MINNESOTA
PUBLIC UTILITIES COMMISSION

Thermal Energy Network Deployment Workgroup Report

12/15/2025

Letter from Executive Secretary to Legislature

December 15, 2025

Senator Nick A. Frentz
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St. Paul, MN 55155

Representative Patty Acomb
Co-Chair
5th Floor Centennial Office Building
St. Paul, MN 55155

Andrew Mathews
Ranking Minority Member
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Representative Chris Swedzinksi
Co-Chair
2nd Floor Centennial Office Building
St. Paul, MN 55155

Dear Senator Frentz, Senator Mathews, Representative Acomb, and Representative Swedzinski,

This report presents the discussions, findings, and recommendations of the Thermal Energy Network Deployment Workgroup ("TEN Deployment Workgroup" or "the Workgroup"), a group of over 80 stakeholders from more than 50 organizations convened by the Minnesota Public Utilities Commission at the direction of the Minnesota Legislature in 2024 Minnesota Laws Chapter 127, Article 42, Section 49. The Legislature specified the makeup of the Workgroup, requiring the participation of several state agencies, including the Department of Commerce, the Department of Health, the Department of Natural Resources, the Pollution Control Agency, and the Office of the Attorney General. In addition, the Workgroup was required to include representatives from a broad range of stakeholder groups, including utilities, clean energy advocacy organizations, labor organizations, geothermal technology providers, consumer protection organizations, cities, and low-income communities. In total, 85 individuals from 56 organizations committed to participating in the workgroup in an official capacity.

Over the course of a year, the Workgroup examined potential regulatory opportunities and barriers for regulated natural gas utilities to deploy thermal energy networks. The Workgroup then developed recommendations for the Legislature for how to structure regulation so that it protects the public interest, accounting for reliability, affordability, environmental, and socioeconomic impacts. The report provides background on TENs and the Workgroup's format, summarizes key takeaways from Commission-hosted informational workshops, describes the roundtable discussions used to develop recommendations, and concludes with the Workgroup's recommendations for the Legislature's consideration.

The recommendations contained in this report are the work of the stakeholders that made up the Workgroup and are not those of the Minnesota Public Utilities Commission.

Sasha Bergman, Executive Secretary

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About Facilitator

The Great Plains Institute (GPI) is a nonpartisan, nonprofit organization focused on transforming the energy system to benefit people, the economy, and the environment. For over 25 years, GPI has worked across the US, combining a unique consensus-building approach, expert knowledge, research and analysis, and local action to find and implement lasting solutions. GPI fosters effective collaboration among regulators, utilities, consumer advocates, environmental organizations, community groups, labor, industry, and other parties to help groups identify transformative and lasting solutions to energy-related challenges. Learn more at www.betterenergy.org.

Usage of this Report

This report summarizes the process and recommendations of the Thermal Energy Network Deployment Workgroup process. The views and recommendations shared in this report represent the collective thinking of the Workgroup's participants. No view should be attributed to any specific individual member, nor the Minnesota Public Utilities Commission. The Minnesota Public Utilities Commission speaks exclusively through its orders, and participated in this process as a host, but not as a member.

Comments

The Minnesota Public Utilities Commission welcomes input and feedback on the content and conclusions of this Thermal Energy Network Deployment Workgroup Report. All workgroup members received an advance copy of this report and were given the opportunity to review and suggest modifications. After the publication of this report, the Minnesota Public Utilities Commission will issue a Notice of Comment Period in Docket No. G-999/CI-24-275 and G-999/CI-21-565 to provide a location for parties to file public comments on this report.

[1] Trey Harsch's employment with the Public Utilities Commission ended on September 26, 2025.

Questions about this Report

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Upon request, this material will be made available in an alternative format such as large print, Braille, or audio recording. Printed on recycled paper.

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- **WSP -** Charlie Marino and Philip Jonat
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Executive Summary

As the United States navigates the energy transition, Minnesota faces unique challenges related to its geography and climate. Thermal energy networks (TENs) have gained traction as a promising technology because they can provide reliable and affordable heating and cooling year-round in Minnesota. Minnesota now joins a growing list of states where regulators are exploring how utilities can leverage TENs to meet their customers' heating and cooling needs. Many other states have also either filed legislation or are considering legislation related to TEN deployment.[2]

What is a Thermal Energy Network (TEN)?

TENs provide space heating, cooling, and water heating to multiple buildings through a shared thermal loop. The pipes that make up the loop are filled with fluid (typically water or a water-glycol mix), and this system can distribute thermal energy without combusting natural gas. There are many characteristics of TENs – such as pipes and drilling – that benefit from existing knowledge and skills of natural gas utilities.

Minnesota's Steps So Far

While municipalities, private businesses, and other non-regulated entities have historically operated TENs, Minnesota has passed two laws to enable gas utilities to pilot TENs:

- **Natural Gas Innovation Act (NGIA) (2021):**[3] Allows natural gas utilities to pilot innovative resources (including TENs) to reduce the throughput of conventional natural gas delivered to Minnesota customers. Xcel Energy and CenterPoint Energy are piloting TENs under their plans.[4]
- **H.F. No. 5247 (2024):**[5] Requires the Minnesota Department of Commerce to conduct a state-wide TEN site suitability study and requires the Minnesota Public Utilities Commission (the Commission) to create a thermal energy network deployment workgroup (Workgroup).

Specifically, the workgroup established under H.F. No. 5247 received a directive to examine potential:

- Regulatory opportunities for regulated natural gas utilities to deploy TENs,
- Barriers to regulated natural gas utilities deploying TENs,
- Public benefits, costs, and impacts of deploying TENs, and
- Rate design options.

[2] See Pages 18-19 for full list.
[3] Minn. Stat. § 216B.2427, Natural Gas Utility Innovation Plans. https://www.revisor.mn.gov/statutes/cite/216B.2427
[4] Currently, both TEN pilot projects are evaluating suitable sites and working on formal site suitability studies, which, once complete, will be filed for review by the Commission. CenterPoint: Docket No. G-008/M-23-215; Xcel: Docket No. G-002/M-23-518.
[5] H.F. No. 5247, Article 42, Section 49, https://www.revisor.mn.gov/bills/text.php?number=HF5247&version=0&session=ls93&session_year=2024&session_number=0&type=ccr

The legislation directed the process to culminate in "a report containing findings and recommendations regarding how to deploy [TENs] within a regulated context and in a manner that protects the public interest and considers reliability, affordability, environmental impacts, and socioeconomic impacts," and that the report be filed for public comment. This report is a result of the Workgroup efforts.

The Workgroup met eight times between October 2024 – June 2025, over four informational sessions and four roundtable discussions. The Commission convened the informational sessions, and the Great Plains Institute (GPI) convened roundtable discussions. The Workgroup included 85 representatives from 56 groups, including Minnesota state government agencies, utilities, clean energy advocacy organizations, labor organizations, geothermal technology providers, consumer protection organizations, a tribal government, cities, consumer advocacy groups, and low-income community organizations. More information on Workgroup membership, schedule, structure, and approach is detailed starting on Page 14. The informational sessions and workgroup discussions informed the development of the recommendations included in this report.

TENs Considerations from Informational Sessions

Presenters at the informational sessions identified a range of potential positive and negative impacts of TENs, as well as general considerations that the Workgroup could consider when forming recommendations. These are summarized below. (Full discussions are available on pages 18-39).

Potential Impacts of TENs	***Potential Positive Impacts***
	• **Grid Support:** By improving efficiency and lowering peak electricity demand, TENs can reduce strain on the grid and limit the need to build out new electric infrastructure. • **Emissions Reductions:** TENs could support Minnesota's 2050 net zero emissions goal[6] by electrifying traditionally fuel- or mixed-grid-powered services. • **Jobs:** Building and maintaining TENs uses many of the same skills as natural gas infrastructure, and therefore could offer expanded job opportunities for utility workers and HVAC contractors. • **Highly Efficient:** TENs can heat and cool buildings more efficiently than air-source heat pumps, electric resistance heating, or efficient gas furnaces. • **Network Scalability:** Once a TEN is built, it can expand to serve more buildings, increasing system stability and potentially expanding system diversity. It can also become cheaper to expand the system once established. • **Fuel Cost Savings:** Because TENs reduce gas consumption and use electricity efficiently, they can cut both electric and gas bills.

[6] Minn. Stat. § 216H.021, subd 1, Greenhouse Gas Emissions Reporting. https://www.revisor.mn.gov/statutes/cite/216H/full#stat.216H.021

	• **Reliability and Resilience:** TENs are capable of delivering reliable thermal services year-round, including during extreme weather events. • **Utilization of Local Resources:** TENs can leverage local thermal resources (such as wastewater exchange, lakes, and ice rinks), which could improve resilience and reduce cost. • **Safety and Air Quality:** The use of non-combustible fluids reduces or eliminates the risk of gas leaks, explosions, and exposure to indoor air pollutants. ***Potential Negative Impacts*** • **Cost Implications of Redundant Infrastructure:** Utilities may have to maintain both gas lines and thermal loops unless current laws change around utilities' duty to serve customers, meaning that customers will be paying to maintain two systems that may serve similar purposes. • **Remaining System Life:** There could be adverse rate impacts in areas of TEN deployment where gas assets have substantial life left. • **Construction Disruption:** TENs often require street excavation and building access, which can provide disruptions for customers.
Other TENs Considerations	• **Building Efficiency Requirements:** TENs work best in well-insulated, energy-efficient buildings, which may require major retrofits for existing building stock. • **Land Access:** TENs create the potential for complex land access agreements, beyond standard right-of-way approvals. • **Customer Education and "Buy-In" to the System:** Residents and business owners along a TEN loop must understand and agree to receive the benefits. • **Early Costs:** Pilot projects have cost more than anticipated, which is expected in early-stage technology. The U.S. Department of Energy projects that costs are likely to decline significantly as the technology matures. • **Rate Design Uncertainty:** Utility-led TEN pilots are currently financed by the general rate base. Future options might include separating TEN customers from gas customers or sharing costs with electric utilities, but these concepts need more refinement. • **Incentives:** Increasing incentives for TEN-facing technology in buildings would help with upfront costs of TEN implementation. • **Legal/Regulatory Barriers and Opportunities:** Current definitions of TENs, service, and other items in statute and rule can be restrictive and ambiguous. Updating and expanding statutory definitions would result in less ambiguity, greater flexibility, and clarity around cost recovery and allocation for TENs.

Workgroup Recommendations

Building on education gained during the informational sessions and through the roundtable discussions, the Workgroup coalesced around four topic areas for recommendations.

At the conclusion of the roundtable discussions, participants reached consensus on the following recommendations. **Importantly, consensus means that all parties present at the final meeting said that they did not oppose including the recommendation in this report.** In some circumstances, individual parties reached consensus on moving a solution forward even if that party did not support all sub-components of that recommendation.

Table 1: TENs Workgroup Findings and Recommendations

Topic I: Defining TENs in Minnesota State Law Some may interpret Minnesota's statutory definitions of TENs and district energy systems as not being aligned. Specifically, some may interpret Minnesota's definition of TENs as being more narrow than is necessarily required. This ambiguity may create barriers to deployment. Recommendation 1 thus presents pathways through which the definition of TENs could be expanded to avoid unintended restrictions on the types of TENs that can be piloted and later deployed more broadly.
Recommendation 1: The legislature should adopt a definition for TENs that reflects legislative goals and desired outcomes and that would encompass a broad range of systems for gas utility-owned TENs outside of the NGIA context. The new or revised definition should, at a minimum, aim to achieve the following outcomes:
1a: Affordable. Enable affordable TENs service that result in customer costs that are comparable to or lower than other services, as determined in gas and electric integrated resource plans and subject to the Commission's duty to ensure just and reasonable rates.
1b: Cost-Effective Over Time. Support TENs deployment that enables long-term cost reduction as the market scales. Cost-effectiveness criteria as established in NGIA approvals should be applied for pilot projects while post-pilot deployment should be subject to the Commission's duty to ensure prudent investments that are in the public interest.
1c: Carbon-Reducing. Enable Minnesota's regulated gas utilities to further work towards achieving Minnesota's greenhouse gas reduction goals to deploy TENs in a way that is consistent with Minnesota's greenhouse gas reduction goals under Minn. Stat. § 216H.02, prioritizing carbon-free systems and limiting fossil fuels to cases aligned with a clear path to net-zero by 2050.
1d: Variety of Thermal Services. Clarify that TENs can provide space heating, cooling, hot water heating, and other thermal services, including industrial heat, supporting a broad range of end uses. Recognize that the mix of service may evolve over time as lessons are learned from pilot projects and deployment experience.
1e: Variety in Thermal Sources and Technologies. Allow TENs to utilize a range of thermal sources and technologies, prioritizing non-combustion and low-carbon options

for regular operation. Limit fossil fuel use to backup or peak-load scenarios, with a clear pathway to meet Minnesota's 2030 and 2050 greenhouse gas reduction targets. Alternative and legacy systems may be included where appropriate but should be the exception rather than the standard. Recognize that the mix of thermal sources and technology options may evolve over time as lessons are learned from pilot projects and deployment experience.

1f. Targeted Oversight. Commission oversight should be scaled based on factors such as system size, type of customers served, and public interest, ensuring that small-scale, non-utility systems are not subject to unnecessary regulatory burdens, while larger or residential-service systems receive appropriate consumer protections. This should work in tandem with any definitional changes to "public utility" and/or "service" as provided in this report. Recognize that applying these distinctions may be complex in practice, and authority should be delegated to the Commission to determine and refine oversight criteria as needed.

Topic II: Minnesota's definitions of a "public utility" and "service" under § 216B.02

The definitions of "public utility" and "service" (in Minn. Stat. § 216B.02) generally outline the entities that are subject to Commission rate regulation and are thus authorized to recover prudently incurred costs through cost-of-service rates. However, the definitions of "public utility" and "service" may benefit from additional clarity regarding utilities' ability to recover TENs-related costs outside of an Innovation Plan consistent with NGIA.

Recommendation 2: The definitions of "public utility" and "service" in Minn. Stat. § 216B.02 Subds. 4 and 6 may create uncertainty for TEN deployment. The legislature should either modify these definitions or add a new statutory subdivision to clarify that regulated utilities may provide thermal energy as a utility service. This statutory authority should:

- Exempt existing non-utility TENs from becoming regulated public utilities.
- Authorize regulated gas and electric utilities to invest in and recover costs for TENs deployed outside of NGIA, subject to Commission approval and a determination that such investments serve the public interest based on affordability, reliability, and decarbonization benefits.
- Affirm that Tribes retain the authority to self-regulate thermal energy services on tribal lands.
- Ensure customer protections consistent with Minn. Stat. §§ 216B.096, .097, and .0975, and allow low-income assistance under § 216B.16, subds. 14 and 15.

Topic III: Standard of Service/Obligation to Serve

TENs are most cost-effective when all customers in a given area agree to interconnect to the system. If a utility deploys a TEN in a given area, but not all customers in that area initially agree to interconnect to the TEN, the utility may interpret Minn. Stat. 216B.04 as an obligation to continue providing both TEN and natural gas service to this area. This overlapping infrastructure would be costly. Consideration for ways to avoid costs associated with overlapping TENs and natural gas systems could be valuable. Additionally, locating TENs in areas that are most

economical and that contain customers interested in switching to TENs—taking geographic, zoning, and equity factors into consideration—will aid in effective TENs deployment.
Recommendation 3: TENs should be prioritized in certain zones based on geographic, economic, and equity-related factors, along with broader planning considerations. Prioritization should not preclude deployment in other areas; rather, it should guide near-term focus where conditions are especially favorable or policy-aligned. Considerations should include:
3a. Geographic or Infrastructure-Based Suitability. Prioritize zones where traditional gas infrastructure is less feasible or prudent (as evaluated using integrated resource planning to compare TENs with other thermal energy technologies) due to factors such as: o Absence of existing natural gas infrastructure (e.g., new developments or reliance on delivered fuels). o As an alternative to gas or electric system capacity expansion. o End-of-life gas infrastructure. o Building characteristics such as density or HVAC type (e.g., prevalence of boilers). o Access or proximity to renewable thermal resources (e.g., wastewater).
3b. Suitable Sites. Prioritize communities that meet prioritization criteria from the Minnesota Thermal Energy Network Site Suitability Study currently being developed by the Minnesota Department of Commerce.
3c: Interested Communities. Prioritize communities that have demonstrated significant interest in participating in TENs.
3d: Attributes of Successful Pilots. Identify and prioritize communities with similar characteristics to those where TEN pilots have succeeded.
3e: Equity and Policy-Aligned Decarbonization Zones. Prioritize targeted decarbonization zones, including located in low-income and/or environmental justice areas as defined in Minn. Stat. § 116.065, subd. 1(e) (2023), indigenous communities, rural towns, and other areas unlikely to be early market entrants without public investment or policy support.
Recommendation 4: The Legislature should support the development of strategies that would facilitate equitable TEN deployment and incentivize participation from customers that are not interested or have prohibitive barriers to participation, especially in geographic and/or economic zones currently served by natural gas service but targeted for TEN deployment. Such strategies include: • Incentives or financing options. • Ensuring that existing low-income gas customers and/or gas customers in environmental justice areas have affordable service options to support their transition. • Supporting development of customer educational resources and outreach programs about TENs and their functionality. • Leveraging existing or creating new energy efficiency programs and/or other home retrofit and appliance upgrade programs that would help prepare existing homes for TENs.
Recommendation 5: The legislature should review and revise as needed Minn. Stat. § 216B.04 such that if a regulated utility provides an adequate alternative via a TEN to natural gas service

(e.g., heating service of comparable reliability and similar or lesser cost compared to natural gas) to an area that is currently served by natural gas, the utility is no longer obligated to also provide natural gas service to that area, in accordance with specific parameters. These parameters include:

- Establishing a reasonable timeframe by which the utility must safely decommission the natural gas system in areas with both natural gas and TEN service, and by which customers in the area that are still receiving gas service must decide whether they want to interconnect with the TEN or pursue an alternative heating source such as an alternative means of electrification.
- Directing the Commission to establish noticing requirements to ensure that customers are well-informed regarding the point in time at which their natural gas service will cease, similar to the two-year noticing requirement proposed under the New York Home Energy Affordable Transition Act.
- Clarity regarding gas utilities' responsibilities related to existing gas infrastructure once an area is served fully by a TEN.
- Clarity that electric utilities may offer TENs in service areas that are not served by a natural gas distribution system.

Topic IV: Other Ways to Incentivize Deployment

Regulated gas utilities are currently authorized to deploy TENs and recover associated costs in accordance with the existing NGIA framework. Regulated gas utilities could also elect to propose TENs in their Expansion Alternatives Analysis under the new gas utility Integrated Resource Plan (IRP) framework. There could be value in further expanding avenues through which utilities can deploy TENs, recovering prudently incurred costs associated with TENs, and/or enabling deployment of a greater variety of types of TENs to catalyze learning and innovation.

Recommendation 6: The legislature should consider ways to enable utilities to deploy more TEN pilots and/or a greater variety of TEN pilots. Potential pathways through which the legislature could do this include (but may not be limited to) the following:

- Directing the Commission to consider approaches that would ensure TENs are evaluated under the Expansion Alternatives Analysis in gas utility IRPs with analysis of electric grid infrastructure impacts and costs, and/or
- Exploring ways through which more TEN pilots (and/or a wider variety of TEN pilots) could be deployed under the NGIA, such as amending the NGIA cost caps.

The report that follows covers these topics in greater detail.

Introduction

The United States is in the midst of an energy transition, the effects of which are being felt by both the electric and natural gas systems. In light of expected increases to customer rates, aging infrastructure, projected load growth, and concerns about climate change, there is increasing interest across the U.S. in innovative solutions for utility systems. Over the last several years, Thermal Energy Networks (TENs) have gained traction due to their innovative, highly efficient, carbon-reducing design and their ability to provide heating services similar to those provided by natural gas.

At their most basic, TENs are systems capable of providing heating and/or cooling services to multiple buildings on one network. These systems are made of a network of underground pipes filled with fluid (the thermal network), which serve as the vehicle for the thermal energy provided by the system. Each building connects to, and exchanges thermal energy with, other buildings and the thermal energy resources connected to the network. Thermal energy resources include any number of thermal sources (which generate the heating or cooling), sinks (which absorb the heating or cooling), and storage. Potential thermal resources include wastewater exchange, waste heat from industrial processes and data centers, and any number of natural resources such as lakes, rivers, and geothermal boreholes.

TENs credit much of their efficiency to being insulated from variations in outdoor air temperature, and their focus on transferring existing thermal energy from their sources to the receiving buildings. TENs have the potential to replace or avoid natural gas infrastructure and provide efficient thermal services to entire neighborhoods, allowing them to electrify their heating and cooling efficiently.

Until recently, TENs have only been owned by private or otherwise non-regulated entities in Minnesota. Several non-utility entities are currently developing TEN systems in Minnesota: the City of Rochester,[7] the Heights Community in Saint Paul,[8] Como Park Zoo,[9] and the City of Duluth.[10] There are also TENs operating in other states under various ownership models, from the city of Framingham, MA, to a university in Grand Junction, CO, to a housing development outside of Austin, TX.

At first glance, regulated utilities appear to be a good match for this technology because the thermal network itself serves as a natural monopoly not unlike a gas or electric distribution system,

[7] ACHR News. (n.d.). *Creating thermal energy networks in Rochester, Minnesota*. https://higherlogicdownload.s3.amazonaws.com/DISTRICTENERGY/998638d1-8c22-4b53-960c-286248642360/UploadedImages/Creating_Thermal_Energy_Networks_in_Rochester_Minnesota___ACHR_News.pdf

[8] City of Saint Paul. (2023, October 4). *The Heights awarded $4.7 million for geothermal energy system*. https://www.stpaul.gov/news/heights-awarded-47-million-geothermal-energy-system

[9] Como Park Zoo & Conservatory. (n.d.). *Honeywell and Como Park Zoo & Conservatory partner to support Saint Paul's climate action goals*. https://comozooconservatory.org/geothermal/

[10] City of Duluth. (n.d.). *Community geothermal*. https://duluthmn.gov/sustain/news-updates/community-geothermal/

and utilities' experience financing large utility-scale projects. However, TEN deployment by regulated utilities faces barriers which require legislative intervention to overcome.

As interest in TENs has grown in Minnesota, questions have arisen about the legislative steps needed to allow regulated utilities to continue to deploy this technology and better assess its costs and benefits. If pilot projects prove successful, stakeholders question whether utilities are legally permitted to pursue additional TEN projects beyond the pilot stage, and whether the Minnesota's Public Utilities Commission (the Commission) has the authority to provide sufficient oversight as these systems expand. In addition, many questions remain about the long-term regulatory framework needed to ensure that ongoing TEN service is reliable and cost-effective, and about the role that TENs can play in achieving the state's decarbonization goals. While the answers to these questions will be shaped significantly by the results of early utility TEN pilot projects, these questions were also examined by this Workgroup.

