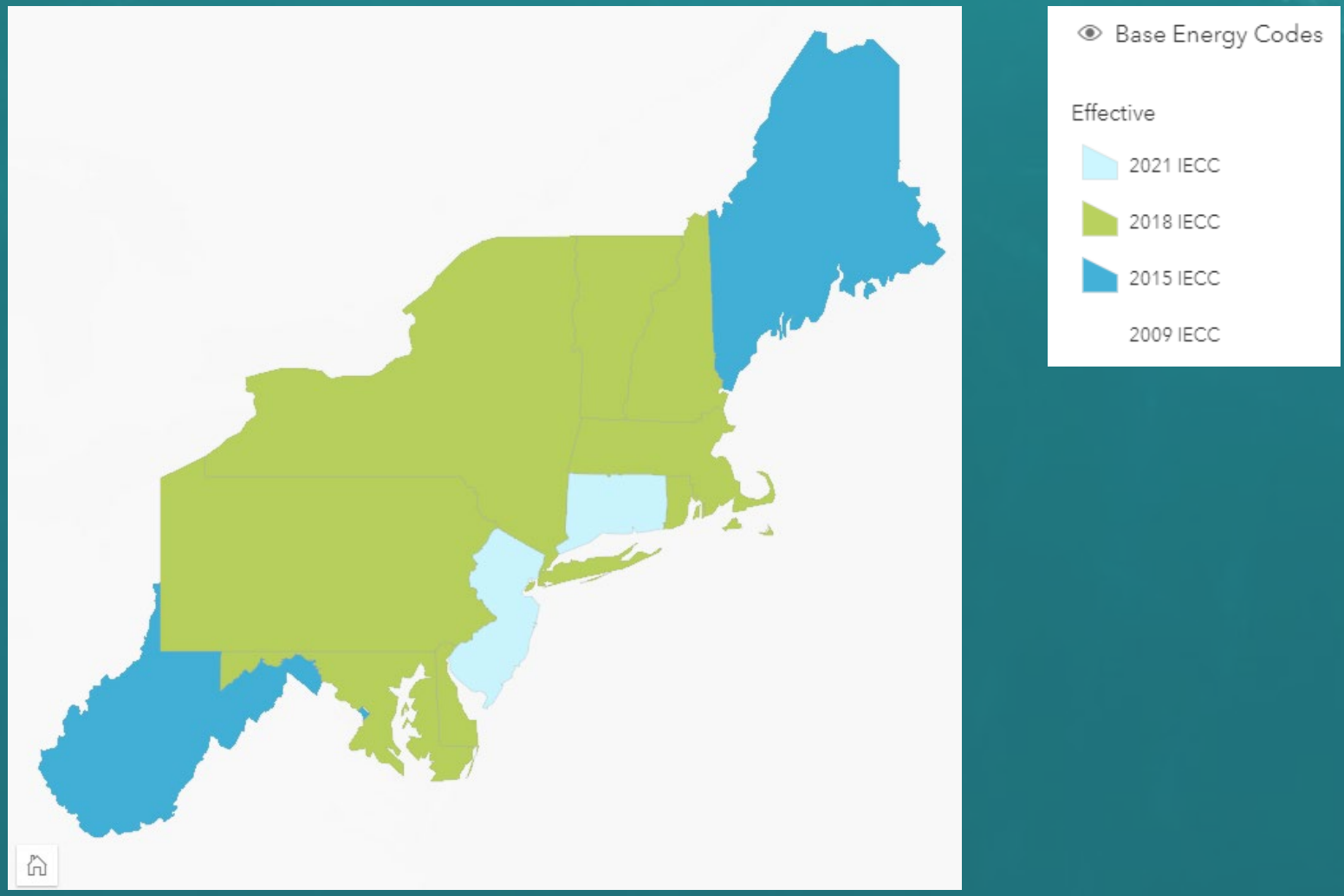
*Updating/creating stretch codes

