NESCAUM

RAP
REGULATORY ASSISTANCE PROJECT

Model Rule: NOx and GHG Emissions Standards for Space and Water Heaters

Webinar Presentation

October 30, 2024

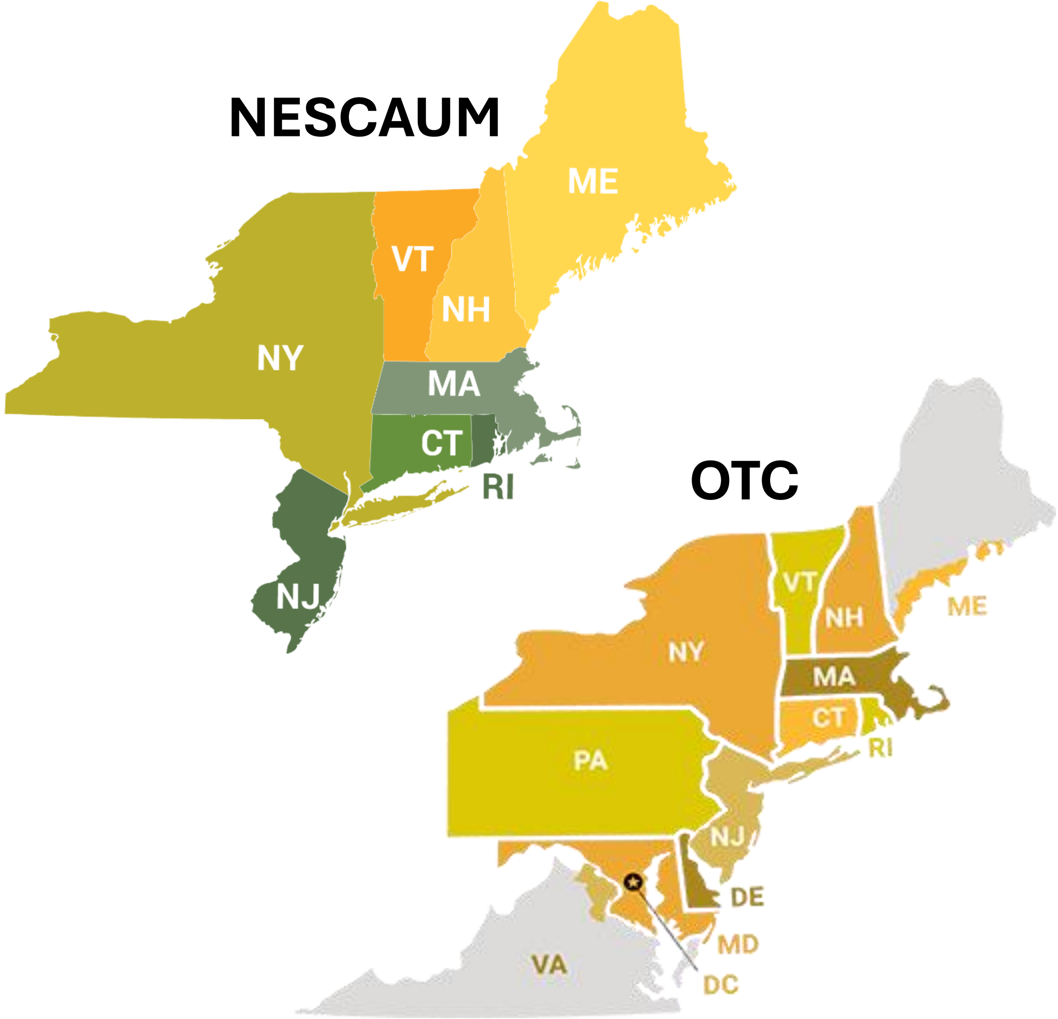
AGENDA

1	Introduction		
2	Zero-Emission Heating Equipment Standards	RAP REGULATORY ASSISTANCE PROJECT	**Nancy Seidman**
3	Model Rule Development & Overview	NESCAUM	**Emily Levin**
4	Emission Reductions and Health Impacts	NESCAUM	**Mahdi Ahmadi**
5	Cost and Market Analysis	Energy Solutions	**Kyle Booth**
6	Q&A		

Northeast States for Coordinated Air Use Management (NESCAUM)

As the regional nonprofit association of state air quality and climate agencies in the Northeast, NESCAUM:

- Assists member states in meeting air quality, climate, and environmental justice goals
- Provides scientific, technical, analytical and policy support to states
- Collaborates with states outside the region to advance zero-emission buildings and vehicles
- Operates the Ozone Transport Commission (OTC), charged with developing and implementing regional solutions to ground-level ozone in the Northeast and Mid-Atlantic



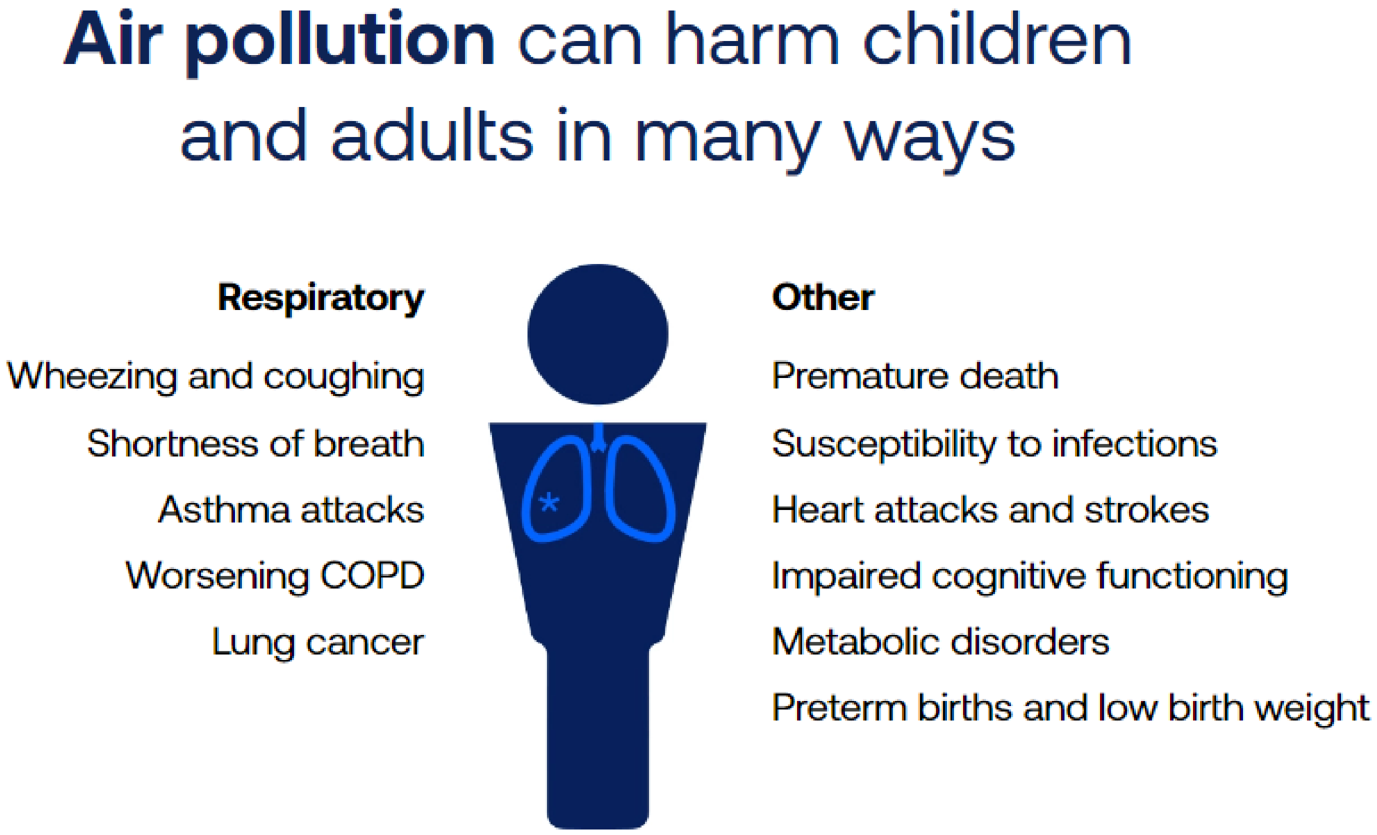
October 30, 2024

Context for the Model Rule

Nancy L Seidman, Senior Advisor, RAP

Combustion Creates Air Pollution – Buildings are Key

- Criteria air pollutants:
  - NOx
  - PM2.5
  - Ozone
- Greenhouse gases (GHG):
  - CO2 from fossil fuel combustion
  - Methane



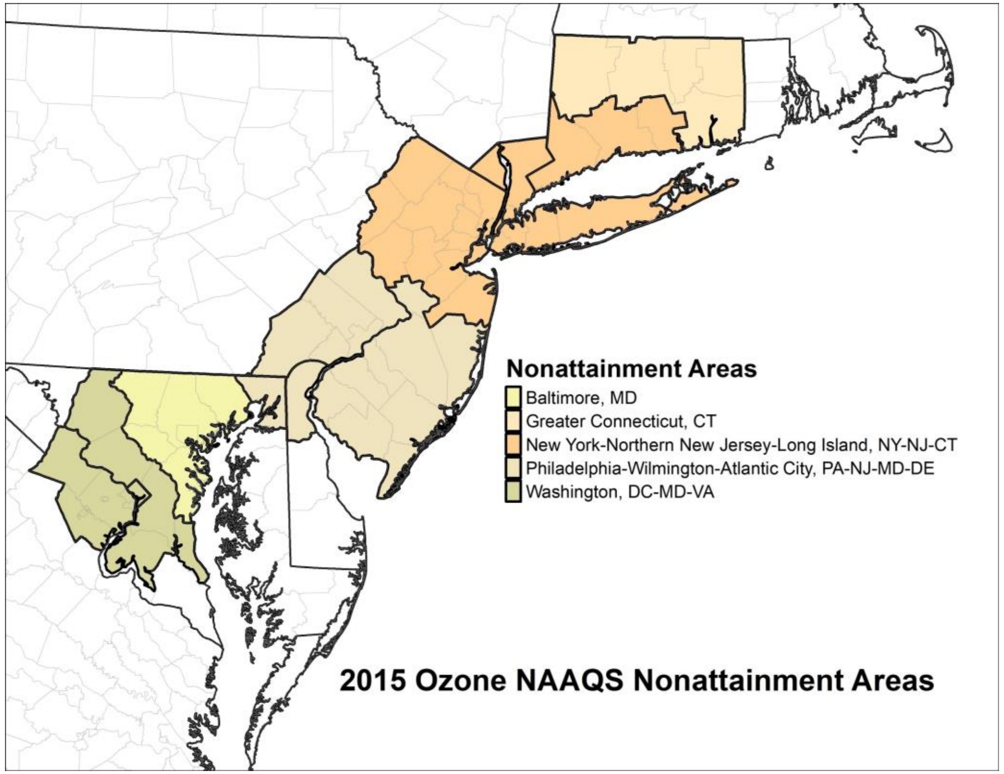
Source: https://www.lung.org/research/sota/health-risks

Ozone Nonattainment in the Northeast and Mid-Atlantic

- NOx emissions from burning fossil fuels in buildings contribute to ozone non-attainment in the region

