Phoenix ENERGY SUPPLY

Presents

Trench Talk

The Nitty-Gritty of Geothermal Design & Installation

An Educational Series of Webinars to Sharpen the Skillls in the Art of Geothermal System Design, Installation and Service

0

Phoenix Energy Supply is pleased to present

Trench Talk

A series of live webinars to serve the geothermal community

"Coppertop"

Tuesday May 9, 2023, 4 PM EDT

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Thanks to today's Sponsor

Providing turnkey vertical and horizontal ground loops for the geothermal heat pump market in New York State.

https://www.sourcerockgeo.com

(814) 449-3318 **sourcerockgeo@gmail.com**

2

2

First Law

energy can neither be created nor destroyed, only altered in form

3

3

Units of Energy

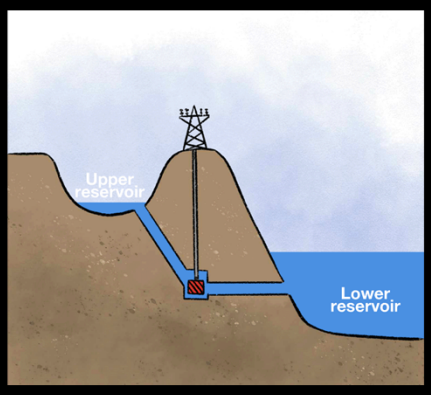
- BTU – British Thermal Unit
- KWH – Kilowatt-hour

1 KWH = 3,412 BTU

"What's in a name? That which we call a BTU, by any other word would still be energy."

4

Storing Energy



Each of these has a <u>value</u> reflecting the cost and overall benefit

5

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The Most Interesting Man?

6

Jens Ponikau

7

Geothermal:
The Ultimate Storage Solution

Jens Ponikau
President New York Geothermal Energy Organization
Buffalo Geothermal

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeothermalHeating.com

1

Buffalo Geothermal

- Specializes in medium and large scale multifamily and commercial projects, especially retrofits
  - Certified Geothermal Designers
- Design-Built only
- Vertically integrated
  - Design
  - Installation
  - Manufacturing
  - Focused on quality and efficiency
  - Fixed cost pricing

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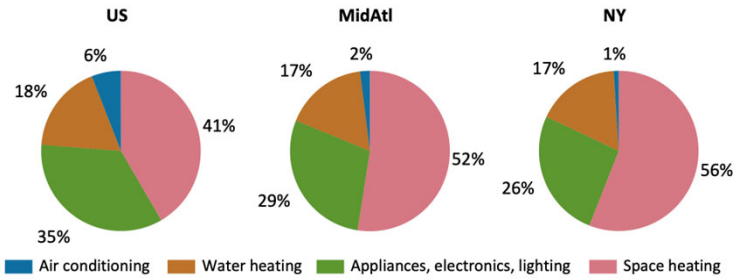
Fossil fuels are used mainly for Heating/Hot Water (North Eastern U.S.) in Buildings

1% of total building energy use (A/C) creates a 7 GW higher summer peak versus winter peak (NY)



CONSUMPTION BY END USE

Since the weather in New York is cooler than most other areas of the United States, space heating (56%) makes up a greater portion of energy use in homes compared to the U.S. average, and air conditioning makes up only 1% of energy use.

https://www.eia.gov/state/print.php?sid=NY

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Cooling Tower and Heating Plant operating at the same time

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Significant different winter peak performance between technologies (Brattle Report Rhode Island)

COP ASHP = 1.3, GSHP (Geo) =3.6

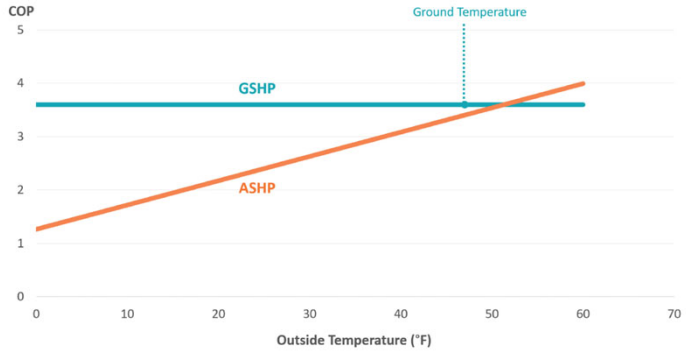

FIGURE 9: RELATIONSHIP BETWEEN OUTDOOR TEMPERATURE AND HEAT PUMP EFFICIENCY (COP)

5

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New Efficiency: New York Analysis of Residential Heat Pump Potential and Economics

Final Report | Report Number 18-44 | January 2019

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Table 4-3. 2018 Statewide Residential and Commercial Thermal Load (Space Heating and Cooling)

End Use	Statewide Residential & Commercial Load (TBtu)
Space Heating	557
Space Cooling	221
Total	778

6

New Efficiency: New York

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Analysis of Residential Heat Pump Potential and Economics

Table 2.2 - FLH Appropriate for Use with GSHP Nominal Capacity	
Albany	1,345
Binghamton	1,534
Buffalo	1,415
Massena	1,469
New York (LGA)	1,222
Poughkeepsie (Newburgh)	1,350
Syracuse	1,412

Statewide weighted average EFLH = 1,321

BTU to Watt conversion factor = 3.412

Heating load = 557 TerraBTU

Peak Load = 557,000 Giga BTU/(3.412 x 1,321)

