



Exploring a Thermal Energy Network for Cambridge Neighborhoods

September 29, 2026





Agenda

01.

Intros and Info Session Goals

- Meet the project team
 - Desired outcomes from today
-

02.

Project Overview

- Climate impacts in Cambridge
 - City’s approach to reducing carbon pollution
-

03.

What is a Thermal Energy Network

04.

Feasibility Study

- Conceptual study site
- Design considerations
- Economics and ownership

05.

Next Steps and Discussion

- Review and Respond to Questions

01. Introductions + Info Session Goals

Info Session Goals

- Learn about the City's commitment to decarbonization
- Understand the purpose and scope of the Thermal Energy Network feasibility study.
- Understand the major findings of the study: What would it take to build a geothermal-based thermal energy network pilot project in Cambridge?

Housekeeping

- This meeting is being recorded, and slides will be posted on the Thermal Energy Network website
- All participants will be muted
- Questions can be submitted throughout the entire meeting through the Teams Webinar Q&A
- Prompts for interactive questions through Menti
- Q&A after the presentation

Project Team



CITY OF CAMBRIDGE
Office of Sustainability

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Rob McKenna



Dallase Scott

Azanta Thakur

MENTI ENGAGEMENT

Let's learn about who is joining us today!

02. Project Overview

Climate goals

Why Thermal Energy Networks?

Project scope

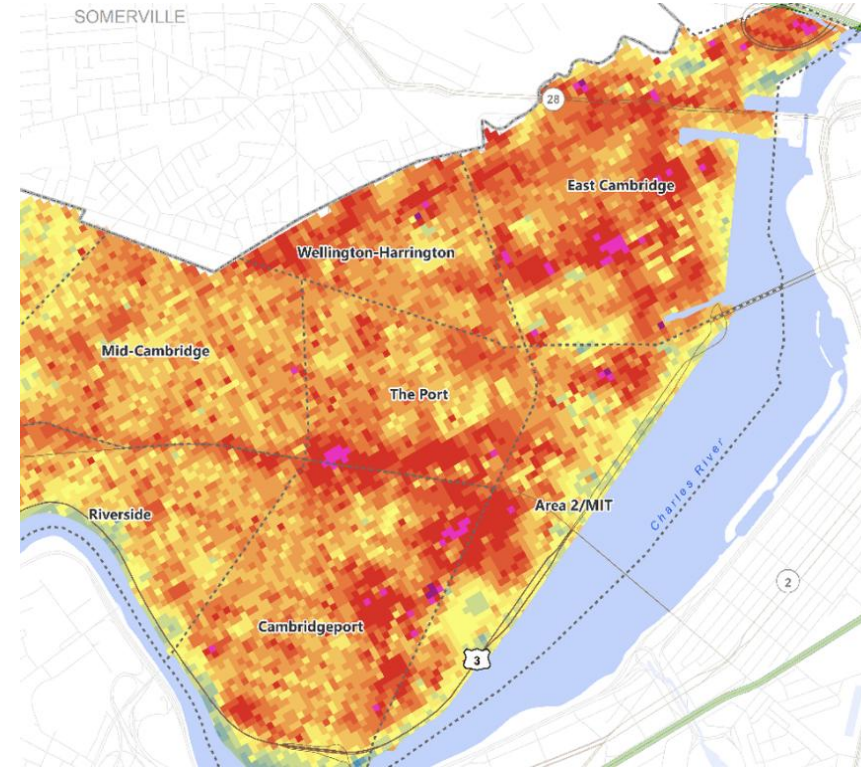
Protecting Our City

The problem:

- Burning fossil fuels releases pollution (carbon) that warms the planet.
- For Cambridge residents, that means greater risks from **extreme heat** and **flooding**.

What Cambridge is doing:

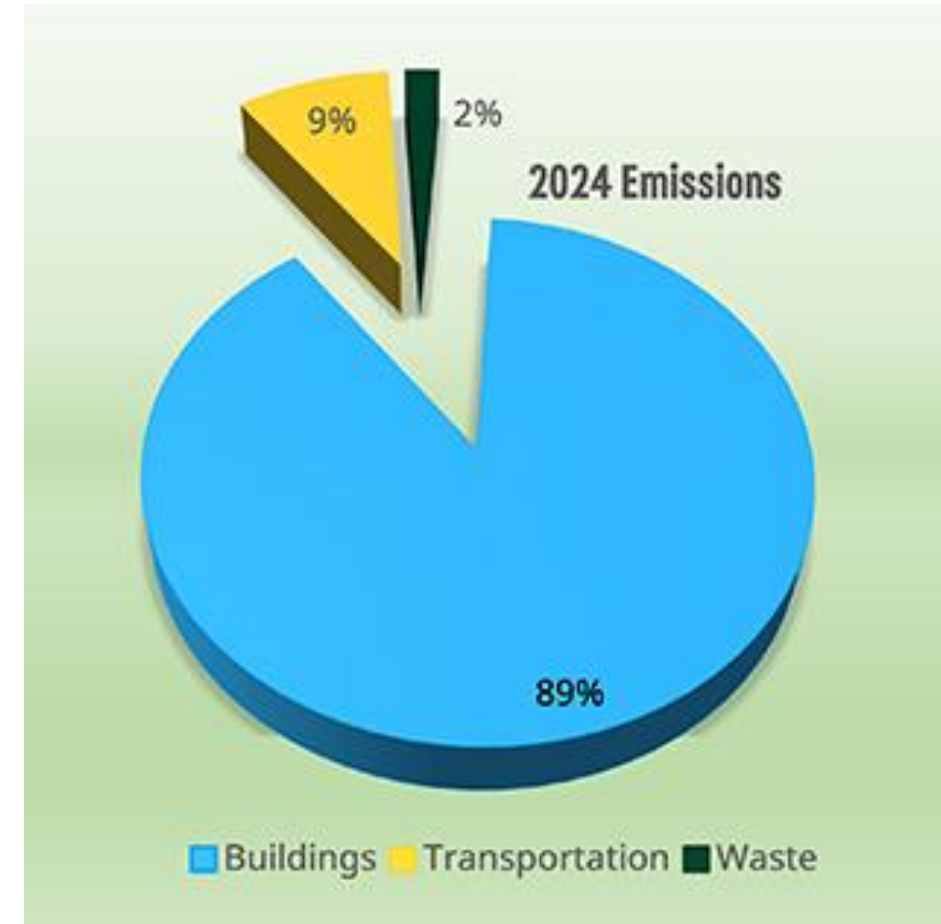
- The City is committed to cutting this pollution in **half by 2030** and reach **net zero by 2050**.



Buildings & Pollution

Heating and cooling buildings have a big climate impact:

- **89 percent** of greenhouse gas emissions in Cambridge are from building construction and operations.



Buildings & Pollution

2023 Net Zero Action Plan

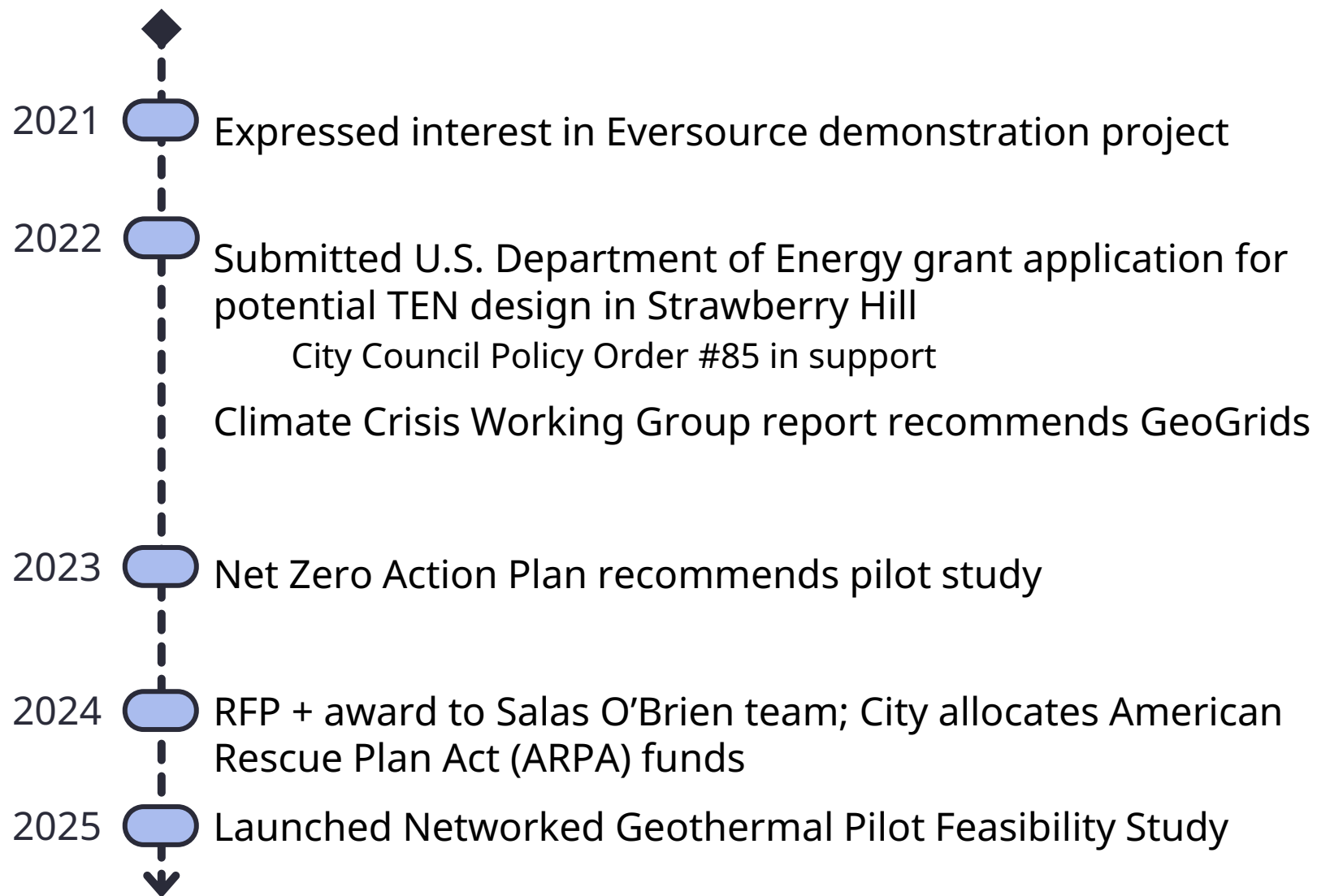


To explore low-carbon district energy technology for heating/cooling

Goal: Complete a feasibility study for a pilot geomicrodistrict

Action Area 1: Energy Efficiency	
1	Action 1.1 Custom Retrofit Program for Residential
2	Action 1.2.1 BEUDO Performance Requirements
	Action 1.2.2 BEUDO Resource Hub
3	Action 1.3 Upgrades at Transaction Points
Action Area 2: New Construction	
4	Action 2.1 Net Zero Requirements for New Construction
5	Action 2.2 Address Embodied Carbon through Green Building Requirements
6	Action 2.3 Net Zero Requirements for Municipal Buildings
Action Area 3: Energy Supply	
7	Action 3.1 Carbon Free Energy Supply
8	Action 3.2.1 Rooftop Solar Requirements
	Action 3.2.2 Community Solar Access
9	Action 3.3 Off-site Renewable Electricity Access
Action Area 4: Financing and Capacity Building	
10	Action 4.1 Local Carbon Fund

