How to Develop a

Thermal Energy Network

A practical guide to adding Thermal Energy Networks to decarbonization plans for your community

VERMONT COMMUNITY THERMAL NETWORKS

ENERGY ACTION NETWORK

To build a sustainable energy future, we need a diverse portfolio of solutions.

Harnessing, moving, and sharing the heat we already have in Thermal Energy Networks (TENs) can help us decarbonize our buildings more efficiently, equitably, and affordably.

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To access the full How to Develop a Thermal Energy Network toolkit, please visit vctn.org/toolkit.

This resource was developed by Vermont Community Thermal Networks in consultation with and including valuable contributions from the Thermal Energy Network Team supported by Energy Action Network.

Why Thermal Energy Networks?

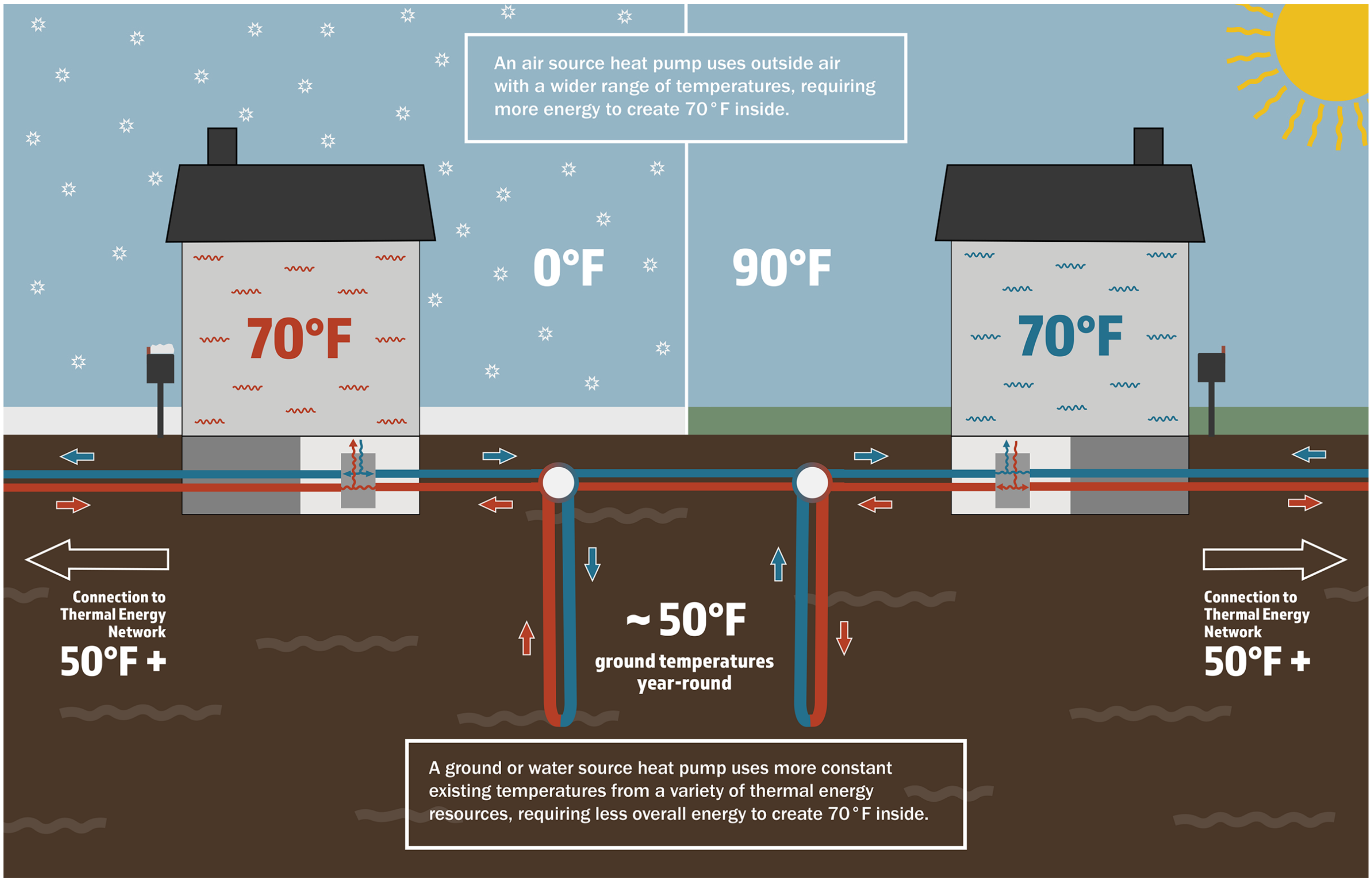
Capturing and recycling existing heat in Thermal Energy Networks (TENs) has a lower impact on the electric grid than many other decarbonization solutions.

TENs can use existing heat.

With TENs, we can access underground thermal energy and recover waste heat that is usually lost. Every day, we vent heat from large buildings, industrial processes, and large-scale refrigeration and send used hot water down the drain. Recirculating this existing heat means that we need to use less electricity to create new heating or cooling.

TENs are highly efficient.

TENs use water source heat pumps,* which operate with significantly less electricity than air source heat pumps. Temperatures from underground or from waste heat are more stable than outdoor air temperatures. Because TENs create heating or cooling from more moderate temperatures, they require less electricity to meet thermal needs year-round.



* This guide uses the term *water source heat pump* to refer to equipment that uses heat recovered from buildings as well as from shallow boreholes. Often called *ground source* heat pumps or even *geothermal* heat pumps, these terms describe the same equipment. In most cases, *water source heat pump* is used here as the most accurate and inclusive term.

Our Challenge

In Vermont, buildings are currently our second largest source of greenhouse gas emissions. Over the next 10-17 years, we must drastically reduce the 2.87 million tons of carbon (CO_2e) emitted each year from burning fossil fuels to heat our buildings.[1] This means providing clean thermal energy to 55,000 gas customers and eliminating the use of about 90 million gallons of oil and propane per year.

Electrifying heating, cooling, and domestic hot water is a key pathway to achieving state-mandated climate goals. Many Vermonters are installing air source heat pumps and taking advantage of this huge opportunity to decarbonize our buildings.

However, as electricity use increases for buildings and other uses, demands on our electric grid could impact customer bills and require building new electric infrastructure. The more we can lower peak use, the more affordable our electricity will be.

A Solution

Water source heat pumps provide a substantially more efficient way to electrify heating and cooling.[2] Connecting multiple buildings to water source heat pump loops via TENs creates an even stronger solution, boosting efficiency significantly by capturing and sharing waste heat. Building TENs wherever possible can make electrification go further faster.

TENs can not only strengthen our ability to electrify buildings, but can also bring the economic and social benefits of local clean energy to more Vermonters. In addition, by moving and sharing the heat we already have, TENs can reduce our reliance on imported energy and fluctuating energy costs and markets.

As highly efficient community-scale systems, TENs can play a key role in our ability to achieve a successful energy transition and ensure that clean heating and cooling are more affordable, reliable, and accessible across our state.

1. Energy Action Network, Annual Progress Report for Vermont, 2023 https://eanvt.org/annual-report

2. http://tinyurl.com/doe-hpguide

What are Thermal Energy Networks?

Thermal Energy Networks (TENs) are highly efficient clean energy systems that:

- **Use water source heat pumps and underground pipes to repurpose thermal energy for heating, cooling, and hot water.**

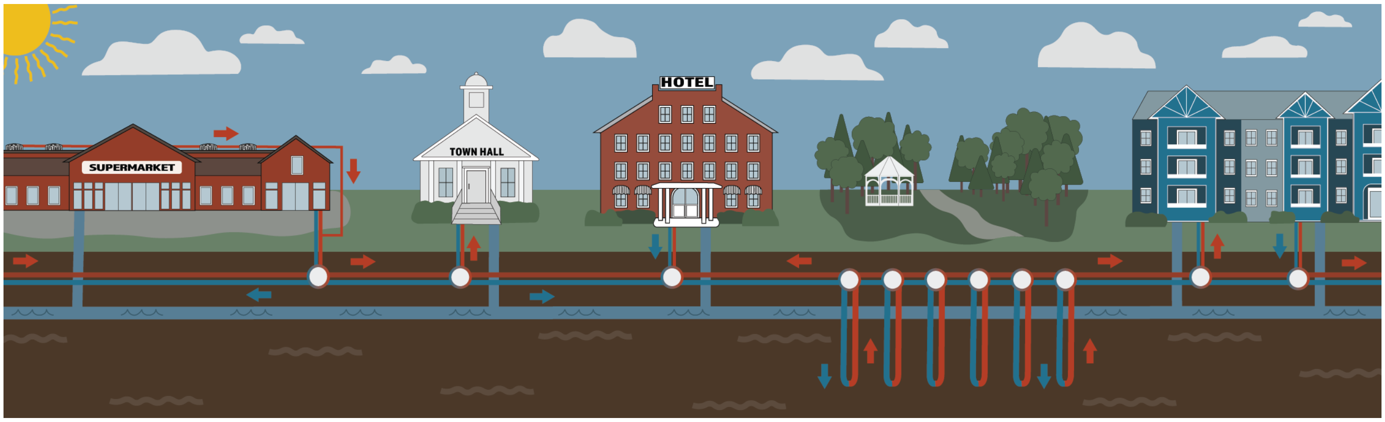
  TENs are already working in many locations, reducing the amount of fossil fuels consumed by heating and cooling buildings, cutting emissions dramatically, and providing multiple benefits to communities.

- **Move heat and balance thermal energy among buildings.**

  TENs can include boreholes to access moderate underground temperatures and can also distribute waste heat from large buildings, refrigeration, industrial processes, or from wastewater. Using existing local heat reduces the amount of energy we need to generate in-state or import.

- **Offer dramatically lower emissions than other systems.**

  TENs also provide safe, healthy, affordable thermal energy to many homes and businesses at once and protect customers from volatile electric and fuel prices. Combining a diversity of thermal energy resources makes TENs an even stronger solution for efficient, resilient, long-term energy infrastructure.



How to Use This Guide

Get started by engaging your community and laying groundwork.

Begin by reviewing this summary and assembling a team to explore the full guide with you. Then:

- **Share videos and fact sheets** to help you create a conversation in your community.
- **Use checklists** to help you identify a project and evaluate what to prioritize.
- **Explore deeper dives** with greater detail, examples, and best practices.

These resources can also be helpful if you want to be TEN-ready.

Maybe you want to employ this solution, but are unsure when a project might be possible. Taking stock of buildings and thermal energy resources, identifying where to start and how to grow a network, ensuring indoor systems can connect to a TEN, and understanding the legal requirements and financial support available are all good investments to make now for when the time is right to embark on a TEN project.

Some sections include technical terms and deeper dives.

Whether describing equipment, project design, or financing, this guide attempts to make technical details readily understandable and to provide helpful information as you connect with experts over the course of a project.

Some aspects may require an expert to provide guidance. Where possible, notes suggest the kind of help to enlist, from municipal staff and leadership to engineering, legal, or financing expertise. Including people with this knowledge and experience in a working group or project team can strengthen your efforts, whether you're just starting out or are ready to develop a TEN.

If you have questions or need expertise not readily available to you, contact info@vctn.org.

This guide is for anyone curious about TENs, but is particularly designed for you if you are:

- A municipal leader interested in initiating TEN planning in your town or city,
- A community member exploring how to start a TEN locally,
- A regional planner supporting communities in clean energy planning and development,
- A business or developer working with a community to implement a TEN,
- An affordable housing organization looking for lowest-cost clean energy solutions, or
- An electric utility considering TEN development in communities in your territory.

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1. START HERE

Identifying the right time and place to develop a Thermal Energy Network (TEN) is key to a successful project. Learning from experts, talking with stakeholders, and bringing your community along can be as important as the design of the system itself. There are multiple benefits of adding a TEN and many ways to involve others in building a neighborhood-scale thermal solution.

LEARN MORE: *Where and When a TEN Makes Sense (p.8)*

ACTIONS

- Watch and share this short video: tiny.cc/tens-video.
- Use the TEN Opportunities Chart (p.9) to look for good local conditions and collect ideas.

WORKSHEET

- Thermal Energy Network Opportunities Chart (p.9)

SUPPORTING MATERIALS *(p.32–35)*

- Fact Sheet: The Basics: Thermal Energy Networks
- Fact Sheet: The Benefits of Thermal Energy Networks
- Fact Sheet: How Thermal Energy Networks are Key to Successful Electrification

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Where and When a Thermal Energy Network Makes Sense

A Thermal Energy Network (TEN) will be more efficient and cost-effective when paired with complementary projects in your community that are in the early stages of development. Local infrastructure projects, new developments, and large buildings with heating systems that need replacing are good places to start.

Conditions that could benefit TEN development in your community:

Local infrastructure projects underway

Any time construction is planned could be an opportunity to tie in a TEN, particularly if the work involves or is adjacent to a building or facility that has excess heat and nearby buildings that can use that heat.*

The “dig once” principle can help a TEN project save money on excavation and paving.

For example:

- A local water or wastewater project is in early stages of development.
    - ▶ *Learn more about Energy from Wastewater (p.38).*
- Water or wastewater systems/sections need repair or replacement.
- Streets or sections of town are scheduled for existing infrastructure work.

New developments

New construction is one of the best opportunities for installing a TEN. Any drilling for geothermal boreholes or trenching for horizontal pipes can be least disruptive, and compatible indoor distribution systems (see vctn.org/s/Compatible-HVAC-Systems.pdf) can be installed rather than retrofitted.

For example:

- An affordable housing development is in early planning stages.
- New residential and/or commercial developments are being planned or permitted.

Good starting points

Starting small is a good initial approach to a TEN. A project that successfully connects two buildings can demonstrate the technology and many of the benefits, inspiring a larger network and showcasing how moving heat can take the place of carbon-emitting, more expensive heating and cooling systems.

