FILED VIA ePUC

August 8, 2024

Holly R. Anderson
Clerk of the Commission
112 State Street
Montpelier, VT 05620-2701

Re: Gas Absorption Heat Pump Pilot

Dear Ms. Anderson:

By this filing, Vermont Gas Systems, Inc. ("VGS" or the "Company") provides notice that it intends to use a portion of its innovation funding to pilot installation of highly efficient gas absorption heat pumps (the "Pilot").

Section 9 of the Company's Alternative Regulation Plan provides that "VGS shall pursue and consider projects, programs, and services that support Vermont's statewide energy goals by advancing promising technologies to facilitate efficient, lower carbon energy choices for Vermont customers."[1] Section 9(e) requires VGS to provide 30 days' advance notice to the Commission and the Department of Public Service ("Department") "before commencing any spending on a project, program, or service under the Climate Action and Innovation Budget that exceeds $25,000." As detailed below, innovation spending on this Pilot is expected to be $97,500. Accordingly, VGS is providing the following notice, addressing all criteria required by Section 9(f).

Gas Absorption Heat Pump Introduction and Background

According to 2021 census data, Vermont has some of the oldest housing stock in the country: Half of homes were built prior to 1977 and twenty-five percent of Vermont's homes were built before 1940. In the years to come, many older homes and small commercial buildings, even weatherized ones, will need a new central heating system that can supply the heat needed to maintain comfort and safety on Vermont's coldest days.[2]

While we are proud to offer electric heat pump water heaters, centrally ducted heat pumps, and ductless mini-split heat pumps to Vermonters choosing electrification, our climate and affordability commitments are best served by advancing a *variety* of lower carbon energy choices. To decrease emissions at the scale necessary to meet Vermont's climate mandates, customers need options suitable to their homes, businesses, and budgets. For many customers with older buildings and those with high energy burdens, an emerging technology–gas absorption heat pumps ("GHPs")–could be considerably more affordable than the electrified

---

1 *See* Alternative Regulation Plan filed on October 26, 2023, in Case No. 22-5085-PET.

2 *See, e.g.*, https://www.efficiencyvermont.com/blog/how-to/is-a-heat-pump-heating-cooling-system-right-for-you.

heating systems we are also offering. Accordingly, certain residential and small business customers looking to replace aging or failing heating systems and water heaters, may look to GHPs to deliver significant improvements in energy efficiency along with the corollary reductions in natural gas usage, greenhouse gas emissions, and customer energy costs.

What is a gas absorption heat pump?

Gas absorption heat pumps work on a similar principle as electric heat pumps: They transfer free renewable heat from air, water, or the ground into or out of buildings within a circulating refrigerant. A generator, condenser, evaporator, and absorber work in lieu of an electric compressor. Heat is transferred between the indoor equipment (e.g., air handler and water tank) and outdoor heat pump unit via a hydronic loop. Electricity powers the fans and controls.

Although GHPs are rooted in technology that is almost 100 years old and has been successfully applied to large-scale commercial heating and cooling equipment,[3] the innovation discussed in this filing is related to manufacturers now offering equipment that can provide simultaneous space and water heating for residential and small commercial natural gas customers. There are multiple major manufacturers working on product launches in this area[4], delivering units and supporting pilots with training and on-site technical assistance. Moreover, the Gas Technology Institute's Emerging Technology Program is launching a large-scale demonstration (which VGS plans to participate in) to help serve as a launching pad for market adoption.

What benefits do GHPs provide customers?

GHPs are up to 50% more efficient than traditional gas space and water heating systems, which typically operate between 70% and 98% efficiency. This means that a customer converting to a GHP from traditional gas heating systems will see immediate energy savings and lower gas bills. For historical context, efficiency on gas combustion heating equipment has improved only incrementally. The National Appliance Energy Conservation Act of 1987 required most new furnaces to be at least 78% efficient beginning in 1992, and today most energy efficient models have an Annual Fuel Utilization Efficiency in the 90s. At 140% or more efficient, gas absorption heat pumps represent a transformative leap in energy efficiency for both space and water heating. As such, GHPs can provide tremendous benefits related to both cost and carbon savings for thousands of Vermonters residing and operating small businesses in aging homes and buildings.

To illustrate, we modeled conventional combustion systems versus GHPs in a weatherized single-family home using data from about 45 homes on the VGS system. From this data, we estimated a 33% savings in annual gas bills with a GHP, which is around $357 per year, plus a

---

[3] In 1926, Albert Einstein patented a gas absorption heat pump refrigerator that was purchased and developed by Electrolux.

