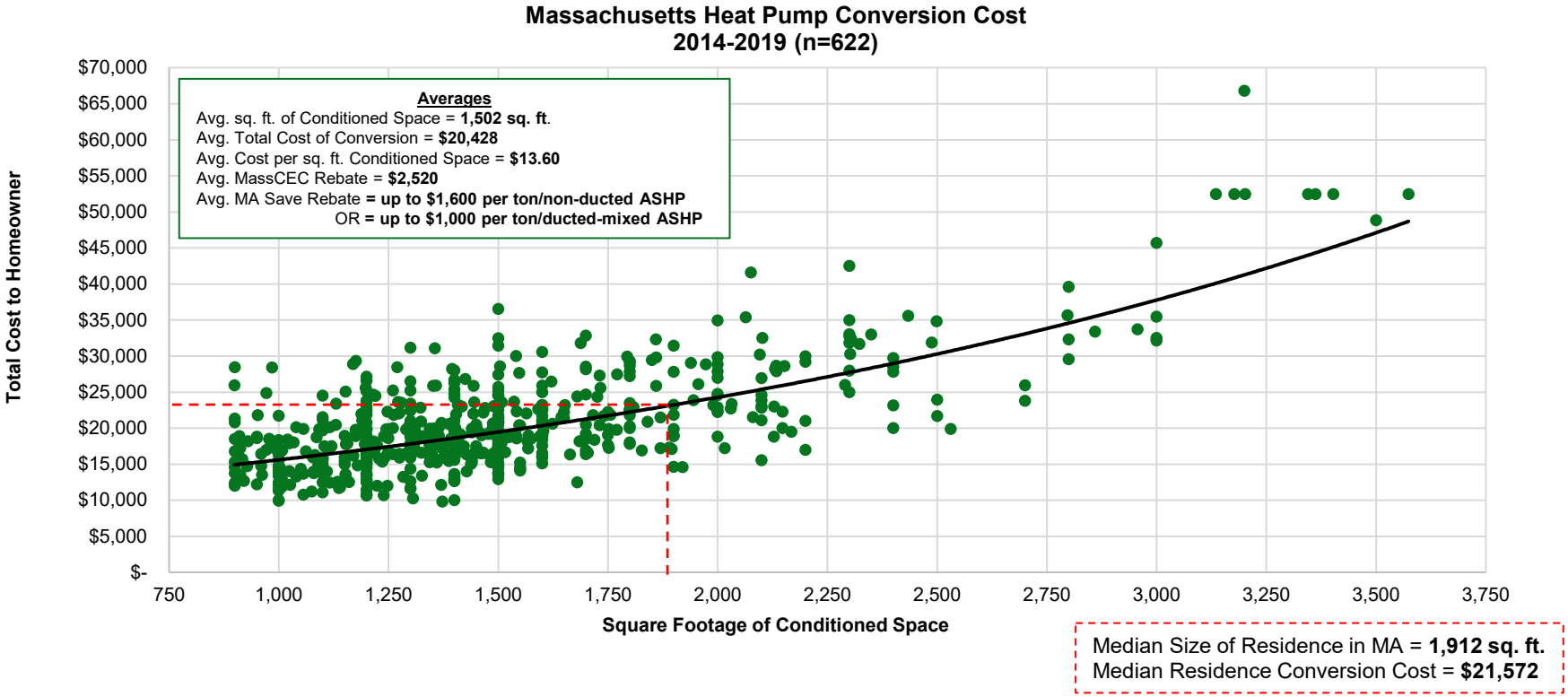
Conversion: Cost

The cost of converting to an electric air-source heat pump system in Massachusetts is substantial and isn't affordable for most low- and middle-class residents



Median Size of Residence in MA = **1,912 sq. ft.**
Median Residence Conversion Cost = **$21,572**