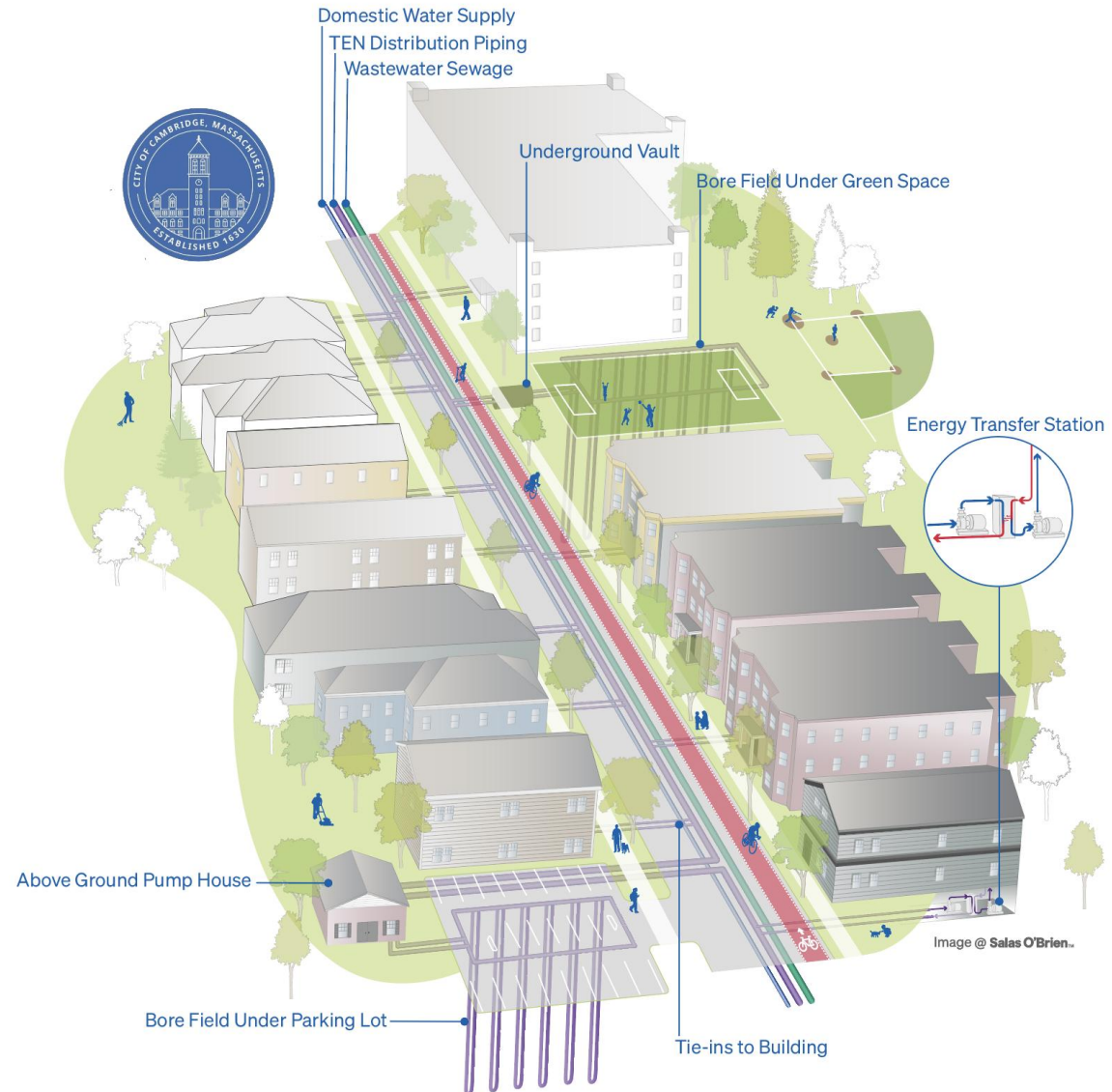
Background on City's interest in TENs



03. Thermal Energy Networks (TENs)

Big Picture Breakdown of a geothermal-based TEN

- ▲ Ground
- ▲ Pipes
- ▲ Buildings
- ▲ Whole network



THE GROUND

The ground naturally holds steady temperatures usually around 50–60°F all year



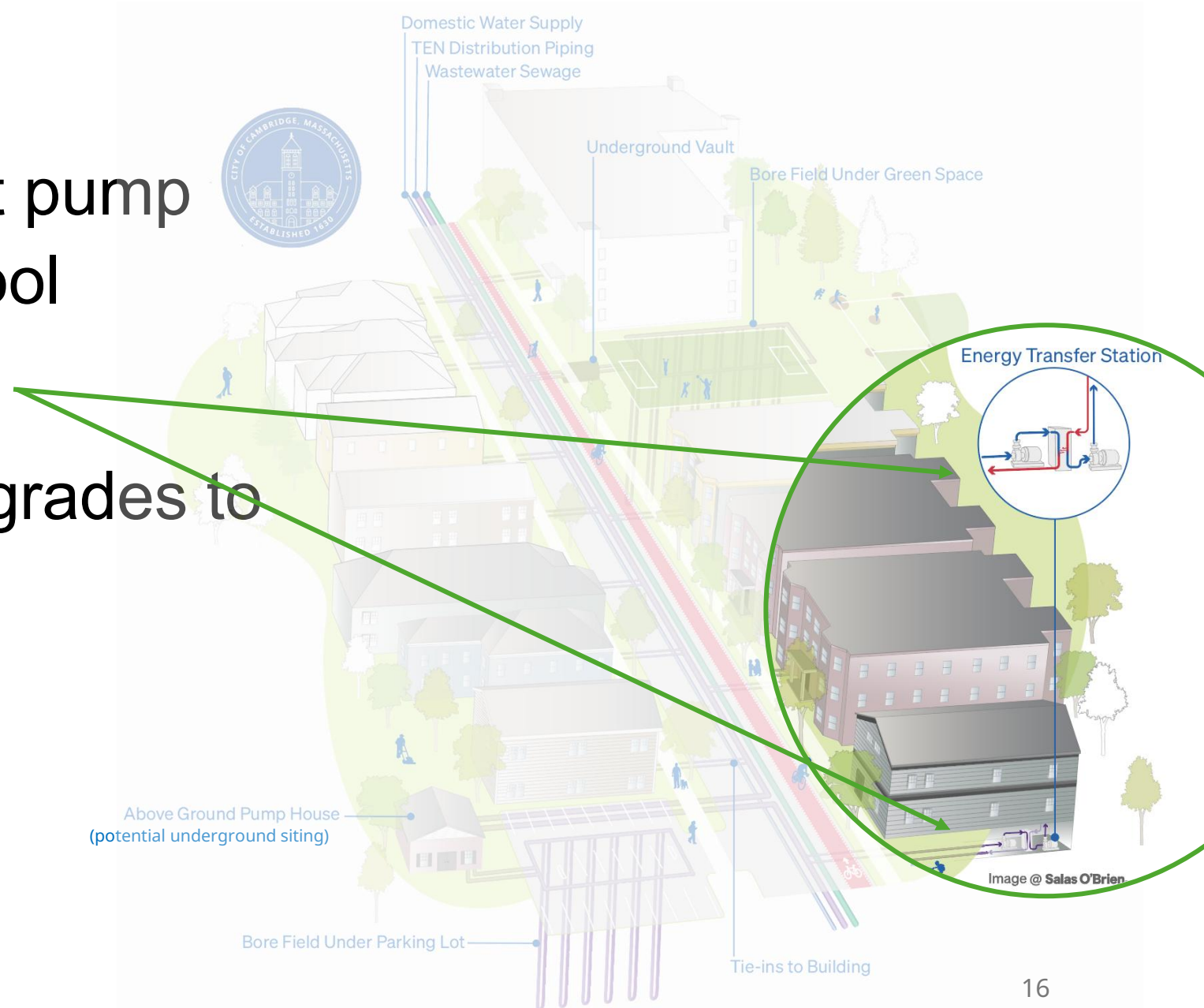
UNDERGROUND PIPES

Underground pipes filled with water connect multiple buildings through neighborhoods



BUILDINGS

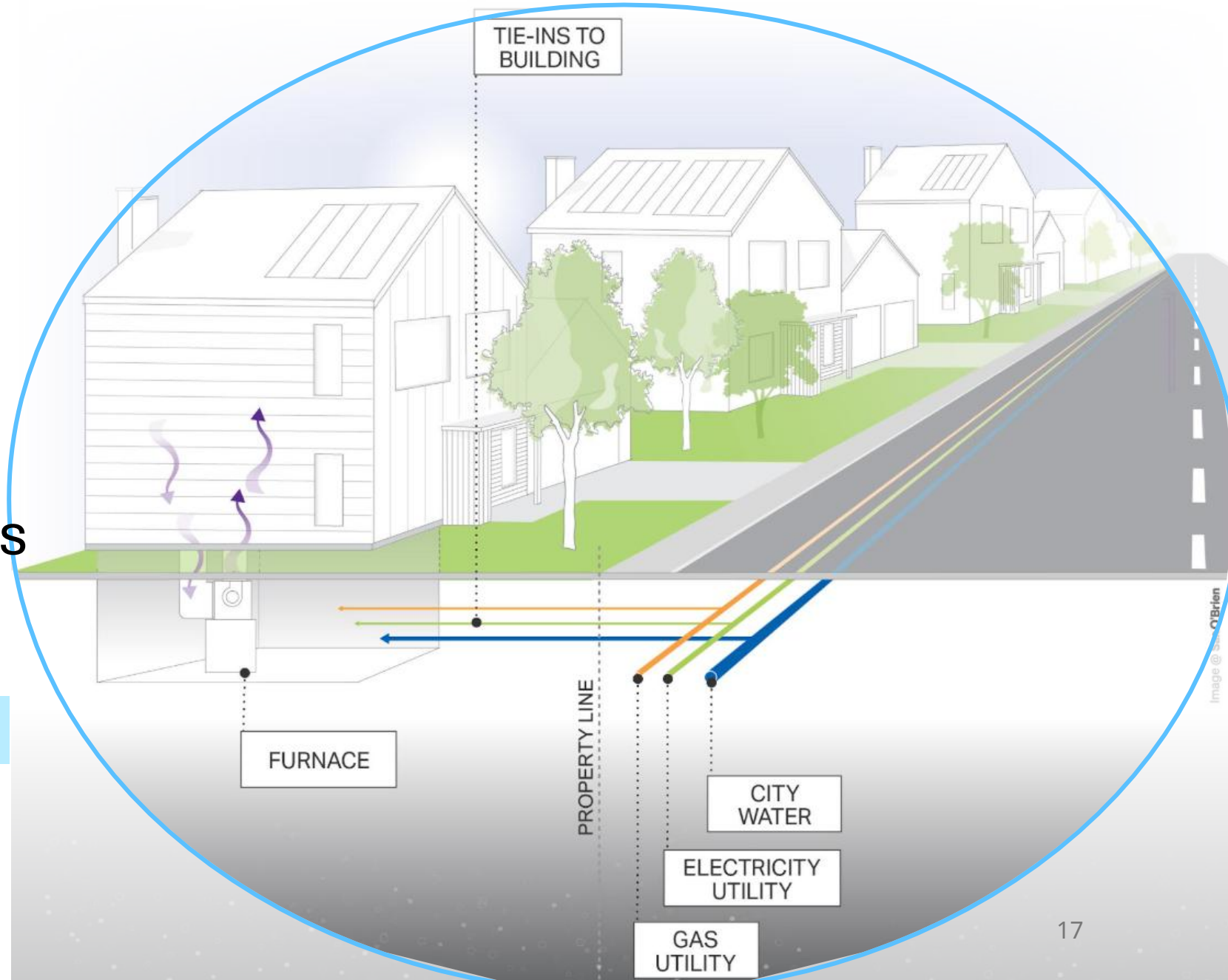
- Each building uses heat pump technology to heat or cool buildings.
- Most buildings need upgrades to connect to the network.



