Exploratory Meeting – District Thermal

Welcome

June 9, 2020
<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noon</td>
<td>Convene NYSERDA, NYC MOS, NYC DDC, NYC EDC, NYSDPS, Con Edison, National Grid, NYPA</td>
</tr>
</tbody>
</table>
| 15 minutes duration | Welcome and Purpose  
Janet Joseph and Susanne DesRoches |
| 30 minutes duration | NYSERDA: Aspirations, and Upcoming District Thermal Solicitation  
Donovan Gordon and Dana Levy |
| 30 minutes duration | NYC: Tools, Resources, and Market Outlook  
Nick Patane and Alex Posner |
| 15 minutes duration | DDC Case Study  
Alex Posner |
| 15 minutes duration | National Grid Case Study Overview of Pilot  
Owen Brady-Traczyk |
| 15 minutes duration | Con Edison Aspirations and Intentions for a District Geothermal Study  
Christine Cummings and Nickolas Hellen |
| 60 minutes duration | Group Discussion: Market Challenges and Opportunities to Work Together to Resolve |
| 3:00 pm      | Adjourn |

Purpose: Seeking to understand District Thermal market potential, trends, aspirations, opportunities to collaborate:

- **Market Potential**: Insights from screening analysis conducted for NYC Mayor’s Office
- **Customers**: Characteristics of sweet spot customers, methods for targeted outreach
- **Solution Providers**: Identifying competent solution providers and attracting them to focus on NY
- **Cost**: Business models, bundling with other infrastructure construction, drivers of early adoption
- **Availability**: Applicability/limitations of available technology
- **Institutional Hurdles**: What are issues regarding franchise areas, rights-of-way, permitting, other
NYSERDA: District-style Heat Pumps

Program Intentions

June 9, 2020

Donovan Gordon

Dana Levy
Big Picture

Carbon Neutral Buildings Roadmap (thru 2050)
- Buildings
- DER
- Building-Electric Grid

Building Electrification Roadmap (thru 2030)
- Heating, Cooling, Hot Water
- Other End Uses
- Manage System Peaks

Heat Pumps
- Joint Management w/Utilities
- LMI Solutions
- Single-building Solution
- District Configuration
- Education/Outreach
- Cooperative Marketing
- Workforce Development
Who’s Who at NYSERDA

Carbon Neutral Buildings Roadmap
- Greg Hale

Building Electrification Roadmap
- Vanessa Ulmer

Heat Pumps … Donovan Gordon
- Joint Management w/Utilities … Wendy MacPherson
- LMI Solutions … Scott Smith/Mary Chick/(Michael DiRamio)
- Single-building Solution … (Courtney Moriarta/Michael Reed)
- District Configuration … Dana Levy/Andre Davis
- Education/Outreach … Scott Smith/Mary Chick
- Cooperative Marketing … Scott Smith/Mary Chick
- Workforce Development … Scott Smith/Kerry Hogan/(Adele Ferranti)
Investment Plan & Budget

• Filed: May 15, 2020
• Approved: May 28, 2020
• $15 Million for Clean Thermal Districts
  – $14 Million for Incentives to Customers
  – $1 Million for Helper Agents, Tools, Etc.

Solicitation Framework ($14 Million)

• Competitive, Quarterly Due Dates throughout 2021 / 2022 / 2023 until funds exhausted

• Three Facets, All Open Concurrently
  – Scoping
  – Design
  – Construction
Timing of $14 Million Solicitation

• June/July: Gather Market Insights
  – Assistance from Int’l District Energy Association (IDEA)
  – Assistance from Underground Energy LLC (Mark Worthington)

• August: Vet Solicitation Strawman

• September/October: Issue Solicitation
Theory of Change

• Single-building Solutions, or District Solutions
  – When to Prefer which Approach?

• Nearly any Project will yield some Learning, but…
  – Seeking most-impactful Learning. How to Define? How to Acquire?

