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Ramping Up Heat Pump Adoption in New York State

Targets and Programs to Accelerate Savings

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Executive Summary

The 2018 New Efficiency: New York whitepaper identifies electrification of thermal end uses in buildings, also known as renewable heating and cooling, as a key energy efficiency and decarbonization strategy in New York State. This report examines the potential of strategic electrification through heat pump technology, under three growth scenarios. It then offers program and policy options to achieve that potential and coordinate activities between the New York State Research and Development Authority (NYSERDA) and utilities. The report assesses multiple heat pump technologies including ground-source heat pumps (GSHP), air-source heat pumps (ASHP), and commercial ASHP applications with variable refrigerant flow (VRF) technology.

With aggressive program and policy support to drive the market for heat pumps, New York could achieve the following results by 2025 and 2030 under a high growth scenario:

- ASHPs installed in two-thirds of New York households by 2030.
- 31 TBtu of energy savings from heat pump installations by 2025, contributing 17% of the savings needed to achieve New York's 185 TBtu 2025 efficiency target.
- 3.5 percent of New York's GHG emissions reductions coming from heat pump installations by 2030, contributing to the goal of 40 percent GHG reduction compared to baseline emissions in 1990. Focusing on the residential sector, for which better data was available, the emissions savings from this level of adoption would be nearly 20%.[1]

Performance Targets and Incentives

- New York should establish a statewide, fuel-neutral target of 30 TBtu of energy savings from heat pump installations by 2025, consistent with the high growth scenario. NYSERDA should serve as the lead for tracking the state's progress toward this target, and should also monitor progress toward key market transformation metrics, drawing on the data it already receives through annual HVAC market reports.
- Utilities should set Earnings Adjustment Mechanisms (EAMs) that include:
    - Ambitious goals for utility energy savings in the form of TBtu savings from all fuels, including unregulated fuels, in addition to existing targets for electricity and natural gas savings from regulated fuels. Establishing "total energy" savings targets will help to align utility program delivery with the 2025 energy efficiency target.
    - Explicit targets and associated EAMs for each utility for both program-based and outcome-based total energy savings from heat pumps. Utilities should work closely with NYSERDA to determine each utility's share of the statewide, outcome-based total energy target for savings from heat pump installations.
- Savings methodologies should count *all* the savings from heat pump installations, including displaced fossil fuels from heat pump retrofits and electric savings from heat pumps installed for cooling. Savings methodologies should also account for increases in electricity usage from heat pump installations that involve fuel switching.

[1] Emissions reductions assume oil is replaced by electricity that gets cleaner over the analysis period. The percent reduction is calculated using 1990 energy-related emissions from Table S-2 in the NYSERDA Greenhouse Gas Inventory, revised February 2017. https://energyplan.ny.gov/-/media/nysenergyplan/final/greenhouse-gas-inventory.pdf.

Coordination of Utility and NYSERDA Efforts

- New York should establish a statewide umbrella initiative to administer upstream heat pump programs and engage the supply chain. Given its responsibilities for statewide market development, NYSERDA is the logical choice to provide this coordination role.
- Building on previous experience with a centralized advisory group that supported implementation of the Energy Efficiency Portfolio Standard (EEPS), New York should establish a similar structure to facilitate statewide coordination on energy efficiency and electrification target-setting, budgets, and program implementation.
- Utilities should serve as the lead for end-use customer engagement and incentives, with NYSERDA offering the utility incentives as a 100% pass-through to customers through its upstream program.
- New York utilities that do not currently offer residential incentives for heat pumps should introduce customer incentives, and utilities that currently incentivize residential ASHPs should increase incentives above the current $100-$250 level.
- NYSERDA should continue its efforts to reach underserved communities, through its Clean Heating and Cooling community program, and explore offering enhanced heat pump incentives for low and moderate-income (LMI) customers.
- Utilities should be encouraged to partner with the New York Green Bank as well as NYSERDA's financing options: the On-Bill Recovery Loan and the Smart Energy Loan.
- Building electrification programs should generally be funded in proportion to their contribution to New York's efficiency and climate goals. Building electrification is projected to contribute approximately 17 percent of the 185 TBtu energy savings target, so a reasonable starting point is to dedicate approximately 17 percent of the total funding for energy efficiency programs in New York (across all utilities, plus NYSERDA) to building electrification.

Electric and Gas Program Coordination

- Increase coordination between electric and gas utilities in New York with the following actions:
    - Phase out conversions from unregulated fuels to natural gas**.**
    - Offer incentives for hybrid heat pumps.
    - Promote all-electric heating equipment in new construction.
    - Promote fuel switching in gas utility service territories with capacity constraints.
    - Develop methods to adjust utility targets and EAMs for overlapping electric-gas service territories.

State Building Energy Codes

- New York should adopt the currently proposed stretch code, which includes a high-efficiency options package. While the stretch code does not directly require heat pump technology, the intent is to incorporate the technology into the code in a manner that does not trigger federal preemption, but encourages builders to consider higher efficiency mechanical systems.

Market Development for Heat Pump Technologies

- Build on NYSERDA's current activities to advance the ASHP market by:
    - Building cross-industry links with the electrical wholesale supply channel.

    - Adopting the NEEP Cold Climate Heat Pump Specification.
    - Working with heat pump and thermostat manufacturers to develop and integrate control capabilities.
- Advance the market for GSHPs and VRFs through the following steps:
    - Creating VRF case studies and marketing materials.
    - Aggressively promoting VRFs in commercial and residential new construction and building codes, and review building code barriers to VRF technology.
    - Evaluating and supporting accelerated transition of heat pumps to the use of lower global warming potential (GWP) refrigerants.
    - Exploring distributor incentives for VRF technology.
    - Developing regional standards for VRFs in the Northeast.
    - Creating a Clean Energy Challenge to encourage state buildings use VRFs.
    - Accelerating NYSERDA's soft cost reduction strategy for GSHPs.
    - Developing and funding demonstration projects that explore the potential for GSHPs to promote grid flexibility.

Introduction

On Earth Day 2018, New York Governor Cuomo announced a 2025 efficiency target of 185 TBtu of energy savings, part of a multipronged strategy to achieve the state's goal of a 40% reduction in greenhouse gas emissions by 2030.[2] If met, the efficiency target would deliver nearly one-third of New York's needed GHG reductions by 2030 – roughly equivalent to the contribution of the goal of 50 percent renewable energy by 2030. Achieving New York's ambitious efficiency and climate goals will take coordination with many sectors of the economy, and significant public and private investment.

The 2018 New Efficiency: New York whitepaper identifies electrification of thermal end uses in buildings, also known as renewable heating and cooling,[3] as a key energy efficiency and decarbonization strategy in New York State. Clean heating technologies are one of the most promising energy efficiency technologies, with potential to deliver a significant portion of the energy savings needed in 2025. This report examines the potential of strategic electrification through heat pump technology under three growth scenarios. It then offers program and policy options to achieve that potential and coordinate activities between the New York State Research and Development Authority (NYSERDA) and utilities. The report assesses multiple heat pump technologies including ground-source heat pumps (GSHP), air-source heat pumps (ASHP), and commercial ASHP applications with variable refrigerant flow (VRF) technology.

[2] NYSERDA and New York Department of Public Service, 2018. "New Efficiency: New York." https://www.nyserda.ny.gov/-/media/Files/Publications/New-Efficiency-New-York.pdf.
[3] NYSERDA's use of the term "Renewable Heating and Cooling" often includes advanced wood heat. Electrification of heating and cooling is only "renewable" when powered by electricity from renewable sources.

Heat Pumps in New York: Current State

Market Penetration

Relative to neighboring states, New York has a low penetration of heat pump installations reported through utility and state programs.[4] Overall market activity appears to be somewhat higher, but still represents a tiny fraction of the total market potential in the state. An HVAC market report completed for NYSERDA found 43,418 ASHPs were sold and installed in 2016 in the state,[5] an annual market penetration of about 0.5% of New York's 8.2 million households.[6,7] Nearly half of ASHP sales had an HSPF equal to or above 10, which is one of the requirements for NEEP's Cold Climate Specification. Similar sales data on the relatively smaller GSHP market was not readily available. According to NYSERDA, although thermal energy use in the residential and commercial sectors produces 32 percent of all combustion-based GHG emissions in New York, heat pump technologies currently represent only 1 percent of the heating and cooling market.[8]

Heat Pump Programs and Incentives

At the time of report writing (July 2018), a range of programs and incentives were available in New York promoting heat pump technologies through both NYSERDA and utilities. These programs vary widely in terms of the technologies supported, incentive design, incentive levels, and sectors served (residential vs. commercial). Incentive designs range from downstream rebates paid to customers, to midstream incentives paid to contractors, to upstream incentives paid to wholesale distributors.

Under Reforming the Energy Vision (REV), and with funding from New York's Clean Energy Fund, NYSERDA leads market development initiatives to reduce costs, accelerate market demand, and increase private investment in energy efficiency and clean energy technologies. NYSERDA's current initiatives to support adoption of heat pumps include:

- **Air Source Heat Pump Program** provides a $500 midstream incentive to participating contractors for eligible ASHPs.[9] NYSERDA has also evaluated VRF technology through demonstration projects and a recent market and technology assessment,[10] and may soon expand the ASHP program to include commercial VRFs.
- **Ground Source Heat Pump Program** provides a $1200-1500 midstream incentive to participating contractors based on cooling capacity.[11]

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[4] A seven-state comparison of heat pump technology adoption in the Northeast can be found at NRDC and VEIC, 2018. "Driving the Heat Pump Market: Lessons Learned from the Northeast." Burlington, Vermont: VEIC. https://www.veic.org/documents/default-source/resources/reports/veic-heat-pumps-in-the-northeast.pdf.

