# Draft 2024 Heating Electrification Forecast

*Load Forecast Committee*

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LOAD FORECASTING ANALYST

LOAD FORECASTING, SYSTEM PLANNING

# Objective

- The purpose of today's presentation is to:
  1. Share the updated draft heating adoption forecasts
  2. Share the draft heating energy and demand forecasts

# BACKGROUND

# Heating Electrification Forecast

*Overview*

- For the CELT 2020 forecast, the forecast focused on residential adoption of air-source heat pumps (ASHPs) across the region
- For the CELT 2021 forecast the methodology was improved to account for both full and partial residential ASHP heating applications
- No updates were made to the forecast methodology for the CELT 2022 forecast
- For the CELT 2023 forecast ISO worked with an external consultant to overhaul the methodology
  - Expanded the scope of the forecast to include both space and water heating for the residential and commercial sectors
  - Adoption was developed based on "heating pathways" approach that considers the various technological pathways for space and heating electrification
  - Detailed demand modeling that considers building type and heating pathway
- Details regarding the CELT 2023 forecast methodology can be found in the 2023 Heating Electrification Forecast

# Methodology Overview

- Heating Electrification Forecast methodology leverages the National Renewable Energy Laboratory's ResStock and ComStock datasets, and is based on four sequential tasks
  1. New England building stock characterization **(slides 5-10 of the CELT 2023 Heating Electrification Forecast)**
     - Comprehensive characterization of the existing New England building stock, including currently deployed space conditioning and water heating technologies
  2. Development of "heating pathways" **(slides 11-15 of the CELT 2023 Heating Electrification Forecast)**
     - Heating pathways specify a technology that could be used to either partially or fully electrify a given building's space or water heating needs
     - Reflect likely routes for adoption of efficient electric heating technologies in New England
  3. Forecast of adoption along each "heating pathway" **(slides 16-19 of the CELT 2023 Heating Electrification Forecast)**
     - Level of adoption of technologies along specified pathways for a variety of building types in the residential and commercial sectors
  4. Hourly demand modeling ***(Slides 33-38 of the CELT 2023 Heating Electrification Forecast)***
     - Captures the electric impacts of each adoption pathway for each building type in the residential and commercial sectors
     - Updates to the partial heating demand modeling were discussed at the LFC meeting held on December 8, 2023

# Heating Electrification Forecast

*Example: Residential Space Heating*

| State | Building Type | % of Households |
|---|---|---|
| NE | Single-Family Detached | 58% |
| NE | Multi-Family with 2 - 4 Units | 17% |
| NE | Multi-Family with 5+ Units | 17% |
| NE | Single-Family Attached | 5% |
| NE | Mobile Home | 3% |

**Starting Share of Housing Units, %**

| Space Heating Fuel | CT | MA | ME | NH | RI | VT | NE |
|---|---|---|---|---|---|---|---|
| Electricity | 16.5 | 14.9 | 5.7 | 8.3 | 9.9 | 5.8 | 12.8 |
| Fuel Oil | 41.9 | 26.7 | 64.3 | 45.5 | 31.4 | 43.5 | 37.4 |
| Natural Gas | 35.4 | 53.3 | 6.2 | 19 | 55 | 17.7 | 38.9 |
| None | 0 | 0.2 | 0.1 | 0.5 | 0 | 0 | 0.1 |
| Other Fuel | 2.8 | 2.2 | 15.3 | 10.3 | 2.1 | 18 | 5.4 |
| Propane | 3.4 | 2.7 | 8.4 | 16.4 | 1.6 | 15.1 | 5.4 |

Existing Building Stock

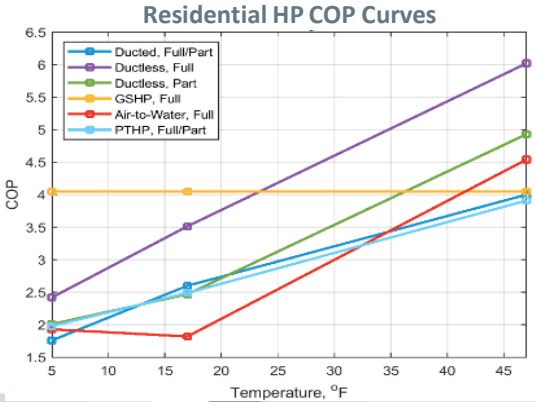
Heating Pathways

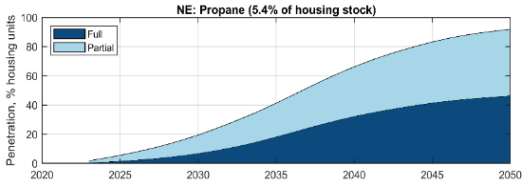
Adoption Forecasting

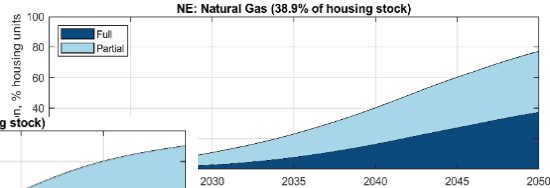
Demand Modeling

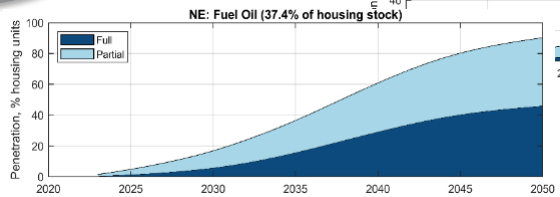
| Heating Type | Technology Type | Heating Displacement |
|---|---|---|
| Space Heating | Ducted ASHP - Full | Full |
| | Ducted ASHP - Partial | Partial |
| | Ductless ASHP - Full | Full |
| | Ductless ASHP - Partial | Partial |
| | Ground Source Heat Pump | Full |
| | Air to Water Heat Pump | Full |
| | Packaged Terminal Heat Pump | Partial |

Building Energy Consumption



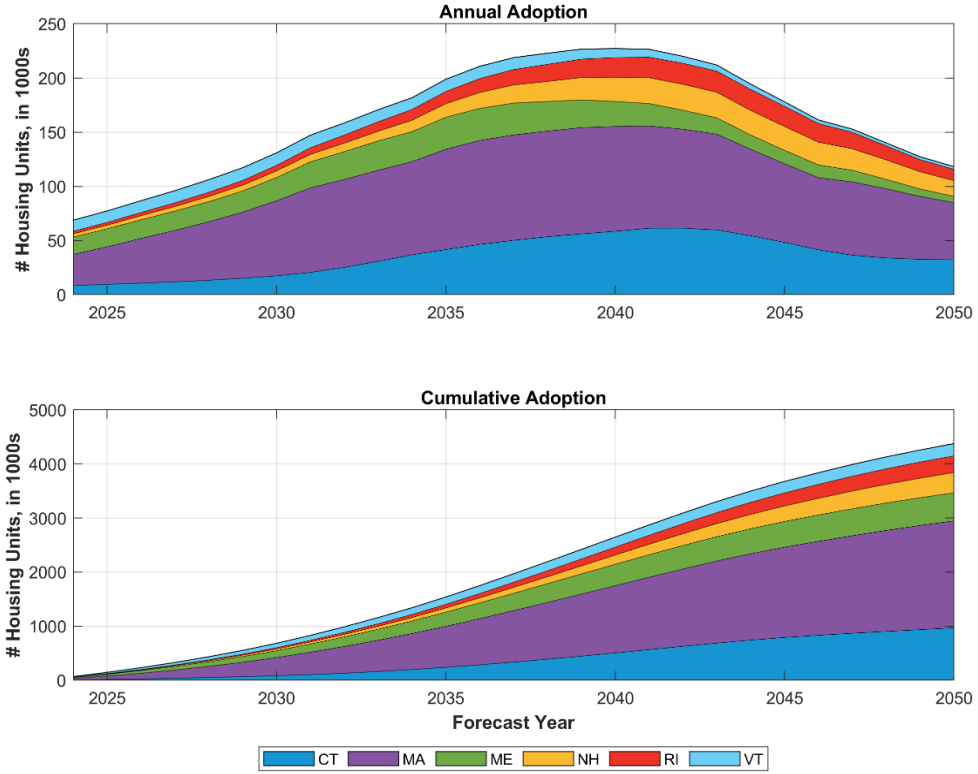
# DRAFT 2024 ADOPTION FORECASTS

# Draft Adoption Forecasts

- Draft 2024 heating adoption forecasts are consistent with the 2023 CELT
  - Incremental adoption starts in 2024, with 2023 removed
- The next several slides focus on the draft adoption forecasts of electrified space and water heating technologies for the entire region
  - State-by-state adoption materials are included as Appendices

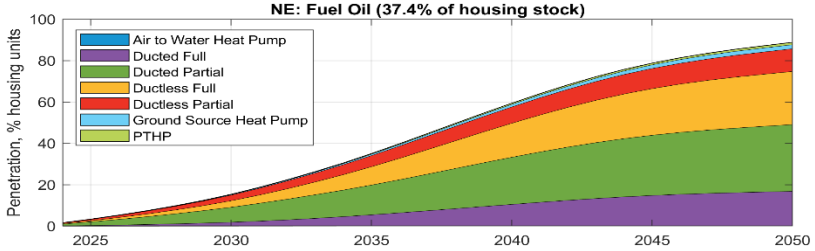
# Residential Space Heating Adoption

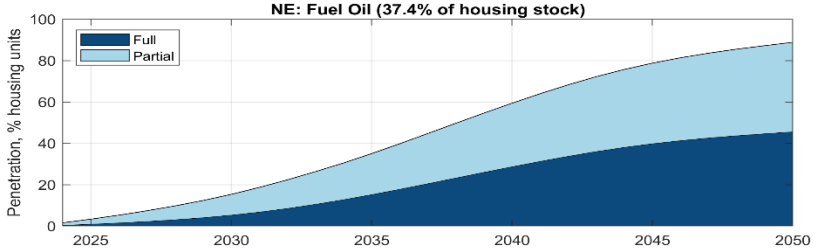
- Adoption forecast for residential space heating (full + partial) is shown to the right
  - Annual adoption (top)
  - Cumulative adoption (bottom)
- Forecast includes more than 4.4 million housing units with electrified space heating electrified by 2050
  - ~69% of total housing stock
  - ~84% of fossil fueled heating
- The regional forecast penetration of electrified residential space heating according to legacy heating fuels is shown on the next slide, including a breakdown of full versus partial heating
  - Similar graphics for state forecast penetrations are included in Appendix I

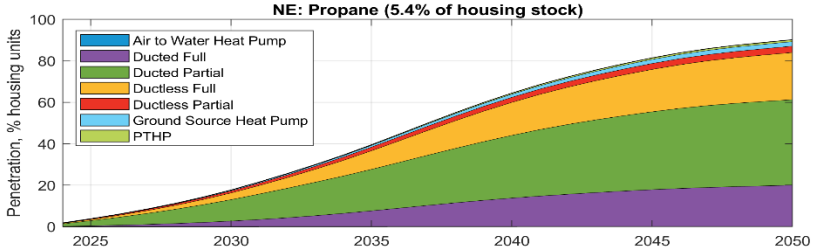


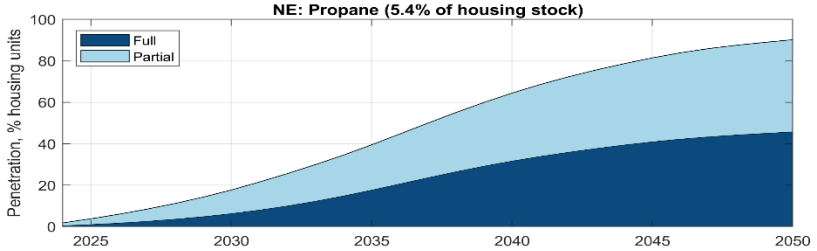
# Adoption By Legacy Residential Space Heating Fuel