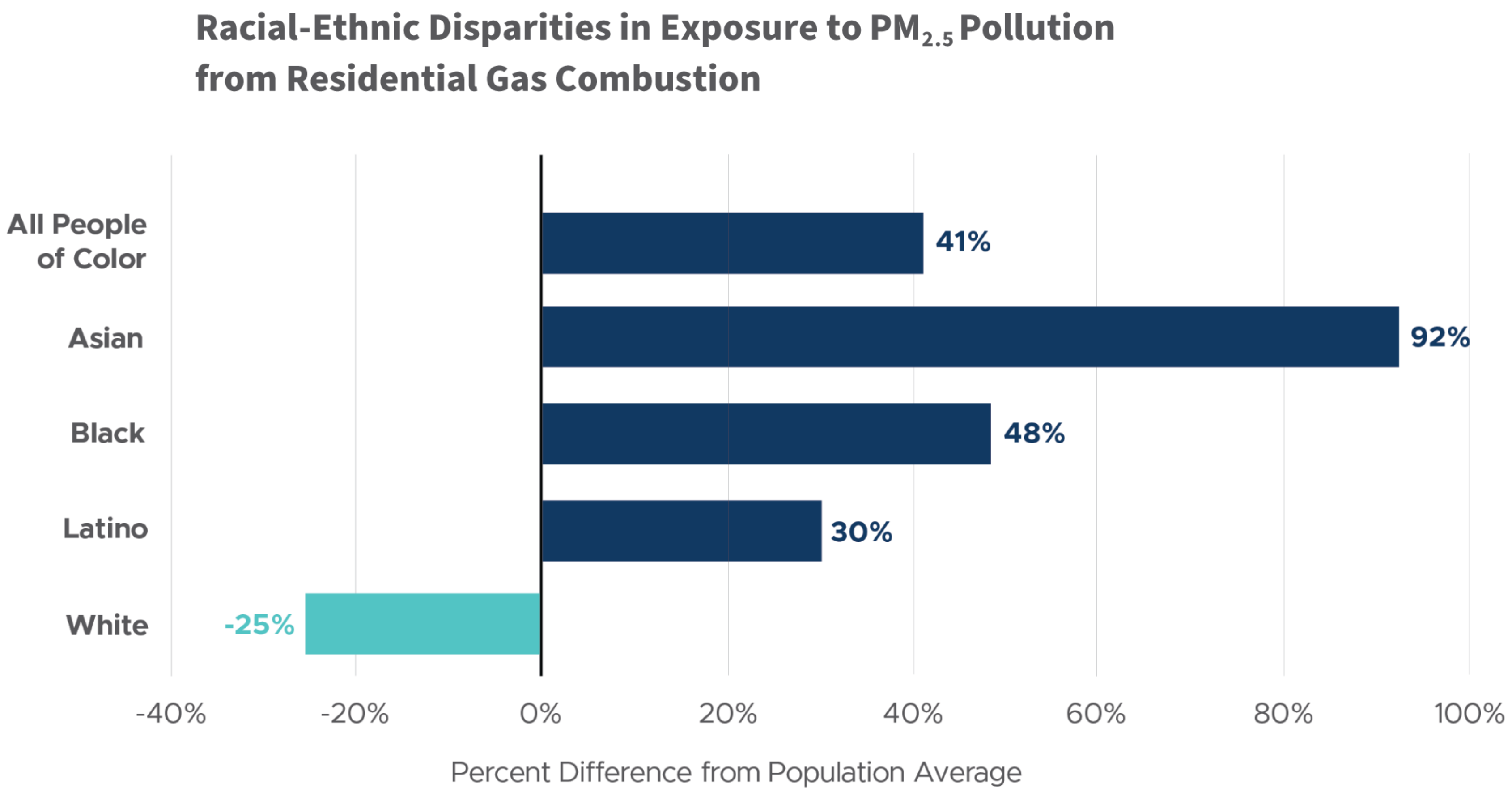
Nonattainment Area	Population	2015 NAAQS Status	2008 NAAQS Status
Greater Connecticut, CT	1,629,115	Marginal[a]	Serious
New York City, NY-NJ-CT	20,217,137	Moderate	Serious[b]
Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE	7,437,135	Marginal[a]	Marginal
Baltimore, MD	2,662,691	Marginal[a]	Moderate
Washington, DC-MD-VA	5,136,216	Marginal[a]	Maintenance

Source: EPA Air Quality Design Values, https://www.epa.gov/air-trends/air-quality-design-values#report. Accessed April 25, 2022.



70 ppb 8-hr average 2015 ozone NAAQS (National Ambient Air Quality Standard)

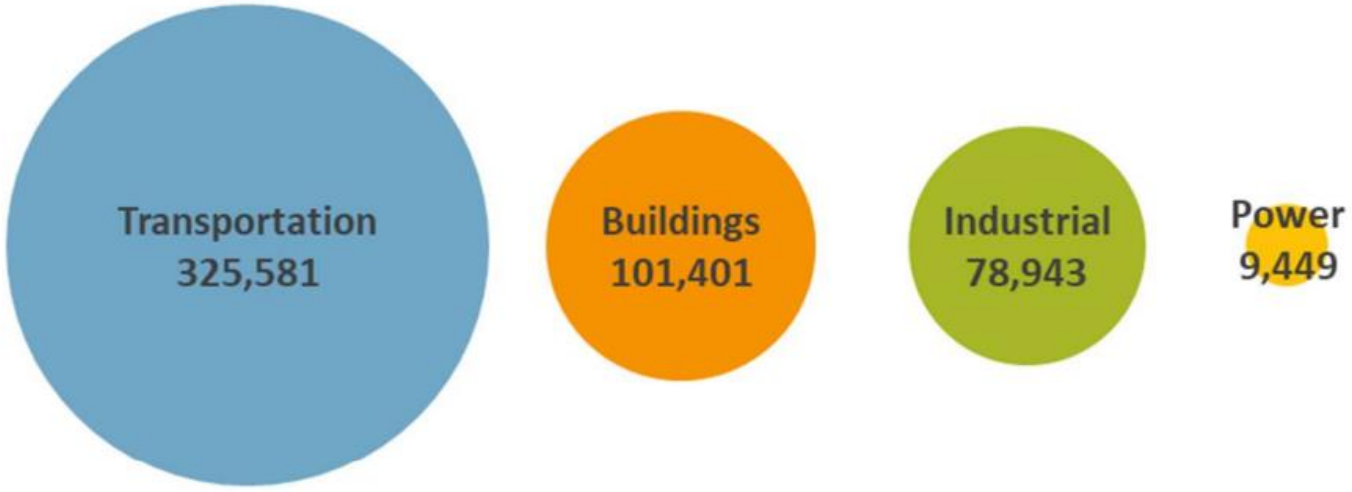
Pollution from Combustion Equipment in Buildings Disproportionately Harms People Of Color



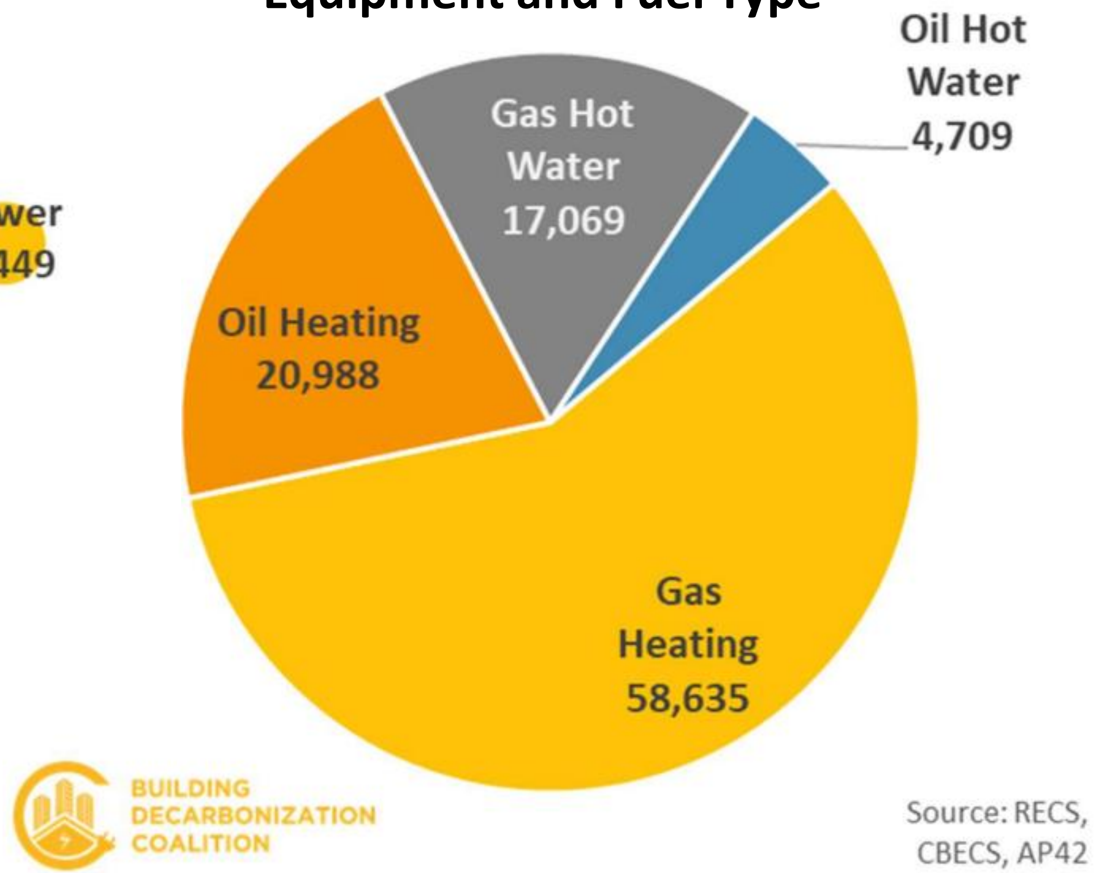
People of Color are exposed to nearly **twice as much** $PM_{2.5}$ formed by residential gas equipment as Whites.

Source: Christopher W. Tessum et al., *$PM_{2.5}$ Polluters Disproportionately and Systematically Affect People of Color in the United States*, 7 Sci. Adv. eabf4491 (2021).

NOx Emissions (Tons) From Onsite Fossil Fuel Combustion in Residential Buildings in the Northeast

