COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC UTILITIES

Petition of Boston Gas Company d/b/a National Grid for Approval of a Geothermal District Energy Demonstration Program	)	D.P.U. 21-24

INITIAL BRIEF OF HOME ENERGY EFFICIENCY TEAM, INC.

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I. INTRODUCTION

Home Energy Efficiency Team, Inc. ("HEET") appreciates the opportunity to file this initial brief in support of the Petition of Boston Gas Company d/b/a National Grid ("National Grid" or the "Company") for Approval of a Geothermal District Energy Demonstration Program (the "Geothermal Projects"). Utility-led networked ground source heat pump systems ("networked GSHP systems") present a significant opportunity to provide safe, reliable and affordable heating and cooling while advancing the Department of Public Utility's ("Department") requirements to reduce greenhouse gas ("GHG") emissions and assure equity across ratepayers.

National Grid's proposed Geothermal Projects will provide multiple benefits, including new information about the design, siting, customer engagement, implementation and operation of utility-led networked GSHP systems, that confirm the reasonableness of the size, scope and scale of the projects. Additional benefits include opportunities to demonstrate long-term energy and cost savings for customers that outweigh any short-term bill impacts to customers, including the opportunity to avoid passing on stranded costs of new gas infrastructure to ratepayers.

Meeting the Commonwealth's ambitious climate change mandates in an equitable and affordable manner will require systemic changes in the way residents and businesses heat and cool their homes. A critical step in this process is testing the viability and efficiency of new renewable, non-GHG emitting heating fuels and technologies. Utility-based networked GSHP systems present a tremendous opportunity for existing gas local distribution companies to facilitate the transition from natural gas as a source of thermal energy and develop new business models. Because networked GSHP systems are in the public interest, the Department should approve National Grid's proposed Geothermal Projects.

II. PROCEDURAL HISTORY

On February 18, 2021, National Grid filed a petition (docketed as D.P.U. 21-24) with the Department for approval of a five-year geothermal demonstration program, including an increase in rates and customer participation fees designed to collect approximately $15 million in additional revenue. The Department approved HEET's motion to intervene on May 4, 2021. HEET submitted direct testimony by Stephen H. Bryant, former President, Columbia Gas of Massachusetts, and Donald Cary Smith, Managing Member, the Grey Edge Group, on June 23, 2021, and submits this preliminary brief in accordance with the Department's July 27, 2021 briefing schedule.

III. BACKGROUND

A. Home Energy Efficiency Team

HEET is a mission-oriented nonprofit organization seeking to cut carbon emissions. HEET dedicates significant resources to developing, researching, assessing and refining the concept of street-segment networked GSHP systems installed in the right of way of the street by gas utilities, often referred to as GeoMicroDistricts, as well as opportunities for linking together GeoMicroDistricts to create a larger-scale GeoGrid. As part of its work, HEET has created and continues to manage collaborative opportunities to share learning around this issue. For example, HEET developed an ongoing stakeholder engagement process called "Community Charrettes" that assemble stakeholders across diverse sectors to surface potential problems and find solutions.[1] These stakeholders include gas local distribution company ("LDC") executives and workers, training centers, climate scientists, geothermal installers and scientists, community

[1] In this context, "charrette" means a community meeting in which stakeholders are informed of a project's status and attempt to assess projects, resolve challenges, and suggest solutions for the future.

organizers, state agency representatives, activists, legislators, architects and more. HEET's most recent charrette, held in August 2021, offered community input into the site selection for Eversource's demonstration installation of a GeoMicroDistrict. Over sixty participants attended (in person and virtually), including city officials, developers, community members, housing authorities, geothermal experts and others for the four-hour event.

B. Networked Ground Source Heat Pump Systems

A networked GSHP system connects many individual heat pumps in buildings with an ambient temperature shared loop to ground heat exchangers (*i.e.*, boreholes) and other thermal sources and sinks.[2] Exh. HEET-DCS-1, at 5. In other words, networked GSHP systems use ambient temperature loops, *i.e.*, a low-temperature energy sharing network that can share heating and cooling between buildings and make use of waste heat between buildings. Id. A networked GSHP system may include additional components and networked assets, such as: (i) measuring and metering equipment; (ii) a functional building load management and fluid transportation control system; and (iii) building load control features and devices, including thermal storage, conventional assets and other consumptive or energy generation/consumption devices and/or equipment. Id. at 5-6.

A networked GSHP system that serves a street segment or other collection of buildings in geographic proximity would pump thermal energy in a closed loop in that street or area and supply thermal energy, through service lines, to connected customer buildings. Each connected customer building would contain a heat pump replacing the pre-existing furnace or boiler. The

[2] A ground source heat pump, also referred to as a geothermal heat pump, is a type of heat pump used to heat and/or cool a building by exchanging heat with the ground, often through a vapor-compression refrigeration cycle. Exh. HEET-DCS-1, at 5.

heat pump removes, from the shared loop (*i.e.*, the loop of pipes in the street) of water,[3] as much thermal energy (either heating or cooling) as the building demands. The thermal energy removed from the supply loop is then circulated inside the building through the building's heating, ventilation, and air conditioning system, whether forced air or forced water. The water then returns to the loop at an incrementally lower or higher temperature than is initially supplied. This shared loop is filled only once, with the water recirculated through the system. The water in the loop is ambient temperature for a networked GSHP system, meaning that on an annual basis the system balances at the ambient temperature of the ground in that location. The temperature of the water should be maintained within a design window determined by both the ambient temperature of the ground and by the actual load profile of the buildings over time, and usually ranges from 40 or 50 degrees to 80 or 95 degrees Fahrenheit. This ambient temperature design approach optimizes the efficiency of the attached heat pumps, minimizes thermal energy losses, and maximizes the ability of the system to recapture and reuse waste heat through load canceling.

