



## Case Study

### New York Air-Source Heat Pump Installations 2017-2019

---

*Report Prepared For:*



**Climate Action  
Council**

# Disclaimer

This study was created by Diversified Energy Specialists, Inc. and is intended for public distribution. All data was obtained from the public New York State data website.

NYSERDA offered a residential ASHP rebate program from 2017-2019 which provided rebates for ASHP installations in New York, providing nearly \$14,950,000.00 in incentives. “Air source heat pumps have been an efficient source of cooling for years but advances in technology now allow them to effectively address heating needs in cold climates, helping customers lower their energy costs and reduce greenhouse gas emissions. NYSERDA launched the Air Source Heat Pump Program to expand the adoption of advanced ASHPs and encourage wider use for space heating and cooling.” The New York State Public Service Commission allocated funding for this program through the Clean Energy Fund to expand the ASHP market in New York and to support installations for customers who pay for the System Benefits Charge surcharge on their electricity bills.

All data collected by NYSERDA was obtained from applications for rebates within the program. All data was self-reported by the ASHP installer with assistance from the homeowner.

This case study is up to date as of June 30, 2022.

# NYSERDA 2017-2019 ASHP Program

*Each participating installer was eligible to apply for and retain a \$500 ‘Participating Installer Incentive’ for each qualified and installed ASHP system, while additional ‘Site Owner Incentives’ were available for installations determined to be a ‘Whole-House Solution’*

## Whole-House Solution ASHP System

**Whole-House Solution ASHP System:** An ASHP System installed as a home’s primary heating source, designed with a full-load heating capacity between 90% and 120% of peak heating load, corresponding to the approved heat load calculation determined by utilizing a Manual J or an equivalent energy simulation program or calculator. These ASHP systems must include at least one of the following configurations as defined by the Northeast Energy Efficiency Partnership:

- ✓ Singlezone Ducted, Centrally Ducted
- ✓ Multizone All Ducted
- ✓ Multizone All Non-ducted that includes two or more indoor heads
- ✓ Multizone Mix of Non-ducted and Ducted that includes two or more heads

ASHP Systems and for integrated controls; all Site Owner Incentives must be passed on or otherwise credited to the site owner in their entirety. The program provides flexibility to participating contractors to decide how best to use each of their qualifying \$500 Participating Installer Incentives to help grow that portion of their business.

## Whole-House Solution Incentives

NYSERDA will pay out incentives according to the following table:

Qualifying Equipment	Participating Installer Incentive	Site Owner Incentive
2-Ton Whole-House Solution ASHP System	\$500	\$1,500
3-Ton Whole-House Solution ASHP System	\$500	\$2,500
4-Ton Whole-House Solution ASHP System	\$500	\$3,500
5-Ton Whole-House Solution ASHP System	\$500	\$4,500
Other than Whole-House Solution ASHP System <sup>4</sup>	\$500	\$0
<b>Qualifying Control/Thermostat</b>		
Integrated Control Package	\$0	\$500
Dual Fuel Thermostat	\$0	\$50

## Target Market Segment(s) – Study Scope

- ✓ “The target market includes residential, multi-family, commercial, and institutional buildings owners/managers/developers that have a stronger value proposition, such as sites that currently use oil and propane, or have limited access to natural gas, as these represent high value use cases across market segments based on project economics. Due to the newness of the market, NYSERDA did not limit the offering to any particular market segment, allowing the strongest value proposition use case(s) to emerge”
- ✓ This scope of this study was limited to residential single-family detached homes that were determined by Diversified Energy Specialists to be a whole-home solution, inclusive of supplementary heating sources. The methodology of determining whether an application was considered a whole-home solution for this study is outlined on the next slide

Source: Diversified Energy Specialists Research & Analysis; NYSERDA

# Whole-Home Solution: Filter

An application qualified to be a whole-home solution in this data set if it was rewarded a total NYSEERDA incentive equivalent to a whole-home solution (1) and either the applicant self-reported that the ASHP system provided 100% of the heating load for the home's conditioned square footage (A) or NYSEERDA qualified the system as a whole-home solution (B)

1

## Total NYSEERDA Incentive

- ✓ Less than 1,000 sq. ft. (≥ \$1,500)
- ✓ 1,000 – 1,500 sq. ft. (≥ \$1,500)
- ✓ 1,500 – 2,000 sq. ft. (≥ \$2,500)
- ✓ 2,000 – 2,500 sq. ft. (≥ \$3,500)
- ✓ 2,500 – 3,000 sq. ft. (≥ \$4,500)
- ✓ 3,000+ sq. ft. (≥ \$5,000)



A

## Applicant / Installer Self-Reported

Percentage of residences square footage to be conditioned by the ASHP system  
(100% / Less than 100%)

OR

B

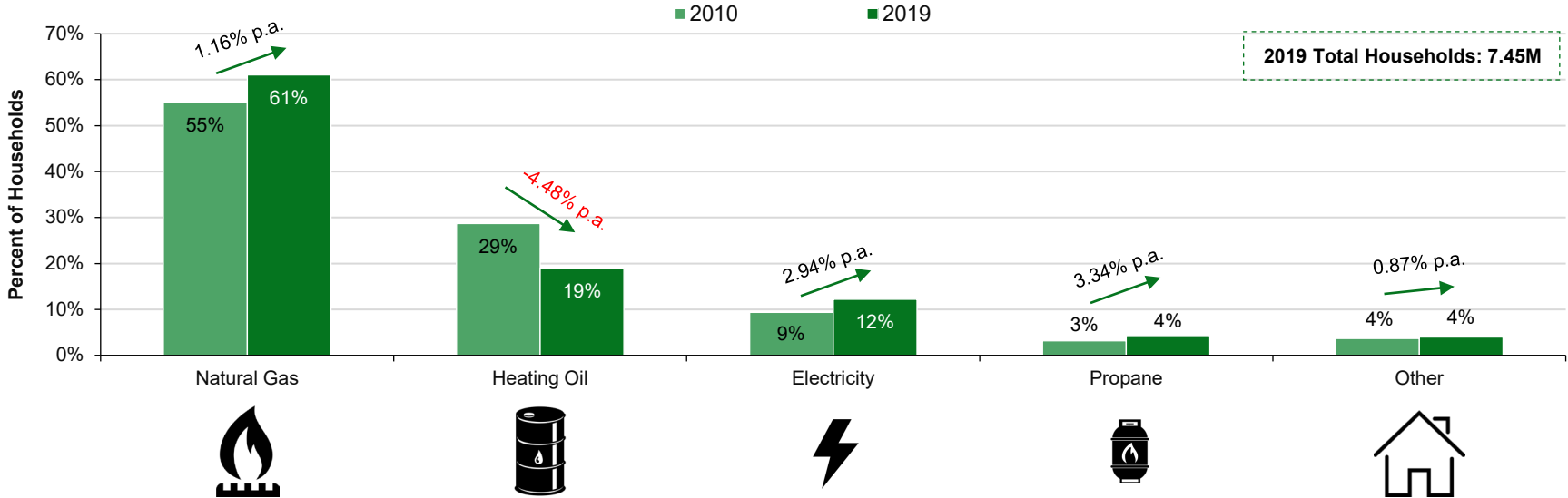
## NYSEERDA

Whole-Home Solution ASHP System  
(True / False)

# New York Residential Heating Fuel

Most residences in New York use natural gas and heating oil for their heating needs, but electricity has grown quickly due to utility incentive programs and state government subsidies

Residential Heating Fuel in New York  
(2010-2019)