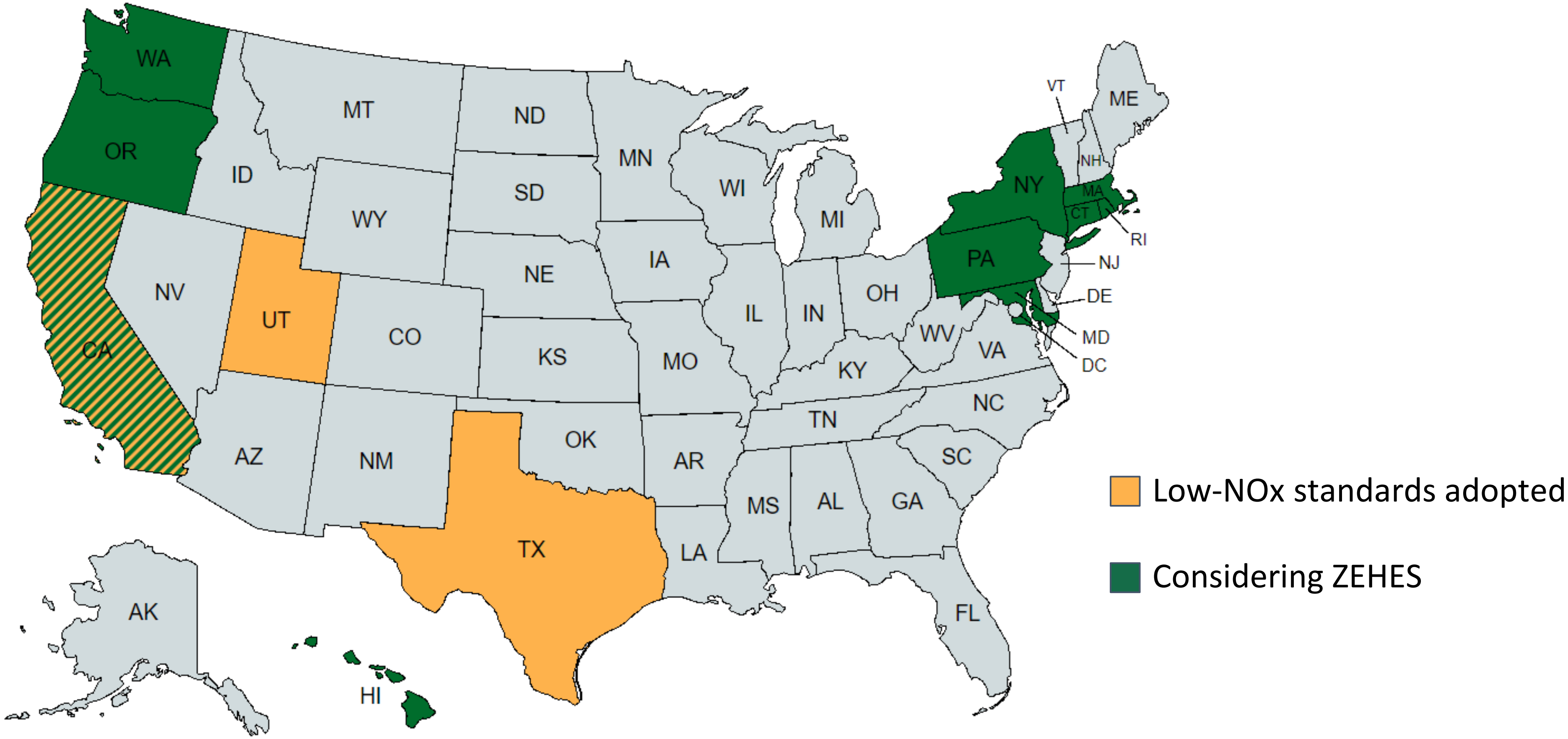


Breakdown of Building NOx Emissions by Equipment and Fuel Type



Source: Building Decarbonization Coalition 2022; 2020 data– EIA State Energy System Data, AP42.

Three states have adopted low-NOx standards for water heaters and at least ten states are considering ZEHES



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Status of State and Air District ZEHES Regulations

Bay Area Air Quality Management District

Bay Area (CA) air regulators adopted the nation's first zero-emission standards for water heaters and furnaces in February 2023

South Coast AQMD

South Coast (CA) air regulators adopted zero-emission standards for large water heaters in June 2024; working now on standards for small furnaces and water heaters

California Air Resources Board

California Air Resources Board (CARB) committed to implement zero-emission standards by 2030 in its 2022 ozone reduction plan; currently developing regulations for water heaters and furnaces

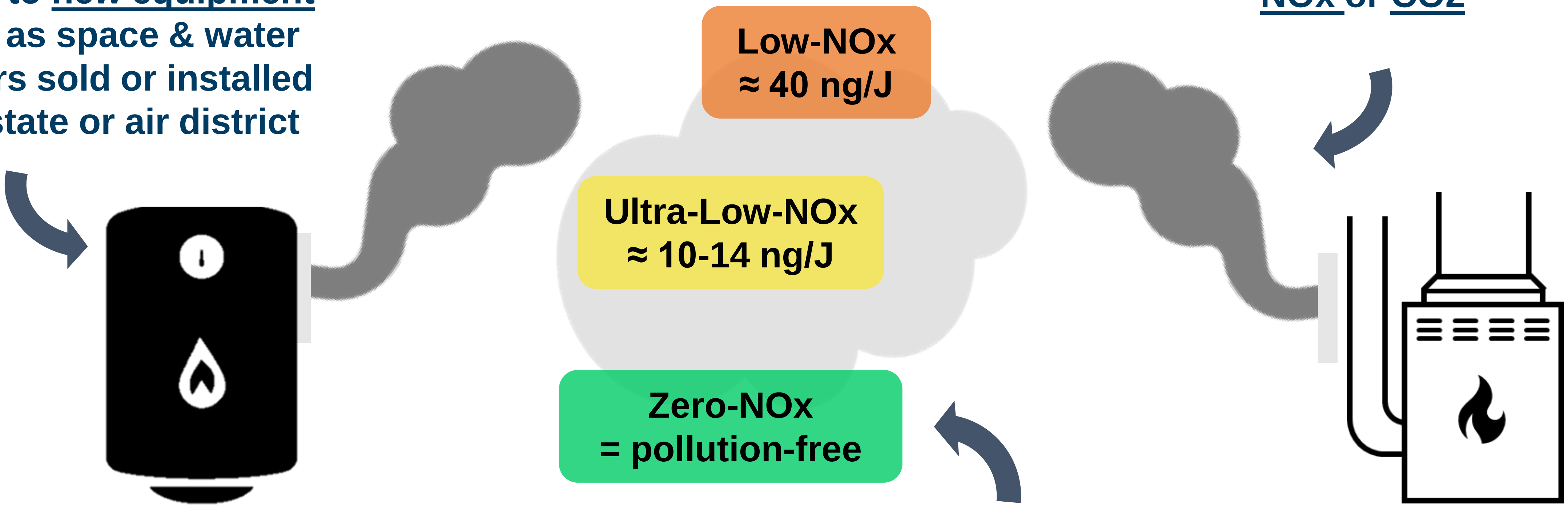
Maryland Department of the Environment

Maryland is developing a ZEHES regulation as directed by its December 2023 Climate Pollution Reduction Plan and June 2024 Executive Order

Zero-Emission Heating Equipment Standards (ZEHES) Overview

Apply to new equipment such as space & water heaters sold or installed in a state or air district

May target NOx or CO_2



Phase in over time, to achieve zero emissions by 2030

Limit emissions per unit of heat output

ZEHES are Sticks, not Carrots!

- Building energy codes
- Appliance efficiency standards
- Building energy performance standards (BEPS)
- **Zero-emission heating equipment standards (ZEHES)**

- Utility efficiency programs
- ENERGY STAR certification
- Incentives and financing
- Education campaigns
- Solar incentives and net metering

Image source: Shutterstock, Etsy

Benefits of Zero-Emissions Heating Equipment Standards

- **Market signal:** Sets a clear date for market transition to zero-emission technologies
- **Feasible:** Zero-emission technologies like heat pumps are available for most applications and perform well in cold climates
- **Effective:** Tackles the major sources of building pollution at time of equipment turnover
- **Fills a Gap:** Unlike BEPS, addresses pollution from small buildings; unlike energy codes, applies to new and existing buildings
- **Equitable:** Can be designed and implemented equitably and affordably with proactive engagement of industry and EJ stakeholders

NESCAUM

Model Rule Overview

Emily Levin, Senior Policy Advisor, NESCAUM

October 30, 2024

Equipment Emission Standards Cohort (EESC)

- [U.S. Climate Alliance announcement at Climate Week 2023]
- Ten member states committed to explore adoption of zero-emission standards for space and water heating equipment (CA, CT, HI, MA, MD, NY, OR, PA, RI, WA)
- NESCAUM and U.S. Climate Alliance are co-convening an Equipment Emission Standards Cohort (EESC) of states interested in this policy

Model Rule Development Partners and Process

Emissions Equipment Standards Cohort (EESC)

Maryland Department of the Environment; Vermont Department of Environmental Conservation; RIDEM; DEQ; Department of Energy & Environment; MassDEP; MassCEC; New Jersey Department of Environmental Protection; New York State; Connecticut Energy & Environment; British Columbia Ministry of Energy, Mines and Low Carbon Innovation; CARB

Consultants & Partners

RAP Regulatory Assistance Project; Energy Solutions; Dwight Alpern; EJ Advisory Group

- Review Statutory and Regulatory Authority to Regulate Emissions from Space and Water Heaters
- Research on Emissions, Health, and Cost Impacts
- Draft Model Rule and Technical Support Document (TSD)
- Collect Stakeholder Input
- Publish Model Rule and TSD 1.0

Inputs to the Model Rule

NOx Standards for Water Heaters published by RAP in February 2023

Assessment of emissions and health impacts of transitioning to zero-emission equipment

Input from stakeholders, including manufacturers and members of NESCAUM's Environmental Justice Advisory Group

Scoping proposals and decisions for zero-emission equipment standards by BAAQMD (final), South Coast AQMD (final and in progress), and CARB (in progress)

Recommendations from Energy Solutions on factors such as market prevalence of fuel and equipment types, equipment definitions, and market readiness

Assessment of the cost and market feasibility of installing air-source heat pumps (ASHPs) and heat pump water heaters (HPWHs)

Model Rule: NOx and GHG Emissions Standards for Space and Water Heaters

Intended Use of the Model Rule

- Provides a template for states interested in developing ZEHES regulations to improve air quality and reduce GHG emissions
- Model Rule is nonbinding and can be adapted by states as they see fit
- States that use the Model Rule must still go through a full regulatory and stakeholder process
- NESCAUM intends to release future updates (Model Rule 2.0, etc.) to add other equipment types and incorporate new information

MARYLAND MATTERS

GOV & POLITICS | ENVIRONMENT | HEALTH | EDUCATION | JUSTICE | TRANSPORTATION | WORK & THE ECONOMY

CLIMATE CALLING | ENVIRONMENT

Moore calls for zero-emission heating systems in Maryland buildings

Executive order also directs state agencies to deliver climate plans

Source: https://www.wypr.org/wypr-news/2024-06-05/maryland-governor-moore-mandates-statewide-climate-action-with-new-executive-order; https://marylandmatters.org/2024/06/04/moore-calls-for-zero-emission-heating-systems-in-maryland-buildings/

Model Rule Provisions

Travel Wild

Model Rule 1.0:

DOES NOT require early replacement of functioning space and water heaters

DOES ensure that polluting equipment will be replaced with zero-emission alternatives at end of life

Key Provisions:

- **Zero-NOx and zero-GHG emissions limits** for small water heaters, furnaces, and boilers sold, leased, or installed starting in 2029.
- **Ultra-low NOx emissions limits** for small and large water heaters sold, leased, or installed starting 12 months after rule promulgation.
- **Labeling and record-keeping requirements** for manufacturers, refurbishers, distributors, and retailers of space and water heaters.