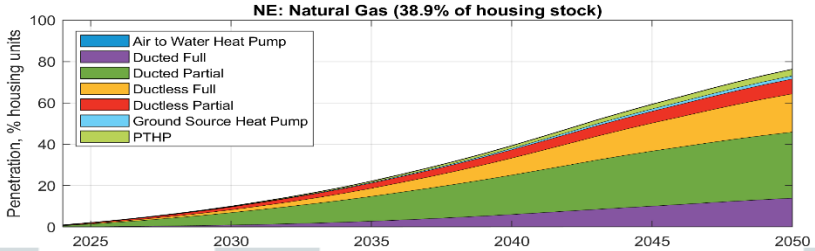
*New England*

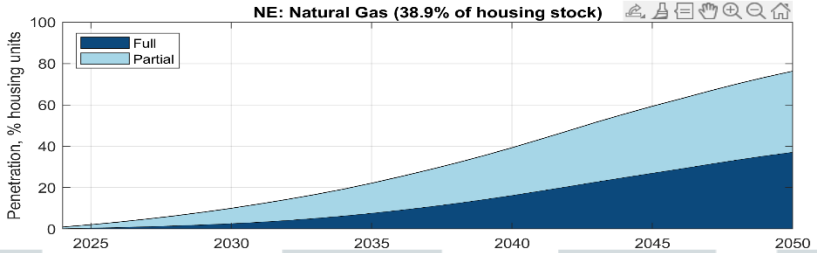


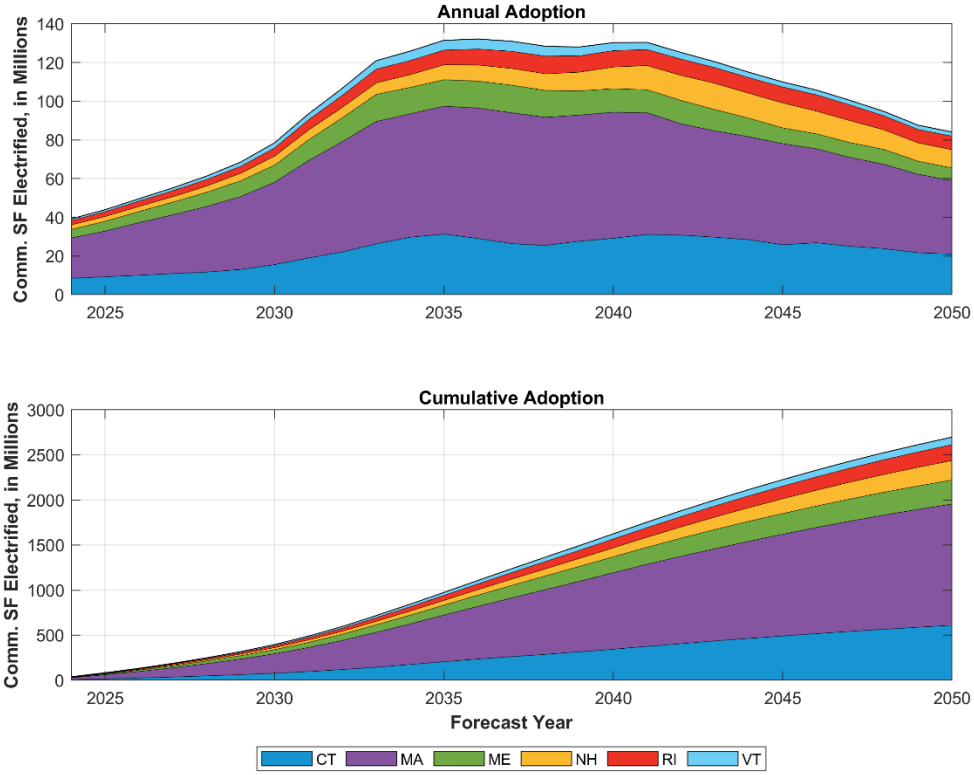



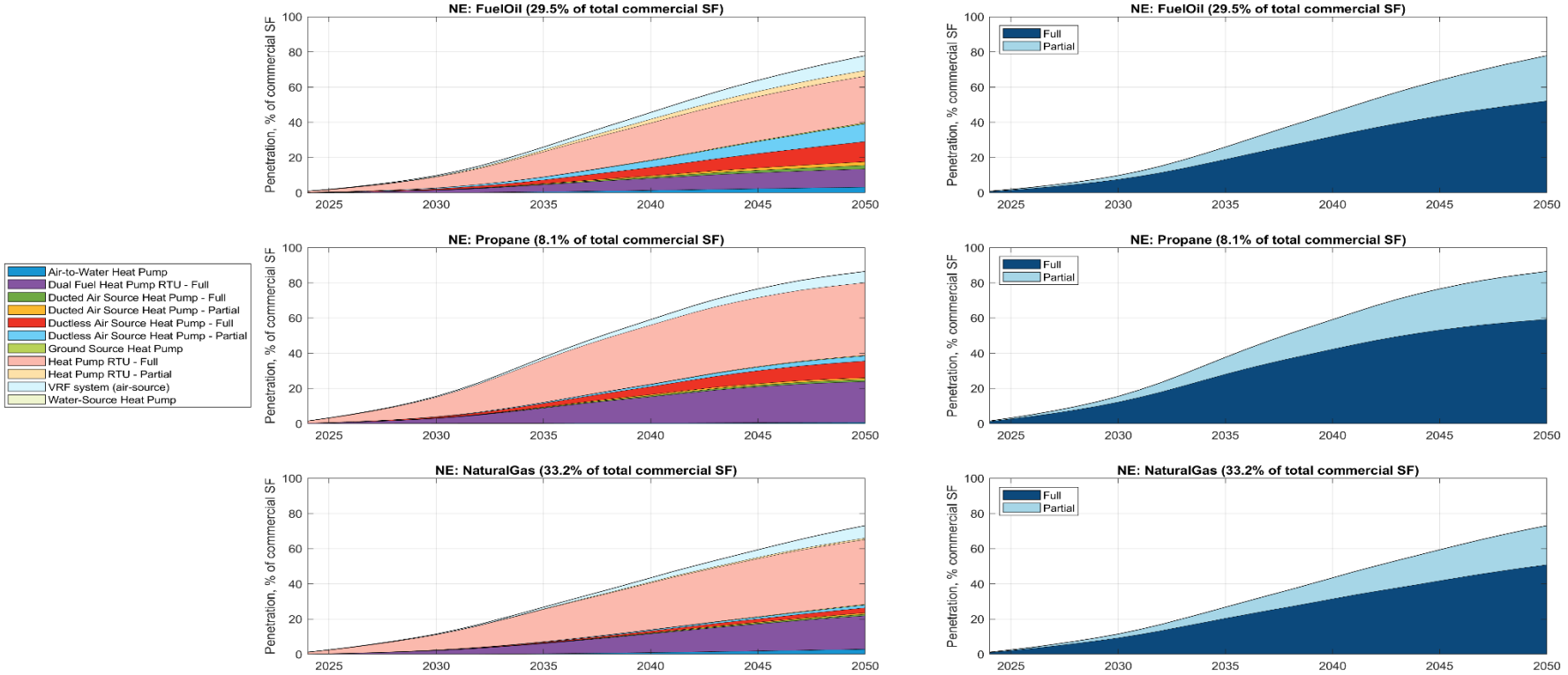
# Commercial Space Heating Adoption

- Adoption forecast for commercial space heating (full + partial) is shown to the right
  - Annual adoption (top)
  - Cumulative adoption (bottom)
- Forecast includes more than 2.7 billion square feet of commercial space heating electrified by 2050
- The regional forecast penetration of electrified commercial space heating according to legacy heating fuels is shown on the next slide, including a breakdown of full versus partial heating
  - Similar graphics for state forecast penetrations are included in Appendix II



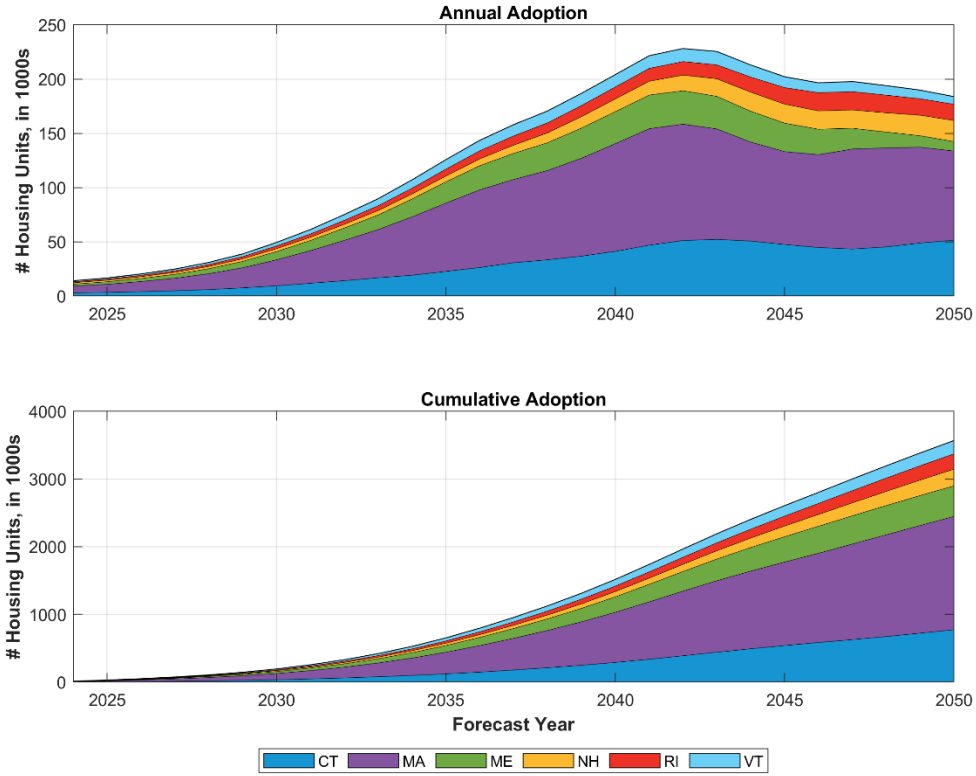
# Adoption By Legacy Commercial Space Heating Fuel

*New England*



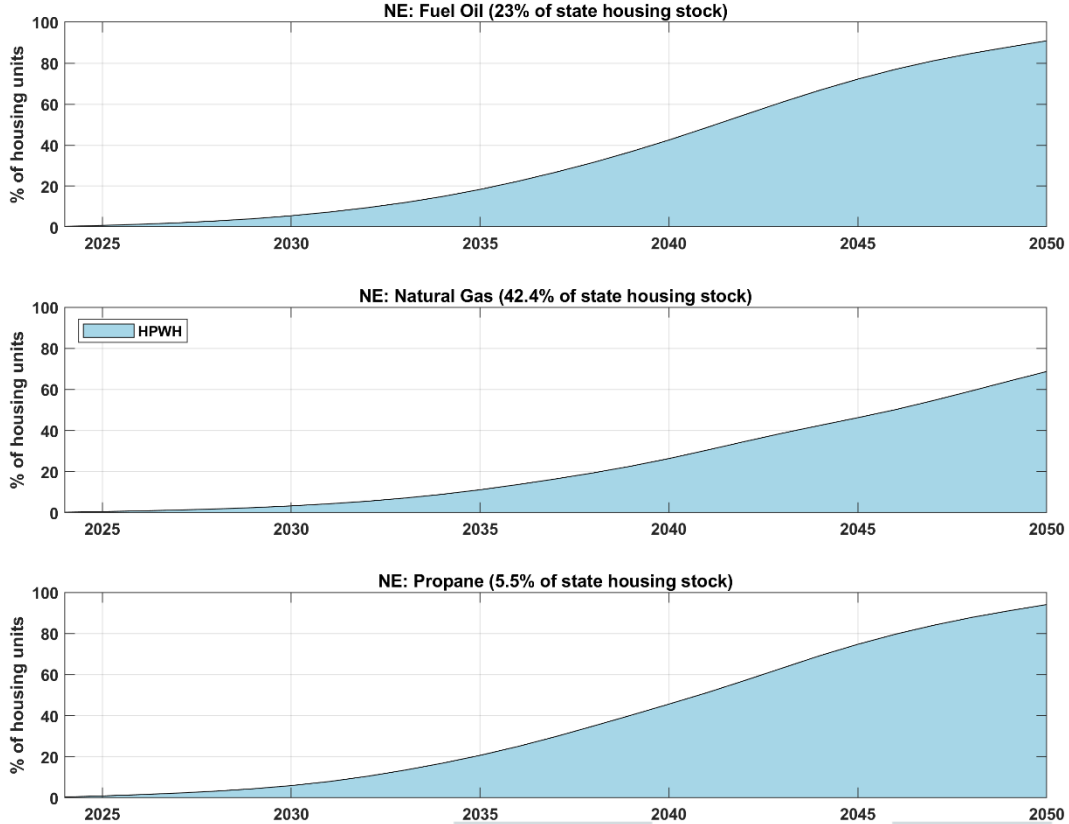
# Residential Water Heating Adoption

- Adoption forecast for residential HPWHs is shown to the right
  - Annual adoption (top)
  - Cumulative adoption (bottom)
- Forecast includes almost 3.6 million homes with electrified water heating by 2050
  - ~55% of total housing stock
  - ~78% of fossil fueled heating
- Regional forecast penetration of HPWHs according to legacy water heating fuels is shown on the next slide
  - Similar graphics for state forecast penetrations are included in Appendix III



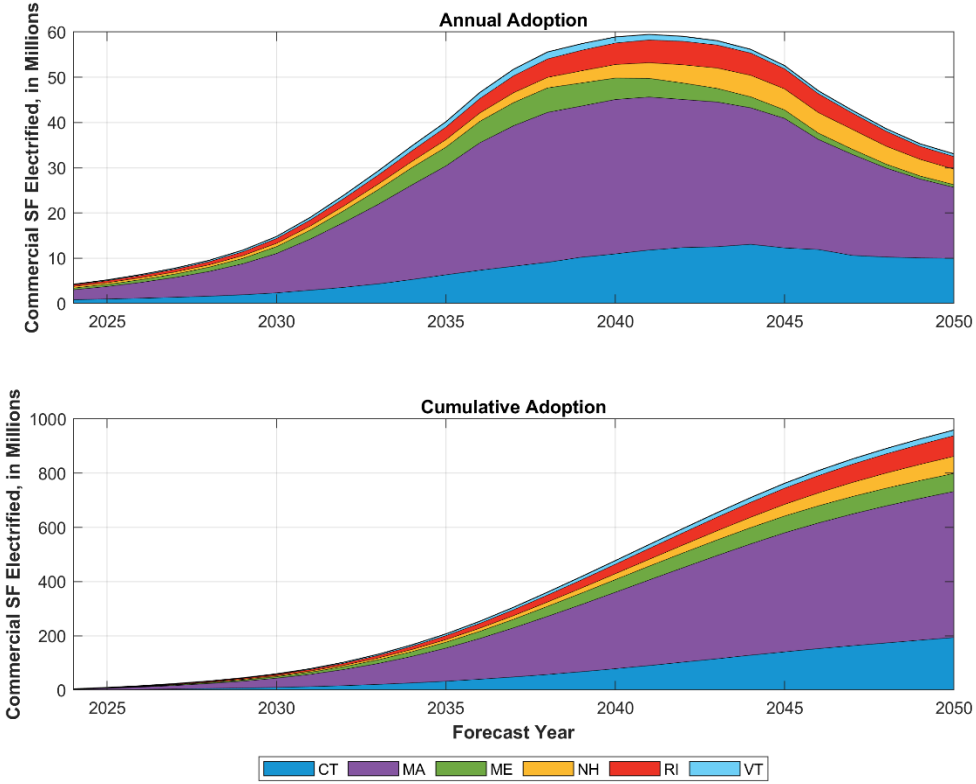
# Adoption By Legacy Residential Water Heating Fuel

*New England*



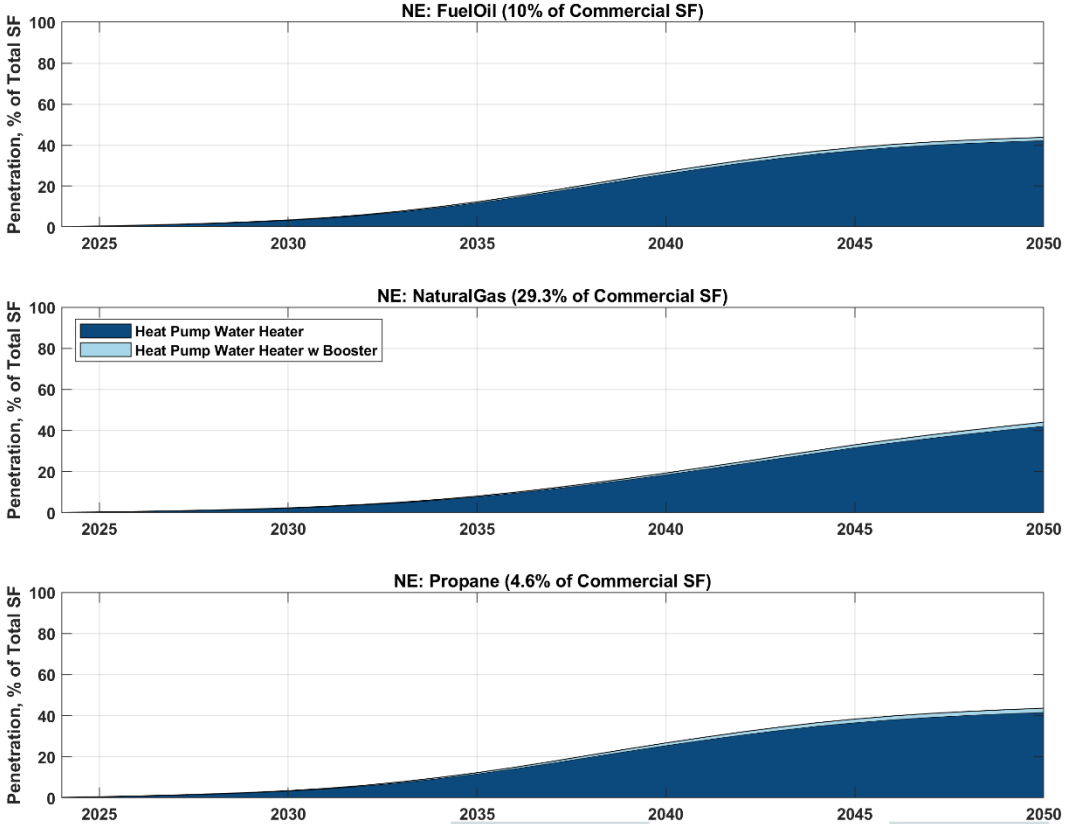
# Commercial Water Heating Adoption

- Adoption forecast for commercial water heating is shown to the right
  - Annual adoption (top)
  - Cumulative adoption (bottom)
- Forecast includes electrification of water heating serving almost a billion SF of commercial space by 2050
- Regional forecast penetration of HPWHs according to legacy water heating fuels is shown on the next slide
  - Similar graphics for state forecast penetrations are included in Appendix IV



