

The Future of Heating and Cooling New England

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Introduction

The New England Municipal Sustainability Network, or NEMS Network, is a group of 30 cities and towns across New England leading efforts towards long-term community viability in the face of climate change. Among many climate mitigation efforts, municipalities in New England seek cleaner alternatives for heating and cooling their buildings and homes. During the May 2017 NEMS Network annual meeting, municipal members identified air source heat pumps (ASHPs) as having this potential and therefore a topic area to explore further. This report examines current ASHP outreach campaign efforts across New England in order to inform NEMS Network strategies for ASHP dissemination as a viable strategy for reducing greenhouse gas emissions the future.

This report first provides background on what ASHPs are and why they have become a topic of interest in New England. The methodology section next outlines the interview and research process. Descriptions of each of the five case study municipalities follow. Themes that emerged from the interviews frame the section on recommendations and barriers to consider for ASHP deployment. The objective of this report is to function as a user's guide for the NEMS Network and other New England municipalities seeking advice for air source heat pump outreach campaigns.

Background

Air Source Heat Pumps

According to the Yale Center for Business and the Environment, renewable thermal technologies "harness renewable energy sources to provide heating and cooling services for space heating and cooling, domestic hot water, process heating, and cooking."ⁱⁱ Examples of renewable thermal technologies include: wood pellets, solar hot water, ground source heat pumps, and air source heat pumps.

An ASHP is called a *renewable* because it moves ambient air between its two units for heating instead of requiring combustion, like boilers and furnaces. Refrigerants in ASHPs draw heat from air outdoors and release it indoors in the winter. In the summer it acts in the reverse by pushing heat out to cool a building. Thus ASHPs are dual systems that provide residents with both heating and cooling comfort¹. Though ASHPs typically heat one room per unit, residents can install multi-head systems or larger systems that heat multiple zones^{xxiii}.

Ductless heat pumps were invented in Japan in the 1970s and have since become the most popular form of heating and cooling in many parts of Asia and Europe^{xxv}. Ninety percent of Japanese homes are heated by a heat pump as well as a quarter of homes in Norwayⁱⁱ. Ducted central heat pumps have been

¹ In this report, ASHPs are synonymous with "mini-split" or "ductless" heat pumps. Mini-split means that the system is split with one coil indoors and one outdoors. Ductless refers to the design only requiring a three inch hole for copper lines to connect the two units with refrigerant, power, and dehumidifying¹. See page 14-16 of the Northeast Energy Efficiency Partnership (NEEP) ASHP Report for a clear description of the terminology specifications: http://www.neep.org/sites/default/files/NEEP_ASHP_2016MTStrategy_Report_FINAL.pdf

sold in the United States for over twenty years, particularly in the southern states. New advances about a decade ago, have created more zonal heating products and those suitable for cold climates. Due to technical advances, heat pumps are now capable of heating in climates as cool as Northern Maine and Southern Alaska^{ii, xx}. ASHPs still lose efficiency as temperatures drop, however, and may require a backup heating system on days colder than -15 degrees Fahrenheit.

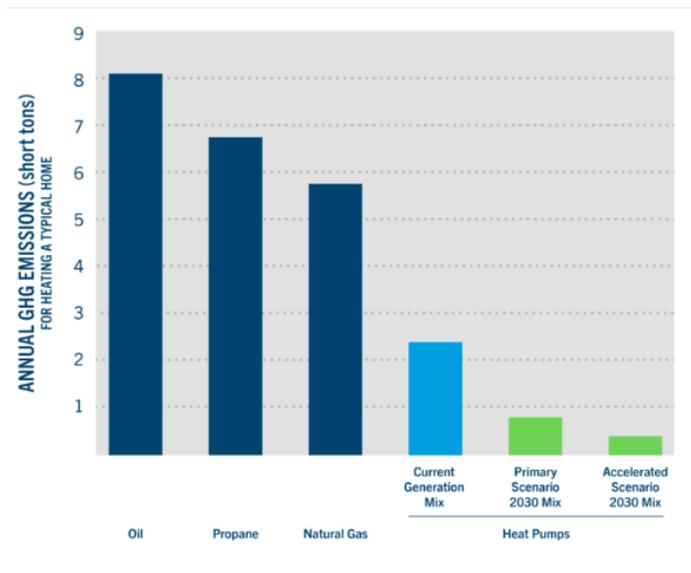
Environmental Case for Heat Pumps

In New England, one-third of greenhouse gas emissions come from thermal energyⁱⁱⁱ, and on average, about half of a residential building’s energy usage comes from heating. Heating and cooling are thus important issues for which to find cleaner solutions. Subsequently, a focus by the NEMS Network on disseminating ASHPs in the residential sector could be strategic and well positioned.

Heat pumps are more energy efficient than other conventional forms of heating and cooling, but still rely on the burning of fossil fuels for their electric supply. Renewable energy, however, can instead generate this needed load. The term “strategic electrification” refers to the process of running as much of society’s energy sources on electricity, so as to set up the infrastructure to switch the electrical supply to renewable energy.

Running ASHPs on renewable energy will lead to significant reductions of greenhouse gas emissions and aid with the transition to a low carbon economy. Furthermore, the implementation of heat pumps will diminish use of propane and oil for heating and especially the rapid rise of natural gas. All three fuel sources are considerable emitters of carbon dioxide and impediments to New England’s long-term climate mitigation goals^{vii} (Figure 1).

Figure 1. Comparison of Emissions from Heating Technologies. Source: Acadia Center Energy Vision 2030^{xxi}



Business Case for Heat Pumps

Air source heat pumps have garnered bipartisan support likely because they are easy to install, relatively cheap, and provide significant energy savings^{xxxi}. Typically, a single zone ASHP costs approximately \$4,000, with an average payback period of five years if a resident were previously using propane, kerosene, electric resistance heaters. ASHPs function at one third of the cost to electric resistance heaters^{xxv}. On top of this, residents can qualify for utility rebates. ASHPs support the local economy by employing regional HVAC installers and manufacturers.