This report presents the discussions, findings, and recommendations of the Thermal Energy Network Deployment Workgroup ("TEN Deployment Workgroup" or "the Workgroup"). Tasked by the Legislature, the Workgroup examined potential regulatory opportunities and barriers for regulated natural gas utilities to deploy thermal energy networks. The Workgroup then developed recommendations for the Legislature for how it might structure regulation to protect the public interest, accounting for reliability, affordability, environmental, and socioeconomic impacts. The report provides background on TENs and the Workgroup's format, summarizes key takeaways from Commission-hosted informational workshops, describes the roundtable discussions used to develop recommendations, and concludes with the Workgroup's recommendations for the Legislature's consideration.

Background

District Heating and Cooling Systems

TENs are commonly described within the context of district heating and cooling systems. District heating and cooling systems can be broadly defined as systems that generate and distribute thermal energy (heating and/or cooling) from one or more thermal production facilities to multiple buildings through a network of underground pipes.[11,12,13,14] These systems are diverse, varying in size, configuration, and energy sources.

By aggregating the heating and cooling needs of multiple buildings into a single, stable load, district heating and cooling systems improve energy efficiency, reduce the need for excess capacity, and

[11] U.S. Department of Energy, *Combined Heat and Power Technology Fact Sheet Series: District Energy*, (2020, September) https://www.energy.gov/sites/default/files/2021/03/f83/District_Energy_Fact_Sheet.pdf
[12] U.S. Energy Information Administration, "District Energy," *Glossary*, accessed April 9, 2025, https://www.eia.gov/tools/glossary/index.php?id=District
[13] Building Decarbonization Coalition, *TEN Definitions*, accessed April 9, 2025, https://buildingdecarb.org/resource-library/ten-definitions
[14] Zeyneb Magavi, Angie Alberto-Escobar, and Isabel Varela, "A Definitional Taxonomy for (Geo)Thermal Energy Networks," (2024). *GRC Transactions*, Vol. 48

enable thermal production facilities to operate more consistently at optimal levels. Steam- and water-based district heating and cooling systems have existed in Minnesota for many years:

- Duluth's city-owned district energy system has been heating buildings since 1932.
- Saint Paul's district energy system has provided heating services since 1983 and cooling services since 1993.[15]
- Cordia's Minneapolis district facility has offered heating services since 1972.[16]

District heating and cooling systems have seen steady advancement through time to accommodate technical innovations, a larger variety of thermal sources and sinks, cooler operating temperatures, new network configurations, and the goal of decarbonization, among other things. Each generation of systems (numbered one through five) can be defined by a set of characteristics that distinguishes it from previous generations:

1. **First Generation**: Steam-based, high temperature, centralized, heating only.[17]
2. **Second Generation:** Pressurized hot water (> 100°C) for improved safety and efficiency.[18]
3. **Third Generation:** Lowered temperature requirements (70-100°C), pre-insulated pipes, reduced heat loss, broader range of thermal sources with fossil fuels as the most prevalent.[19, 20]
4. **Fourth Generation:** Further reduced operating temperatures (≤70°C), enabled lower temperature renewable thermal sources, allowed for thermal storage, enabled bi-directional flows, integrated district cooling.[21, 22, 23]
5. **Fifth Generation:** Near-ambient operating temperatures, decentralized thermal sources, heating and cooling provided via building-level heat pumps, customers can act as both consumers and producers of thermal energy ("prosumers").[24, 25]

[15] District Energy St. Paul. (n.d.). *History*. https://www.districtenergy.com/about/history/
[16] Cordia. (n.d.). *Minneapolis district energy network.* https://cordiaenergy.com/our-networks/minneapolis/
[17] Juliet G. Simpson, Nicholas Long, and Guangdong Zhu, "Decarbonized District Energy Systems: Past Review and Future Projections," (2024, October). *Energy Conversion and Management: X,* Volume 24: 100726, https://doi.org/10. /j.ecmx.2024.100726.
[18] *Id.*
[19] Henrik Lund, Poul Alberg Østergaard, Tore Bach Nielsen, Sven Werner, Jan Eric Thorsen, Oddgeir Gudmundsson, Ahmad Arabkoohsar, and Brian Vad Mathiesen, (2021, July 15). "Perspectives on Fourth and Fifth Generation District Heating," *Energy* 227: 120520, https://doi.org/10.1016/j.energy.2021.120520.
[20] Simpson et al, "Decarbonized District Energy Systems"
[21] *Id.*
[22] Lund et al, "Perspectives."
[23] Matthias Sulzer, Sven Werner, Stefan Mennel, and Michael Wetter, "Vocabulary for the Fourth Generation of District Heating and Cooling," (2021, February). *Smart Energy* 1: 100003, https://doi.org/10.1016/j.segy.2021.100003.
[24] Zeyneb Magavi, Angie Alberto-Escobar, and Isabel Varela, "A Definitional Taxonomy for (Geo)Thermal Energy Networks," (2024). *GRC Transactions*, Vol. 48, https://cdn.prod.website-files.com/649aeb5aaa8188e00cea66bb/671b0629c6bc4b994c041c9c_2024_GRC_Taxonomy_Magavi_Alberto_Varela.pdf.
[25] Simpson et al, "Decarbonized District Energy Systems"

Thermal Energy Networks

TENs are a subset of district heating and cooling systems designed to provide thermal services such as space heating, cooling, and water heating to multiple buildings on a shared thermal loop. As mentioned in the Introduction, several non-utility organizations are currently developing TEN systems in Minnesota:

- The City of Rochester,[26]
- The City of Duluth.[27]
- The Heights Community in Saint Paul,[28] and
- Como Park Zoo in Saint Paul.[29]

The thermal loop serves as the distribution system for the network and consists of a network of underground pipes. These pipes are filled with fluid (typically water but may include glycol in colder climates to prevent the pipes from freezing), which serve as the vehicle for the thermal energy provided by the system.

Small service loops are used to connect individual buildings to the broader network. These buildings then exchange thermal energy with the network using heat exchange equipment such as a water-source heat pump. This equipment is typically, but not always, customer-sited, and thus its upkeep and maintenance are generally the responsibility of the customer. The loop can be built for a single user (e.g. multiple buildings on a college campus), or multi-user (e.g. a neighborhood with houses owned by different customers).

Thermal resources are relied upon to maintain the TEN's operating temperature and include any number of thermal sources, sinks, and storage. These resources include, but are not limited to:

- Geothermal boreholes;
- Wastewater exchange;
- Industrial waste heat;
- Lakes, rivers, ponds, or underground aquifers;
- Data centers;
- Ice rinks; and
- Existing third and fourth generation district heating and cooling systems.

Depending on the thermal needs of an individual system, one or more thermal resources may be required to maintain a TEN's operating temperature.

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[26] ACHR News. (n.d.). *Creating thermal energy networks in Rochester, Minnesota*. https://higherlogicdownload.s3.amazonaws.com/DISTRICTENERGY/998638d1-8c22-4b53-960c-286248642360/UploadedImages/Creating*Thermal*Energy*Networks*in*Rochester*Minnesota__*ACHR*News.pdf

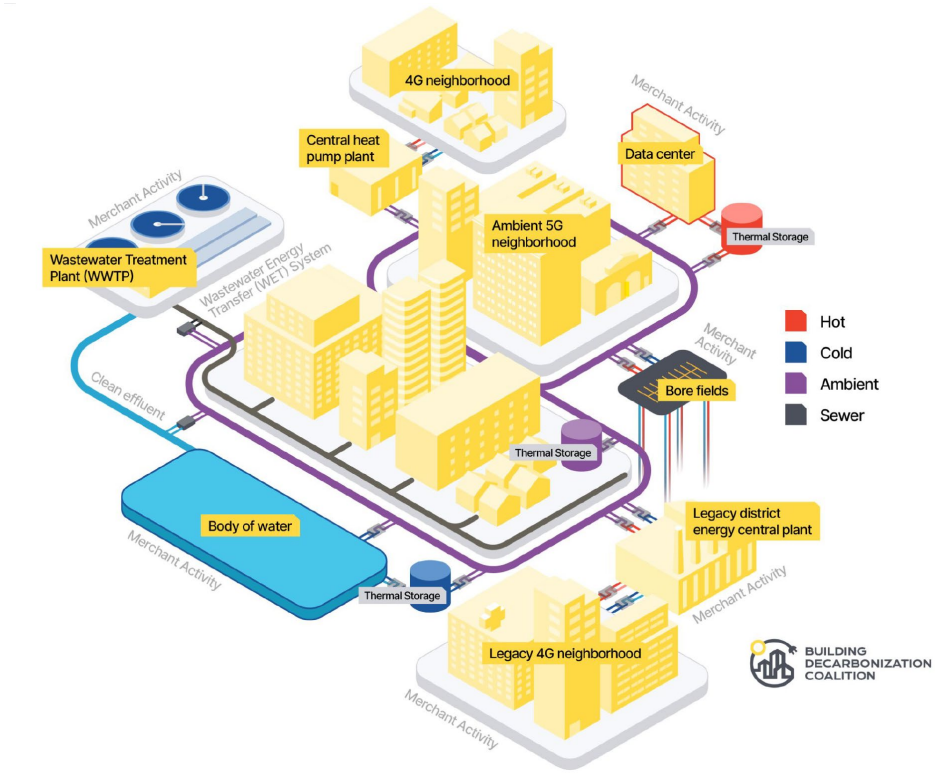
[27] City of Duluth. (n.d.). *Community geothermal*. https://duluthmn.gov/sustain/news-updates/community-geothermal/

[28] City of Saint Paul. (2024, March 27). *The Heights awarded $4.7 million for geothermal energy system*. https://www.stpaul.gov/news/heights-awarded-47-million-geothermal-energy-system

[29] Como Park Zoo & Conservatory. (n.d.). *Honeywell and Como Park Zoo & Conservatory partner to support Saint Paul's climate action goals*. https://comozooconservatory.org/geothermal/

Buildings that rely on the network for heating services will draw heat from the network, leaving it slightly colder. The reverse is true for buildings that rely on the TEN for cooling, as they will take heat from their environment and pump it into the network, making it warmer. Buildings with consistent heating or cooling profiles (like some of the examples above) can be considered a thermal resource depending on the time of year and the general heating or cooling demands of the other customers connected to the network. TENs benefit from having a wide range of buildings with diverse heating and cooling needs. Such diversity in demand helps to maintain system efficiency and can reduce the number of thermal resources required by a TEN.

Figure 1: Diagram of a Thermal Energy Network[30]



Credit: Building Decarbonization Coalition

Depending on several factors – including the number of pipes used in the thermal loop, the maximum temperature of the water within the loop, or whether the system allows for bidirectional energy flows – most TENs would fall within the definition of a fourth or fifth generation district heating and cooling system. Ultimately, what qualifies as a TEN depends on each state's statutory definition. For the purposes of the TEN Deployment Workgroup, the Minnesota legislature defined TENs as:

[30] Figure 1 depicts a thermal energy network functioning under a "common carrier" or "open access" framework, in which the network functions similarly to open-access electric and natural gas systems by allowing multiple providers to use the network to supply end-use customers. (See Workshop #4: Emergent Urban Concepts)

> *A project that provides heating and cooling to multiple buildings connected via underground piping containing fluids that, in concert with heat pumps, exchange thermal energy from the earth, underground or surface waters, wastewater, or other heat sources.*[31]

Natural Gas Innovation Act

The Natural Gas Innovation Act (NGIA) was enacted in 2021 and established a framework for natural gas utilities to pilot innovative resources with the goal of reducing the amount of conventional natural gas delivered to customers.[32] The NGIA lists the allowable innovative resources, which originally only included district energy, but later introduced a separate definition for TENs (see above). Both Xcel Energy and CenterPoint Energy Minnesota Gas proposed TEN pilot projects in their NGIA plans, both of which were approved by the Commission.[33] These projects were filed under the NGIA's definition of "district energy" due to the fact that the definition for TENs had not yet been introduced, but both pilots would also qualify as TENs. At the time of publishing this report, both utilities' TEN pilot projects are in the site evaluation and selection phase.

House File 5247

On May 24, 2024, Governor Tim Walz signed H.F. No. 5247 into law as 2024 Minn. Laws Chapter 127. Article 42, Section 49 of that chapter required the Commission to establish and appoint a Thermal Energy Network Deployment Work Group to examine:

> (1) The potential regulatory opportunities for regulated natural gas utilities to deploy thermal energy networks and
>
> (2) The potential barriers to development while taking into consideration:
>
> - Public benefits,
> - Impact of deployment of thermal energy networks,
> - Costs, and
> - Rate design options.

The TEN Deployment Workgroup was tasked with preparing this report for the chairs and ranking minority members of the legislative committees and divisions with jurisdiction over energy policy and finance by December 31, 2025. This report details the Workgroup's findings and recommendations on how to deploy TENs within a regulated context in a manner that protects the public interest and considers reliability, affordability, environmental, and socioeconomic impacts.

The law also required the Workgroup to file this report in the following Commission dockets, and provide notice to all participants and interested parties that comments on this report and its findings may be filed in:

[31] Minn. Stat. § 216B.2427, Subd. 1(s). https://www.revisor.mn.gov/statutes/cite/216B.2427

[32] The goal of NGIA is to reduce the amount of natural gas produced from conventional geologic sources delivered to customers. Minn. Stat. § 216B.2427, subd. 10.

[33] Xcel's budget is $10.3 million and CenterPoint's budget is $11.6 million for their five-year plans.

- **Docket No. G-999/CI-21-565** – *In the Matter of a Commission Evaluation of Changes to Natural Gas Utility Regulatory and Policy Structures to Meet State Greenhouse Gas Reduction Goals;* and
- **Docket No. G-999/CI-24-275** – *In the Matter of the Commission's Thermal Energy Network Deployment Workgroup*.

One day after publishing this report, the Workgroup will terminate, consistent with the directions provided by the Legislature.

Also included within the law were several additional provisions intended to explore the feasibility of TENs throughout Minnesota. The bill:

- Amended the NGIA [34] to include TENs as an innovative resource distinct from district heating, which permits utilities to include TENs in future pilot projects when submitting Innovation Plans;[35]
- Required utilities greater than 800,000 customers to dedicate at least 15% of their NGIA Innovation Plan budgets toward TENs for five-year innovation plans proposed after July 1, 2024;
- Required the Department of Commerce (the Department) to conduct a state-wide TEN site suitability study.

Workgroup Membership

The Legislature required the Commission to appoint members to the Workgroup, specifying the inclusion of several key organizations, such as the Department of Commerce, the Department of Health, the Department of Natural Resources, the Pollution Control Agency, and the Office of the Attorney General. In addition, the Workgroup was required to include representatives from a broad range of stakeholder groups, including utilities, clean energy advocacy organizations, labor organizations, geothermal technology providers, consumer protection organizations, cities, and low-income communities.

Throughout the month of September 2024, Commission Staff conducted outreach to prospective members and invited them to formally participate in the Workgroup. Staff made efforts to ensure representation from regions across Minnesota. Many participating organizations explained that they maintain offices throughout Minnesota, but nearly all members emphasized that their work served the interests of Minnesotans statewide and did not solely prioritize any specific region of the state. Following this outreach period, additional members were welcomed to join the Workgroup upon request. Many more individuals attended one or more meetings to learn and remain up to date on the Workgroup's discussions but declined to join the Workgroup in an official capacity.

Commission Staff asked each Workgroup member to categorize their organization based on the stakeholder categories provided by the legislature. Some participants indicated that their organizations could fit into multiple categories, and others noted they would be representing

[34] Minn. Stat. § 216B.2427: https://www.revisor.mn.gov/statutes/cite/216B.2427

[35] Innovation Plans are voluntary plans intended to allow natural gas utilities to leverage innovative resources through a suite of natural gas utility-proposed pilot projects with the ultimate goal of reducing the amount of natural gas produced through geologic sources and delivered to customers.

several organizations. In the event that an individual contended that their organization did not fit into any one of categories listed by the legislature, Commission Staff created a new stakeholder category.

In total, 85 individuals from 56 organizations committed to participating in the workgroup in an official capacity. Commission Staff notes that, while the organizations below were invited to informational workshops and roundtables and provided with communications, not all attended sessions.

Workgroup Participants

Academic Institution
- Macalester College

Clean Energy Advocacy
- 100% MN
- Adonis Eco-Housing
- AnnDyl Policy Group
- Building Decarbonization Coalition
- Center for Energy and Environment
- Cooperative Energy Futures
- CURE
- Fresh Energy
- GeoExchange
- Isaiah*
- Minnesota Center for Environmental Advocacy
- Midwest Building Decarbonization Coalition
- North Star Policy Action
- Rewiring America
- Slipstream
- Unidos MN*

Consumer Protection
- Citizens Utility Board

Geothermal Technology Provider
- Darcy Solutions
- Egg Geo, LLC
- FVB Energy Inc.
- Salas O'Brien
- VoltaMetrics LLC
- Jacobs
- WSP

Government Entities
- Hennepin County
- Onsite Energy Technical Assistance Partnerships

Labor Organizations
- International Union of Operating Engineers Local 49
- LIUNA MN & ND
- Minnesota Pipe Trades Association

Minnesota State Departments
- Department of Commerce, Division of Energy Resources
- Department of Health
- Department of Natural Resources
- Environmental Quality Board
- Office of the Attorney General
- Pollution Control Agency

Did Not Self-Select
- Ayada Leads

Representatives of Cities
- City of Minneapolis
- City of Northfield
- City of Rochester
- City of Saint Paul
- Local Climate Solutions

Representative for Low-Income Communities
- Cooperative Energy Futures*
- Greater East Side District Council
- Isaiah*
- Unidos MN*

Tribal Government
- Leech Lake Band of Ojibwe

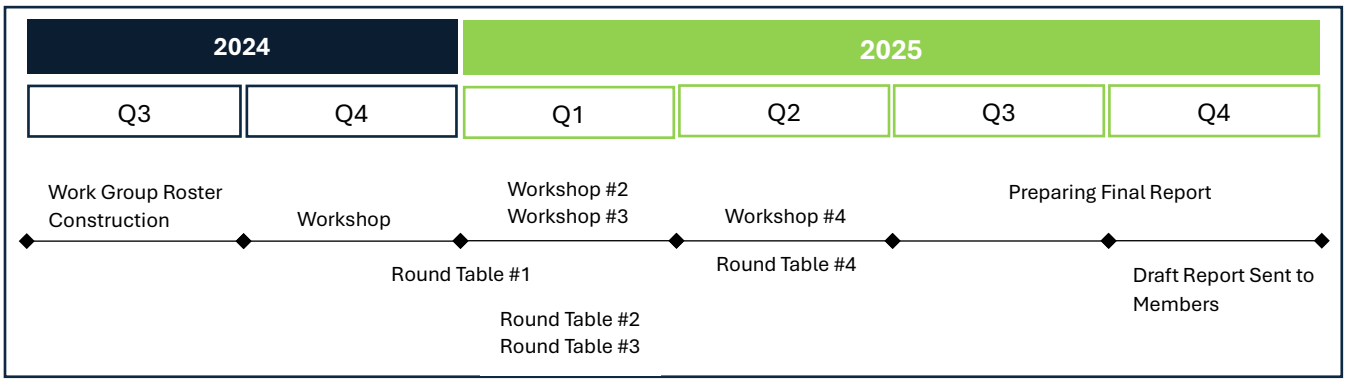
Utilities
- CenterPoint Energy
- Cordia
- Ever-Green Energy, Inc.
- Great Plains Natural Gas
- Minnesota Energy Resources
- Xcel Energy

*Note: Organizations marked with an asterisk (*) are listed under multiple categories based on their scope of work, as self-identified during the outreach process.

Workgroup Schedule and Structure

The Workgroup met eight times between October 4, 2024, and June 13, 2025, to discuss deployment of TENs by regulated natural gas utilities. Workgroup meetings took place approximately once per month and fell under one of two categories: informational workshops and roundtable discussions, alternating between the two.

Figure 2: TEN Implementation Workgroup Schedule



The Workgroup's informational workshops were organized and hosted by the Commission in both hybrid and fully remote formats. The purpose of these workshops was to educate Workgroup members about how TENs work, their potential benefits, the opportunities and barriers to their deployment, cost allocation and ratemaking practices, and relevant policies and legislation from other states that may inform Minnesota's approach to TEN implementation. The insights gained from these informational workshops informed the subsequent roundtable discussions and ensured the Workgroup took the Legislature's required considerations into account when developing its recommendations.

There were four informational workshops, each lasting between two and two and a half hours. Each session featured presentations from three to five speakers and concluded with dedicated time for questions and answers. All workshops were recorded by the Commission and made available on its website.[36] Presentation materials were also filed in Docket No. G-999/CI-24-275.[37] A summary of each workshop is provided in Attachment 1.

The Workgroup's roundtable discussions were designed to provide a space for Workgroup members to speak freely about the potential for Minnesota's regulated natural gas utilities to own and operate TENs. These discussions also served as a forum to develop recommendations for legislative consideration. While the informational workshops were intended to inform roundtable discussions, each session was not limited to the topic of the most recent workshop.

The roundtable discussions were organized and hosted by the Great Plains Institute (GPI), which was selected through a Request for Proposals (RFP) process and contracted by the Commission to

[36] See the Public Utilities Commission's calendar of events. Links to individual workgroup meetings are provided in Attachment 1. https://mn.gov/puc/about-us/calendar/

[37] https://efiling.web.commerce.state.mn.us/documents?doSearch=true&dockets=24-275&documentId=&onBehalfOf=&content=&receivedFrom=&receivedTo=

facilitate these meetings. GPI brought over twenty years of experience convening stakeholders – including Minnesota's natural gas utilities – around complex regulatory issues.

Roundtable discussions followed a rule of non-attribution. Summaries of these discussions do not attribute specific comments to individuals, and written feedback was also kept anonymous. These practices were intended to ensure that (1) no member withheld or altered their views due to concern about being quoted, and (2) members less familiar with the Commission's regulatory processes or new to the topic of TENs felt comfortable contributing their perspectives.

In total, the Workgroup convened four roundtable discussions. The content of these sessions, along with the resulting conclusions and recommendations, is reflected in the sections below.

Public Benefits, Impacts, Barriers, and Costs of Deploying TENs

The Legislature directed the Workgroup to examine the regulatory opportunities for natural gas utilities to deploy TENs, the barriers to development, the public benefits, the costs, the impacts of deployment, and rate design options. In developing its final recommendations, the Workgroup was also required to consider reliability, affordability, environmental impacts, and socioeconomic impacts.

To fulfill these directives, the Workgroup hosted informational workshops with experts from across the United States. These workshops were designed to address each required examination topic, and to provide members with the information they needed to make the required considerations when formulating recommendations to the Legislature.

This section presents information shared in Workgroup information sessions, organized by key topic areas:

- Summary of States' Actions on TENs
- Impacts of Deployment
- Financial Considerations
- Other Topics

Regulatory opportunities and barriers are discussed further in the subsequent section.