= 123.58 Giga Watt

- Without the hot water load
- Without Process heat
- Without EV charging

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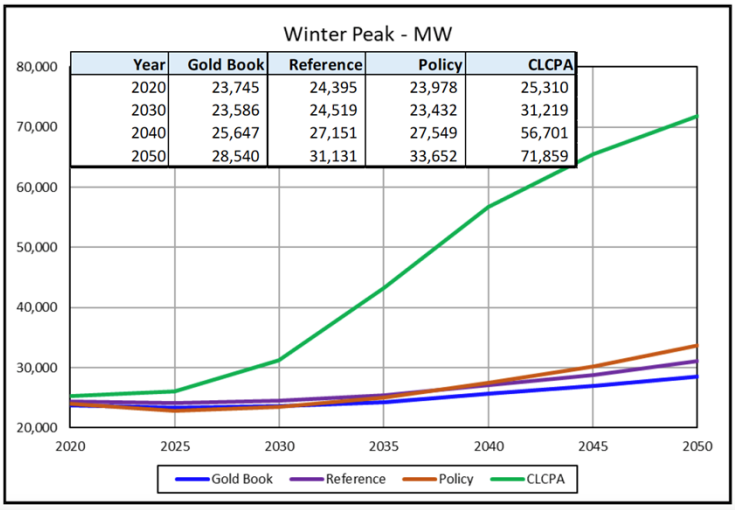
NYISO winter peak impact projection

Figure 47: Winter Peak Forecast Comparison



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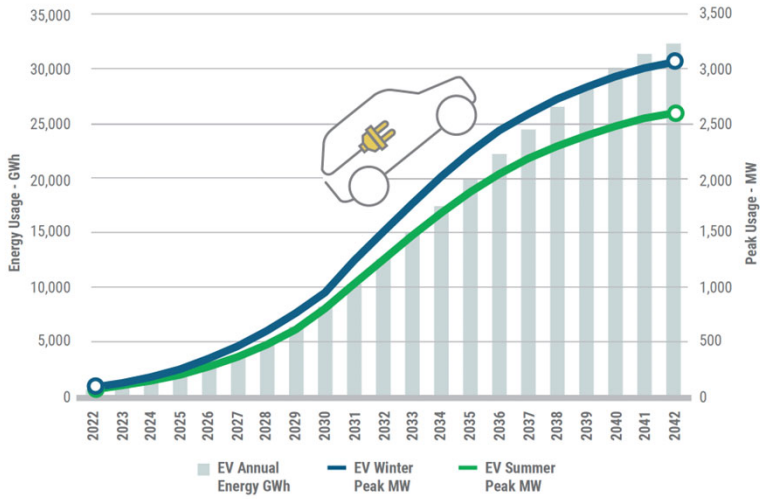
Heating Peak Dwarfs Electric Vehicle Peak

Figure 8: **Electric Vehicle Energy and Peak Impacts - Baseline Forecast**



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Current Plans for battery storage in NYS

- New York will deploy 3,000 MW of energy storage by 2025 and 6,000 MW (6 GW) by 2030
  - https://www.nyserda.ny.gov/All-Programs/energy-storage
- With a 100 GW peak load after electrifying buildings, will last….
  - 4 minutes !

10

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NYSERDA Geothermal Heat Pump Study 2017
Peak Thermal Load Occurs Between 7 - 8 am

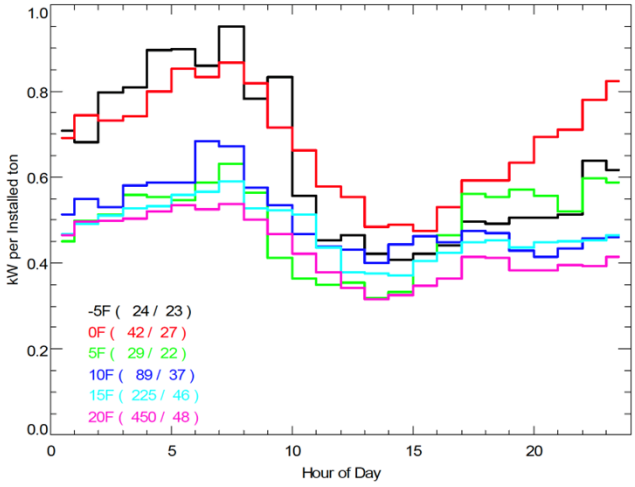

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Figure 22. Average Winter Electric Demand Profiles at Various Outdoor Temperatures

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- (15) 400-ft wells - all within 15% Building's footprint
- Footprint of building would enable up to 30 stories above
- 67 ft/ton

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60 Geothermal Heat Pumps

Qty	Description	Capacity (Tons)
50	Single-stage Water-to-Air HP's for Apts and Corridors (Waterfurnace)	0.75 – 1.0
2	Dual-stage Water-to-Air HP's for Common Areas (Waterfurnace)	3.0
6	State of the art, Variable-speed, Water-to-Air HP's for Commercial Spaces (Waterfurnace)	5.0
2	High temperature, Water-to-Water HP's to generate 100% of the Domestic Hot Water for the Building	5.0

15

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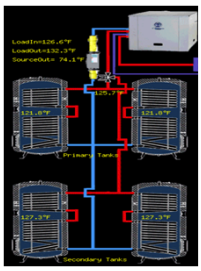

DHW Staged Design

- Staged Design with Preheat – Final Heat
- 1st multi-family building to make 100% of DHW With Geo using Preheat Design
- Uses rejected heat in apartment A/C mode to make hot water. Even though the building is located in a cold-climate (CZ-6) the building is cooling-dominant
- The central DHW system is designed to keep the loop field colder, saving substantial well depth (more than 2 wells @ 500')
- The capital cost savings of shorter loop field completely offset the cost of the DHW HP Equipment
- DHW Capital Costs is literally free
- 4x 162-gallon storage tanks to meet the projected peak hot water usage
- 2x Water-to-Water Heat Pumps allows for redundancy (1x would meet the full DHW load)