[4] GHP manufacturers producing residential-scale systems are utilizing different refrigerants, all with zero global warming potential. Some of the units are drop-in replacements for hydronic systems (boilers), some for forced air (furnaces), and have differing feature sets packaged such as space cooling.

similar reduction in greenhouse gas emissions, or 1.5 MTCO2e per year.[5] Even with these savings, a GHP can reliably meet a building's heating demand at very low temperatures, with less performance drop than an electric air source heat pump ("ASHP"). Additionally, as described above, GHP are packaged systems that sit outside a building, eliminating inside combustion associated with the delivery of space and water heating.

Replacing a legacy natural gas heating system with a GHP can also increase the benefits of a hybrid system. That is, air source heat pumps can still operate as the primary heating source, while the highly efficient GHP provides backup.[6] We estimate that a GHP and ASHP hybrid system in a single-family home could cut carbon emissions by up to 80% while maintaining affordability.[7] But for homes and businesses that are not ready for a hybrid system due to cost or other obstacles, a GHP alone can still provide economic and environmental benefits because a highly efficient GHP would simply reduce natural gas usage—decreasing carbon emissions and heating costs—without substantially increasing electricity costs.

Pilot Description

What will the Pilot look like?

During the Pilot, VGS will pursue installing up to six GHP units over twelve months across a variety of residential and small commercial building types, then monitor equipment operation post-installation. VGS will work with manufacturers to acquire the equipment and will utilize both our own service technicians as well as Vermont-based HVAC contractors to complete the installations.[8] The GHP manufacturers will consult with VGS about site selection and will provide technical training and on-site technical support for the installations, as needed, at no cost to VGS. Through the Pilot projects, VGS will test the equipment's effectiveness related to energy savings and analyze the customer and installer experience.

---

[5] The model represents an average 1,700 square feet, 1940 as the mean year of construction, and average annual natural gas consumption of 820 CCF for both space and water heating, which, at current VGS rates, is approximately $1,050 per year. The modeled furnace and water heater were 90% and 75% efficient respectively. A greenhouse gas equivalencies calculator is available at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

[6] For example, a centrally ducted heat pump can integrate with the GHP air handler in the same way as legacy furnaces. GHPs can be installed in cases where a hybrid system already exists and maintain the same relationship between gas and air source heat pump equipment. The centrally ducted heat pump becomes the primary heating source and, at the appropriate outside air temperature (as determined by an HVAC professional), the GHP provides the heat required to maintain comfort, but at a significantly higher efficiency and lower cost than the legacy furnace system it replaced.

[7] Our modeling with a hybrid heating system consisting of a traditional furnace and centrally-ducted ASHP shows that you can achieve up to a 50% reduction in GHG emissions if the swapover temperature between the two heating appliances is set to 30 degrees. An additional 30% GHG reduction can be achieved by replacing the traditional furnace with a GHP.

[8] No special licenses are required to install GHP beyond natural gas certification, plumbing, and electrical. The equipment runs on a 120-volt circuit and only requires a 15-20 amp circuit.

As a member of Gas Technology Institute's Emerging Technology Program, VGS will also collaborate and share data with the multi-utility cohort that is participating in GHP pilots across the country and Canada, a coordinated effort known as the "North American GHP Demonstration Program". Through pilot data aggregation and analysis, the Gas Technology Institute will support VGS and other participating utilities with a larger pool of qualitative and quantitative analysis aimed at helping build local markets. VGS also intends to use the data from the Gas Technology Institute to understand cost-effectiveness of the equipment for its Energy Efficiency Utility ("EEU").

What are the Pilot objectives?

The overarching goals of the Pilot are to develop market awareness and experience with this technology at residential/small business scale and to test the efficacy of the equipment in a variety of building types, particularly as it relates to energy efficiency, cost-effectiveness, and customer and installer experience. At the end of the Pilot, VGS will be well positioned to determine if GHP installation: meets our customers' needs related to comfort, noise, energy savings, and otherwise; screens as cost-effective, justifying incentive support from VGS's EEU; and would be a suitable addition to VGS's in-home product portfolio. By acting as a market catalyst in this way, VGS can help ensure that Vermonters have access to the most efficient, technologically advanced equipment available, which in this case could also be the most affordable thermal energy option.

To develop market awareness and experience, VGS will facilitate HVAC contractor education and customer testing. VGS will work jointly with the manufacturers to educate and recruit HVAC contractors in our service territory, offering technical trainings on GHP installation and service and providing on-site installation support. At the same time, VGS will recruit customer participation in the Pilot, including both external and internal (i.e., VGS staff) customers. To maximize learning from Pilot installations, we will seek to include a range of building types and applications such as single-family detached homes, multi-family properties, small commercial buildings, and use-specific commercial applications such as pool heating and domestic hot water for hotels and schools.