Summary of States' Actions on TENs

To set the stage for later discussions, the Workgroup heard presentations at informational workshops regarding what other states have taken to explore the viability of TENs. As previously mentioned, Minnesota had already enabled natural gas utilities to pilot TENs through the NGIA prior to passing H.F. No. 5247 into law. By enabling TEN pilot projects and now reviewing the barriers to TEN deployment, Minnesota joined a growing list of states supporting the exploration of TEN deployment by regulated utilities through legislation, including:

- California
- Colorado

- Connecticut
- Maine
- Massachusetts
- Maryland
- New Jersey
- New York
- Vermont
- Washington

Other states have also either filed legislation, or are considering legislation related to TEN deployment, including:

- Illinois
- New Hampshire
- Rhode Island
- Texas
- Wisconsin

TEN Legislation Highlights

NY: *Utility Thermal Network & Jobs Act (2024)*:

- Included new definitions for "Thermal Energy" and "Thermal Energy Networks,"
- Amended definition of "gas corporation" and "electric corporation" to permit these utilities to own, operate, or manage TENs
- Extended the NY Public Service Commission's jurisdiction to include TENs,
- Required 1 to 5 pilot projects from the largest gas and/or electric utilities,
- At least one Pilot for each utility must be proposed in a disadvantaged community,
- Required the NY Public Service Commission to initiate a proceeding to support the development of TENs and Promulgate rules and regulations within two years .

CO: *HB 23-1252 (2023)*:

- Defined "thermal energy" and stated that the resource "must not cause incremental greenhouse gas emissions or rely on increased, long-term combustion of fossil fuels,"
- Permitted gas utilities to offer TEN service,
- Required at least one pilot program proposal, consisting of one or more pilot projects, from large gas utilities by September 1, 2024.
- Required the Colorado Public Utilities Commission to initiate a proceeding to determine if a rule-making and/or legislative changes were necessary to facilitate the development of thermal energy in the state,
- Established labor standards for TEN projects.

The third informational workshop educated members on other states' TEN policies and legislation with the goal of ensuring that Minnesota learns from and builds on the experience of others. In addition to hearing directly from individuals who could speak to New York's and Massachusetts'

TEN policies, the Workgroup heard from the authors of a TEN legislation guidebook – which included a compilation of excerpts from relevant TEN legislation across the country. These resources were made available to Workgroup members for their consideration while crafting recommendations for the state Legislature.

Legislative Guidebook
Statutory Language

Additionally, the third informational workshop introduced the concept of evolving "phases" of TENs policy development, with legislative steps to support each iterative policy phase. Per this informational workshop, TEN deployment for regulated utilities is generally expected to occur in three stages:

1. Demonstration
2. Development
3. Deployment

Two of Minnesota's gas utilities (CenterPoint and Xcel) are currently in the demonstration phase, like many other states: a pivotal phase in which utilities seek approval for and implement a variety of pilot projects. These pilots are designed to test financing methods, assess deployment costs, evaluate the full range of benefits and impacts, and identify the standards, rules, and regulations needed to expand beyond pilot projects. The demonstration stage is critical because the results of these pilots directly shape future rate design options, ownership models, and deployment strategies, as well as the regulatory frameworks necessary to ensure that thermal services from TENs are safe, reliable, and affordable. However, possible policies for the other stages (such as developing a thermal market and interim rate design) are fairly untested, given the early nature of most utility-led TEN projects.

TEN Policy Phases

Demonstration

- Allow or mandate TEN pilot projects
- Establish definitions
- Specify data collection and reporting obligations
- Establish labor, equity, affordability, or climate objectives for pilots

Development

- Create interim rate design
- Develop ownership models
- Update obligation to serve to include TENs as an appropriate alternative to traditional [gas] service
- Consider pipe transition planning

Deployment

- Establish a thermal market
- Integrate gas and electric planning
- TENs formally offered as a non-gas pipe and/or non-wires alternative
- Develop financing mechanisms for system transition

Impacts of Deployment

Public Benefits

TENs provide a multitude of public benefits, including efficiency, resilience, and safety.

Efficiency

A primary benefit of TENs discussed by the Workgroup was its immense energy efficiency potential. To compare the efficiency of multiple technologies that use different types of fuel, practitioners rely on a resource's coefficient of performance (COP). Put simply, a COP refers to the ratio of useful heating or cooling provided by a technology compared to the energy it took to provide that heating or cooling. A COP of 1 refers to a system that effectively converts all of its energy into an equivalent amount of heating or cooling – little to no energy is lost in the conversion. Electric resistance heating averages a COP of 1. Air-Source Heat Pumps (ASHPs) average a COP of 2.5, due to the fact that less energy is required to move heat from one location to another than would be required to directly convert energy into heat. Ground Source Heat Pumps (GSHP) – which are also known as Geothermal Heat Pumps (GSP) – have a COP of 4, but when the heat pump unit is connected to a geothermal TEN), the system averages a COP of 6.

Average Annual COP Across Technologies

Energy Star Gas Furnace: 0.97

Electric Resistance: 1

Air-Source Heat Pump: 2.5

Ground-Source Heat Pump: 4

Geothermal Network: 6

Sources: *ENERGY STAR® Program Requirements Product Specification for Furnaces (April 2024); Winkler & Ramaraj (2023); Liu et al. (2023);* Xcel Energy, *Evaluating a Community Ground Source Heat Pump System at Colorado*

Figure 3. Visual Comparison of Air-Source versus Geothermal Heat Pumps[38]

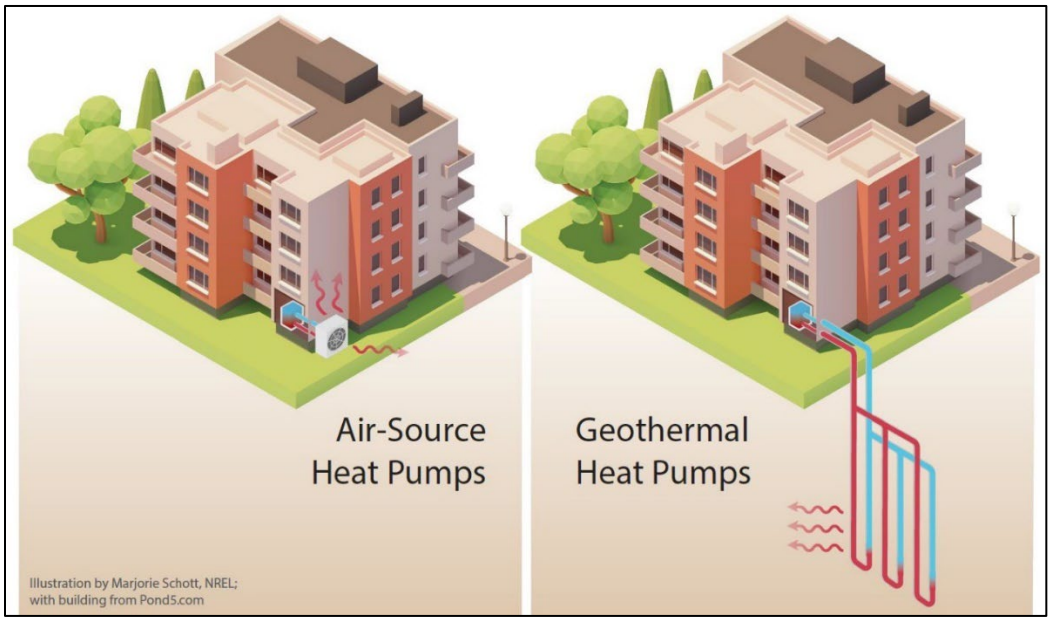
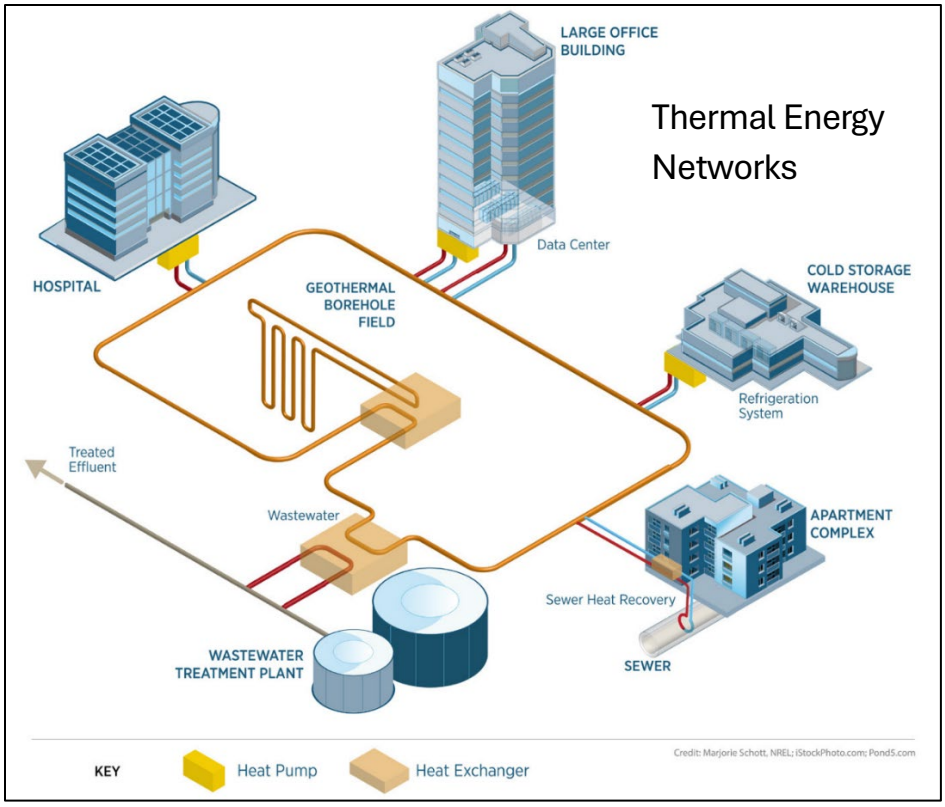


Figure 4. Visual Example of a Thermal Energy Network With Various Sources[39]

[38] U.S. Department of Energy. (2025, January 13). *Pathways to commercialization: Geothermal heating and cooling liftoff report*. https://www.smartenergydecisions.com/wp-content/uploads/2025/04/liftoff_doe_geothermal-heating-and-cooling_updated-2_6_25-compressed.pdf

[39] *Id.*, p. 18, Figure 8.



Many factors influence the efficiency of individual TENs, and the COP of each system will vary depending on a number of factors. However, TENs continue to be an extraordinarily efficient resource, capable of serving a wide variety of customer types. This level of energy efficiency can be achieved for several reasons:

1. TENs do not require energy to generate new heat but instead are designed to transport existing thermal energy from its source to customers.
2. Buildings on the shared system can share their heating and cooling loads, allowing for "load canceling" – where a building's heating demand is met by the energy injected into the system by a building that needs cooling, or vice versa, without needing to tap into any additional thermal resources.
3. Having many buildings with diverse thermal profiles and a mix of heating and cooling demands effectively flattens the system's load curve, improving system efficiency across the peak hours of the day.
4. Unlike ASHPs, which exchange thermal energy with outdoor air and suffer from efficiency loss at extreme temperatures, TENs exchange thermal energy through underground pipes, which better insulate the system from variations in outdoor air temperature.
5. The sheer mass of water moving through the network – enough water to fill miles of pipes up to six inches in diameter – is slow to react to sudden changes in thermal demand and is

thus naturally able to sustain optimal operating temperatures through sudden changes in demand.[40]

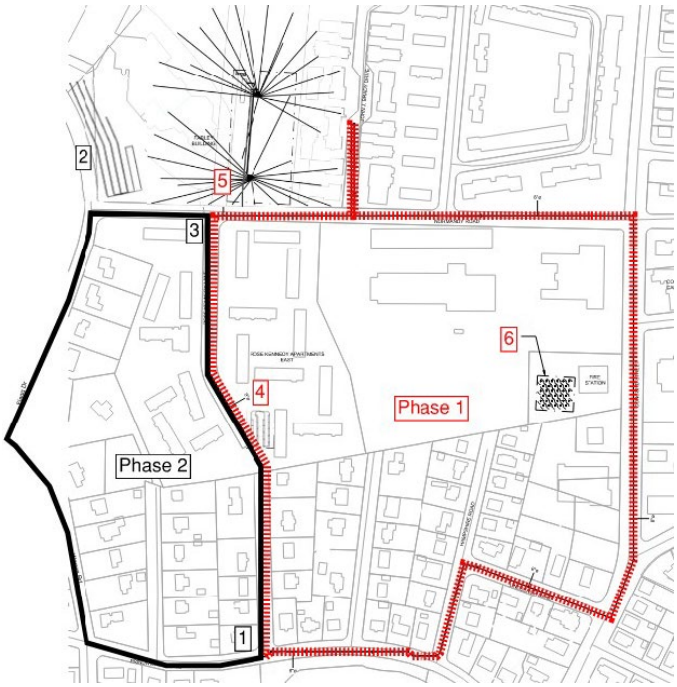
Network Scalability

TENs are a scalable technology, able to grow continuously to serve more buildings once the initial network is operational. Expanding an existing TEN not only benefits new customers by providing them with safe and efficient heating and cooling services, but existing customers benefit from the increased system efficiency and stability that comes with a larger and more diverse network. This is being demonstrated through the design of the Framingham Geothermal Pilot Program.[41]

Framingham is the nation's first utility-owned networked geothermal system. Developed by Eversource Energy – a dual fuel utility – the TEN pilot project began operation on June 4, 2024, as a 375 ton[42] system designed to serve 37 buildings (140 customers), including affordable housing, a fire station, and a community college. Eversource plans to expand the network, adding a capacity of 217 tons to serve an additional 44 buildings. The planned expansion is expected to increase system stability and thus will require fewer boreholes than the initial project, despite adding a similar amount of load and number of customers as the initial system.[43] The scalability of TENs also fits the gas utility model of first establishing a smaller system and expanding it to serve more buildings and/or customers over time.

Figure 5. Planned Expansion of Framingham Geothermal Pilot Program

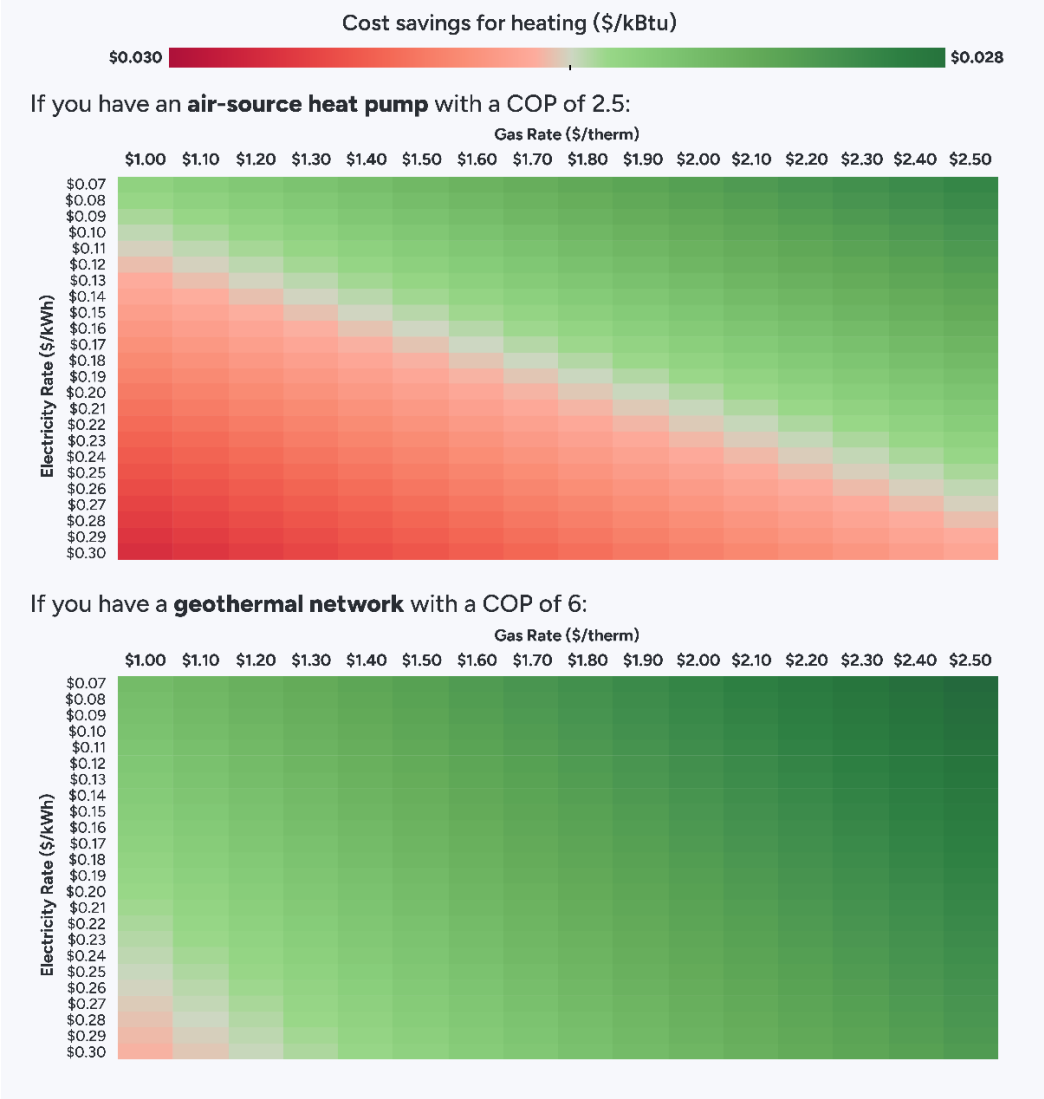
[40] TENs may be outfitted with external boilers and chillers in instances where the available thermal resources are not sufficient to maintain a stable system temperature during sustained periods of peak demand, or may call upon additional thermal sources, sinks, and storage connected to the thermal loop.
[41] City of Framingham. (n.d.). *Eversource geothermal pilot program*. https://www.framinghamma.gov/3315/Eversource-Geothermal-Pilot-Program
[42] Refrigeration tons ("tons") is equivalent to 12,000 Btu per hour (3,517 watts) of cooling or heating capacity. One ton is capable of servicing roughly 700 square feet.
[43] See Workshop #4 for a full discussion. Link to recording in Attachment 1, with slides filed in Docket 24-275.



Fuel Cost Savings

The increased efficiency offered by TENs can significantly reduce customer energy use, which in turn lowers spending on fuel and per-kilowatt-hour charges. This benefit was illustrated during the first informational workshop by the Building Decarbonization Coalition, which presented Figure 6 below comparing potential fuel cost savings from switching to electric heating by using either ASHPs or a geothermal TEN, across a range of gas and electric rates. Figure 6 highlights that customers who electrify their space heating by connecting to a geothermal TEN (assumed average annual COP of 6) would almost always see fuel cost savings. In contrast, customers relying on ASHPs with a lower annual average COP of 2.5 may not achieve the same savings.

Figure 6: Potential for Fuel Cost Savings with High Efficiency TENs[44]



Adapted from the Building Decarbonization Coalition. The figure displays analysis comparing cost per useful kBtu for electricity and gas based on a range of typical gas and electric rates found on EIA. The COPs listed above were used to make this comparison, with 0.8 UEF used for gas appliances. The difference is color coded on a green-to-red scale, with green representing greater savings.

Example: $0.20/kWh and $1.50/therm

Electricity: $0.20/kWh / 2.5 COP = $0.08 / useful kWh = $0.023 / useful kBtu

Gas: $1.50/therm / 0.8 COP = $ 1.875 / useful therm = $0.018 / useful kBtu

Gas is cheaper than electricity in this case by about $0.005 / useful kBtu so it gets colored slightly red.

[44] Figure used with permission from the Building Decarbonization Coalition. Silber-Byrne, J. (2025, October 16). Building Decarbonization Coalition. (n.d.). *Affordable Heat, Efficient Grid*. https://buildingdecarb.org/why-efficiency-matters

These findings are supported by research from Oak Ridge National Laboratory on the impacts of deploying GSHPs.[45] As highlighted in Figures 3 and 4 above, GSHPs are not the same as TENs. They typically serve a single customer or building and the fluid-filled pipes they exchange energy with are located on the property and are not connected to a broader network. However, GSHPs and TENs share several key characteristics including high efficiency, insulation from outdoor temperatures, and the use of fluid-filled underground pipes. As a result, research on the impacts of GSHPs offers valuable insights into the potential of TENs while specific studies on TENs continue to emerge.

Oak Ridge found that the mass deployment[46] of GSHPs would, among other things, lead to significant customer fuel cost savings by eliminating the need for fuel combustion for space heating. Specifically, they found that the mass deployment of GSHPs could save customers $19 billion per year by 2050 in avoided fuel costs.[47]

Reliability and Resilience

TENs are capable of delivering reliable thermal services year-round, including during extreme weather events. Their ability to maintain consistent operating temperatures is due in part to their insulation from outdoor air temperatures and their capacity to withstand sudden changes in demand, both of which are key contributors to the overall efficiency of TENs.

During Winter Storm Uri, which caused widespread service disruption and price spikes across Texas' electric grid, the geothermal TEN serving the Whisper Valley community in Austin, Texas continued operating without interruption, maintaining stable temperatures throughout the event.[48] This reliability not only benefits individual customers, but also contributes to grid resilience.

In their research on the deployment of GSHPs, Oak Ridge National Laboratory found that if every building in Texas capable of supporting GSHPs had one installed, the percentage of unmet electricity demand during Winter Storm Uri would have dropped from 38% to 18%.[49] By equipping buildings with highly efficient weather-resistant heating and cooling technologies, such as GSHPs and TENs, peak electricity demand can be reduced, improving grid resilience and reducing the frequency and severity of rolling blackouts.

Ability to Leverage Local Thermal Resources

A core advantage of TENs is their ability to leverage a wide variety of local thermal resources, including both natural resources and buildings with predictable thermal demand. This flexibility allows developers to design systems that use the lowest-cost mix of thermal resources needed to meet demand, improving cost effectiveness and expanding site feasibility. For example, the number

[45] Xiaobing Liu, Jonathan Ho, Jeff Winick, Sean Porse, Jamie Lian, Xiaofei Wang, et al., *Grid Cost and Total Emissions Reductions Through Mass Deployment of Geothermal Heat Pumps for Building Heating and Cooling Electrification in the United States*, ORNL/TM-2023/2966 (Oak Ridge, TN: Oak Ridge National Laboratory, November 2024), https://info.ornl.gov/sites/publications/Files/Pub196793.pdf

[46] As it relates to this study, "mass deployment" refers to the deployment of GSHPs across 68% of total building floor space in the contiguous United States.

[47] Liu et al, "Grid Costs and Total Emissions," p. xiii.

[48] Whisper Valley. (2021, February 26). *Whisper Valley GeoGrid delivers during Texas winter storm*. https://www.whispervalleyaustin.com/whisper-valley-geogrid-delivers-during-texas-winter-storm/

[49] Liu et al, "Grid Costs and Total Emissions," p. xxiv.

and placement of geothermal wells for a geothermal TEN may depend on the availability of other thermal resources.

Importantly, unless a thermal resource relies on an imported fuel source, these resources are entirely local, keeping energy spending within the community and reducing exposure to fuel price volatility and issues related to supply chains. Note that, as illustrated in the list below, some resources can play multiple roles within the network.