Stretch Codes

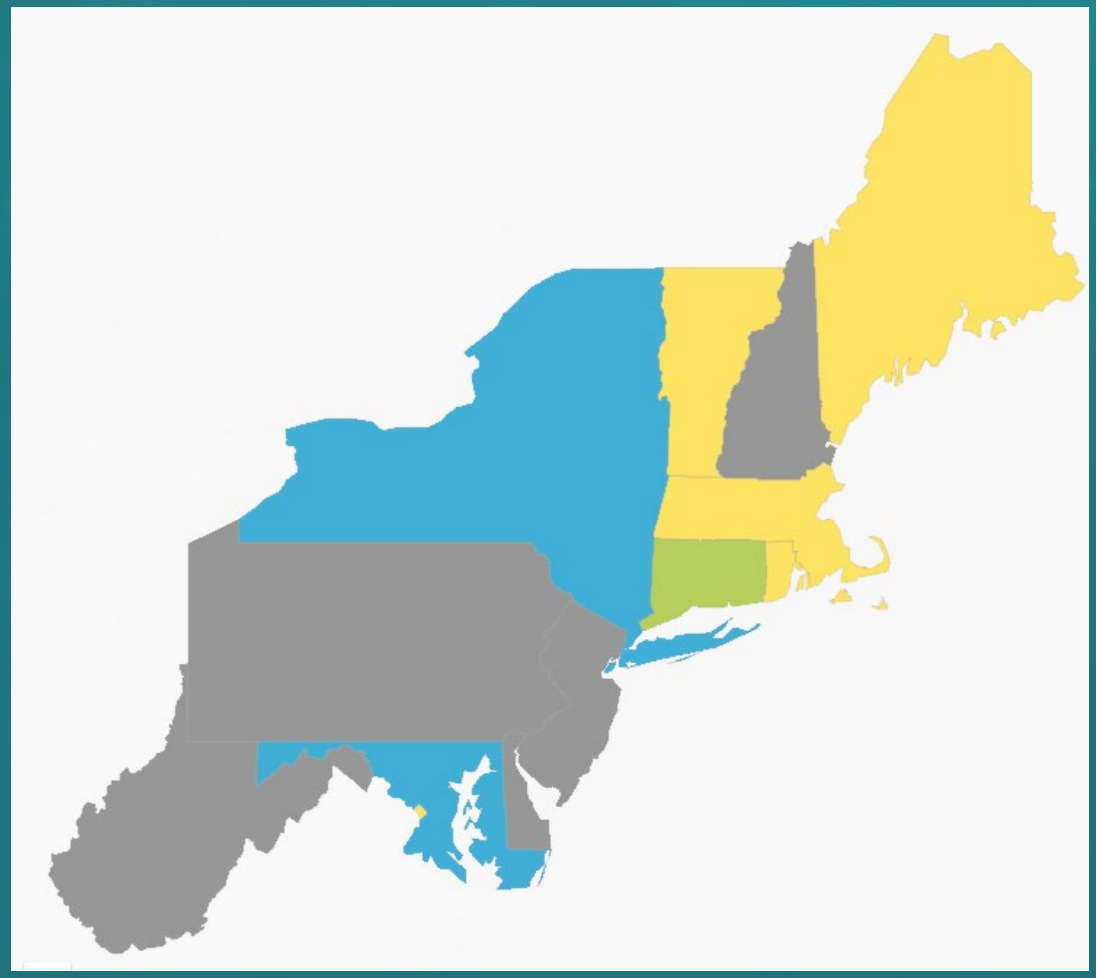




Base Codes
NEEP Region



