Geothermal 101 + Utility Thermal Energy Networks (UTEN) as an Alternative to Natural Gas

April 30, 2025

Street Valve Cover in Framingham, MA

Eversource Pilot

John Ciovacco
NY-GEO Board Member
Aztech Geothermal, President
(518) 309-2000
jciovacco@aztechgeo.com
www.aztechgeo.com

Presenter: John Ciovacco

- Co-Chair NY-GEO Annual Conference

- President Aztech Geothermal
- NY-GEO Board Member
- AEE Certified GeoExchange Designer (CGD) & IGSHPA Accredited Geothermal Installer
- Served as NYS DPS Strategic Advisory Group for EE & Building Electrification
- Consulting to 8 Utilities involving ~9+ TEN projects
- Advisory Board, HEET
- ME from Union College (NY)

Aztech Geothermal, LLC

- 650+ Geothermal Projects (NY & MA)
- Turnkey GSHP HVAC Systems
- Ground Loop Design & Installation
- Consult to MEP Firms
- Provide Inspection & Commissioning
- Formation Thermal Conductivity Tests

GeoCube™
Thermal Conductivity Test Equipment

IGSHPA Accredited Installer

Energy HOME PERFORMANCE WITH ENERGY STAR

BUILDING PERFORMANCE INSTITUTE INC. SM
BPI GoldStar CONTRACTOR

Goldman Sachs 10,000 small businesses ALUMNI

HEAT SMART CAPITAL REGION

CERTIFIED GREEN PROFESSIONAL™

Capital Region Builders & Remodelers Association CRBRA

NY-GEO

WaterFurnace®

Aztech GEOTHERMAL

www.aztechgeo.com

FIRELESS FURNACE

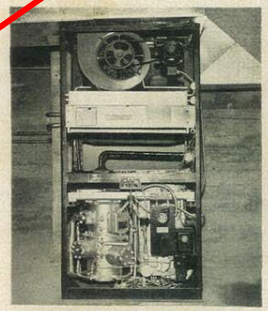
It pumps heat from earth to house

The machine shown at the bottom of the page and explained in the diagram at right burns no fuel, yet it can heat a house in winter, cool it in summer and is at the same time a humidifier. It produces no ashes, soot or smoke and needs no chimney. It is called a heat pump.

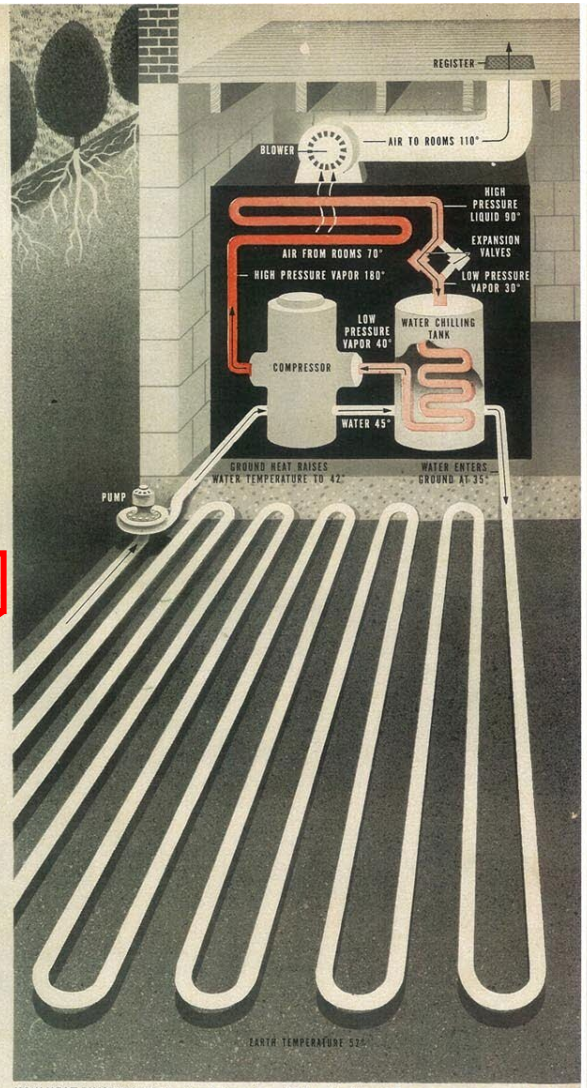
Powered by an electric motor, it works on the same principle as a home refrigerator. Just as a refrigerator takes heat from the food and air inside it and deposits it in the kitchen, the heat pump, when cooling a house, takes heat from the house and deposits it in the earth through pipes buried in the soil. To warm a house the heat pump uses the low temperature heat constantly contained in the earth, increases its temperature and puts it in the house. This is done as follows: water circulating through pipes in ground enters a tank in which are pipes carrying a cold refrigerant, Freon. The Freon, being colder than the water, picks up some of its heat, then goes through a compressor. This compression makes the Freon hot. This heat is used to heat house. Freon is then allowed to expand suddenly and as a result again becomes cold. Next it passes back through the water tank, once more picking up additional heat from the ground-warmed water.

It will be some time before most home owners can buy a heat pump right off a dealer's floor. To-[illegible] pensive engineering problem. The one shown here, called the Miracula, made by the General Engineering and Manufacturing Company of St. Louis, Mo., sells for $2,000. Installation adds another $1,000.

At present the heat pump costs slightly more to operate than an ordinary furnace except in areas of especially low electric rates. In many places, too, installation is totally impractical. However as the efficiency of getting heat from the earth improves, it is almost certain that eventually the heat pump will be able to compete successfully with conventional heaters in most localities. Many large companies have heat pumps under development. Even conservative General Motors admits informally that it is working on a Frigidaire version of the heat pump for the consumer market.

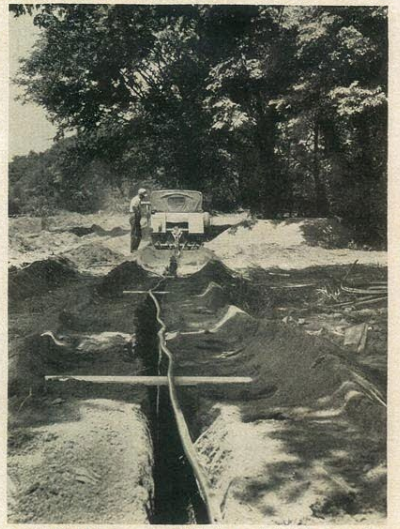


EXPOSED VIEW OF HEAT PUMP shows parts diagramed at right. Compressor is at bottom left, chilling tank at bottom right and blower at top center. Unit is 6 feet 3 inches tall, occupies 6.3 square feet of floor space.

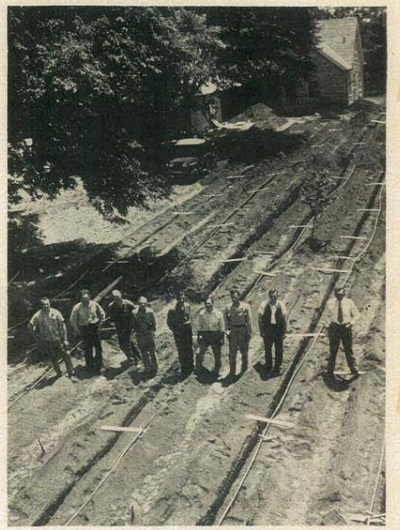


HOW HEAT PUMP WORKS in winter is shown by this diagram. Water circulates through ground pipes, picks up ground heat plus heat from compressor. This warmed water heats special Freon vapor in chilling tank (pink coils). Warmed Freon goes to compressor, becomes hot. Hot Freon goes through coils at top, warms house air. Freon returns to chilling tank through expansion valve. For summer cooling Freon flow is reversed.

CONTINUED ON NEXT PAGE



GROUND PIPE for heat pump is laid in deep trench dug by jeep-drawn ditch digger. Pipe is buried below frost line where year-round temperature remains nearly constant. Here in Jeffersonville, Indiana this temperature is about 52°F.



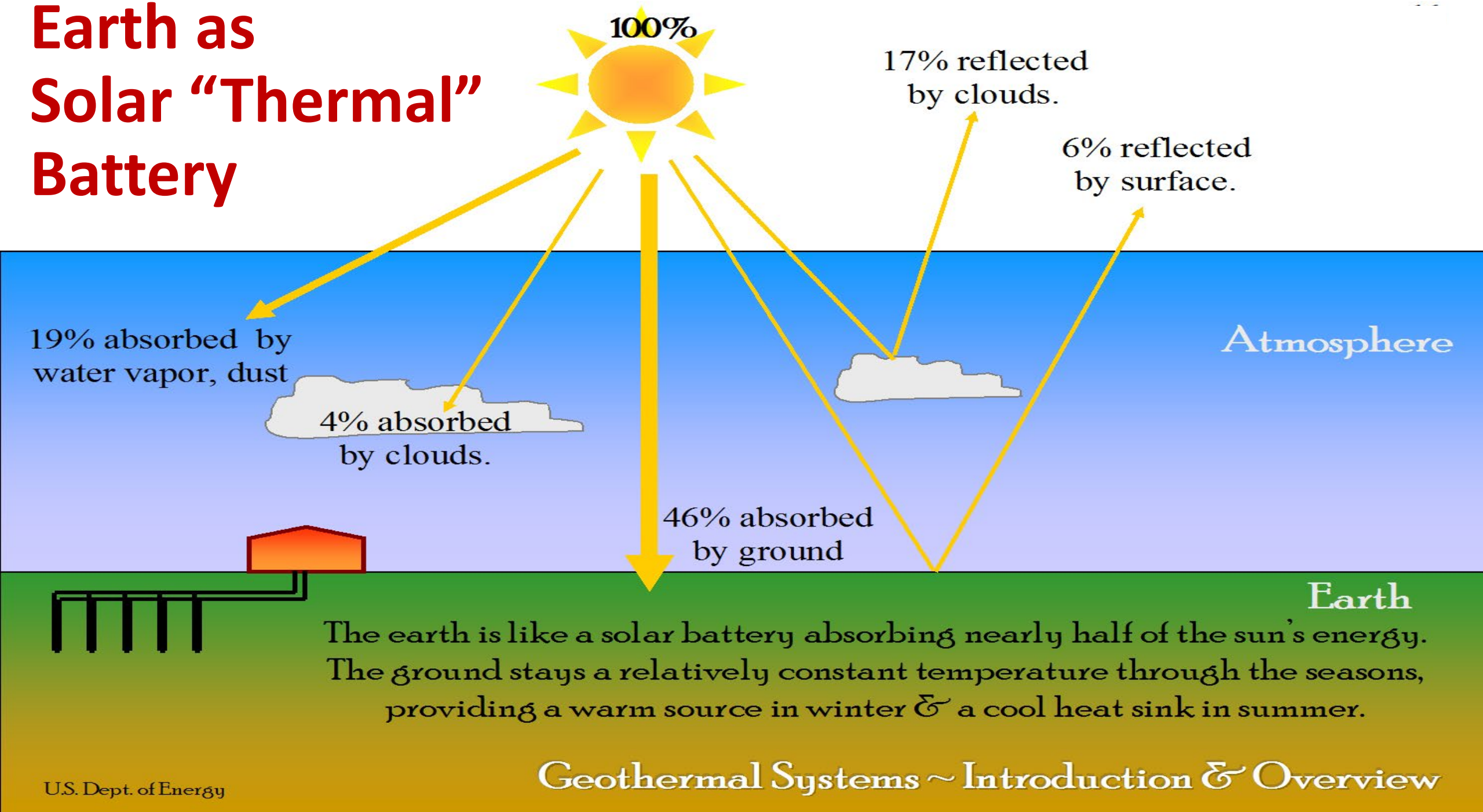
PIPE TRENCHES cover whole lawn in this heat pump installation. Men are the crew necessary to install the Miracula. Miracula can also get source of heat from pipes to wells, lakes or streams, and in warm areas from the air itself.

For those that are concerned about the "new" technology we call Geothermal

Aztech GEOTHERMAL

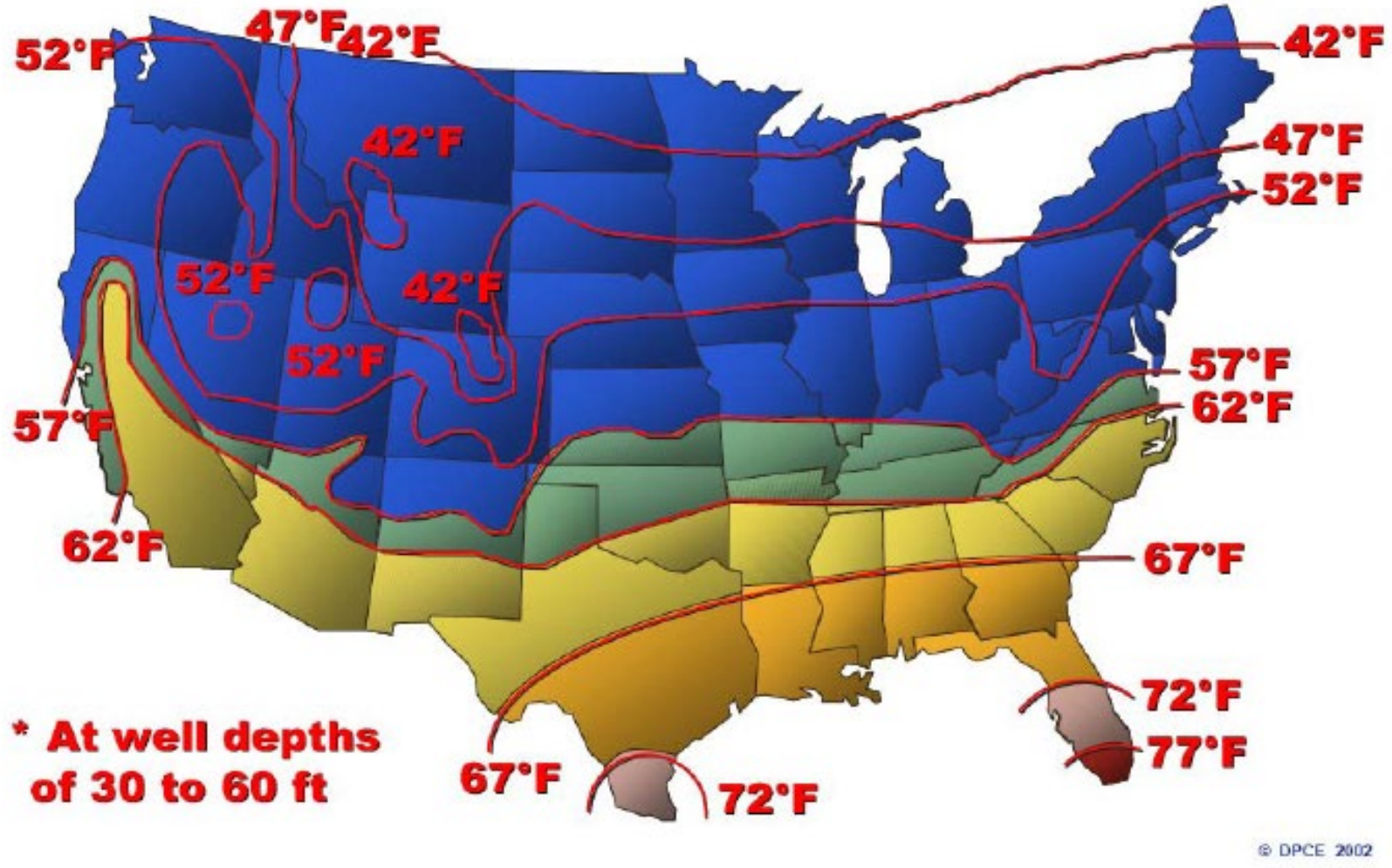
www.aztechgeo.com

Earth as Solar "Thermal" Battery



Ground Source Heat Pump - US Ground Temperatures

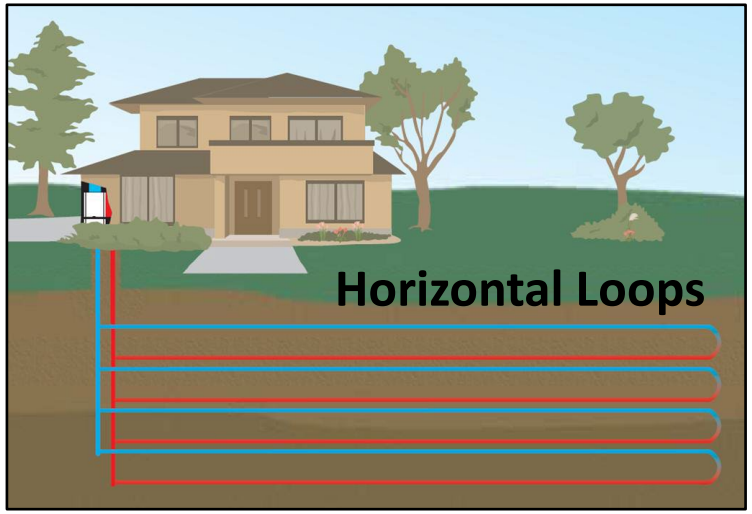
This is the GSHP Map.