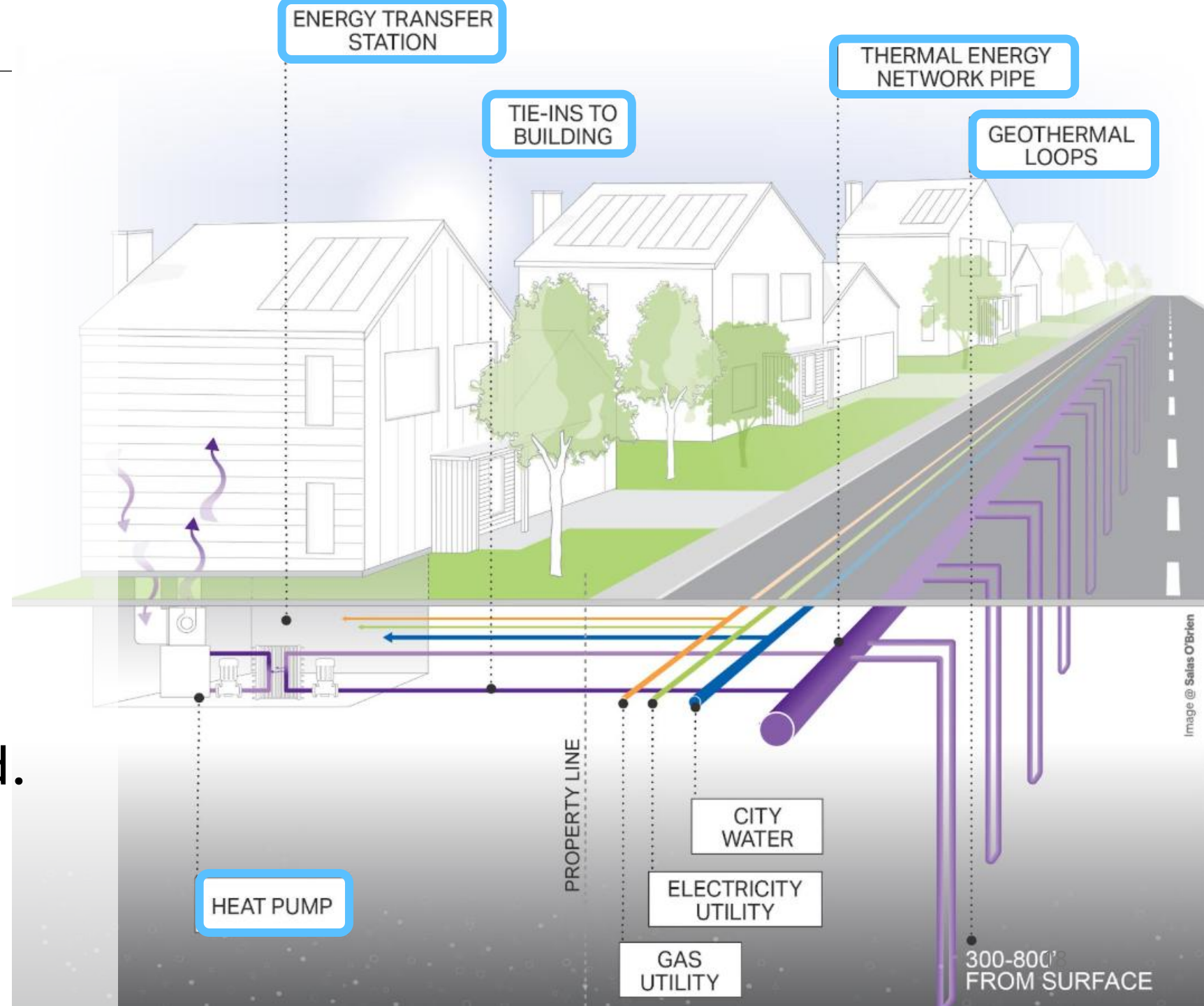
Thermal Energy Networks are **like systems you already know.**

Just like water, electricity or gas pipes connecting homes:

Shared infrastructure + individual connections

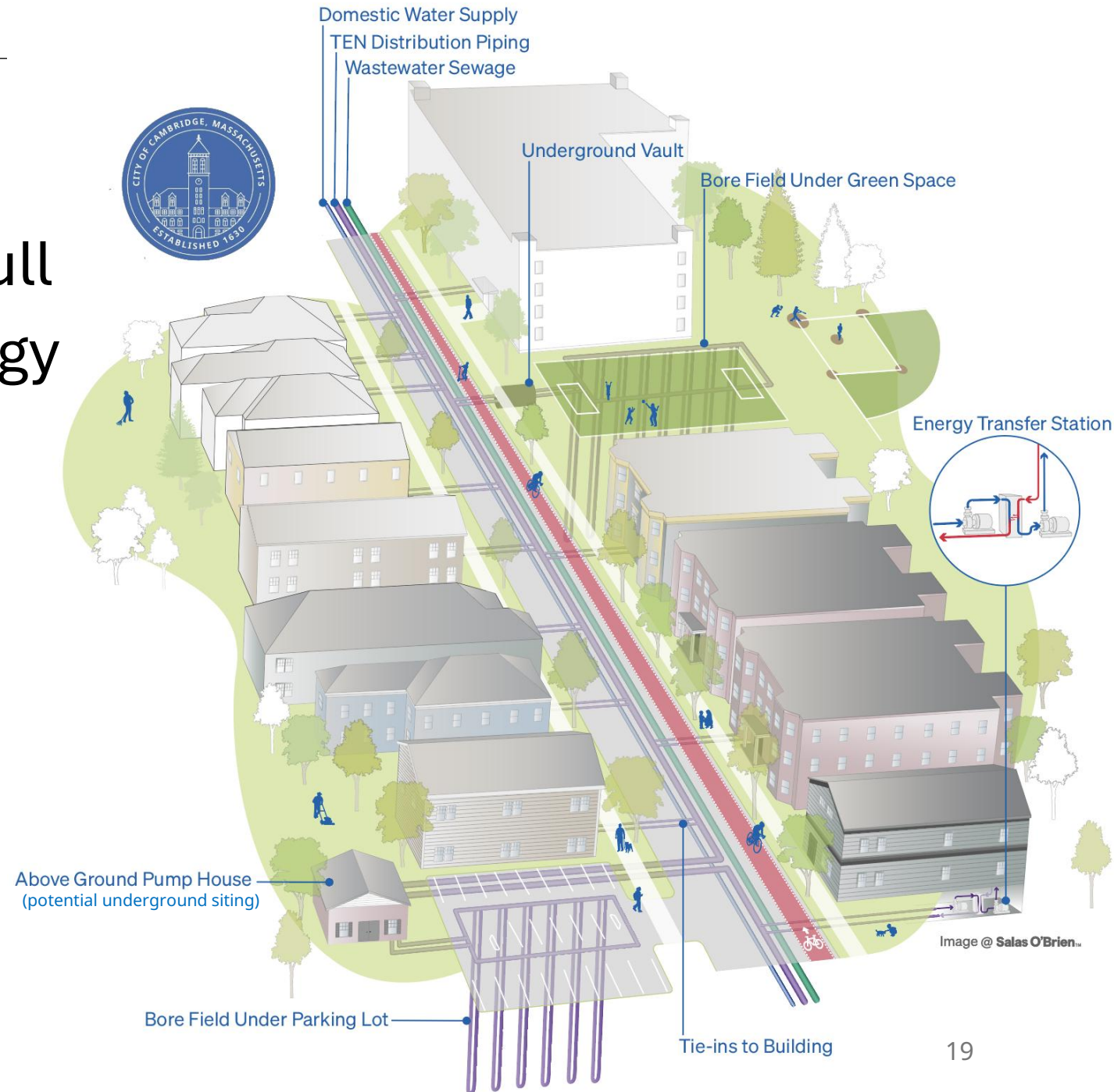


Thermal Energy Networks connect buildings to shared energy underground.

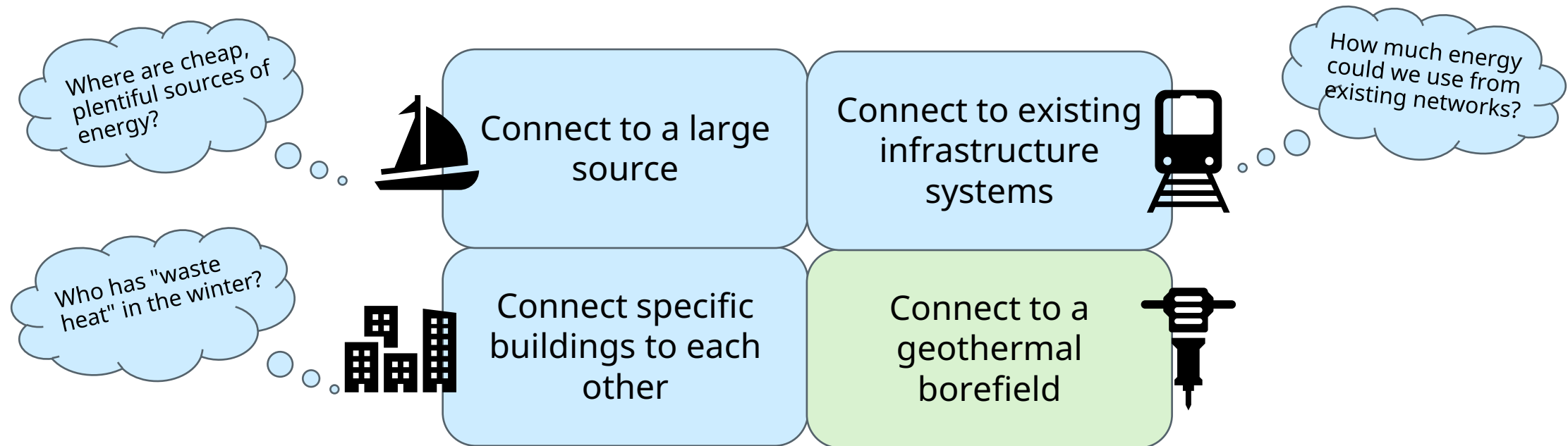


WHOLE NETWORK

- ▶ In winter, most buildings pull heat from the thermal energy network.
- ▶ In summer, buildings send excess heat back into the thermal energy network.



Ways to network thermal energy

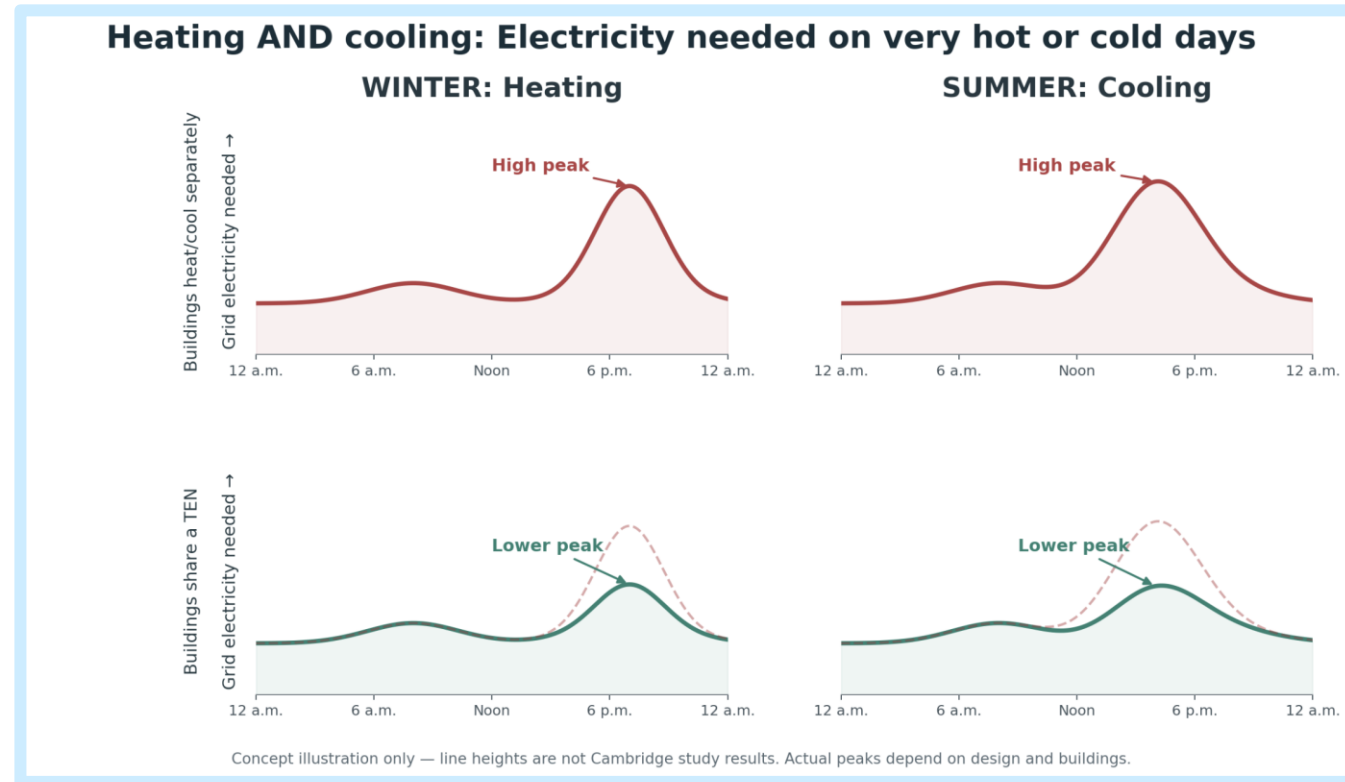


All easier with higher performing buildings. More insulation = less heating/cooling needed

Why should we explore TENs?