Key innovation of our geothermal design

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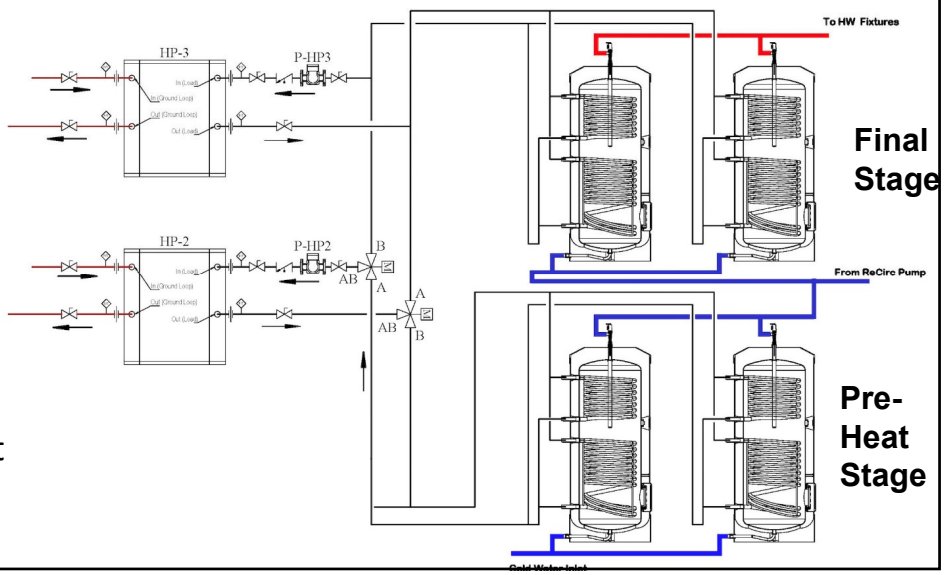
WWHPs and Storage Tanks

- Two WWHPs
  - One serves final-stage tank
  - One HP serves pre-heat tank
- Tanks operate at different temperatures……. SO heat pump COPs are different



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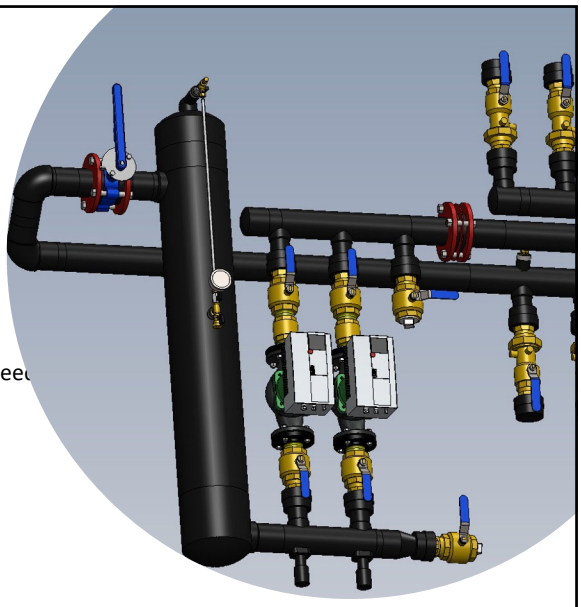
Other Design Features

- Central adaptive pumping solution
  - Average Pumping Power to Date: 396 watts
- Balanced header system
  - No balancing valves
  - No flow restriction, reduced pumping power
- Variable speed pumping
  - Only as much pumping power as needed
  - Revs up and down with the amount of heating and cooling nee and number of heat pumps operating
- No backup heat
  - No gas line in the building, completely emission free



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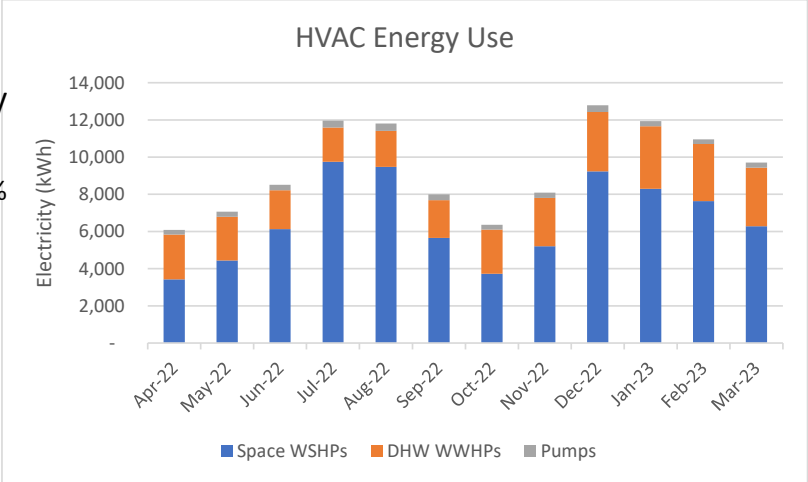
Energy Use Results

Baseline for New Construction (from NYSERDA BEEM) Space heating & DHW: 17,135 therms
Space Cooling: 22,175 kWh

- WSHP energy use
  - Monthly kWh and peak kW higher in winter
- Year-round WWHP Use
- Loop pumping power is only 2-4% of total heat pump power, 15 W/ton peak
  - Best practice is usually 8-10% and 60 W/ton for single family
- Total annual mech energy use is 113 MWh, or 1.8 kWh/sq-ft-yr
- Multifamily space htg & clg is 1.4 kWh/sq-ft-yr