# Adoption By Legacy Commercial Water Heating Fuel

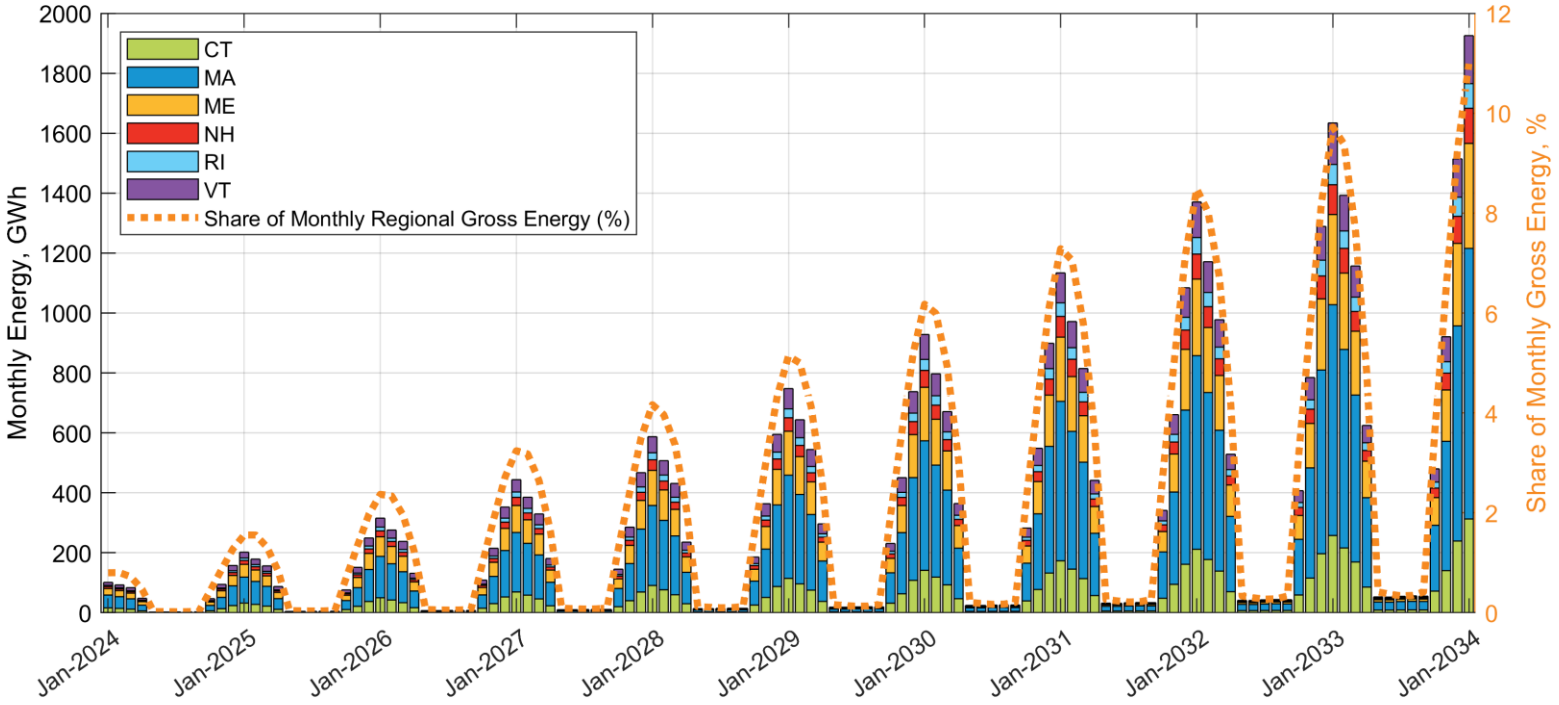
*New England*



# DRAFT 2024 ENERGY FORECAST

# Draft 2024 Heating Electrification Forecast

*Monthly Energy, GWh*



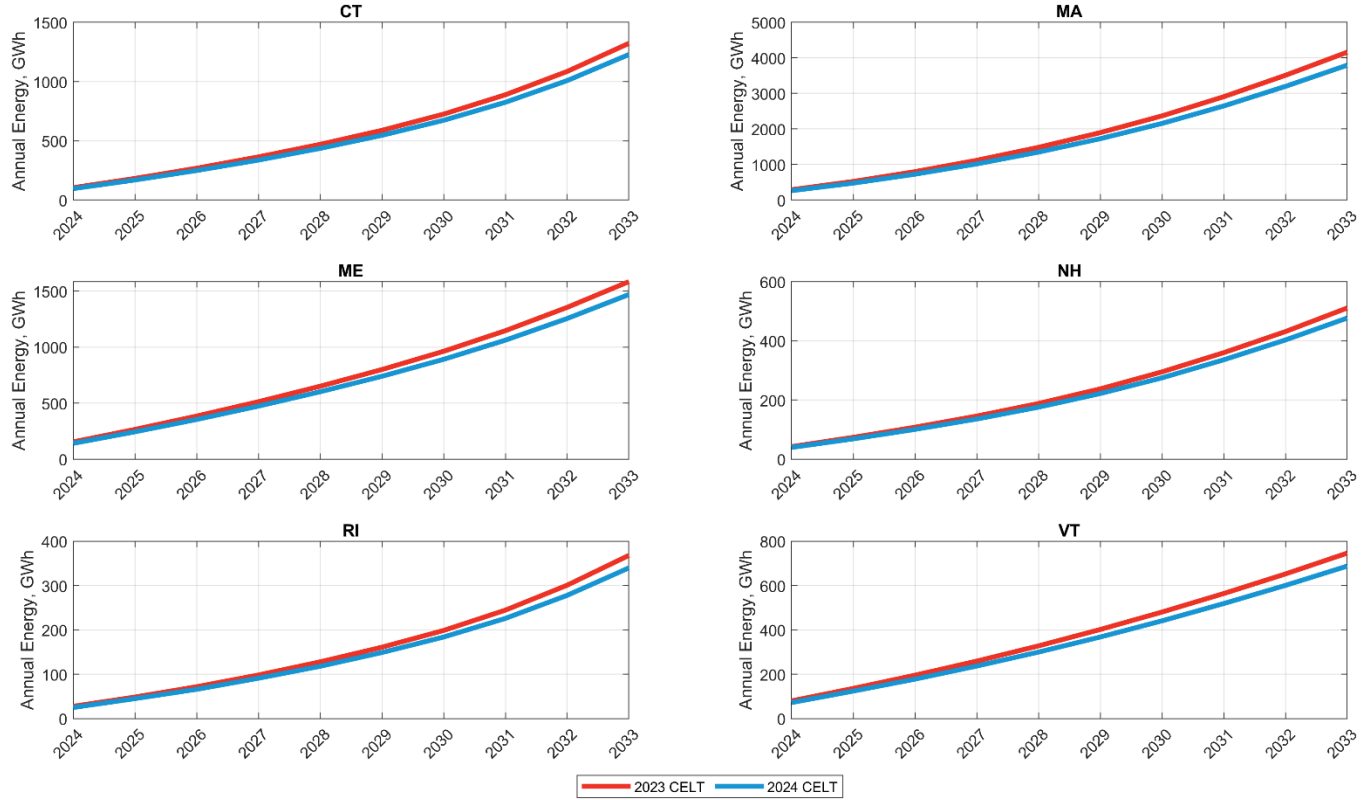
# Draft 2024 Heating Electrification Forecast

*Annual Energy, GWh*

| | Annual Energy (GWh) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
| Connecticut | 96 | 169 | 249 | 337 | 436 | 546 | 673 | 825 | 1,008 | 1,228 |
| Massachusetts | 263 | 475 | 726 | 1,016 | 1,348 | 1,725 | 2,154 | 2,646 | 3,198 | 3,794 |
| Maine | 142 | 245 | 355 | 474 | 602 | 740 | 891 | 1,062 | 1,255 | 1,469 |
| New Hampshire | 40 | 69 | 101 | 136 | 176 | 222 | 275 | 336 | 403 | 477 |
| Rhode Island | 25 | 45 | 66 | 91 | 118 | 149 | 184 | 226 | 278 | 340 |
| Vermont | 72 | 124 | 178 | 237 | 300 | 368 | 441 | 519 | 601 | 688 |
| **Total** | **640** | **1,127** | **1,676** | **2,292** | **2,979** | **3,749** | **4,618** | **5,614** | **6,742** | **7,996** |

# Annual Heating Electrification Energy

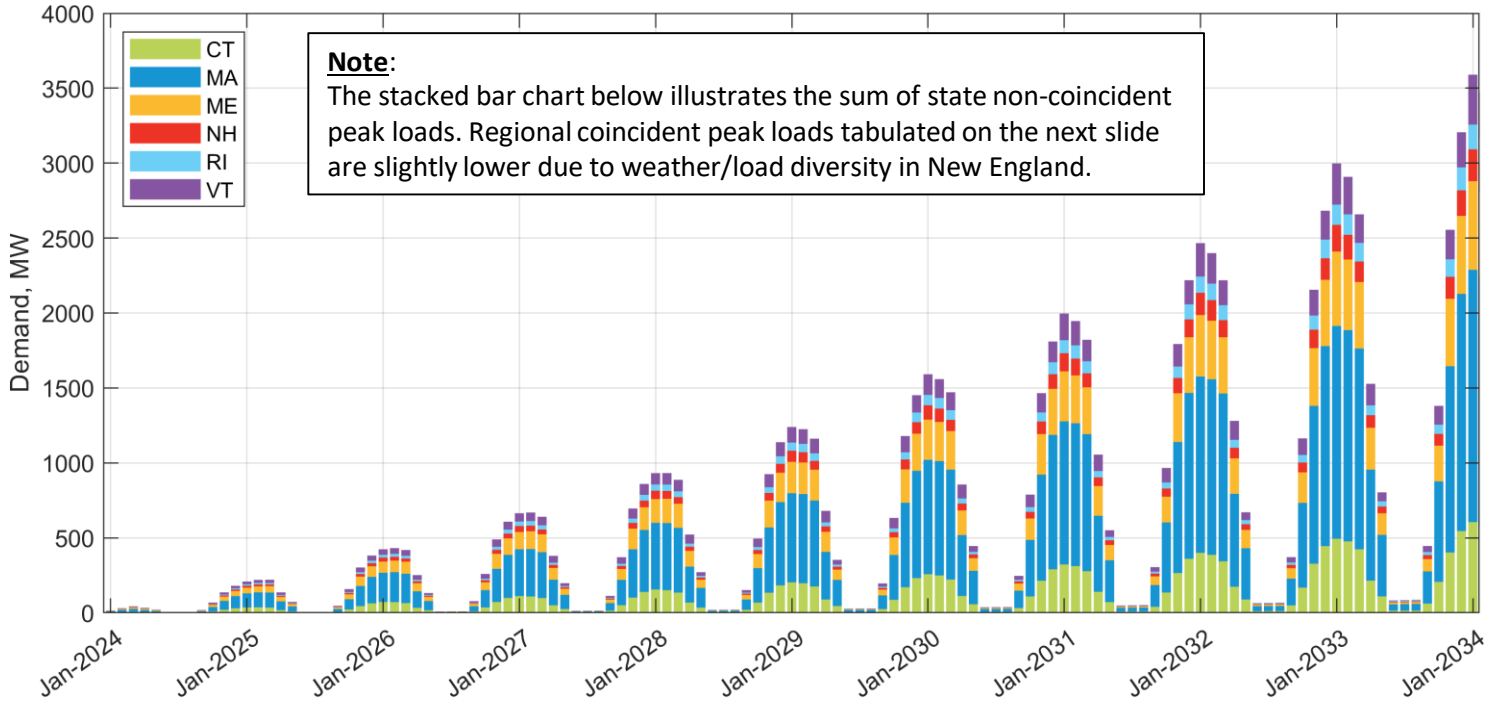
*Draft CELT 2024 vs. Final CELT 2023*



# DRAFT 2024 DEMAND FORECAST

# Draft 2024 Heating Electrification Forecast

*Monthly Demand, 50/50*



# Draft 2024 Heating Electrification Forecast

*Winter (January) Demand, 50/50*

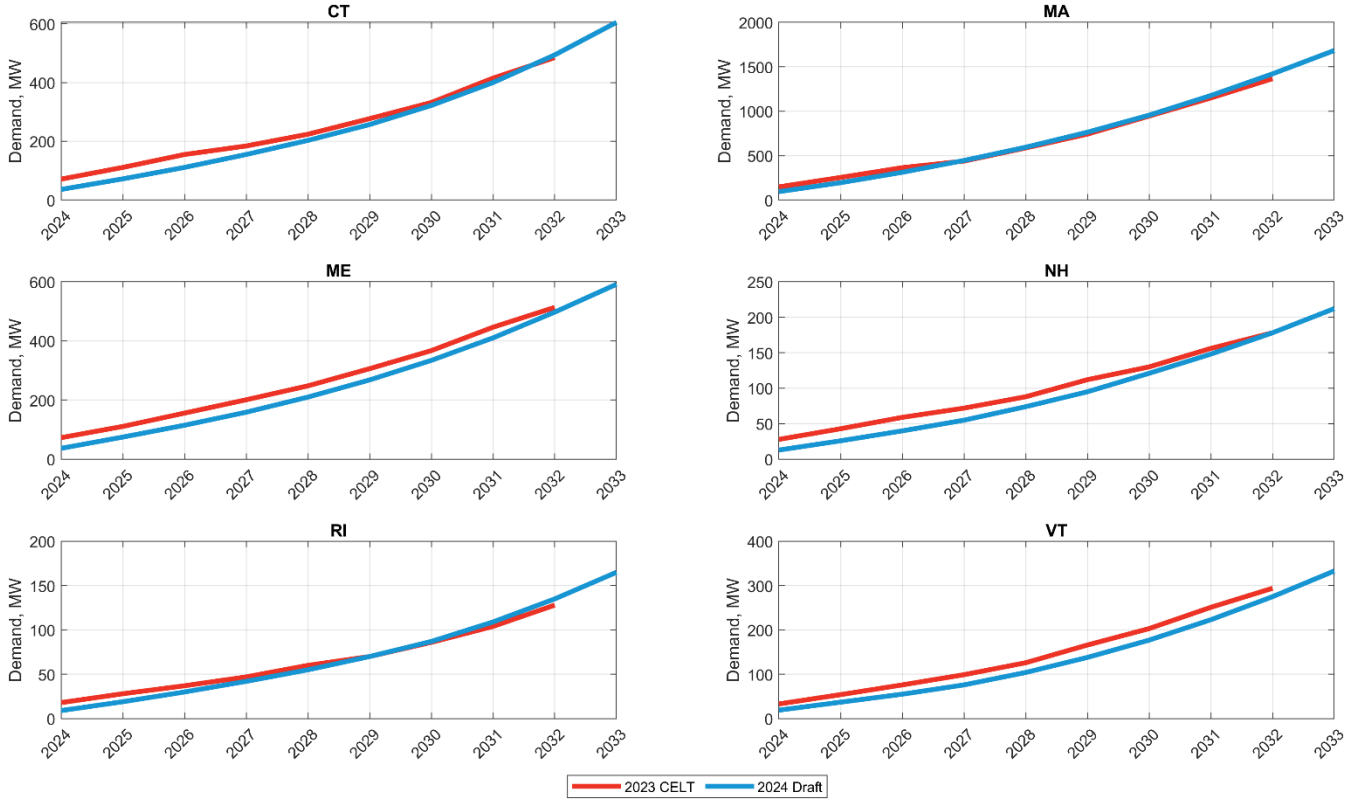
| | Winter Peak (MW) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2024-25 | 2025-26 | 2026-27 | 2027-28 | 2028-29 | 2029-30 | 2030-31 | 2031-32 | 2032-33 | 2033-34 |
| Connecticut | 36 | 72 | 111 | 155 | 203 | 257 | 322 | 400 | 494 | 605 |
| Massachusetts | 94 | 195 | 312 | 445 | 594 | 763 | 955 | 1,176 | 1,420 | 1,683 |
| Maine | 37 | 75 | 115 | 159 | 210 | 268 | 334 | 410 | 497 | 591 |
| New Hampshire | 13 | 26 | 40 | 55 | 74 | 95 | 121 | 148 | 178 | 212 |
| Rhode Island | 9 | 19 | 30 | 42 | 55 | 70 | 87 | 109 | 135 | 165 |
| Vermont | 19 | 37 | 55 | 76 | 104 | 138 | 177 | 223 | 275 | 333 |
| **Total** | **204** | **418** | **661** | **935** | **1,244** | **1,591** | **1,986** | **2,453** | **2,984** | **3,578** |

**Notes**:

1. State values are non-coincident peak loads, while total (regional) values are coincident peak loads. Non-coincident peaks do not sum to coincident peaks due to weather/load diversity across New England.
2. Forecast values are based on heating forecast demand distributions only, and therefore, are slightly different than those based on gross demand forecast distributions, which are discussed separately during today's LFC meeting.