TENs have promising benefits, including:

- High efficiency energy -> lower building emissions
- Potential for neighborhood-scale impact
- Lower peak demand than full electrification

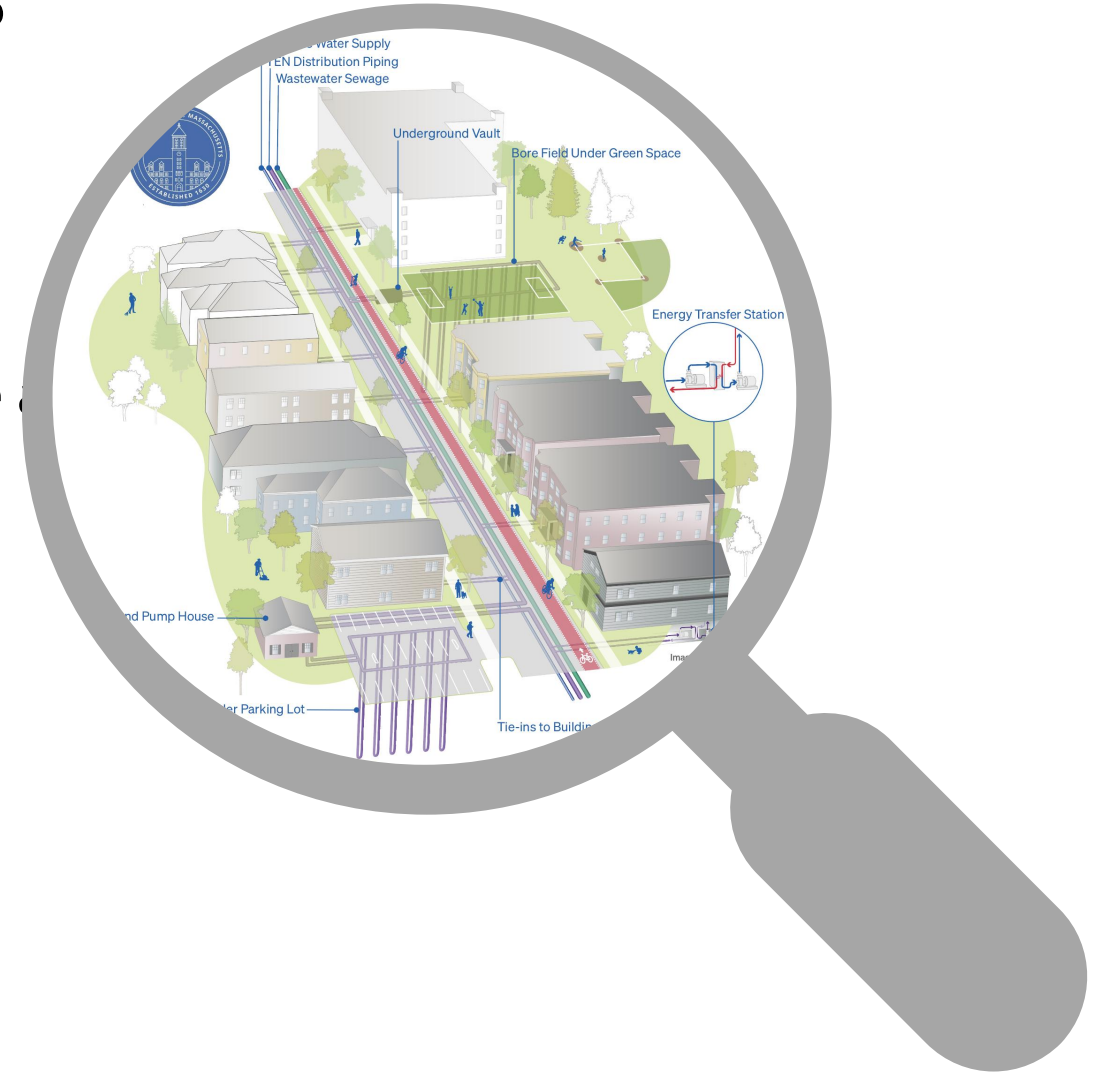


Why did we study neighborhood-scale, geothermal-based Thermal Energy Networks?

This study looked at **Cambridge's actual conditions in 2026:**

What would it take to design, build, and operate a pilot project for **replicable, neighborhood-scale thermal energy networks in Cambridge?**

- Infrastructure + geothermal borefield
- Building conversions + connections to network
- Ownership + operations



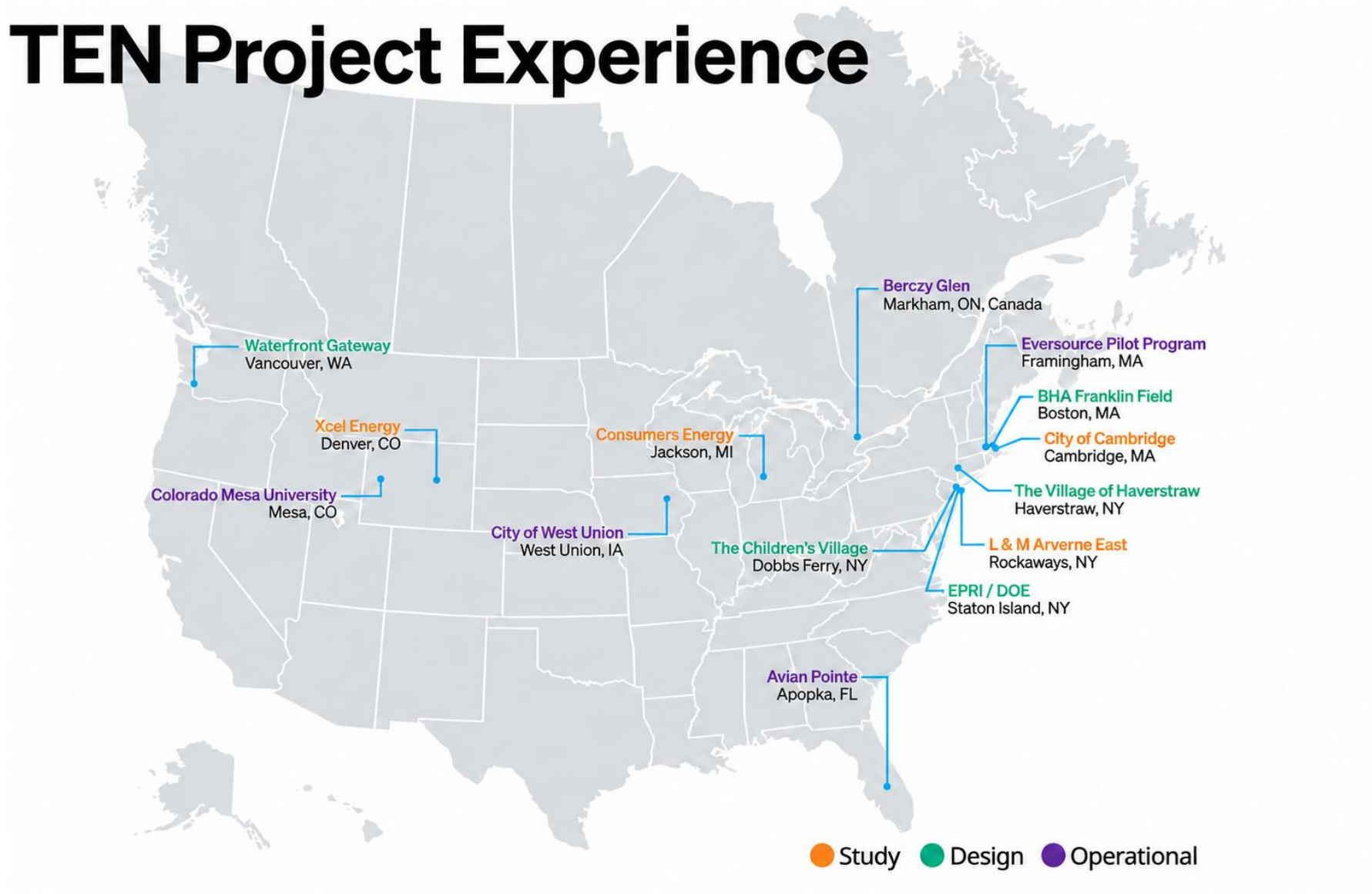
Geothermal technology is already in Cambridge

Cambridge has many buildings that are heated and cooled with ground-source heat pumps:

- King Open/Cambridge Street Upper Schools and Community Complex: 198 wells, 550' deep
- Historic Cambridge Fire Headquarters: 16 wells, 750' deep
- MLK School: 78 wells, 550' deep
- Tobin Montessori & Vassal Lane Upper Schools: 76 wells
- DPW Simard Building: 5 wells, 500' deep
- River Street Firehouse: 2 wells, 675' deep
- City Hall Annex (344 Broadway)



TEN Project Experience



04. Feasibility Study

Site selection

Ground loop

Building conversions

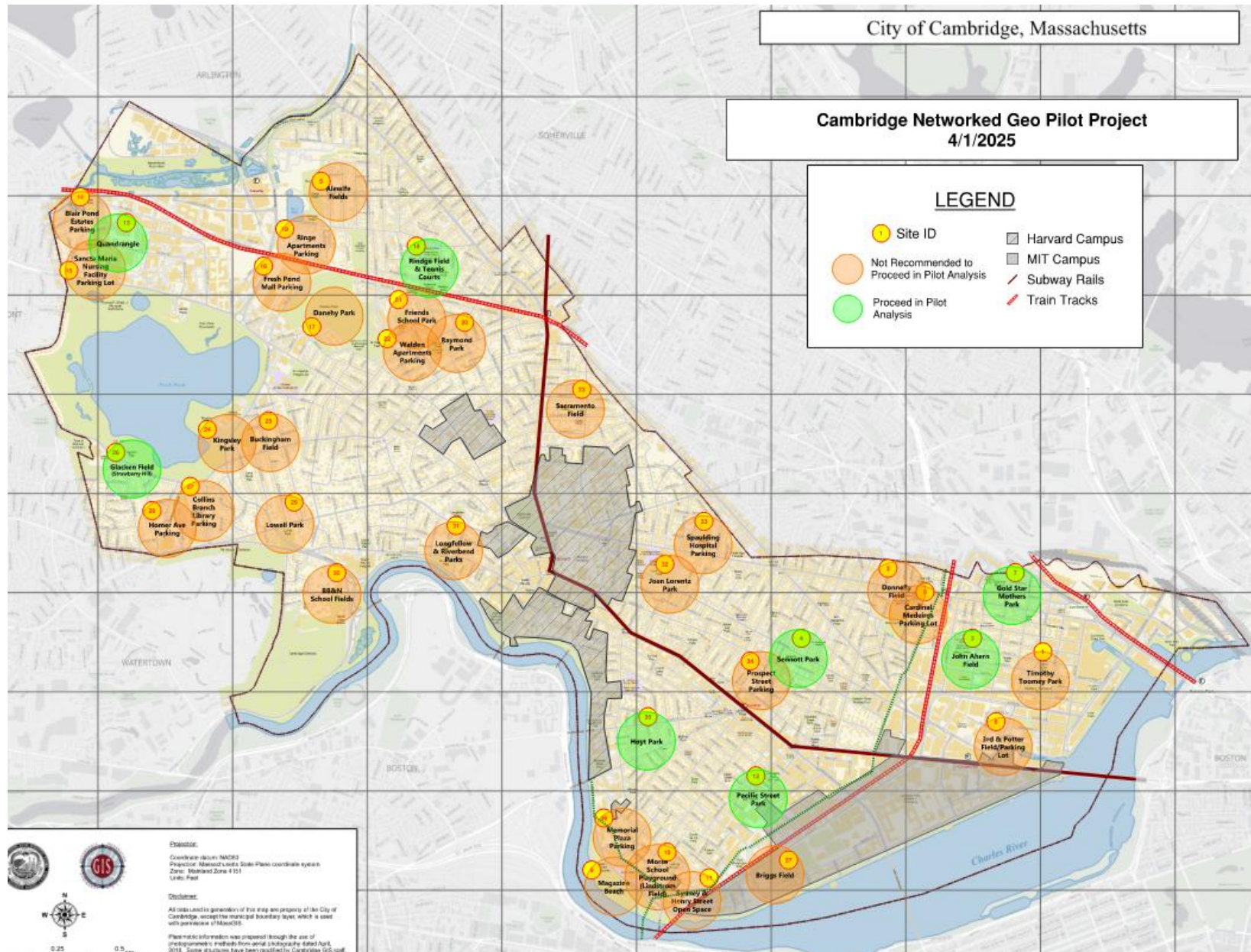
Economics + ownership



Site Selection

A closer look at opportunities throughout the City

Citywide analysis of potential sites



What makes a strong pilot site?