Different buildings use energy in different ways, allowing for synchronous or asynchronous load canceling. Synchronous load canceling happens when, for instance, a supermarket cooling its freezers in the middle of the winter contributes the resulting heat to the shared loops for neighboring buildings to use. Asynchronous load canceling happens when, for instance, that same supermarket is cooling its freezers in the middle of the summer and contributes the resulting heat into the shared loop, but it is then transferred into the bedrock by the borehole array and stored (borehole thermal energy storage) until needed in the winter. The boreholes are typically drilled at relatively shallow depths generally not exceeding 500 feet. At

[3] A fluid other than water could be utilized but HEET recommends the use of water.

this depth, the boreholes are designed to cyclically store thermal energy in the bedrock and retrieve it when needed. (They do not extract the higher-temperature thermal energy of the Earth's core.)

Networked GSHP systems, like National Grid's proposed Geothermal Projects, can be interconnected like Lego® blocks, either immediately or over time, gradually growing into a utility-scale grid, or GeoGrid. This results in an energy delivery system that is both interconnected and independent, providing both the optimization and efficiency of a centralized system and the resilience of a decentralized system. As the system gets larger, there are more and more customers with diverse energy needs, allowing more load canceling (*i.e.*, allowing more energy to be used that would have otherwise been wasted). In this way, the system can achieve increasing levels of efficiency as it grows, while simultaneously decreasing energy costs for customers and increasing energy storage capacity. Installing GeoMicroDistricts incrementally, starting off by replacing distal ends or non-critical sections of the gas system, would allow for phased reduction of gas use while maintaining reliability and continued provision of thermal energy to LDC customers. As discussed further in Section V.A.4, creating a single rate base for all thermal customers, whether supplied by gas or networked GSHP systems, would help support a transition to alternative fuel sources and technologies, "improve the economic viability of gas distribution companies moving forward and help protect consumers from the risk of rate increases due to stranded natural gas assets." Exh. HEET-SHB-1, at 4.

The potential of GeoMicroDistricts to meet the heating and cooling needs of buildings in Massachusetts was demonstrated by a feasibility study commissioned by HEET and performed by Buro Happold Engineering (the "HEET Feasibility Study"). In brief, the study found that interconnected GeoMicroDistricts could meet 100% of the heating and cooling needs of

buildings in a significant portion of individual street segments in the existing Massachusetts gas system.[4]

A networked GSHP system can provide an array of benefits, many of which, as discussed in Section V.A, advance the Department's mandates, including to provide for safe, reliable, affordable energy in a manner that is equitable and reduces GHG emissions. "While the specific type and amount of benefits may vary from project to project, the size, scope and scale of the demonstration projects proposed by National Grid are likely to result in meaningful benefits beyond the new knowledge they will provide." Exh. HEET-DCS-1, at 9.

C. Networked Ground Source Heat Pump Systems in Massachusetts

Utility-led, networked GSHP systems are relatively new; in fact, none has yet been installed in Massachusetts. The Department has, however, approved two demonstration projects. One will be developed and administered by the Department of Energy Resources and the Attorney General's Office in consultation with municipalities and other stakeholders.[5] The second will be designed and installed by Eversource. NSTAR Gas Company, D.P.U. 19-120 (2020). The former project is still in the initial phases and, to the best of HEET's knowledge, design details have not yet been determined. With respect to the latter, in October 2020 the Department approved, with qualifications, a proposal by Eversource to install and evaluate "a geothermal network servicing a large mixed-use profile in a dense urban environment." Id. at 142. The Department "encourage[d]," but did not require, Eversource to consider including a low-income, multi-family building and incorporating existing gas customers into the

[4] HEET, *GeoMicroDistrict Feasibility Study* (prepared by Buro Happold Engineering) 32 (November 2019), *available at* https://heet.org/wp-content/uploads/2019/11/HEET-BH-GeoMicroDistrict-Final-Report-v2.pdf.

[5] A settlement agreement resolving the proposed sale and two pending Department investigations into the Merrimack Valley Incident, D.P.U. 20-59/ D.P.U. 19-140/ D.P.U. 19-141, at 35 n.35 (2020).

demonstration project. Id. at 143 & 147. Although the Department is currently reviewing the implementation plan, Eversource recently stated that it expects to select a site by early October 2021 and to achieve "overall in-service" by mid-2022. NSTAR Gas Company, D.P.U. 21-53, DPU-1-1.

There are some networked GSHP systems outside of Massachusetts, including projects on campuses and small residential loops that serve multiple floors and/or uses in a single building and multiple buildings under common ownership or separate ownership but with shared ownership of common spaces. As discussed further in Section V.B, National Grid's proposed Geothermal Projects will "build upon existing systems in novel and important ways, thereby contributing additional information to the existing knowledge about networked ground source heat pump systems." Exh. HEET-DCS-1, at 7.

IV. STANDARD OF REVIEW

In past proceedings, the Department has considered the following factors when evaluating proposed demonstration projects: (1) the consistency of the proposed demonstration program with applicable laws, policies, and precedent; (2) the reasonableness of the size, scope, and scale of the proposed projects in relation to the likely benefits to be achieved; (3) the adequacy of the proposed performance metrics and evaluation plans; and (4) bill impacts to customers. D.P.U. 19-120, at 138 (citing NSTAR Electric Company/Western Massachusetts Electric Company, D.P.U. 16-178, at 26 (2017); NSTAR Electric Company/Western Massachusetts Electric Company, D.P.U. 17-05, at 234 (2017); Fitchburg Electric Light Company, D.P.U. 16-184, at 11 (2017)). The Legislature has also recently codified the requirement for the Department to prioritize safety, security, reliability of service, affordability,

equity and reductions in GHG emissions when discharging its responsibilities with respect to itself and the entities it regulates. G.L. c. 25, § 1A.