[5] D+R International, 2017. *2016 HVAC Market Report,* prepared for NYSERDA. https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2017ContractorReports/201712-DRUnitaryHVACMarketReport-2016.pdf.

[6] U.S. Census Bureau, State Quick Facts. 2017. Housing Units, July 1, 2016. https://factfinder.census.gov/bkmk/table/1.0/en/PEP/2016/PEPANNHU.

[7] The data in the HVAC market report does not parse out sales by sub-technology (e.g. VRF) or those meeting the NEEP cold climate heat pump specification. NYSERDA is discussing adding this classification detail to future reports.

[8] NYSERDA, 2017. "Clean Energy Fund Investment Plan: Renewable Heating & Cooling Chapter." https://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/cef-renewable-heating-and-cooling-chapter.pdf.

[9] NYSERDA. *Air Source Heat Pump Program.* https://www.nyserda.ny.gov/All-Programs/Programs/Air-Source-Heat-Pump-Program

[10] NYSERDA commissioned an assessment of VRFs in 2018 that identified barriers and opportunities to the heat pump technology and energy savings estimates for commercial office and multifamily buildings. "Market and Technical Analysis of Variable Refrigerant Flow Heat Pump Technology", VEIC. May 2018.

[11] NYSERDA. *Ground Source Heat Pump Program.* https://www.nyserda.ny.gov/All-Programs/Programs/Ground-Source-Heat-Pump-Rebate

- **Clean Heating and Cooling Communities Program** will model itself after New York's successful "Solarize" campaign and work with community-based organizations and local governments to help communities increase awareness and adoption of clean heating and cooling (CH&C) technologies, reduce costs associated with the purchase and installation of CH&C projects, expand the workforce trained in installations, and increase participation of low- to moderate- income (LMI) households.
- A range of initiatives supporting **innovative HVAC technologies and business models**, such as a NextGen HVAC funding opportunity offered in 2017.[12]
- A range of market characterization, assessment, and potential studies to evaluate the current and potential market for heat pump technologies and identify market barriers.[13]

Under REV, investor-owned gas and electric utilities are expanding their role as energy efficiency program administrators, and efficiency is increasingly "treated as a system resource by utilities—accounted for in traditional cost recovery or rate-based approaches and integrated into Distributed System Implementation Plans (DSIPs), which document a utility's integrated approach to planning, investment and operations."[14] Utilities are also pursuing innovative energy partnerships. New York's investor-owned electric and gas utilities are currently accepting "innovative ideas and business models that work in partnership with utilities to cost-effectively electrify space heating and cooling systems across the state."[15] Utilities are seeking ideas on everything from reducing capacity constraints to bundling heat pumps with energy efficiency retrofits. Con Edison is the only utility actively requesting information on how they could convert natural gas customers to electric heat pumps.[16]

As an interim step towards rate-basing electric and gas energy efficiency initiatives, utilities were required to file a 2017-2020 Energy Efficiency Transition Implementation Plan (ETIP). During the next rate period, all utility efficiency programs are expected to be funded through rates and the ETIP will transition to a System Energy Efficiency Plan (SEEP).[17] Utilities are also seeking "non-pipes solutions", or alternatives to new gas pipelines to meet growing energy demand. In December 2018, Con Edison issued a non-pipes Request for Proposals (RFP) to reduce demand and enhance local gas supply. According to the RFP, demand reduction measures may include, "energy efficiency, demand response and environmentally-beneficial electrification of space and water heating."[18] Submissions were due by March 1, 2018. Other gas efficiency programs being pursued by Con Edison include a gas demand response program and an innovation program to encourage renewable alternatives to heating with natural gas.

To promote increased utility investment in REV priorities, New York is testing a ratemaking incentive known as an Earning Adjustment Mechanism (EAM).[19] The tool would allow utilities to

[12] NYSERDA. *Advanced Building Program.* https://www.nyserda.ny.gov/All-Programs/Programs/Advanced-Buildings
[13] NYSERDA. *Evaluation Reports.* https://www.nyserda.ny.gov/About/Publications/Program-Planning-Status-and-Evaluation-Reports/Evaluation-Contractor-Reports
[14] NYSERDA and NY DPS, 2018. "New Efficiency: New York."
[15] NY REV. *Clean Heating and Cooling Innovation Sprint.* https://nyrevconnect.com/innovation-opportunities-clean-heating-cooling/
[16] Con Edison, Gas Innovation Program, Business Innovation to Accelerate Renewable Thermal Adoption, RFI. https://www.coned.com/-/media/files/coned/documents/business-partners/business-opportunities/clean-thermal/request-for-information.pdf?la=en
[17] Case 15-M-0252, In the Matter of Energy Efficiency Programs, Order Authorizing Utility-Administered Energy Efficiency Portfolio Budgets and Targets for 2019-2020 (issued March 15, 2018)
[18] Con Edison Request for Proposals (RFP), Non-Pipeline Solutions to Provide Peak Period Natural Gas System Relief, 2017. https://www.coned.com/-/media/files/coned/documents/business-partners/business-opportunities/non-pipes/non-pipeline-solutions-rfp.pdf
[19] NY REV. *Track Two: REV Financial Mechanisms.* https://nyrevconnect.com/rev-briefings/track-two-rev-financial-mechanisms/

earn a performance incentive on REV-related investments, such as greenhouse gas reductions, energy efficiency, and peak reduction.

Table 1 summarizes the residential and commercial incentives currently offered for ASHPs and GSHPs by the investor-owned utilities in New York. The table notes whether the incentives are structured as downstream rebates to end-use customers, midstream incentives to contractors, and/or upstream incentives to wholesale distributors. Appendix A provides a more detailed summary of utility incentives, including incentive levels for different types of heat pump equipment.

Table 1. 2018 heat pump incentives offered by New York utilities.

	Residential Incentives		Commercial Incentives	
	ASHP	GSHP	ASHP	GSHP
Con Edison	Midstream / Upstream	NA	Downstream/ Midstream / Upstream	NA
Central Hudson	Downstream	NA	Downstream	Downstream
National Grid	NA	Demonstration project only	NA	NA
NYSEG	NA	NA	Downstream	NA
Orange & Rockland	Downstream	NA	Downstream	NA
PSEG Long Island	Downstream	Downstream	Downstream	Downstream
Rochester	NA	NA	Downstream	NA

Heat Pump Savings

Both utility-run and NYSERDA heat pump programs claim NY State deemed savings from the heat pumps, which are primarily based on cooling efficiency rather than heating. Many ASHPs in New York are installed as a fuel switching or “retrofit” measure, in which a customer displaces fossil fuel consumption by heating some or all of the building with an electric heat pump. However, because the utility goals focus on regulated fuel savings, the deemed savings methodology currently used in New York only counts the incremental, “market opportunity” electricity savings associated with installing a high-efficiency ASHP above a less efficient, “baseline” ASHP – even when the heat pumps are installed in homes that utilize oil and propane for heating.

New York’s Current Approach: Strengths and Challenges

New York has a strong foundation to build on as the state seeks to ramp up heat pump adoption. One key strength of the current system is NYSERDA’s well-defined role leading market development through supply channel engagement, training, workforce development, community-based initiatives, and other activities. This broad scope will be critical to transformation of the heat pump market in New York. In addition, New York benefits from a vibrant market of heat pump distributors and installers, including active trade associations and advocacy groups representing both the ASHP and GSHP industries.

Despite these strengths, New York’s level of ASHP market penetration remains lower than several Northeast states, notably Vermont and Maine, which launched robust ASHP programs and incentives several years ago. The programs and incentives currently offered in New York present several challenges that may impede market growth:

- **Inconsistent utility offerings.** As shown in Table 1 and Appendix A, the incentives available vary widely. Some utilities (Con Edison, Central Hudson, Orange and Rockland, and PSEG Long Island) offer incentives for residential ASHPs, while National Grid, NSEG,

and Rochester do not. Only PSEG offers incentives for GSHPs across both the residential and commercial markets, and most utilities do not appear to offer any incentives for GSHPs.

- **Inconsistent incentive designs.** Most of the available incentives are in the form of downstream rebates for commercial and residential customers, but NYSERDA's incentive takes the form of a midstream payment to participating contractors. Con Edison has recently shifted to a midstream incentive design for residential customers in which the utility "provides direct payment of financial rebates to distributors who deliver systems that meet the system requirement guidelines. Distributors are required to issue a minimum of 50 percent of each rebate to the contractor purchasing the qualifying equipment."[20] The inconsistent utility offerings and incentive designs throughout the state presents a challenge for distributors and contractors who serve multiple regions, and may lead to customer and market confusion.
- **Not counting the full benefits.** By only accounting for the incremental electricity savings from heat pumps, utilities and NYSERDA are not recognizing the most significant benefits of heat pump installations to New York's energy system – avoided GHG emissions from reduced use of fossil fuels and system-coincident peak demand reduction from the use of heat pumps for summer cooling.
- **Relatively low utility incentives.** Where available, residential downstream incentives for ductless mini-split heat pumps are generally in the $100-$250 range, although incentives from Central Hudson are a bit higher ($350-500). A recent analysis of heat pump programs across the Northeast found that the most successful programs offered higher customer incentives to reduce the equipment cost, at least $500 per unit for ductless mini-splits.[21]
- **Changing roles for NYSERDA and utilities.** Under REV, NYSERDA and utility roles are evolving. NYSERDA and the utilities actively coordinate their offerings and strive to develop complementary programs as they manage this transition. It will be important for this coordination to continue, to avoid market uncertainty and program gaps or redundancies as NYSERDA and utility programs ramp up and down.

