Stakeholder Charrette Report

Charrette #9: Growing Networked Geothermal

November 10, 2021

Char-rette: a meeting in which all stakeholders in a project attempt to resolve conflicts and map solutions

Background

Decarbonizing the way we heat and cool our buildings is essential to a stable climate and a zero-emissions future.

HEET[1], a non-profit climate solutions incubator, has designed a method for gas utilities to deliver renewable, non-emitting and non-combusting heating and cooling. This technology, known as networked geothermal[2], consists of pipes filled with water that are installed in the street and connected to ground source heat pumps in buildings. The system can be installed and operated by existing gas utilities, providing a way forward for a transition off natural gas and for states and municipalities to meet emission reduction mandates.

Increasingly, utilities and energy advocates across the U.S. and internationally are considering networked geothermal as a viable electrification pathway, business model and alternative to fossil fuels. In Massachusetts, six networked geothermal demonstration projects have been approved for installation and are moving forward.

Each of HEET's charrettes is an ongoing effort to work together across diverse perspectives and backgrounds, generate ideas and anticipate barriers. In this way, we can move towards a just energy transition—one with clean, safe and accessible energy, low customer bills and good jobs—as rapidly, wisely and justly as possible.

Executive Summary

In HEET's Growing Networked Geothermal charrette, participants shared knowledge about how to achieve state emission reduction goals while delivering accessible and affordable energy. In breakout groups, the 37 charrette attendees were asked to act as regulators and consider the challenges and opportunities of different electrification pathways and how each could impact customer heating bills in the future.

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[1] HEET, Home Energy Efficiency Team, is a Massachusetts-based non-profit dedicated to cutting carbon emissions now by driving systems change.

[2] Networked geothermal is also commonly referred to as thermal energy networks. In the past, it has been called the GeoMicroDistrict or GeoGrid.

Stakeholders present included utility executives, regulators, labor and workforce representatives, community organizations, advocates, geothermal designers and installers, and heat pump installers and manufacturers.

HEET deeply thanks all participants for their input. This report will be shared with participants and other stakeholders, including utilities and state regulators.[3] *HEET also thanks E4theFuture and other funders for their support of HEET's charrettes.*

Introduction

Audrey Schulman and Zeyneb Magavi, Co-Executive Directors at HEET, described the challenges of meeting Massachusetts' climate goals by 2050.

In 2021, Massachusetts passed legislation to address climate change, with a mandate to reduce emissions 50% by 2030, 70% by 2040 and to reach net-zero emissions by 2050. The legislation also established goals for different sectors of the economy, including residential heating and cooling.

Massachusetts has calculated that in order to achieve its 2050 goal, one million homes must be electrified by 2030, including transitioning to electric appliances for heating, cooling and cooking.

There are many potential ways to achieve this transition and each will have a different impact on emissions and energy bills. The state's path of action so far has been to replace gas heating systems with air source heat pumps (ASHPs).

Because ASHPs move temperature, rather than create it, they are between two and three times more efficient than gas boilers. While this technology would reduce emissions, the resulting heating bills currently are predicted to be roughly 30% more expensive than gas per energy unit delivered[4].

As part of a state regulatory docket (DPU 20-80), gas utilities are examining how to align with the state's 2050 decarbonization goals. The utilities are working with a consultant and a wide stakeholder process to examine different pathways forward.

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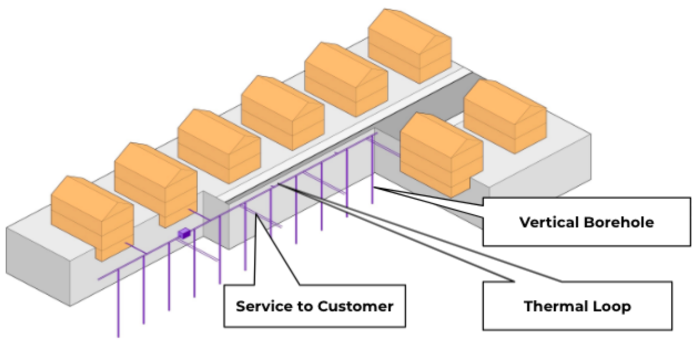
[4] Prediction based on the current Massachusetts cost per energy unit delivered of electricity versus gas.