Model Rule 1.0 Details

Equipment Category	Definition	Ultra-Low-NOx Compliance Date	Ultra-Low-NO_X Emissions Limits	Zero-NO_X & Zero-GHG Compliance Date	Zero-NO_X & Zero-GHG Emission Limits
Category 1 water heater	Designed to combust methane gas: • Storage water heaters <75,000 Btu/hr	[12 months after rule promulgation]	10 ng NO_X/j	January 1, 2029	0 ng NOx/j 0 g GHG/j
Category 2 water heater	Designed to combust methane gas: • Storage water heaters ≥75,000 and ≤105,000 Btu/hr • Instantaneous water heaters <200,000 Btu/hr	[12 months after rule promulgation]	14 ng NO_X/j	January 1, 2029	0 ng NOx/j 0 g GHG/j
Category 3 water heater	Designed to combust methane gas: • Storage water heaters >105,000 and ≤ 2,000,000 Btu/hr • Instantaneous water heaters ≥200,000 and ≤2,000,000 • Hot water boilers ≥300,000 and ≤2,000,000 Btu/hr	[12 months after rule promulgation]	14 ng NO_X/j	———	———
Category 4 water heater	Designed to combust heating oil or propane: • Storage and instantaneous water heaters <210,000 Btu/hr	———	———	January 1, 2029	0 ng NOx/j 0 g GHG/j
Category 1 boiler	Designed to combust methane gas, oil, or propane: • Boilers <300,000 Btu/hr	———	———	January 1, 2029	0 ng NOx/j 0 g GHG/j
[Category 2 boiler]	Designed to combust methane gas, oil, or propane: • Boilers ≥300,000 and ≤2,000,000 Btu/hr	[RESERVED]			
Category 1 furnace	Pipeline gas, oil, and propane furnaces <225,000 Btu/hr	———	———	January 1, 2029	0 ng NOx/j 0 g GHG/j
[Category 2 furnace]	Pipeline gas, oil, and propane furnaces 225,000-2,000,000 Btu/hr	[RESERVED]			

Pollutants Covered

Nitrogen Oxides (NOx)

- **Health Threat:** Form ground-level ozone and secondary PM2.5
- **Air Quality Requirements:** NOx emissions limits can help states reach ozone NAAQS attainment
- **Environmental Damage:** Reduce acid rain, eutrophication, haze

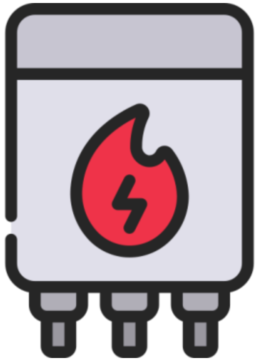
Combustion GHGs

- **Multiple Gases:** CO2, Methane, Nitrous Oxide
- **GHG Reduction Requirements:** State statutory requirements to reduce GHG emissions
- **Climate Change:** Mitigate public health and environmental harm from global warming


GlacierNPS

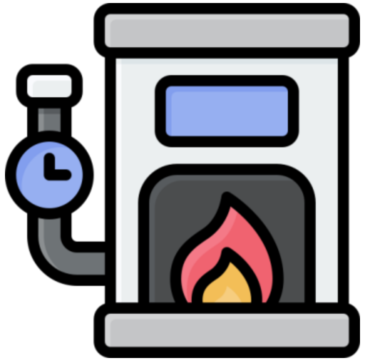

Pixabay

Covered Equipment and Compliance Dates for Zero-Emissions



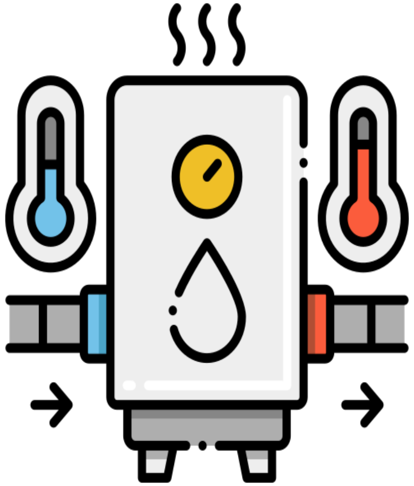
Small Boilers

Small boilers <300,000 Btu/hr designed to combust methane gas, propane, or heating oil



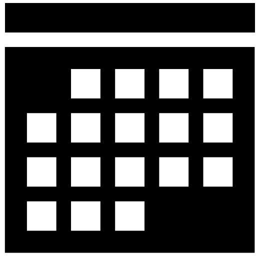
Small Furnaces

Furnaces <225,000 Btu/hr designed to combust methane gas, propane, or heating oil



Small Water Heaters

- Methane gas storage water heaters ≤105,000 Btu/hr
- Methane gas instantaneous water heaters <200,000 Btu/hr
- Oil and propane storage and instantaneous water heaters <210,000 Btu/hr



Compliance Date:
January 1, 2029
Zero-NOx, Zero-GHG

Images: Flaticon.com

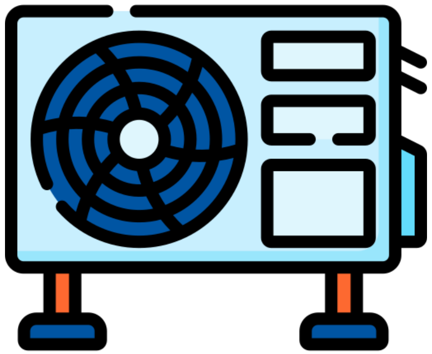
Zero-Emission Technology Options

Hydrogen Combustion

Burning hydrogen is GHG free, and can be NOx free with proper controls

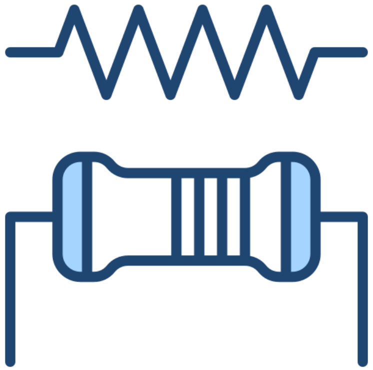
Heat Pumps

Use refrigerant to transfer heat from place to place; can also be used for cooling



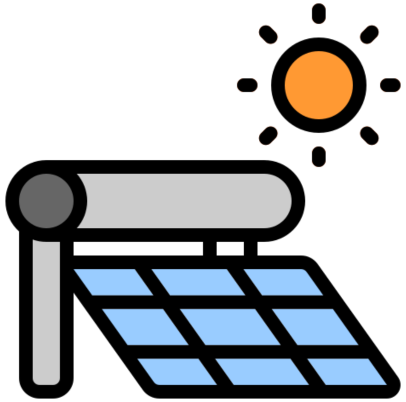
Electric Resistance

Uses electricity to generate heat via heating coils



Solar

Uses solar power to create hot water or air



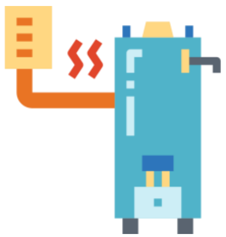
Images: Flaticon.com

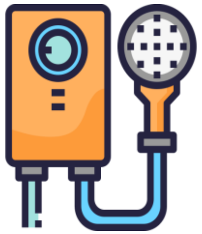
Covered Equipment and Compliance Dates for Ultra-Low-NOx

Smallest Methane Gas Water Heaters

Storage water heaters <75,000 Btu/hr

→ **10 ng/J** →





Small-Medium Methane Gas Water Heaters

- Storage water heaters ≥75,000 and ≤2,000,000 Btu/hr
- Instantaneous water heaters ≤2,000,000 Btu/hr
- Hot water boilers ≥300,000 and ≤2,000,000 Btu/hr

→ **14 ng/J** →

Compliance Date:

12 Months After Rule Promulgation

Images: Flaticon.com

Recordkeeping, Labeling, and Enforcement

The model rule is designed to operate like a product rule enforced mainly through **manufacturers, distributors, and retailers** – not installers or end users

Record-Keeping

- Applies to **manufacturers, refurbishers, distributors, and retailers**
- Requires maintenance of sales records for **5 years**
  - Brand name, product line, model & serial numbers
  - Certification status
  - Dates of manufacture, sale, and/or shipment
- Records **may be inspected** upon request

Labeling

- Applies to **manufacturers, refurbishers, distributors, and retailers**
- Requires labels on **shipping containers and physical equipment**
  - Model & serial numbers
  - Date of manufacture
  - Certification status
  - Maximum heat input capacity

Enforcement

- Applies to **manufacturers, refurbishers, distributors, retailers, and installers**
- Violations discovered through records inspections or other means may be subject to fines or penalties **per piece of equipment involved**

Temporary Installations & Exclusions

Temporary Installations

Who: Home and building owners who need an emergency replacement and building upgrades before installing compliant equipment

What: Temporary leasing of non-compliant allowed for up to six months

How: Manufacturers or installers apply to their state environmental agency to be a ‘registered provider’ and provide temporary leasing of equipment

Requirements: Registered providers must maintain leasing/installation records and are subject to enforcement

Exclusions

These equipment types are excluded or not covered by the Model Rule:

Not Covered

Direct Heating

Less Common Fuels

Electric Equipment

Excluded

Industrial Equipment

Recreational Vehicles

Pool Heaters

Images: Flaticon.com

Supporting Information and Implementation Resources

Image: Flickr; Robbie Shade

Technical Support Document

Policy Development

- Overview of Space and Water Heating Technologies
- Policy Landscape for ZE Standards
- Model Rule Summary
  - Development Process
  - Objectives
  - Use
  - Key Provisions
- Model Rule Details & Rationale
  - Regulated Pollutants
  - Covered Equipment
  - Compliance Dates
  - Enforcement & Penalties
  - Exemptions

Technical Support

- Stakeholder input
  - EJAG Input
  - Manufacturer Feedback
- Implementation considerations
  - Community Engagement Best Practices
  - Program Implementation
- Emissions Reductions
- Health Impacts Screening
- Cost Analysis
  - Installation & Operating Costs
  - Net Present Value
  - Incremental Cost/Ton Avoided Emissions

EJAG Input & Community Engagement Best Practices

EJAG Recommendations

- Minimize exemptions and make them temporary
- Allow for affordable housing compliance delays
- Create funding carveouts to help LMI households afford the transition and energy bills
- Prevent electric resistance from becoming the preferred alternative for landlords

Community Engagement

Make Engagement Easy (provide compensation, translation, childcare, convenient times, transportation)

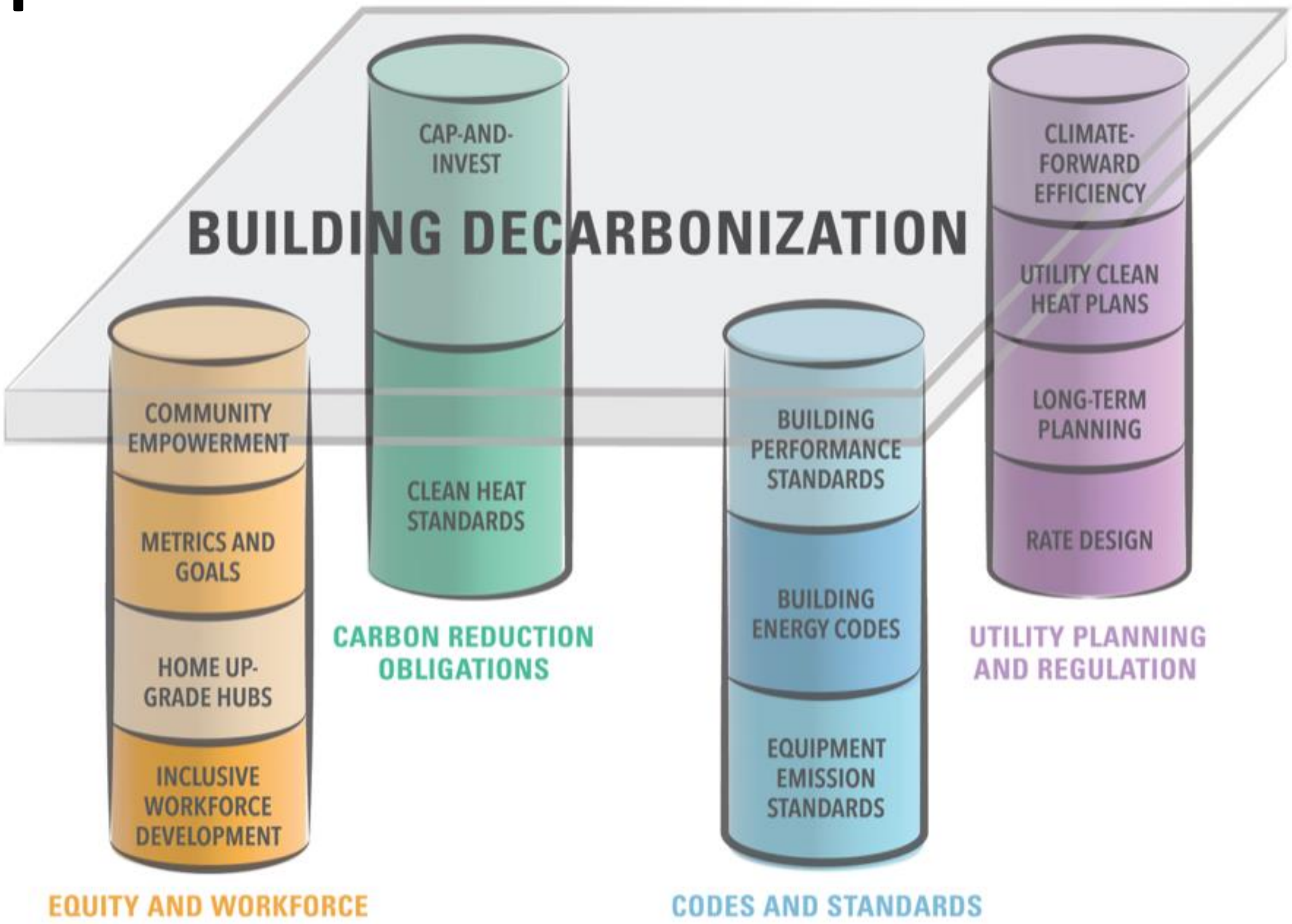
- Include communities from the start of policy development
- Facilitate community-led discussions
- Partner with community-based organizations
- Identify and engage all communities that may be impacted
- Be transparent regarding all community exchanges and decisions made