# Winter Heating Electrification Peak Demand, 50/50

*Draft CELT 2024 vs. Final CELT 2023*



# Draft 2024 Heating Electrification Forecast

*Summer (July) Demand, 50/50*

| | Summer Peak (MW) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
| Connecticut | 0 | 1 | 2 | 3 | 4 | 5 | 7 | 9 | 11 | 14 |
| Massachusetts | 1 | 2 | 4 | 7 | 10 | 14 | 19 | 25 | 33 | 43 |
| Maine | 0 | 1 | 1 | 2 | 3 | 4 | 5 | 7 | 9 | 12 |
| New Hampshire | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 |
| Rhode Island | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 6 |
| Vermont | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 4 |
| **Total** | **2** | **5** | **9** | **14** | **21** | **28** | **38** | **50** | **66** | **85** |

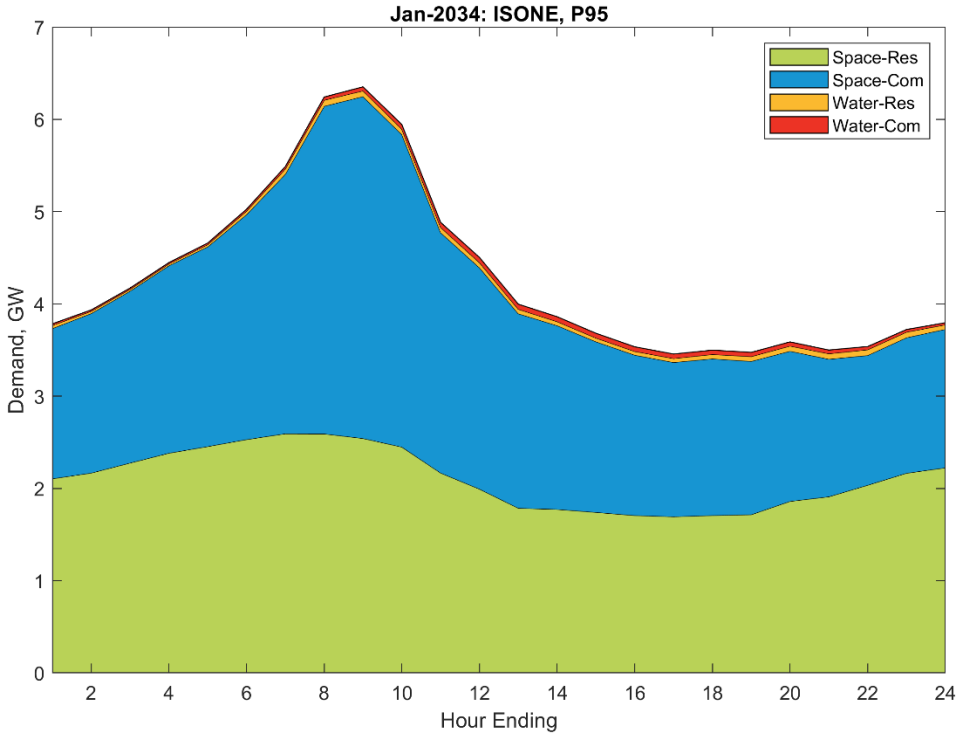
**Notes**:

1. Summer demand values are due to electrified water heating

# 50/50 Winter Peak Composition

*January 2034*

- Plot shows relative composition of hourly winter 50/50 peak demand impacts of heating electrification in January 2033
  - Residential space heating (“Space-Res”)
  - Commercial space heating (“Space-Com”)
  - Residential water heating (“Water-Res”)
  - Commercial water heating (“Water-Com”)
- Demand during morning peak hours is significantly higher than during typical coincident winter peak hour(s) today (hours 18-19)
- ISO will continue investigating the outlook for potential load shape impacts such as these as part of its electrification forecasting efforts



# NEXT STEPS

# Next Steps

- ISO will continue to work with stakeholders to update the heating forecast as needed
  - Significant changes are not anticipated
- Any significant changes to the forecast will be shared at the February 23, 2024 LFC meeting

# Questions

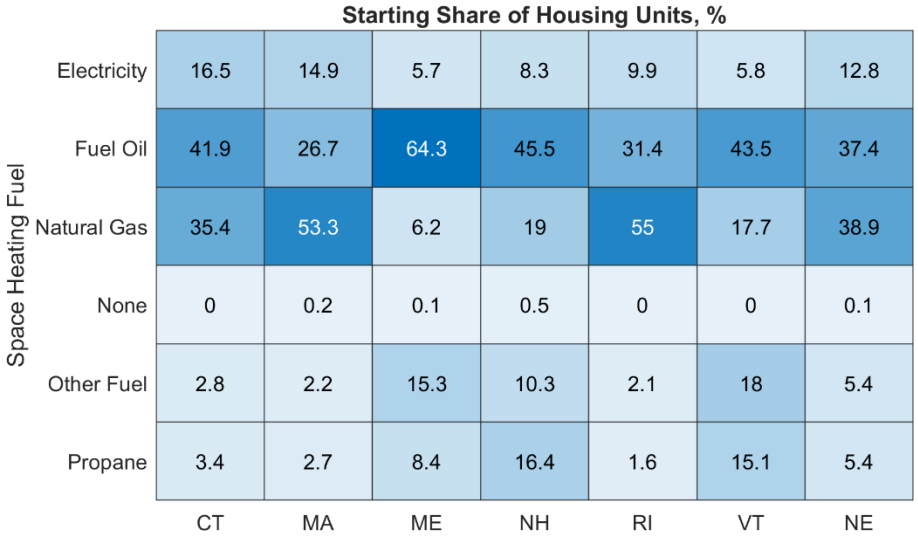
# APPENDIX I

*State Adoption – Residential Space Heating*

# Residential Space Heating

*Legacy Fuel Sources and Heating Electrification Pathways*

- Adoption modeling focuses exclusively on legacy fossil fueled space heating:
  - Fuel Oil, propane, and natural gas



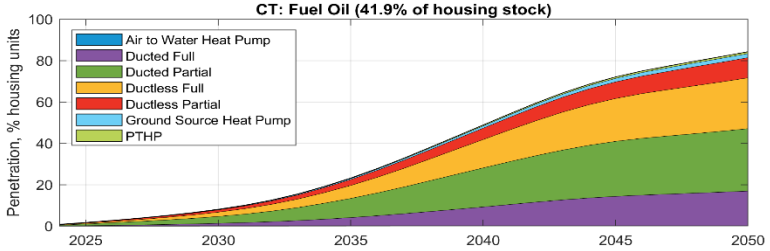

## Residential Space Heating Pathways

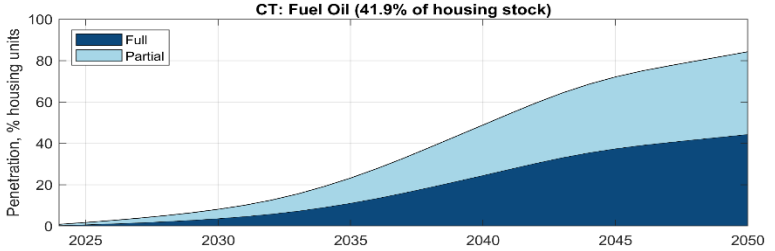
| Heating Type | Technology Type | Heating Displacement |
|---|---|---|
| Space Heating | Ducted ASHP - Full | Full |
| | Ducted ASHP - Partial | Partial |
| | Ductless ASHP - Full | Full |
| | Ductless ASHP - Partial | Partial |
| | Ground Source Heat Pump | Full |
| | Air to Water Heat Pump | Full |
| | Packaged Terminal Heat Pump | Partial |

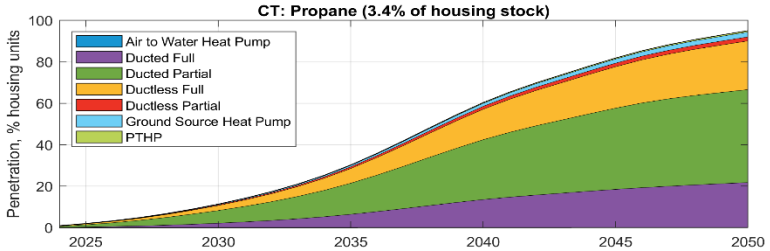
ASHP = Air Source Heat Pump

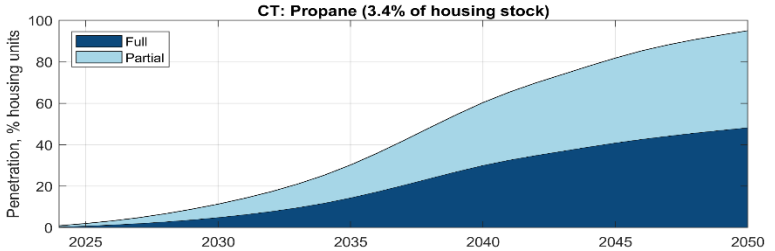
# Adoption By Legacy Residential Space Heating Fuel

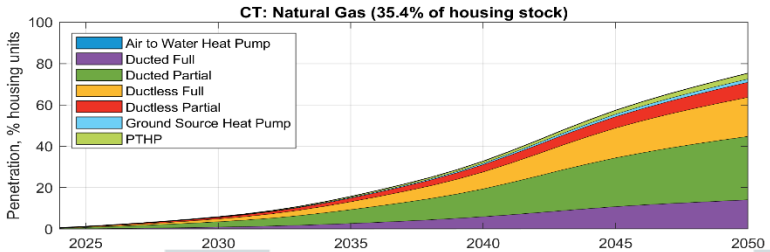
*Connecticut*

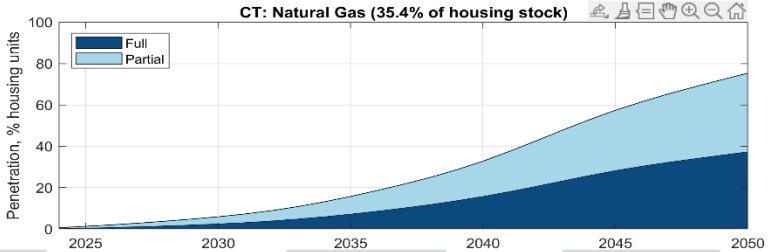


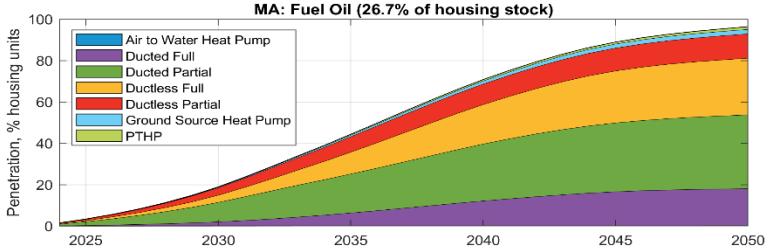



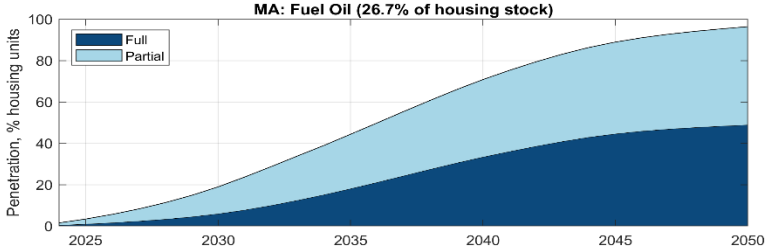



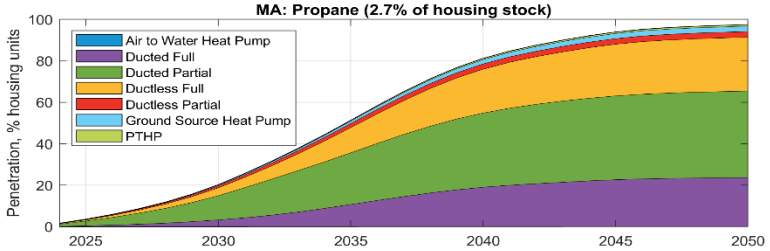



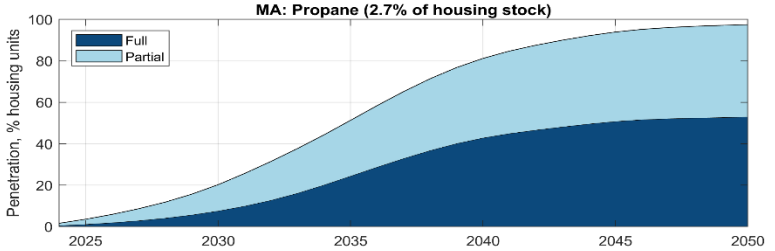
# Adoption By Legacy Residential Space Heating Fuel