Heat Pump Market Potential

Methodology

VEIC conducted scenario modeling to determine the rate of heat pump adoption needed to achieve New York's energy efficiency and climate goals. We modeled different heat pump adoption ramp rates based on three scenarios. In each scenario, ASHPs, both ducted and ductless, including VRFs, get a higher growth rate, while GSHPs have a slower growth assumption based on their lower market share today, and more limited technical potential.

- **Baseline.** This scenario estimates the rate of heat pump market growth under a baseline scenario, factoring in growing markets in the region and generally improved awareness and private marketing, but without specific program supports for heat pumps.

[20] Con Edison, 2018. "Residential HVAC Program Overview." https://www.coned.com/-/media/files/coned/documents/save-energy-money/rebates-incentives-tax-credits/rebates-incentives-tax-credits-for-commercial-industrial-buildings-customers/hvac-program-guidelines.pdf?la=en.
[21] NRDC and VEIC, *Driving the Heat Pump Market.*

- **Moderate growth.** This scenario starts with a 14 percent annual growth rate for ASHPs, both ductless and ducted in the residential and small commercial scale. This is consistent with a Synapse analysis showing that utilities would need to increase efficiency savings by 14 percent each year from 2019 through 2025 to achieve the target of 185 TBtu of energy savings by 2025.[22] The growth rate then ramps up 1 percent faster each year to reach 27 percent growth in the last year, in line with the 25-35 percent annual growth rates for the Northeast region anecdotally reported by heat pump manufacturers
- **High growth.** This scenario assumes that aggressive program interventions are in place to support the heat pump market. ASHP growth rates quickly ramp up to a level as high as possible without exceeding an annual growth rate limit or a cumulative market share rate limit. The growth rate is limited to 59 percent, which is the national average annual growth rate in the solar photovoltaic (PV) market the last 10 years. The cumulative market share limit is 70 percent, the technical potential from NYSERDA's Renewable Heating and Cooling Policy Framework.[23] In comparison, the Northwest Energy Efficiency Alliance (NEEA) used a target market saturation of 85 percent of single family homes by 2029, and cited very high existing penetrations in international markets with long exposure to heat pumps including 90 percent in Japan, 86 percent in China, and 81 percent in Europe.[24]

We made the following key assumptions in conducting the scenario modeling:

- The current installation rate for ASHPs is based on an HVAC market report completed for NYSERDA which found 43,418 ASHPs installed in 2016 in the state.[25] This data includes, but does not separately report, cold climate heat pumps and VRFs.
- Current installation rate data for GHSPs in New York are difficult to find. VEIC used 1,000 installations per year, a number reported to NYSERDA by the industry.
- Future projections of heat pump installation rates are based on the total New York market, not just installations that are directly incentivized by NYSERDA and/or utility programs.
- Projections of energy savings are based on the net energy impact, factoring in gross cumulative fossil fuel savings as well as increases in electric consumption from heat pump conversions. It is important to note that this method differs from the current deemed savings methodology used in New York, which only accounts for the incremental electric savings for a new efficient heat pump relative to a new baseline heat pump.
- Energy savings in this report refer to site energy – how much fuel or electricity an end-user is paying for. Energy policy also often considers source energy, which includes upstream inefficiencies in extraction, conversion, and delivery of the energy to the customer's meter.
- Source energy use is always higher than site energy use, particularly for electricity because converting thermal fuels to electricity, a higher-grade form of energy, is inherently inefficient. Heat pumps today are efficient enough to overcome these upstream losses, and have comparable or lower source energy requirements than the source energy of burning fuels within a building directly for heat. As the grid builds out distributed, renewable generation, the delta between site and source energy is decreasing, increasing the

[22] Synapse, 2018. "Current Energy Efficiency Efforts in New York Relative to Governor Cuomo's Goals."
[23] NYSERDA, 2017. Renewable Heating and Cooling Policy Framework. https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.
[24] ILLUME Advising. 2015. Northwest Ductless Heat Pump Initiative: Market Evaluation Report #4, prepared for the Northwest Energy Efficiency Alliance. https://neea.org/img/uploads/ductless-heat-pump-market-continues-to-increase-dhp-mper-4.pdf.
[25] D+R International, 2017. 2016 HVAC Market Report.

benefits of high efficiency heat pump adoption. A heat pump installed today is expected to last through 2030, when New York's goal is to generate 50% of electricity from renewable sources.

- Other sources and assumptions for energy and GHG emissions savings are detailed in Appendix B.

Findings

Based on our analysis, with aggressive program and policy support to drive the market for heat pumps, New York could achieve the following results by 2025 and 2030 under the high growth scenario:

- ASHPs installed in two-thirds of New York households by 2030.
- 31 TBtu of energy savings from heat pump installations by 2025, contributing 17% of the savings needed to achieve New York's 185 TBtu 2025 efficiency target.
- 3.5 percent of New York's GHG emissions reductions coming from heat pump installations by 2030, contributing to the goal of 40 percent savings compared to baseline emissions in 1990. Focusing on the residential sector, for which better data was available, the emissions savings from this level of adoption would be nearly 20%.[26]

This analysis likely underestimates the GHG savings heat pumps can offer, even under the high growth scenario, due to conservative assumptions for energy savings per home, growth potential in the commercial market, and GHG emissions factor.[27]

Table 2 presents the results of the scenario modeling conducted for ASHPs, GSHPs, and VRFs.

[26] Emissions reductions assume oil is replaced by electricity that gets cleaner over the analysis period. The percent reduction is calculated using 1990 energy related emissions from Table S-2 in the NYSERDA Greenhouse Gas Inventory, revised February 2017. https://energyplan.ny.gov/-/media/nysenergyplan/final/greenhouse-gas-inventory.pdf.

[27] Estimates of savings per home come from the top 20% energy-saving sites from a recent Massachusetts impact evaluation. Heat pumps are increasingly able to save more per installation because their performance in cold weather is improving and because more installation options mean they can increasingly replace central systems. With those changes, heat pumps may be able to save more residential emissions than assumed in this analysis. For commercial savings, there is good data on VRF performance and savings but limited data on the potential commercial market in New York. We used a conservative assumption that 75% of the building area subject to New York City's benchmarking rules would switch to VRFs by 2030. Lastly, this analysis used an average GHG emissions factor for each year. An analysis that relied on build marginal emissions factors would result in higher GHG savings.

Table 2. Heat pump market potential under three growth scenarios.

Scenario	Technology	Annual Installs 2025	Cumulative Installs 2025	Annual Installs 2030	Cumulative Installs 2030	Net Total Energy Savings (TBtu) 2025	GHG Emissions Savings (% of 1990) 2030
Baseline	ASHP (qty)	61,000	465,800	75,400	812,600	6.0	0.5%
	GSHP (qty)	1,200	9,800	1,300	16,000	0.7	0.0%
	VRF (ft^2)	70,200	536,400	86,800	935,700	0.6	0.0%
	Total					**7.3**	**0.5%**
Moderate Growth	ASHP (qty)	168,600	815,100	514,300	2,520,100	10.5	1.4%
	GSHP (qty)	1,400	10,600	1,700	18,300	0.7	0.1%
	VRF (ft^2)	194,100	938,600	592,200	2,902,100	1.1	0.0%
	Total					**12.3**	**1.5%**
High Growth	ASHP (qty)	517,000	2,073,700	758,600	5,437,200	26.7	3.1%
	GSHP (qty)	7,400	27,600	33,400	127,700	1.9	0.4%
	VRF (ft^2)	595,400	2,388,100	873,600	6,261,400	2.7	0.0%
	Total					**31.3**	**3.5%**

Programs and Policies to Promote Heat Pumps

Our scenario modeling shows that heat pumps have the potential to ramp up to levels that contribute significantly to New York's energy efficiency and greenhouse gas reduction goals by 2025 and 2030. To achieve this potential, New York will need a range of policies and programs to encourage heat pump adoption, including:

- Performance targets and incentives
- Coordination of utility and NYSERDA efforts
- Updated program frameworks for gas and electric programs
- State building energy codes
- Market development approaches for both proven and emerging heat pump technologies

Performance Targets and Incentives

New York should establish a statewide goal of 30 TBtu of energy savings from heat pump installations by 2025, consistent with the high growth scenario. Setting an ambitious target will send an important signal to the market about the state's commitment to building electrification as a key pathway to achieve energy and carbon goals, and bolster NYSERDA and utility efforts to develop robust initiatives to drive the market and support customer adoption of heat pumps.