Case Study: DC DOEE "Power on the Block" events

ZEHES Should Be Part of a Comprehensive Approach to Building Decarbonization

Policy brief: Decarbonizing Buildings: How States Can Set the Table for Success

RAP® neep NESCAUM



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Zero-Emission Space and Water Heating: Emissions Savings and Health Benefits Analyses

Mahdi Ahmadi, Energy & Environmental Analyst, NESCAUM

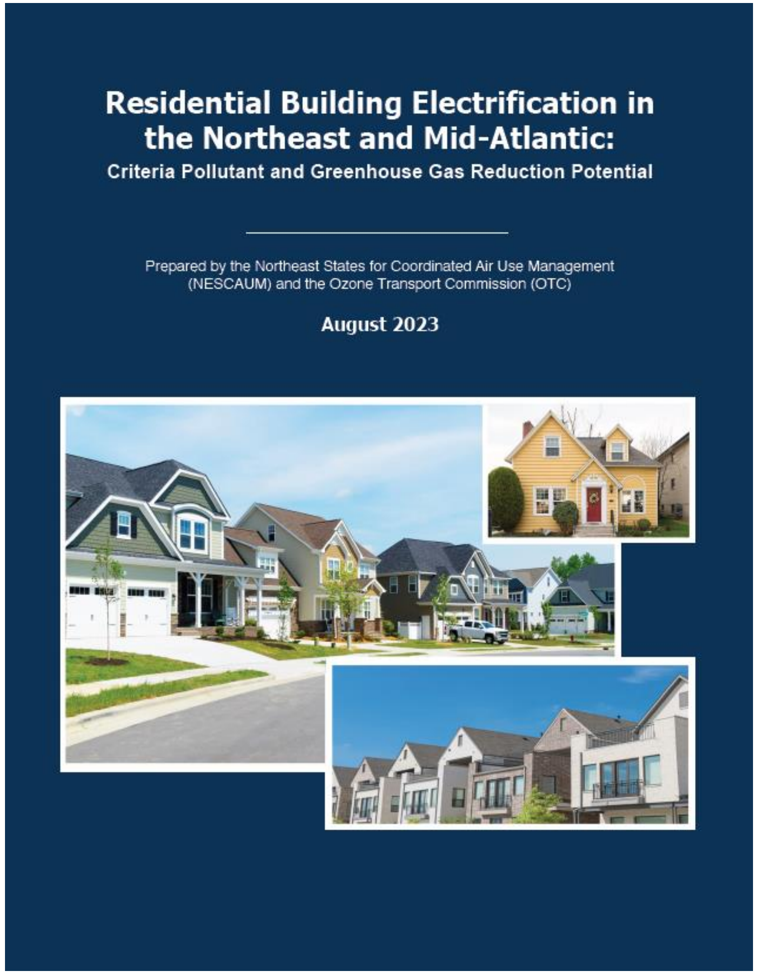
October 30, 2024

Emissions and Health Benefit Analysis Goals

Estimate the potential criteria pollutant and GHG emissions savings of moving to zero on-site emissions for space and water heating

Monetize the health benefits associated with zero emission space and water heating

Apply the analysis to 13 Northeast and Mid-Atlantic Jurisdictions



Emissions Benefit Analysis

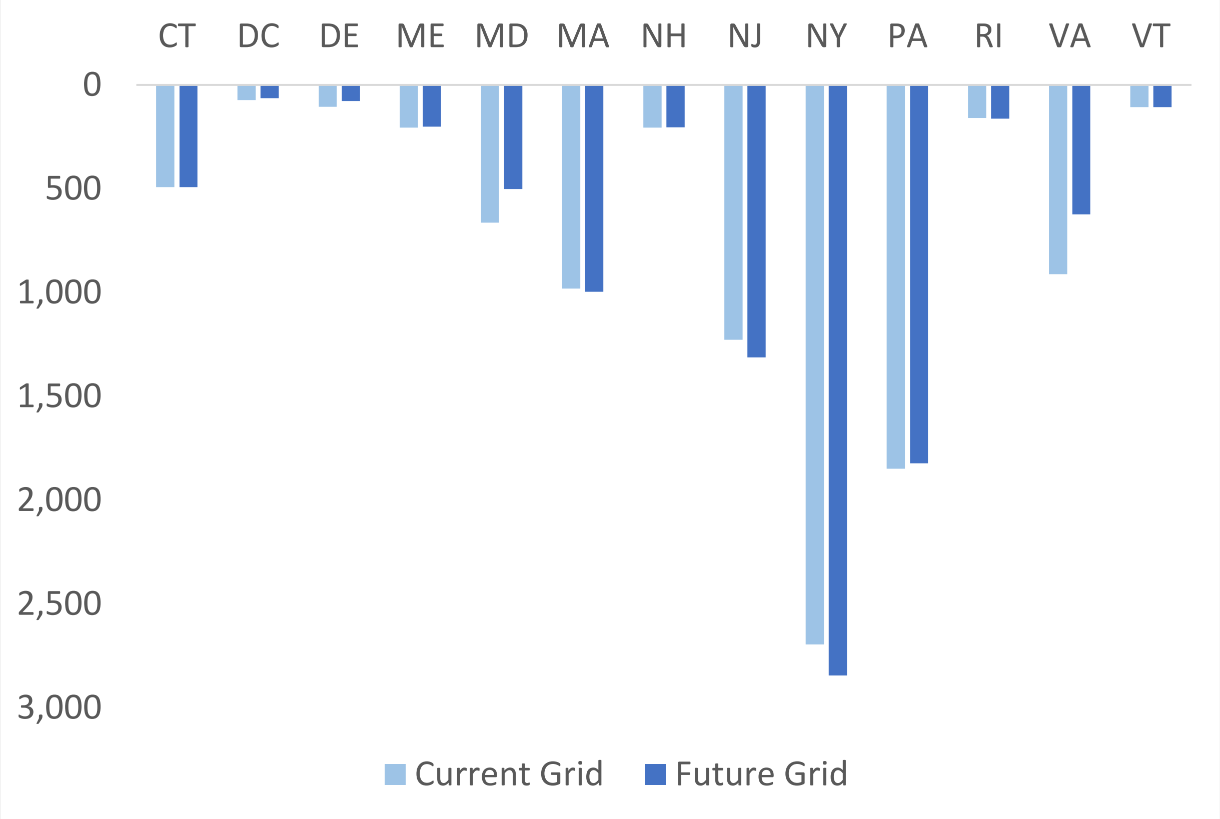
Calculating Emissions Reduction Potential

Data Source	Model Inputs
NREL's ResStock Tool	Changes in fuel and electricity consumption in a zero-emission transition, assuming: • Heat pump water heaters replace combustion-based water heaters • Heat pumps replace combustion-based space heating • Heat pumps replace electric resistance space and water heating
US EPA AP-42	Emission factors for combustion-based heating equipment
US EPA eGrid	Grid emissions related to electricity generation

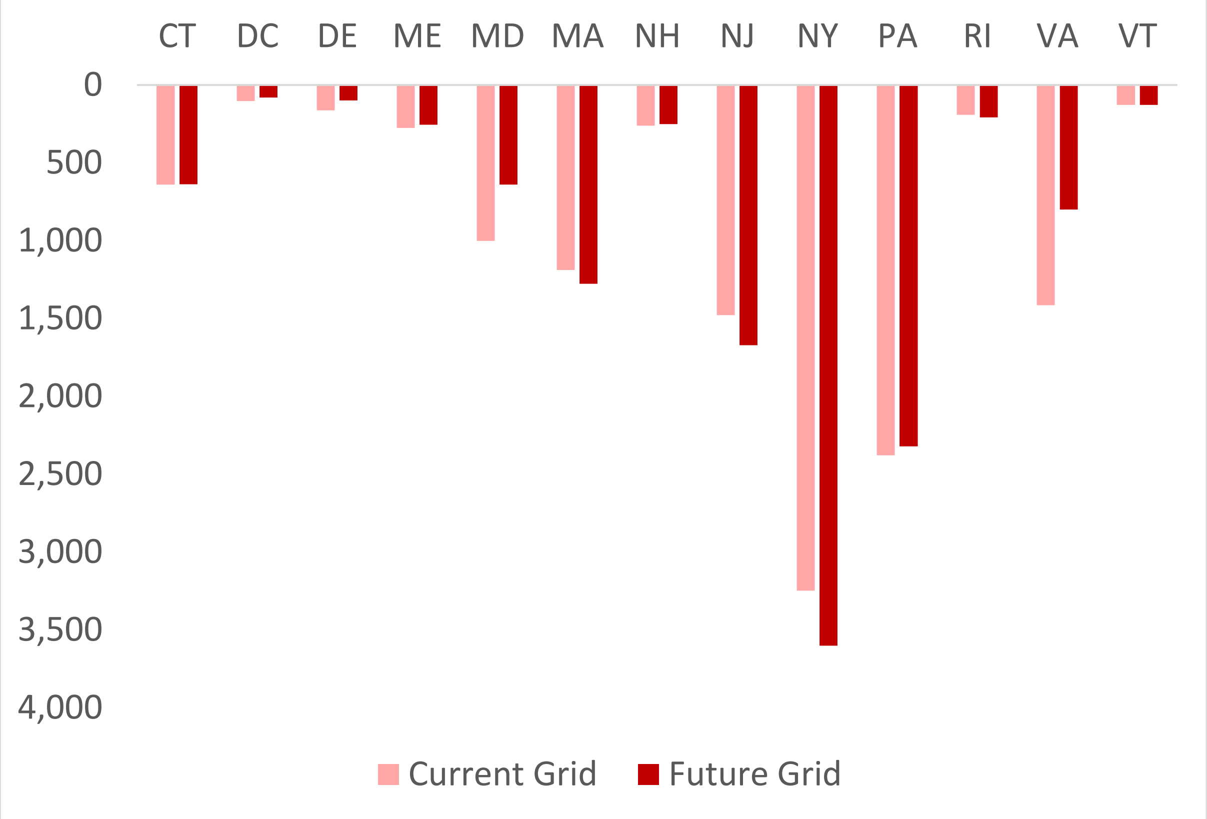
Grid emissions were estimated for both the ***current grid*** *and a* ***future grid*** *assuming greater reliance on renewable energy*