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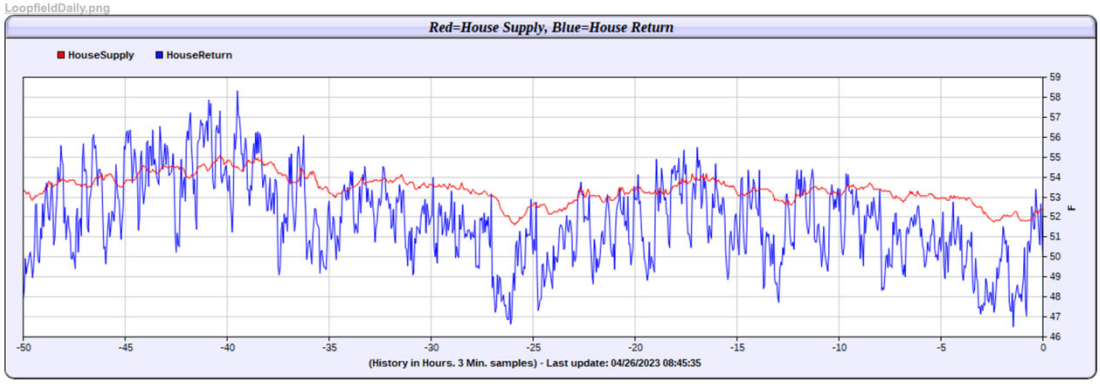
50 hour Loop Water Temperatures
Reacting immediately to energy input and output
Similar to an electric grid battery



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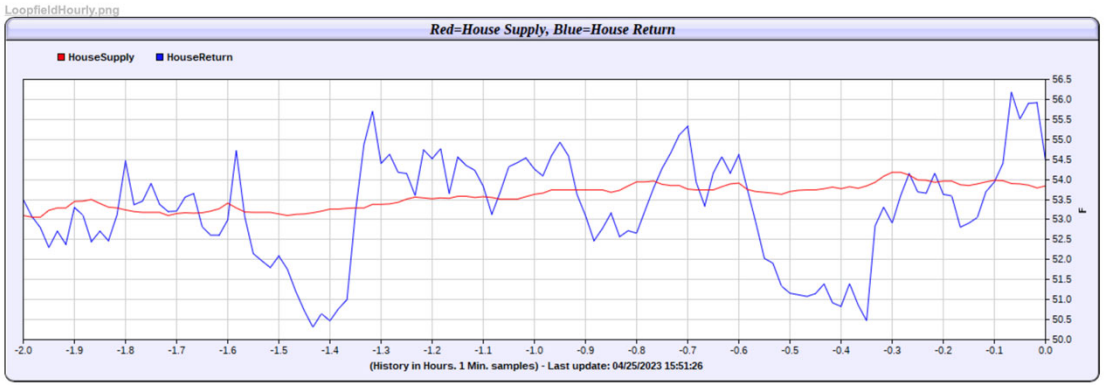
2 hour Loop Water Temperatures
Reacting immediately to energy input and output
Similar to an electric grid battery



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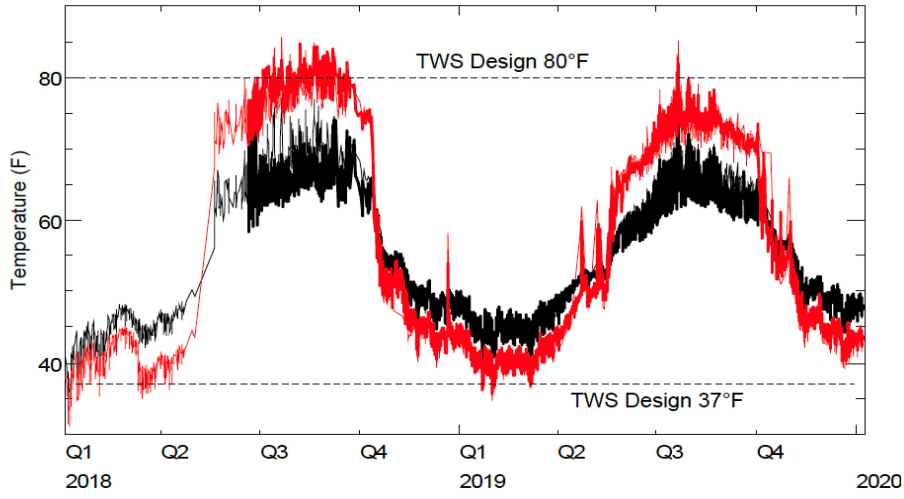
Annual Loop Field Performance

Figure 14. Loop Supply (TWS) and Return (TWR) Temperatures (thick lines are Main Loop)



KEYSPAN GAS EAST CORPORATION d/b/a NATIONAL GRID:
GEOTHERMAL GAS REV DEMONSTRATION PROJECT – FINAL REPORT

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If we would have a battery which….

- Provides 75% energy for a home
- On a 6” footprint
- For a 6 month period (winter)
- Recharged by solar in the summer

- We would not have a grid anymore!

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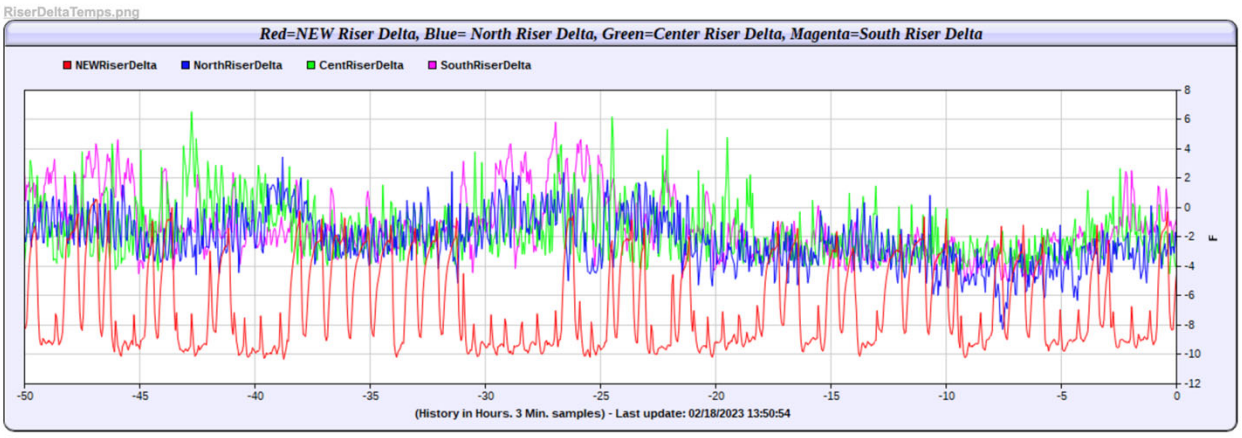
Heat extraction vs heat rejection