- **At least 1 acre of open space** (park or parking lot) available for geo-exchange (**limiting factor in Cambridge**)
- Applies to **multiple building types** in existing built areas
- Has **mix of uses** to support energy balance.
 - Heating and Cooling
- Supportive **anchor** customers
- **Scalable** and/or represents common opportunities in Cambridge and similar cities

Citywide analysis: highest potential sites are parks!

Screened 38 candidate sites down to 9. Land in Cambridge is so scarce and valuable that private open spaces and parking lots unlikely to remain for 50+ years.

Site	Uses and impacts	Potential anchors + participants	Energy + Balance
Pacific Street Park	■	■	■
John Ahern Field	■	■	■
Sennott Park	■	■	■
Gold Star Mothers Park	■	■	■
Morse School	■	■	■
Peabody / Rindge Field	■	■	■
Glacken Field / Strawberry Hill	■	■	■
Hoyt Field	■	■	■
Municipal Parking lot #14	■	■	■



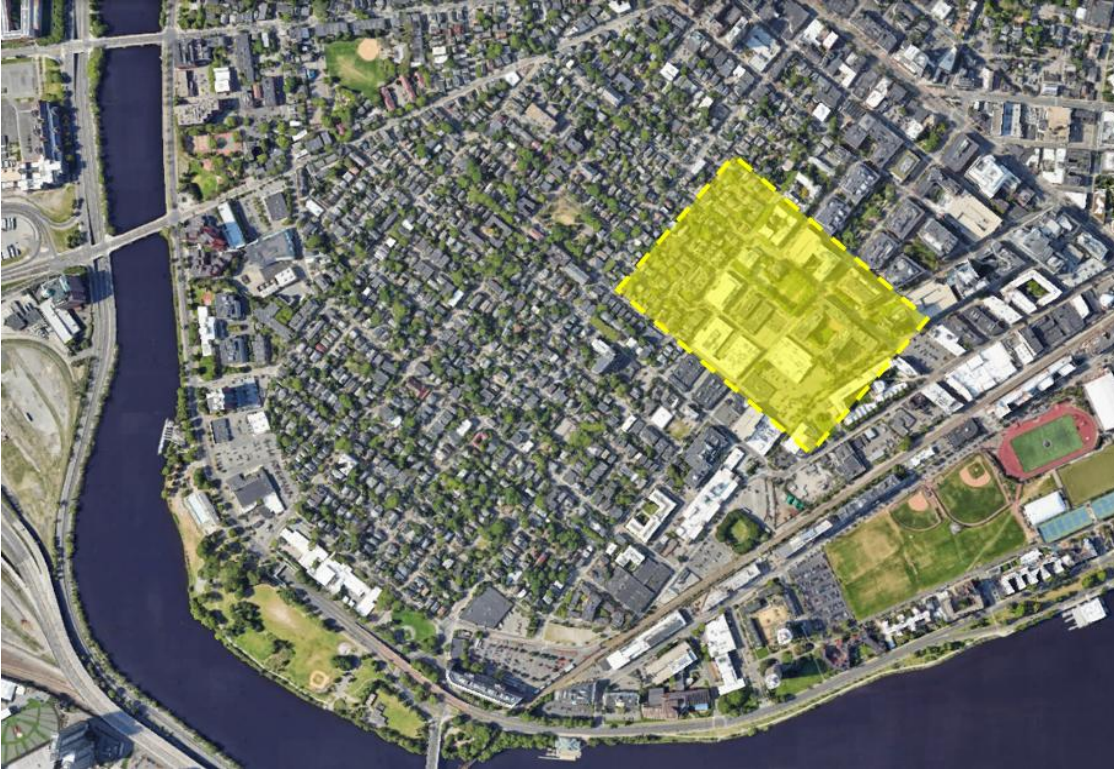
What we learned: Cambridge’s land and streets are full and busy

Several sites may be technically feasible, but none were ready to break ground .

Land	Few sites have an acre+ of available land. Many were recently renovated or are planned for other community priorities, which calls for deeper community engagement. Unlikely to have private parking lots for 50+ years.
Streets	Space under our streets is tight, with gas, water, sewer, stormwater, electric, and telecommunications infrastructure. Crossing major roads, MBTA Red line, and other systems limits a TEN service area.
Structures	Pumps need a building sized 20’ x 20-40’, or a costlier underground vault, if at a park.
Policy	Most candidate sites are protected as open space under Article 97, which requires a two-thirds vote of the Legislature. Changes are under consideration.
Ownership & operations	No clear owner-operator pathway to run a 50-year asset.
Economics	Covered next

So, we moved ahead with the feasibility study...

Conceptual Study Area: Pacific Street Park



Pacific Street Park

Open space for geo-exchange

Land that can be used for the geo-exchange system long-term (50 years) - Park protected as open space.
Playing field, dog park, and pathways.

Anchor Institution

Institution with significant thermal loads that expressed interest in a long-term TEN.

Opportunity to look at Rights of Way

Low-volume streets adjacent to park and nearby bike/ped pathway offered potential to examine borefield in City ROWs.

Diversified thermal loads

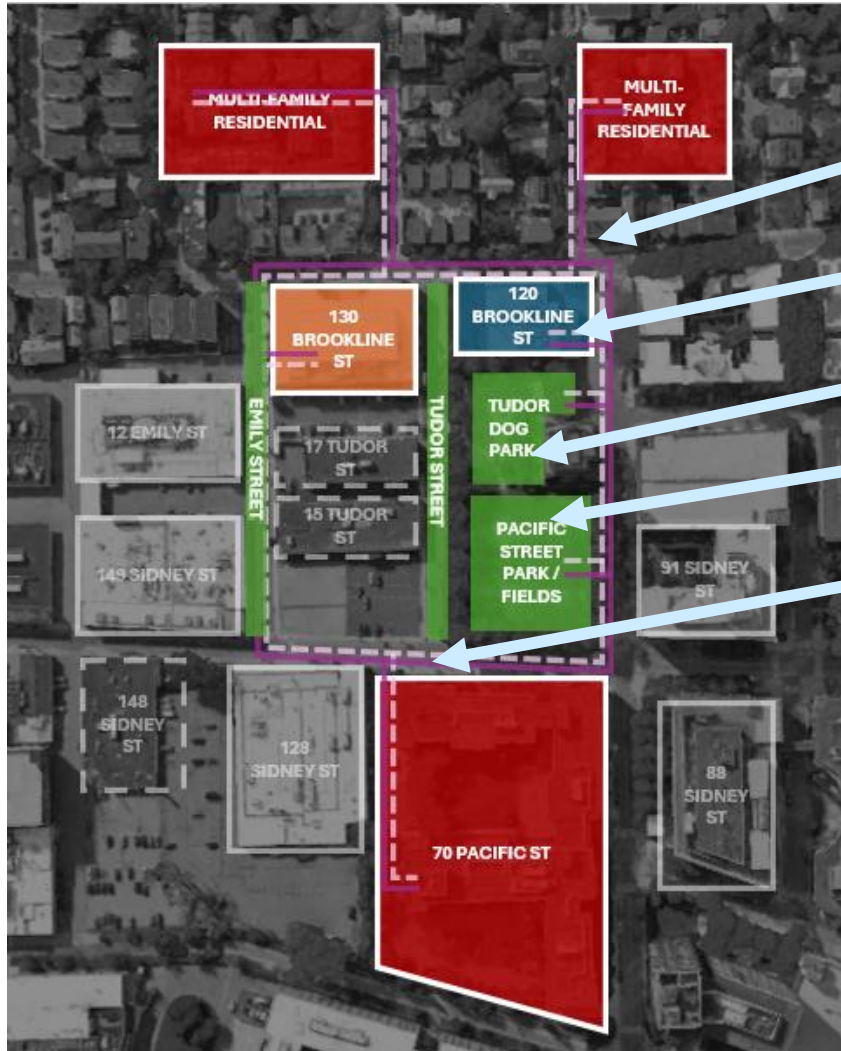
Customers on the TEN with different energy usages; commercial, residential, daytime, nighttime, and year-round heating and cooling
Research, industrial, commercial, residential buildings

Dense neighborhood, but not too dense

A neighborhood with the sweet spot of density. Too dense and there is not space for TEN assets, not dense enough.
Lower traffic streets, open space, short distances between buildings.



What makes a TEN



Ambient Thermal Loop (ATL) - pipes buried underground

Customers – In-building HVAC

Geo-exchange bores – buried underground

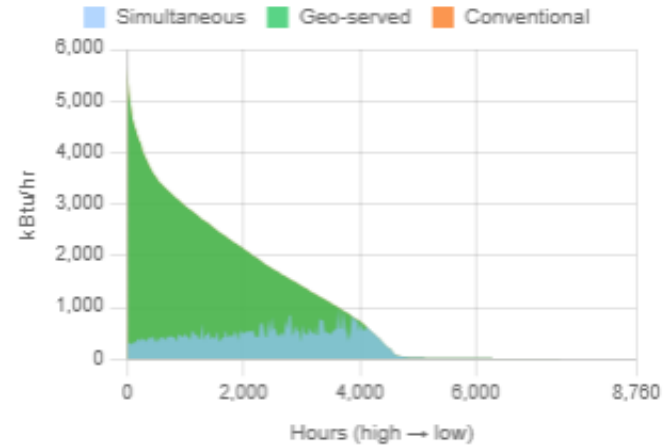
Geo Vault – pumps and manifold in underground vault

ATL Pump Vault – pumps and equipment located in underground vault (exact location TBD)

Alternative: Pumps and equipment located in above-ground pump house. This site does not have an obvious location for an above grade structure. 20' x 20'-40' depending on final equipment selection

What are we investigating at our site?