NYSERDA. As the entity charged with market development, NYSERDA is engaged in a host of activities designed to drive the heat pump market in New York. NYSERDA is well-positioned to serve as the lead for tracking the state's progress toward a 30 TBtu statewide target for energy savings from heat pumps.

NYSERDA should also track progress toward key market transformation metrics, drawing on the data it already receives through HVAC market reports that have been conducted annually from

2013 to 2016.[28] Importantly, the market data includes non-program sales for ducted and ductless ASHPs and GSHPs, providing visibility into the entire New York market – not just installations that participate in NYSERDA or utility programs. The data covers both the residential and commercial markets, but does not currently distinguish cold-climate heat pumps or VRFs as separate product categories. The data contains the number of installations, as well as the distribution by capacity and efficiency. To encourage building electrification, all three numbers are valuable. The number of units and residential market share (percentage of households with a heat pump) indicate the pace and scale of the transition to heat pumps. The capacity of the heat pump serves as a metric for assessing the displaced fossil fuel, while the efficiency level measures the introduced electric load on the utility. Efficiency also tracks the improved performance of heat pump technology in delivering heat and cooling to building loads. The three modeled scenarios can be translated to capacity and average efficiency, by linking them to baseline and target capacities and efficiencies.

Table 3 provides an illustrative target framework for heat pump market transformation, based on the high growth scenario.

Table 3. Illustrative targets for heat pump market transformation.

	2016 Baseline	2025 Target	2030 Target
Statewide energy savings from heat pumps (TBtu)	0	30	85
Residential heat pump market share	2%[29]	25% of households have a heat pump	65% of households have a heat pump
Heat pump capacity, average installation (BTU/hr)	28,000	35,000	40,000
Heat pump efficiency (HSPF)	~9.5	14	15

Market transformation targets should encompass the entire heat pump market, including both ASHPs and GSHPs, rather than setting separate goals for the different technologies. That will allow the market to determine the optimal mix of ASHPs and GSHPs to achieve New York's energy efficiency and climate goals.

Utilities. Under REV, utilities are the entities charged with capturing energy efficiency and building electrification as system resources. As such, utilities are in the process of establishing performance targets and associated EAMs, often in the context of rate cases. Con Edison's rate case joint settlement, for example, proposed a hybrid of top-down outcome-based metrics and bottom-up program achievement-based EAMs.[30] The two program achievement-based EAMs are measured in GWh and system peak MW reductions from both an expanded efficiency program and a new "system peak reduction" program designed to reduce peak demand through load

[28] D&R Unitary HVAC Market Reports for 2013-2016 can be found here: https://www.nyserda.ny.gov/About/Publications/Program-Planning-Status-and-Evaluation-Reports/Evaluation-Contractor-Reports/2017-Reports. Raw data from the 2016 report can be found here: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2017ContractorReports/DR-Unitary-HVAC-Market-Report-2016.xlsx. This data can also be used to inform outcome-oriented utility incentives (described further below).
[29] Combined estimate for ASHP and GSHP from NYSERDA, 2017. Renewable Heating and Cooling Policy Framework. https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.
[30] Con Edison, 2016. *Joint Proposal.* CASE 16-E-006. September 19. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={178701AD-5B92-4D0C-833B-22C37DE32065}

shifting, demand response, storage, and electric vehicles. Con Edison also proposed three new outcome-based EAMs that encourage investment in market transformation activities, as measured through top-down, outcome-oriented targets: energy intensity (kWh usage per customer or employee), customer load factor, and distributed energy resource (DER) utilization.

Building electrification may contribute to achievement of some of Con Edison's EAM targets, such as system peak reduction and improved customer load factor. However, other Con Edison EAMs focus exclusively on GWh reductions from efficiency programs and improved energy intensity, as measured in kWh. This presents a challenge in the context of beneficial electrification that increases electricity usage.

As an outcome of its most recent rate case, National Grid won NY Public Service Commission approval for one gas EAM and four electric EAMs. One of the earnings categories is "Carbon Reduction," which can be met by beneficial electrification and is measured in terms of its relative contribution to total avoided CO2. If National Grid meets its maximum targets, it will receive a positive revenue adjustment, up to $68M over three years. At the time of writing this report, Central Hudson Gas and Electric had requested clarification and a rehearing on its EAMs.[31] We expect to see other EAM proposals as additional utilities file rate cases.

Utilities can encourage heat pump adoption by incorporating the following elements as they develop their energy efficiency and electrification portfolios and associated EAMs:

- **Coordinated delivery of programs** promoting energy efficiency, behind-the-meter DERs (e.g., load shifting, demand response, and customer-sited storage), and electrification programs for both buildings and vehicles. Program silos that separate electrification from energy efficiency may lead to market confusion and inefficiencies, as well as missed opportunities to right-size renewable energy systems and include controls with equipment installations.[32]
- **Demand flexibility,** or load shifting, is a key ingredient to reducing GHG emissions with heat pumps. Using controls to pre-heat and pre-cool can significantly reduce emissions by shifting load from grid peak (high marginal emissions factors from peaker plants) to off-peak (increasingly likely to be solar and wind).[33]
- **Savings methodologies that count *all* the savings** from heat pump installations, including displaced fossil fuels from heat pump retrofits and electric savings from heat pumps installed for cooling. Savings methodologies should also account for increases in electricity usage from heat pump installations that involve fuel switching. Utilities should ensure their Benefit-Cost Analysis handbooks reflect the same approach to counting all savings.[34]

[31] Cases 17-E-0459, 17-G-0460 - Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Central Hudson Gas & Electric Corporation for Electric & Gas Service; Central Hudson Gas & Electric Corporation's Petition for Clarification and Rehearing

[32] Levin, E., 2018. "Getting from Here to There: How Efficiency Programs Can Go Beyond MWh Savings to Next-Generation Goals." Proceedings of the 2018 Summer Study of Energy Efficiency in Buildings. Washington, DC: ACEEE. http://aceee.org/files/proceedings/2018/node_modules/pdfjs-dist-viewer-min/build/minified/web/viewer.html?file=../../../../../assets/attachments/0194_0286_000100.pdf .

[33] Delforge, P. and J. Vukovich, 2018. "Can Heat Pump Water Heaters Teach the California Duck to Fly?" Proceedings of the 2018 Summer Study of Energy Efficiency in Buildings. Washington, DC: ACEEE. http://aceee.org/files/proceedings/2018/node_modules/pdfjs-dist-viewer-min/build/minified/web/viewer.html?file=../../../../../assets/attachments/0194_0286_000088.pdf.

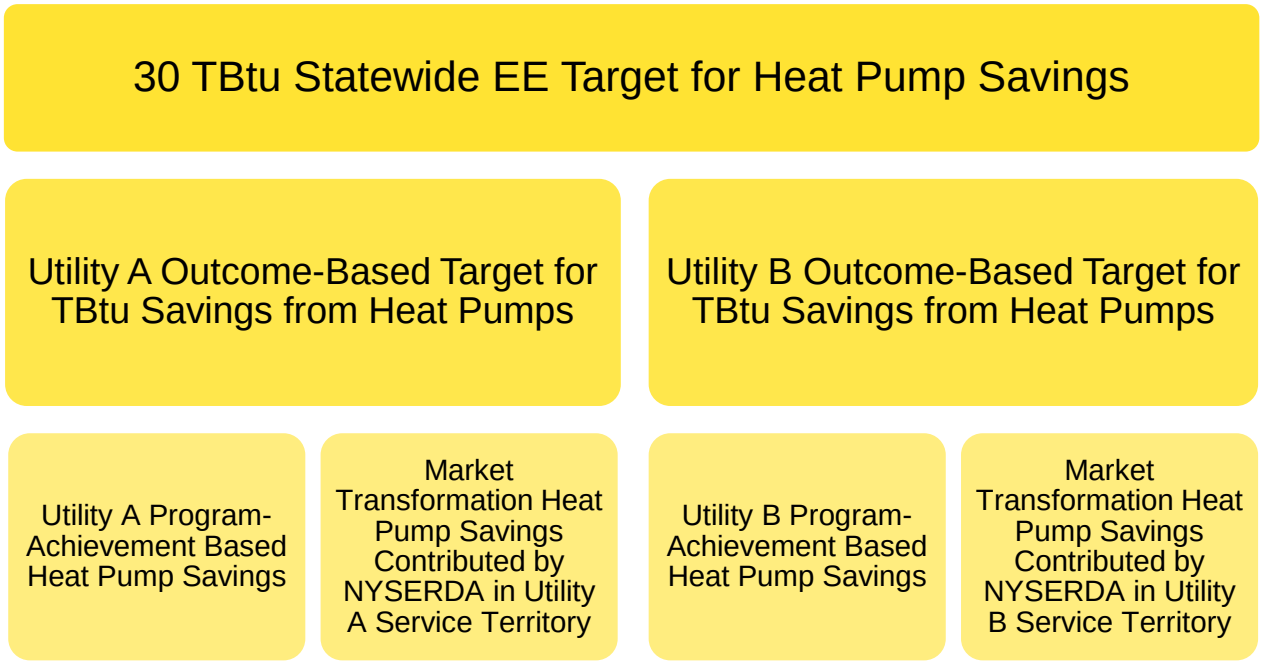
[34] Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework (issued January 21, 2016) (BCA Order).