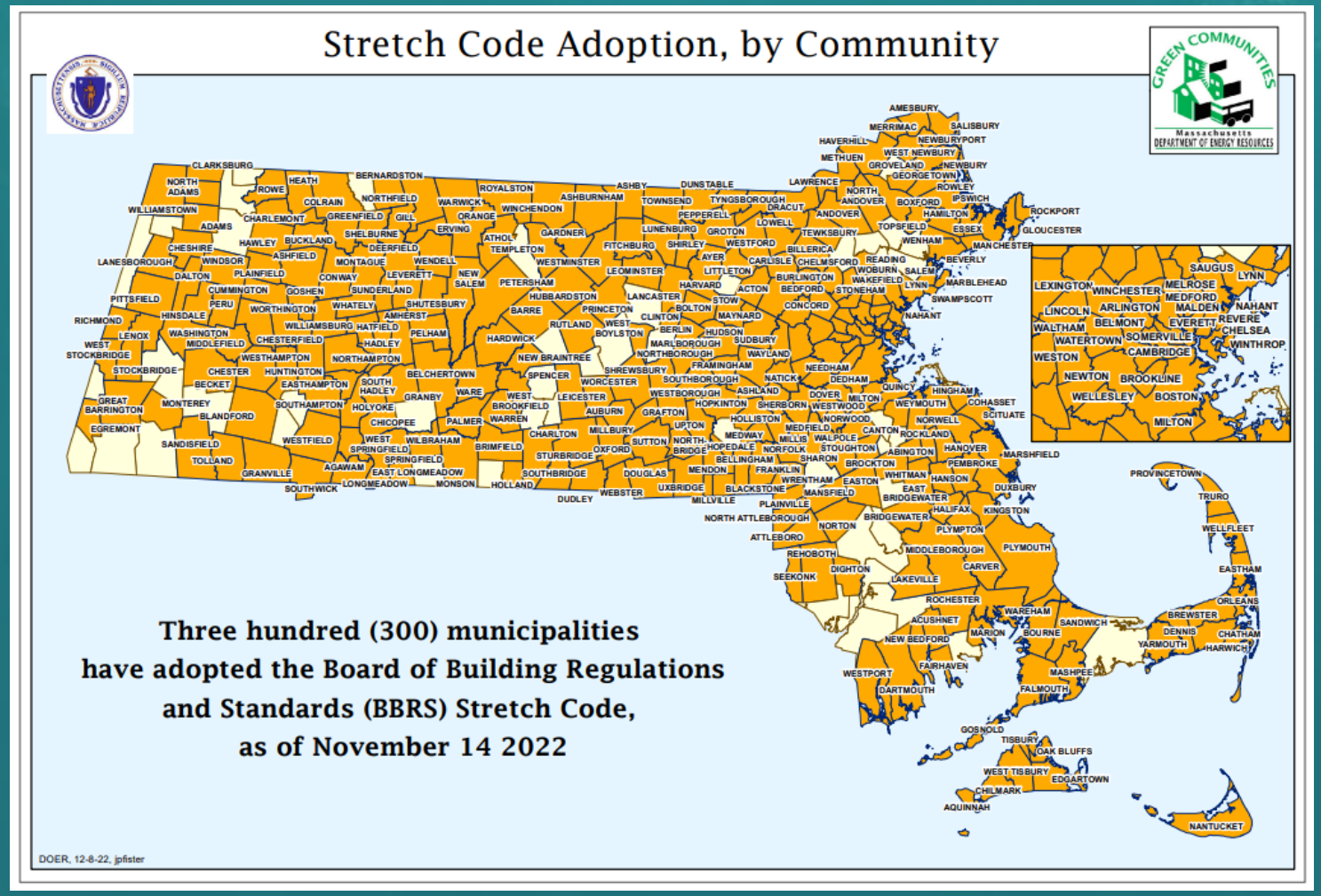
Stretch Codes
NEEP Region