V. THE DEPARTMENT SHOULD APPROVE NATIONAL GRID'S PROPOSED GEOTHERMAL DEMONSTRATION PROJECTS

National Grid's proposed geothermal demonstration projects are consistent with applicable laws, policies, and precedent and reasonable in size, scope, and scale in relation to the likely benefits to be achieved. National Grid's proposal includes sufficient performance metrics and evaluation plans to assure that the projects create new and useful knowledge and will have reasonable impacts on customers' bills. In addition to satisfying the Department's traditional standard of review for demonstration projects, the Company's proposed projects recognize the rising demand for systemic change in the Commonwealth's energy systems and, as described by Stephen Bryant, "present a strategic opportunity to serve the public interest by providing numerous benefits both to ratepayers and gas distribution companies." Exh. HEET-SHB-1, at 2.

A. National Grid's Proposed Geothermal Projects Are Consistent with Applicable Laws, Policies and and Precedent

The Department plays a critical role in assuring the safe, reliable, resilient and affordable provision of energy services to LDC customers in the Commonwealth and is charged with considering the equitable and GHG emission-related impacts of its decisions. See, e.g., G.L. c. 25, § 1A. Networked GSHP systems are an opportunity to simultaneously advance all of these goals while achieving additional co-benefits, such as improved air quality and associated public health. As such:

> There is a pressing need for additional data about the viability and best options for geothermal district energy systems so that the Department and gas distribution companies can strategically allocate resources to energy sources that advance the Commonwealth's public health, safety and environmental mandates.

Exh. HEET-SHB-1, at 6–7.

1. Networked GSHP Systems, Like National Grid's Geothermal Projects, Provide Safe and Reliable Energy Services

In its own words, the Department is responsible for "ensur[ing] reliable and safe services by gas and electric distribution companies to the public." See Report to the Legislature Re: Maintenance and Repair Standards for Distribution Systems of Investor-owned Gas and Electric Distribution Companies, D.P.U. 08-78, at 4 (2009). The courts have similarly interpreted the Department's mandate as ensuring "the safe and efficient distribution of gas," see, e.g., Boston Gas Co. v. City of Newton, 425 Mass. 697, 701 (1997), and the Legislature recently included these goals among the Department's priorities. St. 2021, c. 8, § 15, codified at G.L. c. 25, § 1A. National Grid's proposed Geothermal Projects are not only consistent with these directives but in fact *improve* safety and reliability as compared to the traditional use of natural gas as a heating fuel.

With regards to safety, the shared loop, *i.e.*, the pipes, of a networked GSHP system, is filled with water. Unlike natural gas, there is no danger of an explosion from a water leak. Fixing leaks on a shared loop of water would be similar in cost, and use similar materials, techniques and tools, to fixing a leak on a natural gas pipe, but the former would be safer and easier to pressure test. To the extent that the fuel source for backup supplemental heating is natural gas, safety can be further enhanced by utilizing one or more shared loop backup heaters at a distance from buildings, rather than a backup in every unit connected to a networked GSHP system.

National Grid's proposed Geothermal Projects can also increase resiliency, a core component of reliable provision of energy, in several ways. As described by Mr. Bryant, geothermal district energy systems are:

> less vertically integrated than gas distribution systems. Compared to gas distribution systems, which connect to intrastate pipelines that in turn connect to interstate pipelines, geothermal district energy systems are relatively independent. Although these latter systems need electricity, this can be sourced fairly locally. This lack of interconnection increases resiliency by minimizing the risk of service interruptions due to extreme weather events or constrictions in fuel supplies that must be transported over hundreds of miles of interstate pipelines.

Exh. HEET-SHB-1, at 3–4. In the event that the electricity needed for a networked GSHP system is interrupted, backup power for both water pumps and heat pumps in buildings could be provided by electric batteries in each street segment. This would allow thermal energy to be delivered even if the electric grid goes down, thus creating islands of heating and cooling during power outages.

Finally, another component of reliable service is diversity in both fuel sources/technologies and delivery mechanisms. Networked GSHP systems are an opportunity to deliver renewable, non-GHG emitting thermal energy via pipes, which presents diversity from other electrification efforts that focus on delivering electricity via wires. (Although such systems use electricity for functions such as powering pumps, as noted above, backup power systems could be supported by batteries as a means of creating independent operation in the event of an interruption in electricity.) National Grid's demonstration projects are an opportunity to study the viability of alternative technologies and delivery mechanisms to provide thermal energy in a safer, more reliable manner.

2. Networked GSHP Systems, Like National Grid's Geothermal Projects, Are Affordable and Will Reduce the Cost Impacts of Transitioning Off of Natural Gas

In assessing the affordability of energy and energy services, the Department should consider both immediate and long-term costs. In light of the Commonwealth's commitment to reduce GHG emissions to net zero by 2050 (discussed further in Section V.A.3), the Department

should evaluate the impact of National Grid's proposed Geothermal Projects on affordability of energy and energy services in a decarbonized future with reduced use of natural gas as a thermal energy source. From both a short- and long-term perspective, networked GSHP systems – like those proposed by National Grid – support affordable provision of energy and energy services to Massachusetts customers.

As discussed further in Section V.B, National Grid's proposed Geothermal Projects are reasonable in size, scope, and scale in relationship to their likely benefits, including with respect to costs. While the installation of a networked GSHP system can have higher upfront costs than installation of natural gas infrastructure, the former has no direct fuel costs during its 50-year expected lifespan. The primary costs of networked GSHP systems are operations and maintenance, as well as the electricity to run the pumps. Given that GSHPs are three to six times more efficient than current natural gas systems,[6] and networked GSHPs are likely to be even more efficient given their capacity for synchronous and asynchronous load canceling, the result is likely to be a lower customer cost of energy service, both monthly and over the life of the system (assuming the system is amortized over its lifetime as is the case for gas infrastructure). In addition, the absence of direct fuel costs would reduce cost volatility that leads to fluctuations in energy costs for customers. National Grid's proposed Geothermal Projects will provide valuable information on these points.