Examples of Thermal Resources

Thermal Sources
- Homes during the summer
- Sewer water
- Data centers
- Refrigerated warehouses
- Ice rinks
- Office buildings
- Geothermal boreholes (bedrock)

Thermal Sinks
- Homes during the winter
- Domestic hot water
- Irrigation water
- Sidewalk heating during winter
- Greenhouses
- Industry
- Geothermal boreholes (bedrock)

Thermal Storage
- Aquifers
- Ocean
- Large lakes or rivers
- Water tanks
- Geothermal Boreholes (bedrock)

Improved Safety and Indoor Air Quality

TENs deliver heating and cooling through piped, noncombustible fluids, reducing or eliminating the need for on-site combustion appliances such as traditional gas furnaces. By removing on-site combustion, TENs eliminate the risk of gas leaks or explosions and avoid indoor exposure to combustion-related pollutants, including nitrogen dioxide, carbon monoxide, carbon dioxide, and particulate matter. These air quality improvements are especially important for families living in densely populated areas or in smaller, poorly ventilated homes. While outside the scope of its primary analysis, Oak Ridge National Laboratory concluded that the mass deployment of GSHPs would result in "substantial local health benefits" due to reduced emissions from on-site combustion.[50]

Reducing Strain on the Electric Grid

The deployment of TENs can reduce strain on the electric grid by lowering peak demand, improving seasonal efficiency, and reducing the need for new electricity generation and transmission infrastructure. These benefits are particularly relevant as space heating electrification becomes more prevalent, potentially causing the electric grid to shift from summer- to winter-peaking, especially in colder climates like Minnesota.

The university-owned geothermal TEN at Colorado Mesa University, which began its deployment in 2008, has achieved annual energy savings of 1.3 GWh (10%) and natural gas savings of 58,000 Dth

[50] Liu et al., "Grid Costs and Total Emissions", p. xiii.

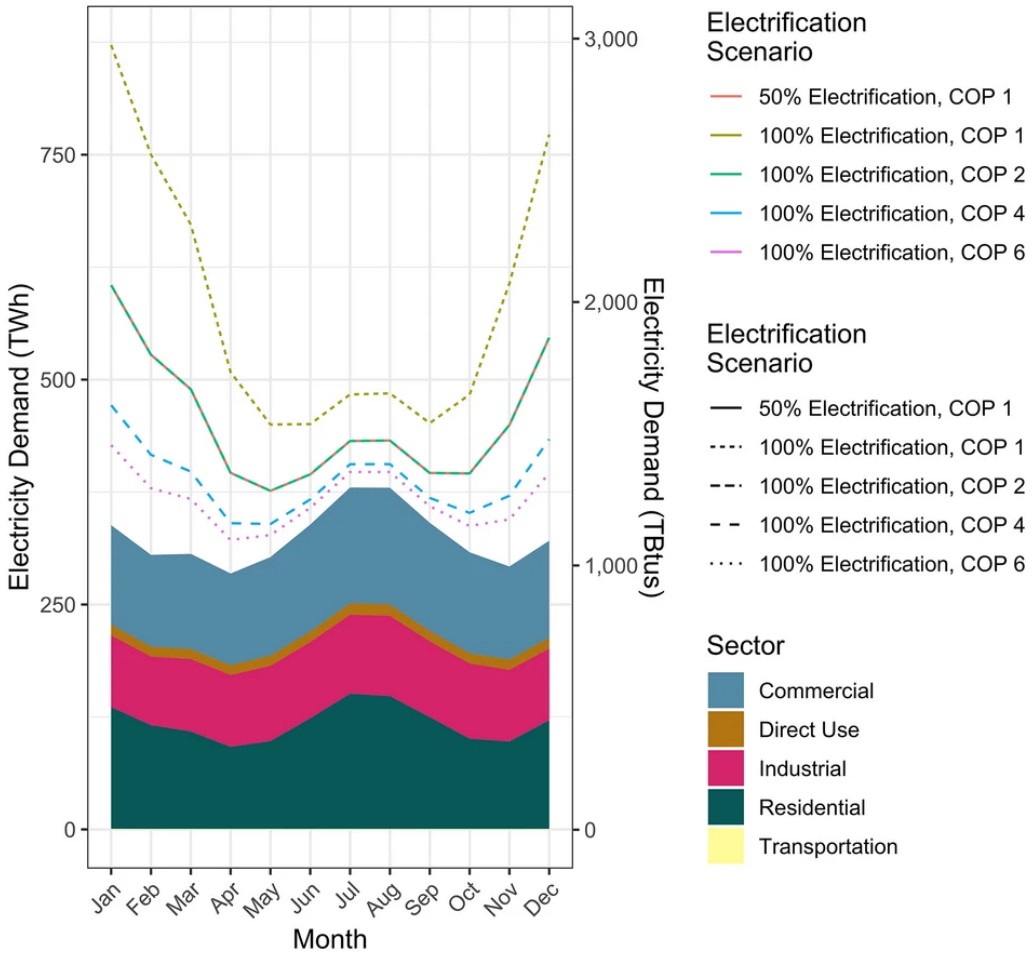
(55%), with a peak COP of 8.9 during the winter. [51] Reaching peak efficiency in the winter is a key advantage of geothermal TENs, particularly in contrast to ASHPs, which lose efficiency in colder weather. By deploying systems that perform best when demand is highest, TENs can help reduce peak electricity loads and avoid costly investments in new generation, transmission, and distribution infrastructure.

This concept was explored in the Buonocore et al. report *Inefficient Building Electrification Will Require Massive Buildout of Renewable Energy and Seasonal Energy Storage*.[52] The researchers modeled how various electrification scenarios – based on COP – would impact seasonal demand and the electricity system. They found that inefficient electrification would sharply increase winter electric demand, creating a load profile resembling the wings of a falcon in flight, which they called the "falcon curve" load profile (see Figure 7 below). Efficient electrification technologies such as geothermal TENs (assumed COP of 6), combined with building efficiency, peak shaving techniques, and dispatchable energy storage could flatten this curve and reduce peak demand. The figure from the report highlights how the use of progressively more efficient electrification technologies would have drastic impacts on seasonal demand for electricity.

[51] Xcel Energy, (n.d.). *Evaluating a Community Ground Source Heat Pump System at Colorado Mesa University*, https://www.coloradomesa.edu/sustainability/documents/cmu-cgshp-summary-2023.09.06.pdf

[52] Buonocore, J.J., Salimifard, P., Magavi, Z. et al. (2022). Inefficient Building Electrification Will Require Massive Buildout of Renewable Energy and Seasonal Energy Storage. Sci Rep 12, 11931. https://doi.org/10.1038/s41598-022-15628-2

Figure 7: "Falcon Curve" Under Different Electrification Scenarios[53]



Current monthly total electricity demand by sector from March 2010 to February 2020, and projected changes to total building energy demand under different building electrification scenarios using technology with varying COPs.

While few studies have evaluated TEN-specific impacts, several have analyzed GSHPs. As previously mentioned, GSHPs share several key characteristics with TENs and can thus offer insight into the impact of their deployment.

Oak Ridge National Laboratory found that the mass deployment of GSHPs, when combined with weatherization, would reduce both grid costs and CO_2 emissions, even in the absence of any broader decarbonization policies.[54] Their modeling assessed three scenarios, both with and without the mass deployment of GSHPs:

1. A base case reflecting current grid conditions;

[53] *Id.,* Figure 4

[54] This was an impact-only study, which did not consider the cost of and available land areas for installing GSHPs in existing buildings or new construction.

2. A grid decarbonization scenario (95% grid emissions reductions by 2035 and 100% clean electricity by 2050); and
3. An electrification futures study scenario with widespread electrification across sectors.

Projected grid impacts of mass GSHP deployment included:[55]

- $300 billion in avoided wholesale grid service costs through 2050, with increased savings in both decarbonization scenarios;
- 585 – 937 TWh/year in avoided new electricity generation, depending on scenario;
- 17-38% reduction in transmission expansion requirements;
- Reduced resource adequacy requirements in both the summer and winter; and
- 3-28% reduction in regional peak electricity load.

The U.S. Department of Energy's *Pathways to Commercial Liftoff: Geothermal Heating and Cooling* report reached similar conclusions.[56] The Liftoff report sought to identify the current role of GSHPs in the market and identify a realistic path to commercialize and scale this technology, concluding that achieving commercial liftoff for GSHPs by 2035 (tripling current U.S. GSHP capacity)[57] could reduce summer peak demand by 12 HW and winter peak demand by 44 GW and lower grid system costs by $4 billion through avoided grid maintenance tied to peak load.

Environmental Impact

TENs can support Minnesota's statutory goal of achieving net-zero emissions across all sectors by 2050 by enabling efficient, targeted electrification of traditionally fuel-powered services, such as space and water heating. According to data reported by the Minnesota Pollution Control Agency, greenhouse gas emissions from the industrial, residential, and commercial sectors have increased by 23%, 38%, and 48%, respectively, between 2005 and 2022.[58] In contrast, emissions from electricity generation has declined by 50%, driven in part by Minnesota's goal of 100% carbon-free electricity by 2040.

The U.S. Department of Energy reports that most emissions from residential and commercial buildings are tied to space heating, cooling, and water heating, including both direct fossil fuel use and electricity consumption from a mixed grid.[59] Site-level data shows that 37% of building emissions come from fuel combustion, the majority of which is for space and water heating.[60] As Minnesota continues to decarbonize its electric grid, shifting end uses like space heating to electricity – particularly when this shift also improves energy efficiency – can reduce overall emissions and support the state's climate goals.

[55] Liu et al, "Grid Costs and Total Emissions."
[56] U.S. D.O.E, "Pathways to Commercial Liftoff."
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[57] The Department of Energy reported that 2022 GSHP capacity was 5.8 million tons.
[58] Minnesota Pollution Control Agency. (n.d.). *Greenhouse gas emissions by sector (2005–2022)*. https://data.pca.state.mn.us/views/Greenhousegasemissionsdata/Emissionsbysector2005-2022?%3Aembed=y&%3AisGuestRedirectFromVizportal=y
[59] U.S. D.O.E, "Pathways to Commercial Liftoff."
[60] Id., Figure 2.

Oak Ridge National Laboratory found that the mass deployment of GSHPs could eliminate 217 million metric tons of CO_2 emissions annually by 2050 in a base-case scenario.[61] This reduction results from both the lower total electricity demand and reduced peak load associated with deploying such high efficiency resources. In more aggressive decarbonization scenarios, GSHP deployment did not yield additional emissions reductions due to the fact that such reductions are already accounted for in those scenarios. However, in such scenarios, the mass deployment of GSHPs still deliver the significant cost savings discussed in prior sections.

Beyond emissions, TENs may also contribute to environmental sustainability by reducing water use. After replacing water-cooled chillers and natural gas boilers with a geothermal TEN, Colorado Mesa University reported saving approximately 10 million gallons of water annually.[62]

Leveraging a Skilled Workforce

TENs present an opportunity to transition the existing natural gas workforce into new roles that support decarbonized thermal infrastructure. This transition is possible due to the similarities between the gas distribution system and TEN infrastructure. For example, both systems use near identical piping materials installed along public right-of-way, allowing gas utility workers to adapt their skills with limited retraining. The same holds true for HVAC technicians, as those currently trained to install ASHPs can transition to GSHPs with relative ease. These overlaps offer Minnesota a pathway to retain and retrain its skilled energy workforce as the state advances toward it's net-zero by 2050 objective.

The U.S. Department of Energy's *Pathways to Commercial Liftoff: Geothermal Heating and Cooling* report found that most occupations involved with GSHP and TEN deployment have high skill transferability, though training needs will vary. The report emphasized a national shortage of drillers – estimated at just over 30,000 workers – which may create challenges in deploying GSHPs and TENs utilizing geothermal boreholes. Drillers face the highest training requirements (typically requiring two years as an apprentice), and their work involves costly equipment. Drilling is often the most variable cost of a GSHP installation project due to a high demand for their labor and variations in the local or regional geology. A shortage of drillers or any other skilled labor could significantly increase project costs, underscoring the importance of workforce development as TEN deployment scales.

The importance of building a specialized workforce was also highlighted by the Operating Engineers Local 150 (Illinois) during their presentation at the second informational workshop. During their presentation, they described the process of deploying a geothermal TEN at their training campus in 2010. While they found many transferable skills within the general drilling industry, they ultimately determined that geothermal well drilling required a distinct training track. In response, they developed a four-year geothermal drilling operator program, launched in 2011, which has since operated successfully and can scale with labor demand.

[61] Liu et al, "Grid Costs and Total Emissions," p.xx.
[62] Xcel Energy, (n.d.). *Evaluating a Community Ground Source Heat Pump System at Colorado Mesa University,* https://www.coloradomesa.edu/sustainability/documents/cmu-cgshp-summary-2023.09.06.pdf

Potential Barriers to Adoption

While TENs have many public benefits, presenters highlighted several potential barriers that may impact the pace and cost of TEN deployment in Minnesota.

Buildings Efficiency Requirements

TENs are most effective in neighborhoods with well-insulated, energy-efficient buildings. Higher efficiency buildings reduces thermal demand, improves system performance, and lowers operating costs. However, many existing neighborhoods may require significant retrofits before being able to interconnect to a TEN. This is less of a challenge for new-build communities, as buildings can be built with energy efficiency measures and ready to be linked to a TEN. While such retrofits can increase project costs, piloting in existing communities provides valuable experience that may reduce future deployment costs, and these costs are common when retrofitting older housing stock for any modern HVAC system.

Land Access Agreements

Utilities may need to secure land access agreements beyond standard right-of-way approvals to install thermal resources like geothermal bore fields. The permitting requirements, costs, and timelines associated with securing these agreements will vary by site and jurisdiction, introducing uncertainty to project development.

Potential for Redundant Infrastructure

Unless statutory language is updated, utilities' obligation to serve under Minn. Stat. § 216B.04[63] could be interpreted as requiring them to maintain both the gas distribution system and a new thermal loop in areas where not all customers elect to switch. This raises concerns about duplicative infrastructure and inefficiencies in long-term system planning, which may raise rates for customers who remain on the gas system. On the other hand, it raises concerns about forcing customers to switch from gas to TENs service.

Remaining Operational Life of the Gas System

Unlike states facing widespread infrastructure replacement such as Massachusetts, much of Minnesota's gas distribution system remains in good condition. Deploying a TEN in areas with substantial remaining gas asset life may require new financial mechanisms to ensure cost recovery and avoid adverse rate impacts for non-participating customers.

Customer Buy-In

Successful deployment of a TEN requires a high rate of customer participation. While a college campus or private business may own multiple buildings but act as a singular customer in its decision to install a TEN, gas utilities serve many communities with multiple customers (e.g. a neighborhood of single-family homes).

Successful deployment of many TENs across the state requires widespread knowledge and awareness of TENs among potential customers. While some groups and organizations in Minnesota have expressed strong interest in TENs, general public familiarity with the technology remains low.

[63] Minn. Stat. § 216B.04. https://www.revisor.mn.gov/statutes/cite/216B.04

In Massachusetts, groups including HEET have long promoted community education about TENs. To date, Minnesota has not had any analogous public awareness campaigns. Effective education campaigns will be essential to first educate potential customers, and then to build trust and secure the community buy-in necessary to construct systems that serve multiple customers.

Disruptive Installation Process

As large infrastructure projects, TENs often require street excavation and building access. These disruptions may pose challenges in dense urban environments or older neighborhoods and should be factored into project planning and outreach.

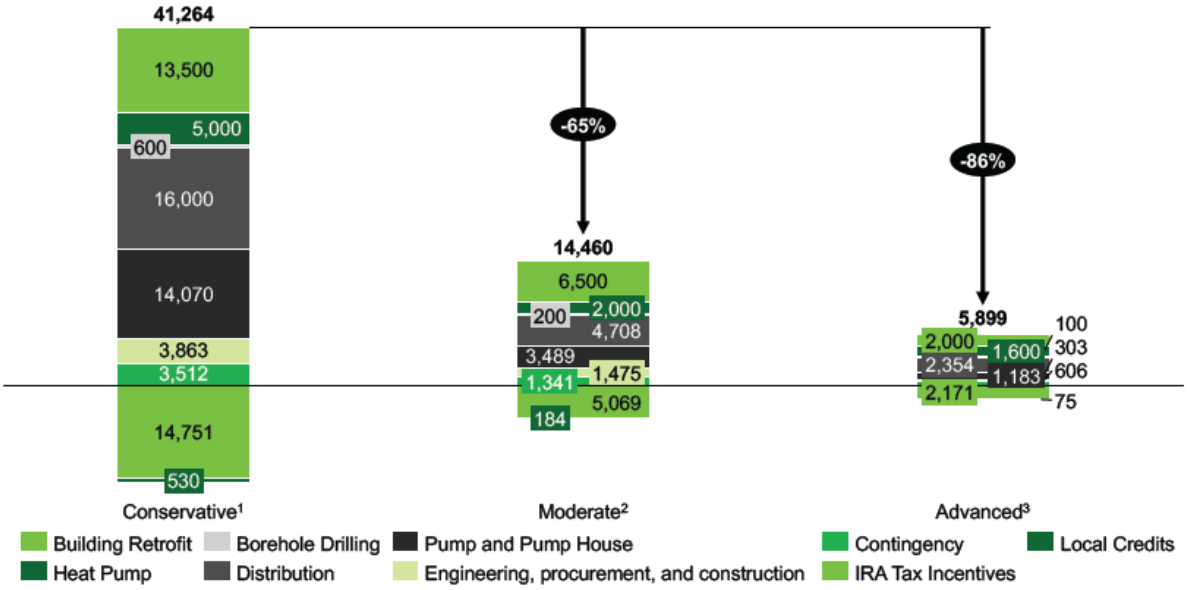
Financial Considerations

Pilot and Project Costs

As can be typical of early piloting of new technology, initial utility-led TEN pilots across the country have generally been more expensive than anticipated. The Department of Energy highlighted the expense of these first-of-a-kind TEN pilots in its *Geothermal Liftoff* report, in which it cited a conservative cost of $41,264 per ton, compared to the $7,800 per ton cost of an individual residence retrofitted with a GSHP system.

However, the Workgroup learned that the cost of TEN deployment is expected to decline significantly with subsequent projects. DOE modeling posited that second-of-a-kind projects – especially those designed to take advantage of the lessons learned from prior projects – could see costs drop by 65% to $14,460 per ton. Over time, costs for TENs that connect new construction may reach parity with single-building GSHP installations on a per-ton basis. DOE modeling predicted future cost declines across the board, but likely to be most pronounced in areas with minimal retrofit needs, such as new construction.

Figure 8: Estimated Cost of TENs ($/ton)[64]



Notes from U.S. DOE about this figure: 1. This Conservative value is based off actual costs from projects, in many cases first-of-a-kind and maximal. 2. Costs here are based on discussions with industry and are meant to represent what the second-of-a-kind project might cost in each area and application. 3. This Nth-of-a-kind estimate further examines the possibilities of deeper cost reduction at each level of installation based on learning curves, and in particular highlights that in cases where retrofits are not needed (new builds, or minimal, costs can be driven down.

The Workgroup also learned that expanding existing TENs is generally less expensive than building entirely new networks. For example, as noted in a previous section, Eversource plans to expand its initial Framingham geothermal pilot system, and this expansion will serve a similar number of customers and load as the initial project but is expected do so at about half the cost of the initial pilot. This is due to improved thermal stability as the network grows, reducing both energy consumption and peak demand. The expansion project is expected to require fewer boreholes and will benefit from many fixed infrastructure components – such as the pump house and monitoring systems – already being in place. Some expansion projects may also be able to draw on existing thermal resources – such as ice rinks, data centers, or existing district heating and cooling systems – reducing the need for additional drilling or the development of new thermal resources.

Notably, a significant share of Framingham's expansion costs was related to the modernization of existing buildings, such as adding insulation, electrical panel replacements, ducting, and remediation of mold or lead paint. These costs are not specific to TENs; rather, they are common barriers to retrofitting older housing stock for any modern HVAC system. Nevertheless, they remain a persistent financial hurdle in deploying TENs in existing communities.

[64] U.S. D.O.E, "Pathways to Commercial Liftoff," p.33, Fig. 21. Note: Since this report was published, the federal reconciliation bill signed into law on July 4, 2025 made substantial modifications to IRA tax credits. Notably, that bill eliminated the Residential Clean Energy Tax Credit (§25D) – which extended to residential ground-source heat pumps – after December 31, 2025. The law preserved the Investment Tax Credit (§48) for construction of geothermal energy properties.

These findings illustrate the importance of the pilot phase in TEN deployment. Early projects carry higher costs, but successive deployments may reduce per-unit costs substantially. Utilities' ability to demonstrate cost efficiencies over time will be essential in informing Commission decisions on future rate design and cost recovery, and in developing public confidence in TEN deployment.

Cost Allocation and Rate Design

While the Workgroup was tasked with exploring rate design options for gas utility-owned TENs, it became clear that this was an area where little has been proven. To date, no state has moved beyond the demonstration phase of TEN deployment, and as a result, long-term rate structures remain largely undefined.

TEN and Gas Rate Bases

First, decisions must be made on how to allocate costs. The costs of many first-generation, utility-owned TEN pilots are currently being allocated across the gas utilities' broader rate base. This approach helps prevent disproportionate cost impacts for the relatively small number of customers served by early-stage pilots. From a regulatory perspective, this is common practice for testing new technologies that show promise of system-wide benefits when deployed at scale. As discussed above, first-of-a-kind TEN projects are generally more expensive than subsequent projects due to higher capital costs, site-specific challenges, and learning-curve inefficiencies. Given these factors, assigning all costs – and the associated risks – to the limited number of participating customers may create a barrier to the deployment of promising, potentially cost-reducing, technologies. Spreading costs across the broader rate base helps mitigate risks and ensures that the bill impacts remain modest.

However, presenters discussed different potential ways to allocate costs as projects scale. As deployment experience grows and per-unit costs decline, gas utilities may no longer need to rely on blended rate bases to support TEN projects. In the long term, mature TEN systems may be able to recover their costs through rates paid by TEN customers, allowing these systems to become self-sustaining as the customer base expands.

Presenters also discussed potential long-term benefits of continued integration between gas and TEN rate bases. While today's mature gas rate base will help stabilize TEN rates, this relationship could reverse in the future. If the Minnesota Legislature's long-term objective is to move more buildings to decarbonized heating solutions, the gas customer base may shrink, leaving remaining customers responsible for covering the fixed costs of legacy infrastructure. In that scenario, a robust TEN rate base could help absorb some of those costs, improving rate stability across both systems.

Additionally, TENs can expand the overall gas utility rate base by serving customers that currently lack access to natural gas and instead rely on delivered fuels. However, some Workgroup members noted that continued blending of gas and TEN rate bases may be a difficult to justify to customers who do not directly benefit from TEN service. That said, it was observed that this approach mirrors how the current gas system operates: existing gas customers routinely help fund system expansion in new areas, even if those expansions do not serve their own neighborhoods.