For example:

- A large municipal building such as a school or town hall has an aging heating/cooling system and could benefit from a geothermal system, becoming an anchor for a TEN.
- Oil and propane customers could save significantly by shifting to repurposing existing heat.
- A large thermal energy resource is within ¼ mile of a building or set of buildings that can receive the waste heat.

* To learn more about how to find waste heat and opportunities to capture and move it, see How to Get a Head Start on a TEN (p.11).

Thermal Energy Network Opportunities Chart

Jumpstart your thinking on where and when to build a Thermal Energy Network (TEN) by using this chart to consider which local conditions could be opportunities for a TEN.

Any one of these conditions can be a good reason to consider a TEN. The more you find, the more broadly you can think about implementing a larger network by creating TEN nodes and connecting new areas over time.

Local Conditions	YES	NO	Notes
Is your community updating or intending to update its energy plan, comprehensive plan, or zoning code?	☐	☐	
Does your community have a wastewater treatment plant?	☐	☐	
Will the wastewater treatment plant require repair or replacement over the next 5-10 years?	☐	☐	
Is the wastewater treatment plant within ¼ mile of other buildings?	☐	☐	
Are capital investments in the sanitary sewer system needed within the next 5-10 years?	☐	☐	
Does your community have a potable water system?	☐	☐	
Are capital investments for the water system needed in the next 5-10 years?	☐	☐	
If your community doesn't have a potable water system, are there plans to construct one within the next 5-10 years?	☐	☐	
Are street openings planned for other infrastructure work?	☐	☐	
Are new buildings, mixed-use, or housing developments in the early stages of planning?	☐	☐	
Does your community have access to open land that could contain a geothermal borefield? *(e.g. recreation fields, parking areas, or green space that could be drilled, then replanted or repaved)*	☐	☐	
Does your community include potential thermal energy resources?	☐	☐	
Buildings with large refrigeration or cooling systems? *(e.g. ice arena, grocery store, cold storage, office cooling, data center)*	☐	☐	
Food or beverage manufacturing? *(e.g. brewery/distillery, drying processes, canning, bakery)*	☐	☐	
Other industrial facilities that likely produce waste heat or significant volumes of wastewater?	☐	☐	
Bodies of water that could be thermal reservoirs, providing and/or accepting thermal heat? *(e.g. rivers, lakes, ponds, reservoirs, quarry/mine)*	☐	☐	
Local or regional electric distribution system interconnections or substations?	☐	☐	

For a more detailed chart and next steps, go to *How to Get a Head Start on a TEN (p.11)*.

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2. IDENTIFY OPPORTUNITIES

Whether or not you're ready to launch a Thermal Energy Network (TEN) now, you can lay the groundwork for an effective process and a successful project. To get a head start on a TEN, it helps to know your buildings and local thermal energy resources, to integrate TENs into local and regional plans, and to upgrade systems in need of replacement with a TEN in mind.

▶ **LEARN MORE:** ***How to Get a Head Start on a TEN (p.11)***

ACTIONS

- Inventory local thermal energy resources.
- Inventory potential TEN buildings.
- Identify opportunities to tie in to upcoming developments.

RESOURCES

- Site Selection for a Thermal Energy Network (p.16)
- Site Selection Factors to Consider (p.17)

▶ **SUPPORTING MATERIALS** *(p.36–44)*

- Fact Sheet: Moving Heat
- Fact Sheet: Energy from Wastewater
- Worksheet: Site Selection Chart

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How to Get a Head Start on a Thermal Energy Network

Whether or not you're ready to launch a project now, you can lay the groundwork for an effective process and a successful project.

To get a head start on a Thermal Energy Network (TEN), it helps to know your buildings and local thermal energy resources, to be aware of upcoming local developments, to add TENs to local and regional plans, and to upgrade systems in need of replacement with a TEN in mind.

1. Inventory thermal energy resources.

What thermal energy is already generated in your community? What facilities or spaces could provide heat to nearby buildings and/or receive excess heat or cooling?

Identify local thermal energy resources such as:

- Grocery stores and large refrigeration centers,
- Ice arenas,
- Wastewater treatment facilities,
- Data processing centers, including buildings that house telephone or internet facilities,
- Breweries, distilleries, bakeries, factories,
- Ponds or reservoirs,
- Office buildings with central cooling systems and year-round cooling loads, or
- Other industrial facilities.

Thermal Energy Resources

A *thermal energy resource* can add heat to a TEN or receive excess heating or cooling, helping to balance thermal loads among buildings. Thus, a thermal energy resource can be a thermal *source* or a thermal *sink*. Generally, a promising thermal energy resource is approximately ¼ mile away from buildings that can use the heating or cooling it provides.

- **Waste heat from buildings:** Excess heat vented from large buildings can be harvested and recirculated in a Thermal Energy Network.
- **Waste heat from wastewater:** Wastewater treatment plants and sewer lines are reliable sources of heat and can also accept excess thermal energy to cool other buildings.
- **Thermal energy resources and TEN customers:** As heating and cooling needs shift from one season to another, an owner of thermal energy resources can both provide heat to other buildings and also be a customer in a network, helping to balance thermal loads among buildings.

- **Geothermal is a thermal energy resource:** As you look for thermal energy resources in your community, include spaces that could host a geothermal borefield or loop field—a place that could be used for laying pipe and/or drilling shallow boreholes and could later be replanted or repaved and returned to its original purpose. A geothermal borefield or loop field can benefit a TEN by diversifying sources of thermal energy and adding thermal storage underground. Geothermal systems can be developed in a variety of ways using various technologies.
- **Surface water can be a thermal energy resource**: Heat exchanging plates or coils can be sunk into lakes, ponds, and other bodies of water. Surface water can be an effective thermal source and sink at different times of year. Environmental review is needed to ensure that any fluctuations in water temperatures do no harm to local species and ecological balance.
- **Other thermal energy resources:** Additional thermal energy resources such as thermal energy storage, solar thermal, or other technologies may be considered depending on local building or community opportunities.

One example of surface water as a thermal energy resource:

WaterFurnace, a leading heat pump manufacturer, has been heating and cooling its 115,000 square foot headquarters for over 34 years using an adjacent three-acre pond.

Their heat exchange loop consists of 12 zones on the bottom of the eight-foot-deep pond. Each zone is constructed from 15 300-foot-long coils of three-quarter-inch pipe connected to the building by two-inch supply and return lines.

In the winter, the underwater pipes capture and move the moderate temperature from the bottom of the pond to heat pumps inside the building, which amplify it for space heating and hot water. In the summer, the heat pumps remove heat from the building to create cooling, returning that heat to the pond or venting it.

During the summer, the pond loop doubles the efficiency of conventional cooling. In the winter when the pond's surface is frozen, the loop is four times more efficient than electric resistance heating and provides considerable savings when compared to the highest-efficiency gas systems.

▶ *For an overview and examples of how a TEN can use existing heat watch this short Thermal Energy Networks video: tiny.cc/tens-video.*

For an introduction to waste heat and thermal energy resources, see:

- Moving Heat*: How Thermal Energy Networks repurpose existing heat (p.36)*
- Energy from Wastewater*: Capturing and reusing thermal energy from wastewater (p.38)*

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2. Inventory potential TEN buildings.

Which buildings are most TEN-ready and could be prioritized to connect to local thermal energy resources?

- Identify a large municipal, institutional, or privately-owned building that could be an anchor customer (and potentially a thermal energy resource) for a TEN.
- List buildings, then group them in clusters that could form the first node of a TEN, a route or corridor for a TEN, and areas for future network expansion.
- Consider whether a building contains available space to host equipment, such as a mechanical room or basement.
- Note building improvements needed such as weatherization and electric capacity upgrades like electric panels, meters, and utility service upgrades.[1]
- Identify existing buildings that contain TEN-ready distribution systems (*see item 5 below for more detail*) such as ducted heating and cooling, low temperature hydronic distribution, or other systems that need less complex retrofits to connect to a TEN.
- Prioritize buildings, including affordable housing developments, with oil or propane systems that could greatly benefit from lower-cost, non-emitting thermal energy.

3. Create a simple map.

- Locate potential thermal energy resources.
- Note distances between those resources and large buildings and residential or commercial areas. What is within ¼ mile?
- Mark open land, such as a green space or parking area, that could host a geothermal borefield.

4. Identify upcoming development projects.

Good timing for a TEN can be informed by upcoming local improvements and developments. Knowing what's already being planned or permitted can inform where and when to start. As long as complementary projects are in the early stages, there can be time to plan for a TEN.

Consult local leaders:

- City council or selectboard,
- Town commissions or committees such as a planning commission, energy committee and/or coordinators, housing or recreation committee,
- Municipal staff: planners, manager, clerk,
- Regional planning commission staff,
- Economic development agencies or organizations,
- Schools and higher education leadership, or
- Others such as housing organizations and community institutions or businesses.

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1. The level of electrical upgrades needed for a TEN varies case by case. When a project is outlined, electric capacity needed can be estimated, but is different for every building and project.

Ask:

- Where are infrastructure plans in the works, such as replacing water or wastewater pipes, roadwork, etc?
- Where are new housing, commercial, industrial, or mixed-use developments being planned?
- Are any of these developers considering all-electric construction, including a geothermal system or a TEN?

If you started with Where and When a Thermal Energy Network Makes Sense (p.8), you may already have compiled much of this information.

5. Add TENs to local and regional plans.

Using steps 1-4 above, you can further support TEN development by explicitly adding TENs to local and regional planning documents. Specific language about TENs included in these plans can provide ways to meet existing infrastructure, energy, and community resilience goals.

Work with your local or regional planners to add wording on TENs that:

- **Identifies thermal energy resources in your plan's infrastructure section (see 1 above).**
  - Describe how and where waste heat can be captured and reused in existing or future buildings.
  - Note how including TENs also supports energy efficiency and conservation goals.
- **Includes a brief description of TENs.**
  - Highlight how using TENs to electrify buildings significantly reduces the amount of energy consumed to heat and cool homes, community spaces, and businesses.
  - Describe local opportunities to incorporate TENs in your plan's energy element/ enhanced energy plan (see 2-4 above).
- **Factors TENs into planning discussions and processes.**
  - Look for opportunities to bring TENs into local planning for smart growth, zoning (e.g. considerations of density and mixed-uses), housing, etc.
  - Include how TENs can play an important role in reducing both greenhouse gas emissions and demands on electric infrastructure capacity.

In addition, you can ask your municipality to add two ways to encourage TEN development:

- **Create incentives for TEN-ready buildings.**[2]
  - Zoning bonuses or incentives can help real estate developers create more housing units or less parking if the project is all-electric or is TEN-ready. Local real estate developers can be engaged in the TEN planning process in the same way they cooperate with municipalities on other infrastructure planning. Aligning their interests with TEN development can accelerate TEN deployment and reduce overall costs.

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2. See Climate Change and Land Use (ccrpcvt.org/wp-content/uploads/2022/05/Climate-Change-and-Land-Use_Standard-Resolution_20220524.pdf) for a variety of other strategies that could be expanded to include TENs and considered at the local and regional levels.

- **Tie TEN-ready work into building or infrastructure capital plans.**
  - A municipality or local government can coordinate TEN plans as it advances other infrastructure work like stormwater drainage or roadway work. Any planned infrastructure work affecting rights of way should consider potential TENs to reduce project costs and timelines.

6. Retrofit buildings along a potential TEN route.

Preparing buildings to connect to a TEN can be accomplished at any time and will benefit whatever heating and cooling systems are in place until a TEN can be built.

If the terms below are new to you, consult a heating and cooling expert such as an HVAC installer or engineer.

Three Ways to Make a Building TEN-ready:

- **Weatherize and improve the building envelope.**
  - Many older buildings need insulation, air sealing, or new windows and doors to take advantage of the efficiencies a TEN provides. This work is beneficial whenever it can be performed, as it reduces the need for oversized heating and cooling equipment and lowers customer bills.
- **Upgrade electric capacity.**
  - While TENs are highly efficient and use significantly less electricity to heat and cool, it is important to ensure a building's electric capacity is sufficient to connect to a TEN. Gather information on current electric systems in potential buildings to share with a TEN developer or designer.
- **Retrofit existing thermal distribution systems.**
  - When replacing an aging heating system, choose a replacement system that accepts low temperature heat and is ready to connect to a TEN. Low temperature water-based systems and low velocity air ductwork systems are easily retrofitted to work for a TEN.

TEN-ready Indoor Heating and Cooling Systems

Planning for a TEN includes identifying the heating, ventilation, and air conditioning (HVAC) systems that already exist in buildings. Some indoor systems are easy to connect to a TEN, some will require adjustments, and others will need to be replaced.

For details on indoor systems for TENs, see vctn.org/s/Compatible-HVAC-Systems.pdf.

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Site Selection for a Thermal Energy Network

Selecting a site for a Thermal Energy Network (TEN) begins with choosing a strong anchor building or cluster of buildings paired with one or more reliable thermal energy resources. An initial project can be as simple as providing heat exchange between two buildings such as a grocery store directly adjacent to an apartment building.

Site selection may also:

- Factor in potential routes, customers, or thermal energy resources for a TEN to expand.
- Consider timing to coincide with other infrastructure or new development projects.
- Prioritize low or moderate income housing or essential facilities and services.
- Identify locations where switching from fossil fuels will provide the greatest social and economic benefits such as in energy burdened communities.

Moving heat among buildings in a TEN is an effective way to accelerate decarbonization because the concept, design, and operation are **site specific.** Systems are informed by local opportunities, tailored to local conditions, and responsive to community needs. Taking time to evaluate and select TEN sites, nodes, and connecting routes is an investment in an efficient thermal energy system.

While there are no one-size-fits-all approaches to community decarbonization, a strategic site selection process to identify a viable first TEN project and plan for future TEN opportunities can create a smoother process and lower overall costs.

Key Criteria for Site Selection:

- The **density** of buildings and proximity to thermal energy resources is important for a TEN to function efficiently and be cost-effective.
- A TEN benefits from a **diversity** of thermal energy resources and thermal loads or building types, providing the ability to balance different sources of heat and to exchange heating and cooling needs.
- Ideal TEN locations contain an **anchor** customer or a cluster of customers within proximity to thermal energy resources.