Cooling Capacity Duration Curve

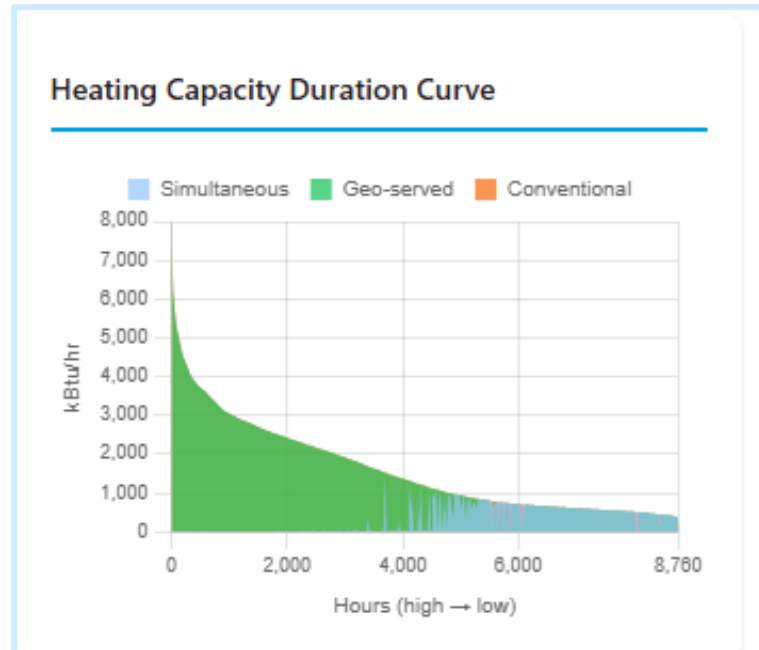


Cooling Capacity is how much cooling the buildings need across a year.

The left side shows the few hours when they need the most cooling; the right side shows hours when they need less.

The green area shows cooling supplied by the ground-based system. The small blue area shows cooling that can be produced most efficiently with energy recovery.

What are we investigating at our site?

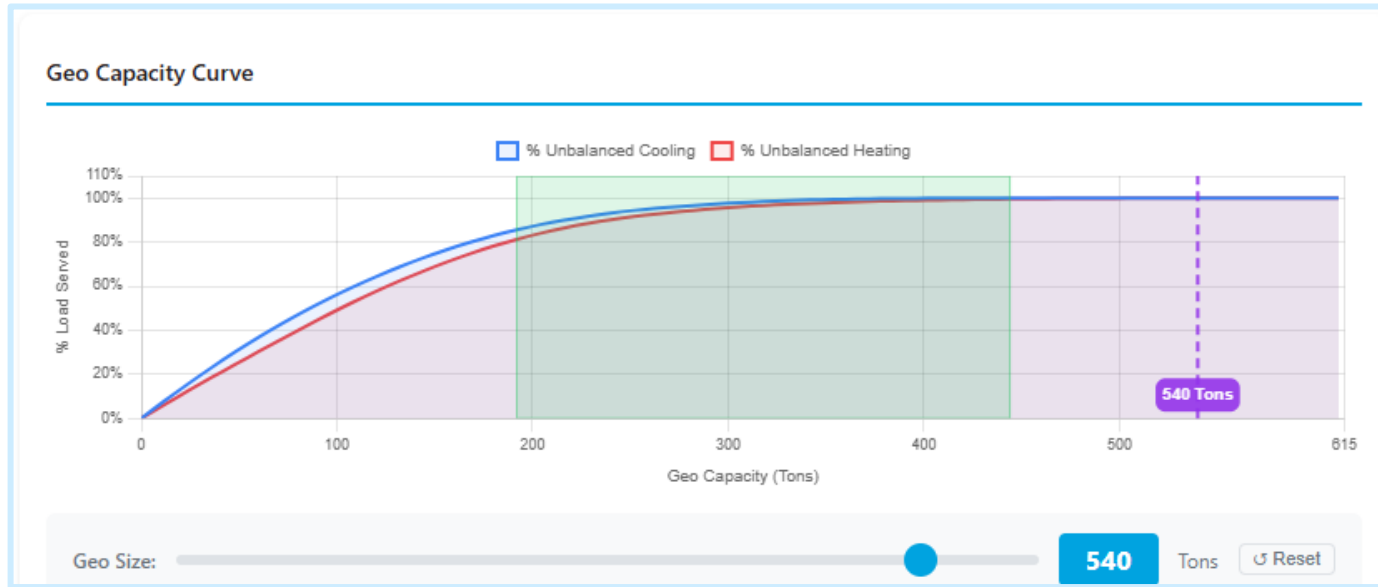


Heating Capacity is how much heating the buildings need across a year.

The left side shows the few hours when they need the most heating; the right side shows hours when they need less.

The green area shows heating supplied by the ground-based system. The small blue area shows heating that can be produced most efficiently with energy recovery.

What are we investigating at our site?

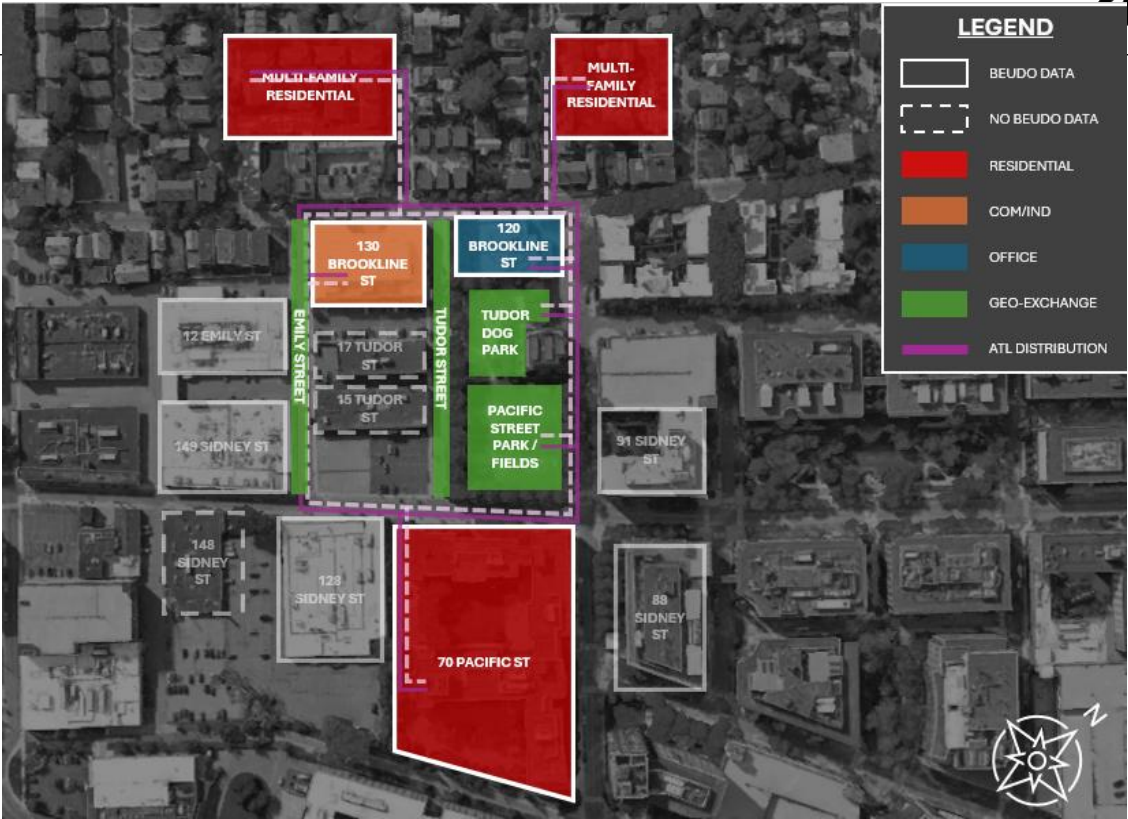


Geo Capacity is how much ground-based heating and cooling capacity would Cambridge need.

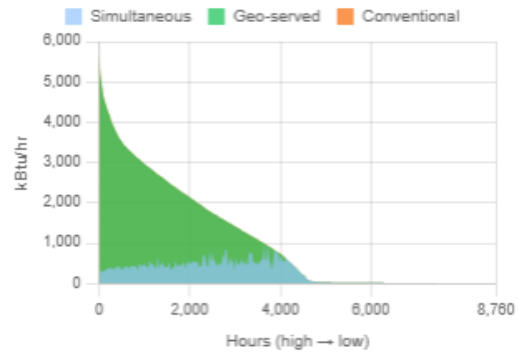
As the system gets bigger (moving right), it can serve more of the buildings' needs (moving up). The blue line is cooling; the red line is heating.

Scenario 1: Baseline

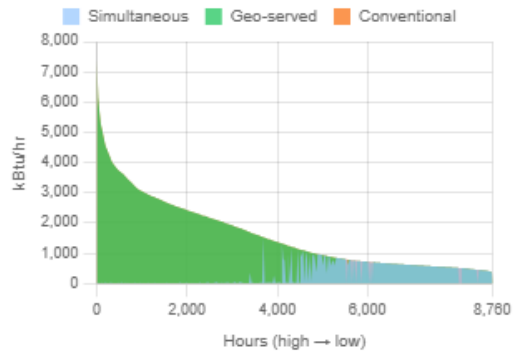
- 127 bores, 850' deep
- 540 tons of geo-exchange
- 100% heating served
- 100% cooling served



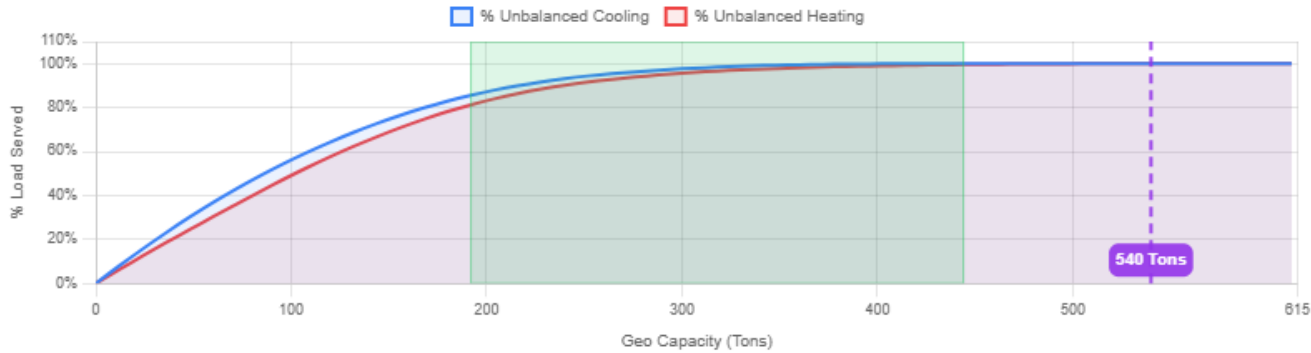
Cooling Capacity Duration Curve



Heating Capacity Duration Curve



Geo Capacity Curve



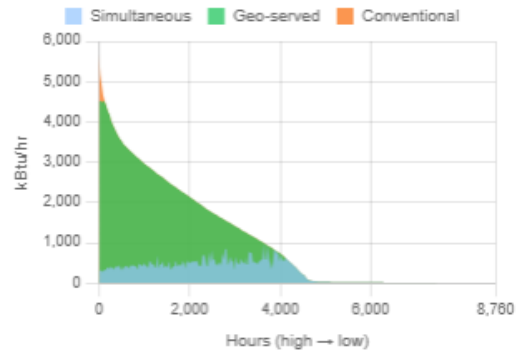
Scenario 2: Optimized

- 82 bores, 850' deep
- 350 tons of geo-exchange
- 99% heating served
- 99% cooling served

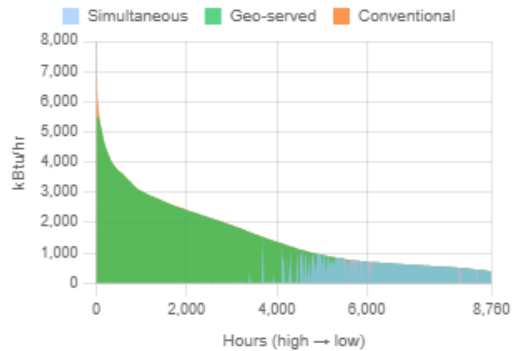
45 fewer bores!
The last 1% of peak needs another source