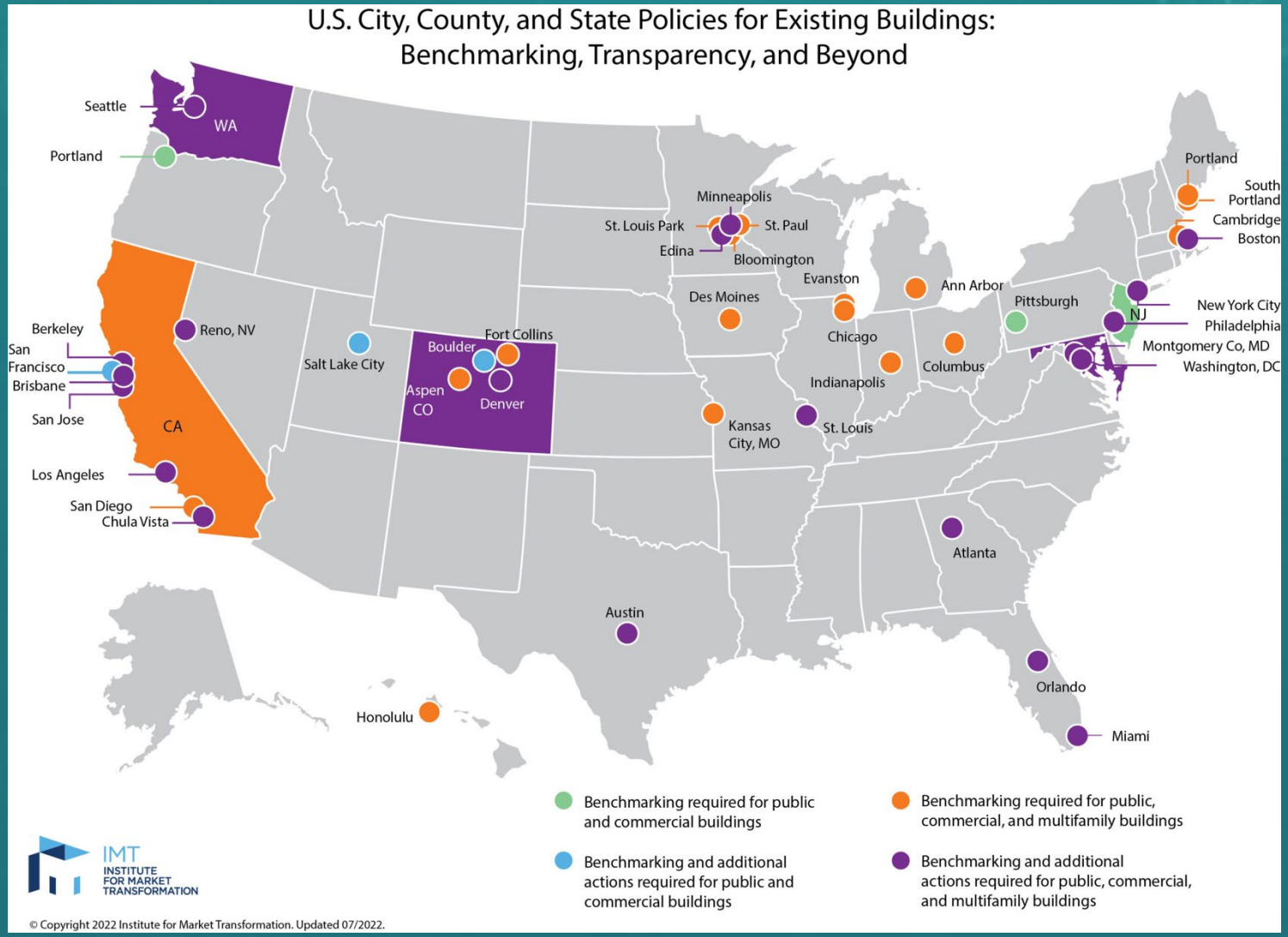
Existing State Stretch Codes NEEP Region