Space conditioning vs DHW production 48 hour period

Southern oriented heat pumps operate in A/C mode, sending thermal energy to DHW and northern heat pumps



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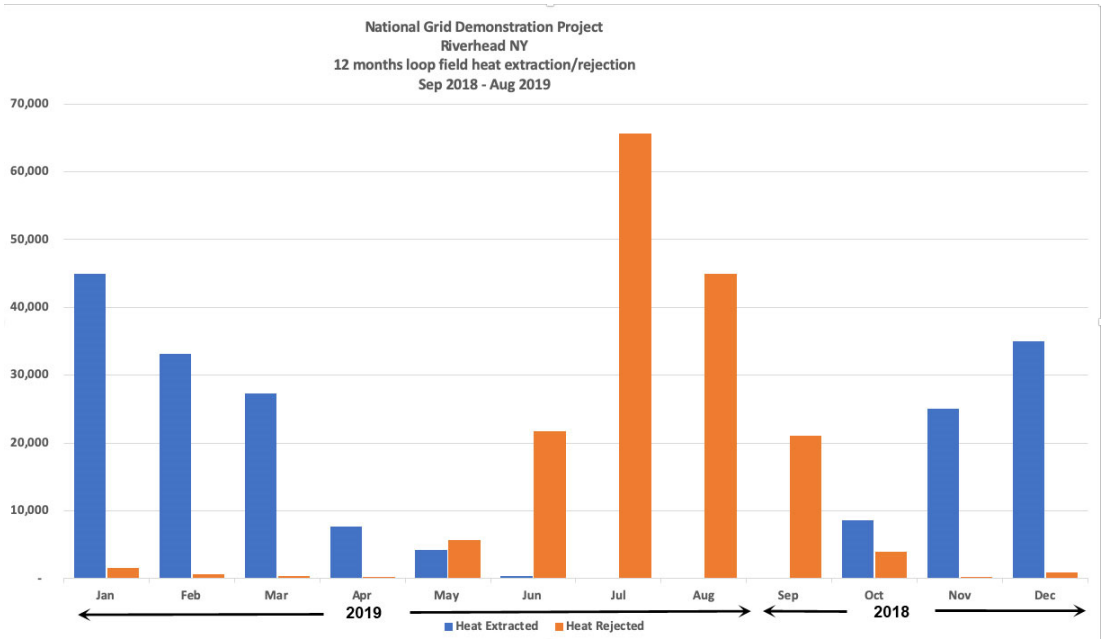
Loop Field Rejection/Extraction



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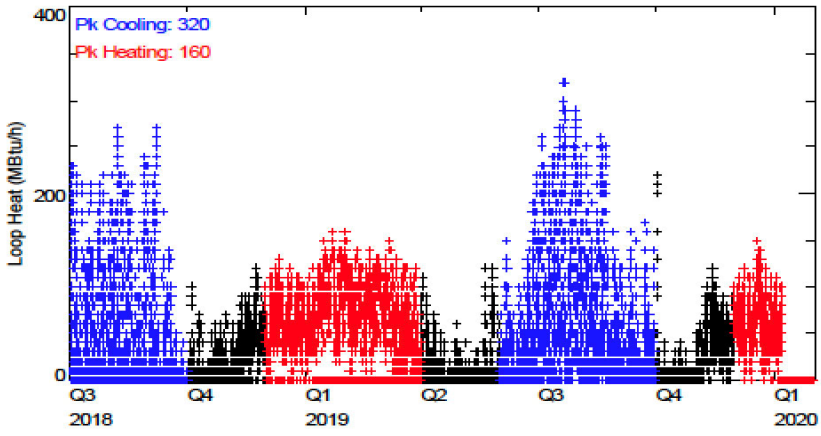
Peak Loads Imposed on Ground Loop:

Twice as high in the summer as in the winter

Figure 15. Plot of Hourly Loads Imposed on the Ground Loop



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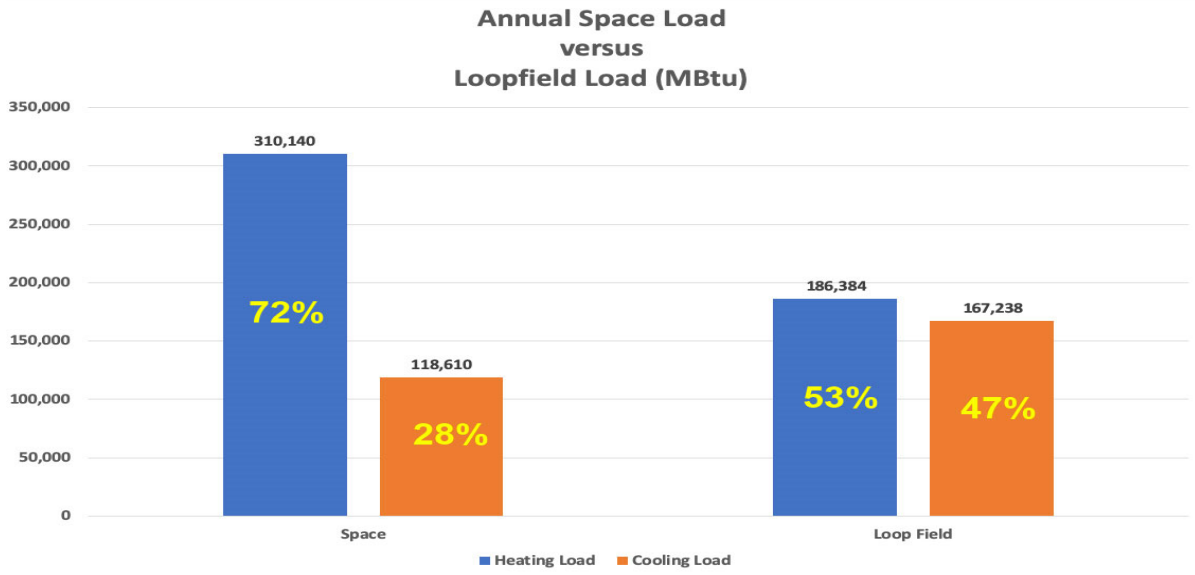
Loop Field Performance