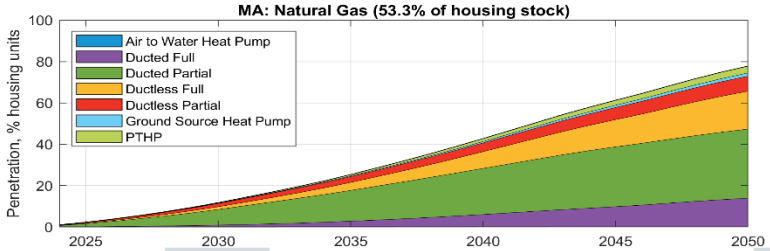
*Massachusetts*

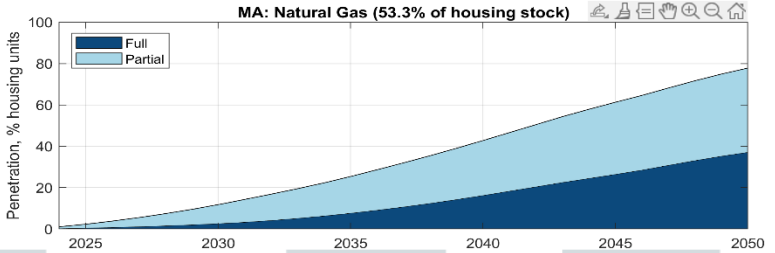


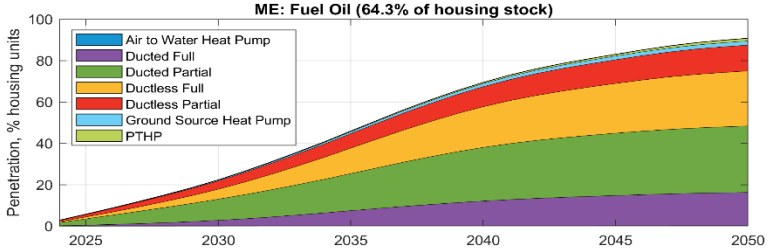



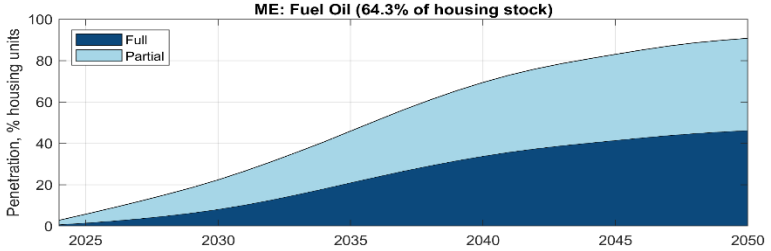



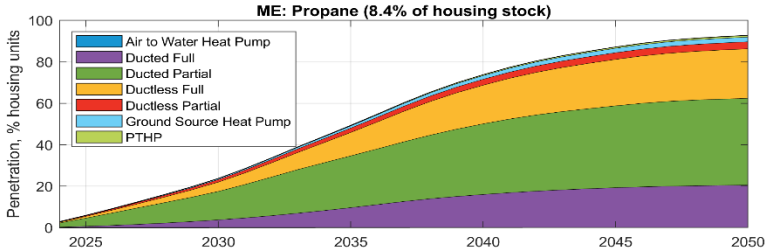



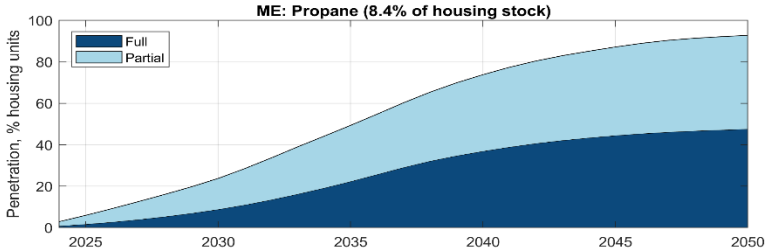
# Adoption By Legacy Residential Space Heating Fuel

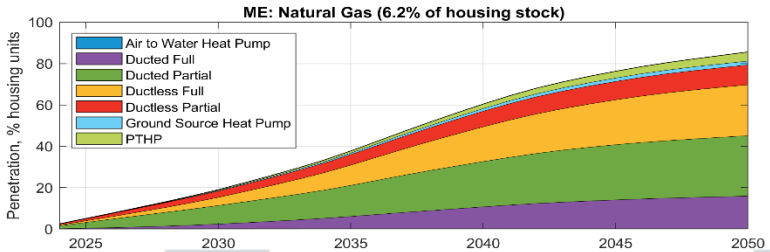
*Maine*

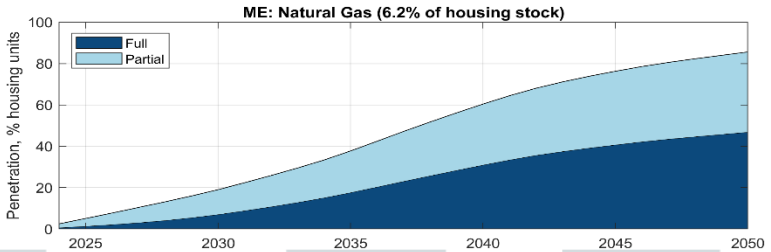


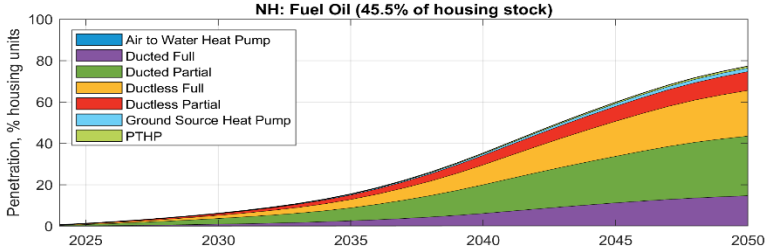



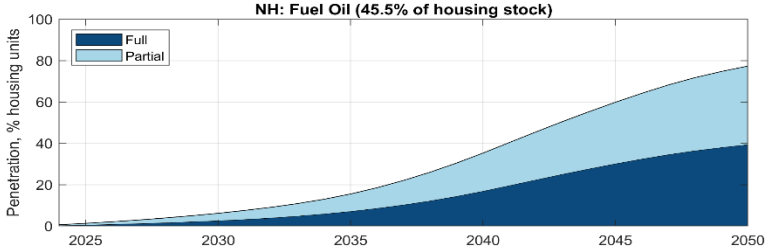



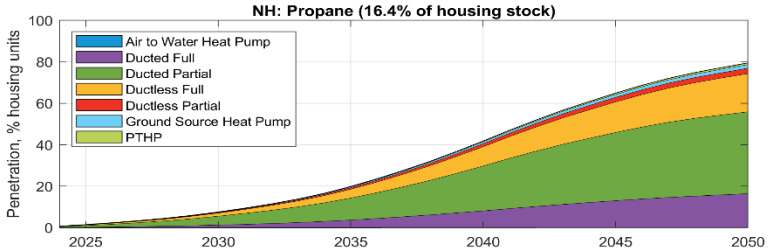



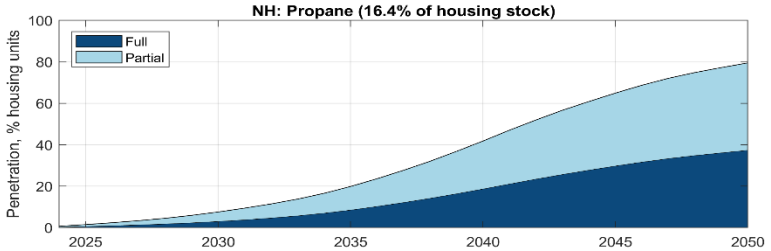
# Adoption By Legacy Residential Space Heating Fuel

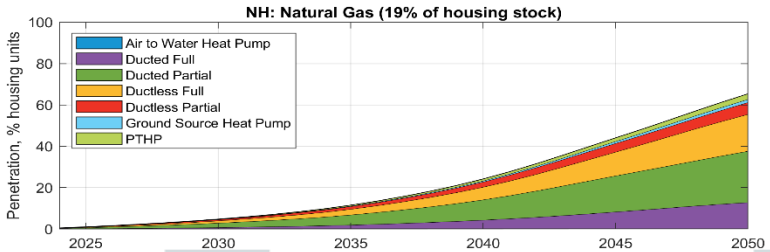
*New Hampshire*

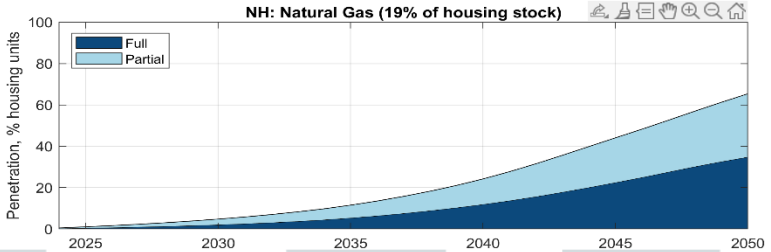


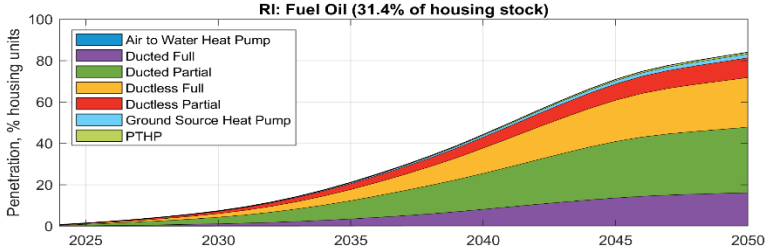



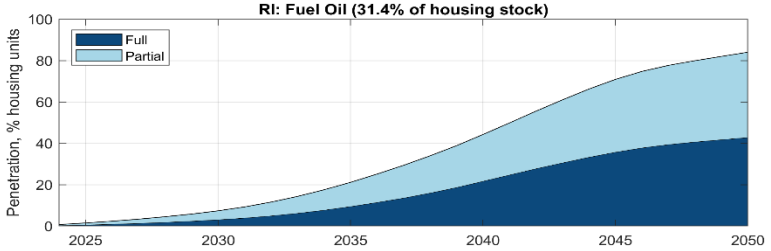



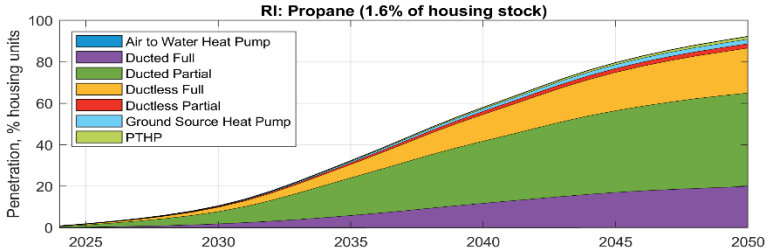



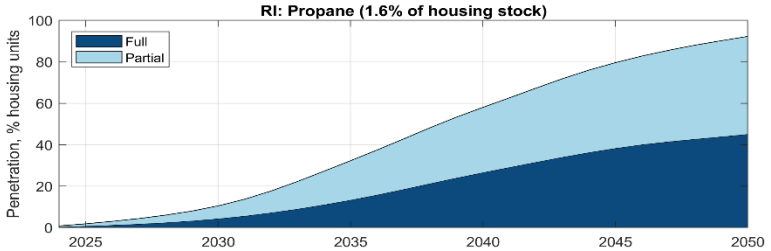
# Adoption By Legacy Residential Space Heating Fuel

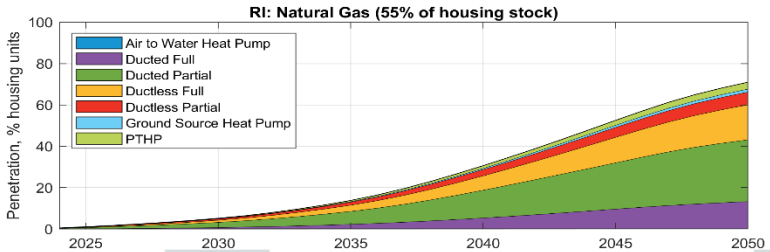
*Rhode Island*

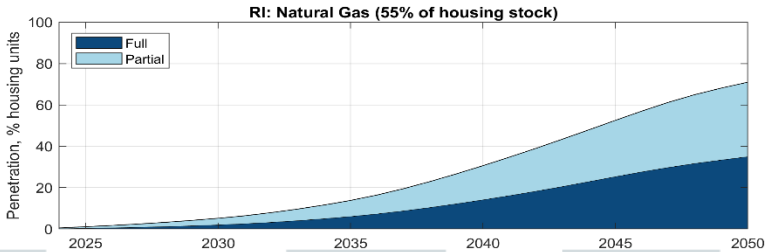


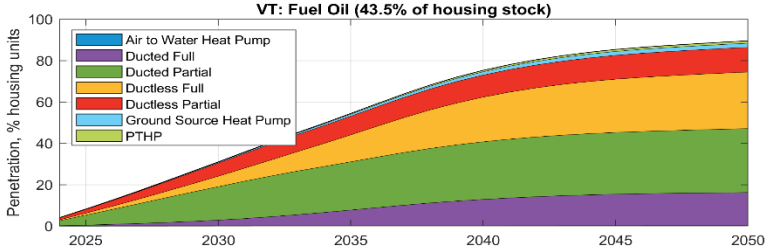



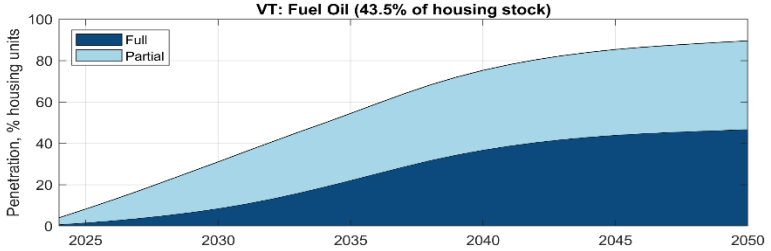



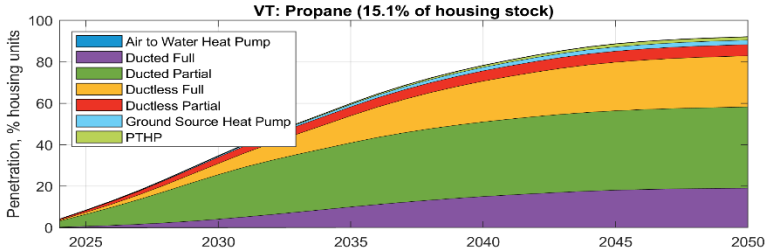



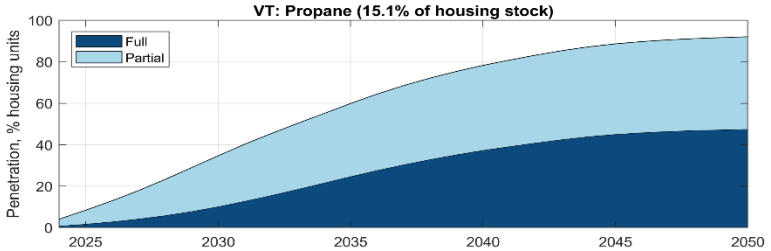
# Adoption By Legacy Residential Space Heating Fuel

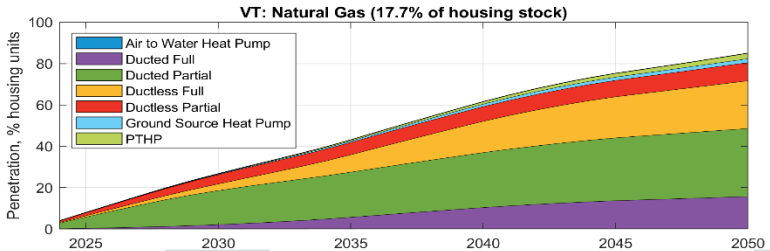
*Vermont*

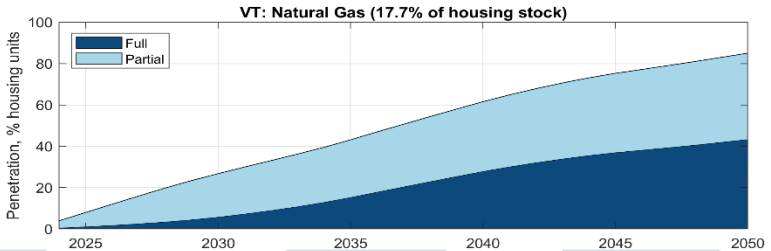


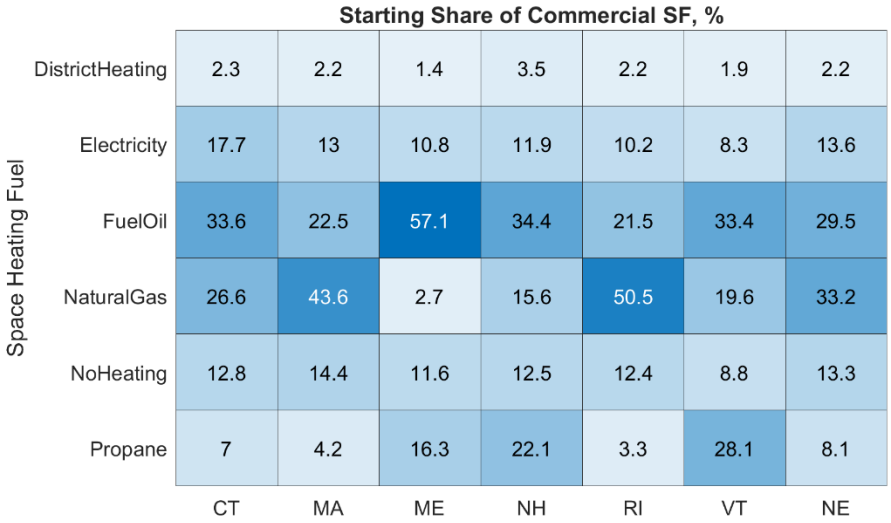
# APPENDIX II

*State Adoption – Commercial Space Heating*

# Commercial Space Heating

*Legacy Fuel Sources and Heating Electrification Pathways*

- Adoption modeling focuses exclusively on legacy fossil fueled space heating:
  - Fuel Oil, propane, and natural gas