In addition to cost savings, heat pumps offer comfort and flexibility. One can decide how many rooms they want to heat or cool in their home and at what temperatures. Only one system is needed for both heating and cooling tasks. Once installed, heat pumps last between 15 and 20 years.

Case Studies

Interest in ASHPs has grown since five of the NEMS Network municipalities were awarded a grant from the Carbon Neutral Cities Alliance to support pilot outreach efforts. The Carbon Neutral Cities Alliance (CNCA) is a global collaboration among cities that seek ambitious and long-term fossil fuel reduction goals^{xiv}. Leah Bamberger, the Sustainability Coordinator of Providence, Rhode Island, devised the idea to apply for an "innovation fund" through the Carbon Neutral Cities Alliance in order to bring thermal solutions to scale in New England. Boston, Massachusetts had to be the lead applicant because of its designation as a CNCA city. Boston and Providence then opened up the application to other NEMS Network members and Portland, Maine; Northampton, Massachusetts; and Somerville, Massachusetts joined.

Each of the five municipalities is both a member of the NEMS Network as well as the Urban Sustainability Directors Network, to which CNCA is an offshoot. The grant application was submitted in July 2016, and the project kicked off in September 2016. The grant continues until the funding's end in March 2018. This report uses these five pilot projects as its case studies for analyzing ASHP outreach programs in New England.

Methodology

Interviews were the main method of data collection, so as to convey the municipal and stakeholder perspective of ASHP deployment in New England. Institutional Review Board approval was obtained for the interview procedure and list of semi-structured qualitative questions. Each interview lasted about an hour.

The CNCA grant cities were selected as the research case studies. Though their ASHPs campaigns have not yet finished, they are some of the furthest along in New England and provide insight for future projects. The NEMS contact interviewees were: Leah Bamberger, the Providence Director of Sustainability; Benjamin Silverman, Boston Climate and Buildings and Program Manager; Oliver Sellers-Garcia, Somerville Director of Sustainability & Environment; Troy Moon, Portland Sustainability Coordinator; Julie Rosenbach, South Portland Sustainability Coordinator; and Chris Mason, Northampton Energy & Sustainability Officer.

Three of the five interviews were in-person at the municipal offices in Boston, Portland, and Somerville. The other two CNCA city interviews, with Providence and Northampton, occurred via a video call platform called Zoom. The only two-person interview was with the Sustainability Directors of Portland and South Portland, who are implementing a more regional approach.

In addition to the NEMS contacts, other stakeholders in the ASHP field were interviewed in order to gain a fuller understanding of different perspectives. They were: Jeremy Koo, a Consultant from Meister Consultants Group, closely involved in the CNCA grant programs; Helle Gronli, Associate Research Scientist at Yale University researching renewable thermal technologies in Connecticut; and Mathew Davis, University of New Hampshire Chair of Earth Sciences, researching the applicability of ground source heat pumps (GSHP) in the residential and commercial sector.

Lastly, the report's researchers attended the 2-day conference in Andover, Massachusetts entitled: "The 2017 Regional Cold-climate ASHP Market Transformation Workshop" hosted by the Northeast Energy Efficiency Partnerships, or NEEP^{viii}. The conference allowed conversations and presentations with manufacturers, installers, municipalities, state agencies and consultants, all in one space. Much of the information gleaned from these meetings is central to this report.

The eight interview recordings were transcribed in order to find common themes across them. Follow-up desk research was conducted to fill in gaps and flesh out background information on ASHPs and outreach efforts.

Outreach Campaigns

Before summarizing the case studies, it is important to articulate why an outreach campaign is even necessary and what the municipality's role is within one. The background section of the report demonstrates why a large-scale uptake of ASHPs is beneficial, both environmentally and economically. Though the heat pump technology is available, the information and ease needed to motivate a resident is still lacking. Municipalities, however, can be this intermediary between these products and their citizens to support the NEMS Network goals of cleaner heating and cooling. This sort of involvement requires some sort of outreach campaign. It may feel strange for local government to support the market integration of particular products. A municipality can inspire impartiality, however, if it focuses on transparency and thoroughness throughout the outreach process.

Despite differences in outreach strategies, each municipality went through a similar installer selection process using a Request for Proposal (RFP). RFPs are beneficial given two aspects of ASHP campaigns. 1. They occur in local areas where there is an untapped ASHP market, 2. They require technical expertise to ensure proper installation. Early in a procurement cycle, a municipality submits an RFP through its purchasing office. This opens up a competitive bidding process for potential installers to send in business proposals. The municipality then evaluates the proposals and chooses those that fit their desired qualifications, such as reliable installation reviews or a competitive price. RFPs alert vendors of a municipality's interest in ASHPs while also demonstrating the public sector's seriousness about quality and impartiality. Sometimes, and in the case for Somerville and Northampton, municipalities choose to submit a Request for Qualification (RFQ) before an RFP in order to gather a pool of potential installers and perform preliminary vetting.

Many of the municipal leaders we interviewed felt local governments' role was to inspire a sense of confidence in their community. A municipality, for example, can ensure that they are offering an ASHP product and installation that is reliable and effective to their residents. There are a lot of energy efficiency companies marketing to property owners. These companies and their services range from fair to worthless, reminds Sellers-Garcia, "I think our role is saying if you've been worried or confused about this, we have checked these people out and this is coming to you in a package of info that is a little simpler for you and answers questions^{vi}." Some municipalities considered their role to go further than providing reliability and awareness, but to supply citizens with lower cost renewable products. As ASHP campaigns gain momentum past the first municipal adopters, cities should consider their own theories of change relating to ASHP campaigns and how hands-on they want to be.