## Analysis

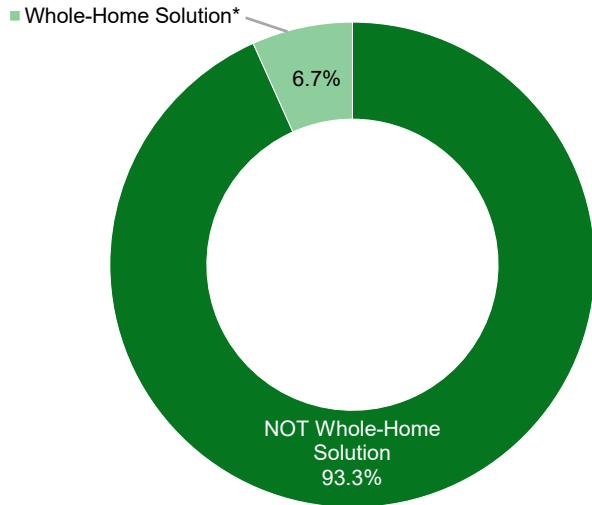
- ✓ From 2010–2019 the residential heating landscape has experienced significant change:
  - ✓ Heating oil has steadily lost market share
  - ✓ Natural gas has steadily grown to three times the share of any other heating technology, while also accounting for the majority of electricity generation
  - ✓ Electricity has grown to 12% of the residential heating market, benefiting from state government subsidies and utility rebate programs
  - ✓ Propane and other heating technologies has slightly grown and still has a small percent of the market share
- ✓ The accuracy of the Census bureau data has been questioned, specifically when a home uses more than one heating technology to meet their annual heat load
  - ✓ Some homes use heat pumps and a supplementary heat source to heat their homes in the winter
  - ✓ Other homes use heat pumps for one or more rooms, while using another technology to heat the rest of the home
- ✓ The NYSERDA ASHP program's objective was to increase electrification in residential buildings in New York from 2017-2019

Source: U.S. Census Bureau, 2010 & 2019 ACS 1-Year Estimates, New York, Occupied Housing Units, House Heating Fuel

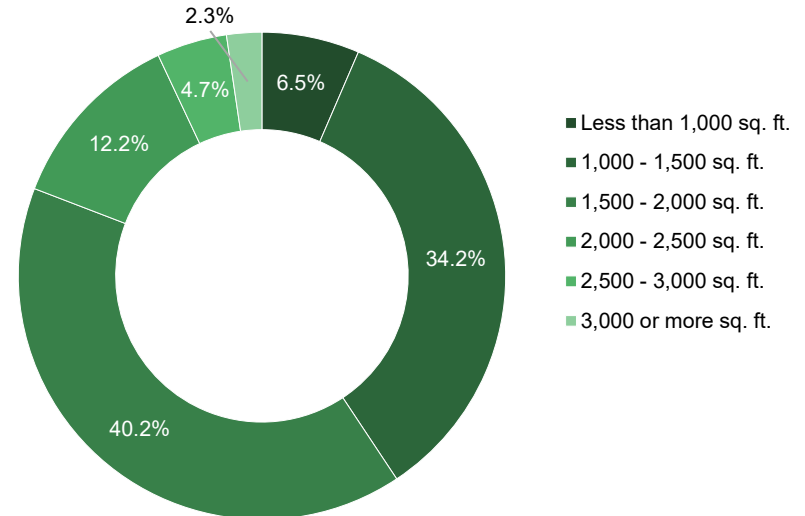
# Applications for Single-Family Detached Homes

From 2017-2019, NYSERDA received 9,730 applications for rebates for ASHP installations. 5,756 of those applications were from single-family detached homes

**Applications for Single-Family Detached Homes**  
(n=5,756)



**Whole-Home Solution by Sq. Ft. Conditioned Space**  
(n=386)



## Assumptions

- \*Applications from single-family detached homes were determined to be a whole-home solution by Diversified Energy Specialists if:
- ✓ NYSERDA rewarded a full-load incentive for the ASHP system, AND
    - ✓ The applicant self-reported that the ASHP system provided 100% of the residence conditioned square footage, OR
    - ✓ NYSERDA qualified the system as a whole-home solution

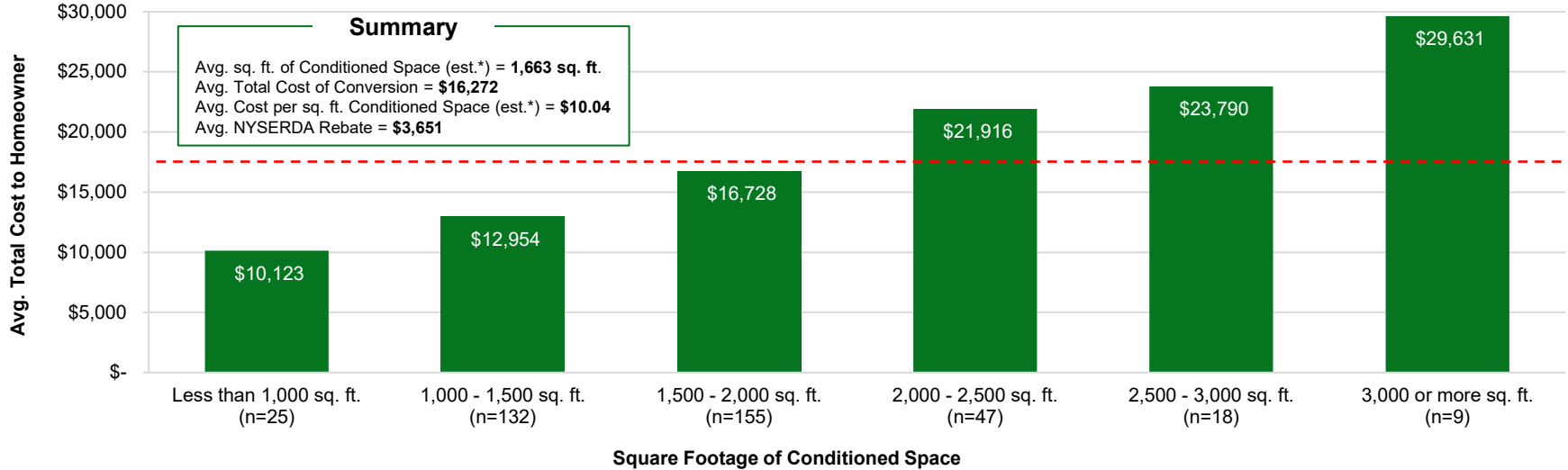
## Analysis

- ✓ In the three years (2017-2019) of the NYSERDA rebate program, 386 ASHP systems were installed in single-family detached homes in New York with the capacity to be a whole-home solution
  - ✓ This equates to 0.005% of residences in New York
- ✓ The median square footage of conditioned space in the 386 applications determined to be whole-home solutions was estimated to be 1,663 square feet, which is 101 square feet below the median residence size in NY

Source: Diversified Energy Specialists Research & Analysis; NYSERDA

# Whole-Home ASHP Conversions

New York Residential ASHP Conversions 2017-2019  
(n=386)