During the Pilot period, VGS will own and maintain the equipment, which will be certified and warrantied.[9] VGS will not charge Pilot participants for the equipment or labor associated with installing or maintaining the GHP.[10] In exchange, participants will allow access to the equipment during the Pilot period and contribute to our data collection, anticipated to last up to 24 months

[9] The GHP equipment installed during the Pilot will be certified by the Electric Testing Laboratories and Underwriters Laboratories, both members of OSHA's Nationally Recognized Testing Laboratories. Specifically, the performance standard certification achieved is ANSI Z21.40.1/CGA 2.91 which is a joint standard that covers the safety construction and performance of gas-fired, heat-activated air conditioning and heat pump appliances.

[10] VGS will not recommend removal of existing heating systems so participants will retain the option to terminate their participation at any time and have their original systems returned to service. VGS would also reserve the right to remove the GHP system and restore the customer's original equipment. Post-Pilot, VGS would remove the redundant equipment at the customer's request.

post-installation. After the Pilot, VGS expects to transfer ownership of the equipment to the customer.

Through the Pilot, we will acquire qualitative insights into the installer and customer experience. For example, for the building occupants, are there comfort, noise, or other issues presented by the GHP; are the GHP system controls responsive, easy to understand, and use; and are there aesthetic concerns related to any of the equipment? For the installer, what were the challenges associated with installation both internal and external to the building; what level of system design is required for different types of distribution systems (e.g., forced air vs. hydronic); and what tests and monitoring is required to ensure that the system is fully functioning as designed?

The Pilot will also test the technical efficacy of the equipment and the anticipated installation costs. Data collected will include whole building energy usage, both before and after installation; building load profiles; supply and return water temperatures and flows; equipment service needs; and costs to install. Data analysis from the Pilot will help inform cost-effectiveness across various building types and equipment configurations. GHP systems can technically support a wide variety of configurations to accommodate both forced air and hydronic heating systems and, in many cases, simultaneously supply domestic hot water. Accordingly, VGS will vary the building types and equipment configurations as broadly as practical within this limited Pilot to quantify variations in energy savings based on the type of application. To test the efficacy of the equipment, we will monitor and measure energy usage for a minimum of twelve months (to ensure including at least one complete heating season). To determine savings, VGS will compare pre-GHP installation billing data to post-GHP installation billing data, while normalizing across heating seasons.

We will also analyze costs associated with installation to inform the overall cost-effectiveness of the equipment in different circumstances. Naturally, project costs are predictable in some cases while others needing additional engineering design are less so. For example, a single-family home replacing a failed central forced air furnace system might be cost-effective while a more complicated retrofit involving a duplex with separate boilers and distribution systems might be cost prohibitive. Accordingly, we will look for opportunities to analyze overall cost-effectiveness with each Pilot site.

Cost and Timeline

This Pilot will be funded by a cost share between VGS's Climate Action and Innovation Budget and VGS's EEU. For the purposes of this notice, the Climate Action portion is expected to be $97,500, which represents approximately 0.1% on base rates. Innovation expenditures of up to $500,000 in expense are already included in rates, however, through the Climate Action and Innovation Budget of our Alternative Regulation Plan. For the VGS EEU cost share, the Resource Acquisition budget will be used as savings claims are anticipated as discussed below. The total estimated Pilot costs are as follows:

Item	Estimated Cost
GHP (6 systems) Includes outdoor condenser, inside air handler, indirect storage tank for domestic hot water	$90,000 ($15,000 each)
Installation labor	$60,000
Measurement & verification	$10,000
Total estimated costs	**$160,000**

Equipment purchases and installation are expected to take place over a 12-month period and data collection may continue for up to 24 months.

Vermont Energy Goals and Greenhouse Gas Emissions

Vermont's 2022 Comprehensive Energy Plan directs the reduction of greenhouse gas emissions by 90% and fossil fuel consumption by 80-95% below 1990 levels, by 2050. Fossil fuel use in Vermont's existing building sector represents approximately 36% of our GHG inventory.[11]

A primary strategy articulated in the Comprehensive Energy Plan for the thermal sector is reduction of thermal energy demand.[12] As mentioned above, GHPs represent a significant improvement in energy efficiency over today's baseline heating equipment for existing homes and small commercial buildings. Typical efficiencies in existing natural gas fired boilers, furnaces, and water heaters range from 70-98%. Therefore, with GHP, reductions in natural gas usage and the resulting greenhouse gas emissions related to space and water heating can be estimated to be between 30% and 50%. As noted above, when combined with ASHPs and weatherization, there is potential to achieve up to 80% GHG emissions reductions in a single-family home application. Though these reductions are lower than targeted, as the Commission has recognized in other contexts, VGS is taking a multi-faceted approach to reducing greenhouse gas emissions in support of meeting Vermont's Global Warming Solutions Act mandates; one aspect of that approach does not need to reduce emissions by 80% on its own to constitute valuable contribution to the Company's mitigation efforts.[13]

For additional environmental benefit, GHPs use a natural refrigerant (R717) with a Global Warming Potential of zero and there are no PFAs, making it one of the most environmentally

---

11 *See* https://eanvt.org/annual-report/2023-apr-key-findings/.