Space Load versus Loop Field Load



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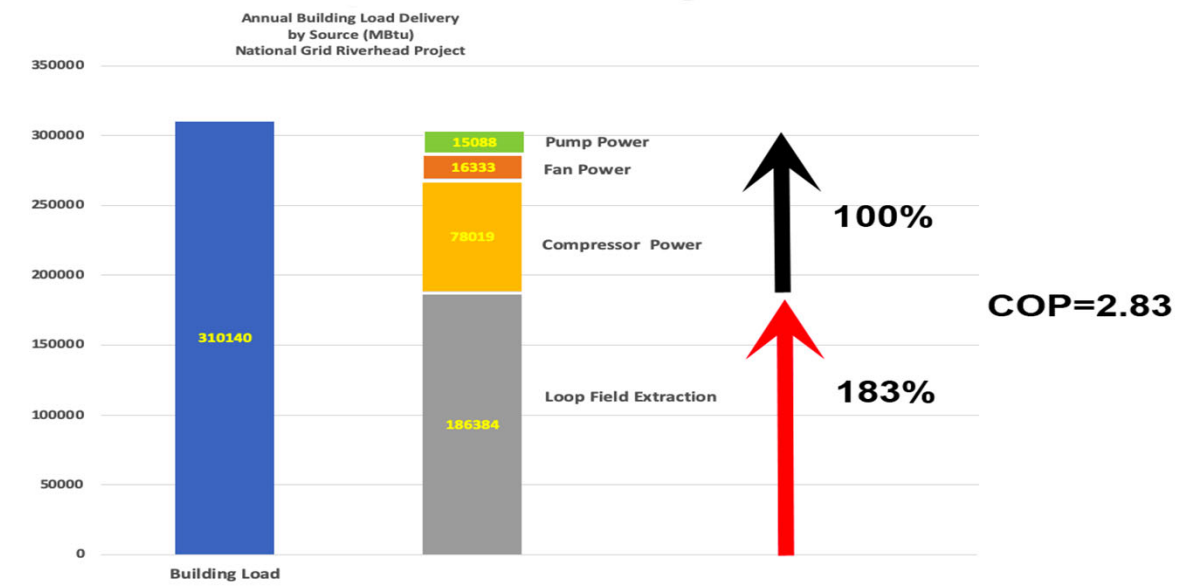
Source of Heat Delivered

In Heating Operation



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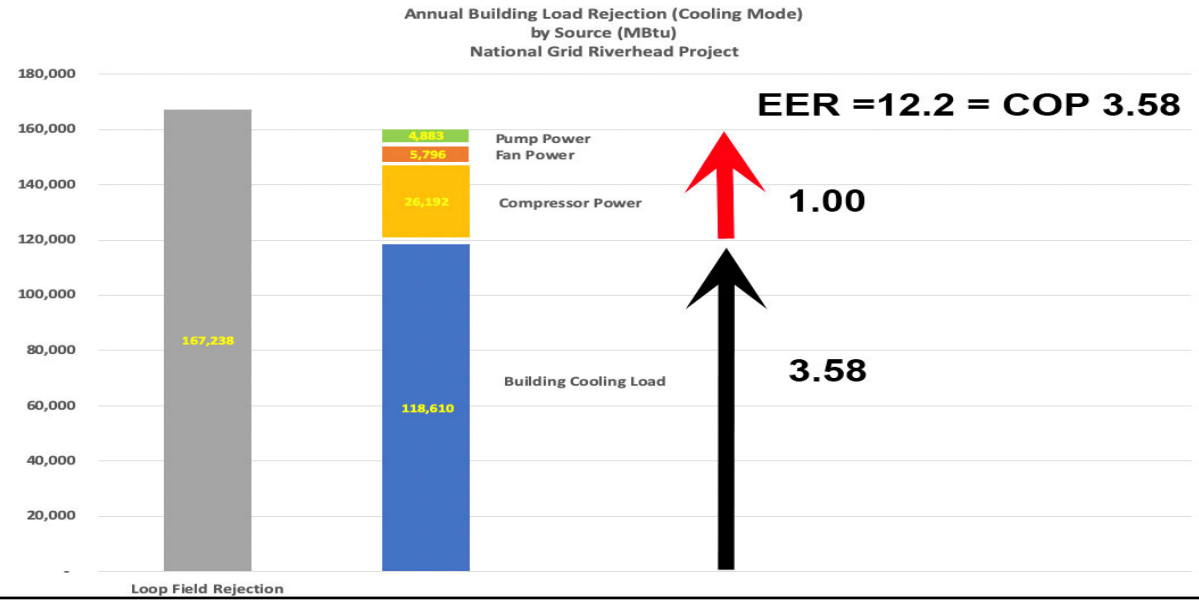
Source of Heat Rejected

In Cooling Operation (simplified)



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The ultimate thermal energy battery

- 1) The loop field stores all the thermal energy of the building in the boreholes for the whole year, enough to provide all the heating energy for the whole heating season.
- 2) It does not need to be connected to other buildings (no district), it makes all the energy it needs. The key is the storage.
- 3) It stabilizes below 30F and does not dip below, since it is making ice around the boreholes, which releases a large amount of heat due to the phase change. It is partly a phase change storage technology.
- 4) It reacts immediately to energy input and output.