Assumptions

- ✓ Applications that reported a contained space under 900 square feet were excluded
- ✓ Applications that reported the installed heat pump capacity at 5° F (Btu) could not sufficiently provide heat for a minimum of 80% of the residences heat load were excluded. This calculation was based on a 40 Btu per square foot requirement
- ✓ Applications that reported the project as new-build construction or an addition were excluded. Only reports of "existing home" or "retrofit" were included
- ✓ Applications that reported heat pumps as a supplemental heat source were excluded
- ✓ Only applications within 2 standard deviations of the mean were included
- ✓ Any application that did not report square footage of conditioned space, any cost metric, installed capacity at 5° F (Btu), or number of heat pumps were excluded

Source: Diversified Energy Specialists Research & Analysis; MassCEC; MA DOER

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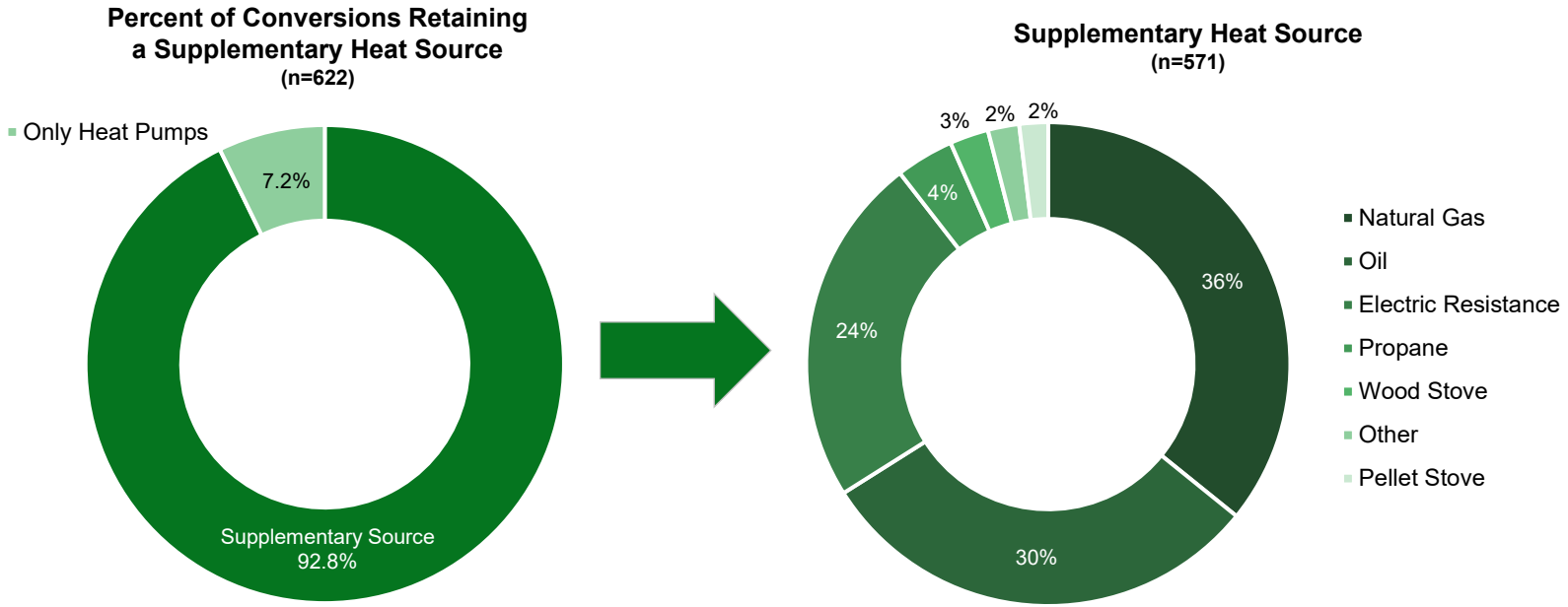
Conversion: Supplementary Heat Source

In addition to the high cost of conversion to air-source heat pumps, most installers recommend retaining a supplementary source of heat due to the heat pump systems inability to sufficiently heat residences in the cold Massachusetts winters



Analysis

- ✓ 92% of homeowners who converted to an air source heat pump system have either kept their existed heat source installed for a supplementary heat source or installed a secondary heat source, knowing that air source heat pumps begin to lose efficiency at 47ºF