## Assumptions

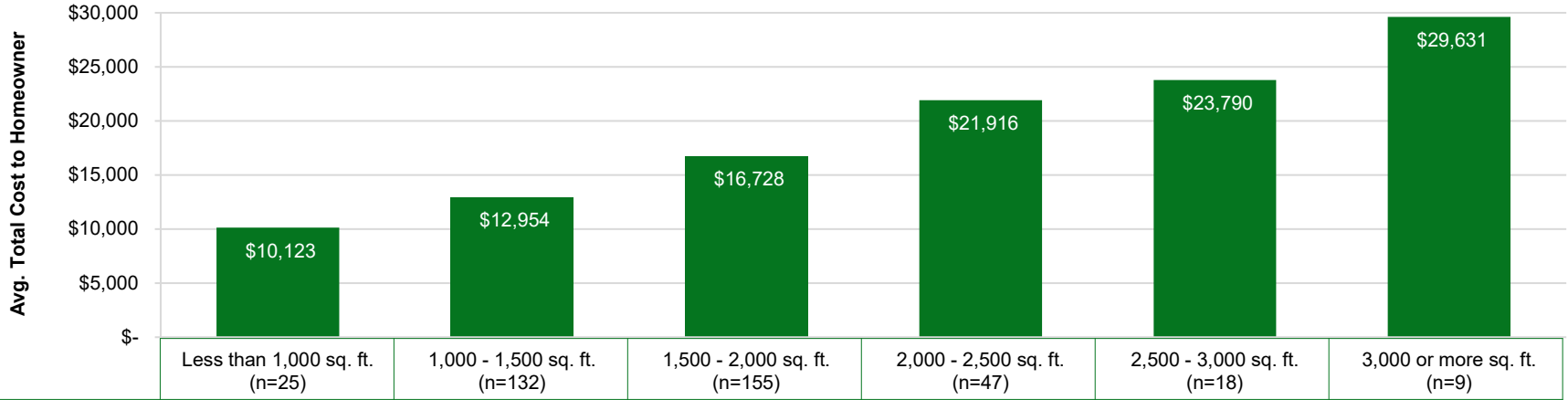
- ✓ Applications that NYSEERDA reported giving an incentive less than a full load incentive were excluded. Full load incentive qualified as:
  - ✓ Less than 1,000 sq. ft. ≥ \$1,500
  - ✓ 1,000 – 1,500 sq. ft. ≥ \$1,500
  - ✓ 1,500 – 2,000 sq. ft. ≥ \$2,500
  - ✓ 2,000 – 2,500 sq. ft. ≥ \$3,500
  - ✓ 2,500 – 3,000 sq. ft. ≥ \$4,500
  - ✓ 3,000+ sq. ft. ≥ \$5,000
- ✓ Applications that NYSEERDA reported as being a whole-home solution were included if they received a full load incentive.
- ✓ Applications that self reported being a whole-home solution were included if they received a full load incentive.
- ✓ Applications listing ground-source heat pumps as their primary heating system were excluded.

\*Estimated cost per sq. ft. was assumed to be 750 sq. ft. for residences reported under 1,000 sq. ft. and 3,500 sq. ft. for residences reported over 3,000 sq. ft. The remaining buckets were assumed to be the median (e.g. 1,000-1,500 sq. ft. was assumed to be 1,250 sq. ft.)

Source: Diversified Energy Specialists Research & Analysis; NYSEERDA, U.S. Census Bureau

# Whole-Home ASHP Conversions

New York Single-Family Detached Home ASHP Conversions 2017-2019  
(n=386)



		Square Footage of Conditioned Space					
		Less than 1,000 sq. ft. (n=25)	1,000 - 1,500 sq. ft. (n=132)	1,500 - 2,000 sq. ft. (n=155)	2,000 - 2,500 sq. ft. (n=47)	2,500 - 3,000 sq. ft. (n=18)	3,000 or more sq. ft. (n=9)
Range	<b>Avg. Rebate</b>	\$2,200	\$2,843	\$3,820	\$4,865	\$5,756	\$6,083
	<b>Low</b>	\$3,500	\$3,200	\$4,500	\$8,000	\$6,700	\$17,437
	<b>High</b>	\$25,825	\$27,216	\$41,301	\$39,482	\$37,370	\$64,461
Legacy Heat Source	<b>Natural Gas</b>	24%	27%	29%	30%	28%	11%
	<b>Oil</b>	20%	28%	27%	34%	50%	22%
	<b>Electric*</b>	28%	23%	23%	19%	6%	33%
	<b>Propane</b>	24%	16%	19%	17%	11%	33%
	<b>Wood</b>	4%	5%	2%	0%	6%	0%
	<b>Other</b>	0%	2%	0%	0%	0%	0%

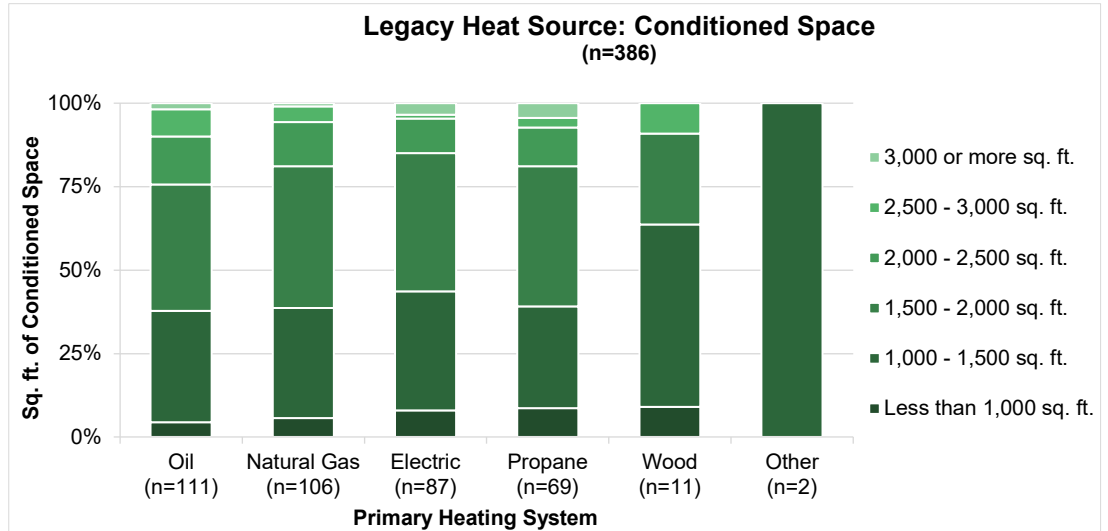
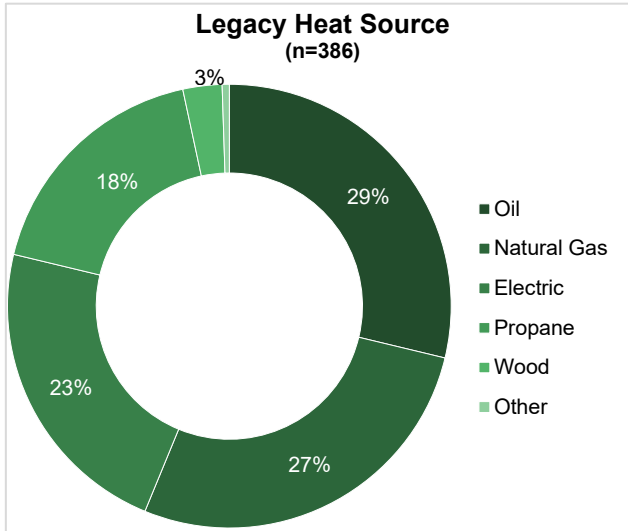
\*Electric is either a conversion from electric resistance heating, an air-source heat pump upgrade or new-build construction