Additional Ideas for Site Prioritization:

- Buildings reliant on oil or propane are prime candidates for switching to a TEN.
- Affordable housing, facilities that serve low and moderate income residents, civic buildings, and non-profit customers can be prioritized to lower or stabilize energy bills and provide benefits associated with cleaner, safer heating and cooling.
- Focusing on or including new construction in a TEN project can be more cost-effective and help avoid or offset the cost of retrofitting existing buildings.
- Working with a single owner of a development or just a few large building owners can streamline decision-making and expedite a project.

▶ *For specifics on thermal energy resources and potential pairings with nearby buildings that can use the waste heat, see How to Get a Head Start on a TEN (p.11) and these fact sheets:*

- Moving Heat*: How Thermal Energy Networks repurpose the heat we already have (p.36)*
- Energy from Wastewater*: Capturing and reusing thermal energy from wastewater systems (p.38)*

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Site Selection Factors to Consider

This list is also available as a worksheet with more detail, resources, and links.

Potential Thermal Energy Resources and Networks

Buildings

- Facilities and buildings that can be thermal energy resources and/or customers
- Buildings that require heating and cooling within ¼ mile or less of thermal energy resources and/or potential borefields
- Compatible heating and cooling (HVAC) systems (see vctn.org/s/Compatible-HVAC-Systems.pdf)
- Existing energy efficiency and electrical capacity
- Local spaces that serve as an emergency shelter and/or provide essential services

Street Conditions and Rights of Way

- Capacity to lay pipe between buildings and to building mechanical rooms
- Available rights of way for street work and street crossings

Complementary Projects

- Town plans to add or improve water and/or wastewater systems
- Current and future plans for residential or commercial development projects
- Projects already in line for street openings

Existing Infrastructure

- Sewer lines where pipes join a larger main before entering the public right of way
- Tunnels, bridges, or stormwater channels that may serve as rights of way or heat sinks or sources
- Other renewable energy or infrastructure that supports thermal storage and TEN development

Geothermal Potential

Land Use and Feasibility

- Ownership and availability of land for geothermal boreholes/borefield(s)
- Existing permitting and land use regulations
- Areas of environmental concern that don't rule out a TEN, but require additional planning and permitting

Geology and Hydrology

- State or regional geologic data and reports that show attractive geological conditions
- Depth to bedrock and underground water flows can determine site suitability

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Community Factors and Opportunities

Participants

- Building owners willing to provide thermal energy
- Building owners willing to become TEN customers
- Current residents and/or businesses willing to engage in a TEN process

Housing and Neighborhoods

- Range of housing, including unit sizes, ages, heating sources, etc.
- Inclusion of rental and affordable housing
- Potential for equitable distribution among different populations
- Mix of income levels in order to benefit a wide range of residents and businesses

Workforce

- Availability of professionally certified drillers, installers, inspectors, and maintenance workers
- Worker compensations that qualify for prevailing wage incentives in the Inflation Reduction Act

Gas Service Territory

- Opportunities to replace gas service
- Gas main and service lines in need of repair or replacement
- Sites at or near the end of local gas distribution pipelines

3. UNDERSTAND OWNERSHIP

There are many ways to own and operate a Thermal Energy Network (TEN). Different kinds of ownership determine how a project can be financed. Weighing the advantages and challenges of a few common ownership models can help identify which approach is most beneficial for your project.

▶ **LEARN MORE:** *Which Ownership Model? (p.20)*

ACTIONS

- Explore ownership models and for-profit, low-profit, or non-profit business models that may fit your community or project.
- Identify related financing and incentive opportunities from the Inflation Reduction Act and other sources.

▶ **SUPPORTING MATERIALS** *(p.45–62)*

- Financing a Thermal Energy Network
- IRA Incentives for Thermal Energy Networks
- Deeper Dive: Ownership Guide for Thermal Energy Networks

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Which Ownership Model?

There are many ways to own and operate a Thermal Energy Network (TEN). Considering both the advantages and challenges of a few common ownership models can help identify which approach is most beneficial for your project.

This summary focuses on three ownership models that can serve a TEN.

- Municipal
- Cooperative
- Third-party

Municipal Ownership

ADVANTAGES	CHALLENGES
• Local control, including over existing thermal energy resources • Lack of profit-seeking motive • Transparency and known entity • Familiar with shared infrastructure and transferable business models	• Lack of local technical expertise • Potential local capacity constraints • Potential budget & bonding constraints • Pace depends on politics
NOTES	**QUESTIONS**
• Municipal ownership can be facilitated by establishing a municipal corporation—a local development corporation or other authorized entity with bonding capacity and separate governance tasked with leading a project.	• Does the community support spending municipal resources on climate or clean energy action? • What existing policies support development of a TEN?

Cooperative Ownership

ADVANTAGES	CHALLENGES
• Self-governance and local control • Equitable ownership and distribution of benefits, including revenue • Place-based identity enhances participation • Membership strengthened by aligned interests	• Finding enough local members • Consistent leaders/lead members • Keeping buy-in affordable • Credit-worthiness of multiple owners (vs. one large entity) can have financing implications
NOTES	**QUESTIONS**
• Can include both thermal energy resource owners and users • May be best suited to a portion of a town or to grow organically over time • Similar to Homeowner's Association (HOA)	• Does the community have an anchor institution or organization to launch/lead a co-op? • What thermal resources are under the control of a potential co-op member?

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Third-Party Ownership

ADVANTAGES	CHALLENGES
• Can function outside political constraints • Can provide expertise for all stages of a project • More seamless transition from development to ownership • More likely to allow for a faster process	• Unregulated de facto monopoly may not allow local input into rates or fees • Level of transparency is up to the company • Investor returns draw money out of the community
NOTES	**QUESTIONS**
• Most third parties are for-profit entities • For-profits have more access to a variety of capital resources, but grant funds are less available	• Do the conveniences of third-party ownership outweigh the challenges of municipal or cooperative ownership? • How does the expectation of investor returns impact the community?

The Role of Large Utility Companies

There may be a role for investor-owned regulated utilities in developing TENs.

Financing: A utility framework allows a gas or electric company to invest in energy infrastructure and recover costs through billed rates over a period of decades. This allows all customers to access energy without needing to pay a significant cost upfront. The more customers who pay to access the energy infrastructure, the more the recovery of the initial investment can be shared.

While a municipal utility can spread out the upfront costs of installing a TEN over many customers in a town or city, that rate base or the total amount of customers is limited to the municipality. A gas or electric company with a large territory, if allowed by its regulators, could use its rate base across a wider population, resulting in somewhat lower costs. However, an investor-owned utility must also generate a return for shareholders, often about 8%-10%, which may offset the cost savings associated with a larger scale TEN installation.

Workforce: Gas workers already have most of the skills needed to install a TEN, as pipefitting and plumbing are primary skills needed in construction. The gas utility workforce can be rapidly retrained and employed in TEN development and construction.

Pilot Projects: Many large investor-owned gas and electric utilities are beginning to explore providing customers with access to TENs using existing regulatory and cost recovery frameworks as well as existing workforce. In some states, such as New York and Massachusetts, pilot projects are exploring a workable business model for investor-owned utilities.

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A TEN generates revenue over time by selling thermal energy.

A utility creates revenue via *rates* established by a regulating authority such as a municipal body or a state's public utility commission.

Other TEN owners can create revenue through *customer charges* such as one-time connection fees, monthly user fees, metered usage rates, or fees based on peak thermal energy use.

For-profit, low-profit, or non-profit?

Another way to look at ownership is to consider who will benefit from the system over time. Decisions about who will own a TEN involve choosing among for-profit, low-profit, or non-profit approaches that impact financing opportunities, customer costs, and whether or not any revenue generated will stay in the community.

For-profit

The owning company charges enough for TEN services to ensure that its investors receive an acceptable return on the investment of the upfront costs and continue to earn dividends, which typically result in higher customer rates or fees. For-profits can include mission-driven companies that operate as a B-Corp, C-Corp, or LLC.

Low-profit

TEN ownership can be set up to return a percentage of the revenue to the community it serves through a Low-Profit Limited Liability Company (L3C) or a Public Purpose Energy Service Company (PPESCO).

Non-profit

A non-profit owner returns any profit beyond what's needed to operate a TEN to the community through reinvestment in the system, as revenue for the municipality, or as co-op member benefits.

Deciding between for-profit, low-profit, and non-profit ownership models relates directly to the potential of a TEN to offer lower customer rates, function as a public good, create local wealth, and support economic development. This choice should be highly localized, as a model that works in one community may not work in another.

Own and operate or transfer?

In most cases, a third party is hired to manage the process of building a TEN. That company may continue to own the TEN for a time or in perpetuity.

One decision when building a TEN with a third party is whether to choose a ***DBOOM*** or ***DBOOT*** approach.

DBOOM: Design Build Own Operate ***Maintain***	**DBOOT:** Design Build Own Operate ***Transfer***
• The third party not only manages the TEN design and build process, but also owns and operates the TEN. • Offers a seamless transition from construction to ownership and service	• After a set term, the third party that manages the TEN design and build will transfer ownership to another entity, most likely a municipality. • Allows a period of third-party ownership in order to de-risk a project before local ownership begins

See the deeper dive Ownership Guide (p.53) for more details on each ownership model and:

- Related financing considerations
- Questions to consider
- Examples of existing projects

Who can own and operate a TEN?

Many TENs are owned and operated privately, but some can benefit from local or state authorization to function as a utility.

Statewide policy such as proposed in VT H.669 / S.252* would allow municipalities and other approved owners to use a utility model to make the upfront costs of a TEN affordable over time.

Municipalities

In Vermont, specific language in a town charter or in state statute is needed to allow a municipality to own and operate a TEN utility. This kind of simple legal provision is standard for shared infrastructure, as many town charters already authorize water and sewer utilities, but does not usually apply to a TEN.

Existing utilities

Gas and electric companies or cooperatives already must seek authorization from the Public Utilities Commission to build and own projects. A simple change to state statute such as proposed in Vermont would allow TENs to follow the same process.

Businesses and organizations

Private TEN owners don't need authorization, but may want to use a utility model to take advantage of longer-term financing. A simple change to Vermont state statute such as proposed in H.669 / S.252 is needed to create this pathway.

For more on the advantages and applications of a utility model, see What Authorization is Needed? (vctn.org/s/What-Authorization-is-Needed).

Consult legal expertise early in your TEN development process to identify any authorizations that might apply to your project.

* See Vermont's Thermal Energy Networks Act Fact Sheet (vctn.org/s/VT-TENs-Act.pdf) for current details on the House and Senate bills.

4. DEVELOP YOUR PROJECT

As with any infrastructure project, implementing a Thermal Energy Network (TEN) depends on good planning, communication, and coordination throughout the process. A core team that understands each phase, maintains stakeholder and community engagement, and can envision the process as a whole can help to build a successful project.

▶ **LEARN MORE:** *What Does a TEN Project Look Like? (p.25)*

ACTIONS

- Assemble a working group to sketch out a project.
- Identify a core project team.
- Create an initial plan for your project.

▶ **SUPPORTING MATERIALS** *(p.63–79)*

- Worksheet: Project Phases Chart
- Deeper Dive: Project Phases for a Thermal Energy Network

This resource was developed by Vermont Community Thermal Networks in consultation with and including valuable contributions from the Thermal Energy Network Team supported by Energy Action Network.

What Does a Thermal Energy Network Project Look Like?

Developing a Thermal Energy Network (TEN) requires many of the same steps and services required to plan, design, and construct other infrastructure.

The charts below are an introduction to the phases that a core project team or third party will coordinate and oversee. You can use them as:

- An overview to help you visualize a project from conception through completion,
- A tool to help identify members of a core project team or to hire a third party, or
- A guide to initiate planning and anticipate next stages in the development process.

Each of the phases describes steps to an inclusive, efficient process with actions, procurement notes, suggestions for stakeholder engagement, and best practices related to TEN development.

▸ *For a deeper dive and more detailed steps, please see [Project Phases for a Thermal Energy Network](#) (p.63).*

▸ *This chart is also available as a blank worksheet to help you identify and keep track of steps specific to your project: [Project Phases Chart](#) (p.70).*

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1. Exploration | 2. Planning | 3. Design & Permitting | 4. Construction | 5. Operations

Collect ideas for how a TEN could be built, owned, and operated in your community.

ACTIONS	• Form a working group to develop a project concept. • Identify potential thermal energy resources and customers. • Assess budget and personnel capacity to support a TEN project. • Consider how a TEN fits within existing town and regional plans. • Evaluate local support for a TEN project.

PROCUREMENT	[Note: Procurement for services needed to develop a TEN is done in stages across a project from pre-design through construction. *See Project Phases (p.63) for more details and best practices.*]

STAKEHOLDER & COMMUNITY ENGAGEMENT	• Identify stakeholders and local champions. • Engage key project partners and needed expertise.

BEST PRACTICES	• Map thermal energy resources within a geographically focused area to understand opportunities. • Site visits: Tour buildings and facilities with an engineer or energy expert to learn how they might function as thermal energy resources and/or customers. • Evaluate potential ownership models (p.20) for financing implications, cost-effectiveness, and stakeholder impact. • Identify other parties that may be interested in collaborating on TEN development.

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1. Exploration | **2. Planning** | 3. Design & Permitting | 4. Construction | 5. Operations

Flesh out ideas and build a business case for the project.

ACTIONS	• Define TEN scope, prioritize potential sites, and create conceptual system design. • Pair viable thermal energy resources with potential customers. • Consult legal expertise re: needed authorization. • Conduct a high-level economic assessment. • Secure seed capital for project development.

PROCUREMENT	• Assemble the core project team or hire a third-party TEN developer. • Consult with environmental permitting and energy modeling experts.

STAKEHOLDER & COMMUNITY ENGAGEMENT	• Engage and educate owners of buildings. • Consider engaging building occupants. • Share project concept with the community.