Assumptions

- ✓ Applications that self-reported whether a backup source of home heating would be used were included
- ✓ For applications that failed to report whether a backup source of home heating was used, DES used their self-reported installed capacity at 5° F (Btu) to determine if the heat pump system could sufficiently provide heat for greater than 90% of the residence's heat load. The determination was made based on a 40 Btu per square foot requirement. If the system could not provide sufficient heat for 90% or more of the residences heat load, DES made the assumption that a supplementary heat source was used

Source: Diversified Energy Specialists Research & Analysis; MassCEC; MA DOER

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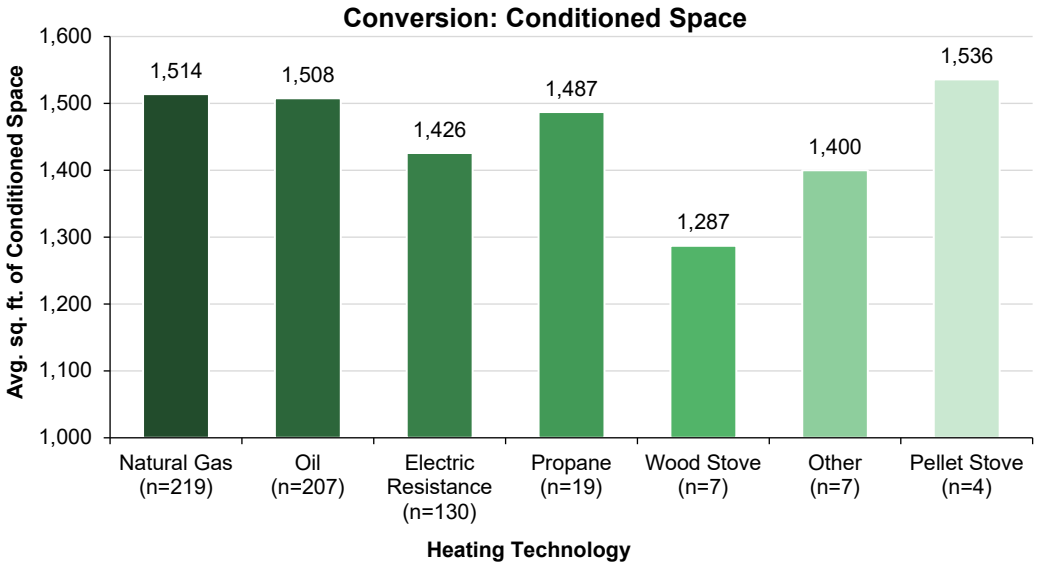
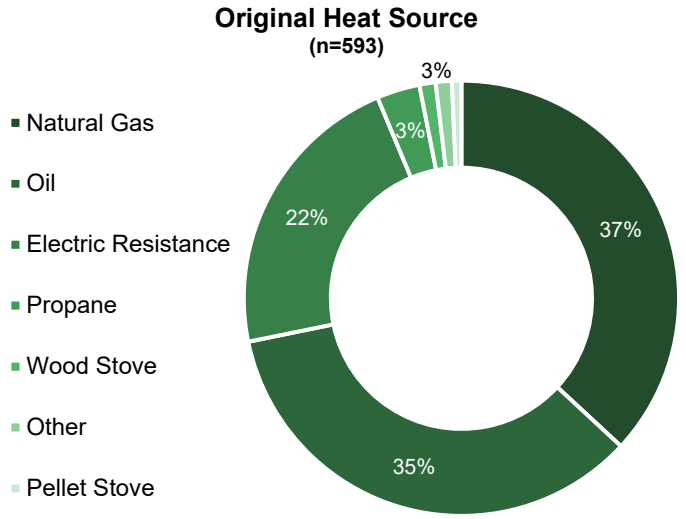
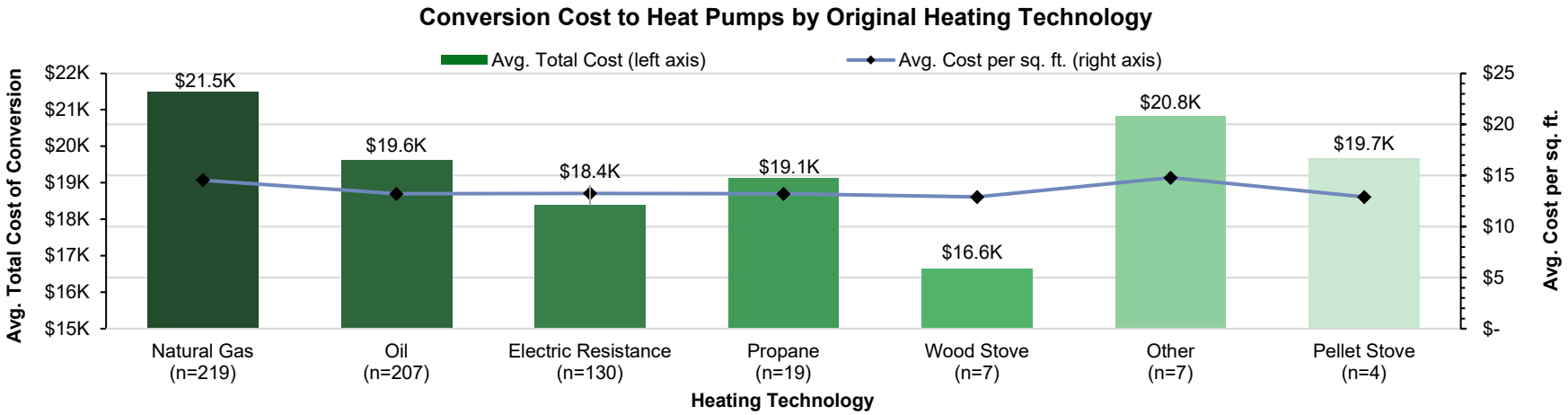
Conversion: Original Heat Source