Source: Diversified Energy Specialists Research & Analysis; NYSERDA

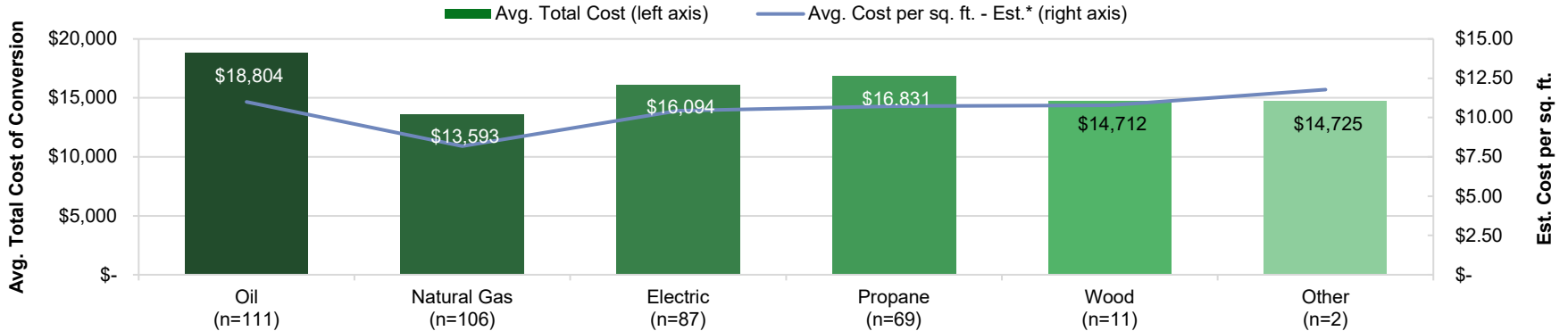


# Conversion Cost: Legacy Heat Source

The legacy heating technology can impact the price of conversion



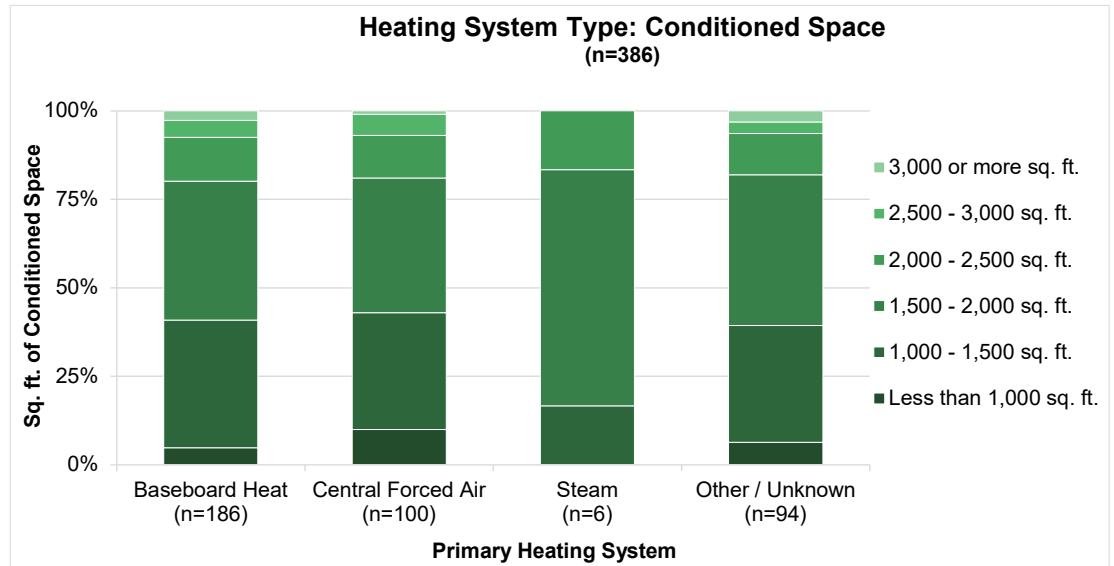
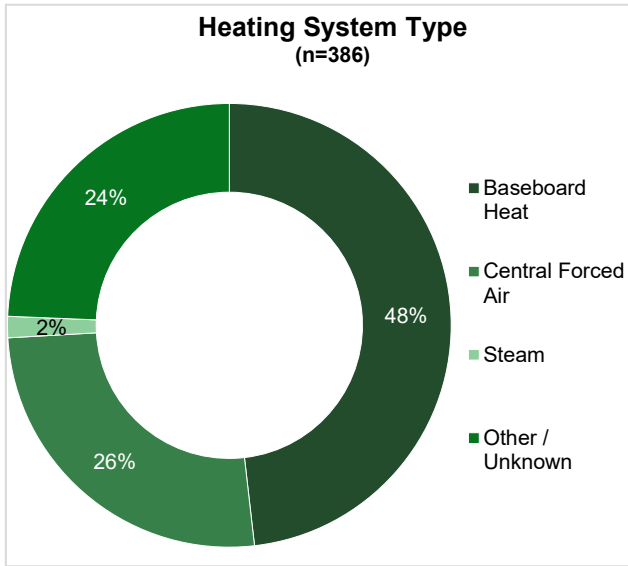
## Conversion Cost by Legacy Heat Source (n=386)



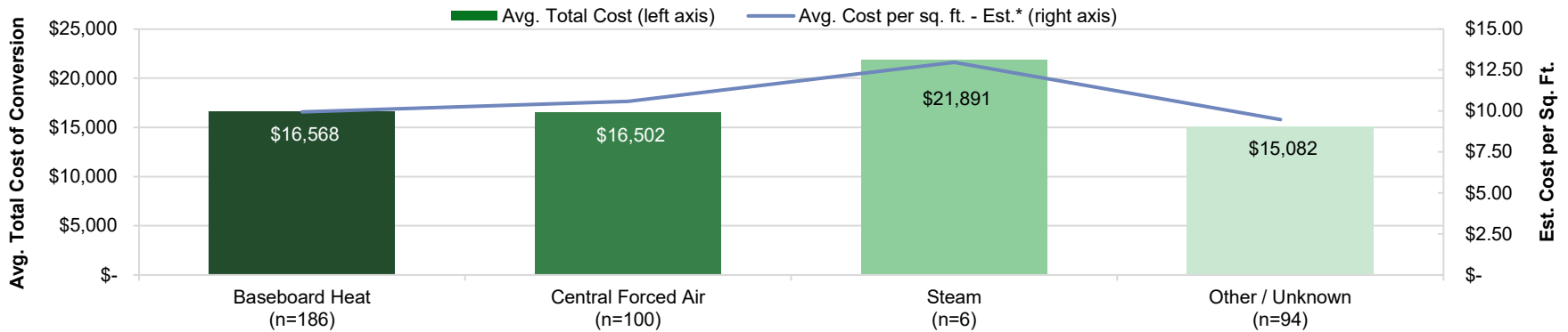
\*Estimated cost per sq. ft. was assumed to be 750 sq. ft. for residences reported under 1,000 sq. ft. and 3,500 sq. ft. for residences reported over 3,000 sq. ft. The remaining buckets were assumed to be the direct middle (e.g. 1,000-1,500 sq. ft. was assumed to be 1,250 sq. ft.)

Source: Diversified Energy Specialists Research & Analysis; NYSERDA

# Conversion Cost: Heating System Type



## Conversion Cost by Primary Heating System (n=386)

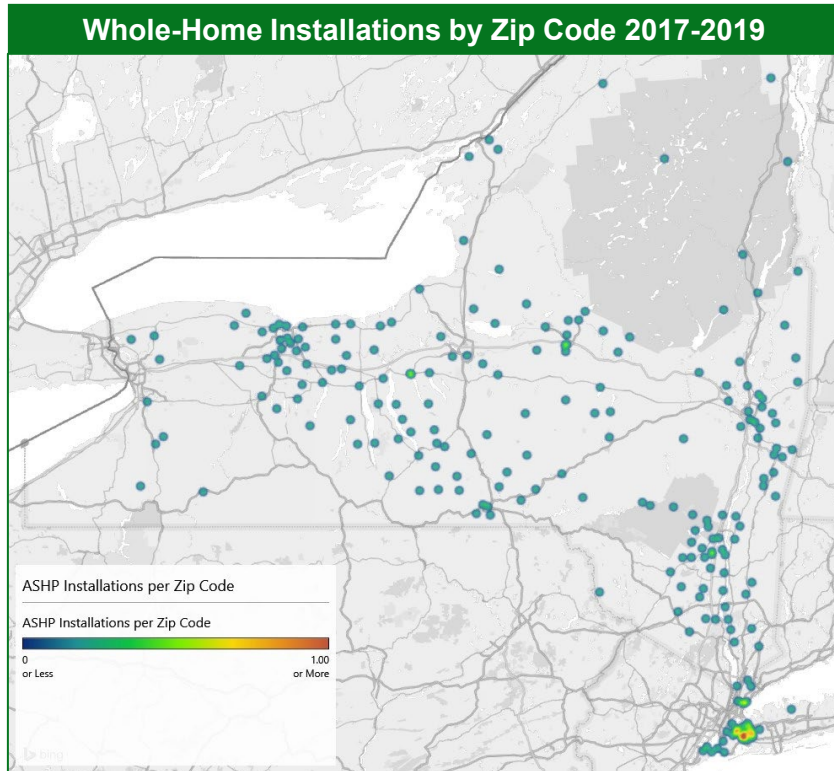


\*Estimated cost per sq. ft. was assumed to be 750 sq. ft. for residences reported under 1,000 sq. ft. and 3,500 sq. ft. for residences reported over 3,000 sq. ft. The remaining buckets were assumed to be the direct middle (e.g. 1,000-1,500 sq. ft. was assumed to be 1,250 sq. ft.)