Gas and Electric Rate Bases

Decisions must also be made about how to design rates for a technology that will benefit both gas and electric customers. One large consideration is that TENs are currently being deployed by gas utilities, but they provide tangible financial benefit to the electric grid and electric ratepayers by improving grid stability and avoiding capital expenditures. While several efforts have estimated the system-wide value of broader TEN deployment, work is still ongoing to understand and quantify the benefits provided by individual projects.

Once these values are better understood, new questions arise regarding how to account for these benefits in regulatory decision-making, and how they might be leveraged as financing tools to support future TEN deployments.

Capturing the full value of TEN co-benefits for both gas and electric systems would be important to deploying TENs at scale.. The challenge lies with the monetization and accounting of these benefits. Most utility investments directly benefit the customers of the investing utility. With TENs, a gas utility investment may produce significant benefits for electric customers and the electric grid. However, when TENs are gas utility-owned assets, electric customers do not contribute to their cost, even when they may financially benefit.

Presenters offered several approaches to better align costs and benefits across systems:

1. **Non-Wires Alternatives:** Given that many electric utilities are required to propose "non-wires alternatives," (investments that could achieve capacity and resource needs without requiring additional transmission infrastructure to be built), presenters proposed allowing electric utilities to pay gas utilities to install TENs in lieu of investing in new or upgraded electric infrastructure, such as substations and transmission lines.
2. **Electric Ratepayer Rider:** Creating a dedicated rider to allow electric customers to contribute toward TEN infrastructure that benefits the electric grid but is built and operated by a gas utility.
3. **Thermal Capacity Markets or Demand Response Models:** Allowing electric utilities to purchase thermal capacity from gas utility-owned TENs as a means to reduce peak demand and system costs.

Fully accounting for and monetizing these cross-system benefits remains a key challenge for TEN development and will likely become a central policy discussion if the TENs pilots prove out and Minnesota policymakers decide to move beyond the demonstration phase of TEN deployment.

Future rate design will be shaped by many variables, including the actual cost trajectory of TEN projects, whether gas and TEN rate bases remain integrated, how cross-system co-benefits are valued and recovered, and the availability of metering technologies capable of accurately measuring customer interactions with the network.

If Minnesota decides to advance beyond the demonstration phase and more data becomes available, rate design will become a central topic for regulatory development. For now, it remains an open question dependent on both system performance and future policy decisions.

Other Topics Presented in Informational Sessions

Sharing Information to Optimize Future TEN Projects

The Workgroup heard from HEET, which presented its *Learning from the Ground* Up (LeGUp) project – an open-source research initiative funded by the Massachusetts Clean Energy Center and developed in collaboration with two national laboratories and several universities. The project focuses on analyzing the potential for geothermal TENs to deliver heating and cooling in Massachusetts, using data from four pilot projects to optimize future deployments and share findings with stakeholders.

All research outputs from LeGUp are open source and publicly accessible for use by policymakers, utilities, and project developers beyond Massachusetts. The project includes ongoing monitoring of TENs with detailed data collection on their effects on grid performance, greenhouse gas emissions, public health, ecology, equity, and overall costs. Data categories collected include:

- The buildings connected to each system
- The number and type of boreholes or bore fields
- System performance
- Characteristics of the thermal loop
- The emissions mitigated
- Subsurface geology
- System costs
- Energy use
- Customer demographics

By leveraging this national LeGUp dataset, Minnesota-based TEN projects can compare system performance, use the LeGUp projects to inform design and optimize efficiency, and better anticipate total project costs. HEET invited all states to require utilities to submit data to the LeGUp database to create a shared foundation for learning across jurisdictions. The state of Maryland already requires the use of LeGUp data in the development of eligible pilot projects.[65] While the Workgroup found the HEET presentation useful, it did not make recommendation on requiring utilities to submit data to the LeGUp database.

Potential Regulatory Framework: The "Open Access Common Carrier"

During the fourth and final informational workshop, Emergent Urban Concepts introduced the "open access common carrier" concept for TEN regulation. This model, which has not yet been put into practice anywhere, recognizes that TENs consist of three distinct components – thermal resources, distribution infrastructure, and behind-the-meter equipment – which do not necessarily need to be owned and operated by a single entity. Under this framework, an open thermal market could be established in which multiple private entities, or "merchants," are permitted to supply thermal energy to the network. These merchants could include "prosumer" customers, who would be compensated for the thermal energy they contribute to the system.

[65] Maryland 2024 Regular Session - House Bill 397 Chapter 564

In this model, the state's regulatory body would be responsible for overseeing the regulated utility in its role as network operator, who would ensure safe, reliable, and affordable thermal services, as well as provide light oversight for systems owned by users with democratic representation (e.g. cooperatives). The thermal resources themselves could be owned by non-utility third parties – such as municipalities, for-profit entities, and college campuses – rather than only by regulated utilities. The network operator would determine which resources to accept based on system needs and availability throughout the day, and would be prohibited from discriminating against thermal energy resource providers through any anticompetitive behavior. This concept is similar to how electric utilities currently distribute electricity obtained through third-party resources, like community solar gardens, rooftop solar, or PPAs with other generation facilities.

The open access common carrier model is just one of several possible regulatory approaches for TENs. Its main advantage is that it enables greater participation from diverse thermal resources, including existing third- and fourth-generation district heating and cooling systems. This could reduce upfront utility investment and support a more flexible system design.

However, concerns remain about the complexity of managing such an open system. Questions arose regarding whether it would be appropriate to require a utility to distribute a resource that they cannot also manage the production of.

As with rate design, final decisions around regulatory frameworks will likely be made through future Commission proceedings after lessons are learned from Minnesota's initial TEN pilot projects. Before a framework such as this could be adopted, several key policy questions would need to be addressed, such as whether TENs or thermal energy services should be classified as regulated utility services, whether the Commission should have oversight authority, how to enable market competition, whether open access requirements should be mandated, and how to establish fair and consistent interconnection standards. These are well-suited for structured discussions once in-state experience has matured.

Regulatory opportunities and barriers are discussed in the following section.

Regulatory Opportunities and Barriers

The Workgroup held four roundtable discussions, hosted by the Great Plains Institute (GPI), to identify the regulatory opportunities and barriers for current TEN deployment, and develop recommendations for how Minnesota's regulated utilities can deploy TENs in a manner that protects the public interest.

Unlike the informational workshops, the roundtable discussions provided Workgroup members with a dedicated forum to speak openly about policy, regulatory, and statutory considerations specific to Minnesota. While informed by the content of the workshops, each roundtable was not limited to the subject of the most recent informational workshop.

Each summary below outlines the roundtable discussions and describes the process through which the Workgroup developed its final recommendations. All Workgroup members were invited to participate either in person or virtually. The scope of these discussions focused specifically on the role of regulated natural gas utilities in TEN deployment, current regulatory barriers, and the statutory and policy innovations that may be necessary to facilitate deployment in a way that

protects the public interest. Topics outside of this scope – such as changing conditions for existing TEN facilities or expanding non-investor-owned utility ownership—were not part of the formal discussion agenda. In addition to the summaries below, GPI's post-roundtable summaries are also available in Attachment 2.

To support open and inclusive dialogue, Workgroup members were asked to respect each other's experience, honor the group's limited time and scope, and adhere to a rule of non-attribution. In keeping with this approach, the summaries provided here do not attribute specific statements to individuals. These ground rules were intended to ensure that participants felt comfortable expressing their views freely, especially those who were new to the Commission's processes or unfamiliar with TEN-related topics.

Roundtable #1: Introductions, Scoping, Identification of Regulatory Barriers and Opportunities

The first roundtable discussion was held on December 20, 2024, and was dedicated to introductions of participating parties, an overview of the roundtable process, and developing a shared understanding of the opportunities, barriers, and priority topics related to TEN deployment in Minnesota. Workgroup members had varying levels of experience with TEN-related topics. Some were industry veterans who had directly been involved with the development of TENs and/or district heating and cooling systems for decades, while others were being exposed to these topics for the first time through the Workgroup. Accomplishing the ultimate task of providing the Legislature with a suite of recommendations would require educating members to ensure that everyone had a shared base-level knowledge about TENs and related policy. This first roundtable discussion was intended to build from the first informational workshop to ensure that a baseline understanding of TENs was developed among all Workgroup members.

Following introductions, the Workgroup heard from a number of members with prior experience with TENs. These individuals presented their perspectives and views regarding regulatory opportunities, barriers, and other considerations related to TEN deployment. Using this information, along with what was learned during the first informational workshop, Workgroup members developed an initial list of regulatory opportunities and barriers. This initial list has been included in Attachment 2 (pages 6-7 of Roundtable Meeting 1 Summary).

Of the items included in the initial list, some members discussed the extent to which special consideration was needed for existing district heating and cooling systems. In response, some members explained that, while gas utilities can spread the costs of their TEN investments across all their customers, existing district heating and cooling systems cannot. They expressed concern that allowing gas utilities to enter the thermal energy market would be unfair to existing systems. However, other parties questioned whether this should be a focus of the group.

Additionally, through this discussion, some members advocated for explicitly aligning TEN deployment with the State's 2050 carbon neutrality goal.[66] They argued that for TENs to work as intended, they must work toward broader state objectives.

[66] Minn. Stat. § 216H.021, subd 1, Greenhouse Gas Emissions Reporting. https://www.revisor.mn.gov/statutes/cite/216H/full#stat.216H.021

In preparation for the second roundtable discussion, Workgroup members were asked to identify their top three topics from the initial list to which they believed the Workgroup should dedicate additional time.

Roundtable #2: Understanding the Legislative Landscape for TENs in Minnesota

GPI convened the second roundtable discussion on February 28, 2025. Prior to this meeting, GPI reviewed members' top three topics from the initial list of regulatory opportunities and barriers, and compiled responses into the following list of "priority topics," believed to be essential for gas utilities' successful deployment of TENs:

Table 1: TEN Workgroup List of Priority Topics

Priority Item	Details
Be cost-effective	• Including consideration for stranded asset costs • Cost-effectiveness for customers • Include customer costs in business model
Enable benefits	• Potential for multiple ownership models
Utilize existing knowledge and expertise	• Existing district energy providers have extensive knowledge
Have regulatory certainty	• Regulatory certainty regarding customer rights/protections • Need clarity beyond initial system costs/ownership (e.g., who pays for land for well fields, pump houses, etc. when they are not public?) • Clear legislative definition • Be fair to existing (i.e., not owned/operated by an IOU) systems

These priority topics were presented to members during the meeting to aid later discussions as progress continued to be made toward the development of the Workgroup's final recommendations to the legislature.

During this meeting, the Workgroup also heard from Xcel and CenterPoint about the TEN pilot projects contained within their NGIA plans. Many Workgroup members were not active in the Commission's NGIA dockets, and so these presentations served as an introduction to the TEN-related work occurring through gas utility NGIA plans. Both utilities anticipated their pilots to be retrofits for existing neighborhoods instead of installations in new developments. Specifics about each system are subject to change at the time of this report's publication. Additional information about each system will be available once utilities have completed their site selection and feasibility studies (est. 2026). Through their pilots, each utility stated that it was hoping to learn about:

Learning Objective of NGIA Pilots	Question(s)
Cost	• What are the costs to construct? • What are the costs to operate?
Performance	• How do TENs perform in a Minnesota climate? • What is the energy load profile?

Customer Adoption	• How does system performance meet customer needs in their homes and businesses?
Future Scalability	• What are the best ways to engage potential customers to encourage participation? • What additional capabilities are needed internally and from the local workforce? • Are their safety and reliability considerations for wide-spread deployment? • What is a viable rate structure? • How would deployment be evaluated within the service territory?

With these presentations complete, GPI guided the Workgroup through a discussion by asking several key questions of the group, including:

1. What existing laws, regulations, and related factors enable regulated gas utility ownership and deployment of TENs?
2. What existing laws, regulations, and related factors impede regulated gas utility ownership and deployment of TENs?
3. What actions would be necessary to remove these barriers to regulated gas utilities owning and deploying TENs?

Existing Enabling Laws and Regulations

Workgroup members identified several examples of regulated gas utilities historically deploying district energy systems, including People's Gas in Pittsburgh and the initial development of the two largest district energy systems in Minnesota (no longer owned/operated by utilities). While no Minnesota statutory language currently prohibits regulated gas utilities from owning or operating TENs, **NGIA was recognized as the only statute in Minnesota that currently enables regulated utilities to pilot TENs and be able to recover the costs from ratepayers.** Some participants noted that it may be legally possible for a utility to form a separate thermal energy subsidiary but questioned whether the Commission would support such a structure, particularly if it involved the development of non-regulated assets.

Existing Legal and Regulatory Barriers

Participants agreed that several Minnesota statutes and regulatory definitions currently hinder the broader deployment of TENs by gas utilities.

1. The current definitions of "public utility" and “service” (Minn. Stat. § 216B.02)[67] do not include thermal energy, making it difficult to authorize rate recovery for TENs outside of NGIA pilots.
2. In addition, the statutory obligation to serve (Minn. Stat. § 216B.04)[68] may be interpreted to require gas utilities to provide gas service to any customer who requests it, which may

[67] Minn. Stat. § 216B.02. https://www.revisor.mn.gov/statutes/cite/216B.02
[68] Minn. Stat. § 216B.04. https://www.revisor.mn.gov/statutes/cite/216B.04

prevent utilities from fully transitioning areas to thermal energy networks. This could result in duplicative infrastructure – maintaining gas pipelines alongside TEN infrastructure – if some customers decline to switch.

Other potential barriers include the lack of customer protections tailored to thermal energy services (e.g., low-income programs), uncertainty around the economic impact of decoupling on TEN adoption, and challenges related to large industrial customers who purchase gas at wholesale rates.

Actions Needed to Remove Barriers

Members outlined several actions that could enable broader TEN deployment by regulated gas utilities. They emphasized the need for robust community education and outreach, citing the success of Eversource and Framingham in Massachusetts. Minnesota community-based organizations have heard strong interest about TENs, and broad interest in clean air, reducing emissions and lowering bills. These community-based organizations could serve as valuable partners in public engagement. Small businesses were also noted as generally supportive, particularly when projects align with infrastructure upgrades along commercial corridors.

Addressing building retrofit costs was highlighted as a critical enabler, with some participants suggesting that state-supported, large-scale retrofits could lower the cost burden on individual TEN projects. Members also recommended that utilities be provided with a clear pathway to propose projects beyond pilots, including the ability to integrate TEN proposals into resource planning processes.

Several regulatory mechanisms were suggested to formalize the transition from pilots to full-scale deployment. These included the creation of a certificate of need process that would evaluate alternatives (such as individual ASHPs, GSHPs, or TENs) in areas where utilities plan to expand or replace infrastructure. Participants noted that this type of analysis could be integrated into existing gas integrated resource planning (IRP) frameworks, which already includes a gas expansion analysis for planned investments over $1 million. The group also highlighted the value of the Department of Commerce's upcoming site suitability study and encouraged attention to rural deployment opportunities. Finally, while this discussion focused on gas utilities, participants noted that electric utilities may also have a role in deploying or supporting TEN infrastructure.

Roundtable #3: Legislative Barriers to Regulated Utility TEN Ownership

After the second roundtable discussion, Workgroup members were asked to participate in a homework assignment to identify points of agreement and disagreement on potential legislative solutions to member-identified opportunities and barriers to TEN deployment. This assignment sought members' perspectives on the following items:

- Minnesota's statutory definition of TENs,
- Minnesota's statutory definition of "public utility" and "service" for cost recovery,
- Minnesota gas utilities' obligation to serve/standard of service,
- Uncertainty around post-NGIA pilot deployment of TENs, and

- The expansion alternatives analysis in Minnesota's gas resource planning order framework.[69]

Responses to this homework assignment were consolidated by GPI, who identified three main policy barriers for the Workgroup to focus on:

1. The definition of TENs.
2. Implications of legislative definitions of "utility" and "service" on cost recovery.
3. The obligation to serve/standard of service.

The third roundtable discussion, held on April 18, 2025, focused its discussion on clarifying and understanding members' feedback. A summary of these discussions is included in the subsections below.

The Definition of TENs

Thermal Energy Networks as defined in HF 5247, *Thermal Energy Deployment Work Group*, Subd. 6 and Ch. 216B.2427, *Natural Gas Utility Innovation Plans*, Subd. 1(s): "a project that provides heating **and** cooling to multiple buildings connected via underground piping **containing fluids that, in concert with heat pumps**, exchange thermal energy from the earth, underground or surface waters, wastewater, or other heat sources."

District Energy Systems as defined in Ch. 216B.2427, *Natural Gas Utility Innovation Plans*, Subd. 1(f): "a heating **or** cooling system **that is solar thermal powered or that uses the constant temperature of the earth or underground aquifers** as a thermal exchange medium to heat or cool multiple buildings connected through a piping network."

The Workgroup discussed how current Minnesota statutory definitions of TENs and "District Energy Systems" may impact the long-term deployment of TENs in Minnesota. Members noted that the existing TEN definition is generally appropriate for the types of new and/or innovative systems likely to be pursued under the NGIA. These ambient systems are nascent technologies that could significantly benefit from dedicated pilots. However, participants raised concerns that this definition may be too narrow to support broader deployment outside of the NGIA framework, potentially excluding other technologies or configurations, such as non-ambient systems, cogeneration with waste heat, or systems that use a technology other than heat pumps for thermal exchange.

The phrase "in concert with heat pumps" was discussed as a potential limitation that may restrict the statutory definition to ambient loop systems. Members weighed the trade-offs of narrower versus broader definitions, including considerations of regulatory oversight and technology flexibility for urban and rural applications. One proposed solution was to amend the statutory language to refer to heating "and/or" cooling, which could expand the definition without significantly altering its intent.

[69] Docket No. G-008,G-002,G-011/CI-23-117, *In the Matter of a Commission Investigation into Gas Utility Resource Planning*, Order (March 27, 2024)

Finally, some members advocated for a definition that describes the desired outcomes of TENs instead of focusing on specific technologies or system configurations. Such a definition could be sufficiently broad while still providing the necessary safeguards to ensure that future TEN deployments achieve their intended goals, such as carbon-free operation, emissions reductions, and interoperability with existing systems and a wide range of thermal resources.

Definition of "Public Utility" and "Service" for Cost Recovery

Public Utility as defined in Minn. Stat. § 216B.02 Subd.4: "…persons, corporations, or other legal entities, their lessees, trustees, and receivers, now or hereafter operating, maintaining, or controlling in this state equipment or facilities for furnishing at retail natural, manufactured, or mixed gas or electric service to or for the public or engaged in the production and retail sale thereof…"

Service as defined in Minn. Stat. § 216B.02 Subd.6: "natural, manufactured, or mixed gas and electricity; the installation, removal, or repair of equipment or facilities for delivering or measuring such gas and electricity."

The Workgroup examined how current statutory definitions in Chapter 216B – specifically the terms "public utility" and "service"[70] – may limit utilities' ability to recover costs associated with TEN projects. Members noted that Minn. Stat. § 216B.1635, subd. 4, provides only narrow cost recovery authority for safety upgrades, rather than for new infrastructure investments.[71] If thermal energy infrastructure is to be treated as a core utility service, participants recommended that any legislative changes be made to Minn. Stat. § 216B.16, subd. 6, to enable recovery across the broader rate base, rather than through specialized riders.[72]

Several options for updating statutory definitions were discussed. These included:

(1) Explicitly incorporating thermal energy service into the existing definitions of utility service and directing the Commission to establish relevant exemptions, as done in New York (see page 19 of this report); or

(2) Establishing thermal energy as a new, third category of utility service, or otherwise clarifying that thermal energy service is an appropriate alternative to natural gas service.

Members noted that defining thermal energy as a distinct category of utility service rather than incorporating it into existing definitions could necessitate modifying all other statutes that reference gas service to include thermal energy service as well.

Workgroup members also discussed the respective roles of the Minnesota Legislature and the Commission. While the Commission is responsible for interpreting and applying existing statutory language, it is the Legislature's role to clarify ambiguities or redefine utility categories where

[70] Minn. Stat. § 216.B.02. https://www.revisor.mn.gov/statutes/cite/216B.02
[71] Minn. Stat. § 216B.1635, Recovery of Gas Utility Infrastructure Costs. https://www.revisor.mn.gov/statutes/cite/216B.1635
[72] Minn. Stat. § 216B.16, Rate Change; Procedure; Hearing. https://www.revisor.mn.gov/statutes/cite/216B.16

necessary. Some participants cautioned that expanding the definition of "public utility" to include TENs could unintentionally broaden the scope of entities subject to regulation.

Obligation to Serve/Standard of Service

Ch. 216B.04. Standard of Service: Every public utility shall furnish safe, adequate, efficient, and reasonable service; provided that service shall be deemed adequate if made so within 90 days after a person requests service. Upon application by a public utility, and for good cause shown, the commission may extend the period for not to exceed another 90 days.

Workgroup members generally agreed that if statutory definitions of "service" or "public utility" were expanded to include thermal energy, no additional changes to the utilities' obligation to serve would be required. However, participants noted that clarifying the existing standard of service – particularly for natural gas utilities – could help ensure a smoother transition in areas where TENs are deployed. Specifically, members suggested that additional guidance may be needed to define how long a gas utility would be required to continue providing service to customers who decline to join a TEN, especially in areas undergoing system transitions. The discussion also highlighted a key difference between gas and electric service obligations in Minnesota: while electric utilities operate within clearly defined service territories, natural gas utilities do not. As a result, many properties in Minnesota are not currently served by natural gas, and no particular gas utility is inherently obligated to extend service to those customers absent a request, particularly when doing so would be cost-prohibitive.

Additional Considerations

The Workgroup explored several additional considerations regarding the deployment of TENs in Minnesota. These discussions focused on geographic and zoning strategies, cost allocation issues, and the continued value of pilot projects and expansion alternatives analysis.

Geographic and Zonal Considerations

Members discussed the potential value of incorporating geographic and zoning considerations into future TEN regulatory strategies. These could include treating new developments differently from existing neighborhoods with legacy gas infrastructure or factoring in proximity to existing gas assets when evaluating the feasibility of TEN deployment. Some members questioned whether areas currently unserved by natural gas should be encouraged or required to adopt electric heating or participate in a TEN.

The group reviewed California's zonal approach, in which utilities identify areas of their service territory well-suited for TEN deployment based on factors such as infrastructure availability and environmental justice. If a supermajority of customers in such a zone opt into a TEN, the utility may wind down gas service within the zone once participating buildings have converted to zero-emissions alternatives.[73] Participants noted similarities with Minnesota's existing innovation plan framework under the NGIA, which requires utilities to conduct both quantitative and qualitative

[73] California Senate Bill No. 1221, Chapter 602 (approved by Governor on September 25, 2024). https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240SB1221

cost-benefit analyses, including considerations of prudency and environmental justice. The forthcoming Minnesota Department of Commerce site suitability study may further support the identification of zones suitable for future TEN deployment.

Cost Allocation and Customer Impact

The Workgroup also discussed the financial and safety challenges associated with maintaining overlapping infrastructure, namely, the operation of both a gas distribution system and a TEN in the same area. As customers begin to transition away from gas service, those who remain may face increased costs as fixed infrastructure expenses are shared among a shrinking customer base. Members emphasized the importance of developing strategies to minimize financial risk for these customers.