The heating technology that is being converted to heat pumps slightly affects the price of conversion







Source: Diversified Energy Specialists Research & Analysis; MassCEC; MA DOER

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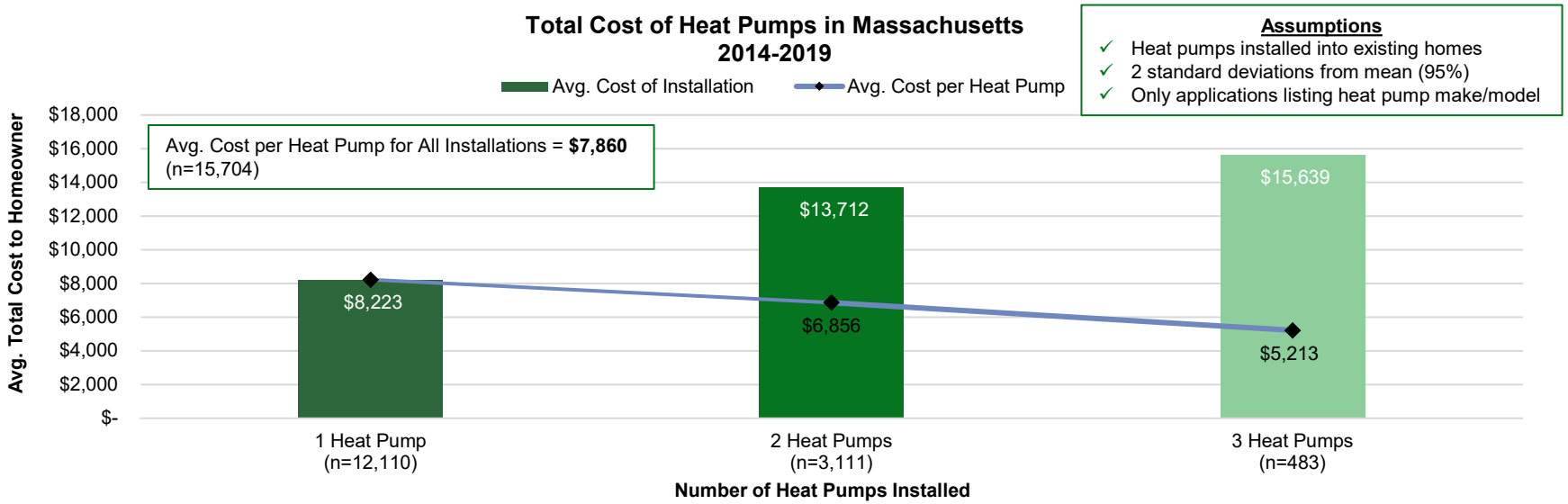
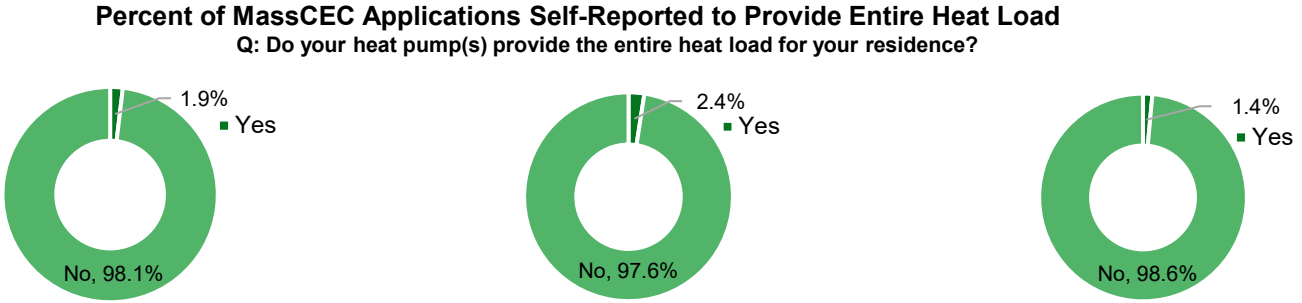
Supplemental Heat Source: Cost