Case Study Summaries

When the Meister Consultants Group first started consulting the five municipalities through the CNCA grant funding, they started with lessons learned from a solarize campaign, whose basic tenants are: build a committee, select installers, launch the program, and provide outreach, imagining a similar "thermalize" or "HeatSmart" campaign. "Every time we worked with new partners and new communities, we learned more about what was going to be challenging about carrying this model over from solarize," explained Koo. "Over half of solar installation companies that have participated in Solarize campaigns in Massachusetts are national (like RGS Energy and Direct Energy) and have offices everywhere. There is nobody like that for the HVAC industry, it's all local. So if you don't have the supply chain for it, it might be tough^{iv}." Such limitations led the cities of Portland and Providence to opt for

more of a showcase strategy, while Somerville, Northampton, and Boston continued with the "HeatSmart" approach.

The showcase and heatsmart models have emerged from the case studies as two viable ASHP outreach strategies that provide ample information and resources to residents. They differ in their scope with the showcase model affecting those who attend ASHP events while the heatsmart model is more labor intensive and seeks to target existing community networks. Below is an overview of each program before delving into lessons learned.

Casco Bay Heat Pump Challenge: Maine

Portland, Maine saw the opportunity to stretch its collective impact into a regional effort and soon elicited the help of South Portland, Scarborough, and Falmouth, Maine. They arrived on the "[heat pump challenge](#)" idea in which Casco Bay cities would host a series of events about ASHPs with the goal of selling 1,000 heat pumps. The one-man Sustainability office in Portland did not feel as if it had the capacity to run a solarize-like campaign and wanted to partner with Efficiency Maine, an independent administrator of energy efficiency resources, as well as the Greater Portland Council of Governments to turn what might have been a Portland-specific effort into a regional program.

Efficiency Maine has helped facilitate 20,000 ASHP installations in Maine in the last 3 years, which is 3% of the state's building stock^{xix, xxx}. The state benefits from over 400 certified installers as well support from Governor LePage's administration. While the LePage administration has been critical of maintaining the state's incentives for other renewable energy technologies, ASHPs have not been similarly contentious, with the governor having installed heat pumps in the Blaine House in Augusta^{xxxi}. Casco Bay cities were thus able to step in and accelerate a market that is already gaining momentum from the state government and utility companies^x.

The participating Casco Bay cities chose five installers based on the quality their customer service and competitive price. They are: *Dyer Electric, Goggin Energy, Pine State Services, ReVision Energy, and ReVision Heat*^{xxxii}. For more information about Efficiency Maine's rebate options, see Appendix 1.

Portland held its first Heat Pump Challenge event in June 2017. The event included tables with vendors, rebate information from Efficiency Maine, tips from homeowners on best practices, and presentations about how heat pumps work^{xxxiii}. Both Moon and Rosenbach liked that the event was focused solely on heat pumps, instead of a larger energy fair. "The vendors were very appreciative that it was a heat pump only event. Instead of it being a huge energy fair, the people coming to your booth are clearly interested in heat pumps. So it helps from a business perspective and it helps to focus the event too" explained Moon. The only real difficulty, reflected Rosenbach, is getting people to the event location. "Once they do, the whole thing sells itself^{xix}." South Portland plans to host the second Challenge event in September 2017, and Falmouth and Scarborough both in October 2017.

In the future, Rosenbach and Moon hope to host one big yearly open house with the same publicity and attendance as Portland's popular annual Bike Swap. The first Heat Pump Challenge event was advertised through local radio and brochures. The outreach felt a bit too last minute, however, and they see gains from bolstering social media publicity before the next showcase.

Providence Energy Fair:

The other grant-funded municipality to have already hosted an event is Providence, Rhode Island. Similar to Portland, Providence lacked the staff capacity for extensive marketing. Portland, however, had

an advantage over Providence because of its growing statewide heat pump interest ^{iv}. One purpose of Providence's Energy Fair was to expand the supply chain and interest for ASHPs in the city and Rhode Island. This is sorely lacking given that no vendors initially responded to the city's RFP, stating that they were too busy with air conditioning installations ^{iv}. Providence was eventually able to find an enthusiastic and respected contractor to speak and sign residents up at the Clean Energy Fair ^{xi}.

The Providence Office of Sustainability hosted the [Clean Energy Fair](#) in June 2017 in partnership with environmental nonprofit People's Power & Light and the Rhode Island chapter of the Sierra Club. The Energy Fair promoted community awareness for energy-saving technologies and sustainability practices. Unlike the event in Portland, which focused on heat pumps, Providence hosted a series of energy-related workshops, nonprofit organization booths, and environmental justice tours. The fair created a community atmosphere with food trucks, Spanish translations, and childcare service ^{xxxiii}. Time will tell how much interest this energy fair method will generate, but its efforts in demonstrating the links between social and environmental justice, energy efficiency, and cost savings are commendable.

HeatSmart Northampton:

Instead of being based solely on events, Northampton, Massachusetts's ASHP publicity strategy is more about gaining momentum through existing social networks. Northampton started HeatSmart outreach efforts with a residential survey. Mason emailed the survey to Solarize Campaign contacts and asked community organizations to forward the survey along to more residents. The survey is also posted on the website. "We did it because it dawned on me during the Solarize campaign that before we ask for outreach help, why don't we ask the community if they are interested, but also as a means of pushing information", says Mason. ^v Six hundred residents responded and provided information about how much public knowledge and interest there was about ASHPs and what sorts of outreach methods would be most beneficial.

Northampton benefits from an active community, involved in local government, especially catalyzed of late by the lack of climate policy on the federal level. The first meeting with volunteers happened in late July, mostly with involvement from Mothers Out Front and Climate Action Now. Penny Geis is the outreach coordinator "coach" for the volunteer efforts ^{xxxv}.