Advancing Learning from Pilot Projects

Members reaffirmed the value of ongoing NGIA-funded pilot projects in advancing understanding of TEN implementation challenges and opportunities. These pilots are expected to generate critical insights into cost-effectiveness, deployment logistics, and community engagement. Some participants suggested expanding the NGIA framework as a potential stopgap legislative solution to support additional pilot activity.

In addition, the group noted that Minnesota's updated natural gas integrated resource planning framework (Docket 23-117) requires utilities to evaluate alternatives to traditional infrastructure projects. The required Expansion Alternatives Analysis could provide a useful tool for identifying areas where TENs may be more appropriate than gas system extensions. Finally, members stressed the importance of ensuring that communities – especially those affected by environmental injustice – benefit from TEN deployment and are meaningfully engaged in siting and implementation decisions.

Roundtable #4: Developing Final Recommendations

On June 13, 2025, the TEN Deployment Workgroup met for its fourth and final roundtable discussion. Prior to this meeting, GPI sent members a survey containing draft recommendations informed by the discussion at the previous meeting. Members were asked to indicate whether they agreed with a recommendation as written, agreed with the concept or objective of a recommendation but would support modifications to the language, or disagreed with a recommendation in concept. Members were also given an opportunity to provide written feedback about each draft recommendation to describe the nature of their agreement or disagreement.

At the fourth roundtable discussion, GPI led members through a discussion of draft recommendations, which had been revised in response to members' survey responses. In total, GPI outlined six revised draft recommendations and several sub-recommendations. Members discussed the revised recommendations, whether further refinements were necessary, and determined whether they were supportive of including the revised draft recommendations in the report. GPI sought group support for recommendations wherever possible but moved forward certain language in situations where individuals had some differences of opinion regarding language, but no members disagreed with a recommendation in concept.

Recommendations

Here, the TEN Deployment Workgroup submits its final recommendations to the legislature regarding the deployment of TENs in Minnesota in a way that protects the public interest.

The recommendations listed below reflect the language that participants in attendance at the final Roundtable meeting did not object to including in the final report. Recommendations were initially drafted based on participant feedback and suggestions during roundtable meetings, which were facilitated by GPI. Participants then had opportunities to complete a survey expressing their support for, opposition to, or suggested revisions to draft recommendations. Draft recommendation language was revised in response to this feedback. The revised draft recommendations were then further revised and iterated upon with stakeholders during the final roundtable meeting; for more details about that discussion, please see Attachment 2, "Work Group 4 Meeting Summary." The recommendations provided below reflect the version of the recommendations reached by the end of the final roundtable meeting.

These recommendations are provided in alphanumeric format for reference purposes only. The numbers and letters associated with each recommendation do not indicate any prioritization or ranking. Each recommendation will include a discussion that outlines the considerations made at the fourth roundtable meeting which influenced each recommendation's final language.

Topic I: Defining TENs in Minnesota Statute

Recommendation 1

The legislature should adopt a definition for TENs that reflects legislative goals and desired outcomes and that would encompass a broad range of systems for gas utility-owned TENs outside of the NGIA context. The new or revised definition should, at a minimum, aim to achieve the following outcomes:

1a: Affordable	Enable affordable TENs service that results in customer costs that are comparable to or lower than other services, as determined in gas and electric integrated resource plans and subject to the Commission's duty to ensure just and reasonable rates.
1b: Cost-Effective Over Time	Support TENs deployment that enables long-term cost reduction as the market scales. Cost-effectiveness criteria as established in NGIA approvals should be applied for pilot projects while post-pilot deployment should be subject to the Commission's duty to ensure prudent investments that are in the public interest

1c: Carbon-Reducing	Enable Minnesota's regulated gas utilities to further work towards achieving Minnesota's greenhouse gas reduction goals to deploy TENs in a way that is consistent with Minnesota's greenhouse gas reduction goals under Minn. Stat. § 216H.02, prioritizing carbon-free systems and limiting fossil fuels to cases aligned with a clear path to net-zero by 2050.
1d: Variety of Thermal Services	Clarify that TENs can provide space heating, cooling, hot water heating, and other thermal services, including industrial heat, supporting a broad range of end uses. Recognize that the mix of service may evolve over time as lessons are learned from pilot projects and deployment experience.
1e: Variety in Thermal Sources and Technologies	Allow TENs to utilize a range of thermal sources and technologies, prioritizing non-combustion and low-carbon options for regular operation. Limit fossil fuel use to backup or peak-load scenarios, with a clear pathway to meet Minnesota's 2030 and 2050 greenhouse gas reduction targets. Alternative and legacy systems may be included where appropriate but should be the exception rather than the standard. Recognize that the mix of thermal sources and technology options may evolve over time as lessons are learned from pilot projects and deployment experience.
1f: Targeted Oversight	Commission oversight should be scaled based on factors such as system size, type of customers served, and public interest, ensuring that small-scale, non-utility systems are not subject to unnecessary regulatory burdens, while larger or residential-service systems receive appropriate consumer protections. This should work in tandem with any definitional changes to "public utility" and/or "service" as provided in this report. Recognize that applying these distinctions may be complex in practice, and authority should be delegated to the Commission to determine and refine oversight criteria as needed.

Topic II: Minnesota's definitions of a "public utility" and "service" under § 216B.02

Recommendation 2

The definitions of "public utility" and "service" in Minn. Stat. § 216B.02 Subds. 4 and 6 may create uncertainty for TEN deployment. The legislature should either modify these definitions or add a new statutory subdivision to clarify that regulated utilities may provide thermal energy as a utility service. This statutory authority should:

- Exempt existing non-utility TENs from becoming regulated public utilities;
- Authorize regulated gas and electric utilities to invest in and recover costs for TENs deployed outside of NGIA, subject to Commission approval and a determination that such investments serve the public interest based on affordability, reliability, and decarbonization benefits.
- Affirm that Tribes retain the authority to self-regulate thermal energy services on tribal lands; and
- Ensure customer protections consistent with Minn. Stat. §§ 216B.096, .097, and .0975, and allow low-income assistance under § 216B.16, subds. 14 and 15.

Topic III: Standard of Service/Obligation to Serve

Recommendation 3

TENs should be prioritized in certain zones based on geographic, economic, and equity-related factors, along with broader planning considerations. Prioritization should not preclude deployment in other areas; rather, it should guide near-term focus where conditions are especially favorable or policy-aligned. Considerations should include:

3a: Geographic or Infrastructure-Based Suitability	Prioritize zones where traditional gas infrastructure is less feasible or prudent (as evaluated using integrated resource planning to compare TENs with other thermal energy technologies) due to factors such as: ○ Absence of existing natural gas infrastructure (e.g., new developments or reliance on delivered fuels) ○ As an alternative to gas or electric system capacity expansion ○ End-of-life gas infrastructure ○ Building characteristics such as density or HVAC type (e.g., prevalence of boilers) ○ Access or proximity to renewable thermal resources (e.g., wastewater)

3b: Suitable Sites	Prioritize communities that meet prioritization criteria from the Minnesota Thermal Energy Network Site Suitability Study currently being developed by the Minnesota Department of Commerce.
3c: Interested Communities	Prioritize communities that have demonstrated significant interest in participating in TENs.
3d: Attributes of Successful Pilots	Identify and prioritize communities with similar characteristics to those where TEN pilots have succeeded.
3e: Equity and Policy-Aligned Decarbonization Zones	Prioritize targeted decarbonization zones, including located in low-income and/or environmental justice areas as defined in Minn. Stat. § 116.065, subd. 1(e) (2023), indigenous communities, rural towns, and other areas unlikely to be early market entrants without public investment or policy support.

Recommendation 4

The Legislature should support the development of strategies that would facilitate equitable TEN deployment and incentivize participation from customers that are not interested or have prohibitive barriers to participation, especially in geographic and/or economic zones currently served by natural gas service but targeted for TEN deployment. Such strategies include:

- Incentives or financing options
- Ensuring that existing low-income gas customers and/or gas customers in environmental justice areas have affordable service options to support their transition.
- Support development of customer educational resources and outreach programs about TENs and their functionality.
- Leveraging existing or creating new energy efficiency programs and/or other home retrofit and appliance upgrade programs that would help prepare existing homes for TENs.

Recommendation 5

The legislature should review and revise as needed Minn. Stat. § 216B.04 such that if a regulated utility provides an adequate alternative via a TEN to natural gas service (e.g., heating service of comparable reliability and similar or lesser cost compared to natural gas) to an area that is currently served by natural gas, the utility is no longer obligated to also provide natural gas service to that area, in accordance with specific parameters. These parameters include:

- Establishing a reasonable timeframe by which the utility must safely decommission the natural gas system in areas with both natural gas and TEN service, and by which customers in the area that are still receiving gas service must decide whether they want to interconnect with the TEN or pursue an alternative heating source such as an alternative means of electrification.
- Directing the Commission to establish noticing requirements to ensure that customers are well-informed regarding the point in time at which their natural gas service will cease, similar to the two-year noticing requirement proposed under the New York Home Energy Affordable Transition Act.
- Clarity regarding gas utilities' responsibilities related to existing gas infrastructure once an area is served fully by a TEN.
- Clarity that electric utilities may offer TENs in service areas that are not served by a natural gas distribution system.

Topic IV: Other ways to Incentivize TEN Deployment

Recommendation 6

The legislature should consider ways to enable utilities to deploy more TEN pilots and/or a greater variety of TEN pilots. Potential pathways through which the legislature could do this include (but may not be limited to) the following:

- Directing the Commission to consider approaches that would ensure TENs are evaluated under the EAA in gas utility IRPs with analysis of electric grid infrastructure impacts and costs, and/or
- Exploring ways through which more TEN pilots (and/or a wider variety of TEN pilots) could be deployed under the NGIA, such as amending the NGIA cost caps.

Conclusion

TENs are a resource capable of addressing several issues facing the state of Minnesota. They can reduce statewide energy costs by improving system resiliency and avoiding the need for new generation, while also minimizing fuel-related expenses for customers. They can improve public health and safety by eliminating the need for on-site combustion and the associated risks of gas leaks and indoor air pollution. They have the potential to lower greenhouse gas emissions and offer a viable tool for gas utilities to stabilize rates and preserve system reliability in a decarbonizing economy. A single technology capable of contributing meaningfully to so many policy objectives is rare, and the steps Minnesota takes today to support the deployment of this technology will determine how fully those benefits are realized.

The TEN Deployment Workgroup thanks the Minnesota Legislature for the opportunity to engage on this topic and appreciates its consideration of our final recommendations. The state is moving through the demonstration phase of TEN deployment. Near-term actions to enable a diverse suite of TEN pilots will substantially impact on the long-term viability of this technology in the future. As Minnesota moves from demonstration toward development and eventual deployment, policymakers have an opportunity to remove statutory barriers, clarify utility and Commission authority, and align incentives with the public interest. By creating a regulatory and legislative environment that supports innovation and encourages collaboration between utilities and communities, Minnesota can position TENs as a central component of a safer, equitable, and more affordable energy system for decades to come.

Attachment 1: Summary of Informational Workshops

Workshop 1 – Introduction to Thermal Energy Networks[74]

Date: November 22, 2024

The first workshop introduced the fundamentals of TENs, ensuring that all Workgroup members had a shared understanding of the basic concepts, technologies, and terminology.

Speakers:

- Ania Camargo – Building Decarbonization Coalition
- Brian Urlaub – Salas O'Brien
- Isabel Varela – HEET
- Dave Podorson – Xcel Energy

Workshop 2 – Impacts of TEN Deployment[75]

Date: February 4, 2025

This workshop focused on the potential impacts of broad TEN deployment. Presentations addressed how TENs may affect the electric grid, how skilled labor is adapting to the technology, and the motivations of communities and developers advocating for TEN use.

Speakers:

- Timothy Steeves – Department of Energy's Geologic Technologies Office
- Marc Poulos – Indiana, Illinois, and Iowa Foundation for Fair Contracting
- Kathryn Sarnecki – Saint Paul Port Authority

Workshop 3 – Policy and Regulatory Innovations[76]

Date: February 4, 2025

This session examined the policy and regulatory changes needed to support successful TEN implementation. Presenters shared insights from other states and discussed findings from the September 2024 report, Accelerating Thermal Energy Network Deployment in Minnesota,[77] published by the Midwest Building Decarbonization Coalition and the AnnDyl Policy Group.

Speakers:

- Ania Camargo – Building Decarbonization Coalition
- Caroline Hon – National Grid

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[74] Link to recording of workshop 1: https://minnesotapuc.granicus.com/player/clip/2452?view_id=2&redirect=true
[75] Link to recording of workshop 2: https://minnesotapuc.granicus.com/player/clip/2496?view_id=2&redirect=true
[76] Link to recording of workshop 3: https://minnesotapuc.granicus.com/player/clip/2516?view_id=2&redirect=true
[77] *Midwest Building Decarbonization Coalition. (2024, September). Thermal energy network policy opportunities and barriers in Minnesota.* https://static1.squarespace.com/static/6548fa466239d21eee818ad3/t/66e0a2dd0bd49504e456aa6c/1725997790857/Thermal+Enery+Network+Policy+Opportunities+and+Barriers+in+Minnesota+-+2024-09+%281%29.pdf

- Peggie Neville – New York Department of Public Service
- Bryce Carter – Colorado Energy Office
- Jacob Serfling – Midwest Building Decarbonization Coalition

Workshop 4 – Rate Design and Cost Allocation[78]

Date: May 30, 2025

The fourth and final workshop addressed issues of rate design and project cost allocation. As TEN pilot projects expand nationwide, many jurisdictions have permitted utilities to use the broader rate base for cost recovery. Presentations explored costs of TEN development, how other states have addressed TEN implementation costs, how such costs are being recovered, and the status of TEN rate design.

Speakers:

- Zeyneb Magavi (HEET)
- Eric Bosworth (Thermal Energy Insights)
- Jared Rodriguez (Emergent Urban Concepts)

[78] Link to recording of workshop 4: https://minnesotapuc.granicus.com/player/clip/2545?view_id=2&redirect=true

Attachment 2: Summary of Roundtable Discussions 1-4

The following pages contain summaries of the Workshop's roundtable discussions on regulatory opportunities and barriers, and the process that led to consensus on final recommendations.

Minnesota Thermal Energy Network Deployment Work Group Roundtable

Roundtable Meeting 1 Summary

December 20, 2024 | 9:00 am to 12:00 pm CT

Contents

Introduction

Roundtable Overview

On Friday December 20, 2024, the Great Plains Institute (GPI) convened the first roundtable meeting of the Minnesota Thermal Energy Network Deployment Work Group (TEN work group). Prior to the December 20, 2024, roundtable meeting, the TEN work group met for an informational workshop on November 22, 2024. Overall, the TEN work group process will consist of four informational workshops hosted by Commission Staff and four GPI-convened roundtable discussions between each workshop.

The purpose of the roundtable is to examine the potential regulatory opportunities for Minnesota's regulated natural gas utilities to deploy TENs and the potential barriers to development. The group will develop findings and recommendations regarding how to deploy TENs within a regulated context in a manner that protects the public interest and considers reliability, affordability, environmental impacts, and socioeconomic impacts. These findings and recommendations will be compiled into a report and submitted to the legislature by December 31, 2025.

A detailed description of the background, purpose, and process plan for the roundtable is included in the *Notice of Work Group* that the Commission filed on August 20, 2024, in docket G999/CI-24-275 and on the Commission's TEN work group webpage.

GPI will prepare a summary following each roundtable meeting. All roundtable summaries, as well as additional group materials, are available to all participants in the group's resource database, hosted via SmartSuite. GPI will also file roundtable summaries and slide decks in docket G999/CI-24-275.

Overview of Most Recent Informational Workshop

The first TEN work group informational workshop was held on November 22, 2024, from 9:00 am to 12:00 pm CT. This workshop focused on work group objectives and deliverables and included an overview of TEN deployment and the status of gas utility-run TENs in Minnesota. Four speakers presented to build a shared understanding of TENs more generally:

- Ania Camargo, Building Decarb Coalition: overview of TENs, what they are, how they work, and what we are seeing nationally.
- Brian Urlaub, Salas O'Brien: experience with early pilot projects and lessons learned thus far.
- Isabel Varela, HEET: review of data being collected and how it is being used to aid future TEN projects.
- Dave Poderson, Xcel Energy: gas utility perspective on TENs.

Copies of the slides from the November 22, 2024, informational workshop are available in docket G999/CI-24-275.

Roundtable Meeting 1 Summary

Objectives and Ground Rules

The objectives for the first TEN work group roundtable meeting were as follows:

1. Build a shared understanding of potential regulatory opportunities for regulated natural gas utilities to deploy TENs.
2. Build a shared understanding of potential regulatory barriers for regulated natural gas utilities to deploy TENs.
3. Develop a list of regulatory opportunities and barriers to use as a basis to prioritize future roundtable discussions, leading to findings and recommendations.

To support a productive meeting environment, GPI asked participants to adhere to the following meeting ground rules:

1. **Respect each other.** Respect each other's experiences and opinions, even in difficult conversations.
2. **Respect the time.** Our time together is limited. Please respect the process and meeting scope to ensure we can make as much progress as possible during this limited timeframe.
3. **Enable honesty through non-attribution.** Outside of these meetings, you may say what was discussed, but please do not directly attribute specific views to any one individual without first obtaining that person's permission to do so.

Overview of Roundtable Meeting 1 Material

Roundtable meeting 1 focused on scoping the universe of potential regulatory opportunities and barriers to TEN deployment by regulated gas utilities in Minnesota. GPI provided an overview of the TEN work group process and legislative directive. Participants then had the opportunity to provide a brief presentation (up to 5 minutes) constrained to the following scope:

- Potential regulatory opportunities for Minnesota's regulated natural gas utilities to deploy TENs, and
- Potential barriers to TEN deployment.

The meeting included the following presentations:

- Overview of roundtable ground rules; legislative directive, duties, and deliverables; and process summary (Aileen Cole, GPI)
- Perspectives on potential regulatory opportunities and barriers from the following organizations:
    - Midwest Building Decarbonization Coalition (Jacob Serfling)
    - Building Decarbonization Coalition (Noah Cordoba)
    - Cordia (Stuart Deets)
    - FVB Energy (Mark Spurr)
    - Egg Geo (Jay Egg)
    - Citizens Utility Board of Minnesota (Olivia Carroll and Annie Levenson-Falk)

Following these presentations, the group discussed their perspectives and views regarding these regulatory opportunities, barriers, and related considerations.

Meeting slides are available here in the work group's resource database.

Participant Presentations

Midwest Building Decarbonization Coalition

- Shared highlights from recent report, *Accelerating Thermal Energy Network Deployment in Minnesota—Policy Barriers and Opportunities*
- Opportunities
    - Deployment in disadvantaged communities to ensure equity; pilot projects important for learning and expansion
    - Multiple ownership models – for utility-, municipal-, and private-ownership
    - Labor standards can support existing and new workforce
- Barriers
    - "Public utility" and "service" definitions – thermal energy not in utility definitions
    - Regulatory uncertainty over thermal energy sales by a private building owner
    - Regulatory uncertainty of "safe, adequate, efficient, and reasonable service"
    - Different definitions between IOUs and municipal utilities for "district heating," "district energy," "heat utility," and "thermal energy network"
    - Customer shutoff protections which only apply to electric and gas service
    - Initial costs and stacking financing – ratepayers, grants, tax credits, Green Bank loans

Building Decarbonization Coalition

- Barriers
    - Ensuring consistent and sufficient environmental regulations for drilling, aquifer monitoring/protection, and thermal exchange
    - Consistency in system design to allow for interoperability
    - Establishing consistent guidance for diverse heat source ownership
    - Determining shared data, metrics, and transparency standards
- Factors still being determined
    - Leveraging avoided costs of gas system investment to pay for TENs establishment and expansion
    - How to include avoided electric system buildout costs as savings for TENs
    - Heat source best practices to maintain TEN reliability emissions elimination goals
    - Deploying TENs in a prudent, cost-effective manner in instances of potential double infrastructure
        - Determining appropriate approach to utility requirement to provide service
- Opportunities
    - Business opportunities for gas utilities in communities they already are positioned to serve
    - Infrastructure and behind-the-meter federal and state incentives

    - Provide a near-term decarbonization pathway for environmental justice communities viz prioritization
    - A clear, preferred pathway for gas system workers into TENs jobs
    - Realize grid benefit by avoiding build out of a 100% air source heat pump scenario

Cordia

- TENs have a long track record
- A lot of expertise and knowledge from district energy practitioners, but a barrier is sharing the knowledge and expertise related to deployment
- If the technology is cost prohibitive it can lead to equity issues
- Rather than starting with pilots, we should accelerate implementation by utilities by foundation from district energy
- Joint partnerships between private sector and gas utilities presents an opportunity

FVB Energy

- Conflicting legislative definitions presents a barrier
- Thermal business is different from gas business—need to ensure consideration for these differences
- Must consider all-in costs of the technology and whether rate basing investments or letting the market decide is better for customers

Egg Geo

- Presented a slide with the components of a Geo-Thermal Energy Network
- Noted that pulling from the New York experience will be beneficial
- A barrier is getting out of siloed generators and customers: difficult to communicate with data centers, ice rinks, etc. as well as drinking water silos

Citizens Utility Board of Minnesota

- Drew from proposals in the Natural Gas Innovation Act (NGIA) plans and other states
- Opportunities include:
    - Gas integrated resource plans and expansion alternative analyses
    - Collaborating with local governments to prioritize greenhouse gas reductions and opportunities for governments to be active
- Questions around:
    - Where TENs could fit in beyond integrated resource plans and NGIA plans
    - Customer consent for neighborhood scale
    - Customer protections
    - Whether Commission has authority to regulate (e.g., definition of “utility” does not include them)

Discussion

This meeting's discussion time was focused on building on the list of regulatory opportunities and barriers that presenters introduced. We have captured some notable highlights below from the conversation.

Notes are in an alphanumeric format for reference purposes only; the numbers and letters do not indicate any prioritization or ranking.

