A Two-Way Street: How Policy Drives Thermal Energy Network Deployment and How TENs Advance the Energy Transition

Hugues-Antoine Dubé & Alex J. Hill, Dunsky Energy + Climate Advisors

ABSTRACT

Policy discussions around Thermal Energy Networks (TENs) often focus on which policies can best enable their deployment, but less attention is given to how TENs can, in turn, advance the broader climate and energy transition objectives that shape those policies. This paper examines that reciprocal relationship across jurisdictions in North America and Europe.

The findings show that TEN deployment accelerates where policies introduce clear accountability, explicit targets, and aligned financial and regulatory incentives, including through Future of Gas proceedings, Clean Heat Plans, and TEN specific legislations. At the same time, TENs contribute to achieving climate objectives by unlocking otherwise stranded waste heat resources, reducing reliance on fossil gas infrastructure, and alleviating pressure on constrained clean electricity systems.

Clean Heat is Clean Heat, Is There a Need to Differentiate Thermal Energy Network[1] (TENs), from District Energy Systems[2] (DES), Campus DES and Steam Utilities?

Rigid distinctions among TENs, DESs, campus systems, and steam utilities are often overstated. At the same time, it is important to recognize the distinct niche and functional strengths of each model within a broader decarbonization strategy.

Steam and campus-based systems play a critical role in decarbonizing existing building stock, particularly across large, established portfolios encompassing millions of square feet. They therefore represent a substantial and pragmatic opportunity to reduce emissions within legacy infrastructure. When supplied with low-carbon energy inputs, modern DES and TENs can perform comparable system-level functions[3] while unlocking different opportunities at the parcel or project scale. These systems can support the decarbonization of new developments and advance beneficial electrification by leveraging locally available energy resources.

In many European jurisdictions, limited emphasis is placed on differentiating among these typologies. For example, the United Kingdom commonly uses the umbrella term "heat networks" to describe a wide range of shared thermal infrastructure models. This paper focuses specifically on Modern District Energy Systems and Thermal Energy Networks, while acknowledging the

---

[1] Thermal Energy Networks: 5th Generation ambient temperature systems are labelled as TENs or Networked Geothermal in most policies and legislations. More details in the appendix.

[2] 2nd, 3rd and 4th generation hot water and cold water are referred to as DES, District Heating (DH) or cooling (DC). More details in the appendix.

[3] While a clear distinction may hold for older generation systems, it is increasingly blurred in modern applications. Many fourth-generation district energy systems are supplied primarily by large-scale heat pumps and can deliver performance similar to fifth-generation networks. More details in the appendix.

important and complementary role of campus and steam systems in the broader heat decarbonization landscape.

Against this backdrop, two important gaps remain in the existing literature. First, limited attention has been given to the policy and governance frameworks needed to integrate TENs into broader energy planning and scale their deployment beyond market-driven adoption. Second, relatively little research has examined how TENs contribute to broader energy transition objectives and how policymakers can systematically recognize and value those benefits across jurisdictions. This paper addresses these gaps through a comparative review of policy frameworks in North America and Europe.

How Can Policies Influence TEN & DES Adoption?

Future of Gas

"Future of Gas" proceedings are reshaping utility planning in ways that directly support TEN and DES adoption. As regulators reassess the long-term role of the gas system under decarbonization targets and load uncertainty, utilities are increasingly required to evaluate infrastructure risk, stranded asset exposure, and alternatives to traditional pipeline investments[4]. These dockets move planning beyond a default expansion model and instead emphasize scenario analysis, coordinated system planning, and the formal evaluation of non-pipeline alternatives (NPAs) as cost-effective and lower-risk options. In doing so, they created a structured policy pathway for Thermal Energy Networks and distributed thermal systems to be considered alongside, and in some cases in place of, conventional gas infrastructure. By aligning regulatory oversight with long term climate and affordability objectives, Future of Gas frameworks help legitimize and accelerate TEN and DES deployment as integral components of modern energy planning.