DES estimates that 96% of the data from the MassCEC rebate program from construction in existing homes was from single or multi-room systems that did not provide sufficient heat for the entire home*





*The average Btu needed to sufficiently heat a home in Massachusetts is 40 Btu per square foot. Of the 16,572 applications of retrofit construction from existing homes, DES estimates that 622 (3.8%) were full conversions (displayed on slide 3). 2 standard deviations from the mean ensured that the above data contains less than 2% full conversions and displays the price of heating less than 90% of a home. Of the less than 2% self-reported to provide the entire heat load for their home above, DES determined that only 17% were accurate based on their self reported Btu output and square footage of conditioned space (see next slide)

Source: Diversified Energy Specialists Research & Analysis; MassCEC

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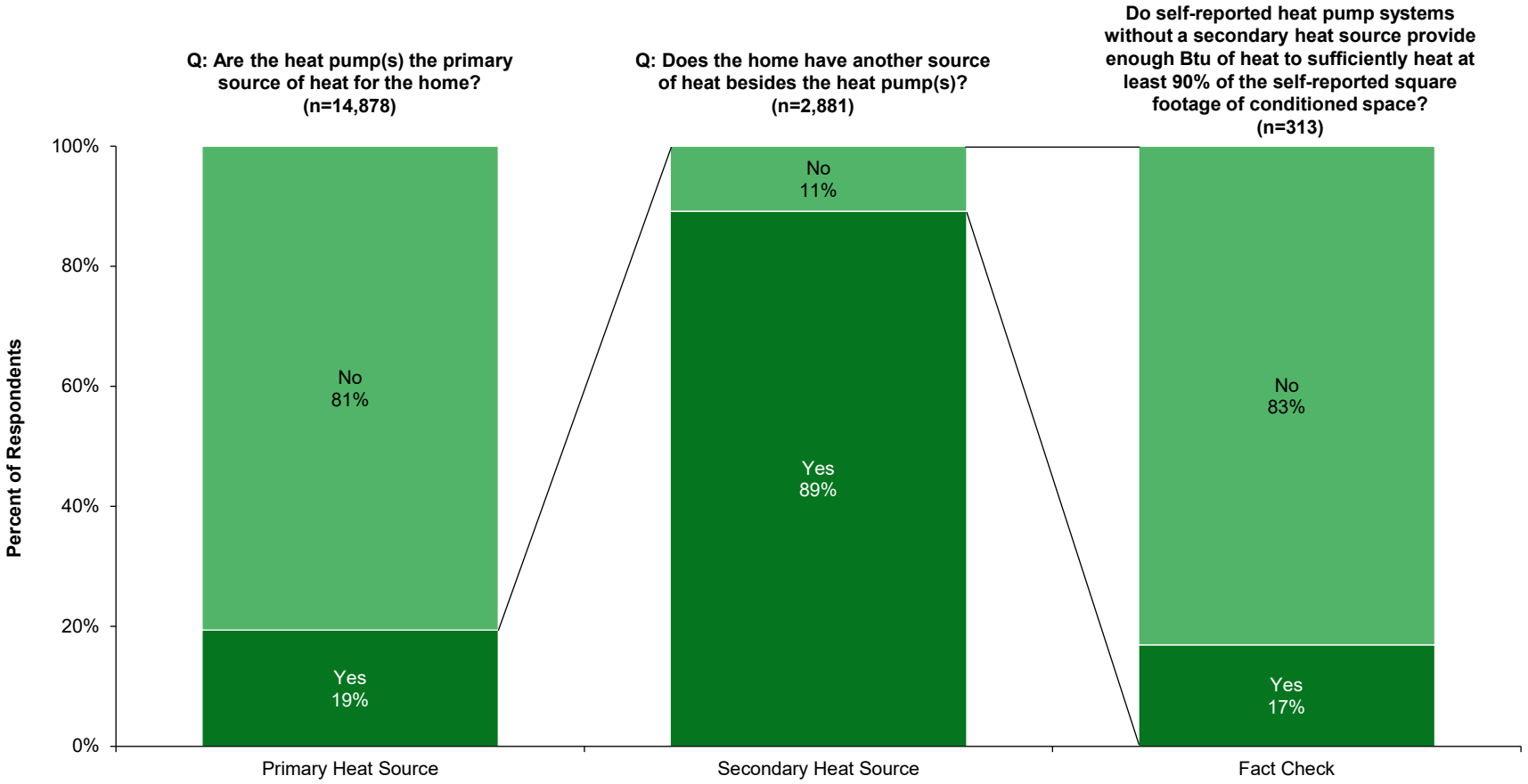
Supplemental Heat Source: Applicable Use

The MassCEC rebate application data shows that air-source heat pumps in Massachusetts are primarily used as a supplemental heat source



Of the applications that self-reported that their heat pump(s) are the residences only source of heat, only 17% reported a Btu output from their heat pump(s) that could provide greater than 90% of their homes heat load. DES fact checked this number using a 40 Btu per square foot requirement

Source: Diversified Energy Specialists Research & Analysis; MassCEC