What is needed to make TENs work well? (On-screen notes)

1. Enable Benefits
    a. Equitably decarbonize disadvantaged communities
    b. Multiple ownership models (utility, municipal, private)
    c. Workforce, job creation
    d. Outcomes listed in legislation – reliability, affordability, environmental, socioeconomic
2. Enable Cost-effectiveness
    a. Leverage avoided costs of gas system investment
    b. Avoided electric system costs
    c. Cost-effective deployment
    d. Federal and state incentives to pay for TENs
    e. Avoid expensive electric system buildout (e.g., all heat pumps)
3. Standards and consistency
    a. Consistent and sufficient environmental regs
        i. Regulatory agencies need to understand the impacts, including groundwater, surface water, etc., and how to regulate them
        ii. KPIs for any system using subsurface as medium of storage
        iii. Permitting for authorities having jurisdiction – this should be non-consumptive use
    b. Interoperability (system design, interconnection – play well together)
        i. Breaking down heat silos
    c. Consistent guidance for heat source ownership (wastewater, data centers, etc.)
    d. Shared data, metrics, transparency standards
4. Knowledge and expertise for effective deployment
    a. Heat source best practices (difference between district systems and geothermal)
    b. Appropriate piloting
    c. Customer education/marketing – to make wise choices about what is best for them
        i. Systems will operate sub-optimally without 100% adoption (but that may not be realistic)
    d. Timeline planning to estimate and achieve scale and impact towards the outcomes
5. Regulatory certainty/enablement
    a. “Public utility” and “service”
    b. Over thermal energy sales
        i. Monetization of a thermal source that pre-existed the TEN (and that may have been waste heat)
    c. Definition of safe, adequate, efficient, reasonable
    d. Customer shutoff protections

e. Initial costs and stacking financing (ratepayers, grants, tax credits, green bank loans)
f. Obligation to serve (OTS) – issue of these being networked, but OTS is a single customer choice model
    i. Legal analysis of whether OTS and how OTS applies
g. Definition of District Energy in NGIA – extremely specific and points to networked geothermal. Opportunity to revise language to enable TENs.

6. Business models/deployment models
    a. Business model that works and that benefits the customer
        i. Equity between those who can and those who cannot join into these systems (related to obligation to serve)
    b. Pathway for gas utilities that works for their business model
    c. Streamlined deployment pathways
    d. Getting out of silos
        i. need to communicate with a wide variety of building/land use types and owners
        ii. Drinking water as a thermal energy asset – Ontario has a drinking water exchange system
    e. Regulatory pathways
        i. NGIA plans
        ii. Gas IRP plans – expansion alternative analyses
            1. Requirement to collaborate with local governments
    f. Partnership opportunities between gas utilities and district energy providers
    g. Heat marketplace
    h. Who owns and serves/operates?
    i. Need to size these appropriately
    j. How TENs will work with existing natural gas infrastructure, and what is the long-term outlook for TENs and the NG distribution system?
    k. Thermal load density – concentrated vs distributed thermal loads, and how to utilize waste heat

Wrap-up and Next Steps

1. Roundtable members are encouraged to send the following to Aileen Cole (acole@gpisd.net) by no later than Monday, January 13, 2025:
    a. Example regulatory models for TEN deployment that you think would be valuable for the group to consider.
        i. Please keep your suggestions tailored to the legislative scope, which focuses on pathways through which regulated natural gas utilities could deploy TENs.
        ii. Legislation starts on Line 708.6 here
    b. Your clarifications, expansions, or additional thoughts on the items/topics listed in the on-screen notes.
        i. Please keep your feedback to brief track-change comments in the Word doc.
        ii. Your top three topics from the onscreen notes that you think the TEN Work Group should dedicate our time to (items can be at any level/tier of the list).
2. Next informational workshop will be held in January 2025.

3. Next roundtable meeting will be held in February 2025.

Minnesota Thermal Energy Network Deployment Work Group Roundtable

Work Group Meeting 2 Summary

February 28, 2025 | 9:00 am to 12:00 pm CT

Contents

Introduction

On February 28, 2025, the Great Plains Institute (GPI) convened the second meeting of the Minnesota Thermal Energy Network Deployment Work Group (TEN work group). This meeting focused on legislative and regulatory changes to enable gas utilities to own and operate TENs, priority topics identified in previous discussions, and updates on pilot projects from utilities. The group continued its efforts to evaluate the regulatory framework necessary for the deployment of TENs in a manner that ensures affordability, equity, and carbon reduction.

Meeting slides are available here in the work group's resource database.

Most Recent Informational Workshop

The Commission currently plans to host four workshops intended to educate the work group on various aspects of TEN development and deployment. These workshops will feature presentations from individuals with expertise in relevant fields, followed by time dedicated to Q&A. The second workshop was held on February 14, 2025, from 10:00 am to 12:00 pm and focused on the impacts of TEN deployment, including: how broad TEN deployment impacts the electric grid, how skilled workers have had to adapt to TEN deployments, and why communities and developers have pushed for the use of thermal energy networks.

The following individuals presented at this meeting:

- Timothy Steeves (Research Fellow with the DOE's Geologic Technologies Office)
- Marc Poulos (Executive Director of the Indiana, Illinois, and Iowa Foundation for Fair Contracting)
- Kathryn Sarnecki (Chief Development Officer with the Saint Paul Port Authority)

Copies of the slides from the February 14, 2025, informational workshop are available in docket G999/CI-24-275.

Work Group Process and Legislative Directive

The meeting opened with an overview of legislative directives and regulatory limitations shaping the work group's scope. The primary objective remains the development of recommendations for legislative or regulatory changes. However, certain topics—such as altering conditions for existing geothermal facilities and expanding non-IOU ownership authority—were noted as outside the work group's purview.

Key questions discussed included:

- How to shape the broader schedule and process for the final report?
- Where to incorporate network expansion considerations, including connecting sidewalks and buildings to reduce truck reliance and water contamination?
- The framing of legislative discussions, particularly regarding long-term natural gas use and decarbonization goals.

Overview of Priority Topics

During the December 20, 2024, roundtable, participants identified priority topics essential for gas utilities' successful deployment of TENs. The complete list of topics identified during that meeting is available in the Roundtable 1 summary, available here in the group's shared SmartSuite database. Following the first Roundtable meeting, GPI provided participants with an opportunity to submit written clarifications or additional thoughts on the items from the list of topics the group developed during the meeting. Participants also had the opportunity to identify their top three priority topics from that list.

GPI consolidated this participant feedback and identified the following four "top priority items" from the larger list, as summarized in the table below. GPI shared this summarized list of participant feedback during Roundtable Meeting 2 and participants confirmed that they have no additional items to add and clarified the scope of the topics.

Priority Item	Details
Be cost-effective	• Including consideration for stranded asset costs • Cost-effective for customers • Include customer costs in business models
Enable benefits	• Potential for multiple ownership models
Utilize existing knowledge and expertise	• Existing district energy providers have extensive knowledge
Have regulatory certainty	• Regulatory certainty regarding customer rights/protections • Need clarity beyond initial system costs/ownership (e.g., who pays for land for well fields, pump houses, etc. when they are not public?) • Clear legislative definition • Be fair to existing (i.e., not owned/operated by an IOU) systems

Discussions centered around:

- Confirming that regulatory certainty should include an "obligation to serve" for utilities engaging in TEN deployments, which is in scope for the work group.
- The need to consider new construction and retrofitting existing buildings.
- Whether there is a need to define potential partnerships with municipalities and organizations to target climate-impacted communities.

NGIA Pilot Project Updates

CenterPoint Energy Pilot

- CenterPoint presented updates on its pilot project, which is currently in the feasibility phase as they are looking at candidate sites to narrow to one final site.
- The project aims to have an operational system within five years.

- Participants will pay a fee as buildings pay to interconnect to this service; goal is to not increase costs for customers.
- Customer affordability remains a key priority, with efforts focused on ensuring predictable monthly bills.
- Comparisons were drawn with similar pilots in Massachusetts, emphasizing cost and scalability considerations.
- Outlined learning objectives, including gaining experience in MN, costs, performance data, customer adoption, future scalability.

Xcel Energy Pilot

- Xcel's pilot will be smaller in scale, focusing on a 500-ton system with an elementary school as an illustrative example.
- The utility plans to engage communities through outreach rather than issuing a formal Request for Information (RFI).
- Still determining participation fee, cost structures, and potential incentives to optimize heat pump sizing.
- Xcel is prioritizing the development of a scalable business model over direct rate-based funding.
- Investigating where cost equation breaks down; potentially at customer retrofit part.

Discussion

Key discussion points included:

- Regulatory definitions and the need for legislative clarity on utilities' ability to own and operate TENs. Current definitions:
    - 216B.04 STANDARD OF SERVICE. Every public utility shall furnish safe, adequate, efficient, and reasonable service; if service shall be deemed adequate if made so within 90 days after a person requests service. Upon application by a public utility, and for good cause shown, the commission may extend the period for not to exceed another 90 days
    - Subd, 6 SERVICE. "service" means natural, manufactured, or mixed gas and electricity; the installation, removal, or repair of equipment or facilities for delivering or measuring such gas and electricity.
    - Chapter 216B Public Utilities, section 2, subd. 4, defines a "public utility" excluding municipal or cooperative utilities) only for the purposes of the retail sale of gas or electric service and 216B.02(6) defines "service" as "the installation, removal, or repair of equipment or facilities for delivering or measuring such gas and electricity"
    - There are Minnesota provisions that allow utilities to develop an unregulated TEN but owning unregulated businesses is discouraged by the Commission.
- Whether gas utilities' "obligation to serve" aligns with TENs replacing end-of-life gas infrastructure. Specifically, how this works in the Gas Integrated Resource Plan Expansion Alternative Analysis context.

- Concerns over how transitioning to TENs might impact remaining gas customers in terms of cost distribution.
- Ensuring small and environmental justice communities have a chance to be educated on and participate in TEN opportunities.
- Lessons from other states, including Massachusetts and New York, where utilities have paid for heat pumps to encourage adoption.
- Gas utility business model barriers, opportunities, and potential solutions.

Wrap-up and Next Steps

- The next TEN work group meeting is scheduled for late March, pending speaker confirmations.
- A roundtable discussion will be convened in April to further refine findings and recommendations.
- GPI will distribute follow-up materials, including meeting questions and homework assignments, to participants before the next meeting.
- All meeting notes and supporting materials will be available in the TEN work group's resource database.

Minnesota Thermal Energy Network Deployment Work Group Roundtable

Work Group Meeting 3 Summary

April 18, 2025 | 9:00 am to 12:00 pm CT

Contents

Introduction

On April 18, 2025, the Great Plains Institute (GPI) convened the third meeting of the Minnesota Thermal Energy Network Deployment Work Group (TENs work group). This meeting focused on a discussion of the policy barriers and opportunities for utility-owned TENs that workgroup participants identified in their responses to the homework assigned after Meeting 2. The discussion during Meeting 3 focused on the topics groups most frequently commented on in the homework responses, including legislative definitions of TENs and district energy systems, legislative definitions of "public utility" and "service," particularly in the context of cost recovery, and utilities' obligation to serve.

Meeting slides are available here in the work group's resource database.

Most Recent Informational Workshop

The Commission plans to host four workshops intended to educate the work group on various aspects of TEN development and deployment. These workshops will feature presentations from individuals with expertise in relevant fields, followed by time dedicated to Q&A. The third workshop was held on Friday, March 28 from 1–3:30 pm and provided participants with an overview of TENs policies, processes, and legislation in Massachusetts, New York, and Colorado.

The following groups presented during the March 28 workshop:

- Building Decarbonization Coalition (Ania Camargo Cortes, Thermal Networks Senior Manager)
- National Grid (Caroline Hon, VP New England Regulation and Pricing)
- New York Department of Public Service (Peggie Neville, Deputy Director, Office of Markets and Innovation)
- Colorado Energy Office (Bryce Carter, Geothermal Program Manager and Naomi Hennefeld, Regulatory Analyst)
- Midwest Building Decarbonization Coalition and AnnDyl Policy Group (Doug Presley, Director of Government and Regulatory Affairs)

Copies of the slides from the March 28, 2025, informational workshop are available in docket G999/CI-24-275.

Work Group Process and Legislative Directive

The April 18 Roundtable meeting opened with an overview of legislative directives and regulatory limitations shaping the work group's scope. The primary objective remains the development of recommendations for legislative or regulatory changes that will inform the Commission's report to the legislature.

Discussion of Homework Responses: Policy Opportunities and Barriers for Utility-Owned TENs

After Roundtable Meeting 2, GPI provided participants with a homework assignment to identify points of agreement and disagreement on potential legislative solutions to participant-identified opportunities and barriers to TENs deployment. Specifically, the assignment sought participant perspectives on the following items.

- Barriers included in the homework assignment:
  - Minnesota's statutory definition of TENs
  - Minnesota's statutory definitions of "public utility" and "service" for cost recovery
  - Minnesota gas utilities' obligation to serve/standard of service
  - Uncertainty around post-NGIA pilot deployment of TENs
- Opportunities included in the homework assignment:
  - The expansion alternatives analysis in Minnesota's gas resource planning order framework

Before Meeting 3, GPI consolidated these responses into three main policy barriers: the definition of TENs, implications of legislative definitions of "utility" and "service" on cost recovery, and obligation to serve/standard of service. The group's third Roundtable discussion focused on clarifying and understanding participants' feedback, which is summarized below.

Definition of TENs

GPI began the discussion by summarizing participant perspectives regarding the following definitions of TENs and district energy systems in Minnesota statute. These definitions are provided below for reference (emphasis added by GPI).

> **Thermal Energy Networks** as defined in HF 5247, *Thermal Energy Deployment Work Group*, Subd. 6 and Ch. 216B.2427, *Natural Gas Utility Innovation Plans*, Subd. 1(s): "a project that provides heating **and** cooling to multiple buildings connected via underground piping **containing fluids that, in concert with heat pumps**, exchange thermal energy from the earth, underground or surface waters, wastewater, or other heat sources."
>
> **District Energy Systems** as defined in Ch. 216B.2427, *Natural Gas Utility Innovation Plans*, Subd. 1(f): "a heating **or** cooling system **that is solar thermal powered or that uses the constant temperature of the earth or underground aquifers** as a thermal exchange medium to heat or cool multiple buildings connected through a piping network."

Group discussion centered around the following:

- Exploring the nature of existing industry definitions and standards that could be useful guidance for defining TENs in Minnesota.

- The current TENs definition is well-suited to the types of TENs that are likely to be pursued via Innovation Plans within the NGIA framework (e.g., ambient loop designs). However, other types of TENs exist, and a broader definition could enable more widespread deployment of different types of TENs outside of NGIA.
- Discussing whether the current definition of TENs and its use of the phrase "in concert with heat pumps" limits applicability of the definition only to ambient loop systems, or whether the existing definition is expansive enough to include other types of thermal energy systems.
    - Evaluating benefits and drawbacks associated with broader and more limited definitions–e.g., increased applicability to specific urban and rural communities and cogeneration with biomass waste heat, increased breadth of necessary oversight by the Commission.
    - Suggesting that a legislative language change to heating "and/or" cooling to the definition of TENs could be a path forward that is less restrictive to only ambient loop heat pump technology.
- Highlighting the importance of developing a shared understanding of desired key outcomes (i.e., cost effective interoperability, carbon free systems) as opposed to only discussing definitions.

Definitions of "Public Utility" and "Service" for Cost Recovery

Next, GPI summarized participants' responses related to the definitions of "public utility" and "service." Discussion focused on 216B.02, subd. 4 (definition of "public utility"), 216B.02, subd. 6 (definition of "service"), both of which are provided below.

> **Public Utility** (excluding municipal and cooperative utilities) as defined in Ch. 216B.02, subd. 4: "persons, corporations, or other legal entities, their lessees, trustees, and receivers, now or hereafter operating, maintaining, or controlling in this state equipment or facilities for furnishing at retail natural, manufactured, or mixed gas or electric service to or for the public or engaged in the production and retail sale thereof."
>
> **Service** as defined in Ch. 216B.02, subd. 6: "natural, manufactured, or mixed gas and electricity; the installation, removal, or repair of equipment or facilities for delivering or measuring such gas and electricity."

GPI also summarized participants' responses related to cost recovery. While GPI referenced Ch. 216B.1635, subd. 4 in the homework assignment, participants expressed in their responses and during the meeting that 216B.16, subd. 6 is more relevant in this context, so discussion oriented around cost recovery as it pertains to that statute.

Participant discussion focused on the following:

- Ch. 216B.1635, subd. 4 is limited in scope to a few specific cost recovery scenarios for safety upgrades rather than new project construction. If pursued, changes to made to

MPUC authority over cost recovery would be better made Ch. 216B.16 subd. 6, as this type of infrastructure investment should be recovered across the utility's rate base, rather than through a special rider.

- Legislative implications of revising the definition of "utility" or "service" to include TENs, including:
    - Explicitly incorporating thermal service into existing definitions and directing the commission to further clarify exemptions (similar to NY's approach).
    - Adding TENs as a third category of utility service (i.e., add a new section to Ch. 216B).
- Differentiating between thermal energy as the commodity and thermal energy networks as the infrastructure. As long as the definition of a TEN is clear, thermal energy would not have to be specified in Ch. 216B.02, and utilities could then treat it like any other resource, subject to typical cost-effective tests and prudence evaluations in front of the Commission.
- Highlighting the distinction between the Commission's responsibility (interpreting existing statute and how to apply it to TENs), and the legislature's responsibility (to address any possible ambiguity in interpretations in the language).
- Enabling regulated utilities more freedom to provide thermal energy without expanding the scope of utilities regulated by the Commission. Consideration of whether adding TENs to these definitions would inadvertently have that effect.
- Evaluating whether the statutory definition of public utility is an exhaustive list or a list of baseline options that are broad enough to not inherently exclude TENs.

Obligation to Serve/Standard of Service

GPI first summarized participant responses related to utilities' obligation to serve, which is established under Ch. 216B.04, *Standard of Service* (see below), then the group discussed their perspectives regarding this as a barrier to utility-owned TENs deployment. Discussion centered around definitions, geographical considerations, costs, pilots, and the Expansion Alternatives Analysis.

> Ch. 216B.04, *Standard of Service*: Every public utility shall furnish safe, adequate, efficient, and reasonable service; provided that service shall be deemed adequate if made so within 90 days after a person requests service. Upon application by a public utility, and for good cause shown, the commission may extend the period for not to exceed another 90 days.

Definitions

- There was general agreement that if the definitions of "service" and/or "public utility" were expanded to include thermal energy, no changes to utilities' obligation to serve would be necessary.
    - The standard of service could, however, be modified to provide more clarity on gas utilities' obligation to serve gas customers under certain circumstances (e.g.,

how long utilities would be required to provide natural gas service to customers who opted out of a TEN)

- Highlighting the difference between obligation to serve gas (compared to electricity—natural gas utilities do not have defined service territories in Minnesota. Many residences, businesses, etc. in MN do not receive natural gas service, and utilities' obligation to serve is not inherently extended to those customers (cost to extend gas service to such customers would be significant)

Geography and Zonal Considerations

- May be value in incorporating geographical considerations such as the following into regulatory approaches:
  - Standard approach being TENs or gas service for new developments vs. existing developments that already have gas infrastructure
  - Proximity of new development to existing gas infrastructure as factor to consider when implementing TENs.
  - Should places unserved by gas service be required either pursue electric heating or participate in a TEN?
- California's zonal approach has some similarities with NGIA implementation:
  - In California, the utility evaluates its service territory to determine "zones" well-suited to TENs, and uses that determination when seeking to determine if a supermajority of customers in that zone would enroll in the TEN. If so, the utility is no longer obligated to provide gas service to customers outside of that supermajority that opted out of the TEN. Zone determination includes factors such as environmental justice and presence/extent of existing gas infrastructure.
  - MN gas utilities filing innovation plans must also conduct a quantitative and qualitative cost-benefit analysis for their own pilots, including consideration for prudency and environmental justice
  - Forthcoming MN Department of Commerce study on site suitability could be relevant for determining possible zones.

Costs

- A scenario in which a utility must maintain two overlapping infrastructure systems at once (a TEN facility and gas infrastructure in the same neighborhood) brings both safety/repair risks and cost risks. Need strategies to minimize risk for customers who may not be early TENs adopters and may remain on the gas system. These customers are at risk of bearing significant gas system maintenance costs because as more customers transition to TENs or electrify, there are fewer gas system customers across whom the utility can recover costs.
- There isn't an equal comparison of the cost of natural gas commodity service and the cost of heat from the TEN, since TENs costs also include capital costs and operation and maintenance costs, and sometimes the customer is installing, operating, and maintaining the heat pump—this differs from other services as far as capital investments and spreading costs across customers

Pilots (NGIA) and Expansion Alternatives Analysis (Docket 21-565)

- Utilities have much to learn from the TENs pilots they are pursuing under NGIA. These pilots will help utilities better understand the issues discussed in this work group.
- Discussing whether NGIA could be expanded as a stopgap legislative solution to enable more TENs pilots.
- The Expansion Alternatives Analysis in the new gas resource planning framework established under Docket 21-565 (Future of Gas) could support more widespread TEN deployment, as part of requirement that utilities analyze potential alternatives to traditional gas infrastructure projects
- Needing to ensure that communities benefit from TENs deployment and that they are involved in decision-making processes related to pilot siting and implementation.

Wrap-Up

The group identified potential barriers, but the group did not reach consensus on concrete solutions for those barriers. However, the group did agree that uncertainty is a real barrier for TENs deployment and should be addressed by legislature or Commission, or both. Some participants expressed that Minnesota should aim to develop “outcomes-driven definitions that are not overly prescriptive,” while others expressed that the goal should be to develop definitions that enable progress towards Minnesota’s policy goals.

The next TENs Work Group meeting will be an informational workshop in May, where discussion will center primarily around cost and rate considerations. The fourth roundtable meeting will likely occur in June.

Minnesota Thermal Energy Network Deployment Work Group Roundtable

Work Group Meeting 4 Summary

June 13, 2025 | 9:00 am to 12:00 pm CT

Contents

Introduction

On June 13, 2025, the Great Plains Institute (GPI) convened the fourth and final roundtable meeting of the Minnesota Thermal Energy Network Deployment Work Group (TENs work group). The goal of this meeting was to synthesize discussions that took place in the prior three meetings, as well as feedback submitted via a homework assignment before Meeting 3 and a survey before Meeting 4, into a set of recommendations that accurately characterize areas of agreement and disagreement between work group participants regarding TENs deployment in Minnesota.

Meeting slides and resources are available here in the work group's resource database.

Most Recent Informational Workshop

The Commission hosted four workshops intended to educate the work group on various aspects of TEN development and deployment. These workshops featured presentations from individuals with expertise in relevant fields, followed by time dedicated to Q&A. The fourth workshop was held on May 30, 2025, from 9 a.m. to 11 a.m. CT. The workshop focused on technology-specific considerations for TENs deployment, Eversource's thermal energy network pilot in Framingham, MA, the benefits and costs associated with networked geothermal at the utility scale, TENs as a tool for modulating peak demand, and lessons learned from New York's Utility Thermal Energy Networks Act of 2022.

The following individuals presented at this meeting:

- Zeyneb Magavi (HEET)
- Eric Bosworth (Thermal Energy Insights)
- Jared Rodriquez (Emergent Urban Concepts)

Copies of the slides from the May 30, 2025, informational workshop are available in docket G999/CI-24-275.

Work Group Process and Legislative Directive

The June 13, 2025, roundtable meeting opened with an overview of legislative directives and regulatory limitations shaping the work group's scope. The primary objective remains the development of a report including recommendations for legislative or regulatory changes.

During the third roundtable meeting on April 18, 2025, GPI presented a summary of homework assignment responses on barriers and opportunities to TENs deployment in Minnesota. Participant feedback focused on three main categories: definitions of TENs and district energy systems in statute, cost recovery for gas utilities, and obligation to serve. The full list of barriers, opportunities, and potential legislative and/or regulatory solutions discussed during that meeting is available in the Roundtable 3 summary and the notes document that was edited live during the meeting (available here in the group's shared SmartSuite database).