BEST PRACTICES	• Engage a procurement and contract manager to coordinate and oversee hiring. • Ensure that RFPs and contracts include the Operations phase to guarantee contractor availability as needed. • Clarify how the project concept will provide adequate, timely financial returns and/or fit developer and investor expectations. • Consult state and local permitting laws and assess how permitting will impact the project timeline.

1. Exploration | 2. Planning | **3. Design & Permitting** | 4. Construction | 5. Operations

Confirm that a TEN project can happen—get to a "go" or "no go" decision.

ACTIONS	• Perform a feasibility study. • Confirm the buildings and facilities involved, size the system, and plan construction phases. • Make a "go" or "no go" decision, then pursue project financing. • Engineer preliminary system design. • Review preliminary design with the full project team, stakeholders, and community. • Begin seeking local approval of the project including filing state and local permits. • Incorporate feedback and finalize detailed system design.

PROCUREMENT	• Finalize contracts with core project team members. • Bid contracts for project management, design engineering, project estimators, project permit expeditors, and construction management and contracting.

STAKEHOLDER & COMMUNITY ENGAGEMENT	• Seek stakeholder and community responses to feasibility study results and preliminary design. • Demonstrate how feedback has been incorporated.

BEST PRACTICES	• Conduct feasibility studies only after key TEN participants are on board and seed capital is secured. • Check that designs and plans provide full details so all contractors can follow plans exactly.

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Concept becomes reality. Ensure the project meets design goals.

ACTIONS	• Work with construction management to oversee the project and coordinate subcontractors. • Engage an Environmental Specialist as needed to expedite environmental permits. • Include a commissioning agent or owner's representative to ensure the project achieves its goals. • Schedule construction activities and engage contractors in accordance with permitting timelines.

PROCUREMENT	• Identify and acquire a project or construction manager who can bring in the various trades and contractors needed to build the TEN. • Plan for equipment and materials procurement if these items are not included in the scope of the general contractor or project manager. • Schedule materials purchases in alignment with the start of construction. • Track payments to contractors to ensure smooth project schedules.

STAKEHOLDER & COMMUNITY ENGAGEMENT	• Create on-site opportunities to educate the public. • Share information frequently through various channels.

BEST PRACTICES	• Communicate early and often with project partners. • Keep the community and neighbors aware of potential disruptions caused by construction including street openings and traffic routing. • Provide regular briefings to local officials and stakeholders who can help share information with community members.

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Foster positive customer experience. Track and share project outcomes and data.

ACTIONS	• Shift financing to a sustainable business model. • Implement billing and customer services, including new customer onboarding. • Contract and/or train maintenance and emergency repairs personnel. • Test and validate system performance. • Track data on energy use, costs, and emissions reductions.

PROCUREMENT	• Identify and hire operations and maintenance staff needed to manage a reliable system. • Acquire a meter reading and billing agent to assist with billing for the thermal energy provided by the TEN, unless this function is already provided by an existing participating utility.

STAKEHOLDER & COMMUNITY ENGAGEMENT	• Install permanent signage to highlight the project and its benefits. • Celebrate successes and explore future possibilities with TEN participants and the community.

BEST PRACTICES	• Validate system performance to ensure energy savings continue and equipment is maintained. • Share project data to build knowledge within the community and across the industry.

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SUPPORTING MATERIALS

Fact sheets, resources, and worksheets listed and linked in each chapter are collected here.

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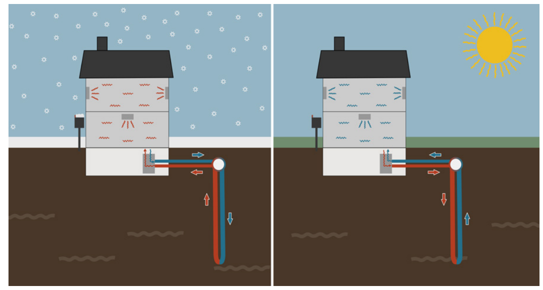
The Basics: Thermal Energy Networks

Community-based clean heating and cooling solutions

In Vermont, we have an opportunity to find and use our own clean heating and cooling.

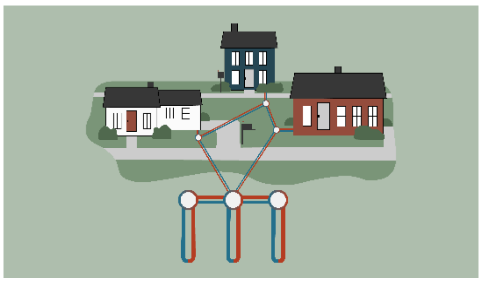
We don't have to rely on importing fuels from out of state or install air source heat pumps in every building. We can add geothermal and other kinds of Thermal Energy Networks to our mix of solutions and benefit many of our communities.

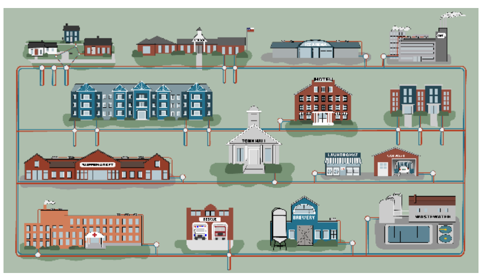


Ground source heat pumps can provide both heating and cooling.

What is a Thermal Energy Network?

"Thermal Energy Network" is an umbrella term that can include networked geothermal and other systems that use water to capture, re-use, and share thermal energy between buildings.





Networked geothermal systems use water-filled pipes in closed loops underground to both heat and cool buildings in a neighborhood or town center. Network pipes are installed at the same depth as gas or water pipes and are connected to individual ground source heat pumps.

Thermal energy can be drawn out of the earth, returned to the ground for storage, and shared between buildings with different heating or cooling needs.

Thermal Energy Networks (TENs) can also capture existing waste heat from building ventilation or wastewater and put it to use to heat or cool buildings in the network.

The more neighborhoods and multi-use buildings that are linked to a shared system, the more affordable and efficient it gets.

TENs are working on college campuses and in communities such as Berczy Glen near Toronto, where 312 households are enjoying reliable, sustainable, local energy. One Massachusetts utility is installing networked geothermal to serve a neighborhood of 45 homes, schools, and a fire station. New York recently passed a law supported by utilities, unions, and environmental advocates that links these systems to quality jobs and kickstarts many new projects. Visit vctn.org/case-studies for more examples of what a TEN can look like.

In Vermont, we can build and benefit from our own clean heating and cooling systems that are:

- **Safe & clean:** With no oil or gas in the pipes, there's no risk of explosions or hazardous leaks, and no climate-damaging emissions.
- **Affordable & reliable:** Customer bills can be low and predictable year-round.
- **Healthy:** Nothing is burned inside, so indoor air is safer to breathe.
- **Flexible:** Systems are designed to fit many locations with minimal footprints.
- **Resilient & secure:** Durable, plastic pipes underground are protected from disruption.
- **Equitable:** As a community-scale solution, they can be available to everyone in a neighborhood, and fossil fuel workers can use skills they already have to install the networks.
- **Local:** We can build our own energy systems right in our communities.

Visit vctn.org to learn more

VERMONT COMMUNITY THERMAL NETWORKS

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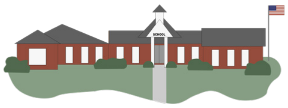
Benefits of Thermal Energy Networks

Thermal Energy Networks are:



SAFE & CLEAN

With no oil or gas in the pipes, there's no risk of explosions or hazardous leaks. While emissions reductions vary from one project to another, many existing installations have been shown to reduce emissions by up to 90%.

AFFORDABLE & RELIABLE

Customer bills can be low and predictable year-round. Geothermal and other kinds of thermal energy are readily available locally and aren't subject to market changes, so rates for consumers on a network can be stable.

HEALTHY

Burning fuels–whether gas, oil, coal, or wood–creates air pollution that can cause and worsen respiratory and other health conditions. Thermal Energy Networks don't involve any combustion, so indoor and outdoor air is safer to breathe.

FLEXIBLE

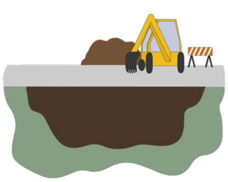
Once installed, most of the infrastructure for a Thermal Energy Network is underground, so streets, parks, and natural areas remain unobstructed. As each network is designed for a unique location, systems can fit into Vermont's landscape, protecting sensitive ecosystems.

RESILIENT & SECURE

Durable plastic pipes underground are protected from disruption. Unlike above-ground fuel storage and outside compressors, Thermal Energy Networks are able to withstand extreme weather like storms and flooding.

EQUITABLE

Most people know geothermal energy as a single-home solution available to those who can afford the upfront cost. A Thermal Energy Network can be available to everyone in a neighborhood. Low and moderate income communities can be prioritized, and all can benefit from lower energy bills.



JUST

Side-by-side comparisons of job descriptions for fossil fuel and Thermal Energy Network installations show almost identical skills, so minimal retraining is required and jobs for this skilled labor are maintained. Pipefitters and gas workers are already constructing Thermal Energy Networks in other states.

LOCAL

We can build our own energy systems in our communities. Local businesses, residents, and municipalities can come together to plan and implement Thermal Energy Networks, growing local wealth by harnessing local resources.

Thermal Energy Networks provide an opportunity for us to build, own, and operate community-scale energy projects in Vermont.

VERMONT COMMUNITY THERMAL NETWORKS

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How Thermal Energy Networks Are Key to Successful Electrification

Harnessing, moving, and sharing the heat we already have can help us electrify our buildings efficiently, affordably, and reliably.

Decarbonizing Vermont's buildings is essential to achieving our climate goals.

To meet our state-mandated emissions reduction targets, we need to heat and cool buildings without using fossil fuels. Electrifying our heating systems has been identified as a core strategy to reduce greenhouse gas emissions. As widespread electrification will increase the demand on our electrical infrastructure, keeping electric heating as efficient as possible is critical to reducing the impact of significantly greater electric use.

Thermal Energy Networks can help lower demand on the electric grid and avoid over-building costly electricity infrastructure, making electrifying heating and cooling more affordable and reliable for everyone.

Ground Source Heat Pumps and Electric Use

Thermal Energy Networks use Ground Source Heat Pumps (GSHPs) and underground pipes to supply highly efficient heating, cooling, and domestic hot water.

GSHPs function like Air Source Heat Pumps (ASHPs), but rather than drawing warmth from the air outside, they use stable temperatures from underground or waste heat extracted from large commercial buildings, refrigeration, and wastewater systems. Like ASHPs, GSHPs use electricity to extract and move heat to deliver both heating and cooling. However, because GSHPs use more constant temperature sources, they are highly efficient and require much less electricity.

GSHPs balance energy loads and reduce peak electric demand by:

- Using less electricity than other technologies.[1]
- Minimizing power drawn from the electric grid when paired with solar to provide the electricity needed to run the system.
- Allowing more electric grid capacity to be used for transportation and other decarbonization strategies beyond heating and cooling.
- Sending excess heat into the ground to store for later use.

When networked, GSHPs deliver even more benefits to the electric grid. Sharing thermal resources between buildings with different thermal needs means that less electricity is needed to provide the same amount of heating and cooling as an individual GSHP or ASHP. For example, a large grocery store with year-round refrigeration needs can create "free heat" for nearby buildings to use in the winter.

Understanding the Falcon Curve

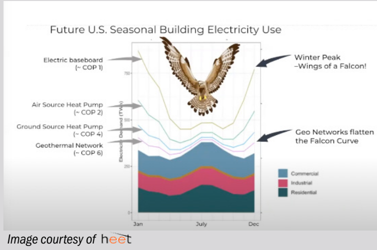

Image courtesy of heet

Using electricity for heating and cooling creates significant winter and summer demands—or peaks—that drive up costs and present energy system reliability challenges.

As we replace more gas, oil, and propane heating with electric systems, we'll increase those winter peaks. As the climate warms and we need to cool more buildings more often, we'll also create higher summer peaks.

The "Falcon Curve"[2] describes the seasonal increases that can result from electrifying heating and adding more cooling.

The graph models how energy peaks are influenced by different technologies, from electric baseboard heating (highest peaks) to geothermal networks (lowest peaks).

Among building electrification strategies, GSHPs and geothermal networks perform best at minimizing peak demand.

In colder climates, researchers expect winter peaks to be even higher than national averages, making flattening this curve even more essential.

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GSHPs Lower Electric Rates and Increase Affordability

Our electric system needs to be able to supply electricity whenever we need it, including at "peak" times. This means that we need to build a system which meets this "worst case" condition. Electric rates are determined by the difference between how much energy we use overall and peak demand on that system. Generally, a higher curve means higher rates and more expensive electric bills. The more we can lower peaks and the less electric infrastructure we have to build, the more affordable our electricity will be.

GSHPs are a key tactic to add to our strategy for successful electrification.

How do we know GSHPs can play a significant role in electrifying buildings?

A recent analysis of electrification strategies across Canada found that including GSHPs reduces the overall cost of electrification, particularly in more northern regions. The report by Dunsky Energy Consulting concluded that:

> *"While GSHPs will cost more upfront to install, the peak load and electric consumption benefits will often more than offset this additional cost."*
>
> *"GSHPs can provide significant benefits by electrifying space heating with much lower peak load impacts – especially in colder climates."*
>
> *"GSHPs can reduce the need to invest in expanded electricity infrastructure by a greater amount, leading to overall cost reductions."*[3]

Overall, the report found that "inclusion of GSHPs (in lieu of ASHPs) could theoretically cut an additional $357 billion from the price tag"[4] of electrification across Canada.

How can Thermal Energy Networks and GSHPs help us achieve a successful energy transition in Vermont?

Much of our electricity in Vermont is produced out of state. Thermal Energy Networks and GSHPs can reduce our need for importing energy and help us be more independent from fluctuating energy costs and markets. We can have more local energy, increasing reliability and resilience.

As we build more solar and other forms of clean electricity in Vermont, we can also add GSHPs in our buildings to reduce electric demand and more easily achieve our electrification goals.