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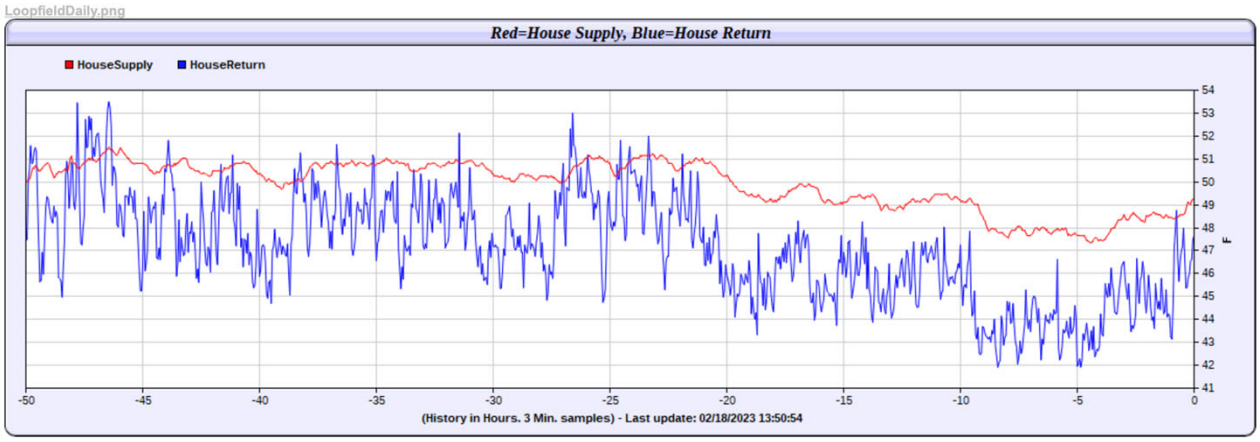
Entering and leaving water temperatures

48 hour period 2/17 -2/18 2023

Loop field increases thermal energy delivery via larger Delta T



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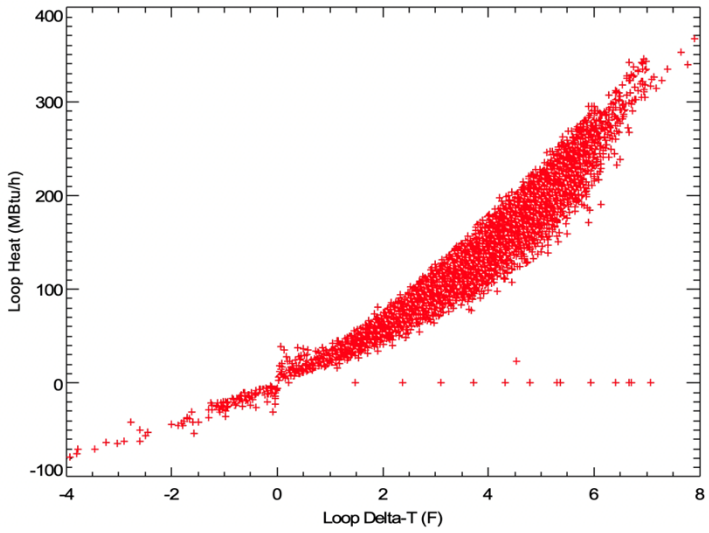
Hourly Heat Extraction ZeroPlace, New Paltz NY
Jan 11th –Feb 12th 2023



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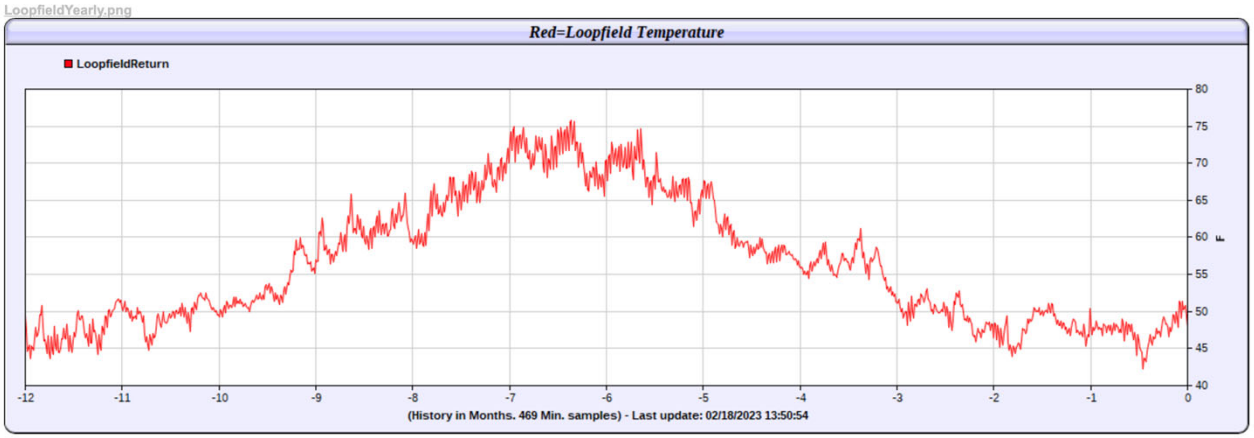
12 Month Annual Entering Water Temperatures 2/18/2022 -2/18/2023 ZeroPlace