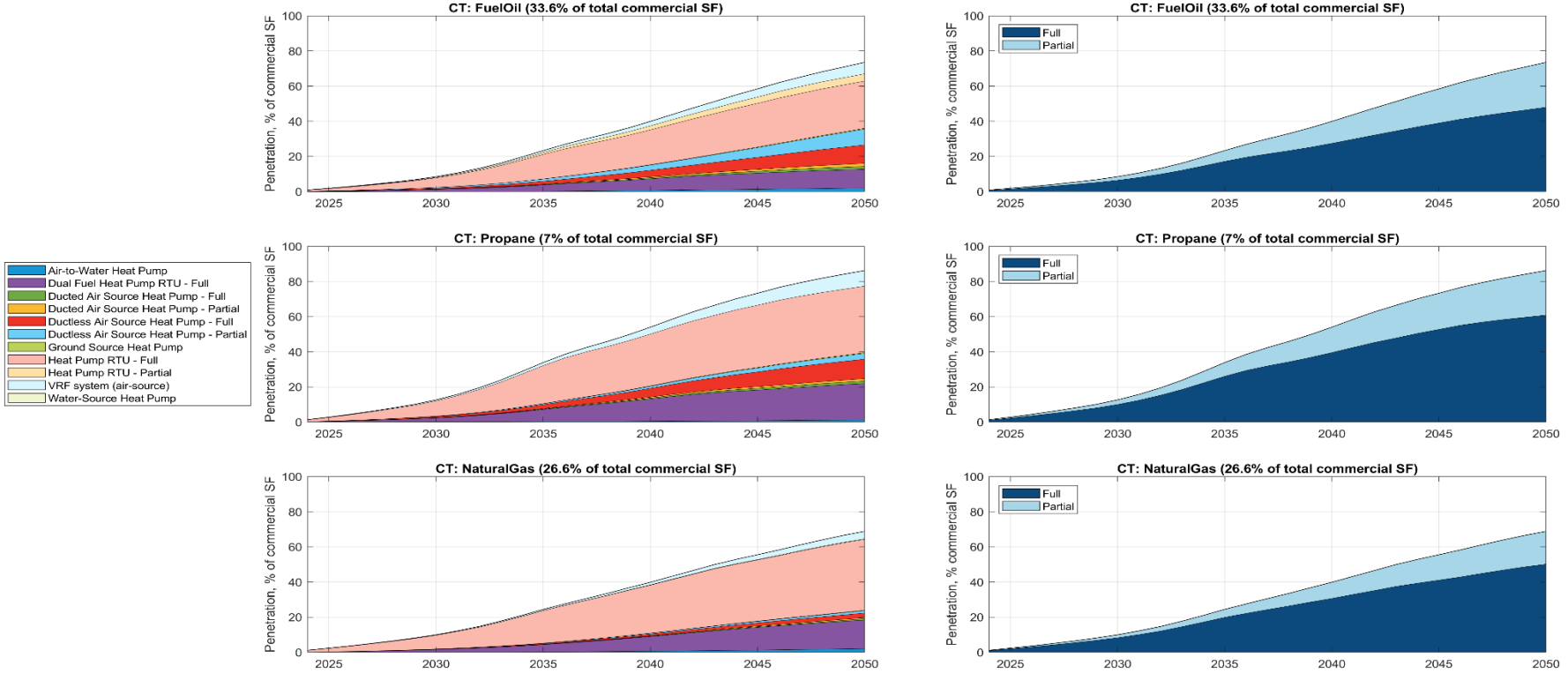

## Commercial Space Heating Pathways

| Heating Type | Technology Type | Heating Displacement |
|---|---|---|
| Space Heating | District Heating via Geothermal Heat Pump | Full |
| | Dual Fuel Heat Pump RTU | Partial |
| | Heat Pump RTU | Full/Partial |
| | VRF system (air-source) | Full |
| | Air-to-Water Heat Pump | Full |
| | Ducted Air Source Heat Pump | Full |
| | Ducted Air Source Heat Pump | Partial |
| | Ductless Air Source Heat Pump | Full |
| | Ductless Air Source Heat Pump | Partial |

RTU = Rooftop Unit; VRF = Variable Refrigerant Flow

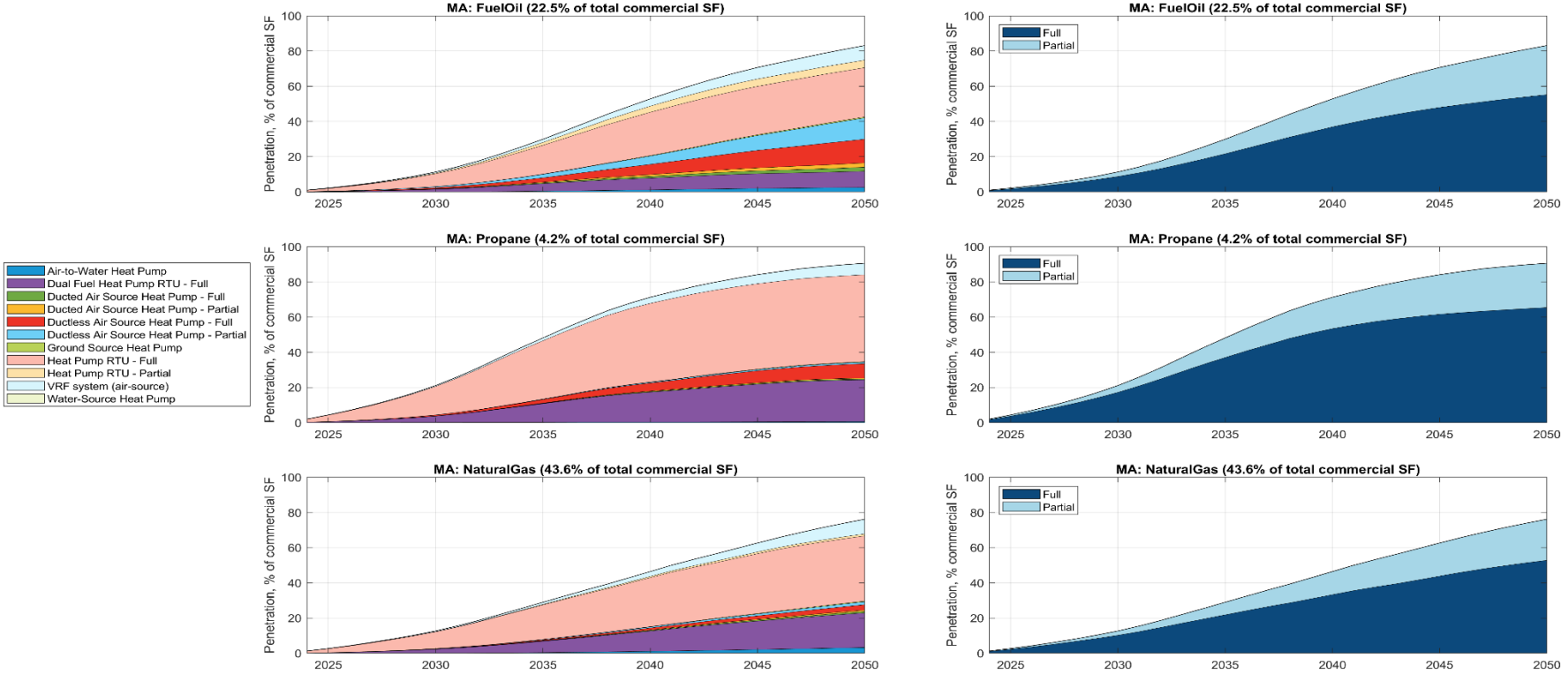
# Adoption By Legacy Commercial Space Heating Fuel

*Connecticut*



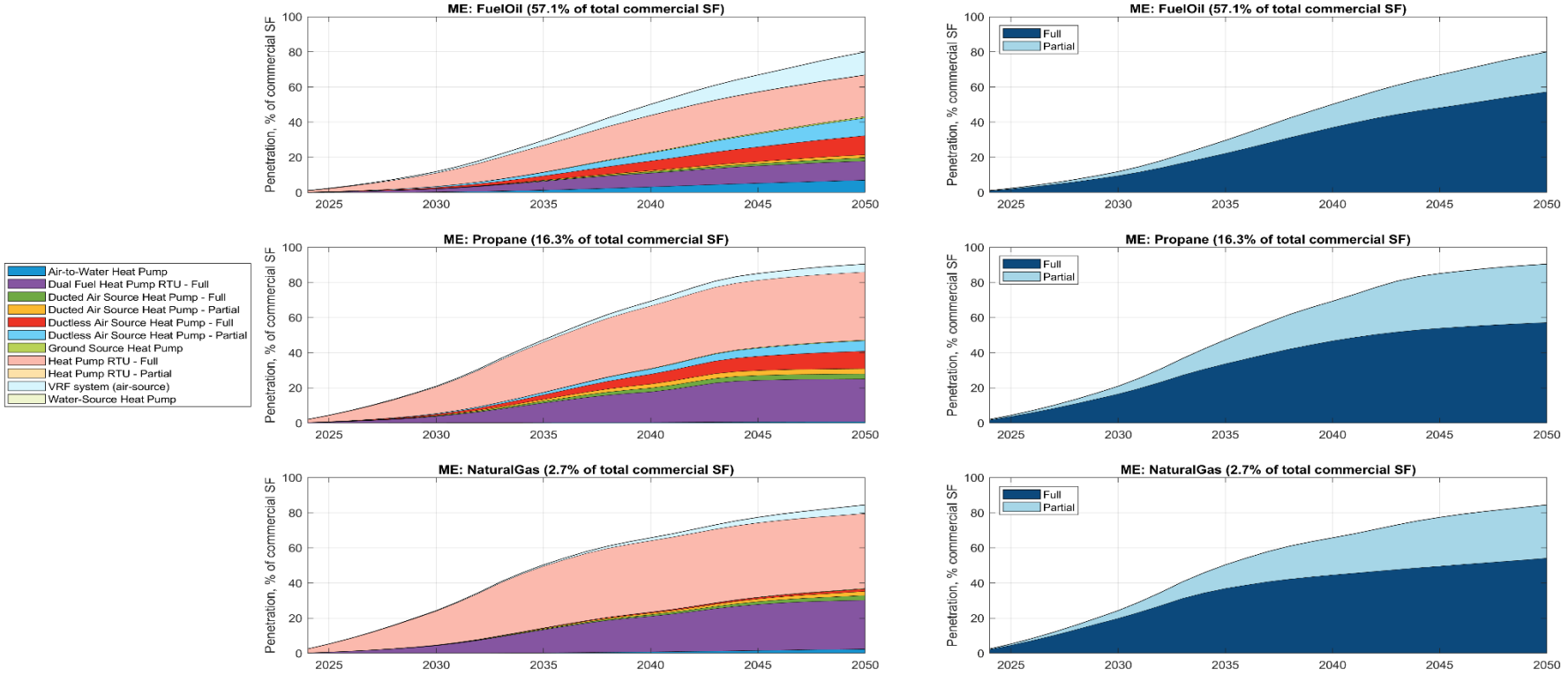
# Adoption By Legacy Commercial Space Heating Fuel

*Massachusetts*



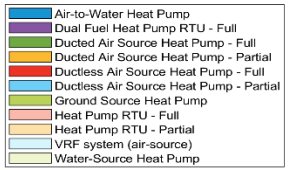
# Adoption By Legacy Commercial Space Heating Fuel

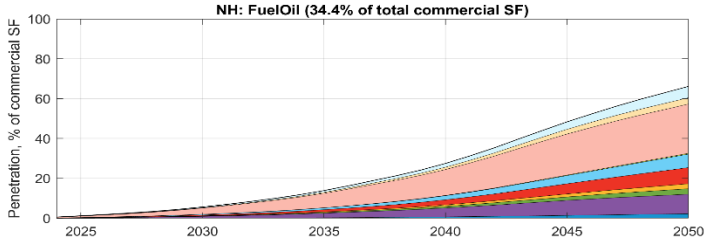
*Maine*

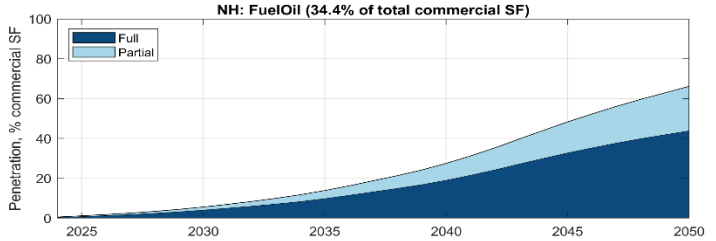


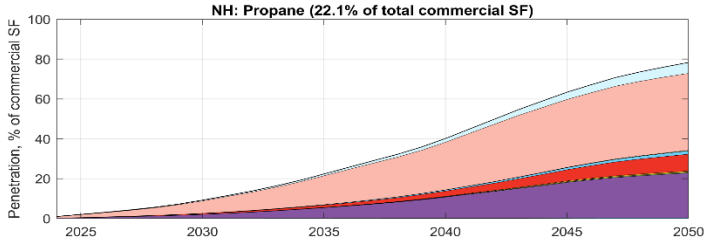
# Adoption By Legacy Commercial Space Heating Fuel