- **Ambitious goals for utility energy savings in the form of TBtu savings from all fuels,** including unregulated fuels, in addition to existing targets for electricity (GWh) and natural gas (therm) savings from regulated fuels.[35] Establishing "total energy" savings targets will help to align utility program delivery with the 2025 energy efficiency target. New total energy savings goals should complement, not replace, existing targets focused on peak demand reduction and electricity savings as a percentage of annual retail sales.
- **Adjustments to existing outcome-oriented EAMs to account for beneficial electrification.** For example, Con Edison's energy intensity EAM, can be updated by adjusting kWh usage measurements for beneficial electrification using NYSERDA heat pump adoption data, so that utilities are not penalized for encouraging electrification.
- **Explicit sub-targets and associated EAMs for both program-based and outcome-based total energy savings from heat pumps.** Utilities should work closely with NYSERDA to determine each utility's share of the statewide, outcome-based total energy target for savings from heat pump installations. Utilities should consider adding a new outcome-based EAM for TBtu savings from heat pumps. This EAM would encompass program-based savings from heat pump installations, as well as market transformation savings from NYSERDA initiatives in the utility's service territory. Collectively, the utility outcome-based EAM would roll up to the 30 TBtu statewide target.
- **Interim total energy savings targets that put each utility on a trajectory to achieve the 2025 efficiency goals.** Utilities should establish annual savings targets for 2019-2025 to encourage a rapid ramp-up of energy efficiency and building electrification programs.

Figure 1 illustrates how utility program achievement-based and outcome-based targets could add up to a statewide target for TBtu savings from heat pumps. While Figure 1 shows this framework for just two utilities for simplicity, in reality, all the investor-owned electric and gas utilities in New York State would be responsible for a share of the statewide target.

[35] As buildings are electrified, some recommend setting total energy goals in units of KWh rather than Btu. New York should consider shifting its efficiency goals to total energy KWh over time. For the purposes of this report, we recommend Btu goals for consistency with the 185 TBtu energy efficiency target.

Figure 1. Illustrative Framework for Statewide and Utility Heat Pump Savings Targets



NYSERDA and Utility Program Coordination

Clarifying and streamlining the role of utilities and NYSERDA will help provide consistent market signals and drive heat pump adoption. It should be clear to manufacturers, distributors, contractors, and end-users which entity is responsible for which part of the market.

As previously noted, New York's current landscape for heat pump programs confuses the market, with inconsistent utility offerings and incentive designs. Further, when utilities do offer incentives for heat pumps, they are relatively low. While in most cases the utilities offer incentives in the form of downstream rebates for commercial and residential customers, Con Edison has recently shifted to a midstream incentive design for residential customers that pays incentives to distributors, who then pass through at least 50 percent of the incentive to contractors. Upstream and midstream incentive designs typically involve a high level of engagement with the supply channel, creating the potential for overlap between Con Edison's efforts and NYSERDA's market development activities and midstream contractor incentives.

A recent report on driving the regional heat pump market found that most successful programs combine two implementation elements: (1) midstream program design and supply channel engagement, to move the market and support marketing and training; and (2) significant incentives (at least $500 per unit for ductless mini-splits).[36] The most successful midstream program designs include a set customer incentive that is applied as an instant discount via wholesale distributors, combined with an administrative fee on a per-unit basis to distributors and/or contractors to cover the time they spent on program data reporting and training contractors on installation of the high-efficiency equipment. Based on this experience, we suggest the following program elements to incorporate these best practices into NYSERDA's heat pump offerings and align utility and NYSERDA offerings.

[36] NRDC and VEIC, *Driving the Heat Pump Market.*

- **Statewide umbrella initiative for market consistency.** NEEA's heat pump market development program, GoingDuctless.com, offers a good model for New York.[37] Under this model, one entity would serve as a central portal to provide: 1) upstream program administration; 2) standard administrative fees for distributors and, if needed, incentives for installation contractors; 3) consistent training requirements for participating contractors across New York; 4) consistent equipment performance standards to drive scale and efficiency, building on the Northeast Energy Efficiency Partnerships (NEEP) specification for cold climate heat pumps;[38] 5) engagement with manufacturers, distributors, and contractors around marketing and sales campaigns and strategies; and 6) data collection, particularly distributor sales data, rebate tracking data, utility surveys, and installer surveys. Given its responsibilities for statewide market development, NYSERDA is the logical choice to play the upstream and midstream role of intervening to accelerate adoption of heat pumps in the market. Under this model, the utilities would continue provide the direct interface with customers and provide incentive payments to customers.
- **Centralized structure for coordination on energy efficiency and electrification goals and programs.** Building on New York's previous experience with a centralized advisory group that supported implementation of the Energy Efficiency Portfolio Standard (EEPS), a similar structure should be established to facilitate statewide coordination on target-setting, budgets, and program implementation. The structure should focus on target setting, as well as high-level alignment of goals and core program designs, while still allowing utilities the flexibility to innovate and test new models.
- **Utilities as the lead for end-use customer engagement and incentives.** Following the Going Ductless model, individual New York utilities would be able to co-brand and determine appropriate incentive levels for qualified equipment. NYSERDA could administer an upstream program for heat pumps and incorporate the utility incentives as a 100% pass-through to customers. This represents a change from the Con Edison residential incentive design, in which distributors have the discretion to pass a portion of the incentive to the installation contractor. Our research indicates that 100% pass-through of the customer incentive in the form of an instant discount is most effective. According to a recent NEEA market evaluation, first cost was identified as a primary barrier to heat pump adoption, and paying incentives only to distributors and contractors does not address this barrier.[39] Additionally, allowing distributor discretion introduces an unnecessary element of risk in which contractors can get different deals from different distributors. Market actors highly value consistency in program design and incentive offerings. NYSERDA's coordinating role can provide this market consistency and streamline market engagement, while still allowing utilities to co-brand and market heat pump offerings to customers and set incentive levels within their budget.
- **Robust incentives.** Research indicates that customer incentives of at least $500 per unit for residential heat pumps are most-effective to jumpstart the market. New York utilities that do not currently offer residential incentives for heat pumps should introduce them, and utilities that currently incentivize residential ASHPs should increase incentives above the current $100-$250 level. In addition to customer incentives funded by the utilities,

[37] NEEA. *Going Ductless*. https://goingductless.com/.
[38] Currently, New York utilities appear to be using different performance criteria for heat pumps and do not consistently require the NEEP specification.
[39] Lee, Lobkowicz, Wang, Ratcliffe, Horkitz. And Chrzan. 2017. "Northwest Ductless Heat Pump Initiative: Market Progress Evaluation Report 6." (NEEA Report E18-364.) Portland, Ore.: Cadmus Group for the Northwest Energy Efficiency Alliance. https://neea.org/img/uploads/northwest-ductless-heat-pump-initiative-market-progress-evaluation-report-6.pdf.

NYSERDA should provide a distributor administrative fee and, if still needed to drive the market, an ongoing contractor incentive. Utilities should also be encouraged to offer higher incentives for heat pumps that are installed with control capabilities to support load shifting and peak demand reduction.

- **Extra support for low-income customers and communities.** A critical component of NYSERDA's responsibilities is ensuring that low and moderate-income (LMI) customers can benefit from the clean energy transition. NYSERDA should continue its efforts to reach underserved communities through its Clean Heating and Cooling community program, and explore the possibility of offering enhanced heat pump incentives for LMI customers.
- **Integrated financing.** Utilities should be encouraged to partner with the New York Green Bank as well as NYSERDA's financing options: the On-Bill Recovery Loan and the Smart Energy Loan. NYSERDA should ensure that these financing vehicles are available to support all types of residential heat pumps (it appears that only GSHPs are currently eligible). It should continue to offer enhanced financing options for LMI customers.
- **Robust budgets dedicated to building electrification**. Under REV, NYSERDA and utilities have different funding sources and mechanisms, and some utilities are transitioning to a new approach to fund efficiency and DER programs through rate cases, rather than system benefit charges. Regardless of the funding mechanism, it will be important to fund building electrification programs at a level commensurate to their contribution to the state's efficiency and climate goals. At a high level, building electrification is projected to contribute approximately 17% of the 185 TBtu energy savings target by 2025. A reasonable starting point, therefore, may be to dedicate approximately 17% of the total funding for energy efficiency programs in New York (across all utilities plus NYSERDA) to building electrification. Providing long-term guidance to utilities about the rough size of the anticipated funding stream for building electrification programs will help utilities to design programs to scale year over year, while simultaneously encouraging long-term investment from private market actors.