State	Residential	Commercial	Notes
MA	HERS/ERI	Percent Better	Stretch, Muni Opt-In (All Electric-HERS 0)
NY	IECC	IECC/ASHRAE	Updating; ZE base 2026
DC	All new construction electric	Appendix Z (zero energy)	Electrification measures in base code 2021, ZE base 2027
VT	Point Based	Base code additional measures	EV Charging, Solar Ready, Air Sealing, Points, HERS; Embodied Carbon, ZE base 2030
RI	DOE ZERH	IGCC	Updating - Zero Code Option
ME	IECC ZE Appendix	IECC ZE Appendix	2021 IECC
MD		IGCC	Statewide Strech Zero/Elc Code

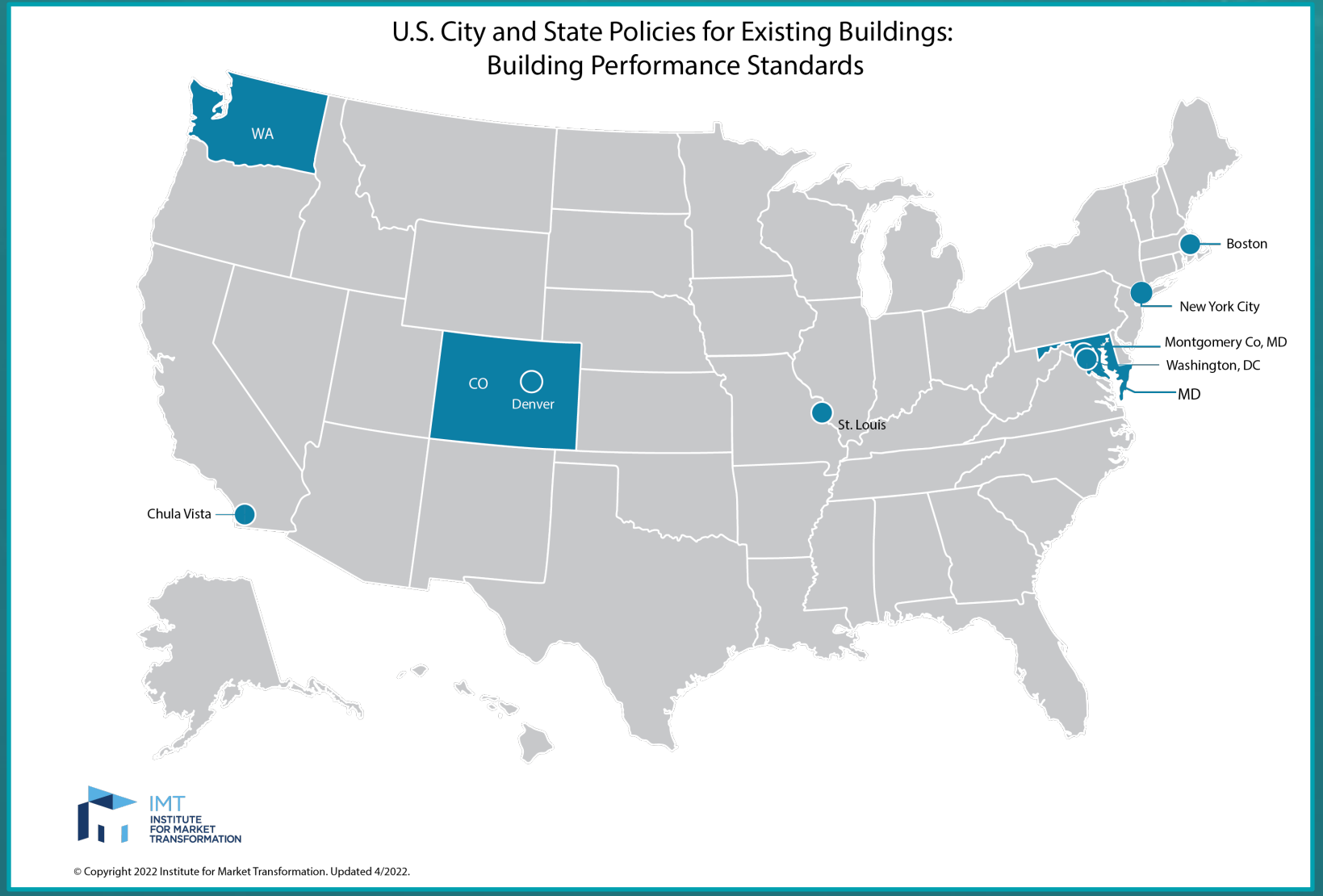
Massachusetts Opt-In Stretch Code Adoption