As long as our electric supply continues to rely on sources that aren't renewable, adding more GSHPs in Vermont will help us reduce our use of electricity that isn't as clean as we need or want it to be.

Thermal Energy Networks and GSHPs will not be the best solution for every location in Vermont, but by installing and networking them where we can—in town centers and neighborhoods across the state—we can accelerate our emissions reductions, make energy more affordable, and contribute to a successful energy transition.

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[1] "The EPA reports that GSHP systems are 44 percent more efficient than air source heat pumps and up to 72 percent more efficient than electric resistance heating with standard air-conditioning equipment." https://www.cesa.org/wp-content/uploads/A-Vermonters-Guide-to-Residential-Clean-Heating-and-Cooling.pdf

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

[3] Dunsky Energy Consulting. Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), 2020, The Economic Value of Ground Source Heat Pumps for Beneficial Electrification. Pages 10-11. https://www.hrai.ca/uploads/userfiles/files/Dunsky__HRAI_Benefits%20of%20GSHPs_(2020-10-30)_F.PDF

[4] Ibid. Page v.

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Moving Heat

How Thermal Energy Networks recycle the heat we already have

As Vermonters, we take pride in braving the cold of deep, long winters, but many of us also appreciate the comfort of feeling warm on chilly days and cool in summer heat.

As our climate shifts and we experience more extreme weather, staying comfortable will become more difficult.

We have an opportunity to mobilize a local resource to meet this challenge.

The solution lies in how we think about heat—not only how we use it, but also how we *re*use it.

Heat is energy. We can capture it, move it, and repurpose it.

In our colder climate, we already put a lot of time, effort, and money into staying warm in the winter—stacking wood, insulating windows, filling fuel tanks, and paying heating bills.

Meanwhile, heat is purposefully vented from large buildings in our communities such as grocery stores, ice arenas, factories, and data centers.

This waste heat can be recovered in *Thermal Energy Networks* and recycled to keep our homes and communities warm.

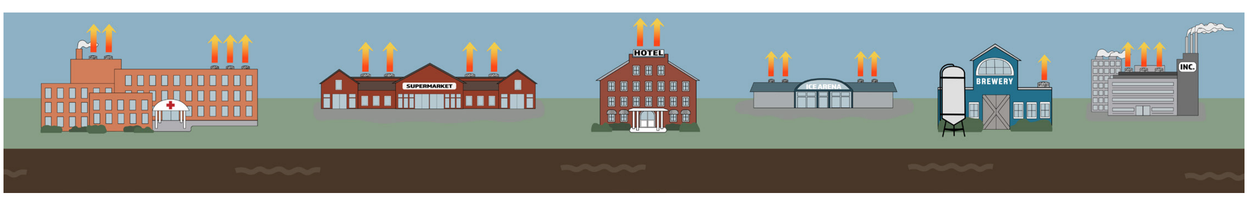
How it works:

Thermal energy can be harvested using standard heat recovery equipment and carried to buildings by water in a network of underground, horizontal pipes that not only share excess heat *among* buildings, but also capture the heat that's venting from buildings, adding it to the network.

These pipes form *closed loops* that move heat where it's needed.

Inside each building, a water source heat pump amplifies that moderate temperature water—about 50°F—to higher temperatures for space heating and hot water.

In the summer, the heat pump makes buildings cooler by rejecting unwanted heat back into the system or storing it underground.



We can see heat in a whole new way, then move it to where it's needed, and move us closer to our clean energy community goals.

To access the full How to Develop a Thermal Energy Network toolkit, please visit vctn.org/toolkit.

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WHERE TO FIND WASTE HEAT

To find existing heat in your community, look for:

- **Ventilation systems on larger buildings** such as hospitals, hotels, apartment or office buildings, schools, libraries, stores, bakeries, restaurants, and factories that use heat for production,
- **Large refrigeration or cooling systems** in ice arenas, grocery stores, cold storage facilities, data centers, telecommunications facilities, and manufacturing facilities,
- **Businesses or buildings that generate lots of wastewater** such as wastewater treatment plants, hotels and multi-family buildings, laundromats, large restaurants, and food production or other manufacturing facilities.

WHERE WE CAN USE WASTE HEAT

Excess heat can be recirculated to buildings within about ¼ mile of where it's vented.

For example, waste heat from a large supermarket refrigeration system could provide heat and hot water to about 15-30 nearby homes.

Exchanging heat between thermal energy resources and users can start small:

- An ice arena near a high school,
- A hospital and an adjacent senior housing complex, or
- A telecommunications facility next to an apartment building.

A Thermal Energy Network can include facilities or equipment that can store heat...

- Warm or hot water tanks,
- Ice storage,
- High-temperature energy storage, or
- Other advanced heat storage technologies.

. . . and incorporate other thermal energy resources:

- Solar panels—PV Thermal systems—can provide heat or accept rejected heat as well as create electricity needed to operate the network.
- Thermal energy from wastewater and/or geothermal borefields can provide heating, cooling, hot water, and storage, diversifying and stabilizing the network.

Thermal Energy Networks are working–saving both energy and money.

- An ice rink in Vancouver provides heat and hot water to nearby buildings—the equivalent of 43 homes—by sharing heat that's removed during the freezing process. Operating the ice rink refrigeration systems is two to three times more efficient and dramatically reduces fossil fuel use at buildings receiving the recycled heat.
- Another neighborhood in Vancouver is cutting greenhouse gas emissions from buildings in half and meeting about 70% of its heating and cooling needs by recovering heat from a wastewater treatment plant.

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Energy from Wastewater

Capturing and reusing thermal energy from wastewater systems

Considering a wastewater project?

Many Vermont communities are taking advantage of new levels of state and federal funding to install, expand, and/or upgrade local water and wastewater systems.

This is the time to add wastewater heat recovery.

About 50% of the energy we use in our buildings goes to heating, cooling, and hot water. We can provide a lot of that thermal energy by capturing and reusing the heat we currently send down the drain.

A wastewater heat recovery system fits in with other wastewater and water infrastructure, requires minimal space, and provides multiple benefits.

The technology is proven and low maintenance. The heat is free and available all the time.

Wastewater has energy. We can repurpose it.

We can recover heat from wastewater to make potable hot water and to heat and cool buildings.

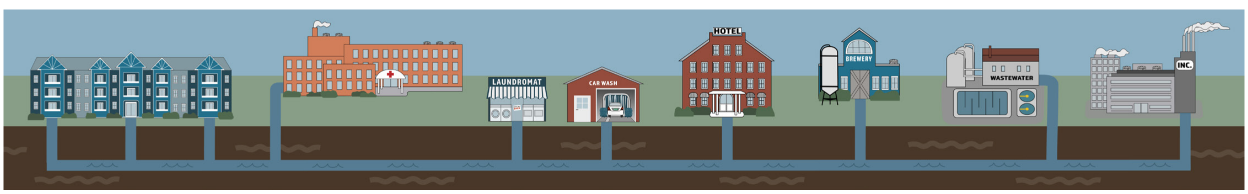
Wastewater can be a heat source or a heat sink, meaning that we can use its thermal energy to make heat and hot water or reject excess heat into the wastewater stream to make buildings cooler.

Wastewater is a continuous source of energy.

We take showers, wash dishes, and do laundry all year round.

- The average person uses 24-30 gallons of hot water per day at 120-140°F.
- Businesses and industries use a lot more water, often at higher temperatures.

That heated water is flowing down drains and out of our buildings as wasted energy and money.



No matter the region or time of year, wastewater exits a building at consistent temperatures.

- The average residential wastewater temperature is 70°F.
- Commercial and industrial wastewater can get up to 140°F or higher.

Even in winter, wastewater in underground sewer pipes carries heat that we can capture and reuse.

Wastewater at volumes we can use for heat can come from a wide range of buildings, including:

- Larger residential buildings such as apartments, student housing, or senior living.
- Commercial buildings such as hospitals, breweries, hotels, and even a car wash or laundromat.
- Industrial facilities that require water in their processes.

This heat can be captured within the building and reused for hot water or building heating and cooling. If it is carried away from the building, it can be captured later in the sewage system.

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Tapping local heat

To capture heat from wastewater that enters a sewage system, we can intercept it at a sewer line or as it flows into a wastewater treatment plant.

Getting energy we can use from wastewater

Wastewater heat recovery systems turn a sewer into a heat exchanger.

- The technology is simple, involving pipes, pumps, and holding tanks.
- The system is sealed and odor free, keeping wastewater separate from the water it heats.

How it works:

- Wastewater is routed into a holding tank that acts as a thermal battery and smooths out fluctuations in flow or temperature.
- Solids fall to the bottom and are flushed out.
- The warm sludge flows into a heat exchanger that works like any heat pump, compressing lower temperatures into usable heat.
- The extracted heat—just the heat, not the wastewater itself—is transferred to potable water in pipes for use as domestic hot water or to heat and cool buildings.
- The wastewater is piped back into the sewage system.

Reaping the benefits

While we work hard to improve our buildings, the wastewater line is one place where we consistently lose energy and money. By harnessing heat from wastewater, we can put that energy back into buildings, lowering our overall energy use, costs, and emissions.

- Inflation Reduction Act incentives make the installation of heat recovery systems a valuable addition to wastewater projects.
- The systems are low-maintenance and offer lower, predictable customer heating and cooling bills.
- Greenhouse gas emissions drop dramatically as the system harvests existing thermal energy.
- Highly efficient water source heat pumps use less electricity than other clean energy solutions.

Using heat that has already been produced and paid for reduces energy costs over time and creates overall savings. Some examples:

Neighborhoods

False Creek, a Vancouver community, is reducing emissions by 62% and saving 3,500 tons of CO_2 by repurposing waste heat. A network of underground pipes distributes heat to over 34 buildings and is expanding to serve other neighborhoods.

Leləm Village, an Indigenous-owned development in Canada, uses the municipal sewer line to create a thermal network. Each building uses a ground source heat pump to connect to the loop and provide heating, cooling, and hot water.

Single Buildings

A 247-room hotel in Alberta is cutting energy costs by 60% by recovering heat from wastewater from four industrial laundry machines. The system allows the resort to stop using 6,000 gallons of propane per year, reducing emissions by 35 tons of CO_2 annually.

A 60-unit development of townhomes in North Vancouver is saving homeowners up to 75% in energy costs per year, reducing fossil fuel use by 9,350 therms per year, and cutting emissions by 49.6 tons of CO_2 per year.

Installing or expanding a wastewater system is an opportunity to maximize thermal energy, cut costs, meet climate goals, and use the heat we already have to benefit our communities.

Visit www.vctn.org for more information

VERMONT COMMUNITY THERMAL NETWORKS

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Site Selection Chart

No two Thermal Energy Network (TEN) projects are alike, so there are many possibilities for good sites and successful systems.

The four charts below match categories listed in Site Selection for a TEN (p.16) and can help you inventory local buildings, identify thermal resources, and assess opportunities for a TEN.

- ***What to look for*** points out factors that can contribute to a good potential TEN site.
- ***What to know*** offers more detail that could help identify a site with even stronger potential.
- ***Your notes*** gives you space to track which factors apply to your potential site, add specifics, and collect questions.

Potential Thermal Energy Resources and Networks

	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
Potential Buildings	▶ Facilities and buildings that can be thermal energy resources and/or customers	*See TEN Opportunities Chart (p.9). May include IT centers, grocery stores (refrigeration), ice rinks, water infrastructure, and more*	
	▶ Buildings that require heating and cooling within ¼ mile or less of thermal energy resources and/or potential borefields		
	▶ Compatible heating and cooling systems	*Buildings that use oil or propane are a good value economically and environmentally to switch to a TEN.* *Steam systems in need of high-grade heat require more retrofitting.* *See Compatible HVAC Systems: vctn.org/s/Compatible-HVAC-Systems.pdf*	
	▶ Building conditions	*Energy efficient building construction and weatherization* *Electrical capacity available at panels, meters, and service*	
	▶ Resilience priority	*Spaces that serve as emergency shelters and/or provide essential services, e.g. municipal building, school, grocery store, library, senior or other congregate housing*	

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	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
Street Conditions and Rights of Way	▶ Capacity to lay pipe between buildings and to building mechanical rooms		
	▶ Rights of way available for street work and/or street crossings	*Work with Town staff and leadership to identify:* • *Planned street or rights of way openings for other/ related infrastructure work.* • *Rights of way free of conflicts with existing infrastructure.* • *Particular rights of way like railroad easements, state highways or interstates, or transmission corridors.*	
Complementary Projects	▶ Town plans to add or improve water and/or wastewater systems	*Check your Town Plan, Capital Improvement Plan, Local Hazard Mitigation Plan, and website.* *Check in with your selectboard or Planning Commission or other committees.*	
	▶ Current and future plans for residential or commercial development projects	*Check your Town website, talk with municipal staff/leadership like a zoning administrator, planning staff, selectboard, planning commission, and/or development review board.* *Talk to local developers and land owners.*	
	▶ Projects already in line for street openings, such as: Road or sidewalk repair, electric, cable, or other utility work *("Dig once" principle is most efficient, cost-effective)*	*Check your Town website.* *Call municipal staff.* *Review selectboard and other Town committee minutes (better yet, attend a meeting and ask in person during public comment).* *Check VTrans Construction Projects Mapviewer: tiny.cc/ vtrans-mapviewer*	

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Existing Infrastructure	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
	Places where branch sewer mains are collected into a larger main before entering the public right of way	*Offers higher, more consistent flow and volume for heat recovery*	
	Transportation facilities nearby that may serve as easily accessible rights of way or heat sinks or sources	*e.g. vehicle tunnels, bridges, stormwater channels, etc.* *Using rights of way for multiple purposes can save money and reduce the need to acquire dedicated TENs rights of way.*	
	Other renewable energy present and in use on-site	*Can be supportive of thermal energy storage and TEN development including but not limited to chilled water piping, cooling towers, water tanks, solar, or battery electric storage.*	