HeatSmart Northampton is expected to run from August 2017 until January 2018. Northampton selected the installer *Express Plumbing, Heating and Solar Services* in June 2017 through their public procurement process based on strong customer referrals, experience in Northampton, and excellent customer service ^{ix}. The installer offers a bulk discount that the city ensures will be felt at the consumer level. A kickoff event will occur in September 2017 at the local senior center so that residents can learn more about the initiative. HeatSmart Northampton also plans to host open house parties with homeowners who have already installed a heat pump to learn about their experiences ^{xxxv}.

One of the ongoing efforts in Northampton – spearheaded by Sustainability Institute fellow Evie Song and Meister Consultant, Erin Camp– is to develop a tool to identify the likelihood of different homes to install ASHPs through market segmentation analysis. Mason hopes to use this information to focus on personalized communication. He might have tailored suggestions for a neighborhood that mostly relies on fuel oil, for example. Mason and Evie see messaging as a continuous barrier for outreach campaigns. One needs to emphasize what is most important to a consumer, and often this is cost savings ^v.

HeatSmart/CoolSmart Somerville

Like Northampton, Somerville views Heatsmart as a next step after their 2016 solarize campaign and expects to launch their heatsmart program in late July. Somerville emphasizes "coolsmart" in their title to remind residents of the often-overlooked cooling aspect of heat pumps. They also do this to remind residents of this added perk since it is more expensive to get a heat pump in Somerville due to its almost 80% natural gas penetration. Survey results from Somerville residents reflecting on their past solarize campaign, demonstrated that word-of-mouth is important for mobilizing residents in addition to the city's approval of the products and process.

Somerville hosted a [kickoff event](#) in August 2017 with the HeatSmart/Coolsmart "Coach," Molly, a Somerville volunteer and resident leading the outreach efforts with the network of volunteers. The kickoff will also include the two installers that Somerville selected in May 2017: *New England Ductless* and *N.E.T.R. Inc.* The companies were chosen for their experience with the building stock specific to Somerville, their customer service, equipment installation expertise, and pricing proposal ^{xxxiv}.

To be part of the thermalize program, residents must sign up on the Heatsmart Coolsmart [website](#) or in person for an installation by December 15, 2017. The chosen installer will call within one business day to schedule an optional and no-cost home visit. The installer helps the resident pick the best option for their needs and then schedules an installation. Along with the Massachusetts rebate (see Appendix 1), the city offers additional participation incentives such as [0% interest deferment loans](#) for low-income residents and a city rebate for the first 100 citizens to sign up ^{xxxiv}. Experience from Solarize showed the importance of having the entire process of obtaining an ASHP as streamlined as possible for the resident. Sellers-Garcia hopes that Somerville can demonstrate that heat pumps can be implemented in a city that is 2/3rds renter and 90% multi family ^{vi}. This can be done with experienced city installers close partnerships with other city groups.

Renew Boston Heat Pump Program

Boston, Massachusetts is also interested in a heatsmart model for its ASHP residential awareness efforts. Though it does welcome the enthusiasm from its active environmental community, the city relies on its programmatic office groups, like Major Walsh's "Renew Boston" and "Greenovate" Initiative, for most of its residential outreach ^{xv}.

Boston was expecting to submit their RFQ, along with Somerville, but due to some lasting backlash from an old project, the city has had to pause their project. In March of 2016, "Next Step Living", a Boston-based firm providing home energy services abruptly closed down, months after many residents reported complaints of bad workmanship and shoddy installations. Since Boston had qualified the company to run a lot of their efficiency and heat pump programs, there has been distrust targeted at the city itself ^{iv}. There requires more recuperation and communication before the city is ready to qualify new installers.

Eventually Boston still expects to submit a heat pump RFQ, a process that the city will need to streamline for various initiatives going forward. After collecting a list of trusted contractors and interested enrollees, Silverman then envisions the Boston Office of Environment sending this information to the Boston Home Center. In this way, each city agency will do what they do best: efficient technology can be met with inclusive housing programs, like "Senior Saves" that helps low-income elderly residents with housing needs. Silverman hopes to rebound Boston's efforts before CNCA's funding ends in March, but he is also realistic. "As I see it, what we are doing now is to lay the foundation and our experience with it and get information out there. The more that municipalities can learn from each other, the better" ^{vii}

Evaluation

Both the showcase strategy of Portland and Providence, as well as the heatsmart approach of Somerville, Northampton, and Boston seems to be worthwhile for expanding the ASHP usage in a municipality. There are, however, various caveats depending on the local situation. The Showcase strategy appears to incite more tangible progress than the heatsmart approach, but this is not quite a fair comparison because the showcase events started earlier. It is easier to set up these events as well as evaluate initial success for how many residents attend the events and sign up for a heat pump installation. The outreach strategies for heatsmart, on the other hand, are more organic and thus harder to articulate the steps for another municipality to try. More creativity requires more capacity. That being said, the heatsmart strategy appears to have a lasting effect in the community. This was seen in Somerville and Northampton with the excitement that had translated over from their Solarize campaigns. The local networking and use of a volunteer community champion appears more difficult and time-intensive, but gets the community engaged with local government over a common goal. If a municipality had the capacity, the two approaches seem to work well together. Events with qualified installers and informative presentations can augment the social networking and targeted outreach.

Barriers to Consider

Below are themes that emerged from the interviews. These are topics that municipalities should be careful to consider, but are hard to find in literature related to renewable thermal deployment. They are consumer awareness, equity, and monitoring.