Benchmarking Existing Buildings



Building Performance Standards (BPS)



Building Performance Standards
NEEP Region

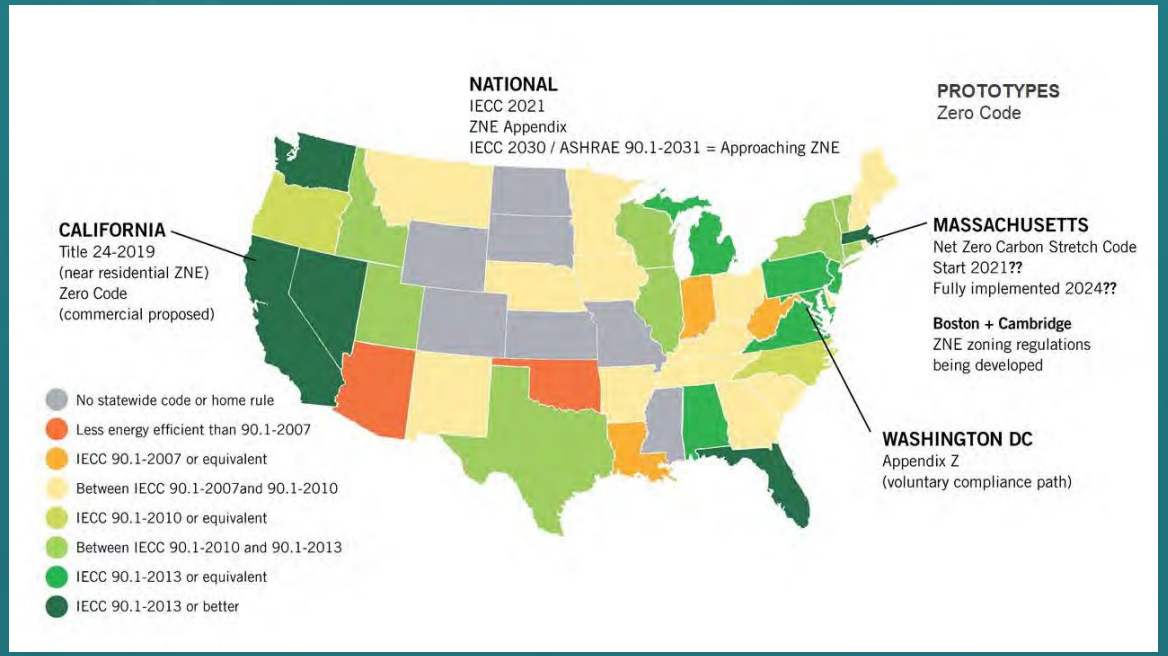
- Boston – BERDO 2.0
  - 50% emissions by 2030 100 % by 2050

- NYC Local Law 97
  - 40% emissions by 2030 2005 baseline

- DC Omnibus Act of 2018
  - 50% emissions by 2032

Zero Energy Codes
NEEP Region

- Washington DC – Appendix Z
- MA – Muni Opt-in ZE Stretch 2022
- On path to zero base code – VT, NY, MA by 2030



Eliminating Combustion and Limiting NOx

- Montgomery County, MD (no incentives for combustion appliances)
- NJ Boiler Rule
- California (BAAQMD & SCAQMD)
- Washington, DC (state building codes council)
- New York (pending)

Appliance Standards:
Existing NOx Emissions Limits from Water Heaters

Texas, Utah, Bay Area, San Joaquin Valley, South Coast, Ventura

Thank you.