Source: Diversified Energy Specialists Research & Analysis; NYSERDA

# ASHP Installations: Location

*Looking at the whole-home ASHP installations by zip code reveals a lack of installations in the coldest part of the state, bringing about the question of operability issues in the coldest climates*



## Analysis

- ✓ There is a consolidation of whole-home ASHP installations in New York City. While this closely aligns with the population density, it also points out:
  - ✓ The median square footage of conditioned space in New York City is far lower than in other parts of the state, which means a more affordable installation cost
  - ✓ The median household income in New York City is the highest in the state

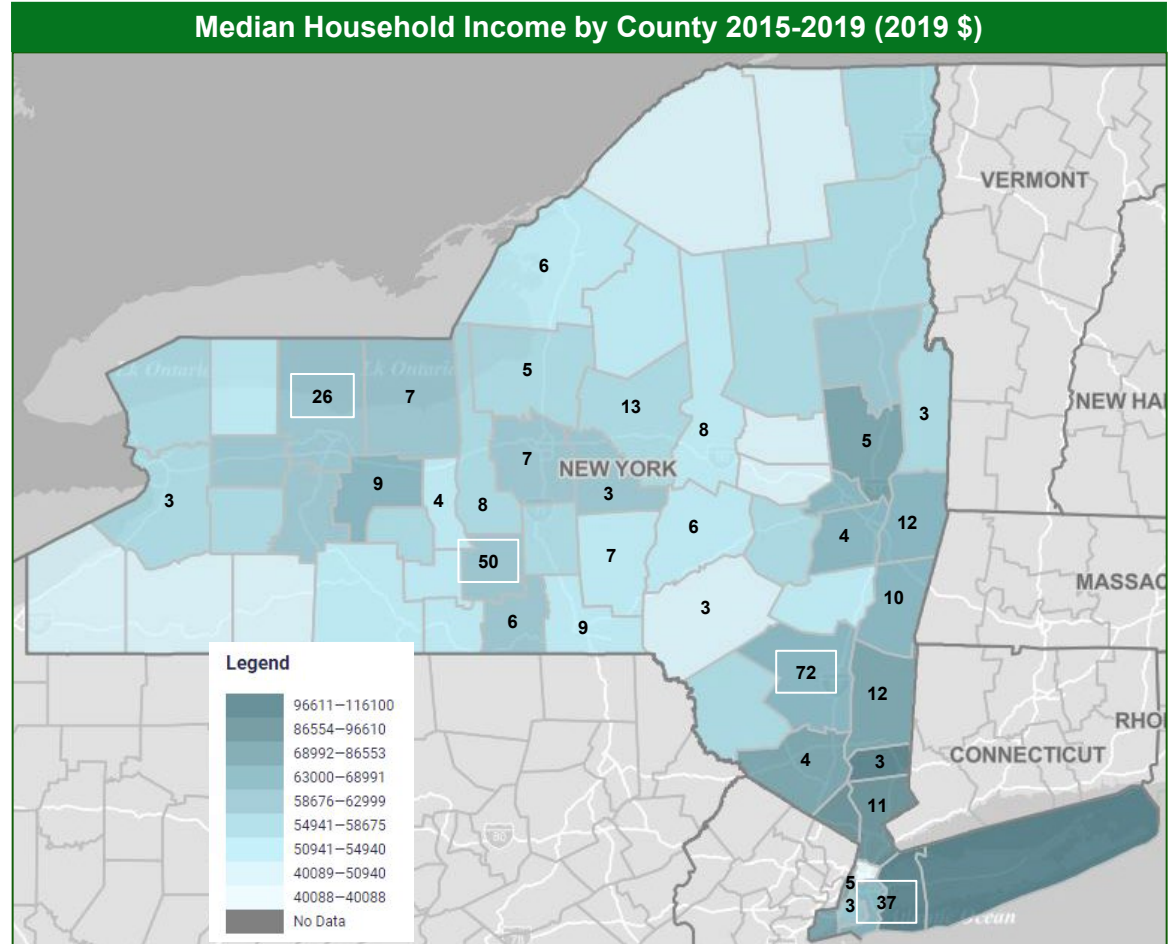
# New York Median Household Income by County

*Most conversions appear to occur in higher income counties in New York*

## Analysis

The map displays numbered labels for counties with 3 or more whole-home ASHP installations and white borders for counties with 20 or more installations

- ✓ The high cost of installing a whole-home ASHP system is a barrier to entry for environmental justice populations
- ✓ The consolidation of whole-home ASHP installations in high-income counties has a considerable impact on low-income counties:
  - ✓ ASHP installations increase the cost of electricity for all ratepayers
  - ✓ Widens the greenhouse gas emissions gap between high-income and EJ communities
  - ✓ Improves air-quality in high-income communities, while EJ communities air-quality is unchanged
- ✓ ASHP installations increase the grid load
  - ✓ Increasing the cost of electricity
  - ✓ Increasing the greenhouse gas emissions from electricity
  - ✓ Increasing the amount of renewable electricity generation needed to meet the state's net-zero carbon electricity goal
- ✓ The rebate comes from the system benefit charge, which all ratepayers in the state of New York pay, but only the high-income households can capitalize on these rebates
- ✓ Assumed that the highest income households in each county are the households installing whole-home ASHP systems



Source: U.S. Census Bureau, 2019 ACS 5-Year Estimates, New York, County, Median Household Income

# Secondary Heat Source

*NYSERDA qualifies an installation as a “whole-house solution ASHP system”, however, the original heat source is not required to be removed, and thus it can be assumed that most homes use a secondary heat source for a portion of their annual heat load*

## 386 Whole-Home Solution ASHP Systems

**Of the 386 whole-home solution ASHP systems Diversified Energy Specialists included in this data set...**

- ✓ 55 self-reported that their ASHP system did not provide 100% of their household's annual heat load
- ✓ 81 were determined not to be whole-home solutions by NYSERDA
- ✓ 69 self-reported having an “Other Fuel Type” and 8 self-reported to have an “Other Primary Heating System”
  - ✓ 39 overlap with applications from the first two data points and 30 are unique
- ✓ 166 / 386 homes, or 45.36%, that installed a “whole-house solution ASHP system” used another heating fuel for at least a portion of their annual heat load
- ✓ The remaining 220 applications did not indicate whether a secondary heat source was used, which means we cannot determine whether a secondary heat source was used