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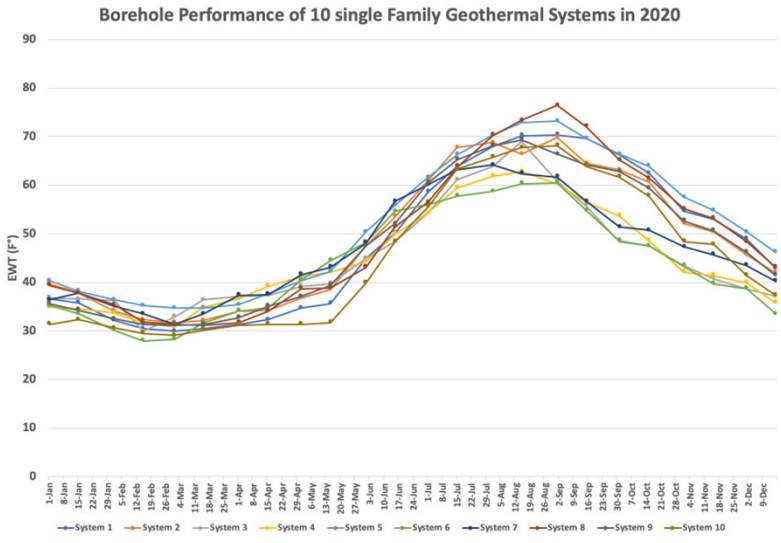
Borehole Performance of 10 Single Family Geothermal Systems in 2020



NYSERDA Contract 174180

Draft Report – October 7, 2022

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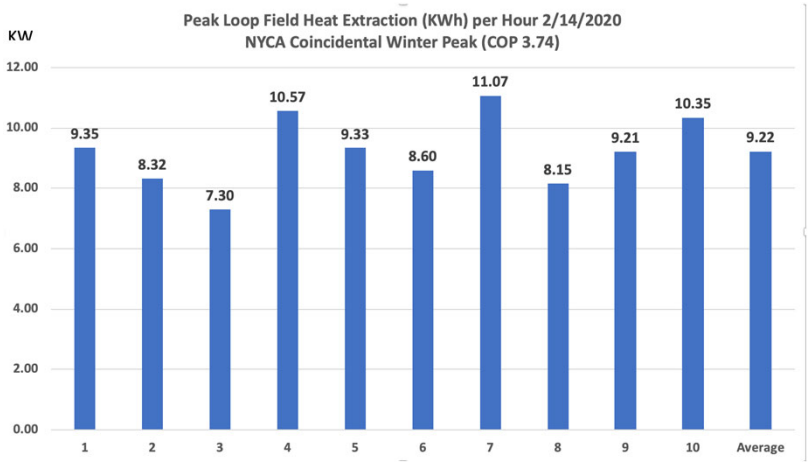
Peak heat extraction of 10 residential systems in Buffalo NY

9.22 kW average



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Average Residential Borehole Thermal Energy Extraction (n=10), Year 2020

Monetary Value

				@ $567/ kWh*
Peak Hour	9.22	kWh	$	5,228
Peak Day (Feb 14)	173	kWh	$	98,203
Monthly Thermal Energy	3.18	MWh	$	1,803,060
Annual	13.05	MWh	$	7,399,350

*"Among projects awarded NYSERDA incentives, average total installed costs for non-residential, retail projects Averaged $567/kWh for installations occurring in 2022 and 2023"
Case 18-E-0130 – In the Matter of Energy Storage Deployment Program.
New York's 6 GW Energy Storage Roadmap Policy Options for Continued Growth in Energy Storage.pdf

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ZeroPlace Loop Field Thermal Energy Delivery

Monetary Value

			@ $567/ kWh*
Monthly Thermal Energy (Jan 11 to Feb 10)	31.38	MWh	$ 17,792,460
Peak Day (Feb 4)	1,706.81	kWh	$ 967,762
Peak Hour	90.86	kWh	$ 51,518
Peak Interval (5-min)	106.98	KW	

*"Among projects awarded NYSERDA incentives, average total installed costs for non-residential, retail projects averaged $567/kWh for installations occurring in 2022 and 2023"
Case 18-E-0130 – In the Matter of Energy Storage Deployment Program.
New York's 6 GW Energy Storage Roadmap Policy Options for Continued Growth in Energy Storage.pdf

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Requirements for Future Heating System

- 1) The heating system's efficiency and capacity must operate independent of the outside temperature
- 2) It must cover the full load without supplement resistance heat.
- 3) It must not only reduce the heating but also the significantly the cooling load.
- 4) It must make all the domestic hot water without electric resistance heat.

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Additional benefits of geothermal geo storage

- No recharge needed for 6 months
  - Electricity generators to recharge are avoided
  - Transmission Lines are avoided
    - Champlain Hudson Power Express $6 billion for 1.2 GW of power supply (summer only)
  - Solar capacity is very limited in the winter months
    - Peak to occur in the early morning hours
  - Wind is intermittent
    - 74 instances in 2020 when NYCA wind fleet output remained below 100 MW for more than 8 consecutive hours (NYISO Power Trends 2021)
  - Recharged automatically in the summer time
  - Capacity does not degrade (in contrast to electric storage)
    - 200+ year life expectancy

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Key Points on Geo as a Storage Medium

1. The experience of European countries that have electrified their building sectors shows that peak demand shifts to around 7 AM before there is solar gain.
2. It is likely that NYS is underestimating the peak demand resulting from electrifying the economy (buildings and transportation) and potentially overestimating what solar and wind can supply.
3. Geothermal is the only renewable energy source with built-in storage capacity, which is essential for meeting CLCPA goals.
4. Meeting the enormous thermal peak requirement in NYS is only possible if 70% of the required energy come from a thermal storage reservoir onsite

New York Geothermal Energy Organization www.ny-geo.org 24

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Zero Place Project Team

- Founder: David Shepler
- Anthony Aebi – ZeroNetNow Inc.
- Keith Libolt - Affordable Housing Concepts

- Architect – Bolder Architecture
  - David Toder, RA

- Builder – Affordable Housing Concepts
  - Keith Libolt - Owner
  - Mike Scirbona – Construction Manager

- Energy Modeling & Consulting – Integral Building & Design
  - Pasquale Strocchia

- Geothermal System and DHW
  - Jens Ponikau – Buffalo Geothermal

- Solar PV & Energy Storage
  - Jeff Irish - SunCommon

- Hugh I. Henderson, Jr., P.E.
  - Owahgena Consulting Inc.

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