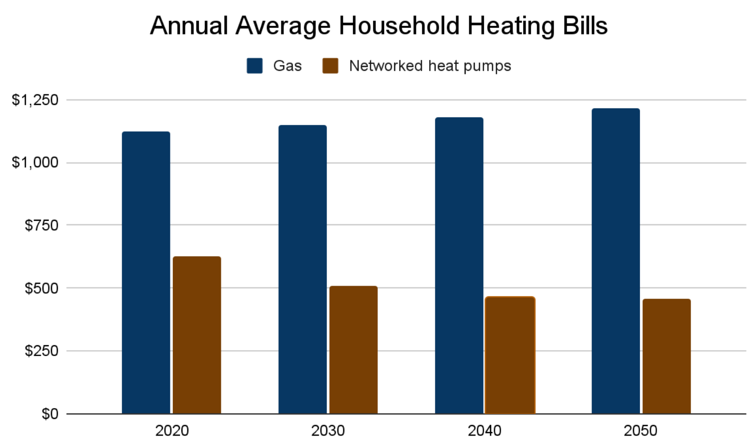
One option under serious consideration is blending other gasses, like hydrogen, with natural gas. When hydrogen is made from renewable energy, it is often labeled "green." However, hydrogen still contributes to climate change when emitted in the atmosphere,[5] with a global warming potential of 5.8 over a 100 year timeframe. It is also the smallest molecule in the universe and burns with an invisible flame, raising questions about safety and increased leak rates. There are additional concerns about how to transport the gas, whether enough can be produced and how much it would raise prices for customers.

In the meantime, gas utilities in Massachusetts are still mandated to repair or replace aging gas pipes that pose safety risks. These replacements, part of the Gas Safety Enhancement Plan (GSEP), are estimated to cost $40 billion over the next 20 years—greater than the cost of all gas infrastructure currently in the ground in its depreciated state. New pipes will be paid for by customers over half a century, even if the pipes are no longer used.

As the state moves gas customers to electric heat pumps, fewer will be left to share the fixed costs of the gas system, increasing costs for the customers who remain. Those left on the system will be lower-income households and renters who cannot afford a new heating system.



One promising way for gas utilities to reduce emissions, stay in business and provide affordable heating and cooling is to replace leak-prone gas infrastructure with street segment-scale networks of ground source heat pumps, also known as networked geothermal. This electrification infrastructure can be owned and maintained by gas utilities who already have the rights of way, customers, workforce and financing.



Ground source heat pumps are approximately twice as efficient as air source heat pumps. Networking them makes them even more efficient, radically reducing the impact on the electric grid of moving buildings to electricity, as well as the amount of renewable energy needed to make that electricity. In a study by Applied Economics Clinic (graph right), the

[5] Derwent, R., Simmonds, P., O'Doherty, S., Manning, A., Collins, W., & Stevenson, D. (2006). Global environmental impacts of the hydrogen economy. International Journal of Nuclear Hydrogen Production and Applications, 1, 57-67.

resulting heating bills of a networked geothermal system are projected to be lower than gas.

Discussion and Attendee Comments

In breakout groups, participants acted as regulators and considered the cost impact of various scenarios leading to electrification of one million homes by 2030.

Breakout Group 1: Business as Usual

Group 1 participants assumed that:

- The state meets its projected goal of 1,000,000 homes moved to electric heat by 2030
- The gas main replacement program (GSEP) continues spending $500 million/year on new gas mains

How will this scenario impact the average residential heating bill over time?

Group 1 Discussion: This scenario projected that customers with air source heat pumps would pay $1,616 yearly for their heating bill through 2030. Customers with gas heating instead would see their heating bill grow from $1,293 to $1,746 by 2030. The cost increase would come from a shrinking gas customer base left to share the operation and maintenance expenses of the gas system, as well as the cost of GSEP.

The group determined that more information was needed on who would be paying for the cost of retrofits (including appliance swaps, heat pumps, electric panel upgrades, insulation and more) to electrify the 1,000,000 homes. The group noted that if gas customers were converted too quickly to electricity, the customers still on the gas system would see an increase in their gas bills each year.