TEN Specific policies[5]

Although Future of Gas proceedings have elevated NPAs in principle, few, if any, TENs have been formally deployed and documented as NPAs. This suggests that unlocking TENs as a viable NPA pathway may require evaluating benefits beyond pipeline deferral alone, including decarbonization, grid, and equity objectives. In response, policymakers are not waiting for market uptake alone but are proactively using regulatory tools to ensure TEN models advance beyond the conceptual stage. Some jurisdictions are mandating that gas utilities study, pilot, or actively pursue networked geothermal projects, while others are focused on removing statutory and regulatory barriers and leaving the decision to explore TENs to utility discretion. Key policy levers include:

- Authorizing and funding pilot projects
- Allowing utilities to fulfill service obligations with TENs

---

[4] Non-pipeline alternative (NPA): A non-pipeline alternative (NPA) is a solution or portfolio of measures that meets energy demand or maintains system reliability without building or replacing gas pipeline infrastructure. NPAs can include electrification, energy efficiency, and networked thermal systems that defer or avoid traditional capital investments.

[5] Current policy developments are largely tailored specifically to TENs rather than DES. Variations in statutory language and definitions across jurisdictions make it unclear whether these frameworks would apply consistently to TEN only or extend to DES across different regulatory contexts.

- Establishing cost recovery mechanisms for thermal network investments
- Expanding or clarifying utility authority to own and operate TEN infrastructures
- Directing utilities to evaluate TENs within long term planning proceedings

With more than twenty pilots proposed or under development nationwide and only a handful operational, these policies reflect a deliberate strategy to create regulatory space for experimentation and learning, even in the absence of a mature NPA track record.

Clean Heat Plans

Clean heat frameworks introduce accountability by assigning clear responsibility for delivering the heating transition, a feature that can materially benefit TEN deployment. In Europe, this responsibility largely rests with municipalities. Recent EU requirements mandate that cities above a defined population threshold develop local heating and cooling plans that map neighborhood level transition pathways and designate where specific infrastructure solutions should be deployed. This shifts clean heat from aspirational targets to concrete spatial planning obligations, effectively placing municipalities in charge of coordinating how their territory transitions away from fossil heating. By linking decarbonization objectives to zoning, permitting, and infrastructure planning authority, municipal clean heat plans can steer TEN development in new construction and growth areas, reduce infrastructure lock in, and provide clarity on where district scale solutions are most efficient.

In contrast, the prevailing U.S. model is primarily utility driven. States such as Colorado and Minnesota require gas utilities to meet emissions reduction targets across their existing customer base, with compliance achieved through regulator approved portfolios of measures. Rather than directing territorial development, this approach focuses on transforming the performance of the current system and its customers, making it particularly suited to retrofit contexts. Early actions may prioritize expansion or decarbonization of existing district energy and campus scale systems, while neighborhood-scale TEN retrofits have yet to be fully tested and documented through pilot projects.

Taken together, municipal and utility-based clean heat models highlight different pathways for assigning accountability in the heating transition. While the appropriate allocation of responsibilities will vary across jurisdictions, both approaches demonstrate the importance of clearly identifying who is responsible for planning, coordinating, and delivering decarbonization outcomes. This is particularly important for TENs, which intersect with electricity, gas, and urban infrastructure planning. As a result, some jurisdictions may benefit from an independent heat planning function to coordinate decision-making and ensure the most appropriate heating solutions, including TENs and DES, are deployed across the broader energy system.

How TENs can help advance broader energy transition objectives

Clear TEN Targets

European countries are increasingly setting explicit targets for heat network penetration as part of their climate strategies, using clear quantitative goals to define the role TENs are expected to play in decarbonising building heat.

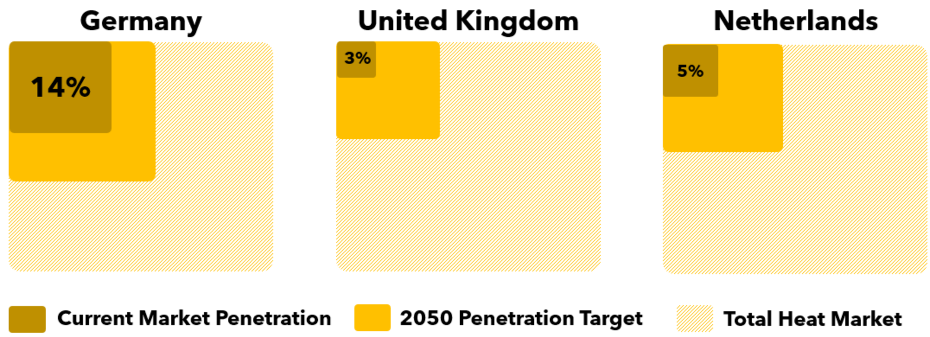

Figure 1 - TEN & DES 2050 Penetration Targets[6]