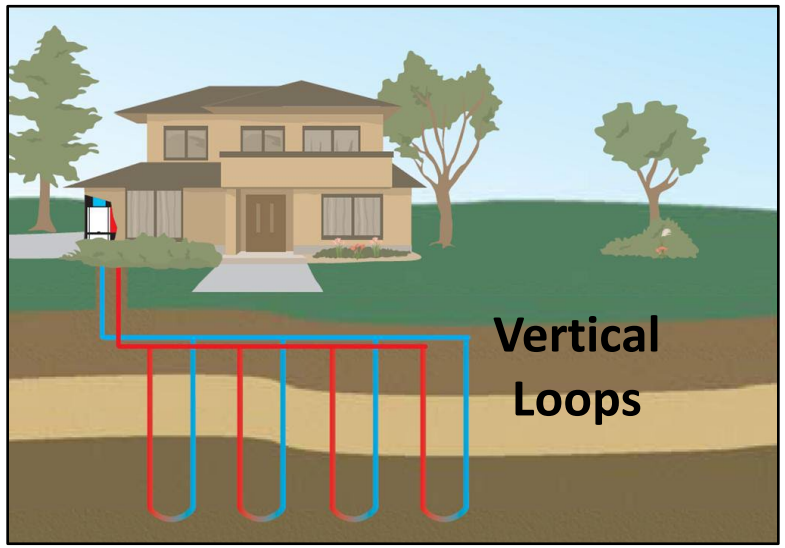


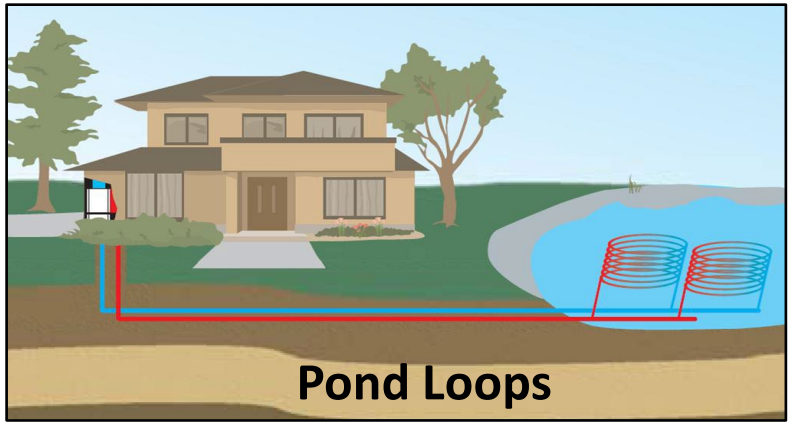
Aztech GEOTHERMAL

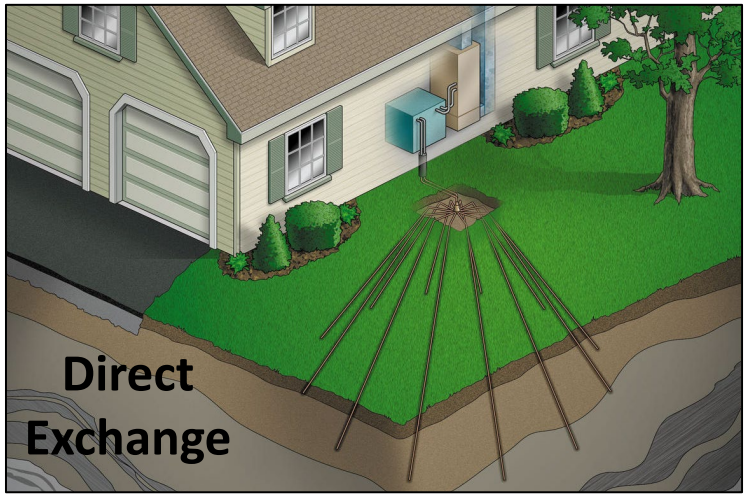
www.aztechgeo.com

Ground Source Heat Pump Closed Loop Options









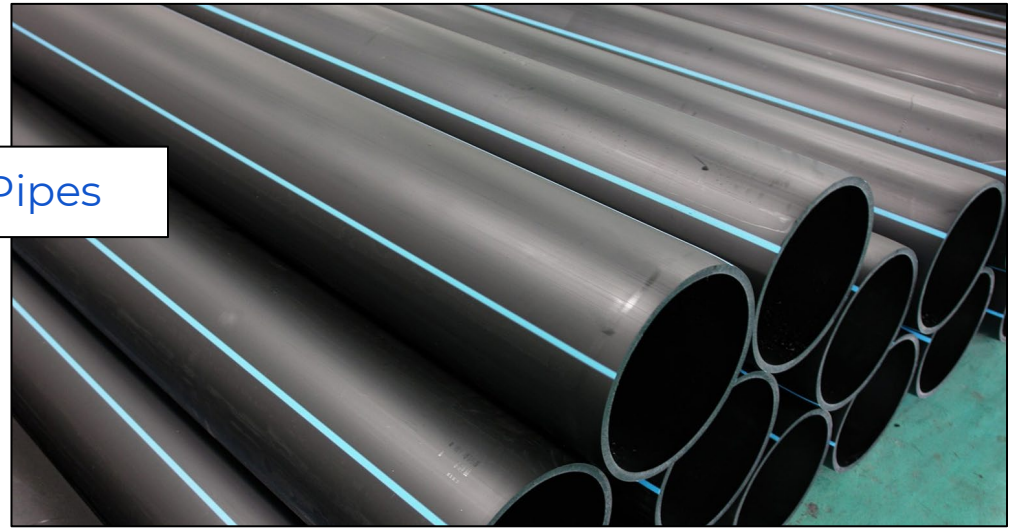
Aztech GEOTHERMAL

www.aztechgeo.com

Common Thermal Infrastructure – HDPE Pipe

Gas Pipes

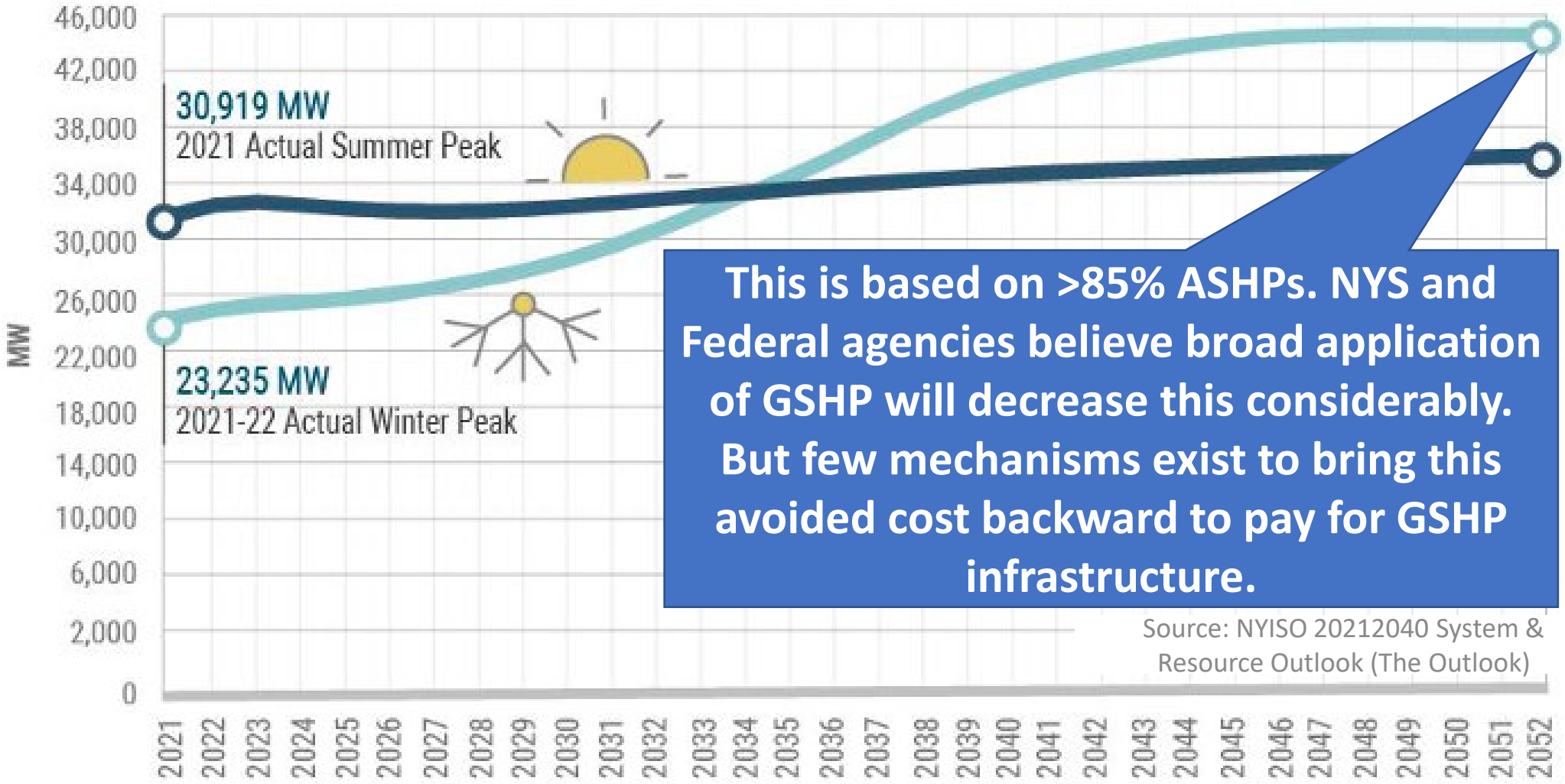
Water Pipes



Geothermal Pipes

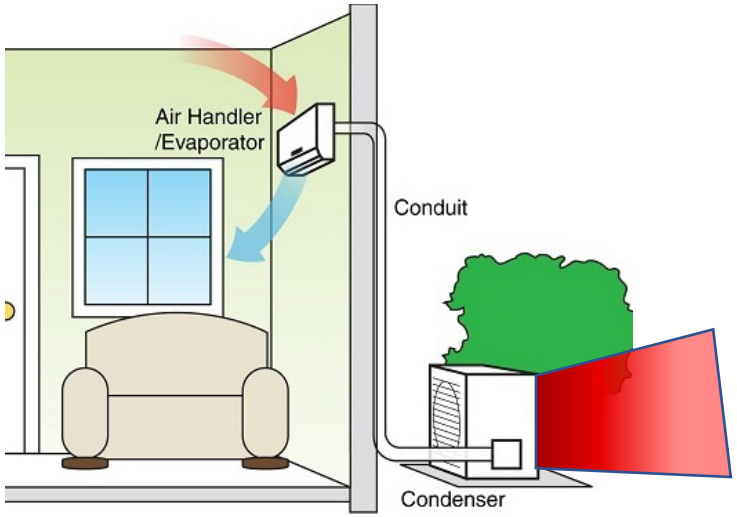
Electric - Winter Peak Approaching – *Updated to 2034*

Figure 5: Electric Summer and Winter Peak Demand – Actual & Forecast: 2021-2052

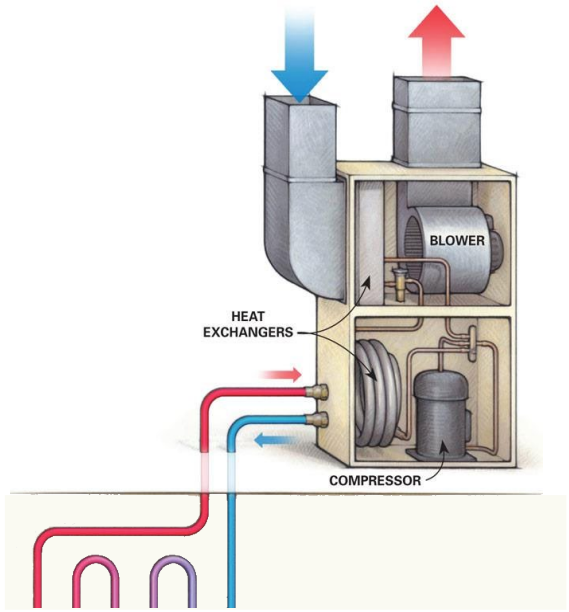


Electric Heat Options

Electric Resistance



Air Source Heat Pumps (ASHP)



Water/Ground Source HPs (WSHP/GSHP)

1.0 COP — **1.5 to 2.5+ COP** — **3.0 to 5.0+ COP**

Efficiency
Coefficient of Performance

Relative Operating Cost

$$$$

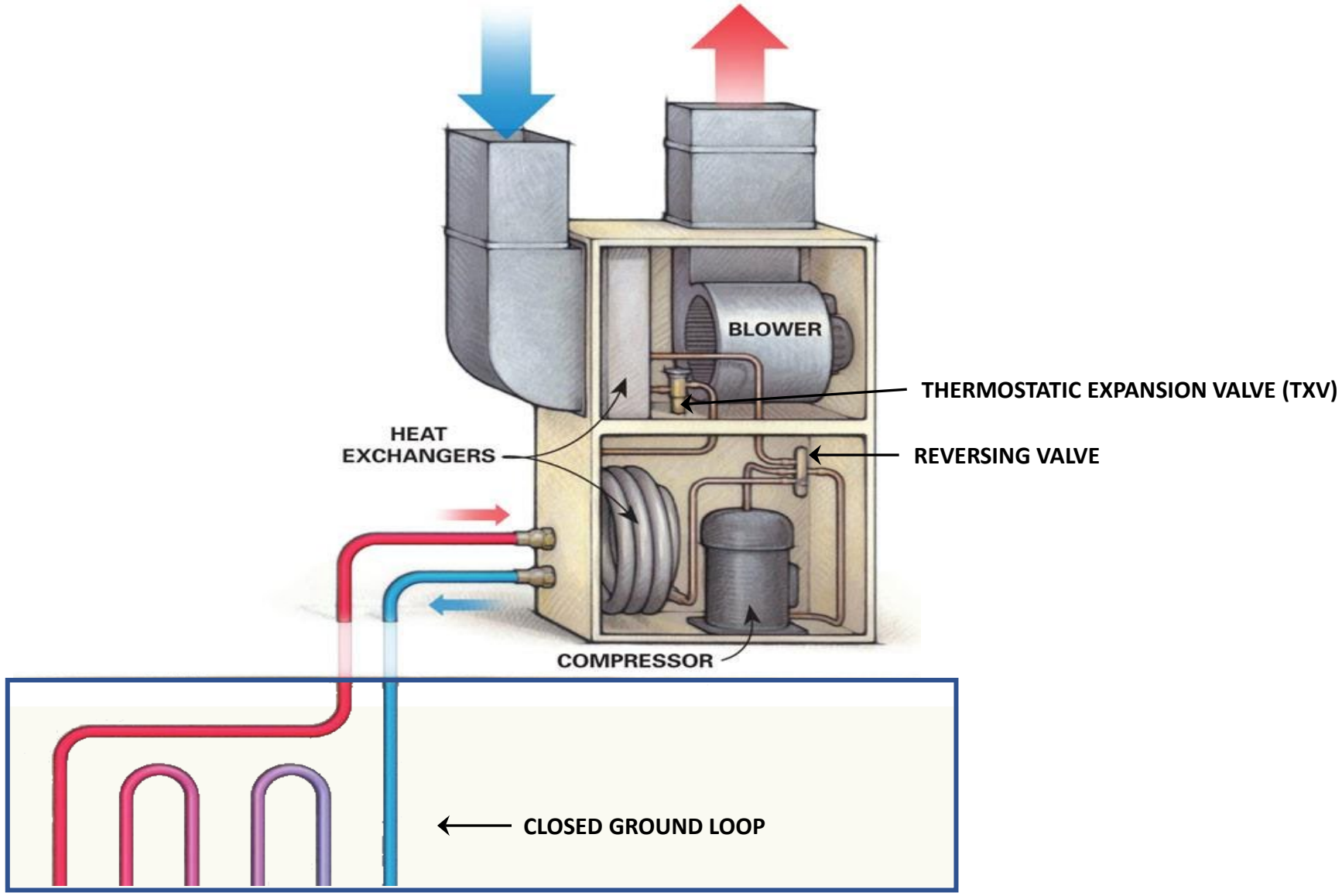
$$ (Propane & Oil)