For more information, contact:

cwu@neep.org

Decarbonizing Energy Codes: Colorado Perspective

Adam Berry
Senior Program Manager for Building Codes
Colorado Energy Office

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Building Codes in Colorado

- Colorado is a home rule state with over 330 authority-having jurisdictions (AHJs) that can adopt and enforce building codes
- Colorado has two statewide codes - electrical and plumbing
- All other building codes are adopted and enforced at the local level
    - Fewer than 20 AHJs have adopted the 2021 IECC
    - Nearly 80 AHJs have no building codes of any kind
- Colorado has adopted a new minimum energy code that AHJs will have to adopt if they adopt or update any other building code
    - Beginning in July 2023, the minimum code will be the 2021 IECC plus pre-wiring requirements for solar readiness, electric readiness, and EV readiness
    - The minimum code will become a more stringent low energy and carbon code in July 2026

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Low Energy and Carbon Code

- As part of its new minimum energy code requirements, the Colorado Energy Code Board will be developing a new low energy and carbon code that will be required beginning in July 2026
- This code will be based upon the 2024 IECC and will additionally include:
  - Updates to the pre-wiring requirements for solar readiness, EV readiness, and electric readiness
  - Additional voluntary appendices for things like zero energy buildings, all electric buildings, energy storage, on-site renewable energy, and more
  - Any amendments to the 2024 IECC thermal envelope, lighting, electrical systems, or additional efficiency options the Board determines appropriate
  - Pathways for both mixed fuel buildings and all electric buildings with appropriate efficiency requirements

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Importance of Strong Model Codes

- States and AHJs rely on strong model codes to be developed by ASHRAE and ICC to meet emission reduction goals and climate targets in new buildings
- In Colorado, most AHJs adopt the model IECC with few or no amendments
- We rely on strong efficiency improvements nationally for the building envelope, mechanical systems, lighting, appliances, and more to ensure significant progress in energy savings from one code version to the next
- Strong appendices, and perhaps future provisions of the code, for zero energy buildings and all electric buildings, among other things, also provide states and AHJs with needed guidance on steps to take to go beyond code minimums

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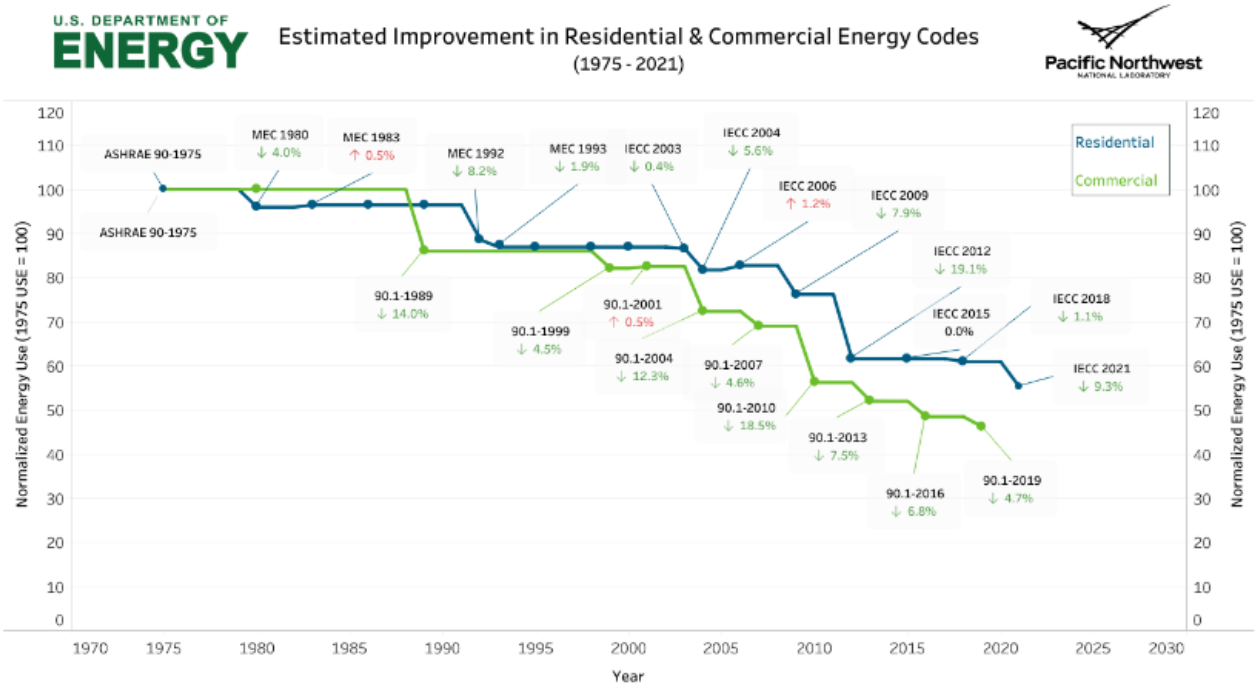
Consistent Incremental Progress