Looking ahead, decarbonizing the Commonwealth's heating and cooling systems will require significant use of renewable, non-GHG emitting fuels and technologies. Nonetheless,

[6] Compare Exh. FOH-1, at 7 (noting that GSHPs have an efficiency of 300–570%) with Energy Star rated Gas Furnaces, https://www.energystar.gov/products/most_efficient/furnaces (noting an efficiency of 97%).

LDCs are continuing to invest ratepayer funds in the replacement of a quarter of the aging gas pipes under our streets,[7] which leads to the risk of stranded assets. As explained by Mr. Bryant:

> Gas distribution companies are continually faced with decisions about repairing and replacing gas infrastructure that has reached the end of its useful life. If replaced, the new assets would typically have a sixty-year depreciable life. However, given Massachusetts' mandate to reach net-zero GHG emissions by 2050, with at least an 85% reduction in emissions, most new gas assets installed today will have a useful life of much less than sixty years. By contrast, geothermal district energy systems are estimated to have a useful life of fifty years.

Exh. HEET-SHB-1, at 4–5. "It is, therefore, in the public interest to expedite the evaluation of geothermal district energy systems so that, if demonstrated to be viable, investment can be redirected to a technology with a longer useful life." Id. at 5.

The point of any demonstration or pilot project is to test the proposed concept for the desired results and the potential for replication and scalability. Knowing what alternatives to natural gas pipeline replacement exist earlier rather than later would result in more informed decision-making and long-term cost savings for ratepayers.

3. Networked GSHP Systems, Like National Grid's Geothermal Projects, Advance the Commonwealth's Mandate to Reduce Greenhouse Gas Emissions

The Commonwealth's climate change laws demand a significant and relatively fast transition from natural gas to alternative sources of thermal energy, and the Department is tasked with helping to advance these changes. As explained by Mr. Bryant, "geothermal district energy

[7] See Applied Economics Clinic, *Planning For The Future: Massachusetts Cleans Up Its Heating*, at 1 (2020) (hereinafter "Planning for the Future"), https://static1.squarespace.com/static/5936d98f6a4963bcd1ed94d3/t/5eea18d1be9fa7700896f97a/1592400083010/Planning+for+the+Future_AEC+Brief_17Jun2020.pdf. This policy brief found that the total cost of the new gas infrastructure (installed between 2015 and 2040 as part of the Gas System Enhancement Plan, with the cost of capital and a 2% annual escalation in price), will be over $17 billion. At the current rate of charge ($5/month), ratepayers will be paying back this infrastructure until 2122.

systems are an opportunity for [achieving this transition] in a way that supports the public interest." Exh. HEET-SHB-1, at 6.

Both the Executive and Legislative branches are moving forward with ambitious climate change mandates, including the reduction of GHG emissions to net zero by 2050. Governor Baker committed to this net zero mandate in January 2020 during his annual State of the Commonwealth address[8] and the Secretary of Energy and Environmental Affairs signed a "letter of determination" to this effect in April 2020.[9] The 2021 Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy, St. 2021, c. 8 (the "Climate Law"), subsequently amended the Global Warming Solutions Act ("GWSA") to incorporate this net zero mandate, which includes a requirement to reduce GHG emissions at least 85% below 1990 levels by 2050.[10] Intermediate requirements include reducing GHG emissions at least 50% below 1990 levels by 2030 and the development of sector-based sub-limits, including for (i) natural gas distribution and service and (ii) commercial and residential heating and cooling. G.L. c. 21N, §§ 3, 3A, 4(h).

The Department and LDCs will have an important role in advancing these climate change mandates, including by supporting a transition away from the use of natural gas to alternative renewable, non-GHG emitting fuels and technologies. For instance, a Decarbonization Roadmap prepared by the Executive Office of Energy and Environmental Affairs ("EEA") highlighted the

[8] Governor's Press Office, *Governor Baker Delivers 2020 State of the Commonwealth Address* (Jan. 21, 2020), https://www.mass.gov/news/governor-baker-delivers-2020-state-of-the-commonwealth-address.

[9] See Exec. Office of Energy and Envtl. Affairs, *Determination of Statewide Emissions Limits for 2050* (Apr. 22, 2020), https://www.mass.gov/doc/final-signed-letter-of-determination-for-2050-emissions-limit/download.

[10] The Massachusetts Supreme Judicial Court has twice ruled that the GHG emission reduction requirements in the GWSA are legally binding mandates, as opposed to aspirational goals or targets. New England Power Generators Association v. Department of Environmental Protection, 480 Mass. 398, 399 (2018); Kain v. Department of Environmental Protection, 474 Mass. 278, 300 (2016).

importance of energy efficiency and electrification in the building sector, including through installation of GSHPs, to meet the Commonwealth's net zero mandate.[11] As such, the Department is required, when evaluating its own actions and those of the entities it regulates, to prioritize, with other factors, the reduction of GHG emissions to meet the Commonwealth's emissions limits and sub-limits.[12] The roadmap also noted the profound impact such changes will have on gas distribution system management, operations, and rates, thus requiring LDCs to make substantial changes to their planning processes and business models.[13] Relatedly, the Department, in an investigation on its own motion into the role of gas local distribution companies as the Commonwealth achieves its target 2050 climate goals, D.P.U. 20-80, is currently overseeing an evaluation of these and other issues relevant to the future role of natural gas companies in light of the Commonwealth's GHG emission reduction requirements. Information from National Grid's proposed Geothermal Projects will inform ongoing assessment and implementation of decarbonization strategies by entities such as EEA, the Department and the gas companies.