• Precursor to District Energy
  – Teaming: Tackle One Variable at a Time – Practice doing District Thermal in NYS Marketplace before assembling a multi-technology Team?
  – All Under One Roof: Pursue Integrated Projects with Solar+Storage etc. to Leverage Synergies which Improve Value?
District: Network serving Multiple Buildings

HOW BALL STATE'S GEOTHERMAL SYSTEM WORKS

A geothermal heat pump uses the Earth as either a heat source—when operating in heating mode—or a heat sink—dissipating heat while in cooling mode. At two district energy stations on campus, the heat pulled from the ground or returned to the ground will be transferred, or exchanged, with heat pump chillers that will be connected to two district loops that run through campus. One is a cold water loop, which flows at a constant 42 degrees, and the second is a hot water loop, which flows at a constant 150 degrees. Inside buildings, heat exchangers and fans will deliver the temperature desired by its occupants.
A “Portfolio” of Projects

• Diverse Examples – Lots of Variety of Learning
  – Upstate, Downstate
  – New Construction, Retrofits
  – Campuses, Downtown Core
  – Ground Loops, Treated Sewage, Watertable Depression Pump, Air Source
  – Novel Business Models

• Pathway to Economically-viable Replications
  – Example: Pioneering Project includes “Belt & Suspenders”
  – Example: First of Many with Repeat Customer
  – Example: Critical Mass Density for O&M Services
So-called 5th Generation District Thermal

<table>
<thead>
<tr>
<th>Piping Configuration</th>
<th>1G</th>
<th>2G</th>
<th>3G</th>
<th>4G</th>
<th>5G</th>
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</thead>
<tbody>
<tr>
<td>District only provides heating</td>
<td>Pipe acts only as source</td>
<td>Pipe acts only as source</td>
<td>Pipe acts only as source</td>
<td>Two different pipes (one as source, other as sink)</td>
<td>Single “ambient temperature” pipe can simultaneously act as source or sink for various buildings, thus enabling “prosumers”</td>
</tr>
<tr>
<td>District provides heating</td>
<td>District only provides heating</td>
<td>District only provides heating</td>
<td>District provides heating and cooling</td>
<td>District provides heating and cooling</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Temperature of Supply Pipe</th>
<th>400 °F</th>
<th>250 °F</th>
<th>190 °F</th>
<th>140 °F for heating 45 °F for cooling</th>
<th>60 °F</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Fluid in Supply Pipe</th>
<th>Steam</th>
<th>Pressurized Hot Water</th>
<th>Water</th>
<th>Water</th>
<th>Water</th>
</tr>
</thead>
</table>

Can use this supply of high-grade heat via an in-building radiator to directly achieve comfort space heating, benefit is simplified mechanical infrastructure within each end-use building

Need to use an in-building heat pump to boost this supply of low-grade heat in order to achieve comfort space heating, but achieve system benefits via lower “thermal leakage” heat loss during distribution (narrower “delta T” between water in the distribution pipe and abutting soils of the trench)
Marketplace Actors

- Dedicated NYSERDA webpage [nyserda.ny.gov/district-thermal-systems]
- Opt-in List of Solution Providers
- Virtual Expositions (Customers can meet Vendors)
Continuing this Collaboration

All Rowing in Same Direction to extent Practicable:

• Recurring Calls in Small Groups?
• Another all-hands Webex?
• Who is Missing from the Dialog?
Contacts

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(212) 971-5342 x3119  Donovan.Gordon@nyserda.ny.gov

Dana Levy
(518) 862-1090 x3377  Dana.Levy@nyserda.ny.gov

Andre Davis
(212) 971-5342 x3078  Andre.Davis@nyserda.ny.gov
DDC Case Study

Alex Posner
New York City Department of Design & Construction

Experience with Geothermal Systems

Margaret Castillo, FAIA
Chief Architect

Alex Posner, PG
Project Director, Office of Sustainability

Mayor’s Office of Sustainability & NYSERDA
June 09, 2020
New York City Department of Design and Construction

PUBLIC BUILDING PROJECTS IN THE 5 BOROUGHS

- CORRECTION
- COURTS
- CULTURAL
- FIRE
- HEALTH
- HUMAN SERVICES
- LIBRARIES
- POLICE
- TRANSPORTATION
Glacial Advance in North America
Figure 1. Location and physiographic features of Long Island, N.Y. (Modified from McClymonds and Franke, 1972, fig. 2.)
Erratic Glacial Boulder
Aquifers in Brooklyn and Queens
Bedrock Formations in Manhattan and Queens
Closed Loop