Breakout Group 2: Adding Hydrogen

Group 2 participants assumed that:

- The state meets its projected goal of 1,000,000 homes moved to electric heat by 2030
- The gas main replacement program (GSEP) continues spending $500 million/year on new gas mains
- The utilities add 10% green hydrogen to natural gas to reduce emissions

How will this scenario impact the average residential heating bill over time?

Group 2 Discussion: While ASHP customers were projected to pay $1,616 yearly, gas customers with blended hydrogen would see their costs grow from $1,690 in 2022 to $1,929 in 2030. This increase would be due to fewer gas customers paying for the gas system and GSEP, plus the cost of hydrogen.

Group 2 suggested that the calculation should also consider the overall utility bill, including the cost of electricity before and after electrification. The group thought that the gas price used in the calculation was underestimated, as an increase in gas price is already expected this year. To ensure affordability across the board, the group noted that a solution needs to be in place to determine how cost increases would be allocated and paid for. Other issues raised included the challenge and expense of insulating old homes, how to provide assistance to lower income residents moving to ASHPs and where this funding would come from.

Breakout Group 3: Networked Geothermal

Group 3 participants assumed that**:**

- The state meets its projected goal of 1,000,000 homes moved to electric heat by 2030
- Funds for the gas main replacement program (GSEP) are spent on installing networked geothermal instead of new gas infrastructure

How will this scenario impact the average residential heating bill over time?

Group 3 Discussion: In this scenario, like the scenarios given to groups 1 and 2, customers who moved from gas to ASHP would expect to pay $1,616 yearly. The gas customers who are incrementally converted to networked geothermal using GSEP funds would see gas or thermal utility bills increase from $1,281 in 2022 to $1,636 in 2030.

Group 3 noted that the cost of utilities installing networked geothermal is not yet certain, since they have not yet installed any systems. It is likely that over time, the price will decrease with efficiency and learning. The group recommended that more research be performed on the cost of installing networked geothermal and how to bring retrofit costs down, such as the cost of upgrades to residential electric panels and wiring.

Breakout Group 4: Air Source Heat Pumps

Group 4 participants assumed that:

- The state meets its projected goal of 1,000,000 homes moved to electric heat by 2030
- All customers on streets with leakprone gas mains scheduled to be replaced by 2030 are instead transitioned to air source heat pumps, paid for by Mass Save

How will this scenario impact the average residential heating bill over time?

Group 4 Discussion: ASHP customers would expect to pay $1,616 yearly. The remaining gas customers would see gas bills increase from $1,280 in 2022 to $1,638 in 2030. The increase in gas bills would come from fewer customers paying for maintenance of the gas system. However, since no additional money would be spent on GSEP, the increase in gas bills would be lower than in some of the other scenarios.

Group 4 noted that, applying today's rates, the gas delivery cost is a higher proportion of a customer bill than the cost of gas supply ($.75/therm delivery vs $.50/therm for supply), so the delivery cost will keep increasing as the number of gas customers declines. As technology changes, higher efficiencies may lower costs. The group suggested considering trends to see if these cost savings can be projected. One way to save money for both the gas utilities and their customers could be moving all customers in one neighborhood off the gas system, shutting down distribution in that portion.

The group noted several costs to consider, including the cost of retrofitting homes, workforce training and development, and fixed costs for a utility (i.e. administrative costs, payroll/HR, compliance, risk, legal costs, equipment).

The group recommended considering making subsidies available for lower income residents in order to make the transition off gas more accessible, as well as restructuring the Department of Public Utilities and the Energy Facilities and Sitting Board to allow for more stakeholder input and transparent processes. The group also asked if customers will be mandated to convert off the gas system. Under those circumstances, even if the system resulted in lower cost energy, supplied cooling and improved indoor air and safety, there would need to be incentives and educational campaigns to help get the information out. Using a system based on individual choice in an energy transition, the group noted, could replicate and exacerbate existing inequalities.

Additional Information:

[HEET slide deck](#)

For more information about HEET and its work on networked geothermal, see the following:

- https://heet.org
- https://heet.org/who-we-are/our-people/
- https://heet.org/geo/
- https://heet.org/community-charrette-reports/
- https://heet.org/library/