Following the third roundtable meeting, GPI provided participants with a survey containing draft recommendations informed by previous participant discussions. Participants were asked to indicate whether they agreed with a given recommendation as written, agreed with a given recommendation in concept but with specified language changes, or disagreed with the recommendation in concept. Participants also had the option to provide short answer written feedback describing the nature of their agreement or disagreement.

GPI received survey responses from 28 organizations. In advance of the fourth and final meeting on June 13, 2025, GPI synthesized participant feedback into a set of revised draft recommendations informed by the survey responses. GPI also provided participants with a copy of the draft recommendations that were included in the survey alongside the revised draft recommendations for side-by-side comparison.

Overview of Priority Topics

During Meeting 4, GPI facilitators outlined all six revised draft recommendations and sub-recommendations, in the order in which they were presented in the survey. Participants discussed the revised versions of the recommendations, whether further refinements were necessary, and whether or not they were supportive of the revised draft recommendations.

These six recommendations covered the following topics, informed by participant discussion throughout the work group process:

- An evaluation of which outcomes the legislature should consider when adopting a new or revised definition of TENs (Recommendation 1);
- Methods the legislature should use to allow utilities to recover costs associated with TEN deployment, likely via changes to statutory subdivisions and/or definitions (Recommendation 2);
- Factors that should be considered when siting TENs in targeted “zones” (Recommendation 3);
- Methods for facilitating equitable, affordable, and informed adoption among customers (Recommendation 4);
- Whether the legislature should revise statutes related to providing adequate alternatives to natural gas service (Recommendation 5); and
- Methods for deploying a greater volume and variety of TENs pilots (Recommendation 6).

Participants who indicated they agreed with the revised draft recommendation in concept but were unable to support it as written were asked to suggest any language changes that would be necessary to enable full support. Participants who were in agreement with a given recommendation as written were asked to remain silent initially to focus the conversation on any necessary changes. The group discussed these potential modifications and incorporated them on-screen via tracked changes based on group discussion and support.

Discussion: Revised Recommendations

GPI began the discussion by presenting each revised draft recommendation, modified in accordance with participant feedback via the survey. For the purposes of this summary

document, this revised language—taking survey responses into account—is provided below in black text in gray boxes. This is the language that was presented to participants on-screen at the beginning of Roundtable Meeting 4.

Changes displayed in red text reflect additional suggestions that were raised and discussed during Roundtable Meeting 4, which GPI incorporated live on-screen in accordance with participant feedback and discussion. As a result, each gray box incorporates feedback from participants that was submitted via previous meeting discussions, the homework assignment, the survey, and the final meeting.

Topic I: Ambiguities in how TENs are defined in Minnesota

Revised Recommendation 1

Recommendation 1: *The legislature should adopt a definition for TENs that reflects legislative goals and desired outcomes and that would encompass a broad range of systems for gas utility-owned TENs outside of the NGIA context. The new or revised definition should, at a minimum, aim to achieve the following outcomes:*

- ***Recommendation 1A:*** *Affordable. Enable affordable TENs service that results in customer costs that are comparable to or lower than other services, as determined in gas and electric integrated resource plans and subject to the Commission's duty to ensure just and reasonable rates.*
- ***Recommendation 1G:*** *Cost-effective over time. Support TENs deployment that enables long-term cost reductions as the market scales. Cost-effectiveness criteria as established in NGIA approvals should be applied for pilot projects while post-pilot deployment should be subject to the Commission's duty to ensure prudent investments that are in the public interest.*[1]
- ***Recommendation 1B:*** *Carbon-reducing. Enable Minnesota's regulated gas utilities to further work towards achieving Minnesota's greenhouse gas reduction goals to deploy TENs in a way that is consistent with Minnesota's GHG reduction goals under Minn. Stat. § 216H.02, prioritizing carbon-free systems and limiting fossil fuels to cases aligned with a clear path to net-zero by 2050.*
- ***Recommendation 1C:*** *Variety of thermal services. Clarify that TENs can provide space heating, cooling, hot water, and other thermal services, including industrial heat, supporting a broad range of end uses. Recognize that the mix of services may evolve over time as lessons are learned from pilot projects and deployment experience.*
- ***Recommendation 1D:*** *Variety in thermal sources and technologies ~~options~~. Allow TENs to utilize a range of thermal sources and technologies, prioritizing non-combustion and low-carbon options for regular operation. Limit fossil fuel use to*

[1] Recommendation 1G was not included in the initial set of draft recommendations that participants voted on in the survey. It was added with the intention of reflecting participant feedback in response to Recommendation 1A in the survey, and was included in the list of revised draft recommendations sent to participants in advance of the Roundtable meeting. For this reason, it is characterized as "Recommendation 1G" in this summary. Recommendation numbering is subject to change.

backup or peak-load scenarios, with a clear pathway to meet Minnesota's 2030 and 2050 greenhouse gas reduction targets. Alternative and legacy systems may be included where appropriate but should be the exception rather than the standard. Recognize that the mix of thermal source and technology options may evolve over time as lessons are learned from pilot projects and deployment experience.

- ~~***Recommendation 1E:** Variety in thermal exchange technologies. Allow TENs to use a range of thermal exchange mechanisms, with efficient electric heat pumps as the primary technology. Alternative or legacy systems may be included where appropriate but should be the exception rather than the standard. Recognize that the mix of technologies may evolve over time as lessons are learned from pilot projects and deployment experience.~~
- ***Recommendation 1F:** Targeted oversight. Commission oversight should be scaled based on factors such as system size, type of customers served, and public interest, ensuring that small-scale, non-utility systems are not subject to unnecessary regulatory burdens, while larger or residential-serving systems receive appropriate consumer protections. This should work in tandem with any definitional changes to "public utility" and/or "service" as provided in this report. Recognize that applying these distinctions may be complex in practice, and authority should be delegated to the Commission to determine and refine oversight criteria as needed.*

Note: Red text is language that GPI incorporated into the draft revised recommendation on-screen during Roundtable Meeting 4, in accordance with the following participant feedback and discussion:

Recommendation 1A (Affordable) and Recommendation 1G (Cost-effective over time)

- Some participants supported the recommendations as written.
- A participant suggested that "comparable to" language be changed to "comparable to or lower than."
- A participant expressed concerns that systems will not be instantaneously cost-effective and shared that comparing TENs to other carbon-free technologies will result in a different cost-effectiveness comparison than comparing TENs against gas heating. The participant expressed support for both recommendations (Recommendation 1A and the new proposed recommendation pertaining to cost-effectiveness over time) if they are presented as distinct sub-recommendations and not interrelated parts of a single sub-recommendation. This change is reflected in the separation of Recommendation 1A and 1G.
- A participant noted that in the electric IRP process (as described in Minn. Stat. 216.2422 Subd. 3) the Commission makes decisions based on societal costs, including the social cost of carbon, and that an argument for reasonable cutoff of excessive costs after the pilot phase could include societal costs.
- A participant supported the inclusion of both affordability and cost-effectiveness and expressed that the intent behind the two recommendations would not be to benchmark

TENs against cost-effectiveness of other technologies as this is not an even comparison for savings over time.

- A participant expressed support for both recommendations but considered that affordability must also be measured by avoided costs. This means that ratepayers could be paying the same or more on their bill in the short term while simultaneously avoiding costs from pollution that would otherwise have had to be mitigated later. Affordability metrics should consider a social cost of carbon and the recommendation should be revised to specifically refer to avoided costs for this reason.
    - Discussion clarified that in both gas and electric IRPs, utilities are required to address social costs of carbon, and that the NGIA also has a societal cost-benefit framework (though it doesn't yield an exact cost-benefit number).
- A participant suggested adding at the end of the cost-effectiveness paragraph "including consideration of societal impacts" so that this is explicitly mentioned.
- A participant emphasized the importance of sector-coupled resource planning and a desire to consider costs holistically across utilities.
    - Discussion clarified that similar to what is required in NGIA framework, Minnesota's new gas IRP planning framework has a Commission order point that established/directed that gas utilities discuss certain factors with other utilities.
- A participant added that they conceptually understand including societal impacts as a test of affordability, but that bill impacts are immediate for ratepayers, whereas societal costs, while real, happen over time. The participant opposed including societal impacts in the recommendation and preferred broader language for this reason. If there is an explicit reference to societal costs in the "affordability" recommendation, then there would need to be an explicit reference to bill impacts there as well.

No participants expressed opposition to the new affordability and cost-effectiveness recommendations as revised during Roundtable Meeting 4.

Recommendation 1B (Carbon-reducing)

- Some participants supported the recommendation as written.
- No parties expressed opposition to this recommendation in concept, but some parties did suggest wording changes.
- Some participants favored the use of the term "carbon-reducing," while others favored the use of "carbon-free."
    - Parties prioritizing the flexibility and adaptation required to deploy pilots and implement cost-effective projects in the short-term favored "carbon-reducing" language while acknowledging that carbon-free is ultimately the long-term goal.
    - Parties who preferred "carbon-free" felt that carbon-reducing was sufficient language for the recommendation in light of these considerations.
    - Parties agreed on the sentiment of the overall recommendation and felt that enabling "carbon-reducing" TENs while specifically "prioritizing carbon free systems" appropriately reflected group's perspectives.

- A participant expressed that in general, new TENs systems should not rely on fossil fuels to meet their needs, but that backup systems relying on fossil fuels may be necessary for pilots.
- A participant pointed to active debate regarding the definition of “carbon-free” in PUC docket 24-352 and cautioned against including the term in this recommendation until the meaning of carbon-free is defined there.

No participants expressed opposition to the carbon-reducing recommendation as revised during Roundtable Meeting 4.

Recommendation 1C, 1D, and 1E (Variety of thermal services, thermal source options, and thermal exchange technologies)

- Some participants supported the recommendation as written.
- Parties agreed that 1D and 1E could be combined while preserving the desired outcome of enabling a wide array of heat sources (e.g., groundwater, deepwater, and wastewater) and technology types (i.e., the method by which heat is transferred from the heat source to the end use).
- Participants debated whether these three sub-recommendations were contributing anything new to the current definition of TENs. Some parties felt they were extraneous, while other parties felt that the phrase “other heat sources” in the original definition was a source of ambiguity, and that the phrase “in concert with heat pumps” was a technological restriction, which these two new recommendations (1C and 1D/E) address.

No parties expressed opposition to the recommendations related to the variety of sources, services, and technologies as revised during Roundtable Meeting 4.

Recommendation 1F (Targeted oversight)

- During the meeting, participants did not oppose language aimed at ensuring that entities deploying TENs that are not currently regulated by the PUC would remain unregulated. Participants discussed potential conflicts between Recommendations 1F and 2 but did not reach consensus on whether further clarification or changes were needed. Suggestions and concerns included:
    - Participants suggested changing it to “systems that are not currently rate-regulated by the PUC” or leaving it as written.
    - Participants also expressed concern about potential overlap between Recommendation 1F and Recommendation 2. One participant shared that there are utilities that are subject to MN’s Carbon Free Standard that aren’t regulated for rates. This participant felt that changing language to “non-utility-owned systems” rather than “rate-regulated utilities” would solve these concerns, but that focusing on the utility definition in Recommendation 2 already clarifies this issue.

Topic II: Minnesota's definitions of a "public utility" and "service" under § 216B.02

Revised Recommendation 2

Recommendation 2: *The definitions of "public utility" and "service" in Minn. Stat. § 216B.02, Subds. 4 and 6 may create uncertainty for TENs deployment. The legislature should either modify these definitions or add a new statutory subdivision to clarify that regulated utilities may provide thermal energy as a utility service ~~by adding "thermal energy" to the definitions of "public utility" and "service" in Minn. Stat. § 216B.02, Subds. 4 and 6~~. This authority should:*

- *~~Establish appropriate regulatory thresholds based on system size and type of service and e~~Exempt existing non-utility TENs from becoming regulated public utilities;*
- *Authorize regulated gas and electric utilities to invest in and recover costs for TENs deployed outside of NGIA, subject to Commission approval and a determination that such investments serve the public interest based on affordability, reliability, and decarbonization benefits.*
- *Affirm that Tribes retain the authority to self-regulate thermal energy services on tribal lands; and*
- *Ensure customer protections consistent with Minn. Stat. §§ 216B.096, .097, and .0975, and allow low-income assistance under § 216B.16, subds. 14 and 15.*

Note: Red text is language that GPI incorporated into the draft revised recommendation on-screen during Roundtable Meeting 4, in accordance with the following participant feedback and discussion:

- Some participants supported the recommendation as written.
- Participants discussed potential conflicts between Recommendations 1F and 2 but did not reach consensus on whether further clarification or changes were needed. The revised language is based on the following discussion:
    - One participant felt that the original language for Recommendation 2 was preferrable to the group's additions and was unable to support the more open-ended revisions, which they felt would create difficulty for the legislature.
    - A participant expressed caution about the fact that the statutes being discussed are foundational, so it may be better to provide the statutes as context but make the recommendation more open-ended to allow the legislature to assess where the necessary changes should be made.
    - Some participants felt mentioning the statute at all was restrictive, but others felt that mentioning it was necessary because utilities have indicated that this specific statute restricts their ability to deploy TENs.
    - One participant felt that the first bullet was too likely to leave open the option for existing unregulated TENs to become regulated utilities. Changes were made to reflect this.
    - Some participants suggested combining Recommendation 1F and Recommendation 2.

- Some participants raised broader questions around which TENs projects are eligible to be regulated by the Commission and suggested that the group recommend the legislature direct the PUC to initiate a separate proceeding to address this question. Others felt that due to time constraints at the end of the final roundtable meeting, they were not comfortable deciding whether to recommend that a new PUC proceeding be initiated.

Topic III: Standard of Service/Obligation to Serve

Revised Recommendation 3:

Recommendation 3: *TENs should be prioritized in certain zones based on geographic, economic, and equity-related factors, along with broader planning considerations. Prioritization should not preclude deployment in other areas; rather, it should guide near-term focus where conditions are especially favorable or policy-aligned. Considerations should include:*

- ***Recommendation 3A:*** *Geographic or infrastructure-based suitability. Prioritize zones where traditional gas infrastructure is less feasible or prudent (as evaluated using Integrated Resource Planning to compare TENs with other ~~heating~~ thermal energy technologies) due to factors such as:*
  - *Absence of existing natural gas infrastructure (e.g., new developments or reliance on delivered fuels)*
  - *As an alternative to gas or electric system capacity expansion*
  - *End-of-life gas infrastructure*
  - *Building characteristics such as density or HVAC type (e.g., prevalence of boilers)*
  - *Access or proximity to renewable thermal resources (e.g., wastewater)*
- ***Recommendation 3B:*** *Suitable sites ~~and interested communities.~~ Prioritize ~~communities that express significant interest in participating in TENs and/or~~ communities that meet prioritization criteria resulting from the Minnesota Thermal Energy Network Site Suitability Study currently being developed by the Minnesota Department of Commerce.*
- ***Recommendation 3E:*** *Interested communities. Communities that have demonstrated significant interest in participating in TENs.*
- ***Recommendation 3C:*** *Attributes of successful pilots. Identify and prioritize communities with similar characteristics to those where TENs pilots have succeeded.*
- ***Recommendation 3D:*** *Equity and policy-aligned decarbonization zones. Prioritize targeted decarbonization zones, including located in low-income and/or Environmental Justice Areas as defined in Minn. Stat. § 116.065, subd. 1(e) (2023), indigenous communities, rural towns, and other areas unlikely to be early market entrants without public investment or policy support.*

Note: Red text is language that GPI incorporated into the draft revised recommendation on-screen during Roundtable Meeting 4, in accordance with the following participant feedback and discussion:

Recommendation 3A

- Some participants supported the recommendation as written.
- One participant suggested adding an additional sub-bullet to account for non-pipeline alternatives.
- One participant suggested referring to "thermal energy" to be consistent with references in previous recommendations.
- One participant suggested adding an additional sub-bullet to account for waste heat.

Recommendation 3B

- Some participants supported the recommendation as written.
- A participant expressed that including language that prioritizes "interested communities" could be detrimental to pilot deployment in the environmental justice communities described in Recommendation 3D. This could lead to affluent communities with more time and resources receiving pilots at the expense of communities that are less equipped to express interest but may benefit more from deployment of a pilot.
- Many group members agreed that community interest and low-income/environmental justice areas were both important factors to consider but suggested different approaches for balancing them effectively.
    - A participant noted that utility engagement campaigns are expensive, so interested communities will be vital for making TEN deployment easier and more cost-effective. Saying we will prioritize them may be harmful for equity, but having interested communities represented is important.
    - One participant specified that if one of the recommendations in the final report involves removing utilities' "obligation to serve," there may be some communities that would not want to transition to TENs, so respecting that by prioritizing places that do express interest in transitioning could prove important.
    - A participant suggested establishing a threshold for a number or proportion of interested community members rather than just using the word "interested."
    - A participant suggested using a weighting system for community scoring criteria similar to a system used in Colorado, where equity could have a certain weighted value in site selection.
    - One participant suggested that the phrasing "community interest" would be an improvement over "interested communities" because it would make clear that there would need to be more inclusive engagement within a community rather than just local government leadership (e.g. a mayor, demonstrating sufficient interest in the absence of broader community support). While no participant expressed opposition to this suggestion, the group did not incorporate it into the revised language or discuss it in detail.
- A participant reinforced the importance and relevance of the Minnesota Thermal Energy Network Site Suitability Study currently being developed by the Minnesota Department of Commerce and suggested highlighting siting considerations determined in

accordance with that study in a new bullet separate from community interest ("Recommendation 3E").

No parties expressed opposition to the new Recommendation 3 as revised during Roundtable Meeting 4.

Revised Recommendation 4

Recommendation 4: *The legislature should support the development of strategies that would facilitate equitable TENs deployment and incentivize participation from customers that are not interested or have prohibitive barriers to participation, especially in geographic and/or economic zones currently served by natural gas service but targeted for TENs deployment. Such strategies may include:*

- *Incentives or financing options*
- *Ensuring that existing low-income gas customers and/or gas customers in environmental justice areas have affordable service options ~~via targeted incentives~~ to support their transition.*
- *Support development of consumer educational resources and outreach programs about TENs and their functionality.*
- *Leveraging existing or creating new~~The creation of~~ energy efficiency programs and/or other home retrofit and appliance upgrade programs that would help prepare existing homes for TENs.*
- ~~*Ensuring that like natural gas customers, TENs customers would be protected under the Cold Weather Rule.*~~

Note: Red text is language that GPI incorporated into the draft revised recommendation on-screen during Roundtable Meeting 4, in accordance with the following participant feedback and discussion:

- Some participants supported the recommendation as written.
- One participant expressed that the new recommendation focuses too much on new programs when existing programs could be leveraged without necessarily creating new ones.
- Participants who had suggested the inclusion of the Cold Weather Rule in their survey response shared that they were comfortable removing the mention of it from Recommendation 4 as it is already covered by the reference the group made to Minn. Stat. §216B.096 in Recommendation 2.
- A participant suggested adding a reference to specific programs that included on-bill financing, low-income assistance, and home retrofits.
    - Some participants shared that they have encountered issues with on-bill financing options specifically and favored reference to a broader range of financing options instead.
- Survey feedback indicated that multiple participants felt the original language referring to "holdout customers" in the survey was too limiting and anticipated opposition that might

not materialize. However, one participant who had supported the previous language felt that removing the phrase “holdout customers” left the new draft recommendation inadequate for addressing potential opposition. This prompted the addition to the first paragraph.

No parties expressed opposition to the new Recommendation 4 as revised during Roundtable Meeting 4.

Revised Recommendation 5

Recommendation 5: *The legislature should review and revise as needed Minn. Stat. 216B.04 such that if a regulated ~~gas~~ utility provides an adequate alternative via a TEN to natural gas service (e.g., heating service of comparable reliability and similar or lesser cost compared to natural gas) to an area that is currently served by natural gas, the utility is no longer obligated to also provide natural gas service to that area, in accordance with specific parameters. These parameters may include:*

- *Establishing a reasonable timeframe by which the utility must safely decommission the natural gas system in areas with both natural gas and TEN service, and by which customers in the area that are still receiving gas service must decide whether they want to interconnect to the TEN or pursue an alternative heating source such as electrification.*
- *Directing the PUC to establish noticing requirements to ensure that customers are well-informed regarding the point in time at which their natural gas service will cease, similar to the two-year noticing requirements proposed under the New York Home Energy Affordable Transition Act.*
- *Clarity regarding gas utilities’ responsibilities related to existing gas infrastructure once an area is served fully by a TEN.*
- *Clarity that electric utilities may offer TENs in service areas that are not served by a natural gas distribution system.*

Note: Red text is language that GPI incorporated into the draft revised recommendation on-screen during Roundtable Meeting 4, in accordance with the following participant feedback and discussion:

- Some participants supported the recommendation as written.
- A participant asked that Recommendation 5 incorporate more specific parameters regarding when a utility might need to provide notice to an area with both existing gas service and a TEN.
- Discussion noted that this recommendation only refers to gas, while Recommendation 2 refers to gas and electric. As written in advance of the Roundtable Meeting, Recommendation 5 would not be applicable to electric utilities, though other recommendations could be. For the sake of putting forth a set of unified and consistent recommendations, a participant suggested that Recommendation 5 should not include the word “gas” and should instead say “regulated utility.”

    - Some participants debated how to phrase this and whether Recommendation 5 should specify that in cases where gas and electric territories overlap, the gas utility should be responsible for the TENs while the electric system should not be and this should not apply. Some participants agreed with the recommendation to remove "gas" and retain "utility."
- A participant noted that the term "TENs" itself was not referenced in the heading of this Recommendation and that it should be for additional clarity regarding the adequate alternatives outlined in the sub-bullets.

No parties expressed opposition to the new Recommendation 5 as revised during Roundtable Meeting 4.

Topic IV: Other ways to incentivize TENs deployment

Revised Recommendation 6

> ***Recommendation 6:*** *The legislature should consider ways to enable utilities to deploy more TENs pilots and/or a greater variety of TENs pilots. Potential pathways through which the legislature could do this include (but may not be limited to) the following:*
>
> - *Directing the MPUC to consider approaches that would ensure that TENs are evaluated under the EAA in gas utility IRPs with analysis of electric grid infrastructure impacts and costs, and/or*
> - *Exploring ways through which more TENs pilots (and/or a wider variety of TENs pilots) could be deployed under the NGIA, such as amending the NGIA cost caps.*

Note: Red text is language that GPI incorporated into the draft revised recommendation on-screen during Roundtable Meeting 4, in accordance with the following participant feedback and discussion:

- Some participants supported the recommendation as written.
- One participant felt that the recommendation should explicitly require coordinated system planning across the gas and electric utility systems.
- One participant felt that the language of the second bullet must reflect that NGIA cost caps represent a barrier to TENs deployment for gas utilities.

Wrap-up and Next Steps

- GPI will prepare a summary outlining participants' feedback on the revised draft recommendations from this meeting.
- The Commission is preparing the work group's report to the legislature.
- All meeting notes and supporting materials will be available in the TENs work group resource database.