Consumer Awareness

Each of the CNCA grant recipients spoke of the necessity for greater consumer exposure to ASHPs in order to spread the technology. Especially since their cold climate capabilities have only emerged in the last decade, ASHPs are relatively unheard of in New England^{viii}. A recent survey in Northampton found that 40% of the 207 respondents were unfamiliar with cold climate air source heat pumps (CC-ASHPs)^{ix}. Unfamiliarity breeds uncertainty, especially when residents need to find a means to heat and cool their homes relatively quickly if they are replacing an existing system. The more people that see ASHPs around them will accept them as an established technology, according to Rosenbach^{xix}. Mason has taken the exposure strategy to heart from his experience with Northampton's Solarize campaign. Like solar panels, ASHPs have outdoor units that have a "natural advertising effect of their own," potentially convincing neighbors that they also should look into the product^{xvi}. Municipalities can serve as examples by implementing heat pumps in their own buildings, according to Gronli. Portland, Maine is installing four more in city hall so that the building will be entirely warmed and cooled by heat pumps. Open houses are also a tangible outreach strategy to get residents to actually see a heat pump in action.

Consumer interest can send ripples out to the other important stakeholders critical for ASHP dissemination, including manufacturers, utilities, state policy makers, and installers. Based on interviewee experience, HVAC installers tend to be more reactive than forward thinking^{xi, iv}. Therefore it would take more consumer demand before installers fully incorporated ASHPs into their business model. When a resident calls to say that their boiler broke, the installers should be advising that they replace it with a heat pump, says Bamberger. Eventually there should be contractors who work exclusively with heat pumps. Another potential stakeholder group that could ease the transition to ASHPs is landlords. For instance, Mason noted a particular Northampton landlord who advertises their apartments as being sustainable, including having lower utility costs. This could be a strategy to reach

the renter population ^v. In addition, realtors could sell heat pumps in homes as a resilience measure and a long-term investment. Ultimately, there need to be more conversations and education to get the word out about ASHPs and frame them as a viable option for consumers.

Equity

In addition to better consumer awareness, there can be better ASHP accessibility. Early adopters of new technologies are often the wealthy, who are able to take risks, and front the costs ^{xvii}. Many of our interviewees were concerned about this narrow audience, noting that a reliable and efficient heating system should be accessible for everyone. One recurring recommendation for making ASHP outreach more equitable is to collaborate with existing groups to ensure that ongoing housing, affordability, and development efforts include ASHP accessibility. This method seems to decrease transaction costs and create meaningful partnerships that promote environmental justice. The South Portland Sustainability office is working with their Community Development Block Grant Program through the U.S. Housing and Urban Development Department, HUD, as is Somerville. Northampton works with Community Action, a regional non-profit, to alleviate the financial burden of fuel costs and heating system repair. The Boston Home Center works with low-income citizens and seniors, especially, with all help relating to home buying. Silverman sees this intercity agency partnership as key for widespread heat pump accessibility ^{vii}.

In addition to collaborating with existing state and municipal departments, interviewees highly recommend the use of rebates and incentives to help lower-income residents. Rebates tend to be run by private-public partnerships and funded by a charge on customer's energy bills. Programs in Maine and Massachusetts may be models for widespread accessibility because of their comprehensive packages including tiered rebates for different income brackets (Appendix 1).

Future work can be done to reform incentive programs in other New England states to spur higher efficiency systems and cost savings. Bamberger, for instance, would like to see Rhode Island emulate the Mass Save rebate program, whereas currently it only offers rebates for cooling technologies. Resident, Yulia Rothenberg of Dover, New Hampshire, would like to see more tiered financing from the NH Saves program in New Hampshire. Since she was just above the low-income designation, she was not able to reap enough reward for her to feel like purchasing an ASHP was an economically sound choice ^{xxxv}. Rothenberg was also not satisfied with NH Save's model of only allowing residents in certain utility zones to participate and only while the funding lasts. Because of this stipulation, she will not be able to install an ASHP until funding has been replenished in Spring 2018 ^{xxxv}. It would take state policy change to increase the rebate amounts and coverage offered. This appears to be necessary in order to achieve widespread accessibility and dissemination of fossil-fuel reducing technologies. State governments can promote increased rebate programs as a case for increased resiliency to temperature extremes as well as a collective investment in community's building stock.

Emphasis should also be placed on long-term energy savings and quality installations. As Silverman says: "you can cover the initial cost with Mass Save, but it's really about the energy costs over years and decades that will have the largest impact on lower income people." Mandatory energy audits before a heat pump installation can ensure that a home has the proper insulation to enable maximum efficiency and cost savings. Better socio-economic data, as is used in Northampton, can allow municipalities to target those demographics who are most vulnerable to extreme temperatures and high energy costs. Elderly populations, for instance, tend to be more susceptible to heat exhaustion, but would need help figuring out a thermostat interface ^{xxiii}. Renters also may not have as much say in how and how well their

home is heated or cooled. For ASHPs to be an integrated climate solution, efforts must dovetail environmental and social concerns.

Monitoring

ASHPs in New England are still new enough that attention must be paid to tracking the utility of ASHPs as well as ensuring their proper use in homes. ASHPs need to be as energy efficient as the municipalities say they are going to be. From a monitoring perspective, Gronli suggests that we should be metering more systems in order to keep testing them under real conditions^x. In addition, metrics still need to be standardized in order to really compare greenhouse gas reductions and the efficiency of room heating^{vi}. The Coefficient of Performance, or COP, is the current industry metric found by dividing the heat provided by an AHSP by the amount of electricity it uses. Unfortunately, Davis asserts that COP factors are full of uncertainty because of the difficulty comparing across heating supplies and its seasonal variability^{xviii}. Another popular metric for ASHPs is the Heating Seasonal Performance Factor (HSPF) measured by dividing the BTU's of total space heated by watt-hours of electricity energy consumed. This allows residents to measure heat pump's efficiency across different temperatures and compared with similar technologies. HSPF appears to be a more stringent, but based on lab test conditions in Virginia and Maryland. Northeast Energy Efficiency Partnerships, or NEEP, requires COP of ≥ 1.75 at 5 degrees in addition to HSPF of 10/11 for its specification because ensuring significantly better performance than electric resistance at temperature lows is critical to cold climate performance^{iv}.