Geothermal Potential

Land Use and Feasibility	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
	Ownership and availability of land for geothermal boreholes and/or borefield(s)	*Municipally owned land, e.g. park, recreation field, or parking lot (check your Town Plan)* *Land owned by potential TEN customers*	
	Permitting and land use regulations	*Consider consulting the Permit Navigator (tiny.cc/vtpermit-nav) and contacting a Community Assistant Specialist (dec.vermont.gov/assistance/permits/specialists).*	
	Areas of environmental concern *These areas don't rule out a TEN, but do require additional planning and permitting.*	*Sensitive areas include wetlands, brownfields, or contamination areas. Check state map viewers like ANR Map Hub (gis-vtanr.hub.arcgis.com), DHCD Planning Atlas (tiny.cc/dhcd-atlas).*	

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	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
Geology & Hydrology	▶ State or regional geologic data and reports for the project location that show generally attractive geological conditions *A driller can provide a local assessment and general knowledge.*	*Existing test borings and geologic reports showing low depths to bedrock* *The presence of other high thermally transmissive rock strata, e.g. granite or other bedrock* *Underground water flow and other hydrologic conditions like aquifers* *The technically inclined can find this kind of detailed geologic information by region or town in the Vermont Department of Environmental Conservation's geologic maps and spacial data (tiny.cc/vtdec-maps).*	

Community Factors and Opportunities

	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
Participants	▶ Building owners willing to provide thermal energy		
	▶ Building owners willing to become TEN customers		
	▶ Current residents and/or businesses willing to engage in a TEN process		

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	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
Housing and Neighborhoods	▶ Range of housing unit sizes, as well as age, heating source, etc.	*For more information and guidance about your area, consult your Town or regional planner.*	
	▶ Inclusion of rental and affordable housing		
	▶ Potential for equitable distribution among different populations		
	▶ Mix of income levels in order to benefit a wide range of residents and businesses		
Workforce	▶ Availability of professionally certified workforce	*Drillers, installers, inspectors, and maintenance workforce*	
	▶ Worker compensations that qualify for prevailing wage incentives in the Inflation Reduction Act	*Unlocks additional tax incentives for a project* *See IRA Incentives for TENs (p.49).*	

Gas Service Territory

	WHAT TO LOOK FOR	WHAT TO KNOW	YOUR NOTES
Opportunities to Replace Gas Service	▶ Gas main and service lines in need of repair or replacement	*A TEN could displace fossil fuel use and avoid further investment in the gas distribution system.*	
	▶ Sites at or near the end of local gas distribution pipelines	*A TEN could be part of a strategy to decommission the gas system by working backwards from the distal ends to replace gas distribution without disrupting service across the system.*	

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Financing a Thermal Energy Network

Financing a Thermal Energy Network (TEN) is similar to capitalization for other infrastructure projects and has the same kinds of process, sources, and considerations.

Common questions include:

- **What funding is available to engage expertise and support pre-development work?**
- **What funding sources are available to pay for upfront capital costs?**
- **How will capital investments be recovered and over what timeframe?**
- **What return on investment is needed?**

Where to Seek Financing Support

In Vermont, three agencies or authorities are established by the state legislature to support specific kinds of development. These agencies have a long history of working with communities, organizations, and businesses to help access long-term debt financing, make local investments, and finance development projects across the state.

All of these agencies are aware of the potential of TENs to support their shared mission of leveraging low-cost financing to help our state and communities thrive. Each one has a different focus:

- **Vermont Economic Development Authority** (VEDA): Commercial and industrial development, sustainable energy projects in particular
- **Vermont Bond Bank:** Municipal infrastructure projects
- **Vermont Housing Finance Authority** (VHFA): Affordable housing development and equitable access to housing

In addition, local banking and credit union communities often support public benefit projects and may be a source of low-interest loans or other capital funding support.

What Kinds of Financing to Pursue

Financing any infrastructure project involves creating a *funding stack* of various sources of capital.

Project costs are funded through some combination of debt and equity. Permanent capitalization is a combination of original equity, permanent debt financing, and proceeds from tax credits or direct payments from the U.S. Treasury to entities eligible for this option.

Bonds: Municipalities are accustomed to issuing bonds to meet capital needs.

Grants: While federal, state, and local grant opportunities change over time, they can provide direct funding for a project.

Loans: Low-interest loans and/or patient capital allow for a longer return on investment.

Public-private partnerships: These collaborations apply particularly well to TEN projects involving municipal buildings and businesses or industry. Both public and private entities can be motivated to contribute funding, as all will benefit from the network by selling thermal energy resources, connecting to the system as customers, or both at once.

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How the IRA Can Play a Role

The Inflation Reduction Act (IRA) provides unprecedented federal tax incentives that apply to geothermal projects and TENs. See IRA Incentives for TENs (p.49) for information on maximizing incentives.

Elective Pay

Formerly called "direct pay" or "payment in lieu of tax credit," this provision in the IRA is a game-changer for municipalities, non-profits, and other non-taxpaying entities because the U.S. Treasury provides cash payments to eligible parties.

- A project owner receives the tax credits and contributes equity to the project. The 30% tax credit offsets the owner's taxes.
- A municipality or non-profit that is well capitalized can contribute funding and then receive a 30% cash refund.

Note: The project needs to be built before a tax credit or cash refund is received. The credits are available during the tax year the project is put into service.

Financing a project with IRA incentives may require a bridge loan to cover costs before incentives are received. Whether a project can take advantage of elective pay or not, all projects must be funded through other means until tax returns are filed.

Bridge Loans

A bridge loan can be a construction loan or other borrowing intended to cover a financing gap between when a project is underway and when permanent financing or incentives are available.

The bridge lender needs to be made confident that tax credits will be received or sold (banks and high income individuals often buy tax credits at a discount). To qualify for a bridge loan to fill the gap between when capital is needed and when tax credits are received or sold, a project needs:

- An accountant or legal opinion certifying that the project qualifies for elective pay or tax credits and will get a refund from the IRS,
- Lender awareness of other incentives available to the project, and
- A commitment from another entity, such as a bank, to buy credits once the project is complete to pay off a portion of construction financing.

How Financing Phases Match Project Phases

This chart pairs financing steps with project phases as outlined in What Does a TEN Project Look Like? (p.25) and illustrates how financing a TEN is achievable by developing a longer-term plan.

PROJECT PHASE	FINANCING CONSIDERATIONS
Exploration Phase	Work to develop a project concept can be provided by in-kind professional services and funded by grants, public/private partnerships, or capital on hand.
Planning, Design, and Permitting Phases	Feasibility and system design is covered by seed capital such as capital on hand or grants, but can also employ energy efficiency funds for specific tasks such as drilling a test borehole. Pre-development loans are possible at this stage, but often come with higher interest rates. Project financing will have lower rates, given greater certainty (feasibility, design, permitting in place).
GO or NO GO decision *If a GO, then pursue construction financing.*	All permits, authorization agreements, and customer agreements are needed before financing the construction phase of work.
Construction Phase	The construction phase is covered by a construction loan or interim debt. To secure a construction loan, a project needs long-term financing identified and a commitment from the lender. To close on this kind of loan, a project must also have: • All permits in place, • Customer contracts signed, • An equity source identified and secured, and • Equity spent or escrowed.
Operation Phase	Long-term financing or "permanent funds" can include: • Proceeds from tax credits/elective pay, • Long-term loan, and/or • Equity. Financing shifts to a sustainable business model so that revenues minus expenses can cover remaining debt.

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Notes for Municipally Sponsored Projects

Municipalities may have more financing options available depending on the design of the project and structure of the security used for repayment.

General Obligation

Financing backed by the *general obligation* of the community will have the largest market acceptance, as repayment is secured by the taxing authority of the community rather than TEN project revenues. This tool can be used to credit-enhance the TEN project, potentially allowing construction and permanent financing to be combined. However, a general obligation security pledge also means that any risk specific to the TEN project will not be isolated and will be borne by the entire tax base.

Revenue Bonds

In contrast to a general obligation security pledge, *revenue bonds* use the revenue stream from a TEN project as the exclusive source of repayment. This limits project risks for a community, but is a much higher risk for lenders. Revenue bonds typically require rate and debt service coverage covenants given the limited security for repayment of the debt.

Municipalities often treat utility-related revenue as "self-supporting" when using general obligation security for financing. This means that revenues from the utility are expected to be sufficient to cover related debt, but are not the exclusive source of repayment.

Inflation Reduction Act Incentives for Thermal Energy Networks

The Inflation Reduction Act (IRA) is a large federal legislative package passed in 2022.

Intended to accelerate clean energy development, this policy expands tax incentives, adds bonuses, and offers direct payment to qualifying entities and projects.

> *"The Inflation Reduction Act is the largest clean energy investment America has ever made, with strategic incentives to make the transition to clean energy and a decarbonized life easy and financially smart."*
>
> *—Rewiring America*
>
> *See Rewiring America's IRA fact sheets, rewiringamerica.org/ira-fact-sheets*

Thermal Energy Networks (TENs) qualify for unprecedented levels of federal incentives.

The IRA makes TEN development a "no-brainer," in the words of architects, engineers, and others with experience implementing geothermal and other kinds of thermal energy projects.

Through 2032, TEN projects are eligible for the highest incentives rates:

- 30% until 2032
- 26% in 2033
- 22% in 2034

There has never been a better time to leverage tax incentives for building a TEN.

This short guide lays out basic information about IRA incentives as they apply to TENs.

- As each project is different, maximizing tax credits will depend on the site, scope, ownership model, and other conditions.
- As the IRA is a complex set of documents and the IRS continues to issue guidance, there are more programs and project-specific opportunities than can be described here.

For more information and for tax advice, please consult with a tax partner such as an accountant or lawyer.

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Summary

The IRA applies to TEN development in three basic categories: tax incentives, bonus incentives, and elective pay.

1. Tax Incentives for TENs

Most TEN projects qualify for large tax credits up to 40% by combining two major incentives:

- 30% residential and/or commercial tax credits, and
- 10% bonus for domestic manufacturing content of many components.

2. Bonus Incentives for Qualifying TENs

Additional incentives are available for projects that include:

- Prevailing wage for construction workers,
- A maximum of 1 megawatt output of thermal energy,
- Low and moderate income housing, and/or
- Location within an energy community (see criteria below).

3. Elective Pay and Transfer of Credits

The IRA is a particularly helpful tool for managing the upfront costs of a TEN when the owner qualifies for elective pay—formerly known as "direct pay"—or for making use of tax credits that can be sold or transferred.

Elective Pay

The IRA allows some entities to use incentives as payment against federal taxes in the form of a refundable credit. After offsetting the entity's tax liability, any excess payment from the incentive will be refunded to that entity.

Entities with no tax liability that qualify for elective pay are tax-exempt organizations, electric co-ops, and state, local, or Indian tribal governments.

Transfer of Credits

For businesses and other entities with tax liabilities, IRA incentives are credits that reduce the amount of tax owed to the IRS.

The IRA also allows entities that are not eligible for elective pay to transfer tax credits. TEN owners can access the value of tax credits, monetizing them via sale or transfer. Often, tax credits are sold at a discount to entities or individuals seeking a reduction in taxes owed to the IRS.

Tax Credits for TENs

The IRA includes both residential and commercial tax incentives for TENs that provide 30% credits through 2032:

- Residential Clean Energy Credit (Section 25D)
- Investment Tax Credit for commercial installations (Section 48)

Also eligible are solar panels, solar thermal systems, and, beginning in 2023, battery storage systems that can be part of a TEN or paired with a TEN.

Distribution equipment such as ductwork or radiant flooring are not included.

Bonus for Domestic Content

An additional 10% incentive applies to most TEN components, as almost all are manufactured in the U.S. using domestic steel, iron, and other materials.

Details

Construction material made primarily of steel or iron must be 100% produced in the U.S.

To qualify for domestic content incentives, the adjusted percentage of components that must be manufactured in the U.S. increases over time:

- 40% for projects that begin construction before 2025
- 45% for projects that begin construction in 2025
- 50% for projects that begin construction in 2026
- 55% for projects that begin construction after 2026

Bonus for Prevailing Wage

To receive this bonus, projects must meet prevailing wage and apprenticeship requirements as laid out in the IRA.

Prevailing wage and apprenticeships are both best practices for TENs where possible, given workforce availability, union density, and certified training programs.

TENs are supported by many unions, including pipefitters and plumbers needed for much of the installation. Many skills needed for fossil fuel projects are easily transferable to TENs.

Bonus for a Maximum Project Output of One Megawatt

To support smaller TENs, projects that provide a maximum net output of less than one megawatt of thermal energy are eligible for an additional incentive of 2%.

For projects that also meet prevailing wage requirements, the bonus is 10% rather than 2%.

As of December 2023, the IRS has yet to provide guidance on how to calculate whether or not a project is under the one megawatt threshold.

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Bonus for Low and Moderate Income Housing

The IRA awards additional tax credits to projects that include low and moderate income housing.

The **High-Efficiency Electric Home Rebate Program** lays out income requirements and caps on incentives for equipment, such as $8,000 on water source heat pumps, a key TEN component.

Details

Income requirements:

- Only households making less than 150% of Area Median Income (AMI) are eligible.
- Households at 80-150% AMI are eligible for rebates of 50% of project costs up to measure-specific caps.
- Households at less than 80% AMI are eligible for rebates of 100% of project costs up to the caps.

Total home cap: $14,000

Additional caps:

- $8,000 for a water source or air source heat pump
- $1,750 for a heat pump water heater
- $4,000 for a main panel upgrade
- $2,500 for wiring
- $1,600 for insulation, air sealing, and ventilation
- $840 for an electric stove, cooktop, range, or oven
- $840 for an electric heat pump clothes dryer

Bonus for Projects in Energy Communities

A 10% bonus tax credit is available for TEN projects installed in *energy communities*. While two of the criteria for an energy community do not apply to most of Vermont, a brownfield site could mean a TEN is eligible.