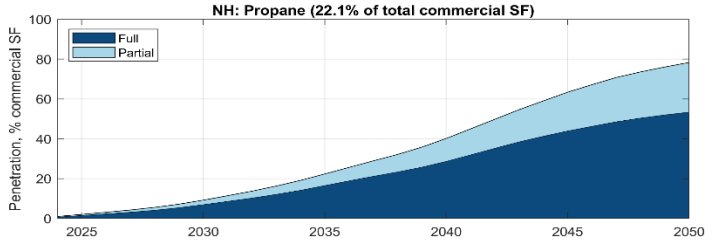
*New Hampshire*

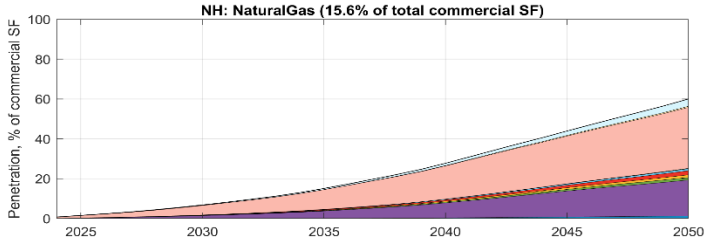


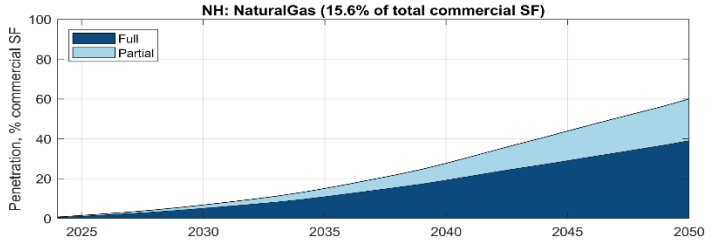



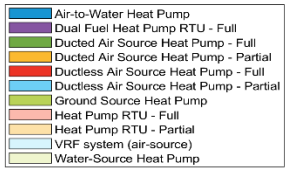



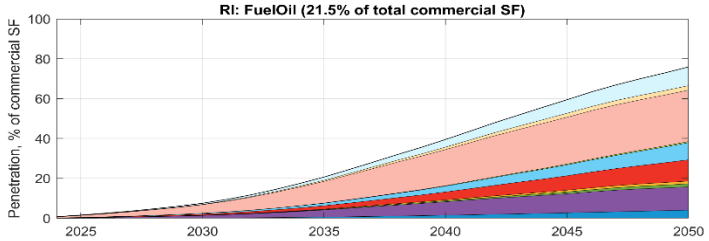



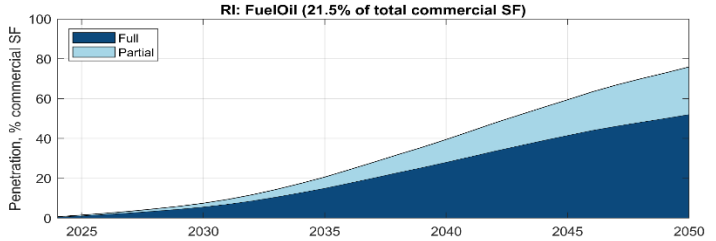



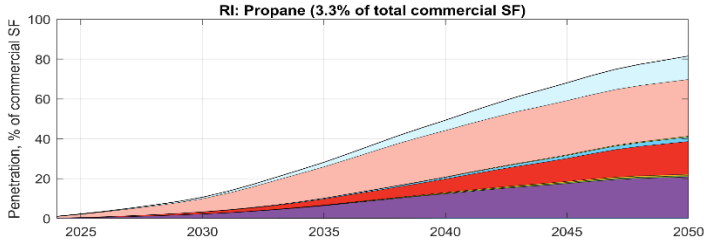
# Adoption By Legacy Commercial Space Heating Fuel

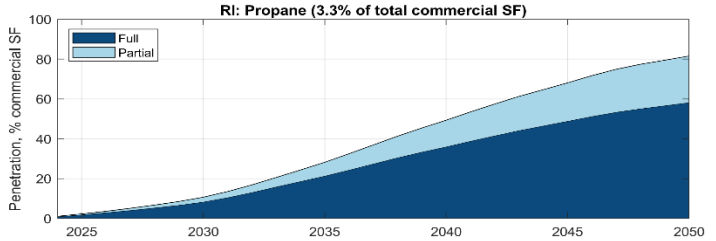
*Rhode Island*

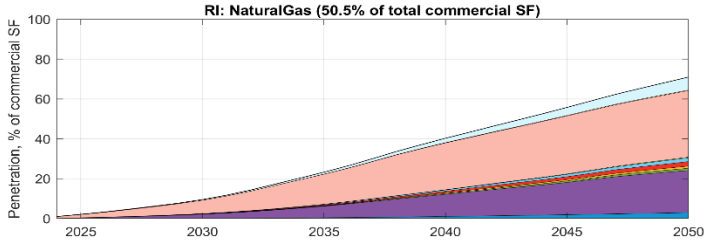


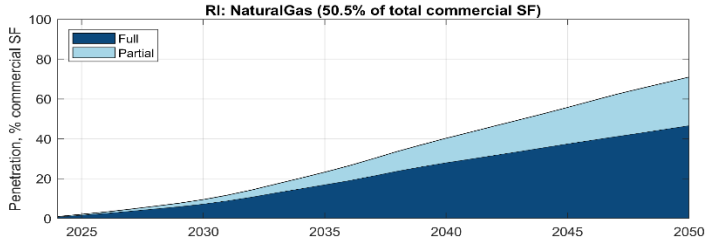



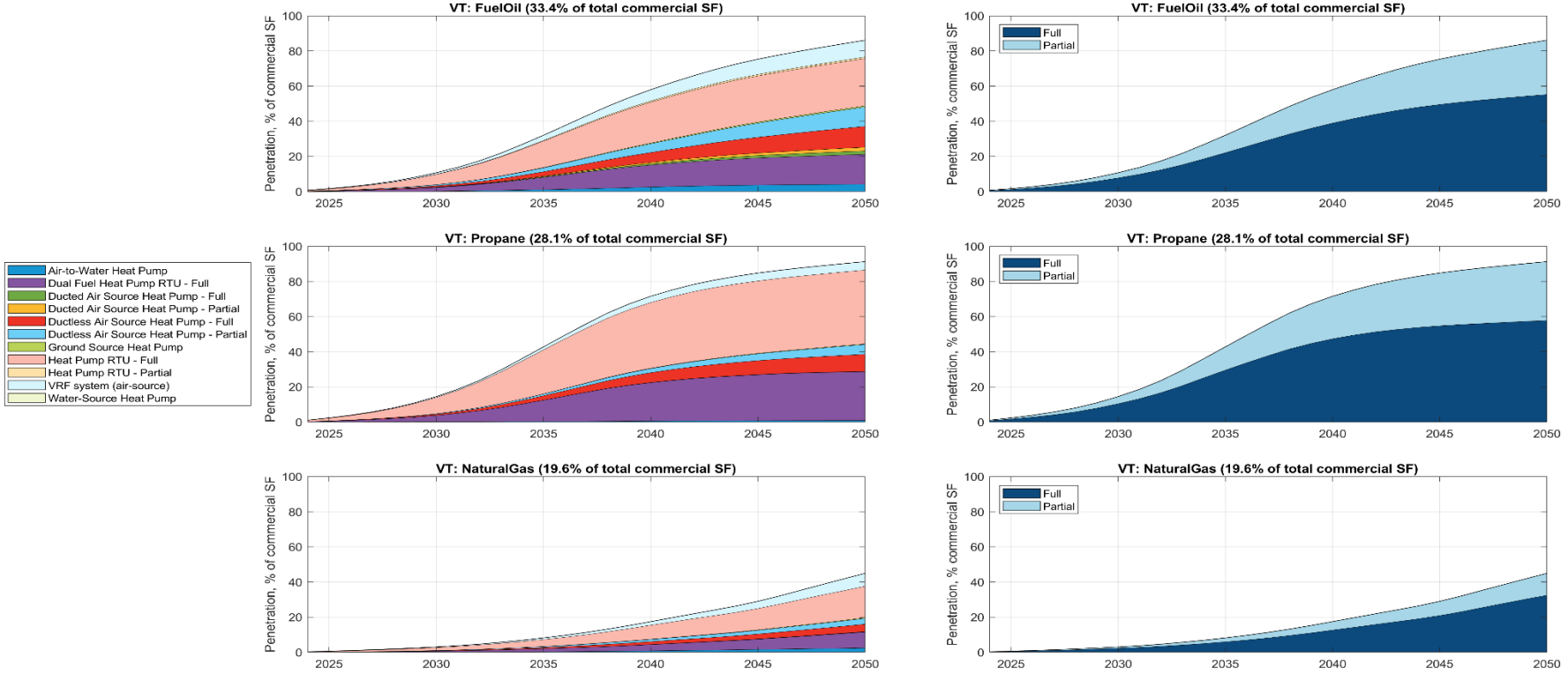



# Adoption By Legacy Commercial Space Heating Fuel

*Vermont*



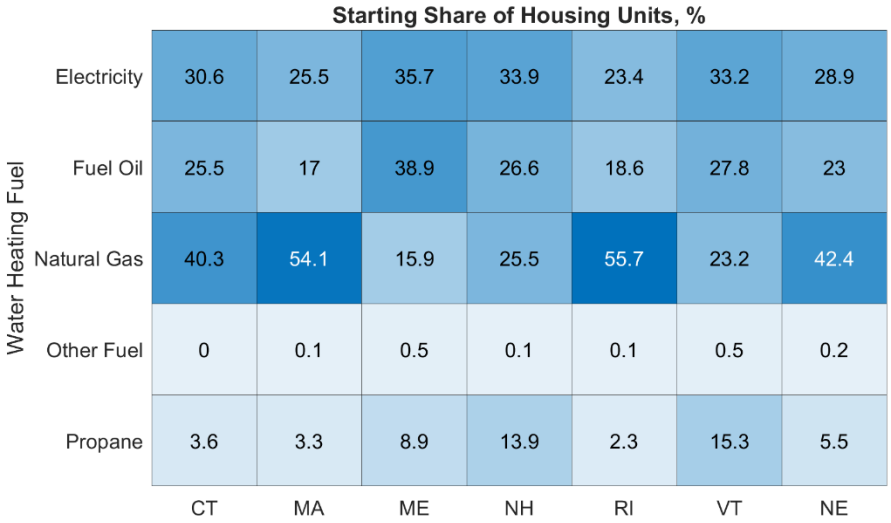
# APPENDIX III

*State Adoption – Residential Water Heating*

# Residential Water Heating

*Legacy Fuel Sources and Heating Electrification Pathways*

- Adoption modeling focuses exclusively on legacy fossil fueled space heating:
  - Fuel Oil, propane, and natural gas

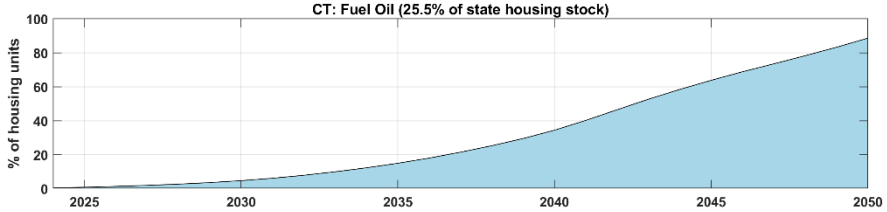


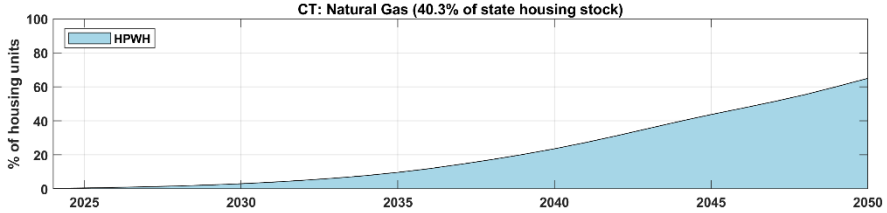

## Residential Water Heating Pathways

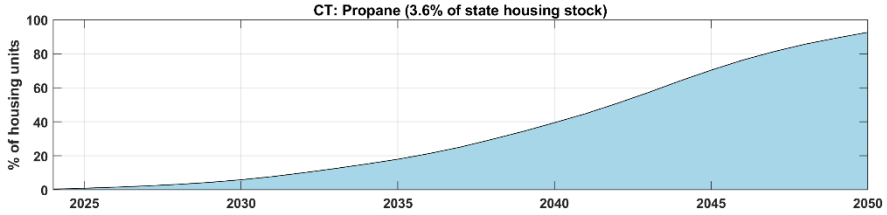
| Heating Type | Technology Type | Heating Displacement |
|---|---|---|
| Water Heating | Heat Pump Water Heater | Full |

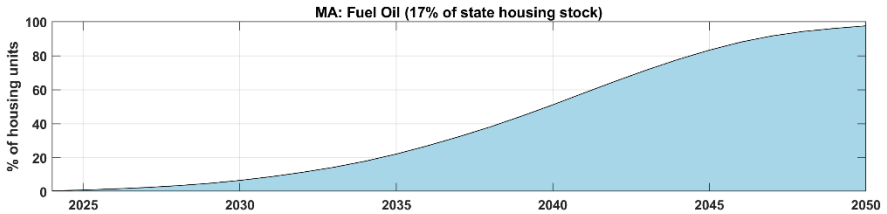
# Adoption By Legacy Residential Water Heating Fuel

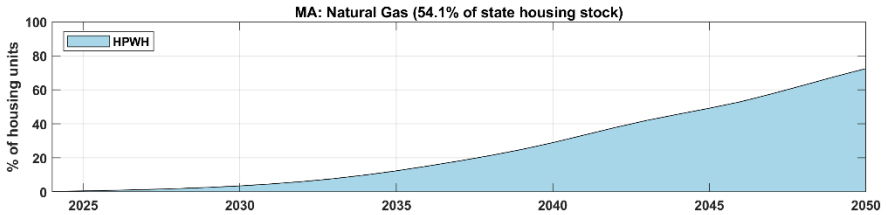
*Connecticut (left) and Massachusetts (right)*

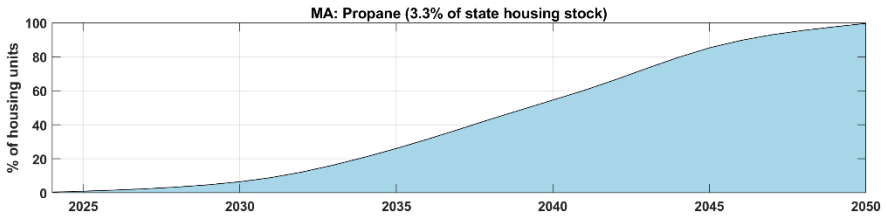


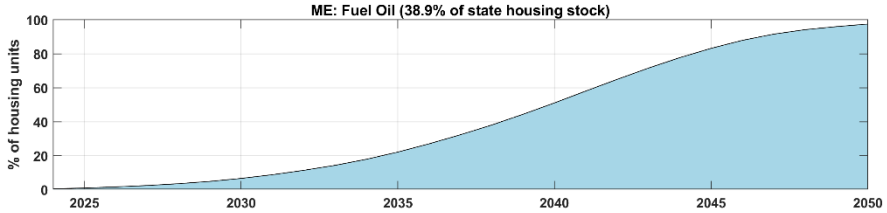



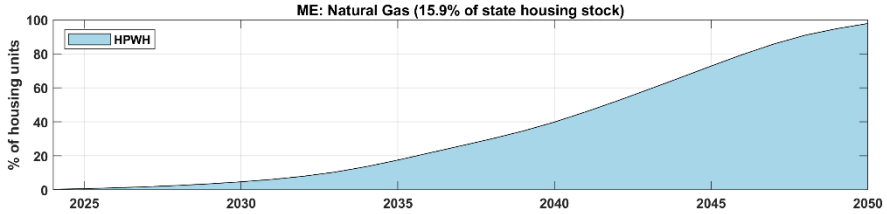



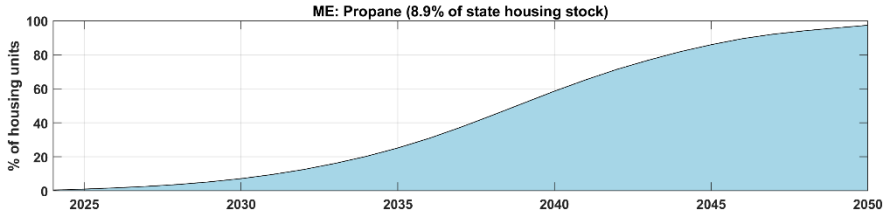



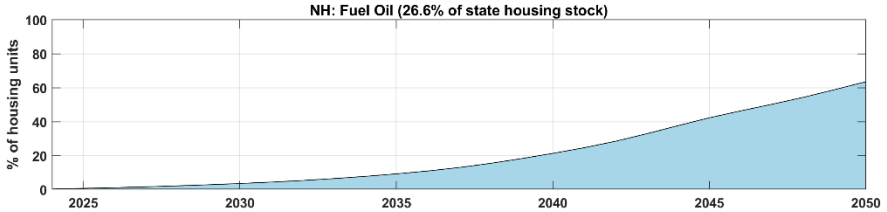
# Adoption By Legacy Residential Water Heating Fuel