Water Heating Conversion: State-by-State Emissions Reductions

Annual NOx Emissions Reduction Potential (Tons)

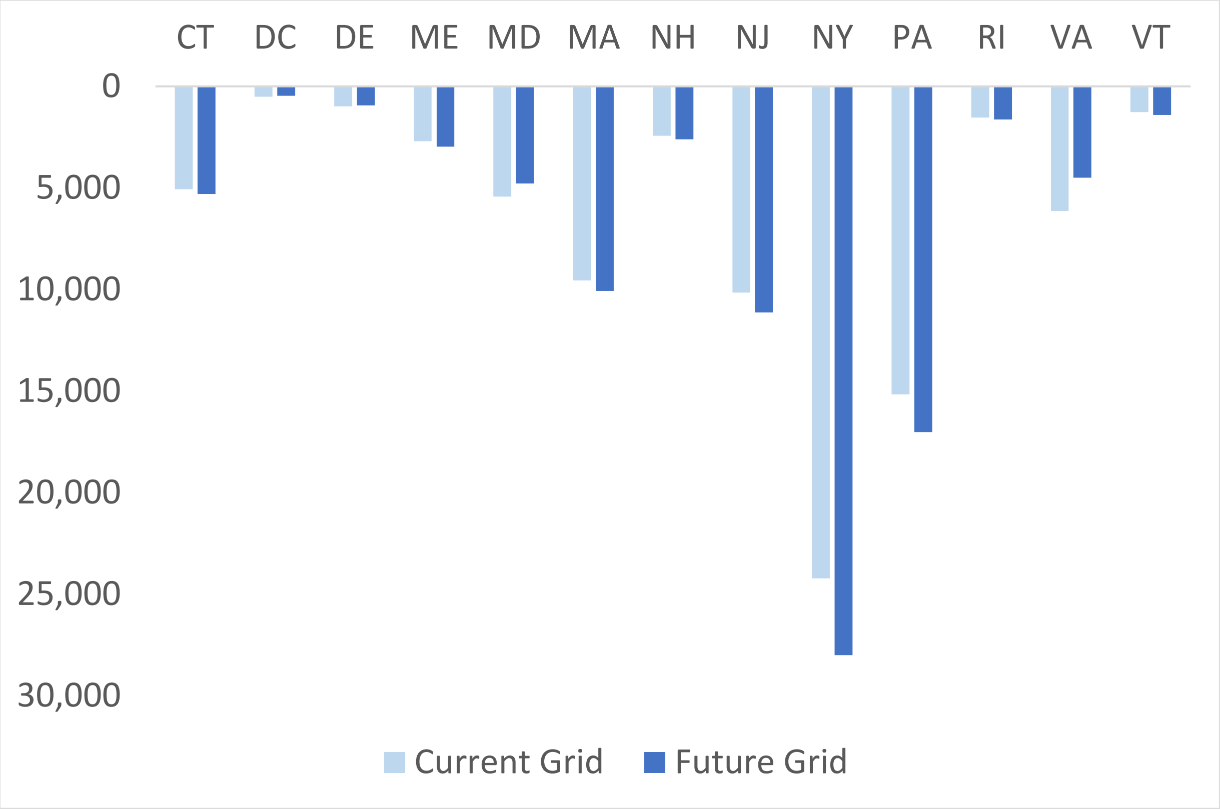


Annual CO2 Emissions Reduction Potential (1,000 Tons)

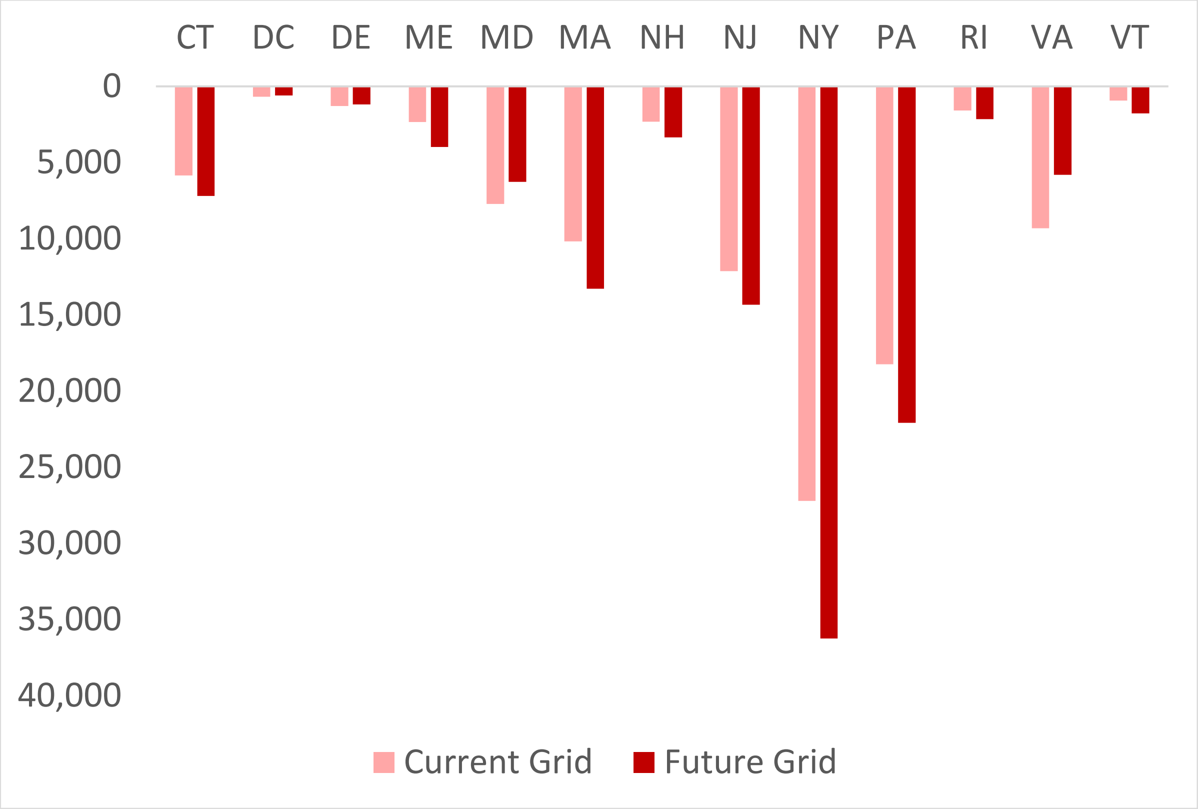


Space Heating Conversion: State-by-State Emissions Reductions

Annual NOx Emissions Reduction Potential (Tons)



Annual CO2 Emissions Reduction Potential (1,000 Tons)



Health Impact Assessment

Health Impact Assessment Overview

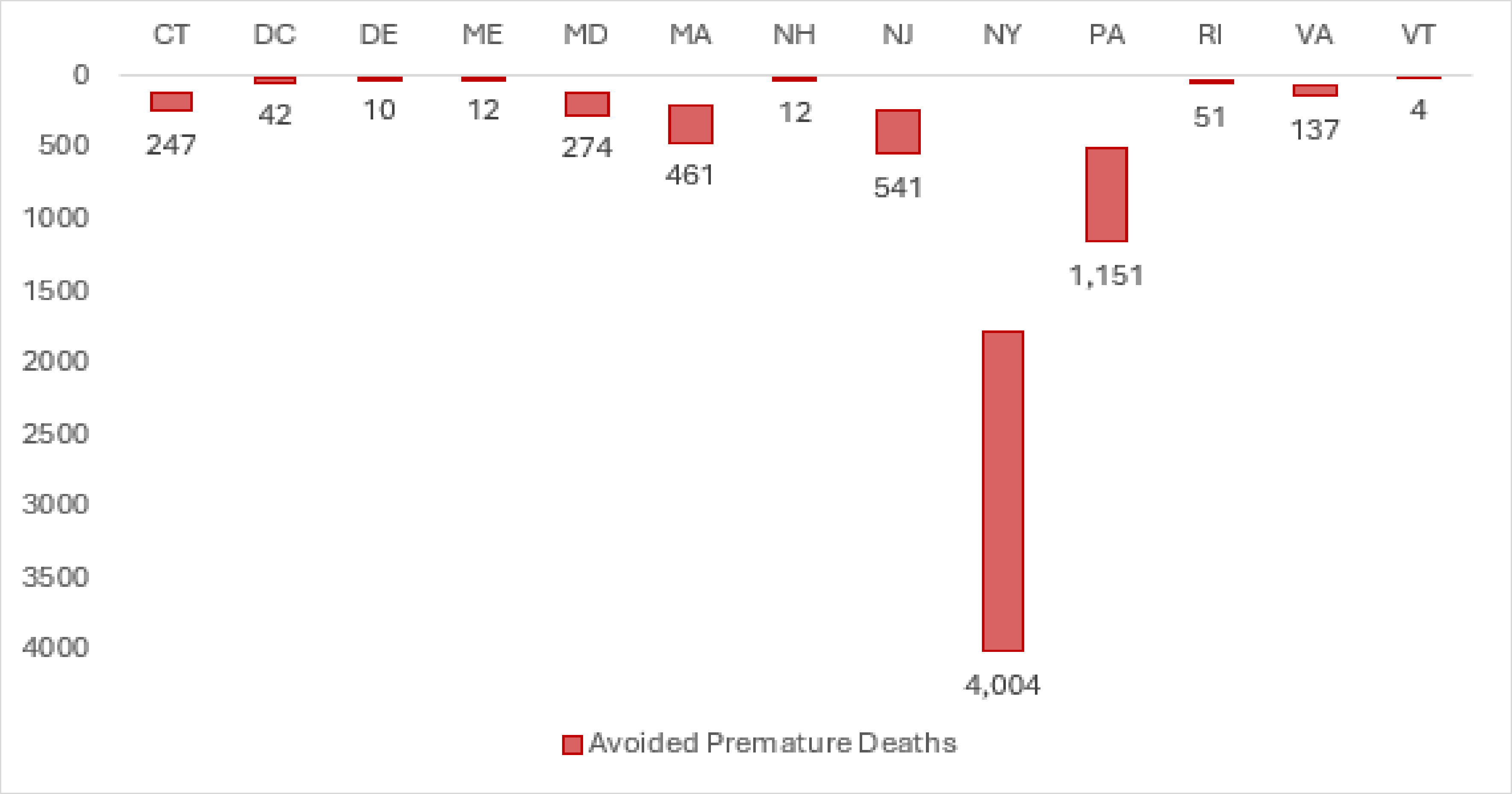
Study Objective

State-by-state estimation of the health benefits of converting residential building space and water heating to zero emission appliances in the Northeast and Mid-Atlantic region