Electric and Gas Program Coordination

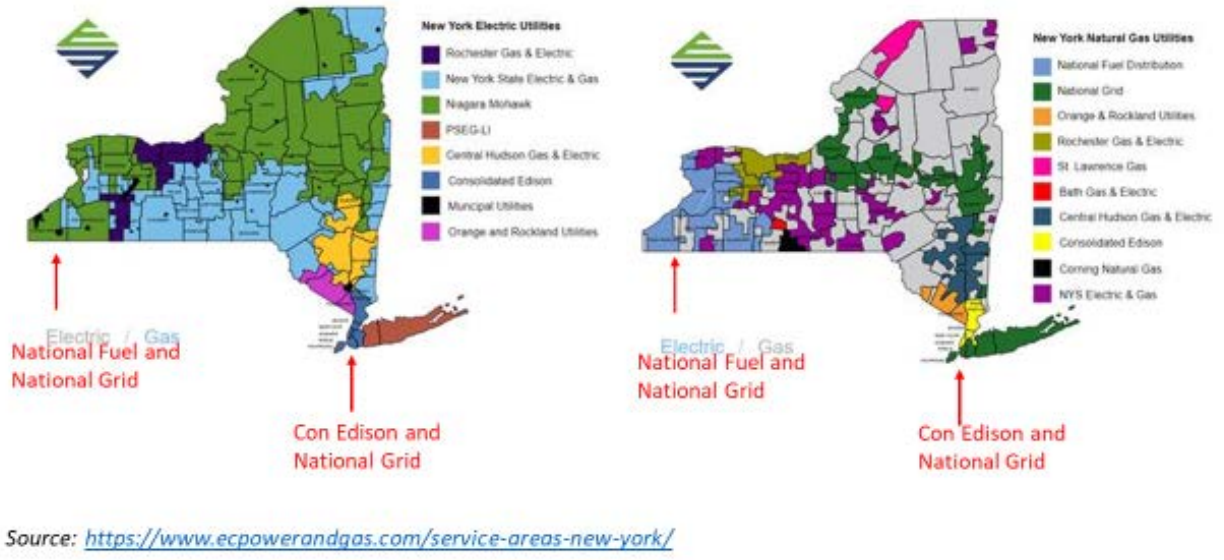
New York regulators have already begun the shift towards addressing efficiency on a comprehensive basis. By setting statewide efficiency targets on a TBtu basis, the "New Efficiency: New York" plan puts includes savings from electricity, natural gas, and unregulated fuels. While the new goal is inclusive of all end-use energy consumption, utilities have not yet made this shift in their energy efficiency targets and programs. All of New York's investor-owned electric utilities also provide natural gas service, plus there are several gas-only utilities. Many of the utilities offer incentives for natural gas heating equipment in addition to heat pumps. Unlike many other states, efficiency programs in New York do not appear to have program rules in place that explicitly discourage fuel switching. This absence of a common barrier created by program designs is helpful. Additionally, the fact that many utilities provide both electric and gas service means that, in general, they may view building electrification as an opportunity rather than a threat to their core business.

These are important advantages, but New York faces some challenges as well. The fact that many service territories, including New York City, are served by different utilities for electric and gas creates program coordination challenges and makes it more complicated to establish total energy savings goals for each utility. Regulators and utilities should consider additional steps to evolve the natural gas efficiency programs in the context of building electrification:

- **Phase out conversions from unregulated fuels to natural gas.** Several utilities offer substantial incentives for natural gas conversions, while others emphasize rebates for natural gas equipment rather than heat pumps. Natural gas conversion programs should be revisited in the context of the state's carbon goals, and in all or most cases phased out in favor of fuel switching programs that promote a switch to heat pumps, administered by the service territory's electric utility. New York's regulatory structure should encourage electric and gas utilities to work together on this phase-out process.
- **Incentivize hybrid heat pumps.** Gas utilities should begin offering incentives to promote hybrid heat pumps as an option for natural gas-heated homes with central air conditioning.
- **Promote all-electric heating equipment in new construction.** High-efficiency new homes with tight, well-insulated building envelopes can rely on heat pumps for heating and cooling without needing backup heating systems – even in cold climates like upstate New York. Ensuring that new construction programs and building energy codes encourage or require all-electric new construction will help New York accelerate the transition to the homes of the future, and avoid locking homeowners into fossil fuels for the long-term.
- **Promote fuel switching in gas utility service territories with capacity constraints.** Con Edison has recognized that due to a growing shortfall of peak gas day pipeline capacity, the company will either need additional pipeline capacity or find another way to balance supply and demand on its natural gas system. To address this, Con Edison is seeking innovative partnerships to convert natural gas customers to heat pumps.[40]
- **Develop methods to adjust utility targets and EAMs for overlapping electric-gas service territories.** As shown in Figure 2, electric and gas service territories overlap in several regions of the state. In general, utilities should coordinate on program design so they do not duplicate customer incentives for heat pumps, and whichever utility is providing the incentive should claim the program achievement-based savings. Outcome-based targets are more complicated. One option is to assign outcome-based targets for electrification only to the electric utilities. Another is to make adjustments to account for the electric utility's program-related savings caused by the natural gas utility serving the area, and vice versa. This is simpler than using oil and gas usage forecasts and measurements within the utility service territory, because those numbers would have to be adjusted for the many non-utility related uses of those fuels.

[40] Con Edison, Gas Innovation Program, Business Innovation to Accelerate Renewable Thermal Adoption, RFI. https://www.coned.com/-/media/files/coned/documents/business-partners/business-opportunities/clean-thermal/request-for-information.pdf?la=en

Figure 2. New York's Overlapping Electric and Gas Service Territories



Source: https://www.ecpowerandgas.com/service-areas-new-york/

State and Local Building Codes

As noted in NYSERDA's "Renewable Heating and Cooling Policy Framework,"[41] state and local building codes may be a missed opportunity to promote heat pump technology. The Framework recommends integrating renewable heating and cooling into both the Build Smart NY initiative and New York State's Stretch Code for new construction and existing building retrofits. While this report supports using building codes to support heat pump adoption. However, advancing heat pumps through building codes can be a challenge given federal preemption rules.

Like most states, New York adopts the International Energy Conservation Code (IECC). The IECC is subject to federal preemption rules that prohibit the IECC from specifying minimum mechanical system and consumer product efficiencies above the minimum federal standard. Equipment and products covered under the federal preemption provision are generally known as "covered products." Studies have estimated that up to 80 percent of energy consumption in residential buildings is attributed to covered products and thus outside the purview of local building energy codes, including HVAC and water heating equipment.[42] The inability for building energy codes to prescribe high-efficiency mechanical equipment makes it difficult to encourage high-efficiency or zero energy building practices through the prescriptive compliance path of the IECC, as well as inclusion of high-efficiency electric heating and hot water systems such as ASHPs. However, some states and jurisdictions are successfully working around this limitation by adopting local amendments to the standard IECC. Local amendment options include:

- Limiting the compliance options to only a performance-based path, which enables builders to choose what combination of envelope and mechanical equipment efficiencies meet the compliance requirement;

[41] NYSERDA, 2017, "Renewable Heating and Cooling Policy Framework." https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf

[42] Alex Chase et al, Federal Appliance Standards Should be the Floor, Not the Ceiling: Strategies for Innovative State Codes & Standards, (ACEEE 2012)

- Developing multiple prescriptive paths that include options for higher mechanical efficiencies, while maintaining at least one package that utilizes the federal minimum standard; or
- Including an additional high-efficiency "options" package from which builders must choose a minimum number of additional efficiency requirements. These options include high-efficiency mechanical systems, but because any given option is not required, but voluntary, the Options package approach is not restricted by federal preemption rules.

NYSERDA's proposed stretch code uses the third path, inclusion of a high-efficiency options package.[43] Section R407, Additional Energy Efficiency Credits, requires buildings to achieve a certain number of credits to comply with the code. Credits may be obtained from a high efficiency building shell, mechanical equipment, and/or renewable energy options. While the proposed NY Stretch code does not directly require heat pump technology, the intent is to incorporate the technology into the code in a manner that does not trigger federal preemption, but encourages builders to consider higher efficiency mechanical systems.

Vermont expects to take a similar approach with its base and stretch codes to be adopted in 2019. Vermont stakeholders intend to assign higher points to heat pump technology over high efficiency fossil fuel systems to further encourage adoption of that technology. Massachusetts stretch code, in contrast, uses the first approach, limiting code compliance to a performance-based path. Compliance with the MA stretch code is achieved by meeting a set performance threshold such as ENERGY STAR, Passive House, or a minimum HERS Index. Using this option, heat pump technology is not directly encouraged or discouraged, but builders may opt to select that technology as the best means of meeting the given performance threshold without triggering federal preemption.

Market Development Strategies

NYSERDA currently leads myriad market development strategies for both emerging and proven heat pump technologies, outlined in documents such as the 2017 Renewable Heating and Cooling Policy Framework[44] and the Renewable Heating & Cooling Chapter of the Clean Energy Fund (CEF) Investment Plan (2017).[45] These efforts should continue and expand to meet the state's heat pump targets.

Heat pumps have been used for decades to efficiently heat and cool homes in moderate climates in the United States and cold climates abroad. Recent technological advances have made them an attractive and cost-effective option in cold climates, and ASHPs are rapidly growing in popularity. The most popular type of ASHP, ductless mini-splits, are likely to be the most common heat pump technology in New York. In heat pump potential studies, ASHPs have been found to be more cost-effective than GSHPs for all applications.[46]

[43] NYSERDA, 2018 Draft NYStretch Code-Energy. https://www.nyserda.ny.gov/-/media/Files/Programs/energy-code-training/Draft-NYStretch-Code-Energy-2018.pdf
[44] NYSERDA, 2017, "Renewable Heating and Cooling Policy Framework." https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf
[45] NYSERDA, 2017. "Clean Energy Fund Investment Plan: Renewable Heating & Cooling Chapter." https://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/cef-renewable-heating-and-cooling-chapter.pdf.
[46] New York State Energy Research and Development Authority, 2015. Heat Pumps Potential for Energy Savings in New York State. Original release date, July 2014. Report No. 14-39. https://www.nyserda.ny.gov/-/media/Files/EDPPP/Energy-Prices/Current-Outlook/Presentations/Heat-Pumps-Potential.pdf.