Geothermal district energy systems could be an important tool for converting the approximately 1,600,000 customers in Massachusetts that use natural gas for heating at a scale and pace needed to meet the Commonwealth's climate change mandates. Exh. HEET-SHB-1, at 3. National Grid's proposed Geothermal Projects would reduce GHG emissions by replacing the use of natural gas with water; the only GHG emitting energy used by the systems would be the electricity needed to operate the water and heat pumps. (As discussed by Mr. Smith, a

[11] Exec. Office of Energy and Envtl. Affairs, *MA Decarbonization Roadmap* 44–49 (Dec. 2020), https://www.mass.gov/doc/ma-2050-decarbonization-roadmap/download.

[12] G.L. c. 25, § 1A.

[13] *MA Decarbonization Roadmap*, *supra* note 11, at 51.

networked GSHP, or ambient temperature shared loop, system would still be a very efficient use of electricity even if connected to a traditional boiler or chiller to provide supplemental occasional heating or cooling as needed to address any potential annual imbalance in the heating and cooling load. Exh. DPU-HEET-1-1(b).) As the electric grid shifts to using more renewable energy, the GHG emissions from the proposed Geothermal Projects would continue to decrease.

The Legislature also contemplated the investigation of projects like those proposed by National Grid as a tool for achieving GHG emission reduction mandates. For example, in the Climate Law, the Legislature authorized the Department to approve "1 or more pilot projects for the development of utility-scale renewable thermal energy," including "sources, systems or technologies capable of substituting for fossil-based natural gas." St. 2021, c. 8, § 99. Notably, the Legislature adopted this law knowing that the Department had already approved two geothermal demonstration projects; the Legislature, therefore, clearly anticipated that more demonstration projects would be valuable and necessary. By significantly increasing energy efficiency (anywhere from three to six times that of current natural gas heating)[14] and electrifying end uses, the Geothermal Projects have the potential, once tested, to provide widespread low carbon heating solutions for the future. Exh. Initial Filing Vol. I of II, Pre-Filed Direct Testimony of the Future of Heat Panel, at 6–7 [hereinafter, "FOH-1"].

4. Shared Solutions, Like National Grid's Proposed Geothermal Projects, Support an Equitable Transition Away from Natural Gas

National Grid's proposed Geothermal Projects are the type of proactive and innovative initiatives that are needed to address potential disruptions, including inequitable distribution of costs and benefits, that could arise as the Commonwealth electrifies. For instance, the

[14] See *supra* note 6 (comparing efficiencies of Energy Star rated GSHPs and natural gas boilers).

Commonwealth's strategy for meeting its GHG emission reduction mandates includes an interim goal of electrifying the space heating deployed in approximately 1,000,000 buildings by 2030.[15] To date, transitioning buildings from natural gas has largely involved installing air source heat pumps in one building at a time. While this process will likely accelerate, it is unlikely to be sufficient to meet the 2030 building electrification goal and, without sufficient public or distributed funding, there is a risk that building-level conversions will be less accessible to low-income consumers. Installing networked GSHP systems can scale these efforts in a manner that accelerates building electrification and addresses this equity concern.

Decarbonizing heating sources in the building sector could lead to (i) a shrinking customer base for gas companies, where conversions to non-gas energy sources may leave a smaller number of consumers to bear a larger share of the fixed costs of the gas system, and (ii) a risk that financial losses from stranded or unprofitable gas infrastructure will be passed on to ratepayers. These disruptions raise equity concerns because lower-income consumers could bear a disproportionate burden of the costs caused by these disruptions as they are likely to have less financial ability to switch off of gas.

According to a recent analysis by the Applied Economics Clinic, geothermal loops present the lowest cost heating option for the average residential home.[16] Most GSHPs for single buildings are installed to supply enough heat for the peak demand hour of the year. This means that single-building installations are oversized for the vast majority of the year. Networked

[15] Exec. Office of Energy and Envtl. Affairs, *MA Interim Clean Energy and Climate Plan for 2030* 29 (Dec. 30, 2020), https://www.mass.gov/doc/interim-clean-energy-and-climate-plan-for-2030-december-30-2020/download. EEA is in the process of updating the Clean Energy and Climate Plan for 2030 to meet a new, higher target of 50%, as required by the recently passed Climate Law.

[16] Applied Economics Clinic, *Inflection Point: When Heating with Gas Costs More* 19 (Jan. 2021), *available at* https://static1.squarespace.com/static/5936d98f6a4963bcd1ed94d3/t/5fff6f26240e712d080225f5/1610575655937/Inflection+Point_White+Paper_AEC_13Jan2021.pdf.

GSHP systems, on the other hand, are designed for thermal balance (*i.e.*, designing and sizing the infrastructure to optimize the amount of time the shared loop of water can be kept within the desired temperature range without need for backup heating or cooling). By designing the system for thermal balance, rather than for peak load, the installed system and its attached boreholes can be smaller and less expensive per building, while the lifetime of the attached heat pumps can be extended. As GSHPs are more efficient than air source heat pumps, they would require less electric capacity, especially during temperature extremes when air source heat pumps would be least efficient.

Overall, LDCs are well-positioned to facilitate an equitable implementation of networked GSHP systems. LDCs have extensive experience managing evolutions in energy systems, working with diverse customer bases, and supporting customer transitions. For example, in the context of transitioning buildings from oil to gas, LDCs "have deployed tools that will be important for [National Grid's proposed Geothermal Projects], such as removing up-front homeowner costs by installing, leasing and financing replacement equipment and connection upgrades." Exh. HEET-SHB-1, at 6. In addition, LDCs have access to low-cost capital and the ability to recover costs over long time periods, factors that can decrease costs to consumers. Exh. FOH-1, at 36. The creation of a combined utility rate base for all types of thermal customers (*e.g.*, both gas and geothermal consumers), and hence a combined investment pool, would further support the role that LDCs can play in scaling up networked GSHP systems and advancing a just transition to a decarbonized future. Exh. HEET-SHB-1, at 4.