## NYSERDA Whole-Home Eligibility Issues

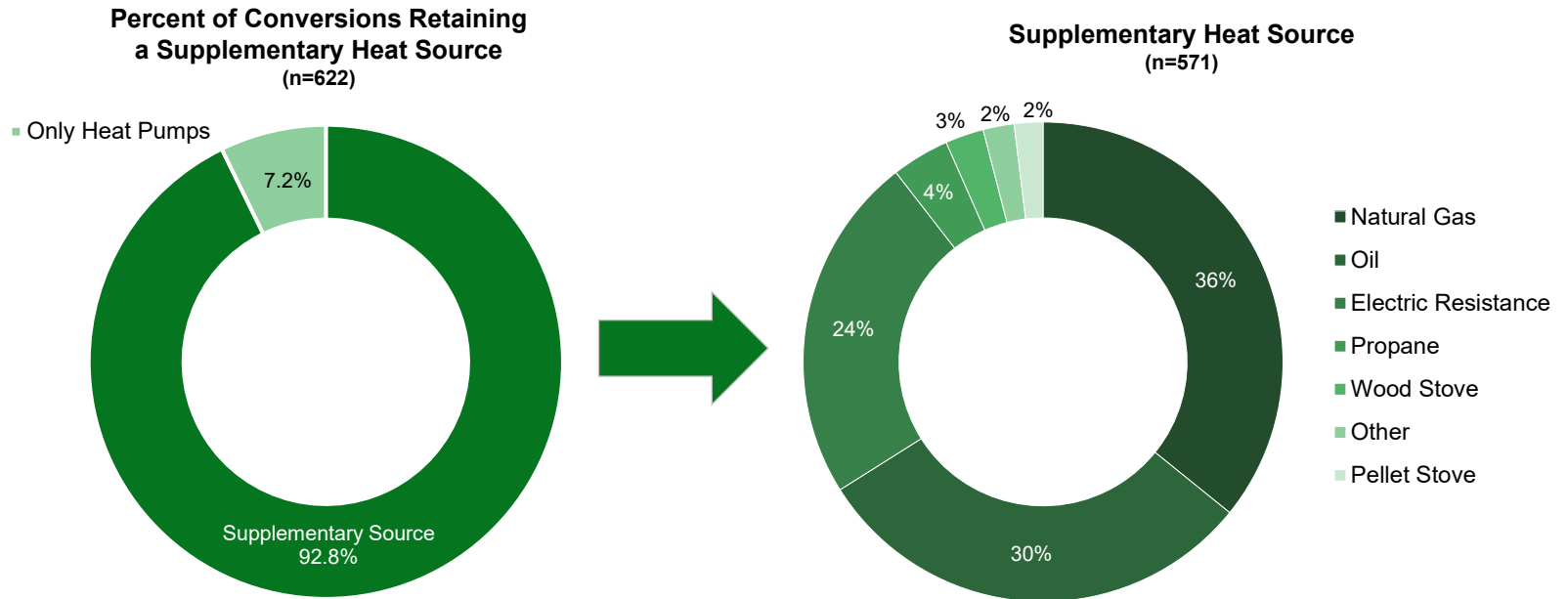
**“Whole-House Solution ASHP System: An ASHP System installed as a home’s primary heating source, designed with a full-load heating capacity between 90% and 120% of peak heating load, corresponding to the approved heat load calculation determined by utilizing a Manual J or an equivalent energy simulation program or calculator”**

- ✓ NYSERDA determined that installations qualified as a “whole-house solution ASHP system” if the system was the home’s primary heating source and had a full-load heating capacity between 90% and 120% of peak heating load
  - ✓ NYSERDA could not verify that the system was the home’s primary heating source without:
    - ✓ Mandating the removal of the legacy heat source
    - ✓ Metering the ASHP system’s usage
  - ✓ All homes that qualified with a full-load heating capacity of 90-99% of peak heating load must have a secondary heat source as backup when the “whole-house solution ASHP system” could not provide enough heat to sufficiently heat the home
  - ✓ An ASHP system can be designed with a full-load heating capacity between 90% and 120% of peak heating load and never used to heat the home. The capacity has no impact on its use
  - ✓ Many field studies have shown that ASHP systems installed with the capacity to provide 100% of the homes annual heat load are only used as air-conditioning systems

Source: Diversified Energy Specialists Research & Analysis; NYSERDA

# MA ASHP 2014-2019: Supplementary Heat Source

*In the MassCEC ASHP rebate program from 2014-2019, most installers recommended retaining a supplementary source of heat due to the ASHP systems inability to sufficiently heat residences in the cold Massachusetts winters*



## Analysis

- ✓ 92.8% of homeowners who converted to an ASHP system have either kept their legacy heat source installed or installed a secondary heat source, knowing that ASHPs begin to lose efficiency at 47°F

## 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 assumed that a supplementary heat source was used

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

# Secondary Heat Source: ASHP Field Study

ISO-New England conducted a field study for their “Final 2020 Heating Electrification Forecast” on the electrical use of 18 residences in Massachusetts before and after whole-home ASHP installations

## Field Study Guidelines

- ✓ To assist in developing assumptions about changes in electricity consumption due to the adoption of ASHPs, ISO licensed advanced metering infrastructure (AMI) data from Sagewell, Inc., including:
  - ✓ Anonymized building-level hourly interval energy consumption for residential sites in northeastern MA
  - ✓ Building characteristics and end-use details that match each AMI point
- ✓ Assumptions regarding energy and demand impacts of ASHP adoption are based on analysis and regression modeling performed on the average hourly electricity consumption from 18 residential AMI profiles:
  - ✓ Each profile corresponds to a residence where an ASHP was installed between the winters of 2017/2018 and 2018/2019, which enables a direct comparison of winter electricity consumption before and after ASHP adoption
  - ✓ A mixture of natural gas and oil legacy heating fuels in the 18 residences

## ISO-NE Conclusions

- ISO-NE used the data collected from these 18 residences to forecast the impact of 750,000 ASHP installations in New England from 2020-2029 on the annual grid load and winter peak load:
- ✓ Forecasted additional annual grid load from 750,000 ASHP installations in New England: 1,715 GWh
  - ✓ Forecasted additional winter peak load from 750,000 ASHP installations in New England by 2030: 661 MW

## Field Study Failures

- ISO-NE wanted to understand and forecast the increase in electricity usage from residences that installed whole-home ASHP systems. When measuring the electricity usage on an hourly basis, what percent of the annual heating load did these newly installed whole-home ASHP systems supply? I asked ISO-NE this question and received this response:
- ✓ **“The 18 residential ASHPs used in the analysis reflect a variety of legacy heating displacement applications, and in aggregate, do not reflect full heating displacement. In aggregate the selected sites represent <50% legacy heating displacement”**

## Field Study Impact on ASHP Adoption

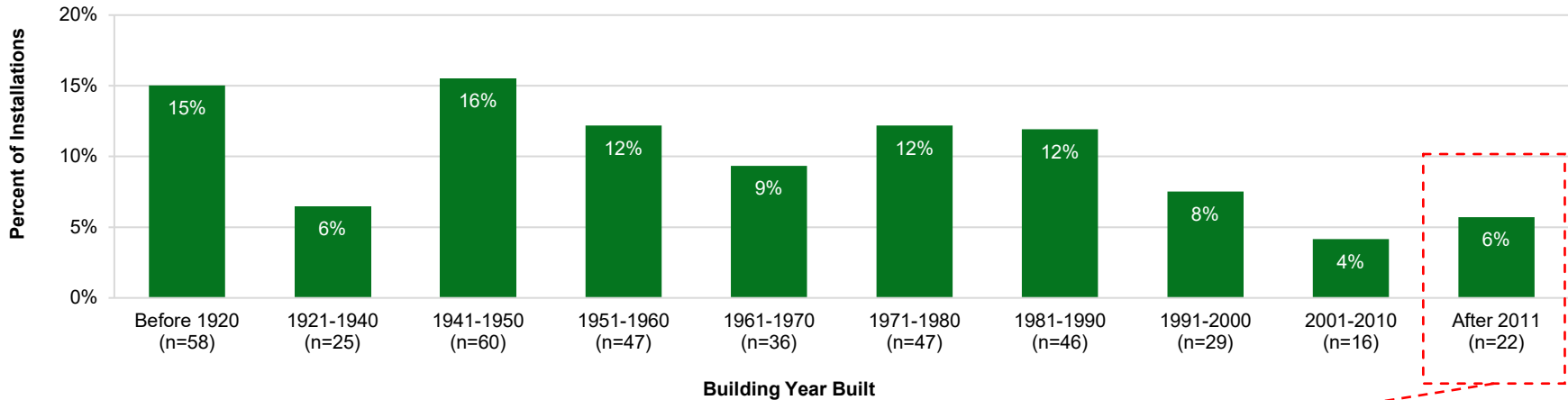
- ✓ Despite the size of the ASHP installations, the 18 ASHP systems provided less than 50% of the residences' annual heat load
  - ✓ This field study, along with others, have proven that the capacity of ASHP systems is much less important than the actual usage. Many homeowners install ASHP systems and chose to use them for air-conditioning systems and continue to use their current fossil fuel system for heating
  - ✓ NYSERDA provided a whole-home incentive based on the capacity of the ASHP installation, but didn't have a method to meter the system usage or to know whether it was being used for heating at all
- ✓ Consumer behavior in field studies has proven that homeowners tend to not use their whole-home ASHP systems for more than 50% of their annual heat load
  - ✓ This could be due to:
    - ✓ The high cost of electricity on cold winter days
    - ✓ ASHP systems operability issues in cold temperatures, leading to the inability to comfortably heat a home on cold winter days
    - ✓ ASHP installers recommending that homeowners retain their legacy heat source and use their legacy heat source when they want to stay warm
- ✓ Of the 386 whole-home solution ASHP installations it cannot be verified that any used their ASHP system to heat their home in the winter
  - ✓ Until a ASHP program requires the metering of the ASHP system or removal of the legacy heat source, these programs will continue to be questioned