According to the CEF Investment Plan for Renewable Heating and Cooling, conventional HVAC installers and project developers are developing solid understanding and experience with ASHPs. For proven technologies like ASHPs, an upstream umbrella initiative that builds on NYSERDA's market development initiatives would advance the market by creating a standard, statewide approach to program design, supply channel engagement, and contractor and customer training. Specific focus areas for further ASHP market development include:

- **Build cross-industry links with** the electrical wholesale supply channel and **electricians** (as done with solar) to increase the value opportunity for a growing workforce.
- **Adopt the NEEP Cold Climate Heat Pump Specification** to promote high efficiency heat pumps, consistently with other states in the region like Maine and Vermont. Nearly half of the ASHPs installed in New York State in 2016 had an HSPF high enough to qualify, and there is opportunity to increase that significantly.
- Work with heat pump and thermostat manufacturers to **develop and integrate control capabilities**, to ensure that building electrification does not result in increased peak demand.

While ASHPs are currently the most common technology, New York should also explore and promote heat pump technologies and applications that are less established in the state. For example, the CEF Investment Plan notes that HVAC installers and project developers largely lack experience and technical expertise to evaluate feasibility and execute projects involving GSHPs and VRFs.

VRFs are not currently promoted by NYSERDA, but VRFs excel in serving buildings requiring "comfort cooling" (e.g. offices, multifamily) and have enormous potential to reduce energy use in New York City. Continued efforts are needed to reduce the soft and upfront costs of GSHPs, which provide highly efficient cooling and heating and can contribute to peak load reductions (GSHPs exhaust heat to the absorbent, cool ground as opposed to hot outdoor air).[47] NYSERDA should consider the following steps to support emerging heat pump technologies and applications:

- **Develop VRF case studies and marketing materials.** NYSERDA can help to educate the commercial building market on the improved performance characteristics of VRFs and best practices for meeting building standards. Case studies, testimonials, and marketing materials are needed to counter misconceptions and raise awareness. Case studies and examples should address a variety of applications, given the wide variation in climate and building stock between upstate New York and the New York City metro region.
- **Aggressively promote VRFs in commercial and residential new construction and building codes,** consistent with an overarching strategy to encourage all-electric heating equipment in new construction.
- **Evaluate and support accelerated transition of heat pumps to lower global warming potential (GWP) refrigerants.** Although not unique to heat pumps, risk of refrigerant leaks could reduce the significant climate benefits of the technology. Developing a multi-faceted approach to mitigating refrigerant leaks includes support for proper design and installation practices, compliance with existing refrigerant safety standards, and advancement of natural refrigerants to replace use of higher GWP refrigerants.
- **Explore distributor incentives for VRF technology.** As previously discussed, upstream and midstream program approaches that engage wholesale distributors are effective

[47] Heat & Cool: Heat Pump Systems, https://www.energy.gov/energysaver/heat-and-cool/heat-pump-systems

because the distributors control stocking and upselling and directly engage and train contractors, mechanical engineers, and architects.

- **Develop regional standards for VRFs in the Northeast.** New York stakeholders should work with NEEP to develop a regional performance specification to promote the highest efficiency VRFs, while supporting a diverse mix of technologies and manufacturers.
- **Review building code barriers to VRF technology.** Recent IECC 2015 code adoption has inadvertently increased costs for VRF applications with requirements for economizers. NYSERDA and state should review building codes to avoid creating barriers or unnecessary costs for new heat pump technologies.
- **Consider creating a VRF "Clean Energy Challenge"** as NYPA and NYSERDA did for GSHP technology, to encourage state buildings to "lead by example" in adopting VRFs.[48]
- **Accelerate NYSERDA's soft cost reduction strategy for GSHPs** and maximize the proposed targeted cost-shared technical assistance for larger projects to address the higher pre-development costs.[49]
- **Develop and fund demonstration projects** that explore the potential for GSHPs to promote grid flexibility, such as improved load factor or peak demand reduction.

[48] NYPA. https://www.nypa.gov/about/geothermalchallenge.
[49] NYSERDA, 2017. "Clean Energy Fund Investment Plan: Renewable Heating & Cooling Chapter." https://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/cef-renewable-heating-and-cooling-chapter.pdf.

Appendix A: 2018 Heat Pump Incentives Offered by New York Utilities

Definitions. *EER* is energy efficiency ratio, the relationship between cooling capacity in Btu and required power input in Watts. The higher the number, the greater the efficiency. *Tiers* refer to relative efficiency, as determined by the Consortium for Energy Efficiency and ENERGY STAR®. The higher the tier number, the more efficient the appliance. Tier designations help utility programs establish rebate and incentive levels. *SEER* refers to seasonal energy efficiency ratio; and *HSPF* refers to heating seasonal performance factor, the primary metric for measuring the efficiency of air source heat pumps. The higher the number, the more energy efficient it is.

Product	Rebate or incentive	HSPF	SEER	EER	Comments
CENTRAL HUDSON GAS & ELECTRIC					
Air source heat pumps – residential					Eligible sectors: Residential, Low-Income
Tier 1	$350	≥ 8.5	> 15	> 12	
Tier 2	$500	≥ 9.0	> 16	≥ 13	
Electronically commutated motor	$200				Must be installed on heat pump
Air source heat pumps - commercial					Eligible sectors: Commercial, Industrial
< 5.42 tons	$125 / ton	≥ 8.5	≥ 15	≥ 12	
≥ 5.42 tons, and < 11.25 tons	$75 / ton			≥ 12	≥ 12.4 IEER, and ≥ 3.4 COP
≥ 11.25 tons, and < 20 tons	$75 / ton			≥ 12	≥ 12.4 IEER, and ≥ 3.4 COP
≥ 20 tons, and < 63.3 tons	$75 / ton			≥ 10.9	≥ 12.0 IEER, and ≥ 3.4 COP
≥ 63.3 tons	$60 / ton			≥ 10.5	≥ 11.0 IEER, and ≥ 3.3 COP
CON EDISON					
Central air source heat pump					Eligible sectors: Residential Single-Family and Multifamily, Small Commercial
Tier 1	$100 / ton	≥ 9	≥ 18	≥ 13	
Tier 2	$150 / ton	≥ 9	≥ 20	≥ 13	
Ductless mini-split heat pump					
Tier 1	$200 / ton	≥ 9	≥ 18	≥ 12	
Tier 2	$225 / ton	≥ 9	≥ 20	≥ 13	
NATIONAL GRID					
HVAC systems	Varies. See **Comments**				Eligible sector: Commercial, Industrial (Upstate NY only)

Product	Rebate or incentive	HSPF	SEER	EER	Comments
					Customized incentives for large C&I customers, with tiered incentives for completing 3, 4, and 5 projects. HVAC is one of the measures eligible for incentives and the tiered bonuses
NYSEG					
Air conditioner or heat pump < 20 tons					Eligible sectors: Commercial, Industrial, Local Government, Nonprofit, State Government, Federal Government, Tribal Government, Agricultural, Institutional
Tier 1	$80 / ton			11.5	
Tier 2	$100 / ton			12.0	
Air conditioner or heat pump, between 20 and 63 tons					
Tier 1	$50 / ton			10.5	
Tier 2	$90 / ton			12.0	
Air conditioner or heat pump ≥ 63 tons	$25 / ton			9.7	+ $5 / ton for each 0.1 EER above minimum qualifying EER
ORANGE & ROCKLAND					
Heat pumps					Eligible sectors: Commercial, Industrial, Local Government, Nonprofit, Schools, State Government, Federal Government, Multifamily Residential, Institutional
< 5.4 tons	$25 / ton			14.0	
5.4 to < 11.25 tons	$25 / ton			10.8	
≥ 11.25 to < 20 tons	$25 / ton			10.4	
≥ 20 tons	$25 / ton			9.3	
PSEG LONG ISLAND					
Air source heat pumps					Eligible sectors: Construction, Residential, Installers / Contractors, Multifamily Residential, Low-Income Residential
Tier 1	$350 / system	≥ 8.5	≥ 15		
Tier 2	$450 / system	≥ 8.5	≥ 16		
Ductless mini-split heat pumps					
Tier 3	$250 / system	≥ 8.5	≥ 18		
Ground source heat pumps					Many specifications (not presented here) about water to air, water to

Product	Rebate or incentive	HSPF	SEER	EER	Comments
					water, for closed- and open-loop systems. Using DGX as an exemplar.
Tier 1: DGX	$1,000 / ton (new) $500 / ton (retrofit)			≥ 16 and ≤ 21	COP ≥ 3.6
Tier 2: DGX	$2,000 / ton (new) $700 / ton (retrofit)				Higher across all types. COP ≥ 4.0
ROCHESTER GAS & ELECTRIC					
Air conditioners or heat pumps ≥ 5.4 to 20 tons					Eligible sectors: Commercial, Industrial, Local Government, Nonprofit, State Government, Federal Government, Tribal Government, Agricultural, Institutional
Tier I	$80 / ton			11.5	
Tier II	$100 / ton			12.0	
Air conditioner or heat pump ≥ 20 tons and < 63 tons					
Tier I	$ 50 / ton			10.5	
Tier II	$90 / ton			10.8	
Air conditioner, heat pump ≥ 63 tons and < 300 tons	$25 / ton			9.7	+ $5 / ton for each 0.1 EER above minimum qualifying EER

Sources for Utility Incentives

Central Hudson
Residential: http://www.savingscentral.com/pdf/rebate_electricgas_residential.pdf
Commercial: http://www.savingscentral.com/pdf/rebate-eligibility-prescriptive.pdf

Con Edison
Commercial: https://www.coned.com/-/media/files/coned/documents/save-energy-money/rebates-incentives-tax-credits/rebates-incentives-tax-credits-for-commercial-industrial-buildings-customers/hvac-program-guidelines.pdf?la=en

National Grid
Commercial: https://www.nationalgridus.com/media/pdfs/bus-ways-to-save/ee7151-uny-tiered-incentive-program.pdf.

