



COST OF RESIDENTIAL AIR-SOURCE HEAT PUMPS

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Prepared For

Policy Makers in the Northeastern United States

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I. Summary of Data

Diversified Energy Specialists is a renewable energy consulting and environmental markets trading company based in Wilmington, Massachusetts. We have extensively studied the installation cost of residential air-source heat pump systems to the homeowner. We have completed case studies on residential air-source heat pump rebate programs in New York and Massachusetts and have closely followed the recently completed Massachusetts Clean Energy Center’s Whole-Home Heat Pump Pilot Program.

A. Study 1: MassCEC Whole-Home Air-Source Heat Pump Pilot Program

The Massachusetts Clean Energy Center recently concluded a Whole-Home Air-Source Heat Pump Pilot Program, which ran from May 2019 to June 2021.¹ The pilot program required that the air-source heat pump system must be capable of heating the entire home and be in use throughout the heating season to be eligible. For existing homes, the program only served installations displacing natural gas. For new construction, the homes could not include any fossil fuel appliances for other uses like hot water and cooking. On September 13, 2021, the program director, Meg Howard, provided the results of the Whole-Home Heat Pump Pilot Program.²

Table 1: Massachusetts Clean Energy Center Whole-Home Heat Pump Pilot Program

Project Type	Number of Projects in MassCEC Pilot	Average Conditioned Square Footage of Home	Median Project Cost
Existing Building	126	1,674	\$20,000
New Construction	31	1,468	\$14,000
Gut Rehab	11	1,173	\$12,700
Total	168	1,603	\$18,400

The program director, Meg Howard, concluded that “Costs were higher than we hoped.” Providing further analysis into the data, she stated, “Of the retrofit projects in our pilot, 25% required an electric service upgrade, while 38% reported that their natural gas heating system also provided their domestic hot water, which meant that homeowners either had to leave their natural gas boiler in place just to heat their hot water or else buy a new hot water heater as part of the project.”³

B. Study 2: MassCEC Residential Air-Source Heat Pump Rebate Program 2014-2019

The Massachusetts Clean Energy Center offered a Residential Air-Source Heat Pump Rebate program from 2014-2019. Diversified Energy Specialists filed a public information request and received the rebate applications. Over the course of the program, 16,572 applications were submitted for retrofit air-source heat pump installations in existing homes. Based on the data provided, Diversified Energy Specialists estimated that 622 of those applications for rebates installed air-source heat pump systems with the capacity to provide 80% or more of the residences annual heat load.

¹ <https://files-cdn.masscec.com/Program%20Summary%20%E2%80%93%20Whole-Home%20ASHP%20Pilot%202021%2021.pdf>

² https://www.masscec.com/blog/2021/09/13/masscec-pilot-showcases-success-whole-home-heat-pumps#Case_Studies

³ https://www.masscec.com/blog/2021/09/13/masscec-pilot-showcases-success-whole-home-heat-pumps#Case_Studies

Table 2: Massachusetts Clean Energy Center Residential Heat Pump Rebate Program 2014-2019

Project Type	Number of Retrofit Installations	Average Conditioned Square Footage of Home	Average Project Cost
> 80% Annual Heat Load	622	1,502	\$20,428

Based on the application data, Diversified Energy Specialists estimated that 92.8% of the 622 retrofit installations retained their existing central heating system as a supplemental heat source.

C. Study 3: NYSERDA Residential Air-Source Heat Pump Rebate Program 2017-2019

NYSERDA offered a residential Air-Source Heat Pump Rebate Program from 2017-2019. NYSERDA published the application data on New York State’s publicly available data website.⁴ Over the course of the program, 5,756 applications were submitted from air-source heat pump installations in single-family detached homes. Based on the publicly available data, Diversified Energy Specialists estimated that 386 of those applications for rebates could be considered whole-home solutions.