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Biodiesel vs. Electrification: Northeast Case Study

Background Information

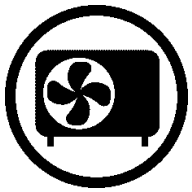
- One family residence in Methuen, MA
- Square footage of conditioned space: 1,902
- Facility construction type: Retrofit
- Prior Heating System:

In an effort to collect unbiased, randomized, and accurate data, DES recently began marketing its aggregation services to residential heat pump owners in the MA APS. This study on the true cost of converting to a heat pump system began after seeing many false statements and misrepresented data by utility companies. This is one example of a heating oil to heat pump conversion that I've received

Old Heating System

- Prior Heating System:
  - Oil
  - Heating distribution type: Baseboard
  - Did you have a supplementary fuel type?: No

ASHP Installation



- Air Source Heat Pump Renewable Thermal Installation Details:
  - Renewable thermal distribution type: Baseboard
  - Renewable thermal system utilization as percentage of the facility annual heating load: 95%
  - Do you have a supplementary fuel type?: Yes
  - Supplementary fuel type after renewable thermal generation unit installation: Oil
  - Supplementary fuel type utilization as percentage of the facility annual heating load: 5%
  - Installer: NETR LLC
  - Date in service: 6-26-2019
  - Heat pump manufacturer: Mitsubishi Electric Cooling & Heating
- Heat pump model: MXZ-5C42NAHZ
- Heat pump quantity: 5
- Total system cost: $23,046
- Was a rebate received from MassCEC?: No
- Did you receive any additional public funding?: No