$ (Natural Gas)

Aztech GEOTHERMAL

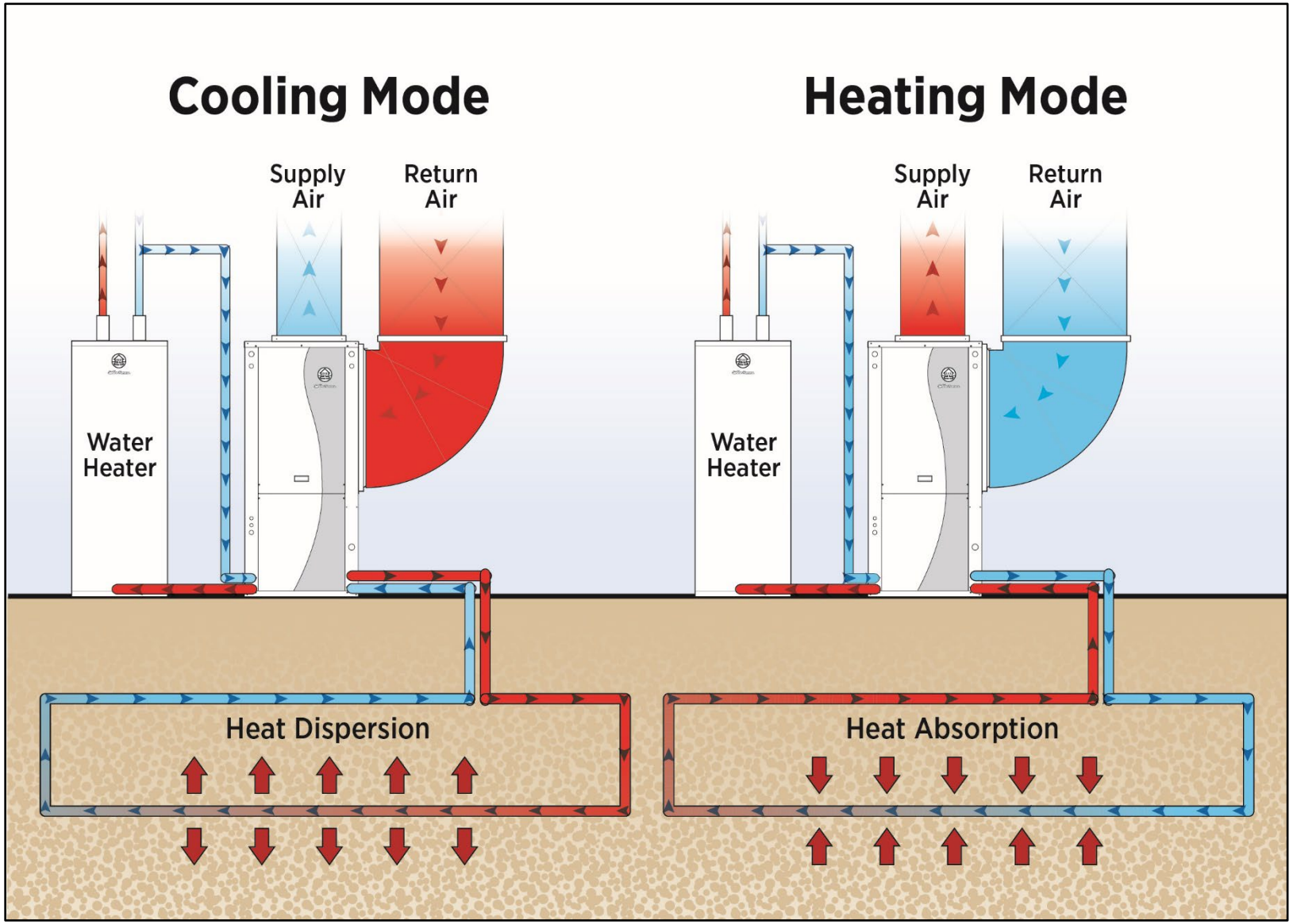
www.aztechgeo.com

Basic Water-to-Air GSHP System



Aztech GEOTHERMAL

Systems are Reversable



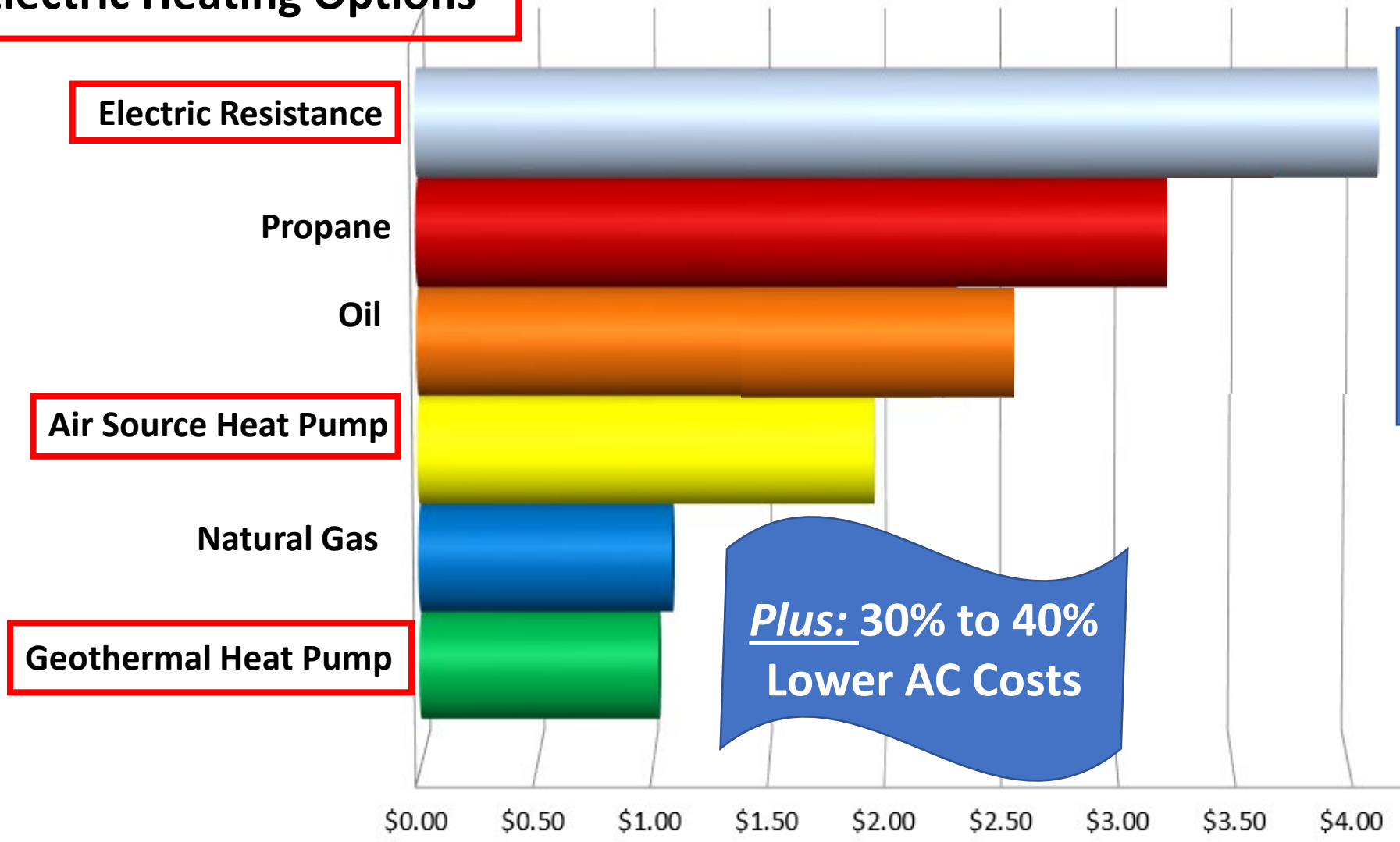
Aztech GEOTHERMAL

www.aztechgeo.com

GSHPs are the Lowest Operating Cost *(barely…)*

Electric Heating Options

1 Therm = 100k BTU →~30 kWh



Energy rate cost allocation and related rates ($) will need to change to increase savings for GSHPs vs. Natural Gas

Plus: **30% to 40% Lower AC Costs**

Oil @ $2.97/gal

Propane @ $2.69/gal

Natural Gas @$1.00/therm

Geothermal @ $0.14/kWh

Electric @ $0.14 kWh

Air Source HP @ $0.14/kWh

Utility Thermal Energy Network & Jobs Act (UTENJA)

Signed into *NYS law* by Gov. Hochul on July 5, 2022

- Seven (7) Largest Utilities to Propose Up to 5 Thermal Energy Network Pilot Projects
- Key Criteria for Pilot Projects
  - Pilots need to involve disadvantaged communities (DC)
  - Law applies prevailing wage and direct entry pre-apprenticeship requirements to thermal energy projects
    - Oct. 2022 - First PSC Filing form 7 Utilities
      - ➢ 15 Sites Proposed Statewide
    - Dec. 2023 - More Refined Proposals Submitted
      - ➢ 13 Sites Proposed Statewide
    - Sept. 2023 – Now 12 Projects - 9 Stage 2 approval – 3 awaiting approval

UTEN Pilots to Stage 2

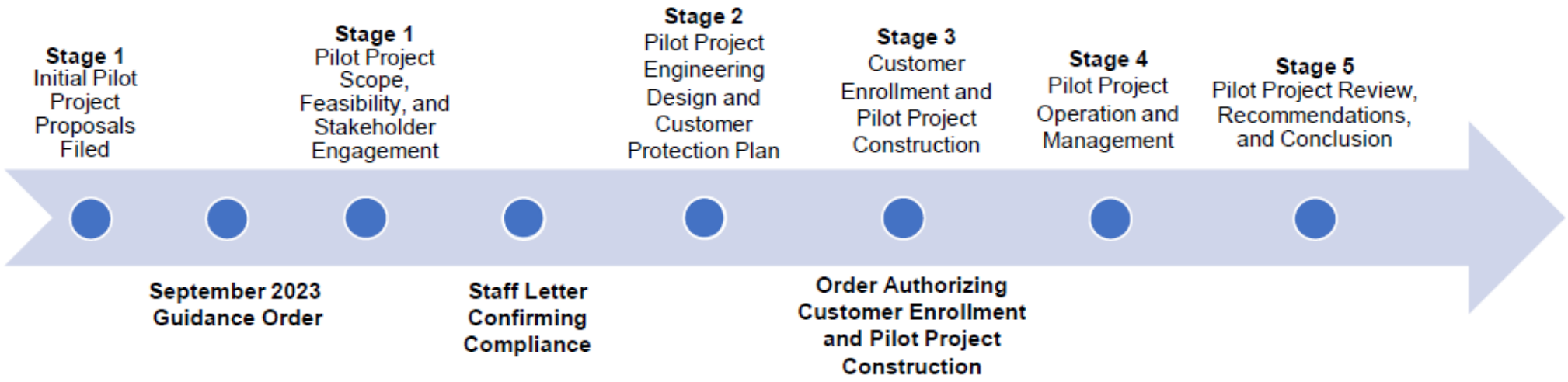
Proposed Pilot Sites – April 2024

1. **National Grid & LIPA - Brentwood**
2. **National Fuel - Buffalo**
3. **RG&E - Rochester**
4. **O&R - Haverstraw**
5. **NYSEG - Ithaca**
6. **National Grid - Brooklyn**
7. **National Grid - Syracuse**
8. **National Grid - Troy**
9. **Con Edison - Mount Vernon**
10. **Con Edison - Rockefeller Center**
11. **Con Edison - Chelsea**
12. **Central Hudson - Poughkeepsie**

On April 9, 2024, Staff filed letters advancing nine of the twelve remaining UTEN pilot projects to Stage 2, the Pilot Project Engineering Design and Customer Protection Plan, while requiring additional information to ensure feasibility for the three remaining proposed projects.

UTEN Stage-Gate Process

Pilot Project Stages and Timeline



All pilot project proposals are currently in Stage 1.

- Initial Pilot Project Proposals filed on January 9, 2023.
- Guidance Order provides clarifications, establishes stage-gate approach, and identifies additional information needed to advance projects to next stage.
- **Utilities file Final UTEN Pilot Project Proposals by December 15, 2023.**

Individual pilot project decisions will be provided beginning at Stage 2.

- Staff issues letter confirming compliance with Guidance Order and advances project(s) to Stage 2 or notes deficiencies to be addressed.
- **Utilities file Final Engineering Design and Customer Protection Plans for each pilot project within 9 months of Staff letter.**

Advancement of Pilot Project to Stage 3 through project-specific Commission Order(s).

- **Utilities file Final UTEN Pilot Project Engineering Design and Customer Protection Plans. Filings will be issued for public comment.**
- Order will finalize pilot project operational requirements, cost recovery, CPPs, performance monitoring and reporting structure.
- Pilot project will be operational for a minimum of 5 years.

NEW YORK STATE OF OPPORTUNITY. Department of Public Service

BDC Materials on US National Thermal Energy Networks

Eight (8) states in the US have legislation in place to encourage TEN development

Key Links to Building Decarbonization Coalition TEN Resources:

[TEN's Terminology]

[TEN's Examples]

[TEN's Legislation]

[TEN's Factsheet download]

[TEN's Legislative Policy]

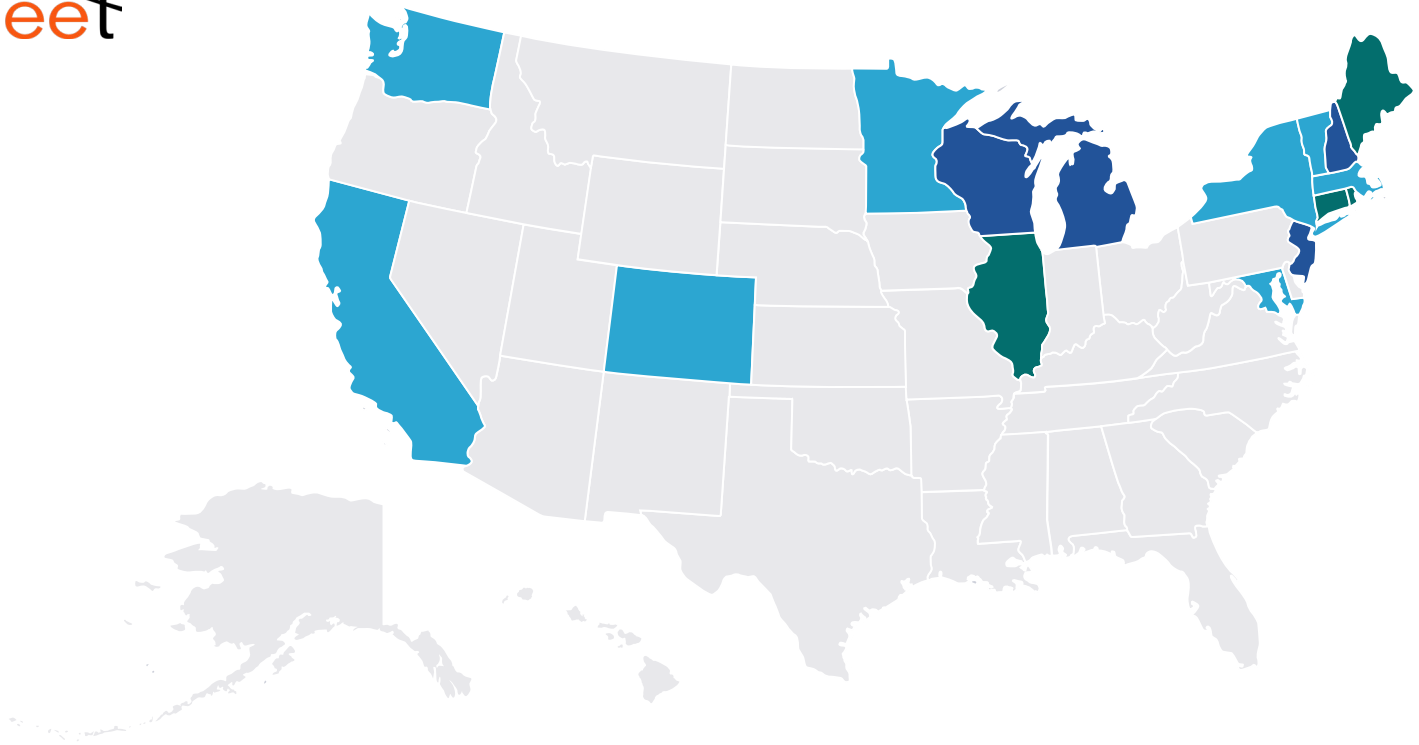
[Neighborhood-Scale Building Decarbonization Map]