Table 3: NYSERDA Residential Heat Pump Rebate Program 2017-2019

Project Type	Number of Whole-Home Installations	Average Conditioned Square Footage of Home	Average Project Cost
Single-Family Detached House	386	1,663	\$16,272

Based on the application data, Diversified Energy Specialists estimated that a minimum of 45.4% of the 386 single-family detached house installations retained their existing central heating system as a supplementary heat source. Many applications did not include a response regarding a supplementary heat source, therefore Diversified Energy Specialists views 45.4% as a conservative estimate.

II. Conclusion

The extensive data sets in Massachusetts and New York suggest that the installation of air-source heat pump systems at the residential level is too costly for most low- and middle-income homeowners in the northeast. The average conditioned square footage of the homes for these installations was lower than the median household size in both Massachusetts and New York, suggesting that homeowners in average and above average sized homes are choosing not to install air-source heat pump systems for their heating needs. Scaling the average cost of installation to the median sized household in each state provides a clearer picture of the residential cost of installation homeowners face.

Table 4: Cost of Residential Air-Source Heat Pumps (Existing Home)

Program	State	Median Square Footage of Residence	Estimated Project Cost
MassCEC Whole-Home Heat Pump Pilot Program	MA	1,912	\$22,843
MassCEC Air-Source Heat Pump Rebate Program	MA	1,912	\$21,572
NYSERDA Air-Source Heat Pump Rebate Program	NY	1,764	\$17,260

⁴ <https://data.ny.gov/Energy-Environment/NYSERDA-Supported-Air-Source-Heat-Pump-Projects-20/dpke-svni>

The applications from the NYSERDA Residential Air-Source Heat Pump Rebate Program provided a zip code for each project. When plotting the zip codes on a heat map, a concerning trend was apparent. Due to the high cost of air-source heat pump installations, the applications were highly concentrated in counties with the highest median household income in the state. The ramifications of this trend are vitally important for lawmakers to understand. Air-source heat pump installations concentrated in high-income counties will improve the air-quality and health of the residents in that county. There is an inequity in greenhouse gas emissions in the northeast. Environmental justice communities are burdened with a disproportionate level of greenhouse gas emissions versus higher income communities. Converting the residential thermal sector to high-cost air-source heat pump systems will only widen the gap in air-quality between higher income communities and environmental justice communities. In addition, installations of high-cost air-source heat pumps in wealthy communities will add to the grid load and winter peak load. Increasing the grid load and winter peak load will increase the cost of electricity for all ratepayers and increase the carbon intensity of electricity. Environmental justice populations will not be able to afford the installation of air-source heat pumps but will be burdened with higher electricity costs and continued poor air-quality because of the installations of air-source heat pumps in wealthy communities.

Policy in the northeast has historically focused on retrofitting air-source heat pump systems in homes with fossil-fuel fired systems at the end-of-life of the fossil-fired system. Replacing and upgrading a natural gas, propane, or heating oil system at the end-of-life in the northeast typically costs a homeowner \$7,000 - \$10,000. When comparing that cost with the cost of retrofitting an air-source heat pump system in their home, it is apparent how most low-and middle-income households in the northeast will allocate their heating system upgrade dollars. Spending an additional \$10,000 - \$15,000 to retrofit an air-source heat pump system is not affordable for most homeowners.

States in the northeast have set lofty residential electrification goals. Looking at Massachusetts as an example, the state has set a goal of one million households using high-efficiency electric heating systems by 2030, converting at a rate of 100,000 households per year. In an August 2021 article, the Boston Globe estimated that only 461 homes were converted to electric heat in 2020, missing the state goal by 99,539 conversions.⁵ The NYSERDA Residential Air-Source Heat Pump Rebate Program resulted in 386 whole-home air-source heat pump installations over a 3-year period, averaging just over one hundred conversions per year. In addition to the low conversion rate, a majority of the homes that converted to air-source heat pump systems in the northeast retained their legacy fossil fuel system as a supplementary heat source.

⁵ <https://www.bostonglobe.com/2021/08/21/science/massachusetts-should-be-converting-100000-homes-year-electric-heat-actual-number-461/?p1=StaffPage&p1=Article> Inline Related Link