Key Takeaways

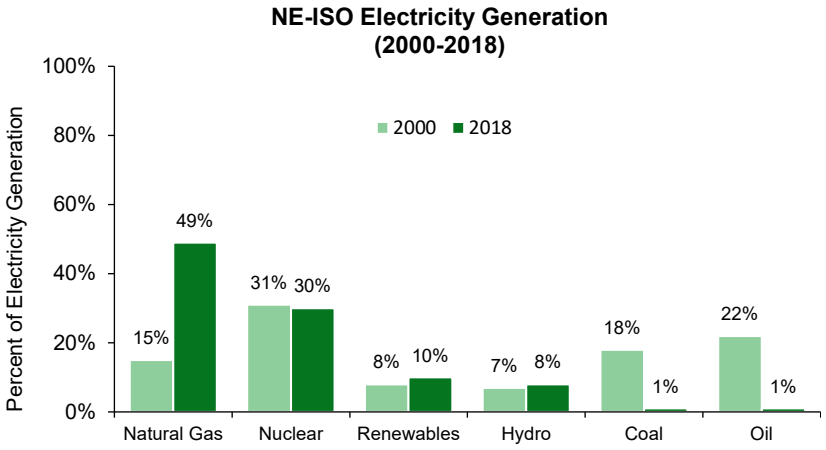
- $23,046 to convert a 1,902 square foot residence
- 5 air-source heat pumps to condition a 1,902 square foot residence
- The Installer, NETR, instructed the homeowner to keep his heating oil system because the 5 heat pumps couldn't sufficiently heat his home in cold New England winter temperatures
- NETR informed the homeowner that he would need to use oil to sufficiently heat his home at least 5% of the time
- Most studies by utility companies suggest that a conversion from oil to a heat pump system will cost the average homeowner between $4,000 and $10,000

EIA: Average square footage of home in… MA = 2,076. Northeast = 2,232. US = 1,971

Source: Diversified Energy Specialists Research & Analysis

Electricity Generation Mix

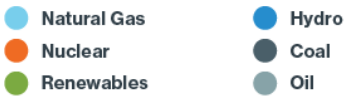
The carbon intensity of a 50% biodiesel blended heating oil can compete with the carbon intensity of cold climate heat pumps in the Northeast

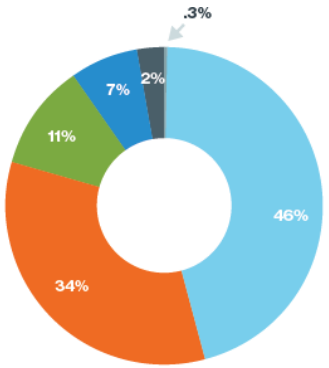


- ✓ Cold climate heat pumps and a 50% biodiesel blend both reduce carbon intensity by roughly 40%
- ✓ Heat pumps cannot sufficiently heat most northeast residences in temperatures under 17°F
- ✓ Cold-climate heat pumps have a negative impact on grid operations and cost
- ✓ As conversions to cold climate heat pumps and electric vehicles occur, the additional load will increase the winter peak load, increase the price of electricity, and increase the carbon intensity of electricity

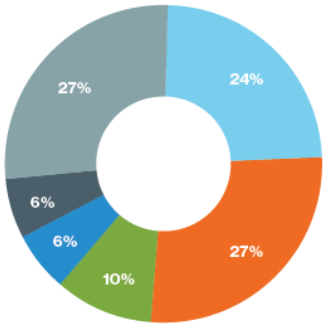
Oil Generation is High During Extreme Winter Cold

Oil generation was 27% of the regional fuel mix during the cold spell of winter of 2017/2018 compared with 0.3% for most of the month of December.