In the United Kingdom, heat networks currently supply only a small share of total heat demand, roughly 2 to 3%, yet government analysis indicates that they could provide close to 20% of heat by 2050 under net zero pathways. Establishing a defined penetration target creates a measurable benchmark that aligns infrastructure planning, regulation, and public funding with long term emissions objectives. It also signals to utilities, local authorities, and private developers that district scale thermal solutions are not marginal technologies but central components of the national decarbonization strategy. By moving from incremental deployment to target driven scale up, the UK example illustrates how clear TEN penetration goals can anchor broader energy transition planning and mobilize coordinated investment over time.

Beyond market growth, this expansion is designed to unlock the full range of low carbon and recovered heat resources available across the country. Heat networks provide a platform to aggregate and distribute energy from large scale heat pumps, rivers and ambient sources, energy from waste facilities, industrial and commercial waste heat such as data centers, and geothermal resources. By creating interconnected thermal infrastructure, the UK aims to capture heat streams that would otherwise remain unused or inefficient at the building level, thereby maximizing resource utilization and accelerating overall heat decarbonization.

Waste Heat Valuation

Many states and provinces have adopted economy wide decarbonization and clean energy targets, yet fewer policies explicitly recognize the infrastructure required to unlock otherwise inaccessible thermal resources. Quebec's waste heat valuation program represents a notable example of aligning climate objectives with the system level capabilities of TEN and district energy. As part of its decarbonization strategy, the province provides financial support to capture and utilize industrial and commercial waste heat that would not be recoverable at the individual

[6] Visual Inspired from: UK Department for Energy Security and Net Zero. (2024).

building scale. The program recognizes that without networked thermal infrastructure only a fraction of this resource could be economically salvaged.

The initiative is structured in two stages. The first supports feasibility studies, covering up to 75% of eligible costs to a maximum of approximately $110,000 USD. The second supports capital investments limited to waste heat capture infrastructure, with funding equal to the lesser of 75% of eligible project costs or a performance-based amount calculated at approximately $1,850 USD per annual ton of avoided emissions plus approximately $6/GJ of avoided clean energy. In the Quebec context, where the electricity grid is largely clean but increasingly capacity constrained and subject to pronounced winter peak demand, the additional ~$6/GJ reflects the system value of reducing electricity demand and highlights the significant value of capturing and utilizing waste heat resources. By incentivizing projects that lower electric load, the program helps free up clean electricity for sectors that are more difficult to decarbonize. In doing so, Quebec treats waste heat as a strategic and undervalued resource and leverages TEN infrastructure to maximize its contribution to broader climate objectives.

Case study: Humano District

A notable example is Humano District Energy in Sherbrooke, which captures waste heat from a next-generation liquid-cooled quantum computing data center and distributes it through a thermal network to heat a nearby residential district. Supported by Quebec's waste heat valuation program, the project demonstrates how TEN infrastructure can unlock emerging waste heat opportunities that would otherwise remain stranded, delivering a 62% reduction in energy consumption and a 97% reduction in GHG emissions while transforming a high-performance computing facility into a community-scale low-carbon heat source.

City Net-Zero Targets

Most major cities have adopted carbon reduction targets within their climate action plans, yet relatively few explicitly identify TENs or DES as primary implementation mechanisms. As municipalities transition from goal setting to enforcement, some are introducing programs that directly create pathways for district scale thermal solutions.

City of Denver provides a notable example. As part of its commitment to achieve net-zero emissions by 2040, the city has identified fossil gas combustion as a significant source of emissions and recognized that zero-emission ground-source, water-source, and multi-source thermal energy systems will be needed to decarbonize building heat at scale. To address one of the primary barriers to deployment, namely high upfront development costs, Denver's Office of Climate Action, Sustainability and Resiliency established the District Energy Conversion Incentive, which provides funding for scoping studies, detailed design, and capital investments for eligible thermal energy systems serving multiple buildings.

Rather than relying solely on regulatory requirements or market adoption, Denver is using targeted financial incentives to accelerate the development of district-scale thermal infrastructure. In doing so, the city demonstrates how municipalities can translate climate commitments into tangible deployment pathways for TENs and other shared thermal systems, helping unlock projects that may otherwise struggle to advance despite their significant decarbonization potential.