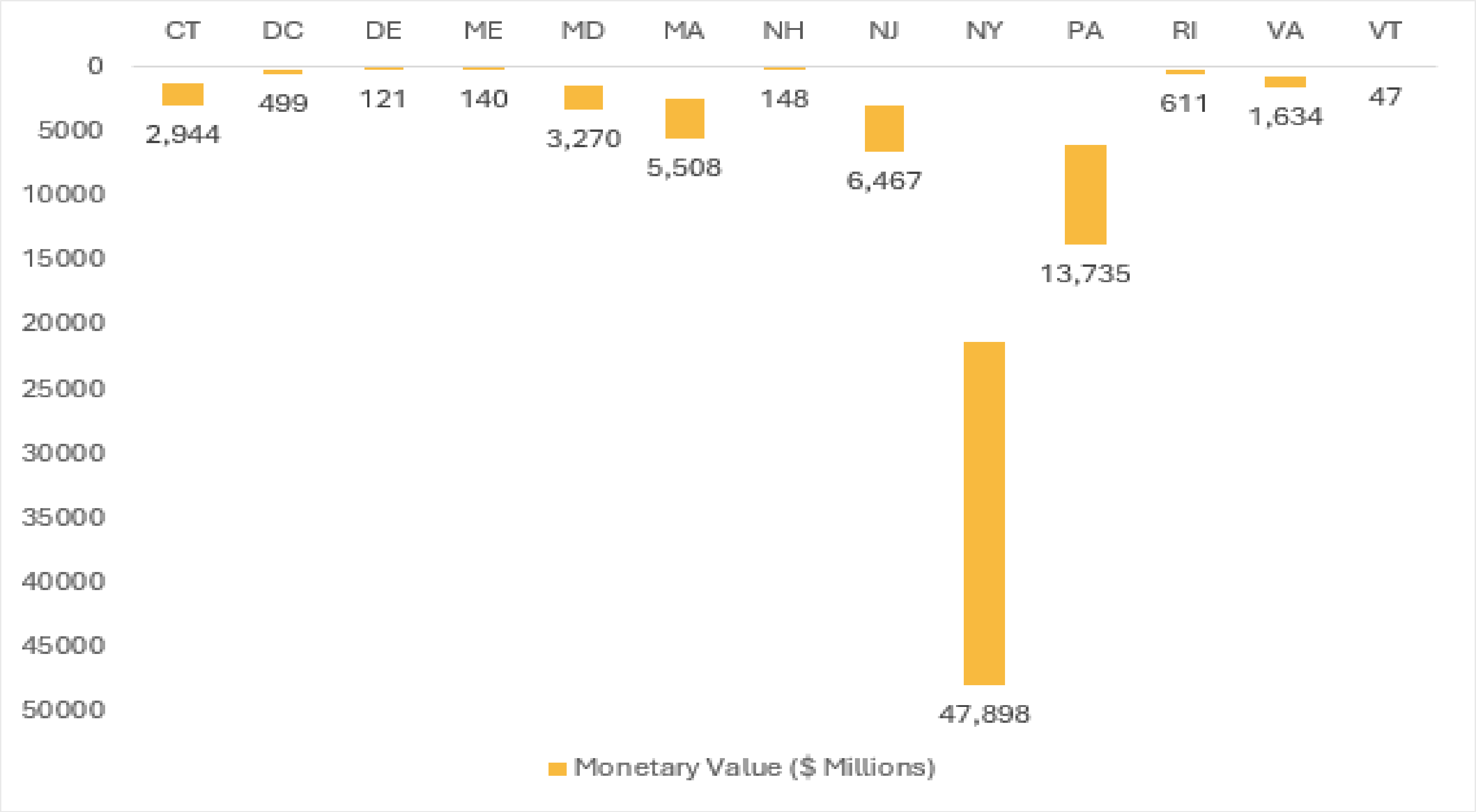
Study Methods

ResStock Simulation Results → **Emission Reductions** → **COBRA Simulations** → **Health-related Benefits**

Space & Water Heating Premature Deaths Avoided (Cumulative Over 2030-2045 Period)



Space & Water Heating Monetized Benefits (Cumulative Over 2030-2045 Period)



Summary

Substantial NOx, PM2.5, and CO_2 emissions benefits found with complete conversion of water and space heating to zero-emission equipment in Northeast and Mid-Atlantic states

Substantial health benefits realized with complete conversion of water and space heating to zero-emission equipment in Northeast and Mid-Atlantic states

Full description of the study method and results of the emissions analysis [available online](#)

Zero-Emission Space and Water Heating Equipment: Cost & Market Study

Kyle Booth

October 30, 2024

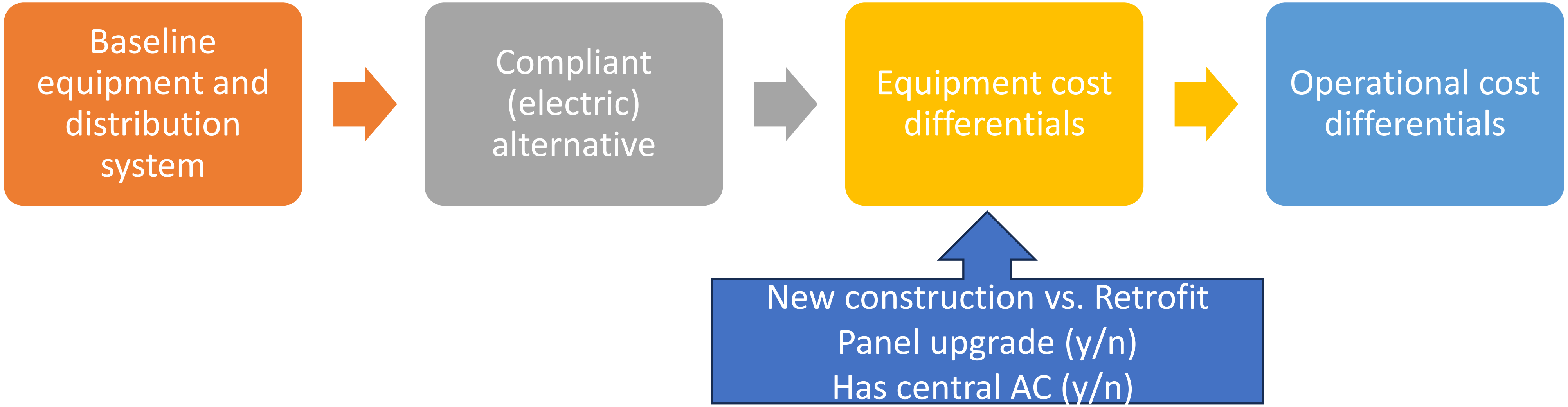
HVAC and Water Heater Cost Study Overview

HVAC and Water Heater Cost and Market Trends Study Objectives

- Assess the installation and operating cost impacts for replacing residential-scale fossil fuel and electric resistance HVAC and water heating systems with electric heat pump technologies
- Provide state-by-state cost estimates for states in the Ozone Transport Commission
- Understand how market trends may impact future costs for heat pumps

High-Level Approach for Cost Analysis

- The analysis took standard installation scenarios, rooted in U.S. DOE Appliance Standards Technical Support Documents when possible:
  - Replace a fossil fuel or electric resistance water heater with a heat pump water heater
  - Replace a fossil fuel or electric baseboard heating system with a heat pump (multiple configurations)
- Adjusted for state differences for equipment and labor costs using RS Means
- Accounted for varying energy costs using state and utility Energy Efficiency Technical Reference Manual (TRM) methodologies, pulling electricity and fuel costs from EIA and sample utilities in OTC states
- Supplemented the analysis with additional reports, state-specific data, and market actor interviews



Installation Cost Analysis

Factors Making Heat Pump Installation More or Less Expensive

Less Expensive

- Sufficient electrical and wiring
- Has existing ductwork
- Has central AC
- Has electric resistance heat
- Fewer individual heating zones

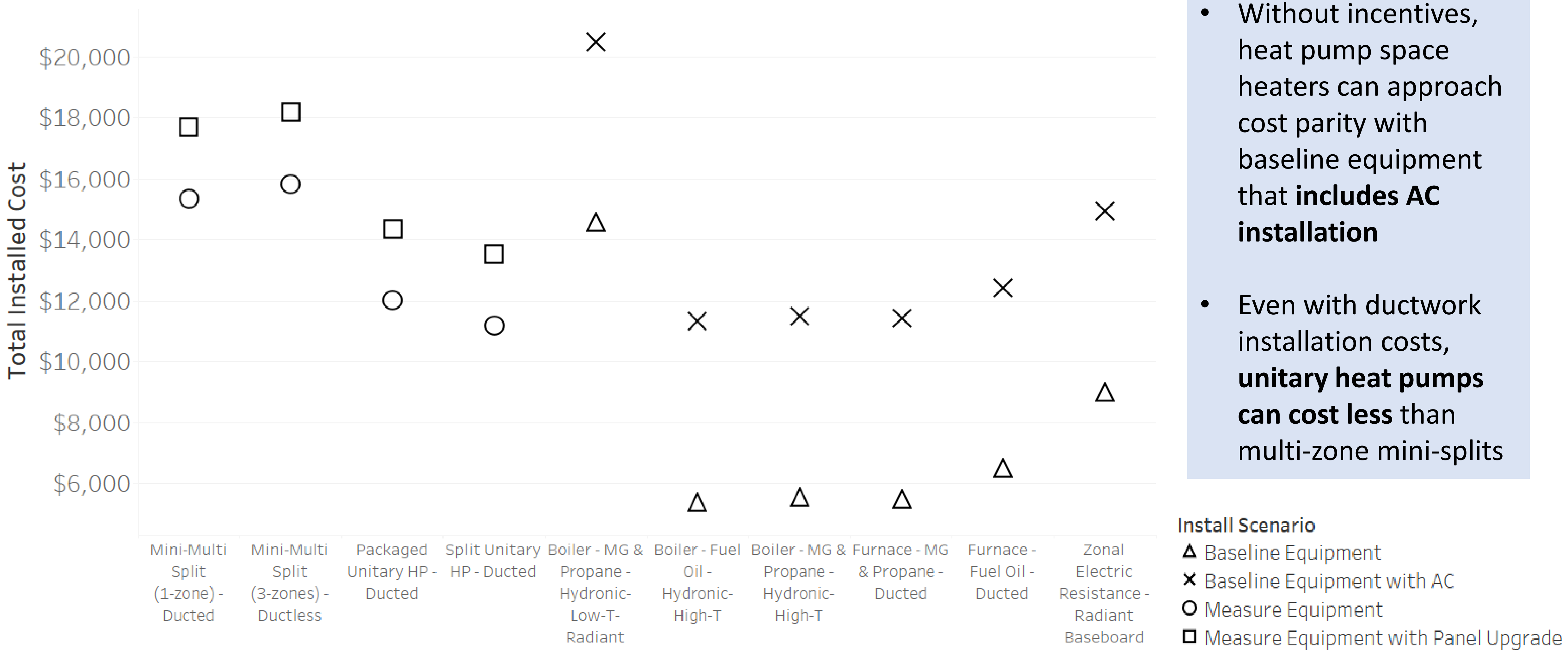
More Expensive

- Existing system is a boiler
- No ducts or insufficiently sized ducts
- Insufficient electrical and wiring
- More individual heating zones

HVAC Installation Costs (Equipment + Labor, National Average)

HVAC Equipment Total Install Cost by Equipment Type

Assumes new construction or retrofit with no compatible infrastructure with installed equipment