Average Fuel Mix for Most of December 2017 (Dec. 1–26, 2017)



Average Fuel Mix for Extreme Cold Spell (Dec. 26, 2017 to Jan. 9, 2018)

Source: ISO-NE; DES Research & Analysis

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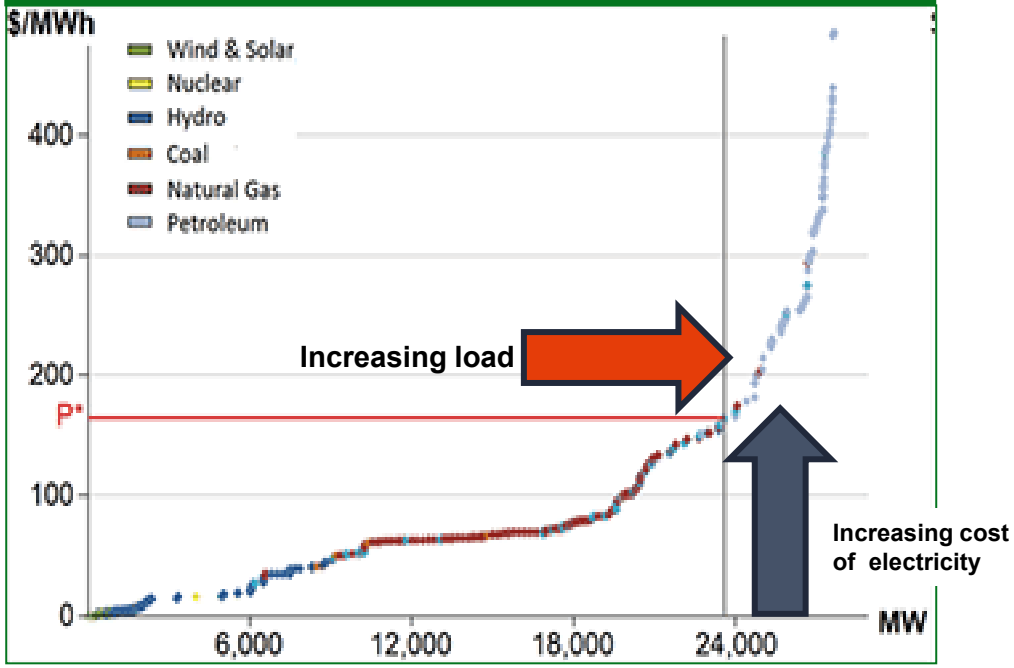
Increasing Cost of Electricity

As the grid load increases and we see the seasonal peak loads increase, the price of electricity increases exponentially

ISO-NE: Grid Load vs. Wholesale Price



Analysis

- ✓ All generators earn same market clearing price determined by highest successful bidder
- ✓ A 48,000 Btu/hr cold-climate heat pump will add roughly 6 kW to the grid load
- ✓ 750,000 more heat pumps in New England would add 4,500 MW to the peak grid load
- ✓ Wholesale power supply cost would rise from $100 per MWh to $200 per MWh approximately (or 20 cents per kWh). Cost savings to heat pump customer would disappear completely if not go negative. Resulting retail electricity cost including delivery charge would go above 30 cents per kWh for all residential, commercial and industrial customers.
- ✓ Slope of price curve becomes steeper at higher grid load due to poor efficiency of generator at margin plus short duration of extreme peaks thus greater impact of fuel consumption during start-up.

Source: ISO-NE, Ray Albrecht, National Biodiesel Board

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Winter Electricity Pricing

Wholesale pricing of electricity in ISO-NE is much higher on average in the winter than summer

ISO-NE: Weekly Average Prices for Wholesale Power

Analysis

- ✓ Highest prices occur during winter months.
- ✓ Cumulative sum of wholesale prices determine average supply charges on customer bills.
- ✓ Peak power prices are hidden from customers.
- ✓ Most utility and state agency calculations of heat pump savings use average annual prices for electricity.
- ✓ Winter prices for wholesale power will continue to rise with added thermal loads, coming from the conversion to cold climate ASHP and electric vehicles.
- ✓ Everybody pays the higher prices.

Source: ISO-NE, Ray Albrecht, National Biodiesel Board