12 *See* Vermont Department of Public Service, *2022 Vermont Comprehensive Energy Plan* at 164 ("achieving Vermont's energy and climate-related goals will also require new strategies for further reducing thermal energy consumption across all the market segments").

13 *See e.g.*, Case No 22-2230-PET, *Petition of Vermont Gas Systems, Inc., pursuant to 30 V.S.A. § 248(i), for approval of an out-of-state renewable gas purchase contract with a term exceeding five years*, Final Order Approving Contract (Vt. Pub. Util. Comm'n, Nov. 8, 2022) at 27 ("Although other mitigation strategies, such as efficiency and weatherization, may be more cost-effective than RNG at reducing net greenhouse gases, VGS provides a necessary utility service that is relied upon by thousands of Vermonters. For those customers who are unable to fuel switch away from natural gas in the near-term future, whether for financial or logistical reasons, regulatory policy should be directed at reducing the emissions profile of the natural gas that those customers will continue to use in a cost-effective manner.")

friendly refrigerants available. The small amount of refrigerant used is entirely contained within the packaged outside unit and does not circulate into the building.

Efficiency and EEU

VGS believes installing highly efficient GHPs could lower costs and emissions for all VGS customers and help decrease customer energy burdens. The VGS Innovation and Efficiency teams are collaborating on this Pilot with an objective to determine cost-effectiveness, whether offering GHPs is something that the EEU could support for the benefit of ratepayers, and, if so, what level of incentive would be appropriate to offer low- and moderate-income Vermonters. A preliminary analysis utilizing 2024 Avoided Energy Supply Cost values demonstrates this measure would screen as cost-effective based on the estimated savings determined from the 45-home evaluation presented earlier.[14] The EEU funding for the Pilot is from the EEU's Resource Acquisition budget, supporting custom measures, because we anticipate there will be savings claimed from the Pilot installations. The Pilot also provides the EEU the opportunity to observe the measures' performance in the field as well as access data from the Gas Technology Institute to determine whether and how the EEU might offer incentives for GHPs as standard Technical Reference Manual approved measures in the future. If the Pilot demonstrates that GHPs can be cost-effective, then the EEU may add the equipment to its program offerings, thereby enhancing the EEU's work by offering efficiency gains before unobtainable by Vermonters.

Variance from Tariffed Services

No variance from tariffed services is necessary. Equipment installation and maintenance will be provided to Pilot participants at no cost to them. As discussed above, following the Pilot, VGS will evaluate integrating GHPs into EEU programs through our Demand Resource Plan, and adding GHP installations into our in-home portfolio of products, which is reviewed as part of our annual "untariffed services" filing.

Customer Outreach

We will not conduct broad customer outreach at the Pilot phase. Pilot participants will be recruited: through our partners serving low- and moderate-income populations, such as Champlain Valley Office of Economic Opportunity and Champlain Housing Trust; through our EEU commercial leads; and from VGS staff. We are focused on having a diversity of building and customer types to test the value of GHPs. For example, low- and moderate-income single and multi-family homes are a segment of the market we believe could receive high value given Vermont's dual decarbonization and equity goals. In the commercial sector, GHPs may offer benefits for decarbonization and operational expenses to counter ever-increasing costs diluting a small business's competitive advantage. If the Pilot progresses to an EEU program or joins our portfolio of in-home services, we would utilize the same communication streams the EEU and

[14] Cost-effectiveness screening was based on a $15,000 incremental cost for a GHP versus a baseline efficient furnace and water heater, with savings based on the parameters outlined in the model.

sales teams use successfully now, presenting the several options VGS offers and, as always, emphasizing the importance of weatherization in all energy efficiency efforts.

Conclusion

Installation of Gas Absorption Heat Pumps would add important diversity to the suite of lower carbon energy choices VGS offers. This is because the efficiency benefits electrification provides often come with increased utility expenses, while a highly efficient GHP would simply reduce natural gas usage, thereby decreasing carbon emissions and heating costs, without substantially increasing electric bills. Generally speaking, existing homes and small commercial buildings need a central system that can handle the entire load on Vermont's coldest days. Because electricity is more expensive than natural gas, using a GHP would be considerably more affordable than any other heating system available and, as follows, reduce CO2 emissions significantly. Accordingly, this is an important option for low- and moderate-income Vermonters to consider when their existing system fails, and therefore, piloting GHP installation is well suited to VGS's innovation program.

We are available to the Commission and the Department to answer any questions about his filing.

Respectfully submitted,

/s/ Mary G. Bouchard

Mary G. Bouchard
Regulatory & Corporate Counsel
Vermont Gas Systems, Inc.
mbouchard@vermontgas.com