Along with on the industry side, strides can be made to improve homeowner protocols for ASHP use. Unlike a solar panel, which one can attach to their roof and forget about, there are a few tricks to ensure ASHPs are working properly according to the manual. One strategy, offered by Northeast Energy Efficiency Partnerships, or NEEP, is a Homeowner's Checklist. This deals with everything from selecting the right sized appliance for ones room to making sure snow does not harm ones equipment. State agencies can provide these free materials. Efficiency Maine also provides a monthly newsletter outlining best practices and Massachusetts Clean Energy Center provides [tips](#) for homeowners. This includes maintenance like keeping coils and filters clean.

This strategy assumes, however, that the resident is already using the ASHP properly. Integrated controls and smart thermostats are a way to set preferences and maximum efficiency so that residents do not need to worry about frequent monitoring. They can link up the use of ASHPs with other heating sources in a household and avoid dueling heat sources. For instance, your old furnace might come on as backup in temperatures lower than negative 10 degrees Fahrenheit, but only then to avoid dueling heating sources. Many ASHP models provide a remote so that customers can set temperature settings and occupancy levels to enable maximum efficiency. Efficiency Maine and Green Mountain Power of Vermont employ integrated controls to ensure that customers are using heat pumps for optimal energy savings and displacement of heating load^{xxv}.

Particular ASHP selection and monitoring protocols should highlight sizing and refrigerants in order to ensure that ASHP systems work efficiently and divert as much greenhouse gas as they are advertised to do. ASHPs provide flexibility because different systems are sized to meet the heating and cooling of different sized zones in ones home. Oversizing can lead to poor performance. Fischer of Efficiency Maine installed the smallest system (9,000 BTUs) in his home in Southern Maine to prove that it could still displace 95% of its needed heating. The largest indoor unit capability can get up to around 30,000 BTUs. Residents should consult their contractors as well as homeowners who have ASHPs to figure out which sized system would make the most sense for how much space they are trying to heat and cool^{xxv}.

Another technological concern that residents, manufacturers, and municipalities should be cognizant of is the potential harm of refrigerants that enable ASHPs to operate. As Davis explains: “In the US, the main refrigerant compound used to be R-22 (a chlorofluorocarbon) and that was banned because of its ozone depleting characteristics. The replacement is R-410A (a hydrofluorocarbon). So while R-410A isn’t harmful to the ozone layer, it is a very powerful greenhouse gas...and can be released to the atmosphere during the manufacturing, operating, and maintenance of any heat pump.^{xvi}” Refrigerant leakage is rarely an issue in a proper ASHP installation, but is still essential to consider. This cautionary example reemphasizes that heat pumps need to be monitored at every step of the implementation process in order to ensure that they are as environmentally beneficial as they are touted. Eventually, Davis hopes that a viable alternative to even R-410A is found so that there are no worries of greenhouse gas leakage.

Heat pumps are the best heating and cooling option now, but municipalities must always keep their eyes out on the horizon for whatever technology that might eventually be better, says Silverman. A municipal leader is in the difficult job of needing to promote clean technologies based on the best current information, while also staying knowledgeable on the innovation improvements that are constantly occurring, albeit slow.

Recommendations

This section includes recommendations and likely factors for a successful ASHP campaign based on the case studies and interview themes.

Eliminate Natural Gas Expansion

New England is the most oil-reliant region in the United States. Municipalities can use the volatility in the oil market to persuade residents to replace their old heating systems that depends on the dirty fuel^{xxxvii}. This replacement, however, threatens to be the more economical fuel source: natural gas^{xix}. There is urgency for municipalities to target residents using heating oil and convince them to instead purchase an ASHP. Natural gas contributes to climate change while also establishes lasting heating infrastructure that is hard to reverse. “If you install a new natural gas boiler, this year, you are going to have that, collectively we are going to have that, for 20 years,” reminds Bamberger^{xi} When utilities promote natural gas expansion it is “a total disconnect from our long-term goals of carbon neutrality^{vii}.” Bamberger refers specifically to a local example where National Grid threatens to establish natural gas facility right on Providence's port^{xi}.

ASHPs are a less carbon intensive heating source and their deployment sets up the infrastructure for a renewable electricity supply in the future. This type of “strategic electrification” is occurring in the high-emitting heating sector with ASHPs as well as the high-emitting transportation sector with electric vehicles. There is some worry that such electrification could cause too much demand on the electricity grid. Massachusetts Clean Energy Center has been looking into this with other agencies and does see that it is a long-term worry. This is one of many reasons for the nation to upgrade its aging electrical grid to account for the added electricity load^{xviii}.

City	Natural Gas	Fuel Oil	Electricity	Other
Boston	78%	16%	11%	3%
Northampton	48%	43%	9%	0%
Portland	13%	81%	5%	1%
Providence	68%	31%	1%	0%
Somerville	77%	22%	1%	0%

Figure 2. Current Heating Fuel for each CNCA City. Meister Consultants Group 2017.

Natural gas makes up 77% of the current heating fuel in Somerville and 70% in Boston (Figure 2) ⁱⁱⁱ. Silverman reminds that it is still impactful to target the 30% of Boston residents who are not on natural gas because this is still several thousands of homes. Each municipality should target those residents with fuel oil first to intercept their transition to natural gas. Some electrical heating appliances should be targeted as well. Electric resistance heaters, for instance, are so environmentally unfavorable that the Regional Greenhouse Gas Initiative (RGGI) supports all projects that replace them. The transition from an electric resistance heater to a heat pump is easy for residents and installers because it does not necessitate fuel-switching ^{iv}.

There can be concerted efforts to ease the uptake of ASHPs while reducing natural gas in New England. Cities and regions can strengthen ASHP rebate programs and tax or ban natural gas use. Silverman asserts that, "as long as a BTU of natural gas is cheaper than everything else, we are not going to beat it. It is not something we can do without a lot of legal difficulty, but the industry as well as regulators can make a dent at that." In places like Northampton, where there has been a moratorium on using natural gas since 2014, it is easier to sell ASHPs as a cost-effective energy system. Massachusetts as a whole has been trying to ban fracking, while Vermont has had a no-frack policy since 2012. In order for this to be an effective measure to curtail natural gas expansion, New England would need to ban both the consumption and production of natural gas.