Source: Building Decarbonization Coalition

Thermal Energy Network Legislation

BUILDING DECARBONIZATION COALITION

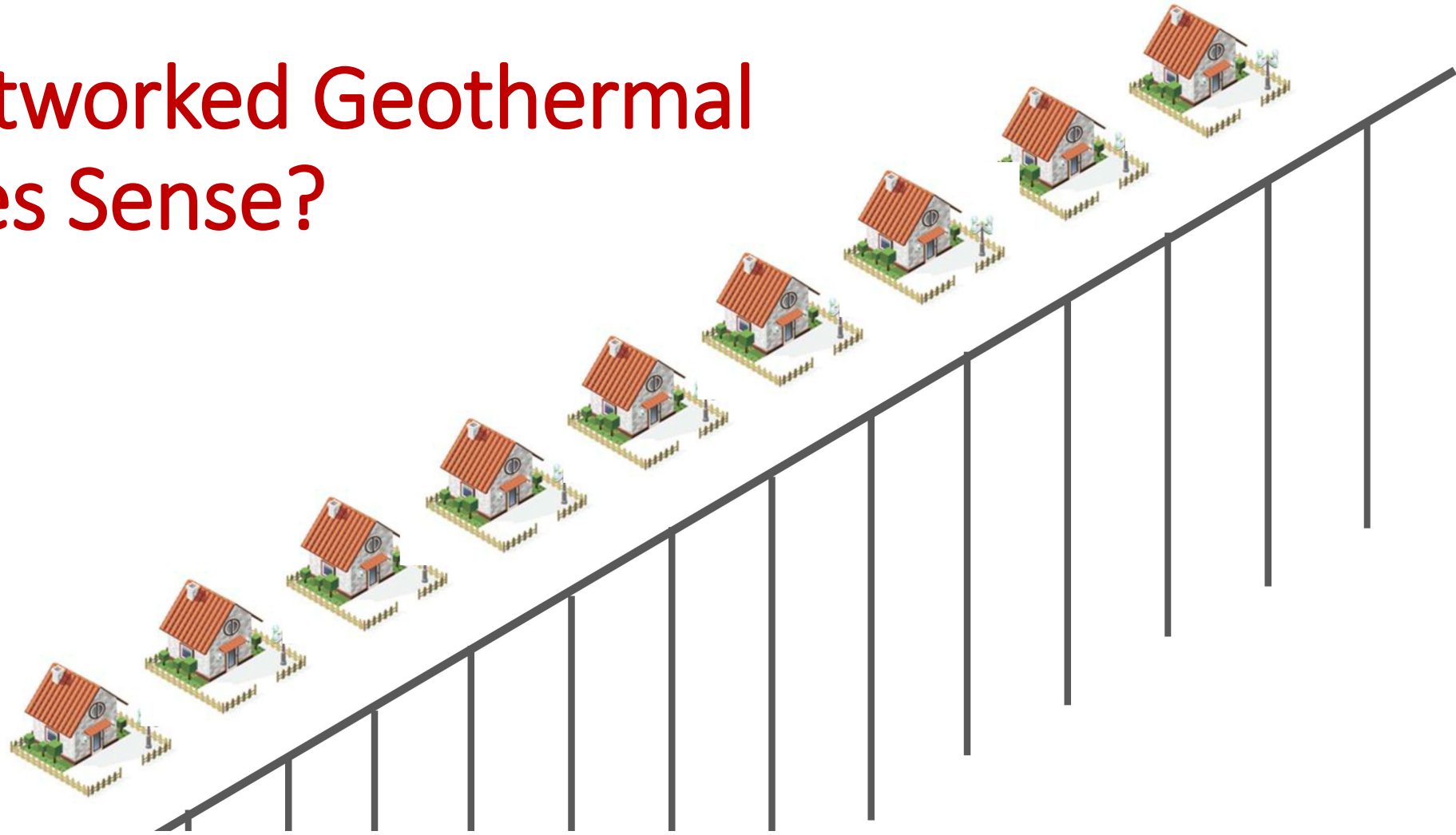
heet



Passed Legislation **Filed Legislation** **Considering Legislation**

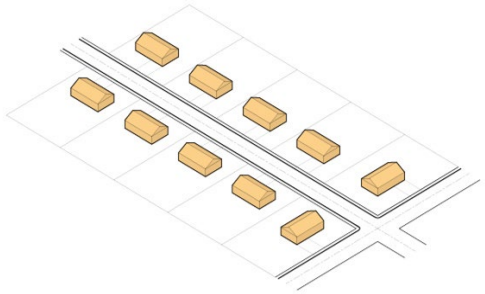
1. **MA** - An Act Driving Clean Energy (2021-2022)
2. **MN** - Natural Gas Innovation Act (2021 + 2 bills with TENs in 2024)
3. **NY** - Utility Thermal Network & Jobs Act (2022)
4. **CO** - Thermal Energy Act (2023)
5. **WA** - Promoting the Establishment of Thermal Energy Networks (2024)
6. **MD** - WARMTH Act (2024)
7. **VT** - Act relating to Thermal Energy Networks (2024)
8. **CA** - Gas corporations: ceasing service: priority neighborhood decarbonization zones (2024)

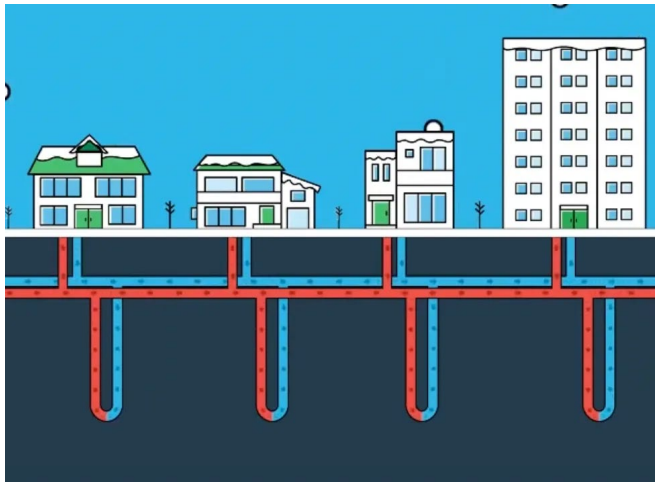
Where Do Networked Geothermal Systems Makes Sense?



Thermal Energy Networks vs. Individual Building Systems

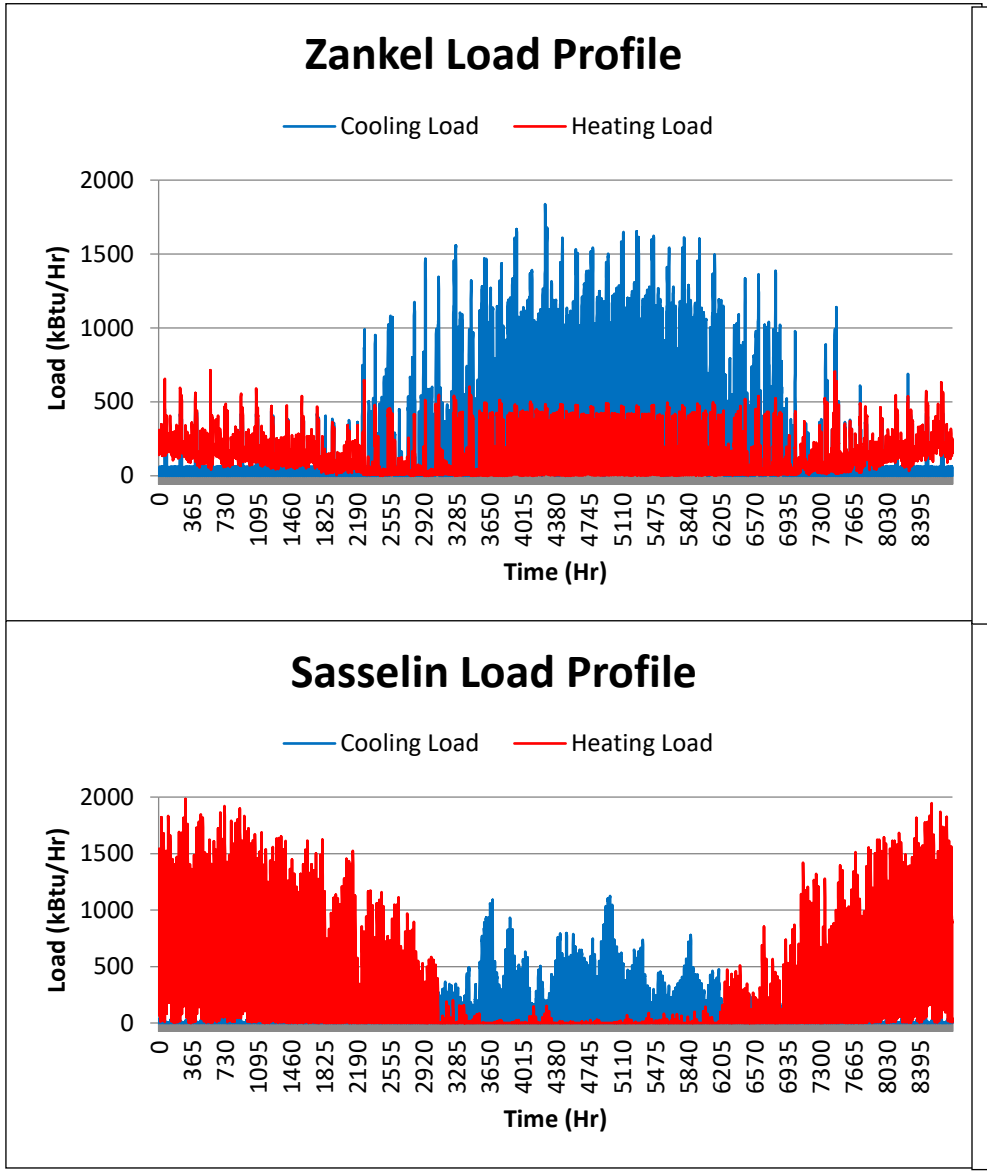
- Networked systems (assuming ambient loops) are best if the following 3 conditions exist:
  1. **Commonly owned land & buildings**
  2. **Diversity of load – i.e., different types of buildings with different hourly loads**
  3. **Buildings are close to each other**
- Generally speaking…
  - **TENs are often less practical to install or operate if at least 2 of the 3 above conditions are not present.**

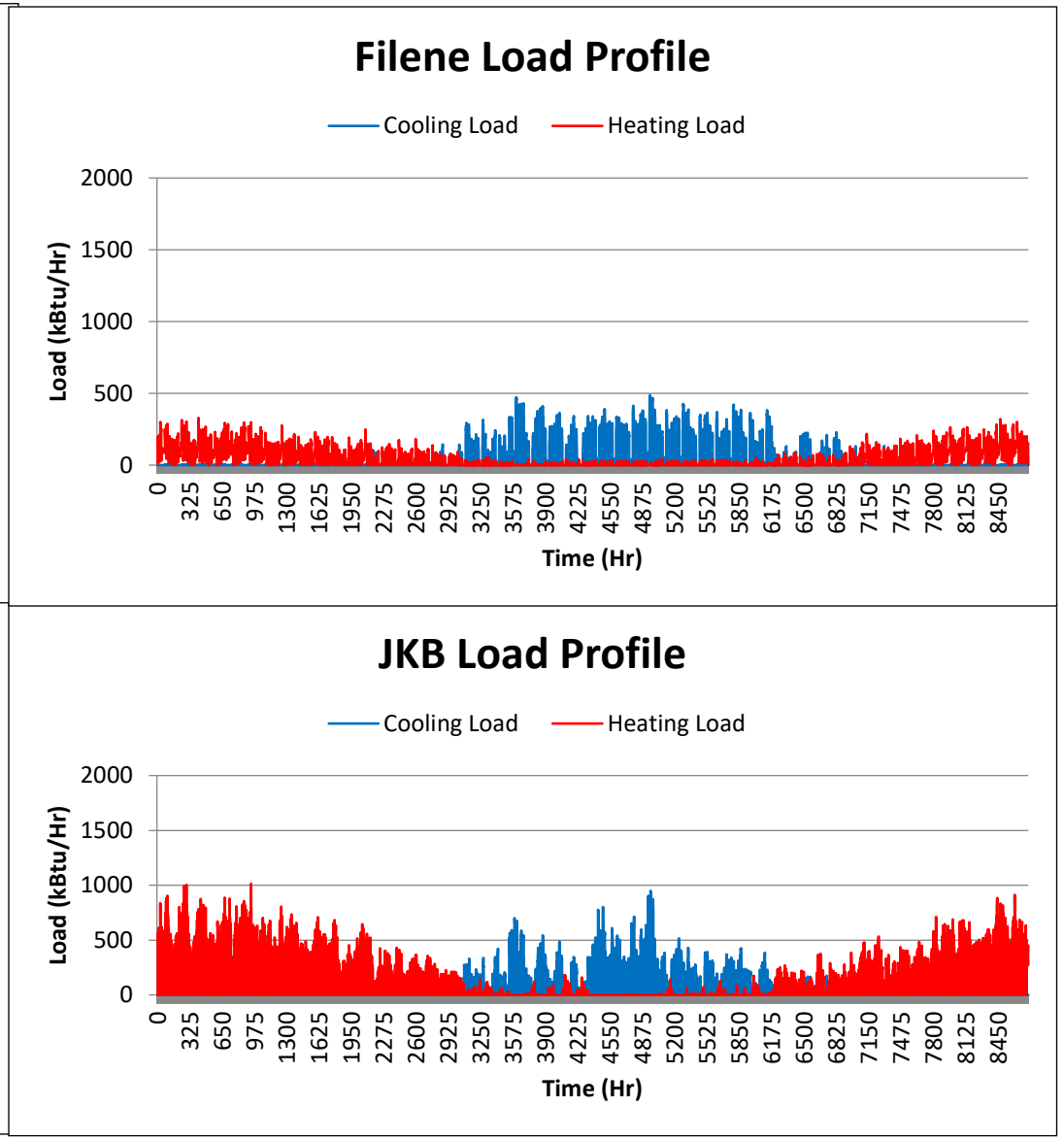




Regulatory considerations may justify districts, even if none of the conditions are present!