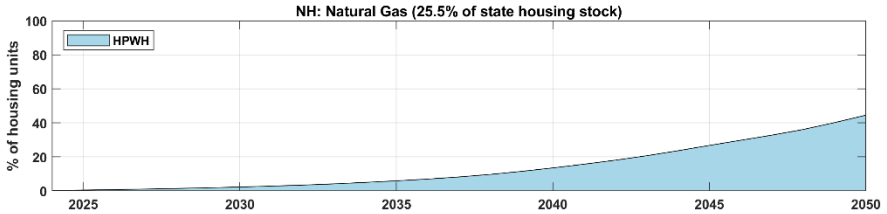
*Maine (left) and New Hampshire (right)*

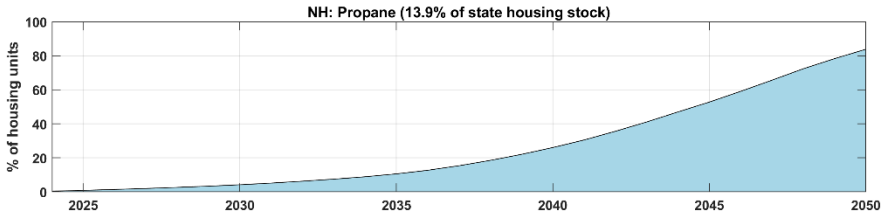


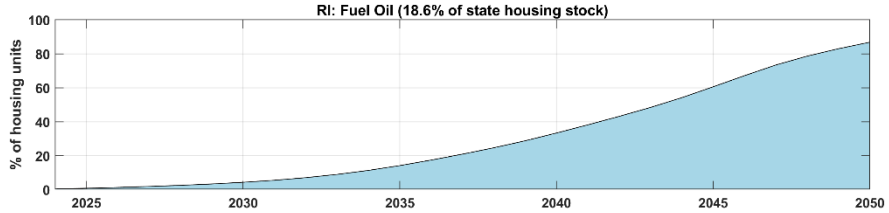



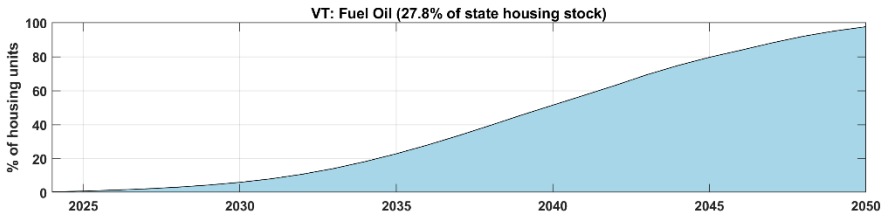



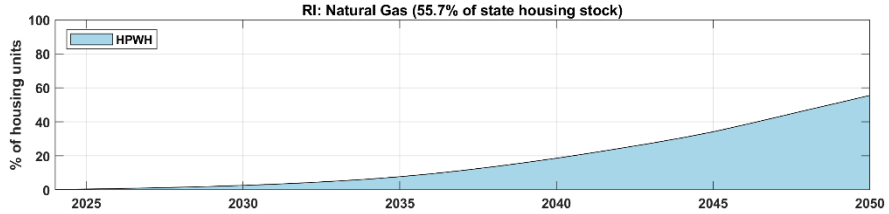



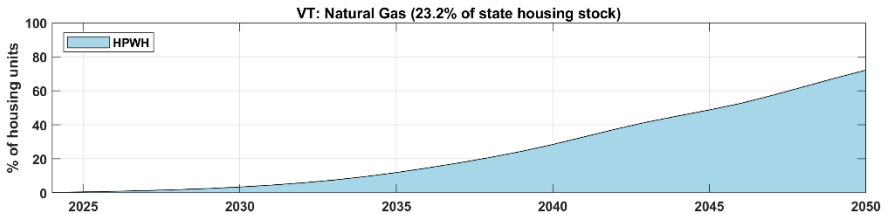
# Adoption By Legacy Residential Water Heating Fuel

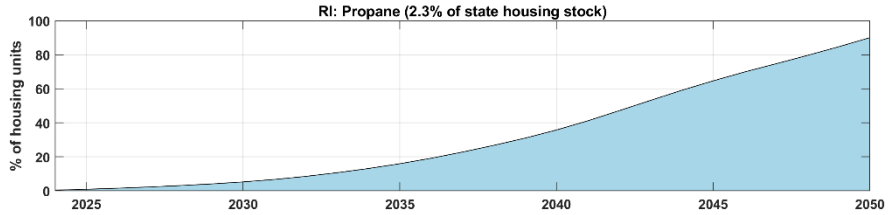
*Rhode Island (left) and Vermont (right)*

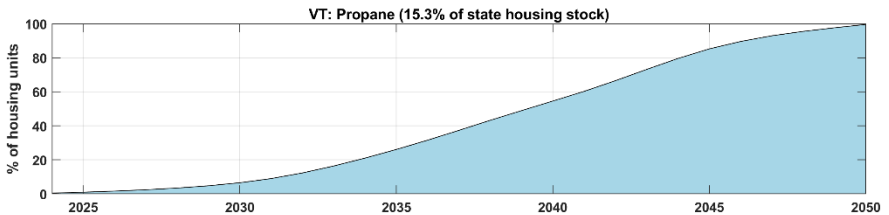


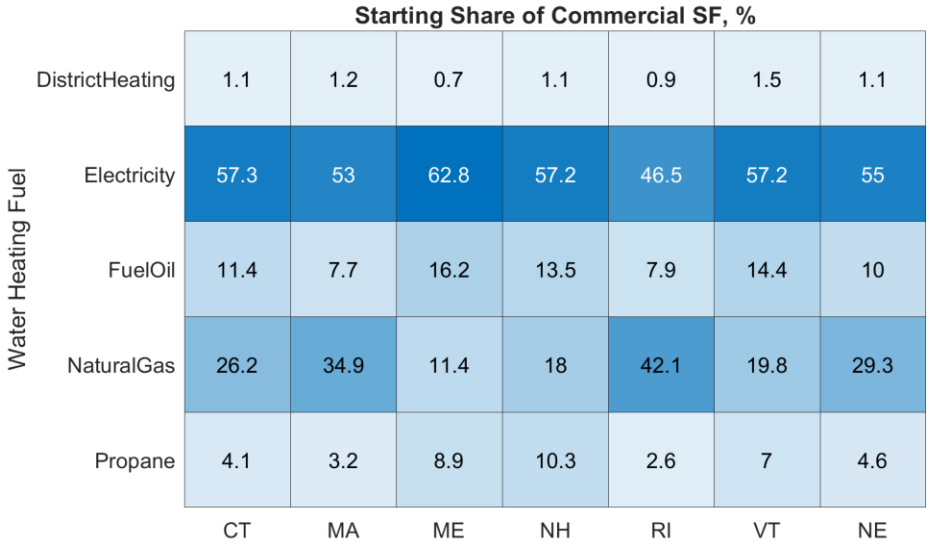
# APPENDIX IV

*State Adoption – Commerical Water Heating*

# Commercial Water Heating

*Legacy Fuel Sources and Heating Electrification Pathways*

- Adoption modeling focuses exclusively on legacy fossil fueled space heating:
  - Fuel Oil, propane, and natural gas

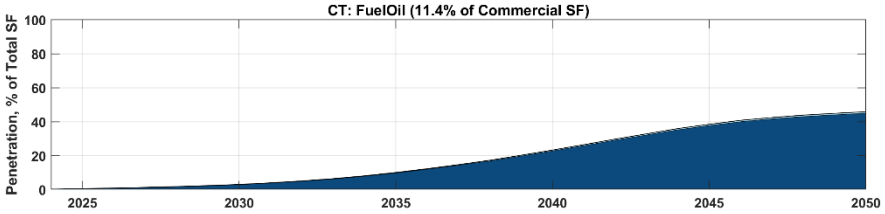


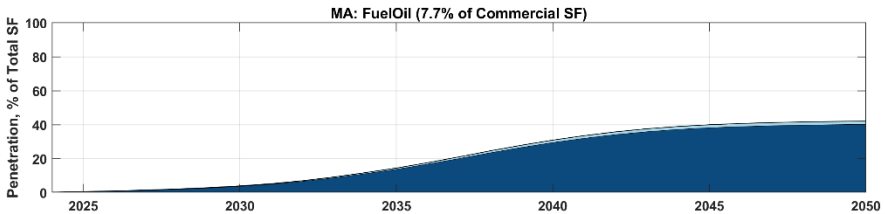

## Commercial Water Heating Pathways

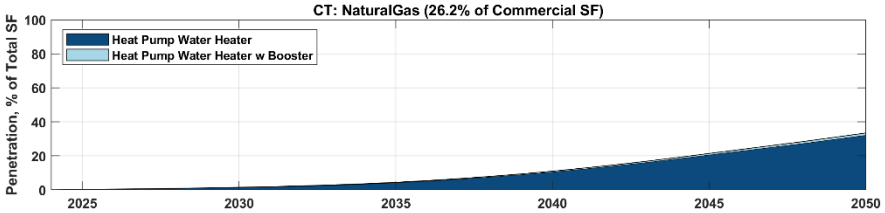
| Heating Type | Technology Type | Heating Displacement |
|---|---|---|
| Water Heating | Heat Pump Water Heater | Full |
| | Heat Pump Water Heater with Booster | Partial |

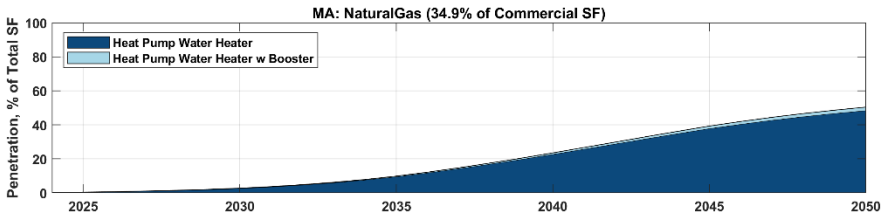
# Adoption By Legacy Commercial Water Heating Fuel

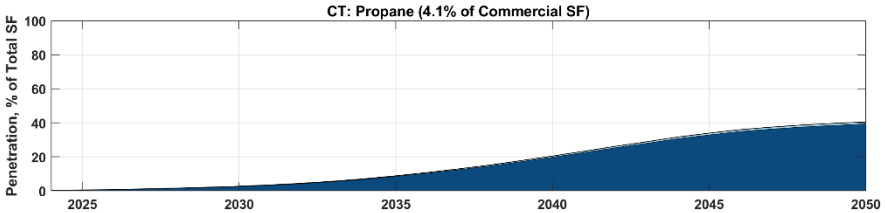
*Connecticut (left) and Massachusetts (right)*

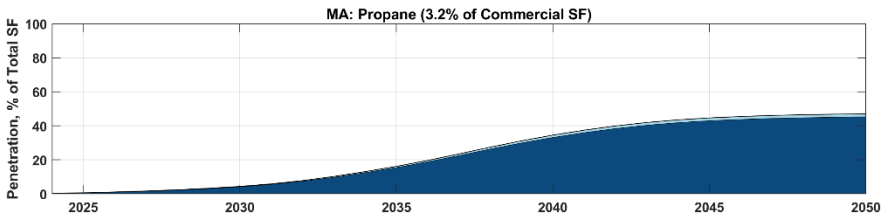


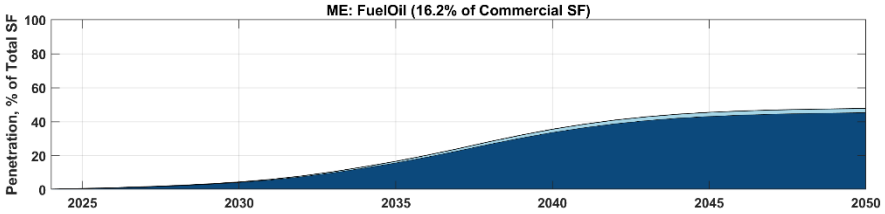



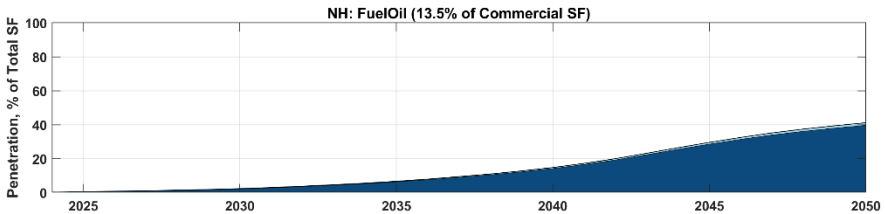



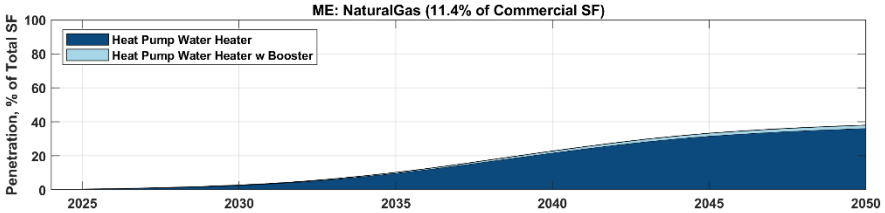



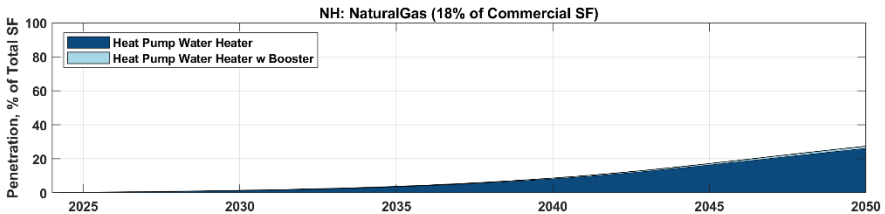
# Adoption By Legacy Commercial Water Heating Fuel

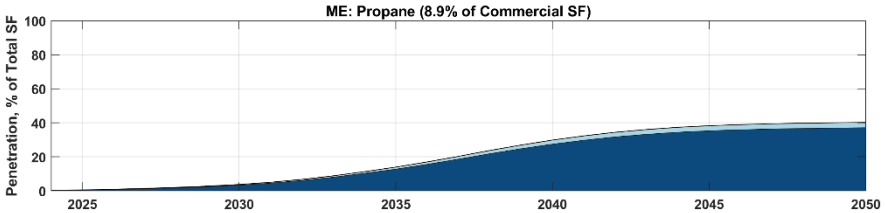
*Maine (left) and New Hampshire (right)*

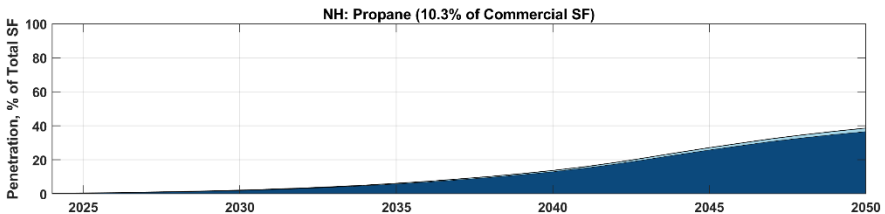


# Adoption By Legacy Commercial Water Heating Fuel

*Rhode Island (left) and Vermont (right)*