State Policy

Most outreach efforts focus on grassroots organizing. This is essential to inspire residential community interest in heat pumps. These efforts, however, can be complimented and accelerated by top-town state and regional policies. For instance, heat pumps could be required by way of a city building code. Municipalities in New England are often preempted by the state from creating their own building codes. They also often do not have the capacity and funding to develop their own codes. A carbon neutral building code, however, would be a quick way to make a big difference in requiring ASHPs as building's heating and cooling supply. Silverman has found that municipalities can instead move towards *zoning* articles that require LEED certification and function similarly to building codes. Silverman also sees gains in updating the American Society of Heating, Refrigerating and Air-Conditioning, or ASHRAE, to aim for carbon neutrality ^{xiii}. There could be legislation that replaces all air-conditioning units with heat pumps in new construction. Because of all of the old infrastructure in the Northeast, policies could be tailored to retrofits as well as new buildings.

Municipalities across states can leverage the regulatory mechanisms that target buildings, thermal energy, and climate reductions to creatively spur ASHP deployment. They can, for instance, push for higher [renewable portfolio standards](#) (RPS) so that there is a greater directive to reduce greenhouse gas emissions in the heating and cooling supply. There needs to be tangible ways to monitor and track these targets, however, because even municipal aims for "carbon neutrality" or "net zero" are often more in name than action.

Thermalize, Solarize, and Weatherize

Heat pumps are important for green house gas mitigation and energy savings, but both of these goals can be strengthened if this "thermalize" model is realized in conjunction with "solarize" and "weatherize" models. Solarize refers to the community deployment and bulk purchasing of solar panels and weatherize refers to campaigns to insulate homes to withstand harsh temperatures and weather. Bamberger dreams of one day facilitating a program that supplies both solar and heat pumps. "Folks

that have good solar potential for their roofs can install heat pumps ", she says. "Then you can generate all of your needs onsite potentially and that's huge savings"^{vii}. Electrification is only strategic if renewable energy replaces the fossil fuels generating one's electricity. Silverman of Boston would recommend including good insulation work as well. "You know, I'm a big advocate for doing all three together and you start getting into the cost savings if you do them all at once"^{xiii}."

Energy audits can reveal that people have a hole in their building, which would counteract their heating and cooling attempts with a heat pump. Weatherization is part of the messaging in Northampton through collaboration with their HeatSmart program and Ener-G-Save program. This is similar to HeatSmart/CoolSmart Somerville's partnership with Somerville Energy Efficiency Now (SEEN). It remains difficult to advertise for insulation and air sealing, however, because these steps towards resiliency are not clearly visible to residents and neighbors. In addition, efficiency measures are typically run by utilities and are thus hard to access. In order to actualize an integrated approach including photovoltaics, heat pumps, and insulation, there needs to be better messaging between the different groups providing these services and maybe even bundled rebates. Municipalities can be conduits to streamline this deep decarbonization process. *Energize 360* of the Sea Coast New Hampshire region is a promising example of this integrated approach at its beginning phase^{xxxvi}.

Leveraging the network

A willingness to share among communities seems to be integral to the CNCA projects' success. Northampton was able to modify Somerville's RFP, for its own usage, for example. The role of the Meister consultant seemed to reduce transaction costs, provide technical assistance and research, and allow for a bird's eye view of what everyone is doing. Meister created much of the CNCA grant funded cities' messaging, their websites and their flyers. Similarly, to this project, the NEMS Network aims to function as group of municipalities learning best practices from one another with the help of a consultant; namely the University of New Hampshire Sustainability Institute (UNHSI).

In the future, UNHSI could provide sustainability fellows in individual NEMSN municipalities to kickstart their outreach campaigns. This could be upfront research about the building stock and fuel sources of different neighborhoods, such as Song's work in Northampton, or more of a messaging and volunteer coordination project. A fellow could even create a database of the top-quality installers in each New England state or county. Based on this report, UNHSI could also promote a broad regional communications effort to spur public interest and knowledge.

The ASHP project seems to showcase value in comparing efforts across heterogeneous municipalities who differ in politics, population size, and demographics. With the same funding, Portland did not choose the same project as Somerville. Bamberger sees gain from using the CNCA funding again in the future for other cross-municipality efforts. Mason, however, suspects that Northampton would have joined the state pilot through Mass CEC if he were starting now since it is more Massachusetts focused. The NEMS Network will need to continue to balance place-based local needs, but also group cohesion across state lines.

Seasonality and Timing

Municipalities may wonder when the best time is to start an ASHP campaign during a calendar year. One wants to capitalize on timing when both consumers and installers are ready and motivated. In Maine, Rosenbach found that winters are generally a slow season for vendors. This timing could line up well with some residents who need heating, but might not have thought about it until the last minute. To account for this lull in regular HVAC work, Rosenbach has considered changing her Heat Pump Challenge

event in South Portland from September to November to be both beneficial for residents and vendors^{xix}. In contrast, installers in Northampton have experienced the busiest consumer demand for ASHP installation between July and August. Residents there, in Central Massachusetts, are triggered by high temperatures and heat waves and putting in ASHPs for cooling. Most residents don't have any sort of air conditioning and so feel the urgency when they are sweltering^{vi}. They then often decide that a heat pump can be used to replace their heating at the same time. A summer launch in Somerville and Northampton was built around the end of the cooling season and the transition into the heating season to be able to attract customers to both opportunities. Interviewees reported conflicting information, perhaps signifying that habits surrounding seasonality and timing for heat pump deployment is more localized than expected. Patterns can likely be changed, however, depending on the messaging surrounding the ASHP outreach campaigns.