Individual Building Profiles – Arts Quad Node



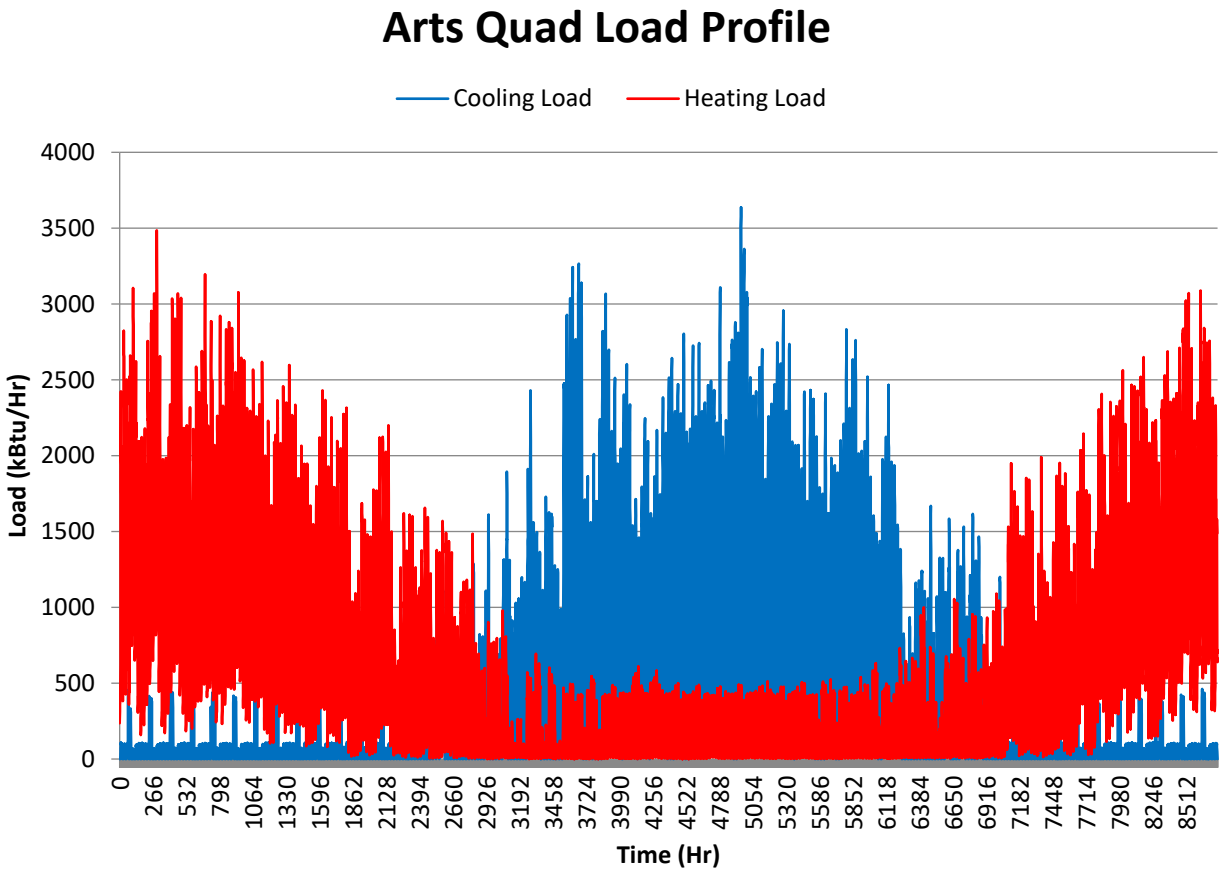


Skidmore College
Saratoga Springs, NY

Networked Geothermal Heat Pump Systems / Alternative to Natural Gas

John P. Ciovacco

Combined Building Profiles – Arts Quad Node



Loop Field Size Savings -Art Node

	# of Loops	Depth	Total Length
Zankel	35	500	17,500
Sasselin	60	500	30,000
JKB	32	500	16,000
Filene	9	500	4,500
Total	**136**		
Combined Loads	**102**	500	51,000

25 % Reduction in Loops

Thermal Energy Network Basic Components

Source: NYSERDA Community Heat Pump Program

1. Building conversions to heat pumps

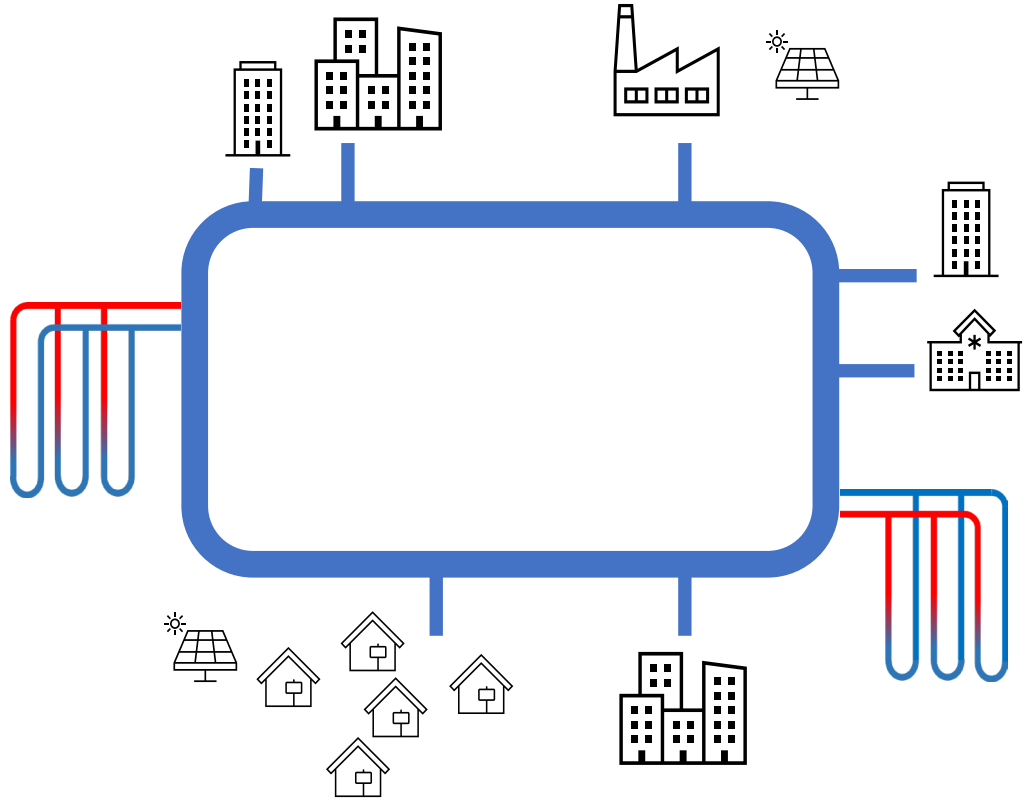
- Located in buildings or central energy plant
- Exchange (extract or reject) thermal energy with the loop

2. Thermal piping network / loop

- Connects multiple buildings to each other and to thermal sources / sinks
- Circulates water or a non-combustible fluid to transfer thermal energy

3. Thermal sources / sinks

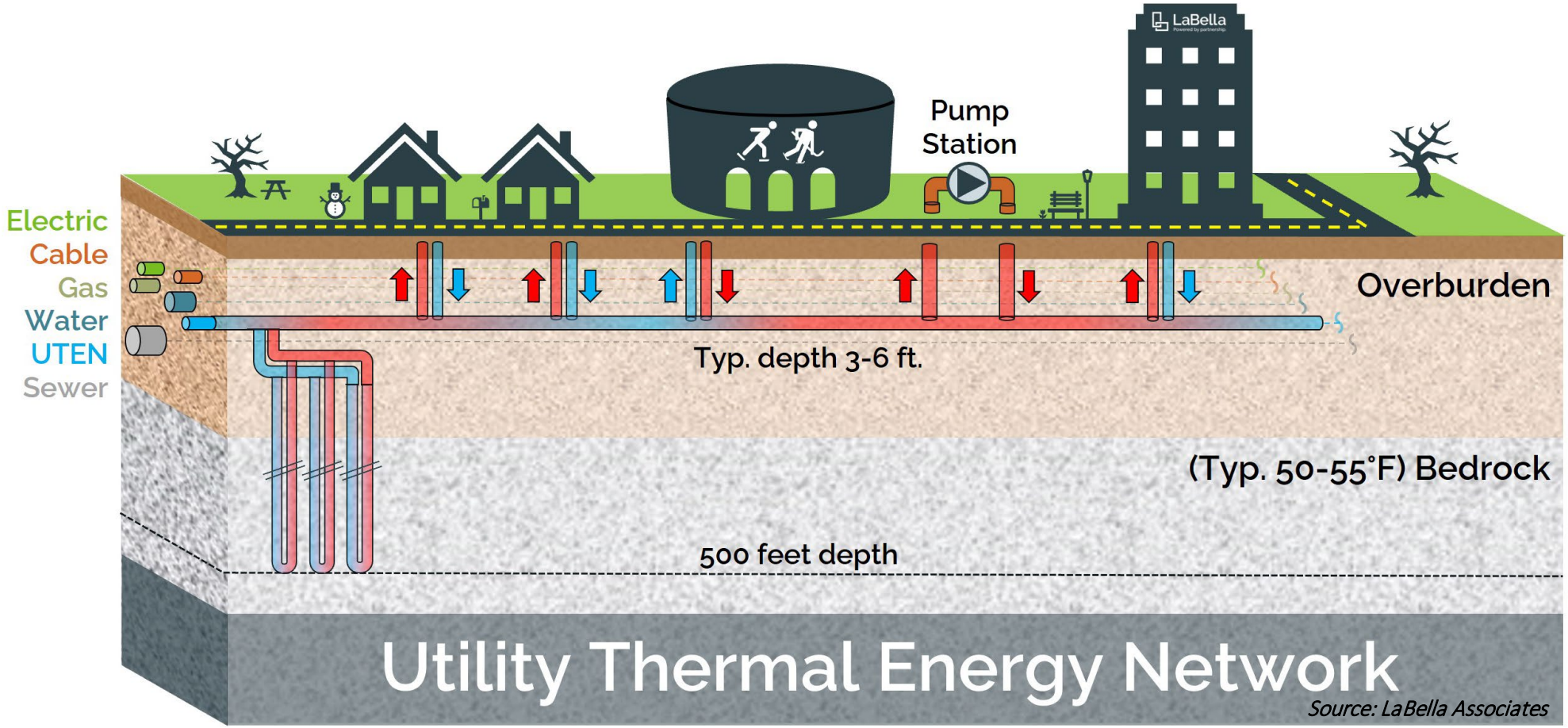
- Geothermal boreholes / ground loops
- Surface water: river, lake, pond
- Waste heat: industrial facility, data center, refrigeration
- Wastewater
- Air



4. Potential upgrades to local electric system

- Local electric load analysis
- Consider demand reduction measures (e.g., Smart Panels)

Regulated Utilities Engage Networked Geothermal



Sample Site Selection Decision Matrix

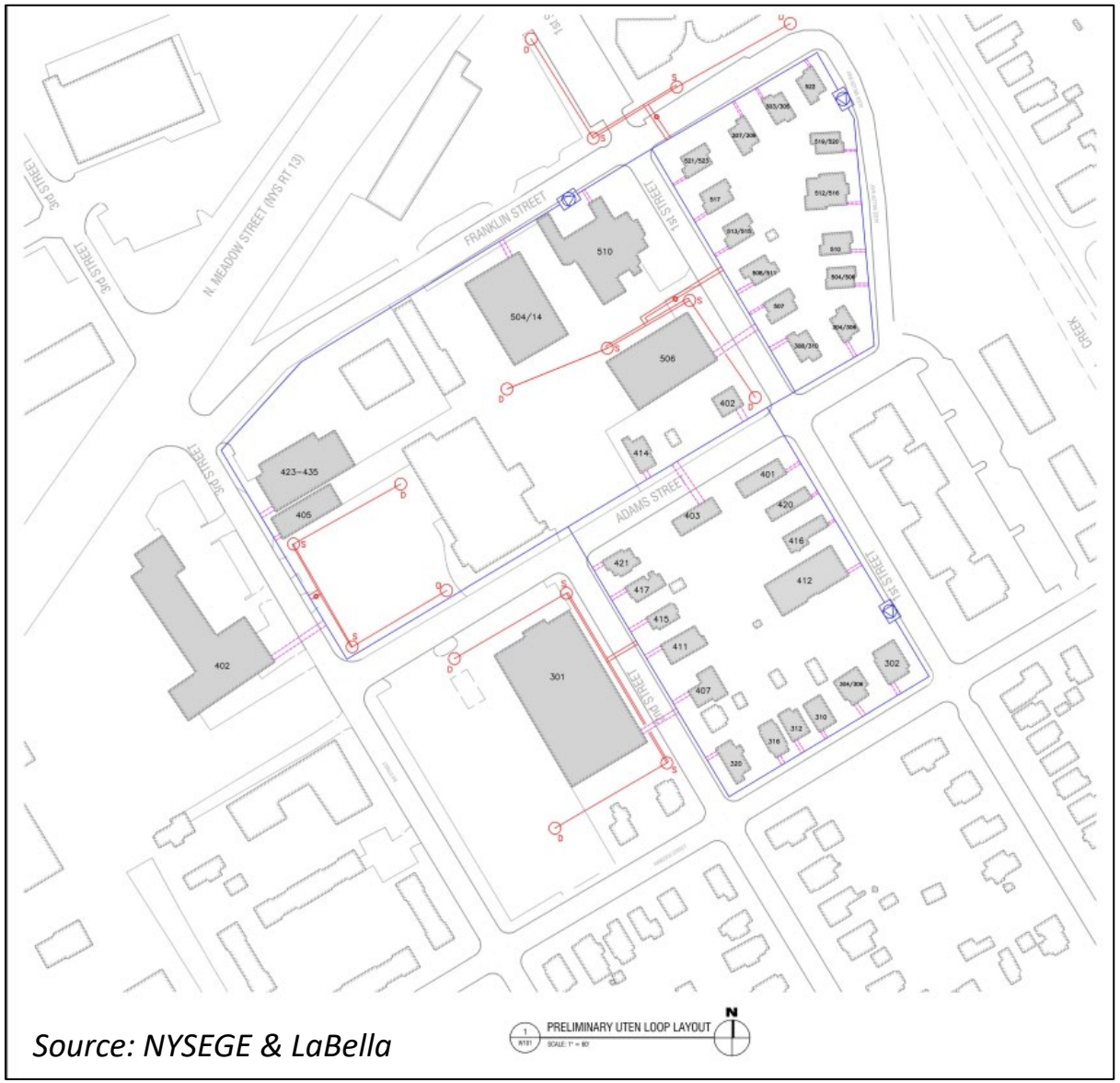
Geothermal District Energy Study - NYSEG and RG&E, May 2022

Table 3: Decision Matrix

Candidate Decision Matrix	Criteria								Weighted Total
	Load Diversity	Building Diversity	On-site Thermal	On-site Electric	Expandable	Replicable	Ease of Conversion	Conversion Risk	
Site	20%	10%	15%	5%	15%	10%	10%	15%	100%
Tops Plaza	10	9	10	7	10	10	7	8	9.2
Greene Town Center	6	6	9	7	6	8	8	7	7.1
Oneonta, B&G Club	7	7	10	10	6	9	8	8	7.9
Price Chopper / CVS	10	9	8	6	7	10	7	9	8.5
Cooper Vision	8	5	9	6	6	6	8	6	7.0
Brockport Corner Mall	7	8	6	5	8	8	9	8	7.5
Spectrum Comm Ctr	8	10	10	7	8	9	8	9	8.7
Dept Motor Vehicles	9	9	10	8	8	8	6	9	8.6
Purity Ice Cream Area	10	9	9	7	8	9	7	7	8.5
Groton Elementary Area	3	6	9	10	3	9	10	10	6.9