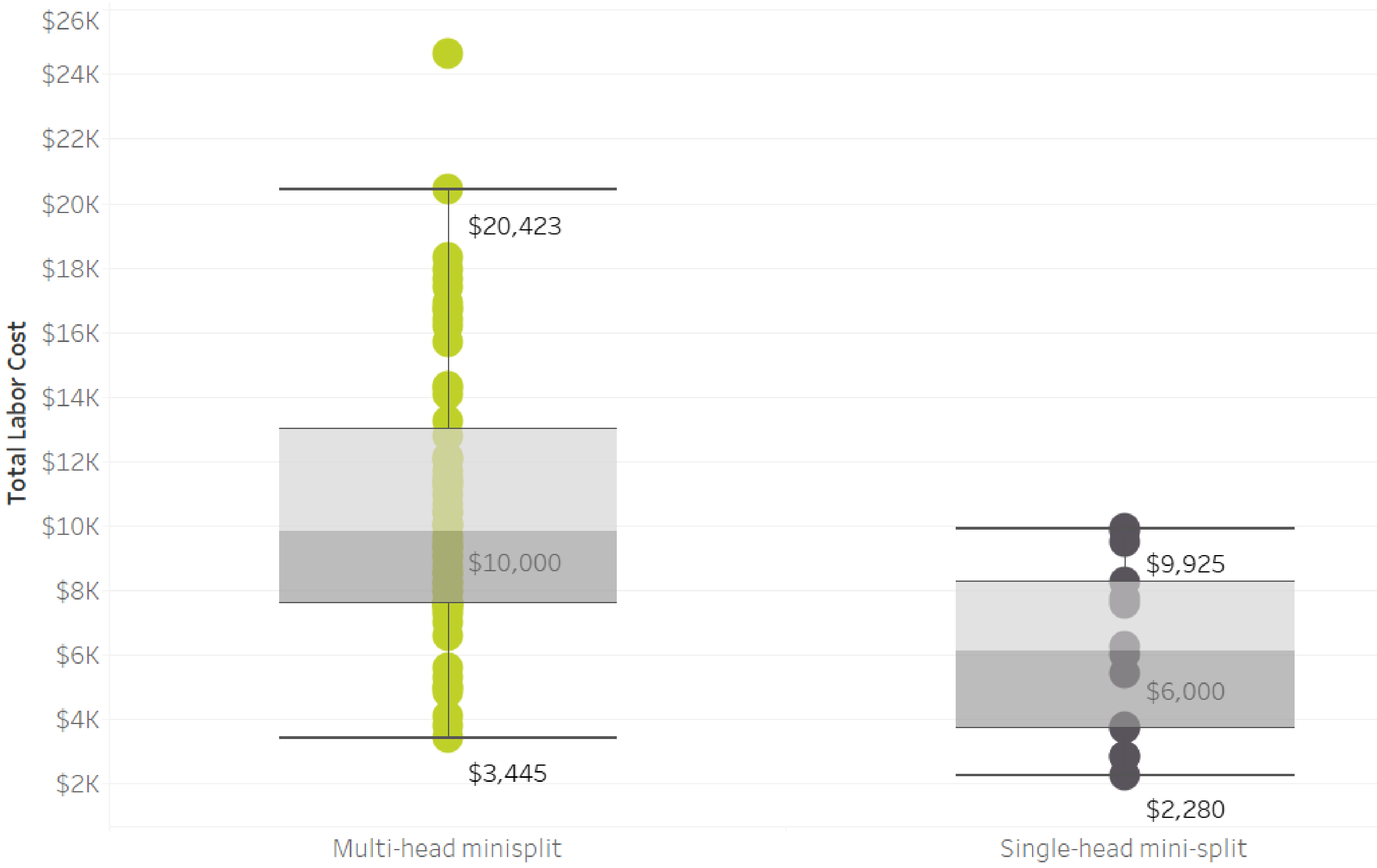
Key Takeaways

- Without incentives, heat pump space heaters can approach cost parity with baseline equipment that **includes AC installation**
- Even with ductwork installation costs, **unitary heat pumps can cost less** than multi-zone mini-splits

HVAC Installation Cost Differences for Common Scenarios

State	3-Zone Minisplit vs. Gas Boiler (No Distribution Upgrades)		Split Unitary HP + Ductwork + Panel Upgrade vs. Gas Boiler + Ducted AC		Split Unitary HP vs. Gas Furnace + AC (No Distribution Upgrades)	
	No Incentives	With Incentives	No Incentives	With Incentives	No Incentives	With Incentives
CT	$10,392	$7,642	$1,932	-$818	$1,350	-$1,400
DC	$10,209	$7,659	$2,160	-$390	$1,705	-$845
DE	$10,463	$8,213	$2,024	-$226	$1,473	-$777
ME	$9,986	$3,986	$2,119	-$3,881	$1,677	-$4,323
MD	$10,119	$7,819	$2,205	-$95	$1,783	-$517
MA	$10,250	$5,750	$1,819	-$2,681	$1,205	-$3,295
NH	$10,110	$5,610	$2,110	-$2,390	$1,645	-$2,855
NJ	$10,267	$8,057	$1,682	-$528	$1,004	-$1,206
NY	$10,578	$7,878	$1,501	-$1,199	$699	-$2,001
PA	$10,204	$8,054	$1,871	-$279	$1,289	-$861
RI	$10,460	$7,710	$1,981	-$769	$1,411	-$1,339
VT	$9,969	$7,669	$2,102	-$198	$1,654	-$646
VA	$10,121	$8,071	$2,308	$258	$1,932	-$118

High Variation in Heat Pump Labor Costs



Empirical Results from MassCEC Whole-Home Pilot

- Multi-head minisplit labor cost range of nearly **$17,000**
- Cost driven by **complexity** of HP project
- Contractors may be charging more to offset **perceived risk**
- **Price transparency** and data sharing may improve install costs

HPWH Installation Costs (Equipment + Labor)

State	Methane Gas Storage	Methane Gas Tankless	Electric Resistance Storage	Propane Storage	Fuel Oil Storage	240V HPWH			120V HPWH	
						With Panel Upgrade	No Panel Upgrade	No Panel Upgrade with Incentives	No Incentives	With Incentives
CT	$912	$1,278	$920	$912	$3,254	$5,926	$3,321	$1,575	$3,473	$1,681
DE	$899	$1,255	$913	$899	$3,254	$5,723	$3,276	$1,593	$3,486	$1,740
DC	$835	$1,154	$859	$835	$3,116	$5,058	$3,042	$1,429	$3,363	$1,654
ME	$791	$1,093	$814	$791	$2,954	$4,793	$2,884	$1,069	$3,189	$1,282
MD	$796	$1,097	$821	$796	$2,990	$4,764	$2,899	$1,329	$3,233	$1,563
MA	$927	$1,303	$932	$927	$3,282	$6,100	$3,377	$1,614	$3,495	$1,697
NH	$822	$1,139	$842	$822	$3,040	$5,052	$2,995	$1,347	$3,274	$1,542
NJ	$973	$1,375	$970	$973	$3,382	$6,568	$3,543	$1,730	$3,584	$1,759
NY	$1,072	$1,529	$1,056	$1,072	$3,618	$7,533	$3,904	$2,033	$3,804	$1,963
PA	$916	$1,286	$922	$916	$3,253	$5,997	$3,337	$1,986	$3,468	$2,078
RI	$901	$1,261	$912	$901	$3,240	$5,798	$3,284	$2,149	$3,464	$2,275
VT	$783	$1,081	$807	$783	$2,933	$4,719	$2,854	$1,698	$3,168	$1,918
VA	$756	$1,035	$788	$756	$2,899	$4,375	$2,756	$1,529	$3,149	$1,804

HVAC and Water Heater Installation Cost Key Takeaways

- Heat pump systems are **generally more expensive** to install (up to 4x higher for HPWHs)
- **Ductwork and electrical infrastructure** upgrades add significant costs:
  - $4,500 for HVAC ductwork
  - $2,400 for HVAC or HPWH electrical upgrades
- **Ducted unitary heat pumps and ductless mini-splits are the least expensive heat pump types**
  - Air-to-water heat pumps and multi-zone heat pumps are the most expensive
- NY, NJ, MA, and CT have highest labor costs
- **Federal, state, and utility incentives** can reduce installation costs for heat pumps compared to fossil fuel equipment

Operating Cost Analysis

HVAC Annual Operating Costs by Equipment Type (With AC)

State	Methane Gas/Propane Boiler	Oil Boiler	Propane Furnace & Boiler	Electric Resistance	3-Zone Ductless Minisplit	Ducted Split Unitary HP
CT	$1,658	$2,674	$2,955	$4,768	$2,100	$2,375
DC	$1,646	$2,834	$2,759	$2,679	$1,244	$1,406
DE	$1,139	$3,019	$2,838	$2,740	$1,229	$1,390
ME	$1,954	$4,057	$4,142	$6,910	$2,843	$3,220
MD	$1,683	$2,677	$2,605	$2,701	$1,229	$1,389
MA	$2,440	$3,575	$3,706	$6,663	$2,825	$3,197
NH	$1,384	$3,022	$3,269	$5,604	$2,351	$2,662
NJ	$1,209	$2,494	$2,364	$2,968	$1,310	$1,482
NY	$1,537	$2,759	$2,647	$4,414	$1,885	$2,134
PA	$1,799	$2,917	$2,654	$3,325	$1,531	$1,729
RI	$1,828	$3,567	$3,919	$5,858	$2,612	$2,953
VT	$1,655	$4,114	$4,251	$6,168	$2,579	$2,920
VA	$1,470	$2,794	$2,787	$2,766	$1,216	$1,376

Water Heater Annual Operating Costs by Equipment Type

State	Methane Gas Storage	Methane Gas Tankless	Electric Resistance Storage	Propane Storage	Fuel Oil Storage	240V HPWH	120V HPWH
CT	$289	$207	$553	$668	$500	$152	$159
DE	$214	$154	$288	$559	$502	$79	$83
DC	$228	$163	$336	$532	$460	$92	$97
ME	$365	$261	$471	$662	$544	$129	$136
MD	$246	$176	$319	$564	$488	$88	$92
MA	$327	$234	$585	$643	$519	$161	$168
NH	$351	$251	$569	$729	$562	$156	$164
NJ	$187	$134	$400	$570	$508	$110	$115
NY	$272	$195	$515	$640	$562	$141	$148
PA	$237	$170	$304	$531	$497	$83	$87
RI	$283	$203	$551	$659	$496	$151	$158
VT	$269	$192	$543	$679	$551	$149	$156
VA	$231	$166	$252	$545	$458	$69	$72

Operating Cost Key Takeaways

- CT, ME, MA, NH, NY, RI, and VT have highest electric rates and associated heat pump operating costs
- Replacing **delivered fuel systems and electric resistance** with heat pumps can yield **significant operating cost savings** (on average, ~$1,100/year)
- Replacing **methane gas HVAC systems** with heat pumps generally results in operating cost savings in DC, MD, PA, and VA, but **increases** operating costs in other states
- **HPWHs reduce average operating costs across replacement scenarios in all states**, with highest savings from transitioning off electric resistance and delivered fuels
- Rate reform may be needed on several fronts:
    - Methane gas rates predicted to rise over time
    - Electrification-friendly rate design

Market Trend Key Takeaways

Workforce Shortages and Cost Impacts:

- Workforce shortages are impacting the timelines and prices of heat pump installations. Without targeted workforce development efforts, this trend is expected to worsen as heat pump adoption accelerates

Commodity Cost Impacts:

- Direct competition for high-demand materials and components may increase heat pump equipment costs

Refrigerant Impacts on Cost:

- Requirements to transition to refrigerants with low flammability and GWP may increase heat pump and AC costs in the near-term due to expenses related to regulatory compliance and developing new product lines and technologies.

Thank you!

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https://www.nescaum.org/our-work/stationary-sources/zehes

Appendix: Equipment Emissions Standards Rely on Clear and Longstanding Regulatory Authority

- The Clean Air Act allows state and local air pollution agencies to adopt air pollution standards more stringent than the federal government (except for mobile sources)
- Equipment emissions standards can be incorporated into State Implementation Plans (SIPs) that states submit to attain/maintain standards for ozone, regional haze, and other pollutants
- Low-NOx standards for residential-scale water heaters and furnaces have been in place for decades in CA, TX, and UT, and CA air districts recently adopted the nation's first zero-emissions standards
- Other states have a long track record of regulating NOx emissions from industrial equipment such as boilers
- Strong state/local authority to regulate equipment <u>emissions</u> contrasts with limited state/local authority to regulate equipment <u>efficiency</u> due to preemption under the Energy Policy and Conservation Act (EPCA)