Conclusion

This paper demonstrates the reciprocal relationship between policy frameworks, TEN deployment, and the achievement of broader climate and energy transition objectives. Future of Gas proceedings, Clean Heat Plans, and TEN specific legislations are creating the regulatory clarity, accountability, and financial signals needed for networked thermal systems to scale. In turn, TENs support broader decarbonization goals by unlocking waste heat, enabling compliance with building performance standards, and reducing pressure on gas and electricity infrastructure.

Although important questions remain regarding affordability, electricity grid impacts, and long-term replicability, TENs demonstrate clear potential to function both as policy supported solutions and as strategic enablers of a more integrated energy transition.

Appendix

The table below highlights the key differences between modern District Energy Systems (DES) and Thermal Energy Networks (TENs).

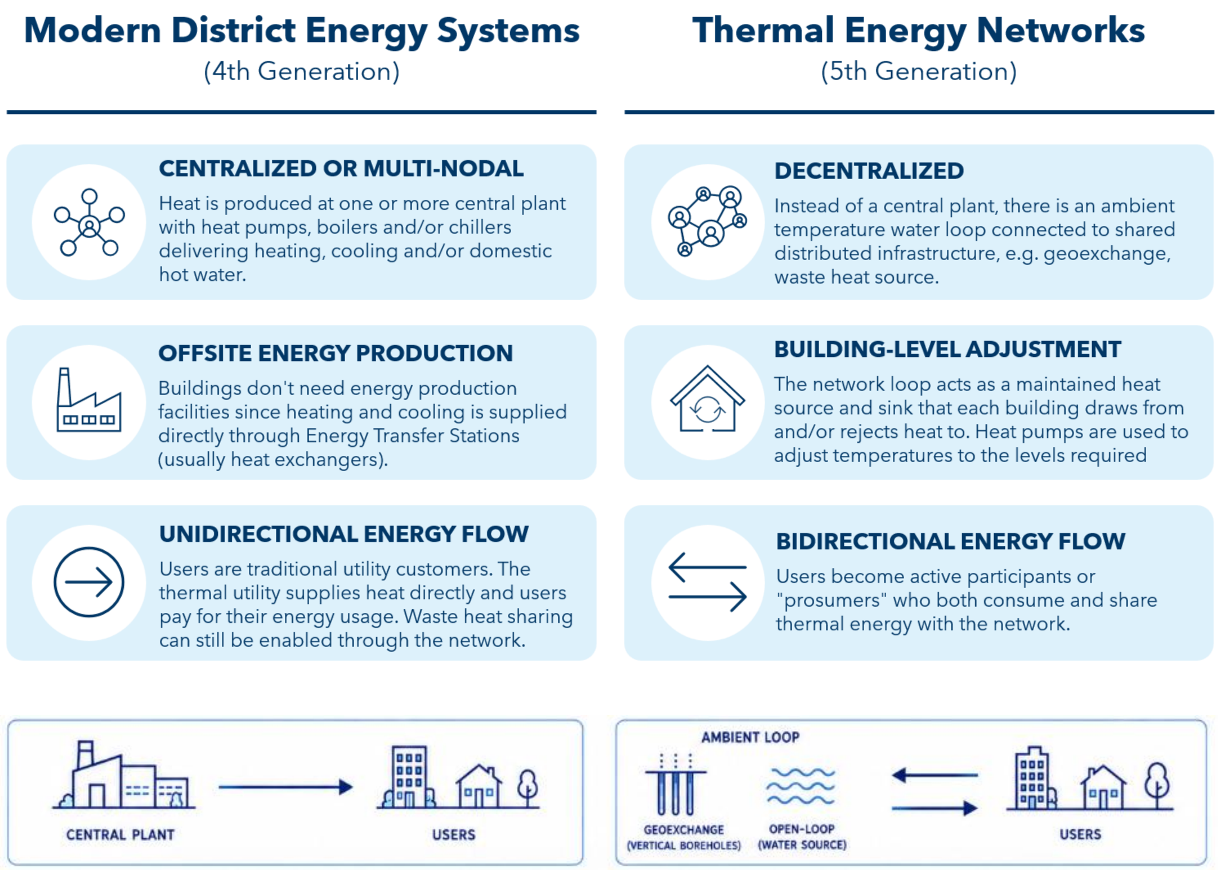

Figure 2 - Modern DES vs TENs[7]

While the two approaches differ technically, both can achieve comparable levels of decarbonization, energy efficiency, and renewable energy integration.