Source: LaBella Associates

NYSEG'S UTEN Proposed Project – Ithaca, NY



Source: NYSEGE & LaBella

Open Loop Geothermal System

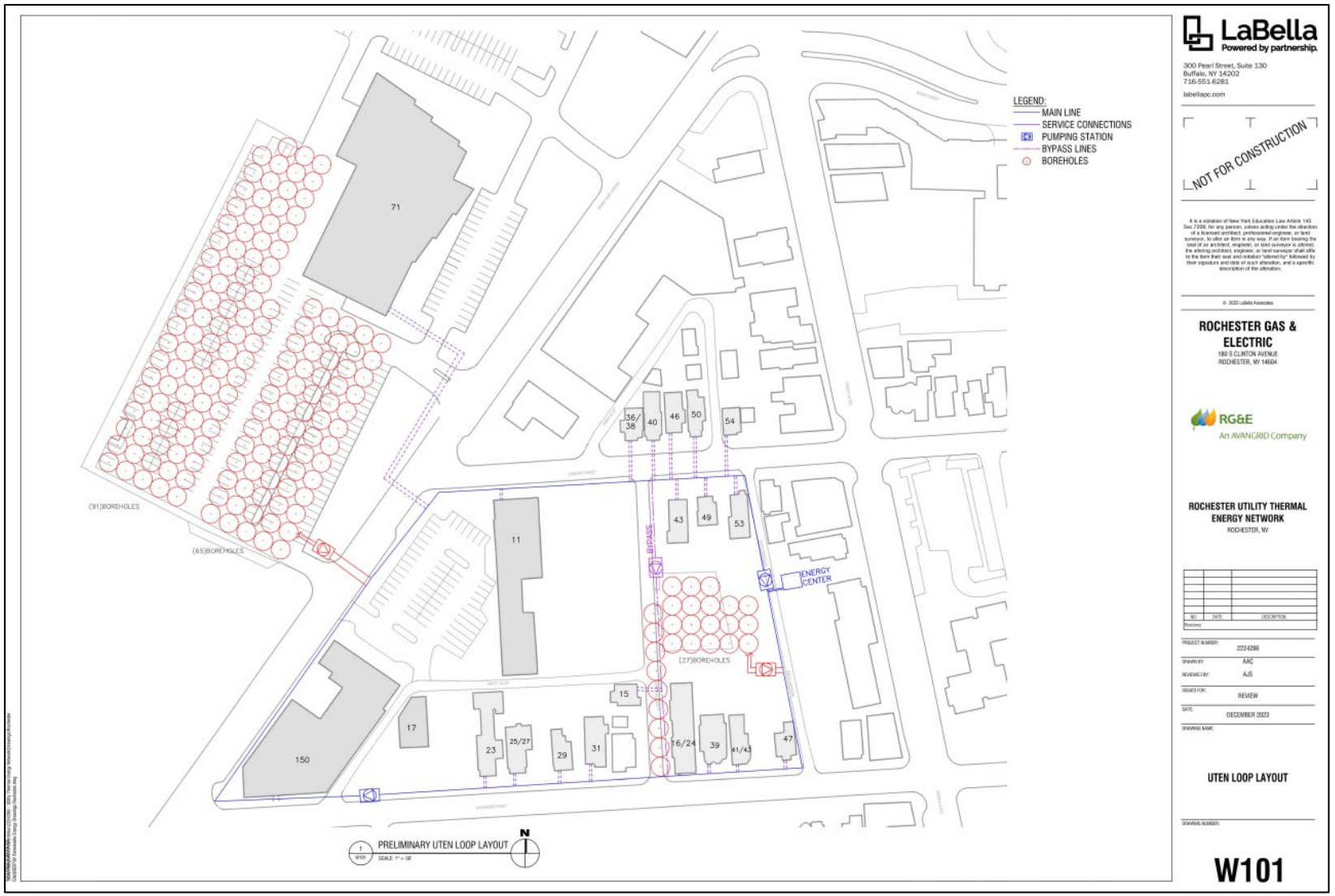
- 8 Supply Wells Proposed
- 8 Discharge Wells Proposed
- Additional DEC Permitting Requirements

39 Proposed Buildings

- 8 Non-Residential Buildings
- 31 Residential Buildings

- Project area is inclusive of a grouping of Ithaca Neighborhood Housing Services homes.

RG&E's UTEN Pilot Project - Rochster, NY



Closed Loop Geothermal System

- 183 Wells Proposed
- 300 Foot Well Depth

21 Proposed Buildings

- 4 Non-Residential
- 17 Residential

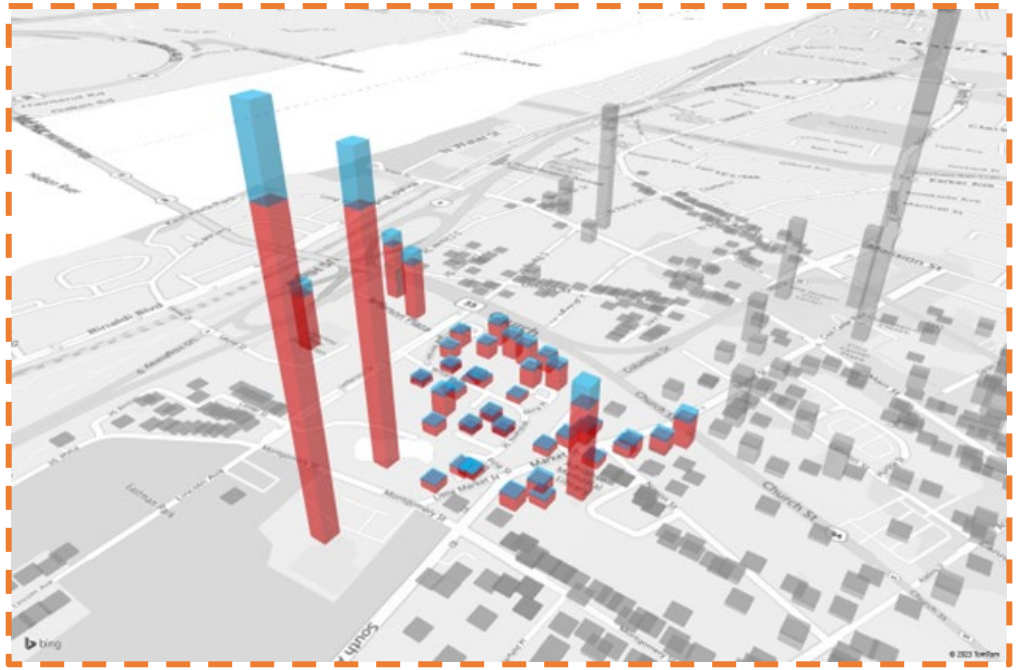
- Natural Gas peak shaving boiler proposed to reduce the total number of required geothermal wells.

NYSEG · RG&E
Part of the Avangrid family

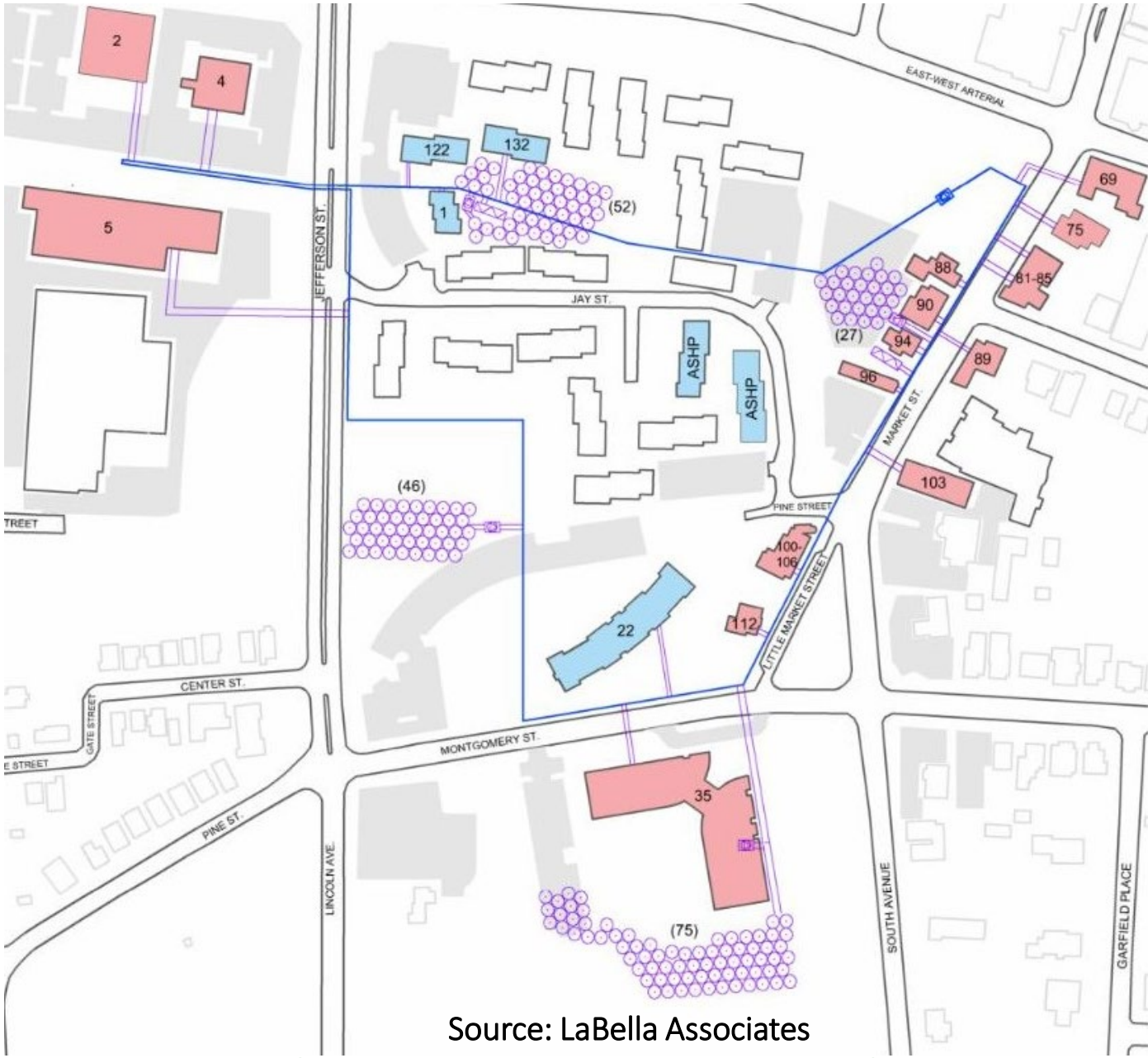
Central Hudson's Poughkeepsie UTEN Proposed Project

- 15 commercial buildings
- 6 residential buildings
- Peak Load: 623 tons

Estimated Thermal Loads



Commercial Buildings | Residential Buildings | Parking Lots



Source: LaBella Associates

Eversource – Framingham Networked Geothermal Pilot

- Project began with rate case in 2020 and site section work starting in 2021
- One pipe system of ~ 1 mile of 8” main
- 37 buildings with 140 individual customers
- 90 boreholes to provide capacity of ~375 tons of load

Source: Eversource Energy
Geothermal Pilot Update
Webinar Oct. 18, 2023

Eversource Energy's Framingham, Massachusetts Networked Geothermal Pilot

Source: Eversource Energy
Geothermal Pilot Update
Webinar Oct. 18, 2023

Eversource – Framingham Networked Geothermal Pilot

❖ Celsius Energy Angled Drilling

Source: Eversource Energy
Geothermal Pilot Update
Webinar Oct. 18, 2023

Eversource – Framingham Networked Geothermal Pilot

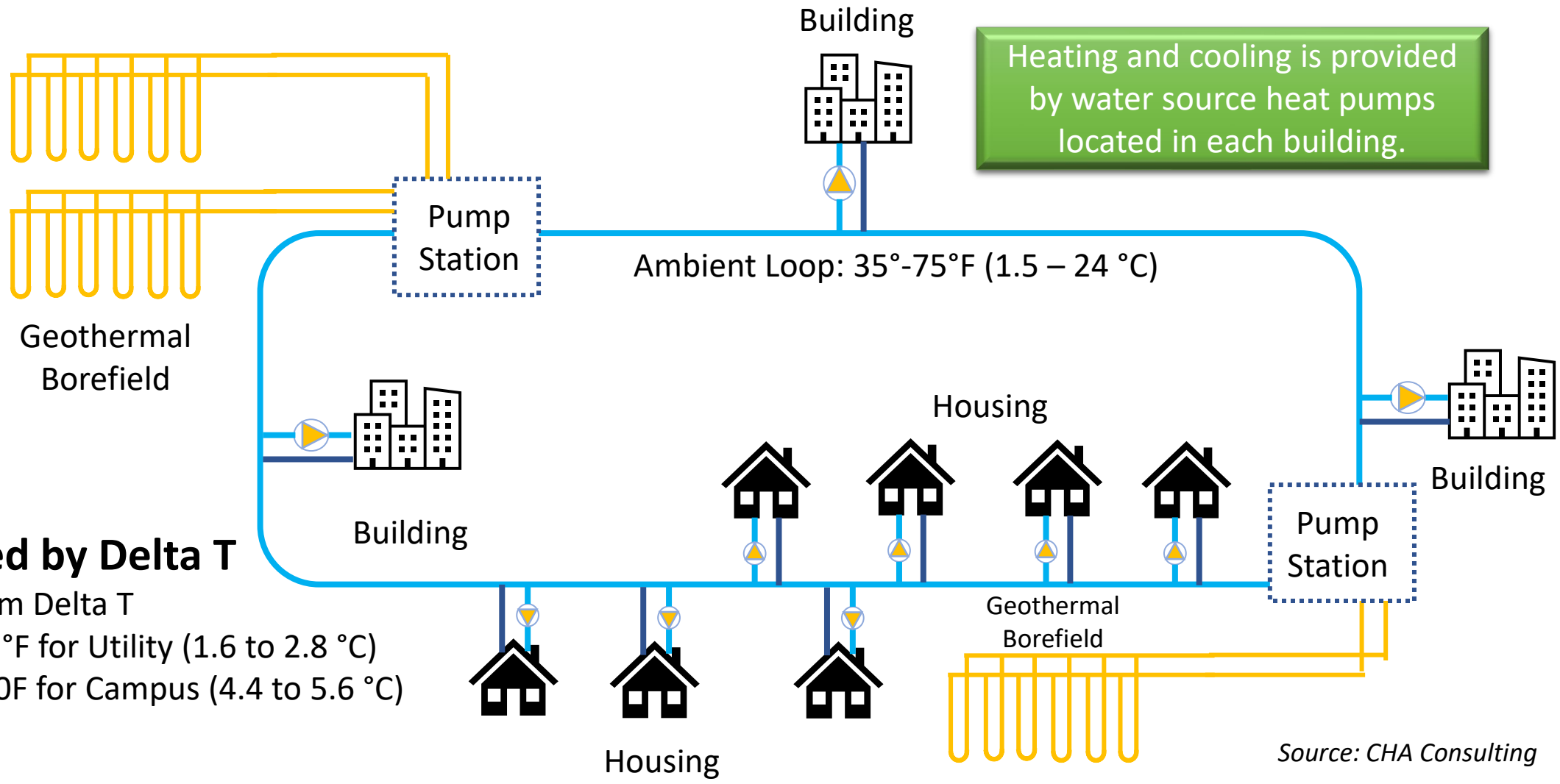
Source: Eversource Energy
Geothermal Pilot Update
Webinar Oct. 18, 2023