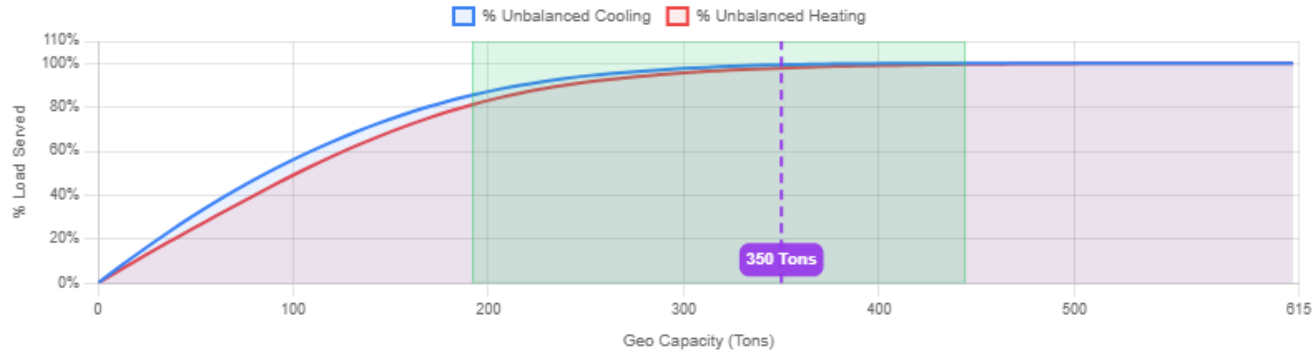
Cooling Capacity Duration Curve



Heating Capacity Duration Curve



Geo Capacity Curve

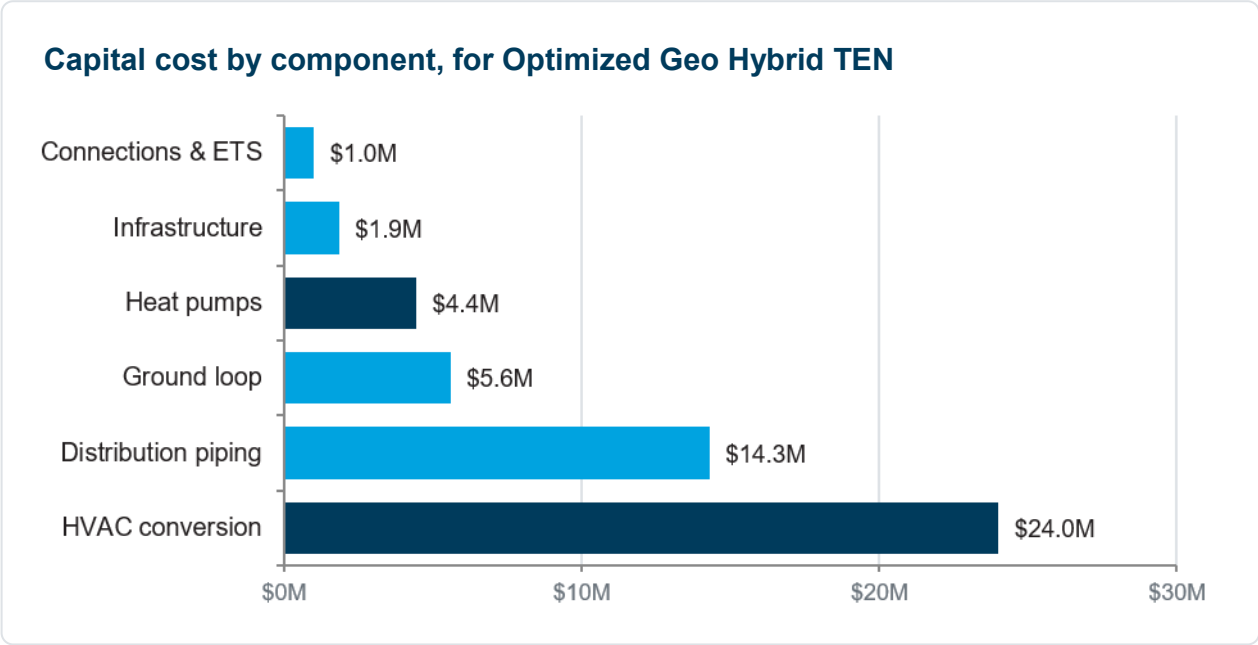


Economics + Ownership

How much would this all cost?

Who are the responsible parties?

Capital Cost: In-building work is the majority of the cost



Ownership boundaries

\$22.8M	network side	Bore field, distribution, pump station and energy transfer stations
\$28.4M	customer side	In-building conversion and heat pumps.

Business-as-usual (replacement in-kind)

\$11.1M – \$24.9M

Stand-alone ASHP

\$30.1M – \$45.2M

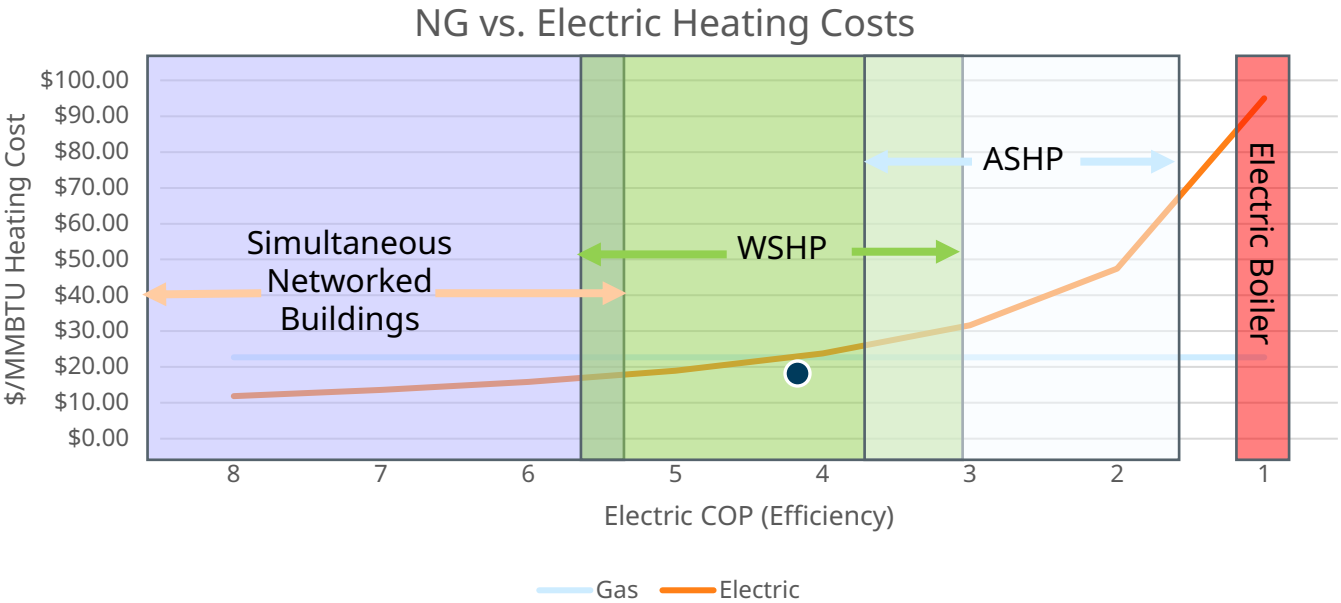
Optimized 99% Geo TEN

\$51.2M – \$76.8M

Analyzed minimum cost of a hybrid system to see how the best case scenario could work

Energy savings do not fund the capital

Cost of delivered heat by system efficiency, at Cambridge retail rates



Break-even COP: 4.3

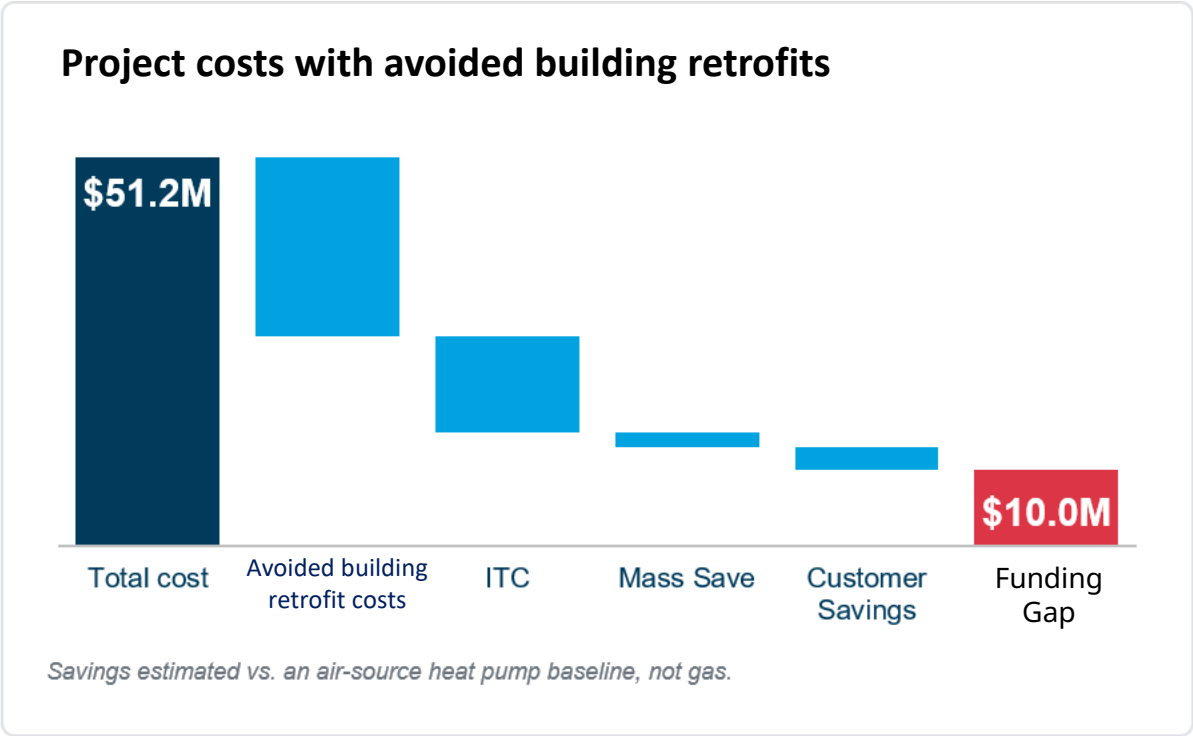
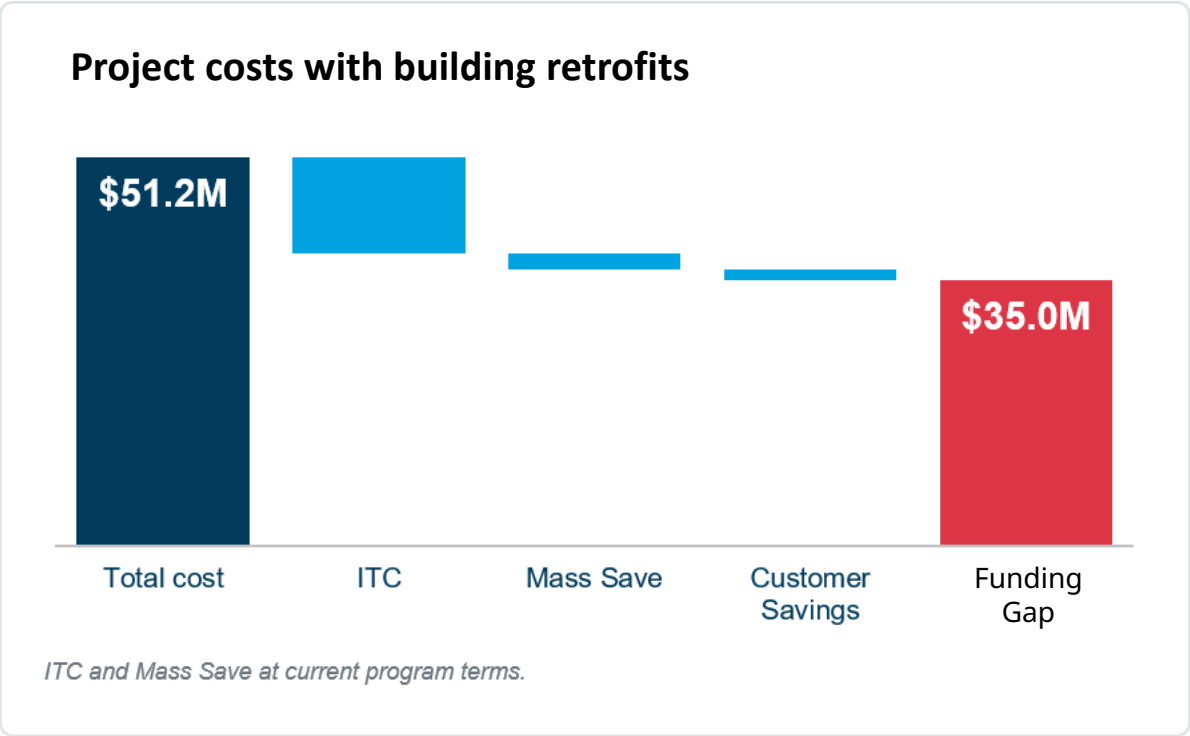
Efficiency vs. cost

- 75.9% HVAC energy used
- 18.9% HVAC energy cost

What would help fund the capital?