NYSEG
Commercial:
http://nyseg.com/MediaLibrary/2/5/Content%20Management/Shared/UsageAndSafety/PDFs%20and%20Docs/NYSEG_RGE_CIRP_Electric_Non_Lighting_Application.pdf.

Orange & Rockland
Commercial: https://www.oru.com/-/media/files/oru/documents/saveenergyandmoney/incentives-and-rebates/commercial-and-industrial/prescriptive-hvac-measures.pdf?la=en.

PSEG Long Island
Residential: https://www.psegliny.com/saveenergyandmoney/energystarrebates.

Rochester Gas & Electric
Commercial:
http://rge.com/MediaLibrary/2/5/Content%20Management/Shared/UsageAndSafety/PDFs%20and%20Docs/NYSEG_RGE_CIRP_Electric_Non_Lighting_Application.pdf

Appendix B: Method for Estimating Energy and GHG Savings

For each year, we calculated cumulative installations from the running sum of annual installations. We then used the quantity to find the year's energy and emissions savings.

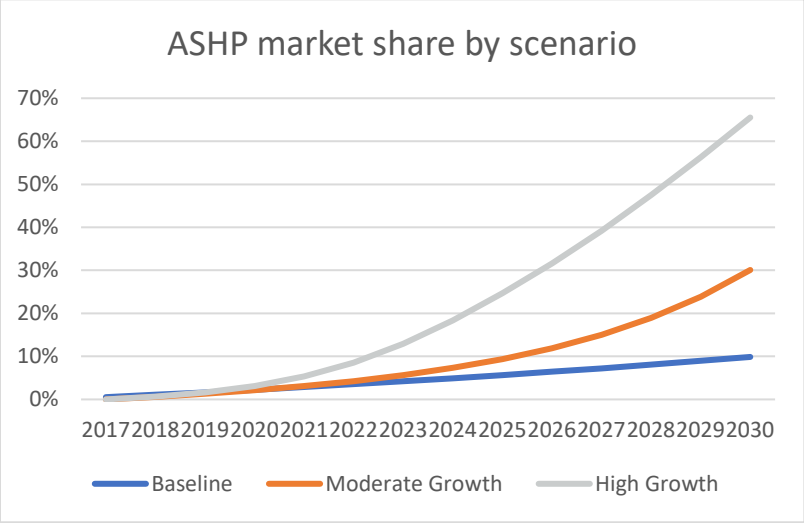
Cumulative fossil fuel savings (TBtu) = Cumulative units * Fuel savings per unit

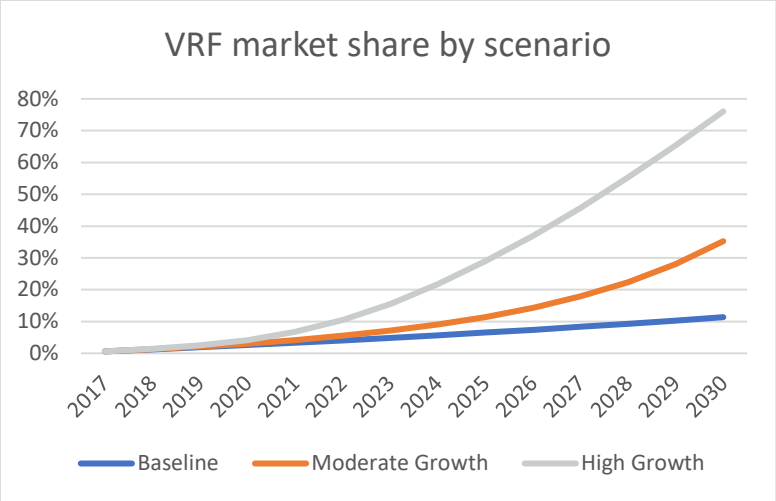
Electric consumption (MWh) = Cumulative units * (electric consumption per unit – electric savings per unit)

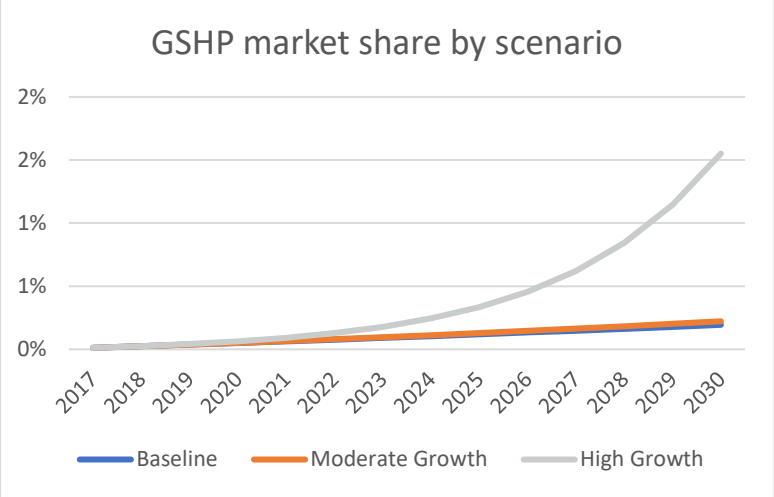
Net energy savings (TBtu) = Cumulative fossil fuel savings – (3.412/1000000) * Electric consumption

Growth Rates

Year	ASHP/VRF			GSHP		
	Baseline	Moderate	High	Baseline	Moderate	High
2017	4%	14%	20%	2%	4%	10%
2018	4%	15%	30%	2%	4%	15%
2019	4%	16%	40%	2%	4%	20%
2020	4%	17%	50%	2%	4%	25%
2021	4%	18%	55%	2%	4%	30%
2022	4%	19%	45%	2%	4%	35%
2023	4%	20%	35%	2%	4%	35%
2024	4%	21%	25%	2%	4%	35%
2025	4%	22%	15%	2%	4%	35%
2026	4%	23%	10%	2%	4%	35%
2027	4%	24%	10%	2%	4%	35%
2028	4%	25%	10%	2%	4%	35%
2029	4%	26%	5%	2%	4%	35%
2030	4%	27%	5%	2%	4%	35%







Fuel Savings Per Unit

Tech	Units	Fuel savings per unit (MMBtu)	Source
ASHP	Average household system	20	Estimate based on fuel switch measures in RI and VT, similar to MA EEAC Ductless Mini-Split Heat Pump Impact Evaluation's top 25% - assuming that installer and customer knowledge will improve and people will get more savings
GSHP	Average household system	90	Assumed to replace all heating and cooling in larger homes/businesses with more balanced heating/cooling
VRF	Square foot of HVAC	0.0214	Adapted from VEIC VRF research for NYSERDA May 2018

Electric Consumption Per Unit

Tech	Units	Fuel savings per unit (kWh)	Source
ASHP	Average household system	2,093 heating	Fuel savings converted to kWh use using 2.8 annual COP, 2000 is estimated from VT study, and similar to MA EEAC Ductless Mini-Split Heat Pump Impact Evaluation
		0 cooling	<400 kWh of annual cooling in MA EEAC Ductless Mini-Split Heat Pump Impact Evaluation is less than the savings for people who already had cooling
GSHP	Average household system	6,593 heating	Fuel savings in kWh using 4 annual COP
		-332 cooling (savings)	Assuming GSHP is twice as efficient as baseline cooling energy from MA EEAC Ductless Mini-Split Heat Pump Impact Evaluation, GSHPs assumed to be installed only in spaces that would otherwise have CAC
VRF	Square foot of HVAC	-327 cooling (savings)	Adapted from VEIC VRF research for NYSERDA May 2018

Emissions

Emissions Factors

Fuel	Factor	Units	Source
Oil	74	kg CO2/MMBtu	EPA
Electricity today	466	lbs CO2e/MWh	eGrid 2016 for NY state
Electricity 2030	273	lbs CO2e/MWh	Using numbers from 2018 Power Trends discussion of CES to estimate RE% today that gives today's emissions factor, and what emissions would be with 50% RE

For the years between 2018 and 2030, we used linear interpolation to estimate the annual emissions factor for the New York grid with continually growing renewable generation.

1990 GHG emissions

Used as the baseline to calculate contribution to the 40% reduction by 2030:

212,870,000 tons CO2e

Energy related emissions, Table S-2, https://energyplan.ny.gov/-/media/nysenergyplan/final/greenhouse-gas-inventory