Networked Geothermal Heat Pump Systems / Alternative to Natural Gas

John P. Ciovacco

Networked Geothermal System Configuration

One-Pipe Ambient

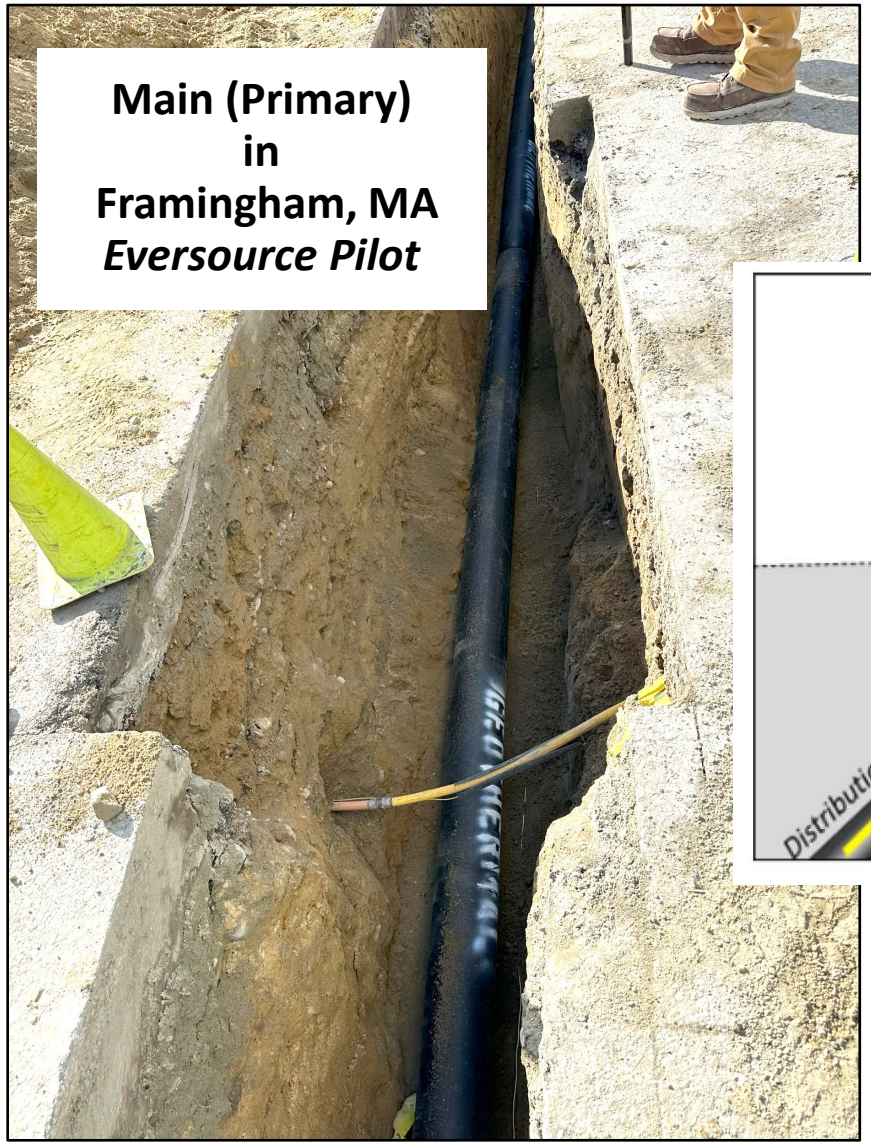


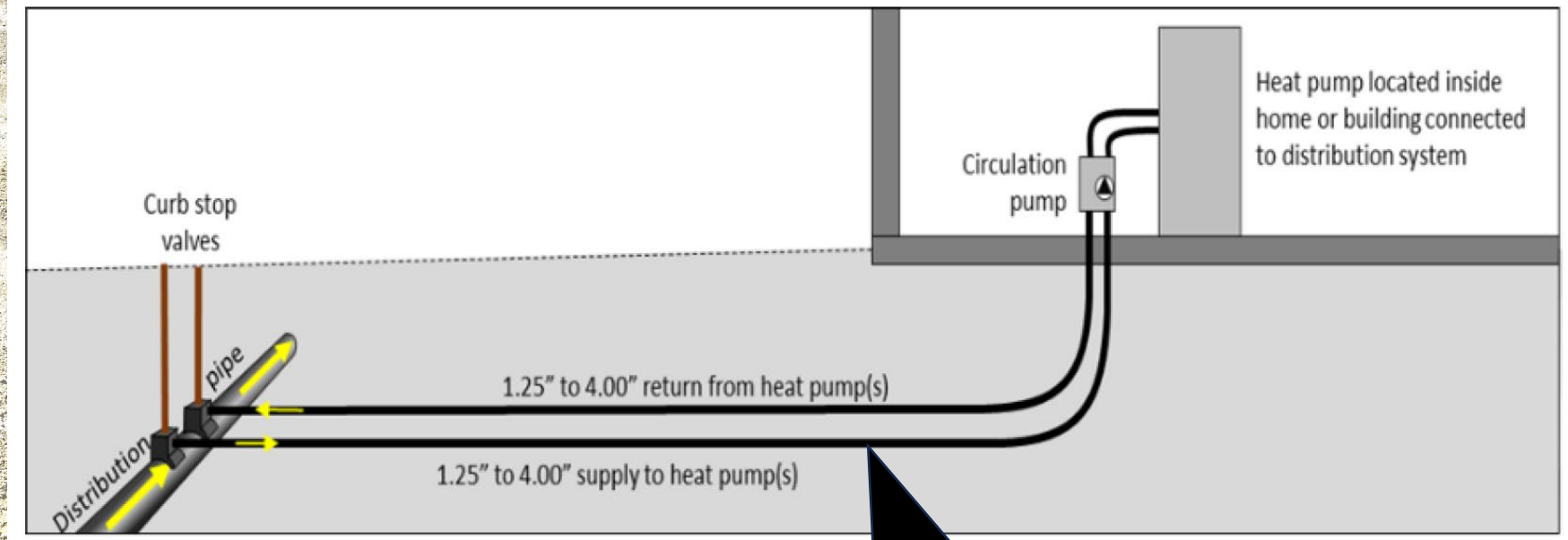
Controlled by Delta T

- Set System Delta T
  - 3F to 5 °F for Utility (1.6 to 2.8 °C)
  - 8F to 10F for Campus (4.4 to 5.6 °C)

Source: CHA Consulting

One-Pipe Systems (Most Common Design)
Mains & Service Lines – Primary/Secondary





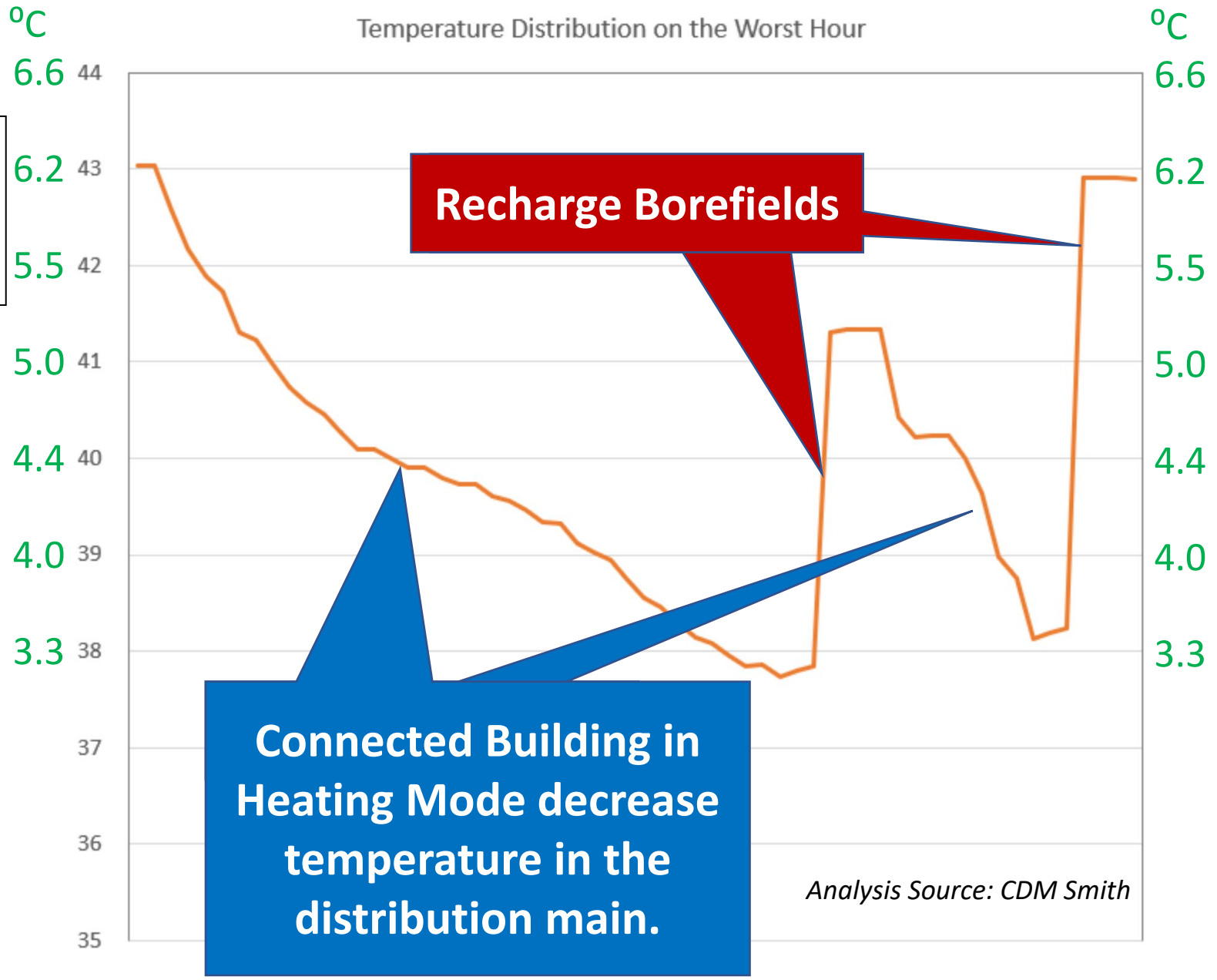
Supply and Return
Service Lines (Secondary)
Connecting Buildings

TRNSYS Modeling

TRNSYS : Transient System Simulation Tool

TRNSYS (pronounced tran-sis) is a flexible graphically based software environment used to simulate the behavior of transient systems.

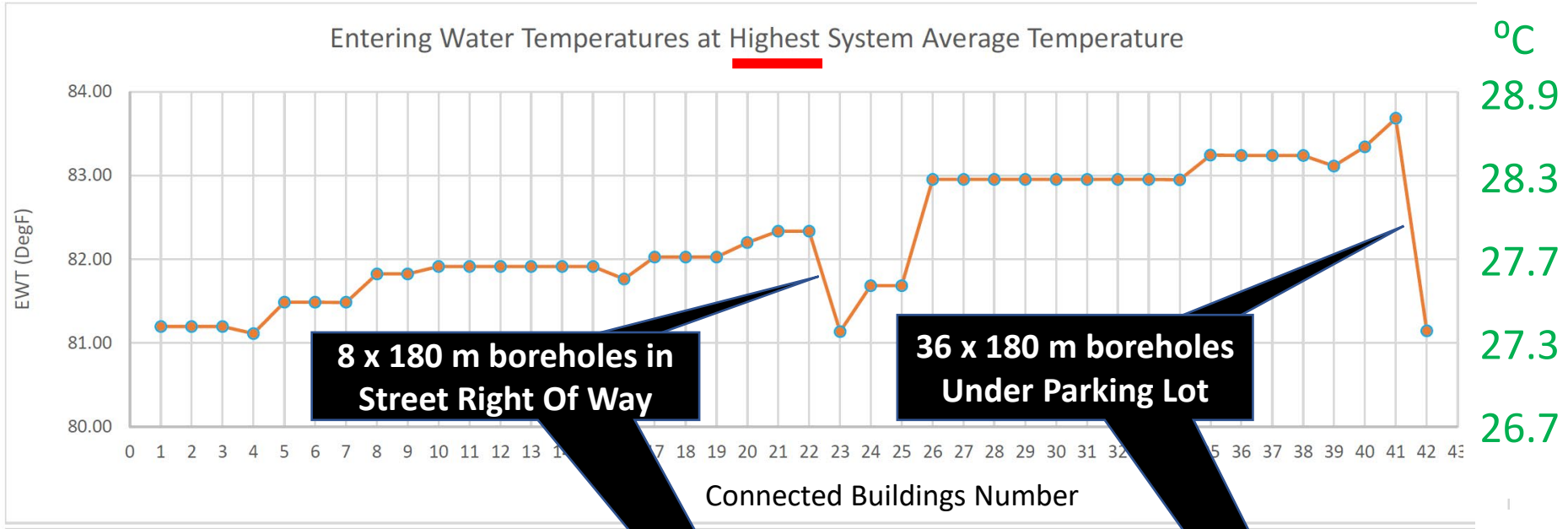
- System delta-T set to ensure customers get similar entering water temperatures
  - 3F to 5 °F for Utility (1.6 to 2.8 °C)
  - 8F to 10F for Campus (4.4 to 5.6 °C)
- Recharge Borefields boost temperature



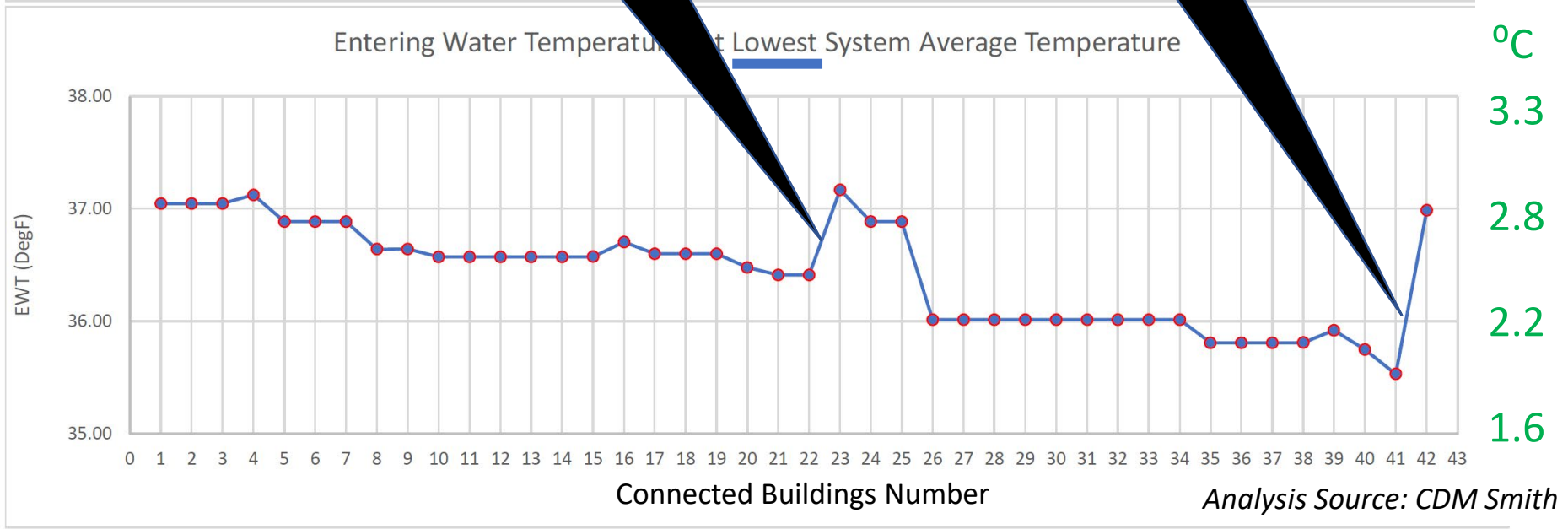
Utility Pilot TRNSYS Modeling – Lowell Massachusetts

42 connected buildings • 2 borefields with 44 boreholes • 200mm distribution main

Summer System Peak Day



Winter System Peak Day

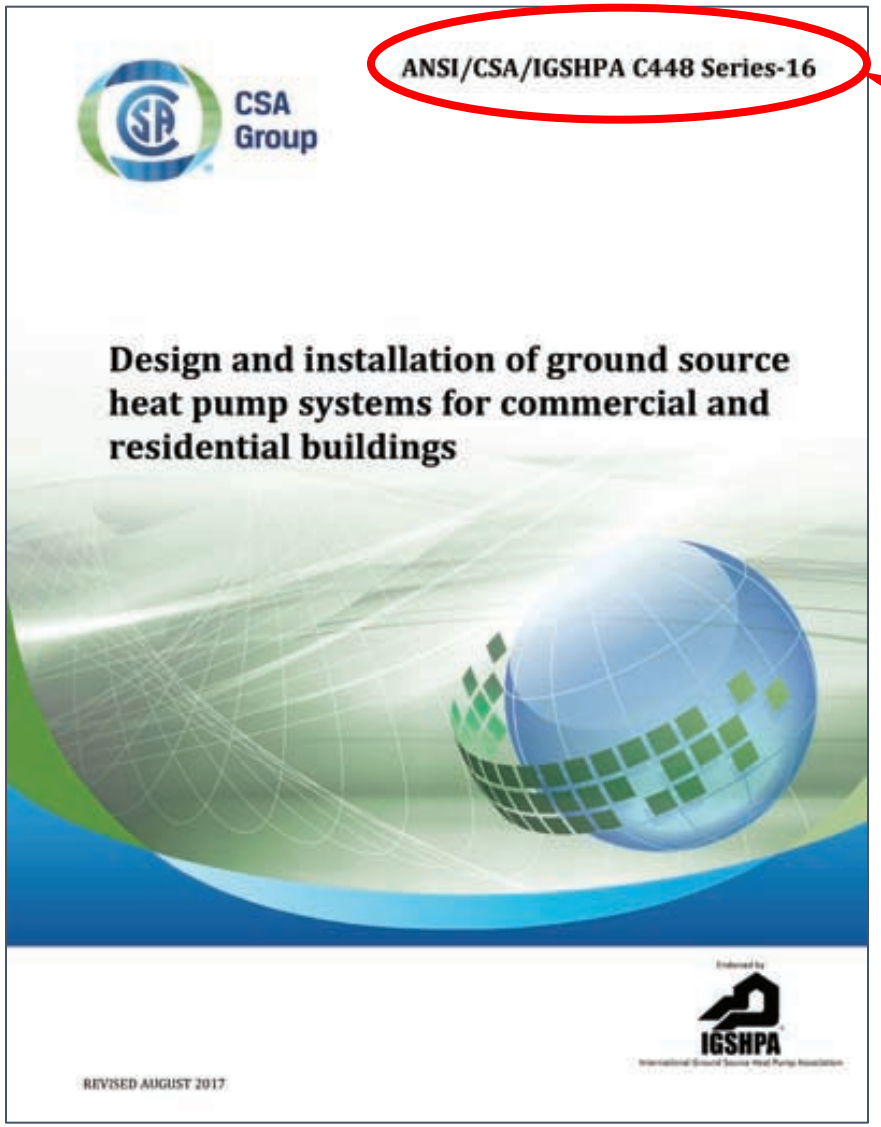


Analysis Source: CDM Smith

Networked Geothermal

Codes, Standards and Tools: Networked Geothermal

Industry Design & Installation Standards



Combined Canadian (CSA) & American (IGSHPA) Standard to be updated end of May 2025