- To achieve a decarbonized future for our buildings, we must make steady progress towards greater efficiency, electrification, on-site renewable energy and storage, and reductions in embodied carbon each code cycle
- Energy codes still need to make significant progress to achieve those goals, and the window of time to make that progress
  - We can no longer afford to punt important advancements for electric readiness, on-site renewable energy, and stronger efficiency requirements to future code cycles
  - Consistent incremental progress also makes it easier for states and AHJs to adjust to code changes overtime and avoid major leaps across code cycles



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Advanced Codes are Feasible Everywhere!

- Colorado has one of the most diverse climates and geographies in the nation, with counties ranging from Climate Zone 4 to Climate Zone 7.
- Even with such diversity, and in many cases extreme climates, several AHJs in Colorado have adopted strong codes that will decarbonize buildings and reduce emissions in their jurisdictions and throughout the state.
- These AHJs are a mix of urban vs. rural and mountain vs. plains communities.

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Crested Butte, Colorado

- Population: ~1,600
- Location: Gunnison County, west-central Rocky Mountains
- Climate Zone 7
- Average summer highs of low 70s, average winter lows of -2 to -6
- First and only AHJ in Colorado to adopt an all electric energy code for all new residential and commercial construction in conjunction with the 2021 IECC
- Also adopted solar ready and solar install requirements as well as EV ready requirements

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Denver, Colorado

- Population: ~715,000
- Location: Front Range, north-central Colorado
- Climate Zone 5B
- Average summer highs of upper 80s, average winter lows of upper teens
- Adopted 2021 IECC with amendments for:
  - Partial electrification of commercial buildings (space and water heating)
  - Electric ready, solar ready, and EV ready requirements for residential and commercial

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Vail, Colorado

- Population: ~4,800
- Location: Eagle County, central Rocky Mountains
- Climate Zone 6B
- Average summer highs of mid 70s, average winter lows of upper single digits
- Adopted 2021 IECC with amendments for solar readiness, EV readiness, and electric readiness in all residential and commercial buildings

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Fort Collins, Colorado

- Population: ~170,000
- Location: Front Range, north Colorado
- Climate Zone 5B
- Average summer highs of mid 80s, average winter lows of upper teens
- Adopted the 2021 IECC with amendments for solar readiness, EV readiness, and electric readiness in residential and commercial buildings

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Current and Future Efforts to Support Decarbonization Codes

- The Colorado Energy Office is developing advanced code provisions as part of our minimum energy code to make it easier for home and building owners to invest in on-site renewable energy, electrification, electric vehicles, and improved energy efficiency.
- CEO also supports training and technical assistance for local governments looking to adopt advanced stretch codes and zero energy codes.
- In the future, CEO intends to provide greater funding and resources to local governments for adoption of green codes, all electric codes, zero energy codes, and more to encourage progress above the statewide minimums.
- CEO also plans to develop a robust workforce development program to educate, train, and certify workers in code compliance and enforcement, construction, design, and more.

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Thank You!

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