- Lower electric rates
- Higher cost of natural gas
- New construction to pay for the inside the building costs
- Outside capital funding
- Policy price on the carbon

Avoiding in-building costs do not close the funding gap



In the best case, lowest cost scenario, the gap is \$10M-35M, depending on who covers in-building costs.

Without external funding, monthly customer costs would more than double

Over 30 years, after incorporating available incentives, to recover capital costs of the network with operating costs of energy, heating/cooling bills would increase by 118%.

For example:



If commercial bill is \$20,000/mo → \$43,600/mo



If residential bill is \$300/mo → \$654/mo

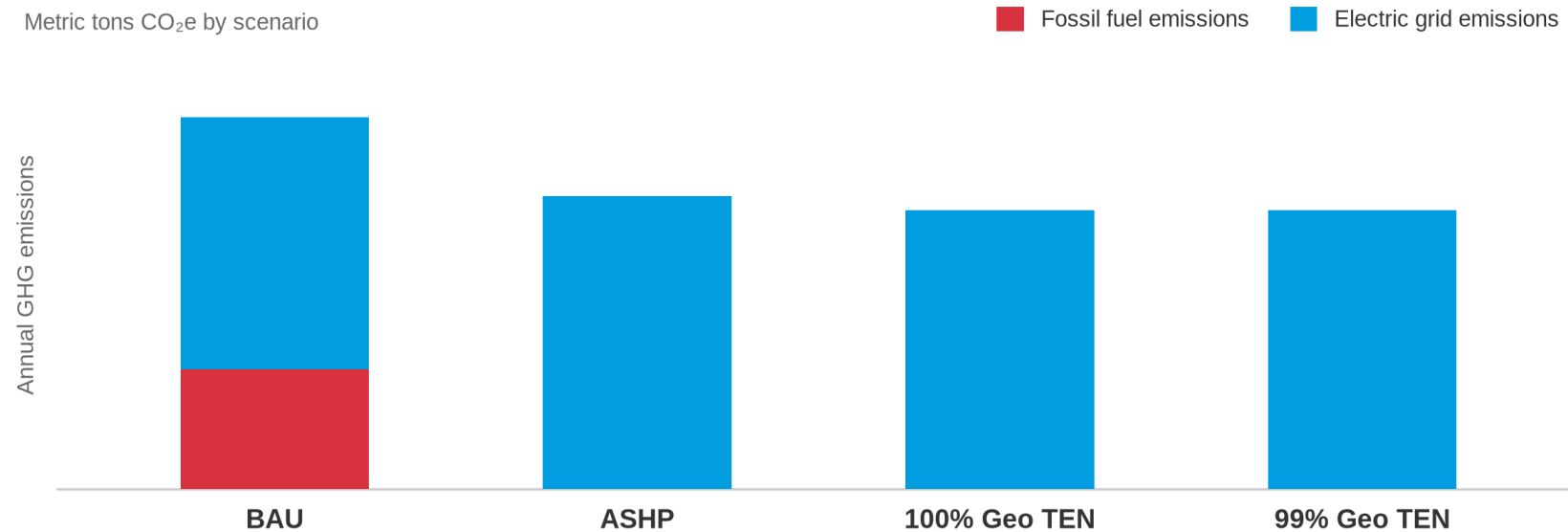
How to charge customers?

Charges could be flat rate, by size of building, by capacity of building equipment, or usage (requires BTU meters to measure heat transfer).

Annual Energy Use and GHG Reduction

GHG emissions comparison

Metric tons CO₂e by scenario



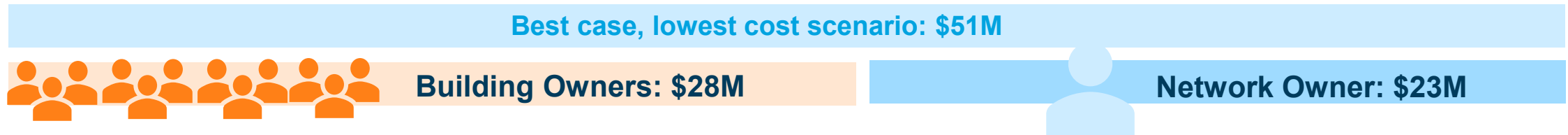
- ▶ Electric grid will get greener over time. These are near-term emission estimates
- ▶ ASHP and TEN options essentially eliminate natural gas usage
- ▶ ASHP and TEN all use about the same total energy, but much less than the BAU.
- ▶ 100% geo and 99% geo systems have essentially the same GHG emissions

Value that a project cannot collect today

Grid Upgrades	• Attribution of infrastructure delays is complex, and any value would go to ratepayers, not the project • Compared with converting every building to standalone electric heat pumps, a hybrid TEN could lower peak. Though, converting to electric is not a requirement across Cambridge
Avoided emissions	Social cost of carbon currently \$190/metric ton of CO2 (EPA)
BEUDO compliance	For large, nonresidential buildings >25,000 covered square feet, a compliance path is valuable to the property owner.

Costs affect multiple stakeholders... all are decision makers!

Funders: Investment tax credit, Mass Save



- Many decisions by many people:
 - Retrofits typically unfold over decades.
 - Each commercial and residential building has an owner, budget, and timeline for HVAC equipment
 - Older steam and hot water systems cost the most to convert
 - Residential units may need increased electrical service (200A)
- Need viability to recoup project costs from customers

Savings are experienced by different stakeholders



Network builder/owner: Investment tax credit; utility program incentives



Building owners: Operating costs for heating/cooling would lower, but not enough to repay project



Electric ratepayers: IF defers major electrical upgrades, avoid or delay rate increase



Everyone: Lower carbon emissions

Who could own and run a network?

- **City-owned**
 - Access to lower cost borrowing.
 - Would need to become a new thermal utility, with staff, billing, customer service, operations, and 50-year asset management.
 - Would need upfront capital, dedicated department, legal authority, and community buy-in among other priorities.
- **Utility-owned**
 - Brings experience; mechanism to sell thermal energy is under consideration.
 - Would need utility interest and regulatory approval for a Cambridge site that provides cost recovery.
- **Third-party or institution**
 - A developer, energy services company, or anchor institution constructs network and sells heating and cooling.
 - Would need committed customers, and a revenue model that pays for project and operation.

What makes TEN more and less viable?

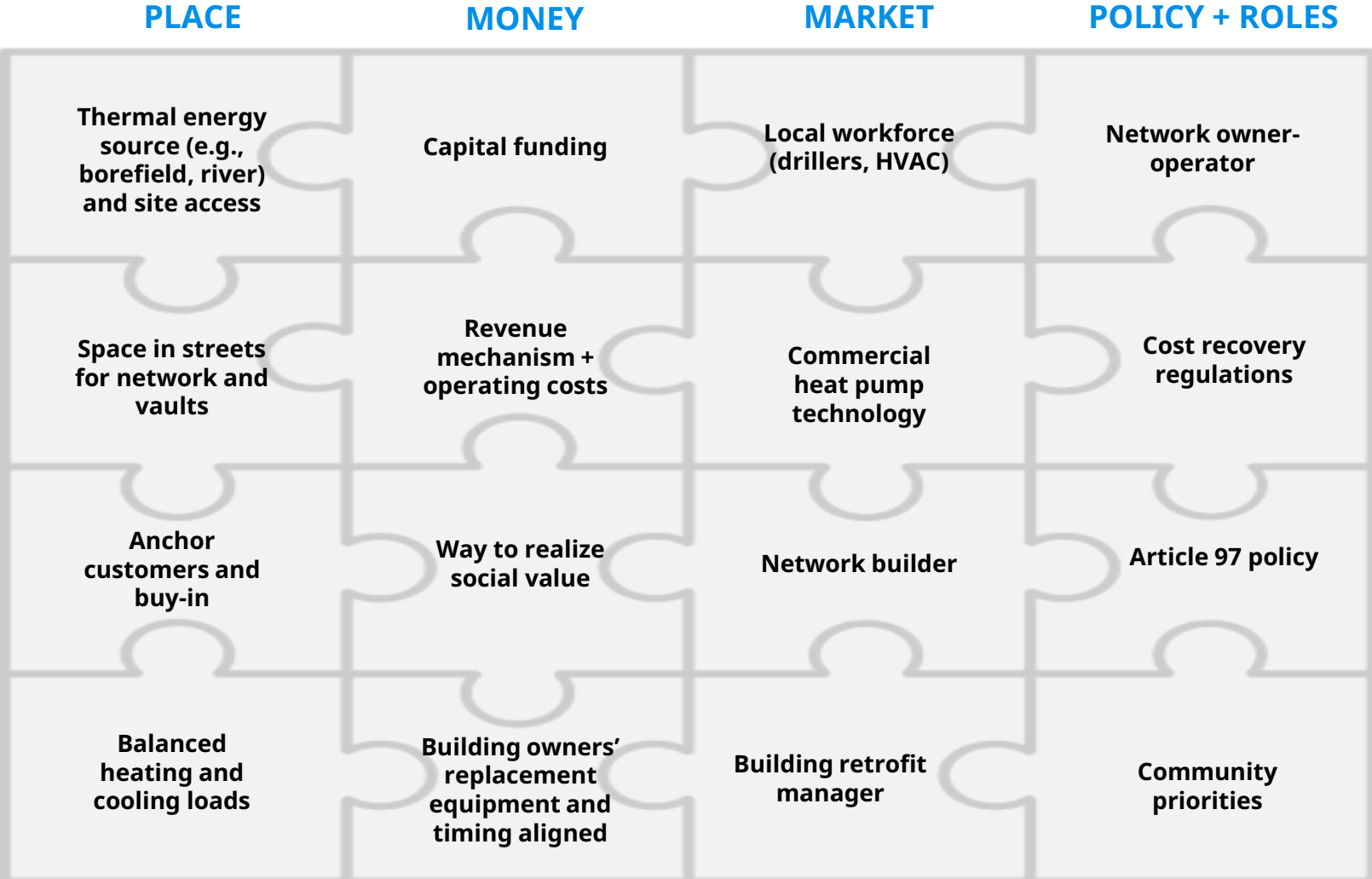
More possible with:

- New Construction
- Dense, mixed-use anchors
- Planned corridors
- Low-cost thermal resources
- Complementary load, i.e., simultaneous heating and cooling

Tougher with:

- Scattered and high-cost retrofits
- Low-rise, building by building
- One-at-a-time conversions
- Expensive/unavailable open space

So, what would it take to build a pilot TEN in Cambridge?



05. Next Steps and Discussion

What's next?

1. Salas O'Brien finalizing technical deliverables + City preparing takeaways
2. Regional BosTEN study
3. Municipal geothermal projects during new builds and renovations.

Are you interested in learning more about thermal energy? Tune into the City Council's [Health + Environment Committee Session](#) on October 20 from 11:30 am - 1:30 pm

Next questions for TENs in Cambridge

1. Are there private sector viable TEN opportunities, e.g., Kendall Square buildings, Alewife Quadrangle?
2. How could TENs play a role in BEUDO buildings with higher thermal load?
3. How could BosTEN change the dynamics for Cambridge?

Q&A

Web page: <https://www.cambridgema.gov/departments/officeofsustainability/thermalenergynetworks>
City contact: ekeefe@cambridgema.gov