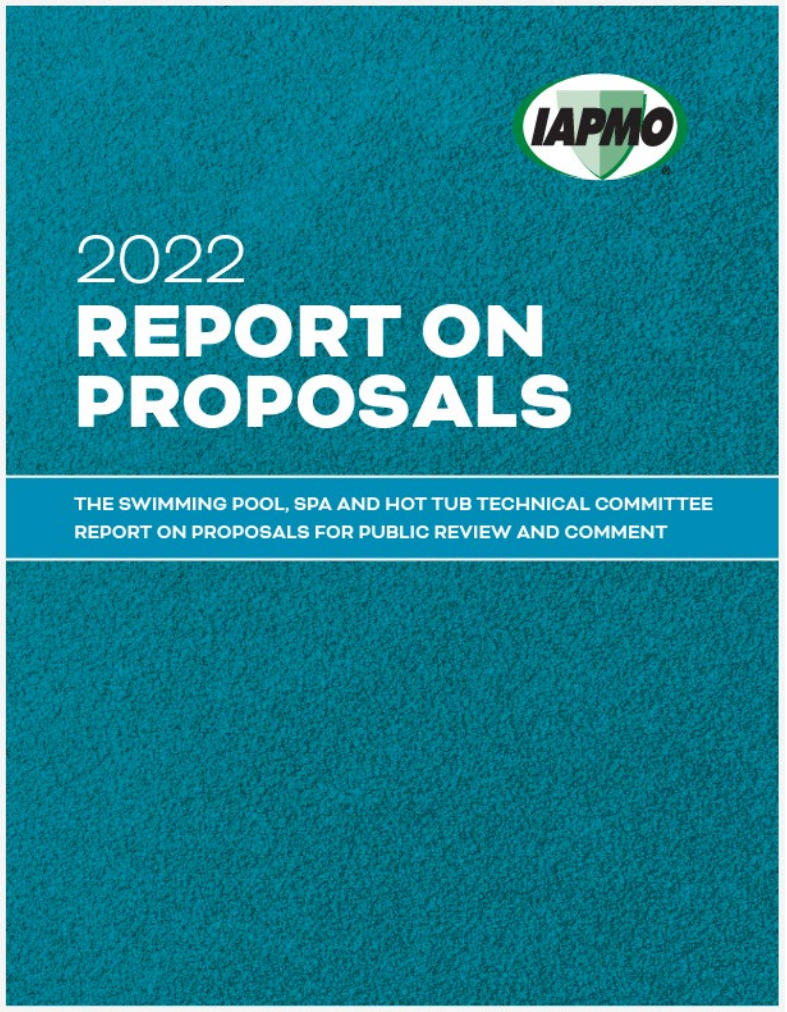
- US and Canadian collaboration through the ANSI process
- Both residential and commercial geothermal systems
- Variety of different types of heat exchangers
- Serves as the best reference document for Authorities Having Jurisdiction (AHJ) regarding the installation of geothermal systems
- Upcoming 2024 Revision - New Sections
  - Energy Foundations
  - District Energy Systems
  - Wastewater Energy Transfer Systems

Code Development:

IAPMO Ambient Temperature Loop (ATL)

Specifically designated ANSI/CAN/IAPMO Z1381-202X

- This code development applies to the district ATL piping systems used in distributed energy systems
- Directed at water-source HVAC equipment in a closed-loop piping arrangement
- Integrates various heat sources and sinks
- Maintain the loop fluid temperature near the long-term average ambient temperature for a specific project location
- Will serve as a reference standard other codes:
  - Uniform Plumbing Code (UMC)
  - Uniform Solar Energy & Hydronics Code (USHGC).



Ground Loop Sizing Software

Uses outputs from common Building Energy Modeling Software

Ground Loop Design

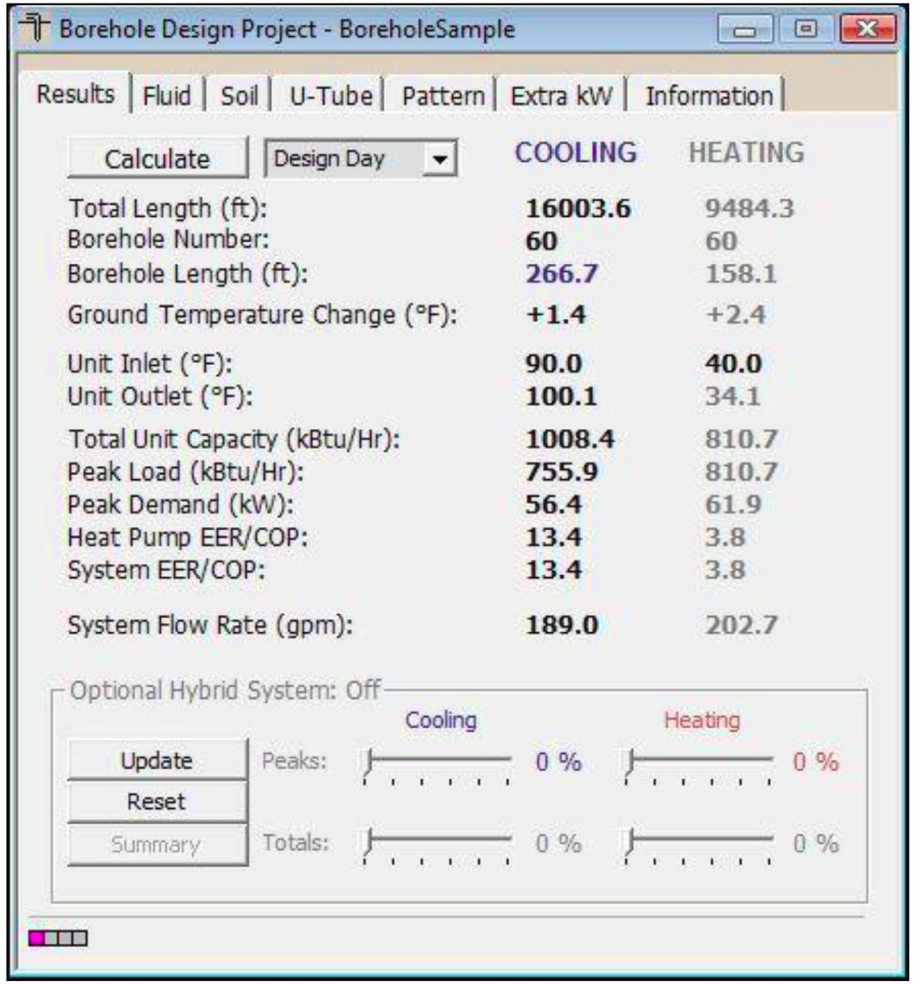
- GeoLink [WaterFurnace Residential]
- GLD [Ground Loop Design]
- Loop Link/Loop Link Pro [Web-based tool]
- GLHEPro Version 5.0
- and others……

System Design

- TRNSYS
- DesignBuilder

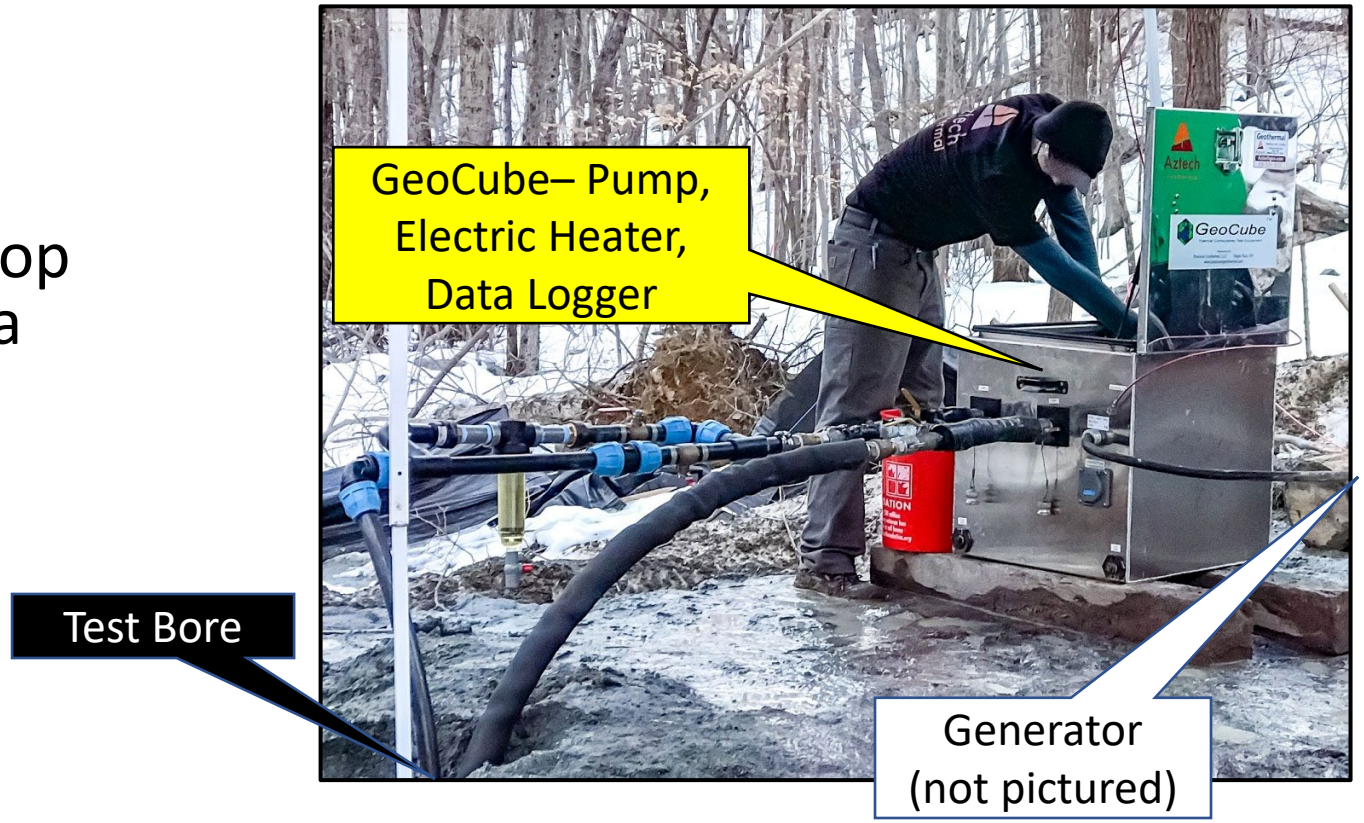
GSHP Feasibility

- GeoFease



Formation Thermal Conductivity (FTC) Test

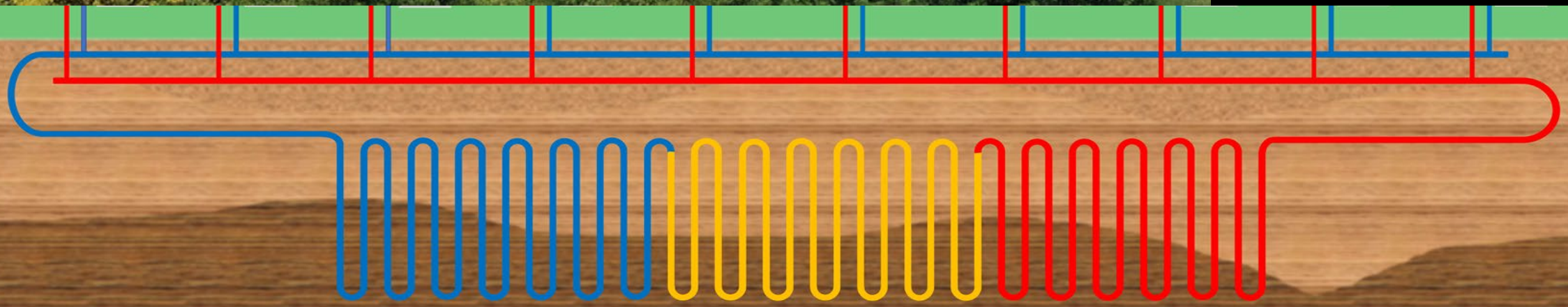
- An FTC Test is conducted on a sample borehole from a large project (~30 tons or more)
- The results will be used to recalibrate amount of ground loop needed based on measured data from the site
  - Conductivity is the speed at which heat flows through the earth under a given temperature gradient
  - Diffusivity is the speed the temperature will decay in the local earth after a heat input is removed
  - Undisturbed Formation Temperature is the mean ground temperature at 30+ feet (generally)



Source: Aztech Geothermal Field Test March 2021

Thank You & Questions?

John Ciovacco
Aztech Geothermal, LLC
(518) 309-2000
jciovacco@aztechgeo.com



Additional Resources

NY-GEO 2025 Conference – Saratoga Springs, NY

THERMAL ENERGY NETWORKS TRACK

YouTube Recordings (soon!) and Presentation Downloads.

1. **Establishing a Thermal Energy Network Program**
2. **Thermal Energy Network Resources**
3. **The Science of TENs - HEET**
4. **Network Modeling Tools**
5. **Approaches to Community Scale Electrification**

NY-GEO 2024 Fall Conference – Brooklyn, NY

For [YouTube Recordings and Sessions Downloads.]

THERMAL ENERGY NETWORKS TRACK

1. **NYSERDA Large-Scale Thermal Program**
   - Campus, Private and Municipal TEN Projects (NYS)
2. **Eversource's Networked Geothermal Pilot**
3. **Creating the Market for Networked Heat Pumps in Europe**
   - UK (Kensa Group) , France (Celsius Energy)
4. **Thermal Energy Network Activity in North America**
5. **Building Regulatory Standards for Thermal Energy Networks**

NY-GEO 2024 Spring Conference – Albany, NY

All 24 Presentations (Slides & YouTube) available for each session at www.ny-geo.org

Utility Thermal Energy Networks (UTEN):

Progressing through stage gate process

Moderator: John Ciovacco / *Aztech Geothermal*

- Joseph Hitt / *NYS Dept. of Public Service*
- Cole Burgess / *NYSEG · RG&E*
- Owen Brady-Traczyk / *National Grid*
- Katelyn Tsukada / *Con Edison*
- **Presentation Deck** • **YouTube Recording**

Opportunity Presented by Municipal & Private Thermal Energy Networks

Moderator: Donovan Gordon / *NYSERDA*

- Sue Dougherty / *NYSERDA*
- Tim Banach / *Endurant Energy*
- John Tesh / *CHA Consulting*
- Dan Sergison / *Salas O'Brien*

Presentation Deck • **YouTube Recording**

Con Edison's Katelyn Tsukada speaks at the UTEN session on April 9th @ NY-GEO 2024 Spring Conference in Albany, NY

NY-GEO 2023 Conference

Networked Geothermal Track (5 sessions)

All 42 Presentations (Slides & YouTube) available for each session at www.ny-geo.org

NETWORKED GEOTHERMAL

The Birth of Thermal Utilities

1. **Mapping the Journey to a Thermal Market**
2. **Measuring Success:** *The Data We Need*
3. **The Policy and the People:** *We Need to Clear the Path Ahead*
4. **The Utility of a Utility**
5. **Scaling Efficiently:** *How We Will Build a Thermal Grid Together*

Sponsored by: heet

NY-GEO 2023 Conference

Additional Networked Geothermal Sessions

Regional Networked Geothermal Initiatives

Moderator:

John Ciovacco / *Aztech Geothermal, NY-GEO BOD*

[Session YouTube Recording]

Presentation Deck:

[Regional Networked Geothermal Initiatives]

Site Selection for Geothermal Networks

Moderator:

Joseph Hitt / *NYS Department of Public Service*

[Session YouTube Recording]

Presentation Deck:

[Site Selection for Geothermal Networks]

All 42 Presentations (Slides & YouTube) available for each session at www.ny-geo.org