Source: Diversified Energy Specialists Research & Analysis; ISO-NE Final 2020 Heating Electrification Forecast

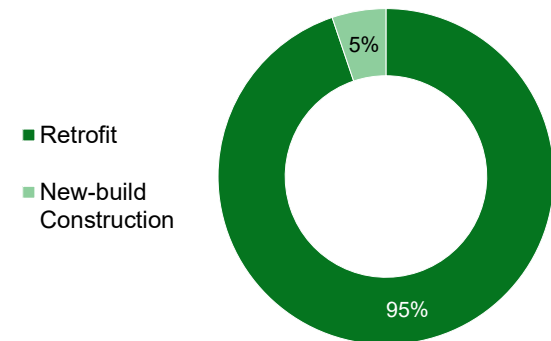
# Retrofit vs. New-build Construction

Nearly all the whole-home ASHP installations were retrofits

Whole-home ASHP Installations  
(n=386)



Retrofit vs. New-build Construction



## Analysis

- ✓ Only 22 of the 386 whole-home ASHP installations were in homes built after 2011
- ✓ Of those 22 homes built after 2011:
  - ✓ 2 self-reported their "Cooling System Age" as greater than 2 years old
  - ✓ 5 self-reported their "Cooling System Age" as less than 2 years old
  - ✓ 15 didn't provide a response
- ✓ Conclusion: At least 366/386 (94.8%) whole-home ASHP installations were retrofits

Source: Diversified Energy Specialists Research & Analysis; NYSERDA



# Case Study: Outliers Included in Data Set

To give a fair analysis of the data, no outliers were excluded from this data set

Outliers Included in Data Set

Sq. Ft. Conditioned	# of Data Points	Avg. Total Cost	# of Low Outliers	Outlier Total Cost Range	Outlier Avg. Cost	Avg. Total Cost Excluding Outliers
Less than 1,000	25	\$10,123	5	\$3,500 - \$5,000	\$4,239	<b>\$11,594</b>
1,000 – 1,500	132	\$12,954	4	\$3,200 - \$4,612	\$4,003	<b>\$13,234</b>
1,500 – 2,000	155	\$16,728	7	\$4,500 - \$6,750	\$6,195	<b>\$17,227</b>
2,000 – 2,500	47	\$21,916	5	\$8,000 - \$10,000	\$9,191	<b>\$23,431</b>
2,500 – 3,000	18	\$23,790	2	\$6,700 - \$9,500	\$8,100	<b>\$25,752</b>
3,000+	9	\$29,631	0	-	-	<b>\$29,631</b>
<b>Total</b>	<b>386</b>	<b>\$16,272</b>	<b>23</b>	<b>\$3,200 - \$10,000</b>	<b>\$6,206</b>	<b>\$16,586</b>

## Outlier Example #1

- ✓ 1,000 – 1,500 sq. ft.
- ✓ Total project Cost: \$3,200
- ✓ Total NYSEDA incentive: \$3,000
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 100%
- ✓ NYSEDA whole-home solution? Yes
- ✓ Legacy heating fuel: Natural Gas
- ✓ Primary heating system: Baseboard Heat
- ✓ Retrofit (building built 1941-1950)
- ✓ Supplementary heat source: No Response

## Outlier Example #2

- ✓ 1,500 - 2,000 sq. ft.
- ✓ Total project Cost: \$4,500
- ✓ Total NYSEDA incentive: \$4,000
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 100%
- ✓ NYSEDA whole-home solution? Yes
- ✓ Legacy heating fuel: Oil
- ✓ Primary heating system: Unknown
- ✓ Retrofit (building built 1981-1990)
- ✓ Supplementary heat source: No Response

## Outlier Example #3

- ✓ 2,500 - 3,000 sq. ft.
- ✓ Total project Cost: \$6,700
- ✓ Total NYSEDA incentive: \$5,050
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 100%
- ✓ NYSEDA whole-home solution? Yes
- ✓ Legacy heating fuel: Propane
- ✓ Primary heating system: Central Forced Air
- ✓ Retrofit (building built after 2011)
- ✓ Supplementary heat source: Propane

## Analysis

- ✓ Looking at some of these whole-home ASHP installations, it's hard not to question the accuracy of the self-reported data. The three examples above show cases where the installation of a whole-home ASHP system were nearly free after the rebate. Looking at the distance from the mean and the number of applications for homes of the same size, it is difficult to believe that these numbers were accurately reported
- ✓ The total cost of an installation was determined to be a low outlier if it was 1.5 standard deviations below the mean for all installations above 1,000 sq. ft. and 1 standard deviation from the mean for installations of less than 1,000 sq. ft. due it's low value and high SD

Source: Diversified Energy Specialists Research & Analysis; NYSEDA

# Case Study: Applications Excluded From Data Set

*Applications that did not receive a full load incentive were excluded from the data set, despite some of them reporting the highest total cost of installation in the program*

## Example #1

- ✓ Less than 1,000 sq. ft.
- ✓ Total project Cost: \$21,129
- ✓ Total NYSEERDA incentive: \$500
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 50%
- ✓ NYSEERDA whole-home solution? No
- ✓ Primary heating fuel: Natural Gas
- ✓ Primary heating system: Baseboard Heat
- ✓ Retrofit (building built 1951-1960)

## Example #2

- ✓ 1,000 – 1,500 sq. ft.
- ✓ Total project Cost: \$22,200
- ✓ Total NYSEERDA incentive: \$1,000
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 25%
- ✓ NYSEERDA whole-home solution? No
- ✓ Primary heating fuel: Oil
- ✓ Primary heating system: Hot Water
- ✓ Retrofit (building built 1951-1960)

## Example #3

- ✓ 1,500 - 2,000 sq. ft.
- ✓ Total project Cost: \$37,602
- ✓ Total NYSEERDA incentive: \$500
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 50%
- ✓ NYSEERDA whole-home solution? No
- ✓ Primary heating fuel: Propane
- ✓ Primary heating system: Central Forced Air
- ✓ Retrofit (building built 1961-1970)

## Example #4

- ✓ 2,500 - 3,000 sq. ft.
- ✓ Total project Cost: \$39,000
- ✓ Total NYSEERDA incentive: \$1,000
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 85%
- ✓ NYSEERDA whole-home solution? No
- ✓ Primary heating fuel: Propane
- ✓ Primary heating system: Central Forced Air
- ✓ Retrofit (building built 1981-1990)

## Example #5

- ✓ 2,500 - 3,000 sq. ft.
- ✓ Total project Cost: \$29,720
- ✓ Total NYSEERDA incentive: \$500
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 40%
- ✓ NYSEERDA whole-home solution? No
- ✓ Primary heating fuel: Oil
- ✓ Primary heating system: Baseboard Heat
- ✓ Retrofit (building built 1991-2000)

## Example #6

- ✓ 3,000 or more sq. ft. (less than 4,000 sq. ft.)
- ✓ Total project Cost: \$42,675
- ✓ Total NYSEERDA incentive: \$500
- ✓ Self-reported percent of residences square footage conditioned by the ASHP unit: 65%
- ✓ NYSEERDA whole-home solution? No
- ✓ Primary heating fuel: Natural Gas
- ✓ Primary heating system: Baseboard Heat
- ✓ Retrofit (building built 1921-1940)