Developing experience with networked GSHP systems will also support a just transition for labor, including pipefitters and others who currently construct and maintain natural gas pipelines and associated infrastructure, by providing opportunities for continuing in their existing

jobs, with existing wages and benefits, through retraining, as needed, to work on this emerging technology.

B. National Grid's Proposed Geothermal Projects Are Reasonable in Size, Scope, and Scale in Relationship to Their Benefits

National Grid's proposed Geothermal Projects are reasonable in size, scope and scale in relationship to the benefits they will provide, including the development of new data and experience regarding the design, construction, implementation, maintenance and viability of networked GSHP systems installed and managed by utilities.

As the Department has noted, "geothermal technology itself is not new." D.P.U. 19-120, at 141. Existing systems, while generally not owned by utilities or utilizing public right of ways, do have multiple buildings with diverse types of energy use connected to a shared loop of ambient temperature water that is connected to boreholes or borehole fields for thermal energy management and storage. Thus, there is enough experience with networked GSHP systems to safely surmise that National Grid's demonstration projects will produce benefits beyond new knowledge. For example, existing networked GSHP systems have demonstrated cost savings for consumers, flexibility for growth and interconnections, and the ability to shift electricity use to reduce demand during peak electrical loads. Exh. HEET-DCS-1, at 9–16.

Despite this baseline of experience with networked GSHP systems, the technology is still nascent, particularly for systems run by utilities. Thus, virtually any new, utility-managed system will have novel characteristics along one or more dimensions, such as the specific technology utilized, the site's geological factors, the buildings' load profiles and uses, the buildings' ownership and occupancy diversity, customers' socioeconomics, customer outreach, and pricing models – to name just a few. While no project will be unique in every respect, National Grid's proposed Geothermal Projects are "reasonably designed to gather information

and insights on geothermal networks that will advance knowledge of their viability, effectiveness, and scalability." D.P.U. 19-120, at 141. Indeed, these projects will advance knowledge in several important ways, including, for instance, a commitment to focus on: (i) replacing leak prone gas pipelines with networked GSHP systems; (ii) prioritizing participation by existing customers; (iii) managing local gas system constraints and peaks; and (iv) engaging low-income customers and environmental justice communities. See Exhs. FOH-1, at 11; DPU-3-18, at 1; DOER-1-3.

In terms of leak prone pipes, the Department has noted that the only prior proposal for utility-managed, networked GSHP system demonstration projects in Massachusetts (*i.e.*, Eversource's) did "not incorporate any study of replacing aging pipes with geothermal technology." D.P.U. 19-120, at 147. However, there is importance in doing so. As Mr. Bryant explained:

> National Grid's proposed demonstration projects will add to the collective knowledge about geothermal district energy systems, including by addressing critical questions about how to replace gas service, including for consumers served by leak prone pipelines, with geothermal district energy systems. This focus on converting existing gas customers reduces the risk of stranding costs in new gas infrastructure and recognizes that Massachusetts' net-zero GHG strategy will require many natural gas heating customers to stop using natural gas in the not-too-distant future. This will be a huge process, and National Grid's demonstration projects will provide important data about a strategic opportunity for making this transition.

Exh. HEET-SHB-1, at 7.

Evaluating strategies for engaging customers and reducing barriers to adoption of geothermal is an important component of demonstration projects, as is producing data on the costs, implementation challenges, and consumer willingness to discontinue gas service.

National Grid's participation in networked GSHP systems will "build upon existing systems in novel and important ways," including by providing valuable new information

regarding the role of utility-owned geothermal systems. Exh. HEET-DCS-1, at 7. A utility-managed demonstration project for networked GSHP systems will provide important insights on issues such as:

> how to deploy these systems in a complex environment that involves factors such as multiple building owners and consumers, utility financing, a mix of private and public funding sources for individual building upgrades (where needed), detailed metering and billing arrangements, and access to right-of-ways. If designed to serve a diverse consumer base, a utility-based system also has the benefit of examining impacts and opportunities across a variety of ratepayers, including low-income consumers and residents of environmental justice communities.

Exh. DPU-HEET-1-7.

The fact that Eversource is also pursuing a geothermal demonstration project does not detract from the value of the information that National Grid's Geothermal Projects will generate. There are many differences between the projects that the two companies will pursue. Even where there may be common elements, such as recruiting participants, there are many approaches to such activities. There is value from multiple approaches to demonstration projects:

> Assuming there is shared access to data from demonstration projects, multiple approaches carried out by different administrators can add value to the learning process and to the ability to quickly scale-up new technologies and operating and financing mechanisms. Multiple companies leading demonstration projects may produce lessons about impacts from different management styles, business practices, and approaches for securing customers that can lead to stronger long-term solutions.

Exh. HEET-SHB-1, at 7. Such learning is critical to support the "large-scale systemic change" that will be needed to achieve the decarbonization required by the Commonwealth's climate change laws. Id. at 5.

National Grid's proposed Geothermal Projects will collect data to demonstrate that deploying GSHPs over a shared loop increases their overall efficiency and effectiveness with the

long-term result of reducing electric load and GHG emissions. Regulated utilities play an important role in this knowledge development in light of their obligation to serve all customers, including low-income consumers, and provide different rates for low-income consumers. The proposed projects will provide the data needed, from a range of different customer scenarios, to make informed decisions on investment of ratepayer funds. Given the potential benefits and savings for participants, ratepayers and the Commonwealth, together with consideration of the risks of not acting, National Grid's proposed Geothermal Projects are reasonable in size, scale and scope relative to their many benefits.

C. National Grid's Proposed Geothermal Projects Include Adequate Performance Metrics and Evaluation Plans

National Grid's proposed performance metrics are sufficient to enable meaningful and useful learning from the Company's proposed Geothermal Projects. From an equity perspective, HEET supports National Grid's proposals to evaluate barriers to participation for low-income customers and environmental justice communities. See Att. DPU 3-4, at 1 (proposed metrics 8 and 9). Ongoing performance metrics and evaluation plans should continue to assess the participation of both low-income customers and environmental justice communities as separate metrics.