Details

An energy community is defined as:

- A location that includes a brownfield site,
- A city with a certain population employed in or tax revenues derived from extraction, processing, transport, or storage of coal, oil, and natural gas with unemployment rates above the national average, or
- A census tract (or adjoining census tract) with a coal mine that has closed since 2000 or a coal-fired power plant that has closed since 2010.

Ownership Guide for Thermal Energy Networks

Introduction

Thermal Energy Networks (TENs) may be owned by municipalities, cooperatives, corporations, non-profits, and other kinds of organizations.

Different ownership models come with different advantages and challenges. One model may work for one project, but may not be feasible for another. Within one community, multiple TEN-owning entities may operate independently, and some may physically interconnect. TEN development is highly flexible, as are the ownership models that may spur new TEN projects.

Ownership Models vs. Business Models

An *ownership model* for who will own and operate a TEN creates a structure in which a *business model* can be identified. A business model covers how services are provided, revenue streams are established, costs are recovered, and systems are maintained or expanded.

TEN Services

A TEN provides thermal energy to multiple customers. Thermal energy may be provided via hot water for direct use in a building for space heating or domestic hot water, chilled water for direct use in building space cooling, or moderate temperature water for use by a water source heat pump within or adjacent to a building to produce space heating, cooling, and/or domestic hot water.

TEN Revenue and Cost Recovery Mechanisms

Operating a TEN generates revenue that can be used to recover upfront costs, to pay for ongoing services, and potentially to create a profit.

A business model can use one or more revenue streams and can recover costs via:

- A one-time connection fee for customers,
- A monthly user fee,
- A metered usage rate to determine how much thermal energy each customer uses and charge based on that amount (which can be based on gallons of water per minute pumped to a customer's water source heat pump), and/or
- A capacity fee based on peak use, set annually during the full system peak. This may also be set as a customer demand charge, which is based on the customer's annual peak usage whether or not this is coincident with the system peak.

While there are relatively established best practices associated with billing cost recovery mechanisms for TENs, billing metrics are established on a project-by-project basis and can depend on the needs of customers or owners.

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The Focus of this Ownership Guide

This guide describes three possible TEN ownership models and related opportunities:

- Establish or tie into an existing **municipal** utility.
- Set up a new **cooperative** or add TENs to an existing organization.
- Hire a **third party** to develop, own, and operate a TEN as a private enterprise.

For each model, we provide short lists of the main advantages and challenges as well as accompanying financial considerations. There are also questions you can use to explore which model works for your project or vision and a few examples that illustrate the model.

To learn about the role of investor-owned regulated utilities in TEN development, see Which Ownership Model? (p.20).

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Municipal Ownership

Municipal ownership of a TEN is similar to a municipal water or sewer department or other municipal corporations performing an activity on behalf of the municipality. Its structure and responsibilities are familiar to any municipality that operates shared infrastructure or hires a third party to own or manage it. Customers of a municipal TEN receive a bill similar to a water or sewer bill.

ADVANTAGES

1. Local control and regulation keeps decision-making in line with community priorities, and elected officials can be held accountable by customers.
2. Municipalities can enact zoning and planning to shape a network and can easily coordinate with broader economic development and decarbonization efforts.
3. Projects can be more equitable. Customers can be prioritized based on need rather than profitability, and decisions may not be influenced by investor pressure to deliver economic projects.
4. Access to existing resources, systems, and rights of way are already established, including access to some thermal energy resources (e.g. a wastewater treatment plant).
5. Municipalities have established stakeholder relationships and communication systems, and may already have the ability to manage and maintain a pipe network and bill customers (e.g. a water department).

CHALLENGES

1. Projects may be constrained by a lack of technical expertise among elected officials and municipal staff, as well as limited capacity, budget, and bonding ability.
2. Pace can depend on local politics, leadership priorities, and capacity. Planning periods may not align with political cycles.
3. Substantial outreach and education may be needed to pass a bond or authorization vote where required.
4. Project development may encounter hesitation to expand the municipality's liability. As municipalities are not usually accustomed to taking on market risk, systems that depend on growth for financial feasibility may broaden the risk profile of municipalities. These perceived risks may make it politically difficult to advance a municipally owned TEN.

NOTES

Some drawbacks of municipal ownership may be reduced or eliminated through establishing a municipal corporation to implement TENs.

A **municipal corporation or special district** is an authorized entity with bonding capacity tasked with developing and completing a project. It has a separate governance structure with a board elected or appointed by elected officials.

The special district is separate from the surrounding municipality. Debt issued by the special district may benefit from tax authority but will not have the broad tax support of a municipality and is therefore a higher risk structure. Conversely, the surrounding municipality will be isolated from project risk.

Benefits of a municipal corporation or special district:

- Allows project development to happen faster because not every decision needs an official action by elected officials or municipal staff who may have other priorities.
- Tasked with completing a specific project and may have more autonomy to get it done outside political cycles and considerations.
- Can be financially advantageous by creating dedicated operating and capital budgets separate from municipal general funds, with TEN revenues dedicated to supporting operations or expansion.

QUESTIONS TO CONSIDER

1. What is the political viability of embarking on TENs development?
    - Does the community support spending municipal resources on climate action or energy in general?
    - What existing policies, regulatory frameworks, or ordinances support or authorize action on TENs?
2. What is the financial viability of a TEN development?
    - What is the municipality's current bonding capacity and does the municipality have authority to bond for this purpose? Can a project receive bond proceeds if it serves a portion (and not the whole) of the town?
    - What financial risk is the community willing to absorb to support a TEN? Who takes on the risk of TEN investment — the entire town or just those that access the network?
3. What thermal energy resources exist, and which are under the control of the municipality?
4. Are there large anchor institutions or facilities located nearby that may benefit from or support the implementation of TENs?
5. What bandwidth does municipal staff have to dedicate to the exploration and development of a TEN?

Financing Considerations

Municipal ownership offers strong financing opportunities. Cities and towns have the authority and ability to raise money through taxation and fees. They also may have capacity to bond for infrastructure projects and access to low cost capital, though any borrowing for a TEN may have to be weighed against other projects planned by the municipality. Typically, borrowing capacity is limited to the political will behind raising revenue to pay for additional bond debt service.

With the Inflation Reduction Act (IRA), non-taxpaying entities such as municipalities can now take advantage of significant tax incentives. Municipalities qualify for *elective pay* (formerly "direct pay"), which allows for a direct payment to the municipality even though the municipality doesn't owe federal taxes. Towns can receive a check from the IRS for qualifying discounts on TEN installation costs. These discounts are direct subsidies and are modeled after the Investment Tax Credit (ITC) rules dictated in the IRA. Typically, a TEN project qualifies for a 30% federal subsidy under these rules. (See IRA Incentives for TENs, p.49, for more information.)

"Because of the Inflation Reduction Act, a local government that makes a clean energy investment that qualifies for the investment tax credit can file an annual tax return with the IRS to claim elective pay for the full value of the investment tax credit, as long as it meets all of the requirements including a pre-filing registration requirement. As the local government would not owe other federal income tax, the IRS would then make a refund payment in the amount of the credit to the local government." irs.gov/pub/irs-pdf/p5817.pdf

Examples

A majority of municipally owned TENs in North America are long-standing district steam or traditional high-temperature geothermal systems. Although TENs are a different technology, these examples show how a municipality can own and operate a district heating (and cooling) system.

West Union, IA: The City of West Union owns a geothermal network, completed in 2012 and operated by a local district energy LLC. Customers pay a monthly fee based on usage. The geothermal bores and a loop field are located under a green space and city streets. The City is exploring how to expand a project of 11 users to a network serving the larger community.

Jamestown, NY: A municipally owned high-temperature system moves heat from a municipally owned power generating station. Jamestown is a rare municipality that provides all utility services and regulates itself through its own Public Utilities Commission, separate from the New York State Department of Public Service.

Boise, ID: A non-profit operated thermal energy utility known as the Boise Warm Springs Water District has provided geothermal heating to residents and businesses since 1892. The system uses traditional high-temperature hot spring geothermal heat without the need for heat pumps. The largest district geothermal system of its kind in the world, it serves over 5.5 million square feet of conditioned space.

Nashville, TN: The Metro Nashville District Energy System is a traditional 4-pipe steam and chilled water district energy system owned by the City, managed by the City's water department and operated by Constellation Energy, a private third-party operator. The system serves large office, institutional, and entertainment buildings in downtown Nashville.

Other municipally owned district thermal systems:

- Tucson, AZ
- San Bernardino, CA
- Pagosa Springs, CO
- Hartford, CT
- Lansing, MI
- Hibbing, MN
- New Ulm, MN
- Rochester, MN
- Virginia, MN
- St. Louis, MO
- Buffalo, NY
- Akron, OH
- Klamath Falls, OR
- Manitowoc, WI

Cooperative Ownership

A cooperative ownership model requires joint control of a business entity owning and managing the TEN. Members may include both customers and suppliers of thermal energy to the TEN. Under a co-op model, any TEN profits are mutually shared.

ADVANTAGES

1. Self-governance and local control can help reduce potential conflicts or hurdles to implementing a project.
2. Equitable ownership and fair distribution of resources and benefits can help gain support for a project.
3. A place-based identity can enhance participation. In particular, a cooperative organization that has a local or grassroots origin can foster an organic sense of ownership and belonging to a project.
4. Membership is strengthened when interests are aligned in a virtuous cycle: e.g. an industrial or farm co-op of member manufacturers or suppliers.

CHALLENGES

1. It may be difficult for a co-op to source enough members or launch the entity with local members.
2. Identifying a consistent lead member or leader over time would be limited to local members and could be harder to maintain.
3. Co-op buy-in may be expensive for individual members.
4. Cohesive membership and unity can be difficult to sustain over time. Member behavior may jeopardize a co-op's existence or its ability to cooperate with local government.

NOTES

A co-op may be a for-profit or non-profit composed of individual members and/or member entities. It can provide a diversity of members by including both the thermal energy resource owner and thermal energy users. The co-op model can also influence the scale of a TEN, as a cooperative may be easier to manage as a smaller entity and:

- Better suited to serve a portion of a town versus all residents and businesses, and
- More likely to grow organically over time rather than as part of a strategic decarbonization plan.

QUESTIONS TO CONSIDER

1. Does the community have an anchor institution or organization that could lead or launch a co-op?
2. Does the community have a history of similar co-op activity?
3. What thermal energy resources are under the control of a potential co-op member?
4. What sources of financing and borrowing capacity exist with potential co-op members?
5. What is the collective political power of potential co-op members?

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6. Are co-op members and possible thermal energy resources located on contiguous parcels to avoid crossing public rights of way?

Financing Implications

Selling shares and diversifying a risk profile by including a diversity of members can help to raise capital for TEN project development.

Examples

Examples below show cooperative ownership of district steam systems rather than TENs, but provide illustrations of how a co-op model can work for thermal networks.

Rochester District Heating Cooperative, NY: A non-profit, customer-owned district heating system provides steam to customers who also own a stake in the system. The steam pipes serve existing buildings in Downtown Rochester and have provided heat for new development in its service territory.

Pittsburgh Allegheny County Thermal, PA: A customer-owned district heating system serves the core of downtown Pittsburgh. A central power-generating plant delivers steam to nearby buildings, providing heat, hot water, and in some cases, cooling to customers.

Third-Party Ownership

Third-party ownership models include TENs constructed, owned, and managed by private, non-municipal entities that are often hired from outside a community. These can include either for-profit or non-profit organizations that specialize in developing and managing infrastructure. Some companies offer "turnkey" service, covering an entire project from conception through feasibility, design, financing, construction, and management.

For the purposes of this guide, third-party ownership does not include businesses incorporated by municipalities (see section on Municipal Ownership).

ADVANTAGES

1. Third-party companies may be able to act faster than more politically invested entities, as they tend to operate with fewer decision-makers and more objectivity.
2. Entities hired to develop and/or operate a TEN are often located outside of the community and can function mostly outside political or other government constraints.
3. Third parties include and/or subcontract the expertise needed to develop, construct, and manage a project.
4. Entities that offer services from project conception to completion can provide a more seamless transition to operation and can be more flexible in terms of transfer of ownership or management.
5. A third-party owner that exists as a public benefit corporation or mission-driven non-profit may more easily align values and interests with a host community.

CHALLENGES

1. A third-party owner that is unregulated but functioning as a de facto monopoly may set or increase customer fees without factoring in customer ability to pay.
2. Decision-making may be opaque to customers and the community, as the level of transparency is up to the company.
3. As a third-party entity is more likely to originate outside a host community, it may see itself as less accountable to that community.
4. Third-party ownership may be in jeopardy if project economics offer lower profit margins over time.

Challenges Specific to For-Profit Entities

- A for-profit owner's drive to create returns for investors can result in lack of customer trust.
- With less local control over providing equitable service throughout a town, decisions may be driven by a company's needs or profit motive rather than the public good.
- Capital returns for investors draw money out of a host community rather than fostering reinvestment (unless the for-profit entity is hosted locally and it or its affiliates conduct no other business elsewhere).

Challenges Specific to Non-Profit Entities

- Non-profits without a source of recurring revenue may encounter the perception that they are reliant on outside funding and may therefore seem less reliable.
- Non-profits can also be perceived as having less expertise or lower quality leadership than a for-profit entity can attract.

NOTES

Third parties may be regulated by a state Public Utilities Commission or by a local government. Each form of regulation likely requires public utility designation by the state legislature or municipal leadership.

- Third-party TEN providers need authorization by municipalities to access public rights of way, unless access is granted by private entities on and between privately-controlled properties.
- A third party that enters into private, bilateral agreements with other third parties, avoiding public rights of way, is unlikely to become a regulated entity.

Currently, most third parties for TEN ownership are for-profit entities. Non-profit third-party entities are emerging. Some third parties begin as unregulated, then become regulated utilities.

QUESTIONS TO CONSIDER

1. Do the conveniences of third-party ownership outweigh the benefits of municipal or cooperative ownership?
2. How does the expectation of investor returns on a TEN impact the community?
3. For a particular third party: Are TENs the entity's core business? What other work does that entity do that profits may be supporting? Are there conflicts between local values or goals and the third party's or its affiliates' other business (e.g. climate adverse activity)?