The key distinction lies in how those outcomes are achieved. Modern DES can achieve outcomes comparable to TENs, but only under certain conditions. Their performance depends largely on the energy sources supplying the network. When powered by central heat pumps, geothermal resources, recovered waste heat, or other low-carbon energy sources, DES can deliver emissions reductions and efficiency gains comparable to those of TENs.

The same principle applies to demand flexibility and peak load management. Depending on local climate conditions and the seasonal performance of air-source heat pumps, DES may require

[7] Visual Inspired from: Building Decarbonization Alliance. Thermal Energy Networks in Canada. 2025

thermal energy storage, renewable gas-fired peaking equipment, or stable thermal resources such as geothermal energy and waste heat recovery to achieve significant peak demand reductions.

TENs, by contrast, possess characteristics that inherently support decarbonization, demand flexibility, and peak load reduction. By leveraging shared ambient-temperature infrastructure connected to stable thermal resources such as geoexchange fields, aquifers, or recovered heat sources, TENs enable highly efficient building-level heat pumps to operate with relatively consistent performance throughout the year. This reduces reliance on fossil-fuel peaking resources and limits the impact of outdoor temperature fluctuations on system efficiency.

TENs can also often reduce winter peak electricity demand by drawing from stable underground or water-based thermal resources rather than relying exclusively on ambient air temperatures. In practice, modern DES and TENs should be viewed as equally viable pathways for decarbonizing heating and cooling systems. Rather than competing solutions, each offers distinct advantages, and the most appropriate approach will depend on site conditions, available resources, existing infrastructure, and development goals.

Reference

[1] U.S. Energy Information Administration. U.S. District Energy Services Market Characterization. February 2018.

[2] United Kingdom. Energy Act 2023. 2023. Available at: https://www.legislation.gov.uk/ukpga/2023/52/enacted

[3] Department for Energy Security and Net Zero. UK Heat Networks Market Overview. 2024. Available at: https://assets.publishing.service.gov.uk/media/66a23740a3c2a28abb50d711/uk-heat-networks-market-overview.pdf

[4] Utility Dive. "How About the Now? An Update on the Future of Gas and Related Gas Industry Developments." 2024. Available at: https://www.utilitydive.com/spons/how-about-the-now-an-update-on-the-future-of-gas-and-related-gas-industr/759197/

[5] National Grid and RMI. "National Grid and RMI Examine Role of Non-Pipeline Alternatives in the Energy Transition." 2024. Available at: https://www.nationalgridus.com/News/2024/05/National-Grid-and-RMI-Examine-Role-of-Non-pipeline-Alternatives-in-the-Energy-Transition/

[6] Building Decarbonization Coalition. "Thermal Energy Networks State Legislation Tracker." Available at: https://buildingdecarb.org/resource-library/tens-state-leg

[7] Building Decarbonization Alliance. Thermal Energy Networks in Canada. 2025. Available at: https://buildingdecarbonization.ca/wp-content/uploads/2025/09/BDA-Thermal-Energy-Networks-in-Canada.pdf

[8] Gouvernement du Québec. "Programme d'aide financière – Valorisation des rejets thermiques." Available at: https://www.quebec.ca/agriculture-environnement-et-ressources-naturelles/energie/reussir-ses-projets-transition-energetique/valorisation-rejets-thermiques/aide-financiere/programme-aide-financiere-valorisation-rejets-thermiques

[9] City and County of Denver. "Rebates for Building Decarbonization." Denver Climate Action, Sustainability and Resiliency. Available at: https://denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-and-Resiliency/Cutting-Denvers-Carbon-Pollution/Efficient-Commercial-Buildings/Rebates-for-Building-Decarbonization

[10] City and County of Denver. "Energy Efficiency Programs and Initiatives." Available at: https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Human-Rights-Community-Partnerships/Programs-Initiatives/Energy-Efficiency

[11] City and County of Denver. "District Energy Conversion Incentive." Denver Climate Action, Sustainability and Resiliency.

Disclosure template

AI-assisted tools used: ChatGPT
Used for: light editing
Human review: The authors reviewed and verified all content, calculations, and citations.