Looking forward and thinking holistically regarding the Department's mandates, such as consideration of GHG emissions, and engagement in comprehensive planning, such as the D.P.U. 20-80 proceeding, HEET recommends several refinements to National Grid's performance metrics and evaluation plans in Section VI.C. These recommendations include suggestions for further ensuring that data collected are transparent, accessible and presented in appropriate context to support long-term planning by the Department and other entities, such as EEA's development of roadmaps to implement the GWSA.

D. National Grid's Proposed Geothermal Projects Present Opportunities to Demonstrate Long-Term Energy and Cost Savings for Customers That Outweigh any Short-Term Bill Impacts to Customers

The evaluation of the bill impacts of demonstration projects must consider both the costs and benefits of the projects. The point of any pilot program is to test the proposed concept for the desired results and the potential for replication. As discussed in Section V.A.2, LDCs are currently replacing leak prone gas pipes across the Commonwealth with natural gas infrastructure that could result in stranded assets – an economic risk that will likely be borne by ratepayers. National Grid's proposed Geothermal Projects present an opportunity to assess an alternative to additional investment in new natural gas infrastructure that could result in long-term cost savings, including by avoiding stranded asset costs. Successful deployment of networked GSHP systems would be a more efficient use of the billions of dollars of Gas System Enhancement Program funds[17] that are currently dedicated to replacing leak prone gas pipelines with new gas infrastructure. See G.L. c. 164, § 145.

Investing in networked GSHP systems provides numerous additional benefits, particularly when utilized as an alternative to expanding or replacing natural gas infrastructure. Examples of such benefits include: (i) improved air quality and associated reductions in related health care costs due to air pollution; (ii) public and worker safety due to reduced potential for explosions and fires; (iii) resilience in energy services; (iv) reduced demand for peak hour gas or electricity and associated need to upgrade capacity; (v) lower GHG emissions; and (vi) lower heating costs. Many of these benefits will provide financial savings, including through avoided additional costs, that accrue not only to ratepayers but to all residents of the Commonwealth, including through the future deployment and expansion of networked GSHP systems.

[17] See Applied Economics Clinic, *Planning for the Future*, *supra* note 7.

Collection of data from National Grid's proposed Geothermal Projects will enable a better understanding of the full range of benefits, savings and costs associated with deployment of geothermal technology. Failing to explore opportunities to reduce safety, economic and environmental risks could increase the long-term costs to customers, both with respect to energy bills and otherwise. The Geothermal Projects, which are reasonable in size, scope and scale, would be a prudent investment by National Grid to obtain data that can be used to realize cleaner, less expensive, and more efficient outcomes for ratepayers while providing broader societal benefits.

VI. RECOMMENDATIONS

As discussed herein, National Grid's proposed Geothermal Projects are reasonable, satisfy the Department's standard of review, and are an important step in advancing the Department's mandates, meeting the Commonwealth's GHG emission reduction requirements, and exploring new business opportunities for LDCs in a decarbonized future. HEET supports National Grid's Geothermal Projects as proposed but offers the following recommendations for further strengthening the projects, including by improving efficiencies and optimizing the value and use of information generated by the demonstration projects. Some of these suggestions aim to support a strategic vision for the potential larger scale deployment of networked GSHP systems as part of the Commonwealth's transition away from natural gas as a heating fuel and a new business model for the LDC of the future.

A. Prioritize Customer Engagement Through Enhanced Outreach and Reduction of Barriers to Participation

"Successful customer engagement is critical for implementing meaningful demonstration projects." Exh. HEET-SHB-1, at 5. In order to support successful advancement of knowledge

about networked GSHP systems, including the transition of existing gas customers to geothermal, HEET respectfully requests that the Department:

(i) Approve National Grid's plans to conduct education and outreach about siting and customer engagement for its proposed Geothermal Projects in collaboration with relevant neighborhood and advocacy organizations, and to make public meetings accessible to local residents with translation services if needed. Exh. DPU-2-4.

(ii) Direct National Grid to work directly with low-income tenants and landlords with low-income tenants, rather than dealing only with Housing Authorities. Such interactions could provide valuable information for addressing split incentives that often exist between landlords and tenants with respect to energy bills and related building renovations.

(iii) Provide National Grid flexibility in distributing the costs of the proposed Geothermal Projects, including models that significantly reduce or remove (i) upfront customer participation costs and (ii) monthly fees. To the extent that participating consumers do incur costs, these should be spread over time to increase customer accessibility. To this point, HEET supports National Grid's proposal to extend participant costs over a longer time period and suggests that the Company consider further steps to reduce individual costs. Exhs. DPU-2-12; DPU-2-16.

National Grid's proposed Geothermal Projects are an opportunity to develop models for ratepayer education and consumer adoption of this technology, both of which are essential to pave the way for large-scale systemic change. Advancing both these types of scalability is consistent with the public interest in having access to an affordable, safe, reliable and equitable source of thermal energy.

B. Strengthen Data Collection, Sharing and Transparency to Support Collaborative Learning and Enhance the Value of the Knowledge Created by the Geothermal Projects

Given that a primary purpose of demonstration projects is to create new knowledge, robust and transparent data collection and dissemination will further the value of such projects. The data and subsequent analysis from National Grid's proposed Geothermal Projects are necessary to inform how the technology can be expanded, replicated, and otherwise deployed in

service of the Department's mandates and the Commonwealth's GHG emission reduction mandates. Relevant to this process, HEET has created a GeoGrid Consortium and Research Team to better centralize and share best practices, study the feasibility of deploying networked GSHP systems and building GeoGrids, and otherwise advise and support the development of this technology for the public good.[18] To support informed engagement and identification of best practices, HEET respectfully requests that the Department direct National Grid to:

(i) Participate, and where appropriate direct subcontractors to participate, in HEET's community charrette process (discussed in Section III.A). See, e.g., D.P.U. 19-120, at 153. HEET will work with National Grid to include site-specific stakeholders and design charrette(s) to reflect issues unique to the Company's proposed Geothermal Projects.