Financing Implications

Third parties can seek TEN development and construction capital from a variety of sources including grants, private equity, tax equity, etc.

- A third party with tax equity appetite can take advantage of federal or local investment tax credits to assist with underwriting a project.
- Grant funds, which are generally more available to non-profit rather than for-profit entities, can potentially lower customer fees.

Non-profit entities may have more difficulty raising capital to install or expand a system. With no profits for investors, they have less access to investor capital markets.

Examples

Toronto, ON: Enwave, a private for-profit corporation, operates a district cooling system which provides cooling services to a multitude of buildings in the city's downtown core. The network contains a deep lake water cooling system whereby summer building heat

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is rejected to the bottom of Lake Ontario, which provides a consistent temperature throughout the year. Enwave is exploring opportunities to convert the system to a TEN that would provide both heating and cooling through the year.

Chicago, IL: CenTrio provides district cooling services to 53 million square feet of building space in the densest part of downtown Chicago. The system includes a large bank of ice storage, allowing CenTrio to shift when electricity is used to provide cooling, reducing electric peaks and costs by avoiding peak usage.

Syracuse, NY: Syracuse University partnered with CenTrio under a 40-year concession agreement to upgrade, maintain, operate, and manage the campus' district heating, cooling, and electric systems. The company is exploring ways to expand the system beyond the campus and into surrounding neighborhoods.

Project Phases for a Thermal Energy Network

Steps and Services to Coordinate and Oversee TENs Development

See What Does a TEN Project Look Like? (p.25) for an introduction to project phases and charts summarizing the Thermal Energy Network (TEN) development steps and services detailed below.

1. Exploration

Collect ideas for how a TEN could be built, owned, and operated in your community.

ACTIONS

- Form a working group or owner team to develop a project concept.
- Identify potential thermal energy resources and large anchor customers.
- Assess budget and personnel capacity to support a TEN project.
- Consider how a TEN fits within existing town and regional plans and/or other infrastructure plans that intersect with potential TENs development, such as:
  - Capital improvement plans,
  - Plans for growth and development, and/or
  - Bylaws/zoning/land use re: specific strategic sites, affordable housing plans, etc.
- Evaluate political support for a TEN project, including for authorizing an entity to develop a TEN. Does a municipal corporation already exist that could develop or own a TEN?

PROCUREMENT

Procurement for services needed to develop a TEN is done in stages across a project from pre-design through construction. Assembling the most qualified and cost-effective team requires effective contract management.

Request for Information (RFI)

Find out who has ideas to help solve project problems.

Request for Qualification (RFQ)

Find out what expertise and resources companies have to offer to the project team.

Requests for Proposals (RFPs)

Find out how much it will cost to engage project team members to satisfy timelines.

- Construction consultants: related to permitting, environmental permitting, energy modeling
- Construction contractors: electrical, mechanical, plumbing, construction project manager
- Engineering, Architecture, and Construction providers

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STAKEHOLDER & COMMUNITY ENGAGEMENT

- Identify stakeholders and local champions, including technical experts, community experts, interested and impacted community members, and developers.
- Engage key project partners and expertise needed to help develop the TEN plan.

BEST PRACTICES

- Map out thermal energy resources within a geographically focused area to understand opportunities.
- Site visits: Invite local champions and potential project partners to tour buildings with an engineer or energy expert and learn how the facilities might function as thermal energy resources and/or customers.
- Evaluate potential ownership models (p.20) for financing implications, cost-effectiveness, and stakeholder impact.
- Identify other parties that may be interested in collaborating on TEN development.

2. Planning

Flesh out ideas and build a business case for the project.

ACTIONS

- Define TEN scope and prioritize potential sites:
  - Catalog numbers, types, and sizes of buildings and thermal loads.
  - Identify waste heat sources and thermal supply.
  - Create a conceptual system design as the basis for a feasibility study in the next phase by pairing viable thermal energy resources with potential customers.
  - Map possible project stages.
- Articulate non-energy and non-financial benefits that apply to your project to help identify funding opportunities and stakeholders. See The Benefits of Thermal Energy Networks (p.33) and How Thermal Energy Networks Are Key To Successful Electrification (p.34).
- Consult legal expertise.
  - Municipal: What do the town charter or bylaws allow re: creating a TEN utility?
  - Private developers: What are the rights of way?
- Conduct a high-level economic assessment.
  - Engage a tax accountant to identify IRA incentives (p.49) that match the project plan.
  - Consider incorporating adjustments to the project plan to maximize tax incentives and leverage IRA benefits.
- Secure seed capital for project development.

PROCUREMENT

- Assemble the core project team or hire a third-party TEN developer to include:
  - Project development: finance and project management, design engineers, architect as necessary,
  - Technical analysis, and
  - Construction management.
- Consult with environmental permitting and energy modeling experts.

STAKEHOLDER & COMMUNITY ENGAGEMENT

- Engage and educate owners of buildings.
- Consider how to engage building occupants or renters.
- Share the project concept with the community.

BEST PRACTICES

- Engage a procurement and contract manager for all of the design and construction.
- Ensure that RFPs or contracts include project team member involvement in the Operations phase to guarantee their availability as needed. Reiterate in project specifications document. Reserve time and money.
- Clarify how the project concept will provide adequate and timely financial returns and/or fit private developers' and investors' expectations.
- Consult State and municipal permitting laws and assess how permitting will impact the project timeline.
- For municipal projects:
  - Understand which boards should be consulted, when they meet, and how to get on their agenda. Boards often meet monthly and are volunteer-based. Ask to be added to their agenda and provide materials well in advance.
  - Convene a design review board (can be part of selectboard work/meetings).
  - Consult town plan and local land use bylaws, zoning, and environmental regulations.

3. Design

Confirm that a TEN project can happen—get to a *"go"* or *"no go"* decision.

ACTIONS

- Perform feasibility study to include an analysis of the technical and economic viability of extracting heat from a particular thermal energy resource and serving a particular customer(s). The level of detail required depends on whether or not investment decisions are being made based on the outcome of the feasibility study (e.g. investment grade analysis).
- Integrate stakeholder feedback to maximize co-benefits.
- Confirm the buildings and facilities involved, size the system, and plan construction phases.

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- Present feasibility study results to the full project team and stakeholders and make a *"go"* or *"no go"* decision.
- After a *"go"* decision is made, pursue project financing.
- Engineer preliminary system design, including:
    - Piping, equipment, and installation cost estimate (based on user loads, heat sources, and equipment capacities),
    - Preliminary energy analysis and system sizing, and
    - Economic analysis including financing models and grants/incentives.
- Review preliminary design with the full project team, stakeholders, and community.
- Begin seeking local approval of the project including filing state and local environmental and construction permits.
    - Speak with the local building department to better understand the specific permits needed for your particular project.
    - Consider consulting the Permit Navigator (tiny.cc/vtpermit-nav) and contacting a Community Assistant Specialist (dec.vermont.gov/assistance/permits/specialists).
- Incorporate feedback and finalize detailed system design, including:
    - Plans and specifications,
    - Detailed energy analysis and HVAC design sizing, and
    - Project budget and financing.

PROCUREMENT

- Finalize contracts with the core project team members: Architecture / Engineering / Construction / Environmental & Permitting Consultant.
- Bid contracts for additional project team members:
    - Project management,
    - Design engineering,
    - Project estimators,
    - Project permit expeditors, and
    - Construction management and contracting.

STAKEHOLDER & COMMUNITY ENGAGEMENT

- Seek stakeholder and community responses to feasibility study results.
- Demonstrate how feedback has been included in project design.

BEST PRACTICES

- Conduct feasibility studies only after key TEN participants are on board and seed capital is secured.
- Check that designs and plans provide full details so all contractors can follow plans exactly. As construction contractors focus on delivering what's in design documents, if designs are vague, contractors rather than TEN designers/engineers will make decisions.

TEN Design and Engineering

Designing a TEN requires knowledge of ground thermal properties, ability to determine piping configurations for connecting multiple customers and waste heat producers, and understanding the pumping needed to move heat.

This work requires an HVAC mechanical engineer with experience in district heating systems, the predecessors to TENs. This engineer will develop energy models and sizing calculations for individual customers, thermal energy resources, and the system as a whole.

Drilling contractors are another integral part of the engineering process. They work with a mechanical engineer to calculate and size the system's ground loop heat exchangers. During the drilling process, with adequate measurements, the depth of wells can be adjusted based on actual conditions.

4. Construction

Concept becomes reality. Ensure the project meets design goals.

ACTIONS

- Work with construction management to oversee the project and coordinate subcontractors.
- Engage an environmental specialist as an active member of the team to identify potential impacts on wildlife and community well-being, as well as seasonal issues depending on construction season.
- Bring in a commissioning agent or owner's representative to make sure the project achieves its goals and to identify ways to save money.
- Schedule construction activities in accordance with permitting timelines, and engage contractors once phases are permitted.

PROCUREMENT

- Identify and acquire a project or construction manager who can bring in the various trades and contractors needed to build the TEN.
- If a general contractor, construction manager, or project manager is not managing the full project construction procurement, identify and acquire additional trades and contractors as needed.
- Plan for equipment and materials procurement if these items are not included in the scope of the general contractor, construction manager, or project manager.
- Schedule materials purchases in alignment with the start of construction.
- Stage construction equipment and materials to align with construction permits. Procurement is an iterative process, and some equipment has long lead times.
- Track payments to contractors to ensure smooth project schedules.

STAKEHOLDER & COMMUNITY ENGAGEMENT

- Create on-site opportunities to educate the public: Install didactic signs and/or construction "peepholes" to invite the community into the process. Include how the system works, where money goes, and shared benefits.
- Share information frequently through various channels, including with the local energy committee and, for example, in school presentations, library forums, and site visits.

BEST PRACTICES

- Meet frequently with partners: Communicate early and often on key workflow stages.
- Use a design-build project delivery model which keeps the same people involved throughout the process; this is best for coordination and communication and minimizes contracting level of effort.
- Keep the community and neighbors aware of potential disruptions caused by construction including street openings and traffic routing.
- Provide regular briefings to local government and other stakeholders who might assist with disseminating information to community members.

5. Operations

Foster positive customer experience. Track and share project outcomes and data.

ACTIONS

- Implement a sustainable business model in which revenues from the TEN minus expenses can cover remaining debt with some cushion. Depending on the ownership model, the plan for revenue generation and recovering upfront costs will vary.
- Implement billing and customer services, including new customer onboarding.
- Contract and/or train maintenance and emergency repairs personnel.
- Create plans for training and maintenance.
  - Make sure facility managers are trained to do this work.
  - Include in the preventative maintenance contract who will conduct needed trainings and maintenance, as well as who will cover costs.
- Commission TEN system: Test and validate system performance.
- Track data on costs, energy use, and emissions reductions. Share results publicly.

PROCUREMENT

- Identify and hire operations and maintenance staff needed to manage a reliable system.
- Acquire a meter reading and billing agent to assist with billing for the thermal energy provided by the TEN, unless this function is already provided by an existing participating utility.

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STAKEHOLDER & COMMUNITY ENGAGEMENT

- Install permanent signage to educate occupants and visitors about the project and its benefits.
- Celebrate successes and explore future possibilities with TEN participants and the community. Interview TEN participants and create opportunities to share stories and information about the project, performance, benefits, and potential to expand the system.

BEST PRACTICES

- Keep project team members involved in the Operations phase (e.g. construction contractor site visits):
  - Save scope, reserve time and money, and
  - Reiterate in project specifications document.
- Validate system performance through off season testing and post occupancy testing (12-18 months) to ensure energy savings persist and equipment is maintained.
- Share project data to demonstrate transparency and build knowledge within the community and across the industry.

Project Phases Chart

Use these charts to identify and keep track of steps specific to your project.

- *See the corresponding charts in* *What Does a Thermal Energy Network Project Look Like? (p.25)* *for suggested steps and best practices.*
- *For a deeper dive, see* *Project Phases for a Thermal Energy Network (p.63).*

1. Exploration → 2. Planning → 3. Design & Permitting → 4. Construction → 5. Operations

Collect ideas for how a TEN could be built, owned, and operated in your community.

ACTIONS	
PROCUREMENT	
STAKEHOLDER & COMMUNITY ENGAGEMENT	
BEST PRACTICES	

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1. Exploration | **2. Planning** | 3. Design & Permitting | 4. Construction | 5. Operations

Flesh out ideas and build a business case for the project.

ACTIONS	
PROCUREMENT	
STAKEHOLDER & COMMUNITY ENGAGEMENT	
BEST PRACTICES	

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ACTIONS	

PROCUREMENT	

STAKEHOLDER & COMMUNITY ENGAGEMENT	

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1. Exploration | 2. Planning | 3. Design & Permitting | 4. Construction | 5. Operations

Foster positive customer experience. Track and share project outcomes and data.

ACTIONS	
PROCUREMENT	
STAKEHOLDER & COMMUNITY ENGAGEMENT	
BEST PRACTICES	

To access the full How to Develop a Thermal Energy Network toolkit, please visit vctn.org/toolkit.

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Thank you for your interest in Thermal Energy Networks.

Please share your questions, thoughts, and requests for more information at info@vctn.org.

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This guide was developed by Vermont Community Thermal Networks in consultation with and including valuable contributions from the Thermal Energy Network Team supported by Energy Action Network.

The team formed in 2022 to accelerate neighborhood-scale decarbonization in Vermont by:

- Building a coalition to co-create a strategy for TENs,
- Exploring multiple ownership models to make TENs available to more Vermont communities, and
- Creating tools & resources to support TEN projects.

The team includes:

- Vermonters with expertise in regional planning, town energy committees, engineering, and environmental law, and
- Representatives from Central Vermont Regional Planning Commission, Efficiency Vermont, VEIC, Vermont Economic Development Authority, Vermont Bond Bank, Energy Action Network, and VGS (Vermont Gas Systems).

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