## Analysis

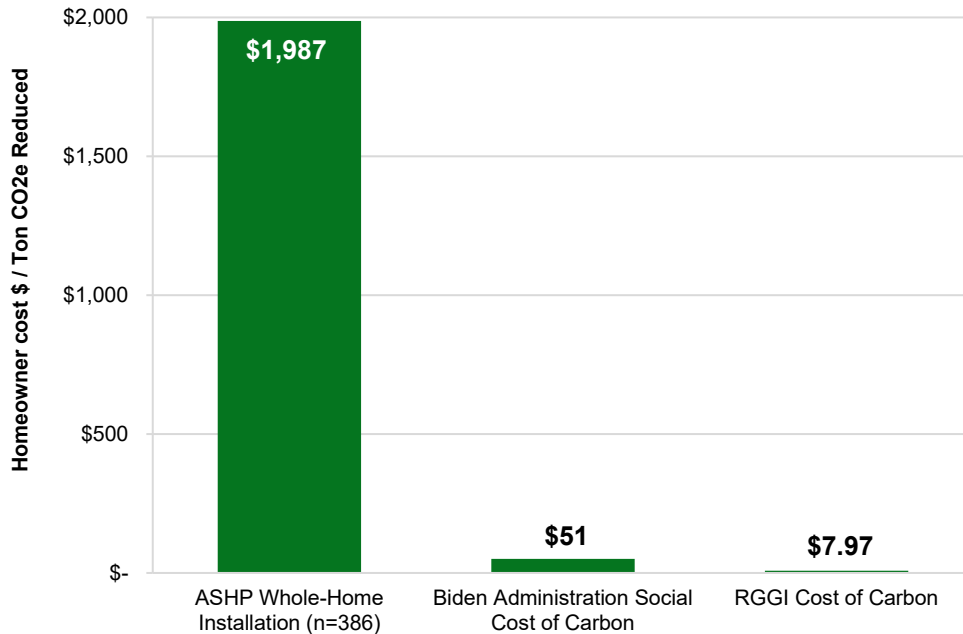
- ✓ **Example 1:** It cost over \$21k to heat 50% of this less than 1,000 sq. ft. home
- ✓ **Example 2:** This project cost over \$22k to heat 25% of this 1,000 – 1,500 sq. ft. home
- ✓ **Example 3:** This ASHP system cost over \$37k to heat 50% of this 1,500 – 2,000 sq. ft. home
- ✓ **Example 4:** Heating 85% of this 2,500 – 3,000 sq. ft. home cost \$39k
- ✓ **Example 5:** It cost nearly \$30k to heat 40% of this 2,500 – 3,000 sq. ft. home
- ✓ **Example 6:** Heating 65% of this 3,000 – 4,000 sq. ft. home cost over \$42k

Source: Diversified Energy Specialists Research & Analysis; NYSEERDA

# The Cost of GHG Reduction

*Does the homeowner cost per ton of carbon dioxide reduced justify these programs?*

**Cost per Ton of CO<sub>2</sub>e GHG Savings per Whole-Home Conversion**  
(Homeowner Only Cost)



## Assumptions

- ✓ Electric Grid: 1,433 lbs/MWh – or 420 lbs/MMBtu
  - ✓ Based on 2020 GREET natural gas as long-term marginal electric power and includes transmission and distribution losses
- ✓ Average cost of whole-home conversion: \$17,286
  - ✓ Based on median size residence in New York of 1,764 sq. ft.
- ✓ Heat pump efficiency: COP of 2.01 @ 5°F, COP of 2.47 @ 20°F, COP of 3.09 @ 40°F, and COP of 3.71 @ 60°F
- ✓ Annual Home Heating Load: 100 MMBtu
- ✓ Annual lifecycle GHG CO<sub>2</sub>e (HHV) emissions for heating one home in tons:
  - ✓ Whole-home electric heat pump: 6.9 Tons of CO<sub>2</sub>e
- ✓ No supplemental or backup heat sources were considered

## Cost of Carbon

- ✓ Comparing the cost of CO<sub>2</sub>e reduction in the Regional Greenhouse Gas Initiative (RGGI) for the eastern states of the U.S. and President Biden’s estimated social cost of carbon raise many questions about ASHP rebate programs
  - ✓ The Regional Greenhouse Gas Initiative is a cap-and-invest initiative that reduces CO<sub>2</sub> emissions from the power Sector
    - ✓ The current market value (June 2021) of 1 Ton of CO<sub>2</sub> in the RGGI is \$7.97, or 0.4% of the cost of 1 Ton of CO<sub>2</sub> reduction in NYSERDA’s ASHP rebate program
  - ✓ President Biden directed his team to assess the social cost of carbon. The team put a number on how much damage a metric ton of carbon dioxide emitted today will do in the future, in order to show how much a given climate policy would benefit the economy in the long run
    - ✓ On February 26, 2021, the Biden administration announced an initial estimate of \$51.00 per ton of carbon, or 2.6% of the cost of the NYSERDA program

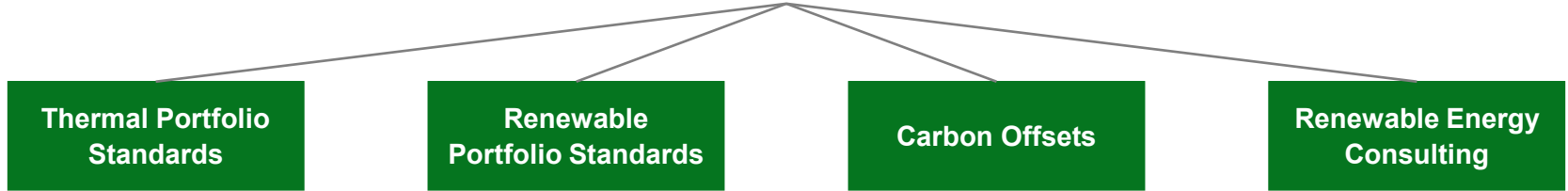
Source: Diversified Energy Specialists Research & Analysis, GREET, NORA, Wired

# Key Takeaways

*These programs are not working as intended*

- ✓ Only 0.005% of residences in New York converted to whole-home ASHP systems through the NYSERDA rebate program from 2017-2019
  - ✓ Most of the applications determined to be “whole-home” solutions were actually partial-home solutions. Most homes had an alternative heat source, which provided an unknown percentage of the annual heat load
  - ✓ Without program requirements mandating the removal of the household's legacy heat source, not allowing a supplementary heat source, or mandating metering of the ASHP systems' usage, homeowners will continue to take advantage of ASHP rebate programs and install systems that are only used for air-conditioning
- ✓ Field studies show that homeowners are choosing to not use their ASHP systems to heat their home in the winter, regardless of the systems capacity. This consumer behavior could be due to:
  - ✓ The high cost of electricity on cold winter days
  - ✓ ASHP systems operability issues in cold temperatures, resulting in the inability to comfortably heat a home on cold winter days
  - ✓ ASHP installers recommending that homeowners retain their legacy heat source and use their legacy heat source when they want to stay warm in the winter
- ✓ Whole-home ASHP systems are expensive
- ✓ ASHP installations increase the winter grid load and winter peak load, which:
  - ✓ May increase the cost of electricity for all ratepayers
  - ✓ Increases the amount of renewable electricity generation needed to meet the goal of zero-carbon electricity

# Background & Contact Information



- Diversified Energy Specialists**
- ✓ Renewable energy consulting
    - ✓ Thermal technologies
    - ✓ Greenhouse gas emissions reduction
    - ✓ Cap-and-trade programs
    - ✓ Rebate programs
  - ✓ Environmental markets trading
    - ✓ Renewable portfolio standards
    - ✓ Thermal portfolio standards
    - ✓ Low-carbon fuel standards
  - ✓ Carbon offsets
    - ✓ Purchasing
      - ✓ Procurement
      - ✓ Aggregation

**Contact Information**

Joe Uglietto  
President  
(978) 245-8730  
[Joe@DiversifiedEnergySpecialists.com](mailto:Joe@DiversifiedEnergySpecialists.com)  
[www.DiversifiedEnergySpecialists.com](http://www.DiversifiedEnergySpecialists.com)