Conclusion

New England winters are brutal. On the coldest night of the year, around January 20th, residents need to ensure that their home is adequately warm. Anthropogenic climate change promises extreme cooling as well as warming. Heat pumps not only provide comfort, but safety and resiliency to these temperatures extremes. This is an additional benefit of a heat pump along with carbon reductions and cost savings. The five grant funded case studies in this report are some of the first air source heat pump campaigns in the New England region. They will each continue learning best practices until their project completion in Spring 2018. On the heels of the CNCA project, a new ASHP initiative is starting through Massachusetts Clean Energy Center across the entire state of Massachusetts. This signifies that there is continued interest in ASHPs in New England. This report offers strategies and barriers to consider in order to improve upon municipal air source heat pump outreach campaigns.

Abbreviations

ASHP: Air Source Heat Pump

BTU: British Thermal Unit

CC-ASHP: Cold Climate Air Source Heat Pump

CNCA: Climate Neutral Cities Alliance

COP: Coefficient of Performance

GSHP: Ground Source Heat Pump

HSPF: Heating Seasonal Performance Factor

HVAC: Heating, Ventilation, and Air Conditioning

KWH: Kilowatt Hour

NEMSN: New England Municipal Sustainability Network

RFP: Request for Proposal

RFQ: Request for Qualification

PV: Photovoltaic

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Appendix

1. New England State ASHP Incentive Programs

Massachusetts

Mass Save is an effort between Massachusetts's electric utilities and energy efficiency providers to help communities save energy. The funding comes from a charge on residents' monthly bills. Mass Save offers up to \$300 in rebates for each mini-split indoor unit. The Income Eligible Program may even provide a free heating and cooling equipment replacement. Those qualifying for other income assistance may also benefit from discounted utility bills, fuel assistance, and payment plans. For more information see the [Mass Save Income Eligible Brochure](#). On the ground, a successful Mass Save program requires that the municipal sustainability program ask for residents' income levels and choose contractors who will use and direct customers to the Mass Save program, according to Mason.

Massachusetts Clean Energy Center (Mass CEC) offers a second rebate option through their well-funded Residential Air-Source Heat Pump program in their Clean Heating and Cooling department. Mass CEC receives money from the Renewable Energy Trust Fund, a combination of a charge paid by electric ratepayers and by participating municipal electric departments. Homeowners are eligible for a standard rebate of \$625 per ASHP head, for up to three heat pumps. Rebates can get as high as \$2,5000 for multi-head systems. Details about which heat pumps are eligible as well as income-based rebate adders can be found in the [Program Manuel](#). Rebates should be filled out within 90 days of an installation through e-mail^{xxvii}. Northampton's [pricing manual](#) shows how a Massachusetts resident can take advantage of both Mass Save and Mass CEC rebates.

Maine

Efficiency Maine is an independent administrator of energy efficiency programs in Maine run by a Board of Trustees and overseen by the Maine Public Utilities Commission. Low-income residents, who use an approved contractor, can receive up to \$2,000 in rebates for installing a ductless heat pump, which pays for 80% of the cost. Heat pumps can also be part of larger home energy upgrades qualifying residents for up to \$3,000 in incentives. Lastly, Efficiency Maine offers micro loans of up to \$4,000 over a 10-year period for homeowners to afford energy saving improvements like ductless heat pumps. For more information see the [Low Income Home Energy Savings Program e-brochure](#). There have been 3,000 installations to date through the Commercial and Low Income program in Maine^{xxiii}.

New Hampshire

NH Saves is administered by the [Community Action Agencies](#) located throughout the state and funded by a monthly utility charge on customers' electricity and natural gas bills. Mail-in rebates are only available for electric customers in zones provided by Eversource, Liberty Utilities, New Hampshire Electric Co-op, and Unitil. However, funding tends to dwindle by the end of the calendar year. For instance, as of August 16, 2017 there were only funds remaining for the NH Electric Co-op. Rebates are \$500 per ton of cooling (12,000 BTUs) with a five ton limit per home. An Energy Assistance Program is

also available for customers within the four eligible utility zones. Before filling out the [form](#), the owner should verify that the ASHP equipment meets the efficiency and electrical load requirements^{xxvi}.

Connecticut

Energize Connecticut is an initiative of the Connecticut Energy Efficiency Fund, supported from a charge on customer's energy bills, Southern Connecticut Gas Company and Connecticut Natural Gas. If a Connecticut resident is installing an Energy Star certified ASHP and they are an Eversource or United Illuminating, they can receive an instant discount of \$300 per single head in a home and \$500 for a multi-head system. A resident using electric resistance heating can receive a \$700 rebate to incentivize the transition from this energy intensive heating source. One must have a Home Energy Assessment prior to installation in order to qualify^{xxv}.

Rhode Island

The utility, National Grid, is the primary provider for ASHP rebates in Rhode Island, as the cover electricity usage for the bulk of the state. Given the proper Energy Star certification and sizing dimensions, an ASHP will be awarded up to \$300 per mini split. For more information, see the [National Grid Rebate form](#). There is also a [mail-in rebate](#) initiative through the Rhode Island Department of Energy Resources on Block Island. Islanders can receive up to \$500 depending on the efficiency rating of their installed appliance^{xxviii}.

Vermont

Efficiency Vermont was the first energy efficiency utility in the U.S. and is administered by Vermont Energy Investment Cooperation (VEIC) and funded by a charge on Vermonter's electricity bills. Currently, up to \$800 in rebates are available if the time of purchase falls between from July and the end of December 2017. The electrical services company, Green Mountain Power, offers an on-bill leasing program for heat pumps and the Efficiency Vermont rebates can also go to reducing this monthly lease payment. Lastly, VEIC is offering a bill credit to members who install heat pump in 2017^{xxiv}.

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