(ii) Seek public input on metrics for data collection from networked GSHP systems as well as participate in the HEET Research Team's development of a standard set of metrics to allow comparison between projects, including by submitting data from the proposed Geothermal Projects to HEET's GeoGrid Database. Sufficient data should be collected to adequately measure the full range of costs and benefits of the proposed Geothermal Projects. Standardizing these metrics with Eversource and other utilities will support comparison of results across multiple installations and other low carbon heating solutions, thus enhancing learning, and the resulting data will support analysis of the challenges and benefits of scaling geothermal infrastructure.

(iii) Consider opportunities to use control software for the proposed Geothermal Projects that integrates data acquisition features that can create a learning profile in order to optimize information collection and the systems' operational efficiencies and costs. The information that would be generated by such learning profiles will be particularly important as networked GSHP systems begin to scale. Exh. DPU-HEET-1-3.

(iv) To the extent permitted by law, make all data from the proposed Geothermal Projects, including the cost of capital, transparent and publicly available. If relevant, all efforts should be made to anonymize and otherwise find means of sharing confidential consumer or business data rather than withhold such information. To the extent data still are not shared, National Grid should clearly describe what information is not available to the public and seek public input on how to share lessons from the withheld data.

[18] HEET's research team includes researchers and analysts from Lawrence Berkeley National Laboratories, University of California Berkeley, Harvard University's T.H. Chan School of Public Health, U.S. National Renewable Energy Laboratories, MIT Sloan School, and Buro Happold Engineering.

Accessible and transparent data will support opportunities to learn and think about both the immediate next steps and long-term strategies for deploying networked GSHP systems and the benefits they can provide. Transparent, accessible data normalized for comparison with other demonstration efforts will allow the public's investment in these demonstration projects to maximize the delivery of public benefit.

C. Incorporate Additional Design Components and Evaluation Metrics to Further Enhance System Performance and Project Learning

HEET recognizes that one point of demonstration projects is to test different technologies and system configurations, and that a single project is unlikely to optimize all design features. As such, any evaluation of National Grid's proposed Geothermal Projects should acknowledge what features were not tested but that could have improved the system's performance or efficiency. In this vein, HEET respectfully requests that the Department direct National Grid to:

(i) Design the proposed Geothermal Projects as dynamic systems that "consider not just aggregated peak load but also the fluctuations and durations of load demand, using stochastic modeling and optimization to determine the necessary infrastructure." Exh. DPU-HEET-1-2. Relatedly, to ensure that the Geothermal Projects are best designed to meet the varying load requirements of the buildings connected to the system, the Department should ensure that National Grid retains significant control over building retrofits and heat pump sizing. Exh. HEET-DCS-1, at 8.

(ii) Engage its design team in a third-party design review process that allows networked GSHP design specialists not directly employed by National Grid to consider and comment on the site selection, modelling, and design decisions. Given the innovative nature of these demonstration projects and the lack of standardized "rules of thumb" for the design process, HEET recommends this as a tactic to minimize risk and maximize positive outcomes.

(iii) In evaluating the performance, efficiency and cost of the proposed Geothermal Projects, identify significant design features and business models that were not utilized but could have affected performance, efficiency or cost. This should include, for example, to the extent applicable, design features and business models such as: (i) the use of a single backup heater on a shared loop of water, rather than backup heating units for each customer, as the former would be more efficient, less expensive, and less disruptive from a construction and installation

perspective; (ii) the opportunities for interconnection with other networked GSHP systems and introduction of additional thermal sources and sinks on an ambient temperature shared loop, and the impacts of such connections on the Geothermal Project's resiliency and National Grid's ability to shift loads to address intermittency or other constraints on the electric grid; and (iii) a combined rate base for all thermal customers, whether gas or geothermal. To the extent data are available to quantify the impacts of such design choices, such data should be made available to the public.

(iv) In comparing the costs of the proposed Geothermal Projects to the cost of new natural gas infrastructure, account for the fact that, in light of the Commonwealth's aggressive GHG emission mandates, geothermal infrastructure has a longer useful lifespan than new natural gas infrastructure.

(v) Engage its workforce, including direct employees and contractors, in the Geothermal Projects, including by providing training, during and after the installation of the Geothermal Projects, on how to install, operate and maintain networked GSHP systems.

In light of the numerous design options for networked GSHP systems and increased opportunities for efficiencies as the systems scale and interconnect, any assessment of National Grid's Geothermal Systems by the Company or the Department must account for opportunities to maximize efficiencies that were not integrated into the demonstration projects.

Finally, an overarching recommendation is that National Grid's design, siting, implementation, and assessment of the proposed Geothermal Projects should be subject to a robust stakeholder process.

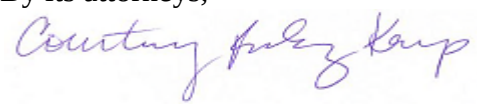
VII. CONCLUSION

For the reasons discussed herein, HEET respectfully requests that the Department approve National Grid's proposed Geothermal Projects.

Respectfully Submitted,

The Home Energy Efficiency Team, Inc. (HEET)

By its attorneys,



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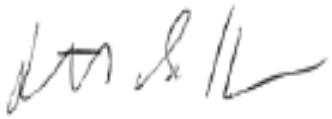
DATED: August 11, 2021

CERTIFICATE OF SERVICE

I certify that I have this day served the foregoing document on all parties of record in the above-captioned proceeding in accordance with the requirements of 220 C.M.R. § 1.05.



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Jonathan S. Klavens

DATED: August 11, 2021