- System uses anti-freeze or water solution within HDPE loops for heat transfer
- Pumps needed to circulate fluid
Areas for Closed Loop

• Can be installed anywhere, but more costly to drill into bedrock

• Lowest maintenance of each system, but requires most space
Open Loop

- Uses ground water in an aquifer for heat exchange
- Requires one or more supply and diffusion wells
Areas for Open Loop

- Most common in Brooklyn and Queens because of prolific aquifers
Standing Column Wells

- System combines supply & diffusion wells into one unit
- Heat exchange with bedrock rather than ground water
- Each well approximately 1,500 ft. deep
Areas for Standing Column Well

- Most common in Manhattan and areas with shallow depth to bedrock, i.e. Bronx
- Ground water presence increases thermal capacity
Geothermal Heat Pump Manual

2002

2012
Geothermal Tool

Welcome to the New York City Geothermal Pre-feasibility Tool. Use this tool to identify areas where ground source, or geothermal heat pump systems may be an option for retrofitting buildings’ heating and cooling systems. View instructions for using this tool on our Help page.

In One New York: The Plan for a Strong and Just City, the City committed to reducing greenhouse gas (GHG) emissions 80% by 2050. Reducing emissions in buildings, the largest source of GHG emissions in New York City, is key to reaching this goal. Geothermal heat pump systems are a promising way to reduce emissions from buildings and tap into a cleaner future grid.

Success of geothermal heat pump systems is dependent on a number of key variables, so building owners should still conduct a full feasibility study before installing them.

This tool was brought to you by the New York City Mayor’s Office of Sustainability and the New York City Department of Design and Construction, pursuant to New York City Local Law 6 of 2016.

Explore Feasibility
## Geothermal Tool

### Feasibility

<table>
<thead>
<tr>
<th>Selection</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Address</td>
<td>161-18 59 AVENUE</td>
</tr>
<tr>
<td>Borough</td>
<td>Queens</td>
</tr>
<tr>
<td>Block</td>
<td>6739</td>
</tr>
<tr>
<td>Lot(s)</td>
<td>44</td>
</tr>
<tr>
<td>BBL(s)</td>
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### Building**

<table>
<thead>
<tr>
<th>Lot Area (SF/FL)</th>
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<tbody>
<tr>
<td>Building Area (SF/FL)</td>
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<tr>
<td>Building Footprint (SF/FL)</td>
<td>770</td>
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<tr>
<td>Building Type*</td>
<td>Other: SF/FL</td>
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### Calculation

<table>
<thead>
<tr>
<th>Depth To Bedrock (ft ±25 ft)</th>
<th>494</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth To Water (ft ±25 ft)</td>
<td>24</td>
</tr>
<tr>
<td>Lloyd Aquifer (Present/Not Present)</td>
<td>Present</td>
</tr>
</tbody>
</table>

### Geothermal System

<table>
<thead>
<tr>
<th>Standing Column Well</th>
<th>Closed Loop</th>
<th>Open Loop***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geological and Technical Suitability (Yes/No)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Potential Capacity (Tons)</td>
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<td>9</td>
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<tr>
<td>Full System Feasible (Yes/No)</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Hybrid System Feasible (Yes/No)</td>
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<td>Carbon Footprint Reduction (Tons CO2e)</td>
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<tr>
<td>Annual Cost of Carbon ($)</td>
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<td>Annual Potential Savings with Geothermal System ($)</td>
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<td>571</td>
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<td>Projected Incremental Payback with Carbon Credit (Years)</td>
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<td>6</td>
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<tr>
<td>Projected Incremental Payback without Carbon Credit (Years)</td>
<td>12</td>
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## Geothermal Tool

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Current NYC DDC Projects Using Geothermal

• Queens Botanical Garden
• Brooklyn Childrens Museum
• Bronx Zoo - Lion House\Madagascar Exhibit
• Weeksville Heritage Center
• Staten Island Museum (Renovation of Building A), Snug Harbor, Staten Island
• FDNY Rescue Company 2
• Washington Square Park
• Bronx River Boathouse
Queens Botanical Garden
Heating and Cooling Loads
(Open Loop)

• 16,000 sq. ft. building, 2 levels
• 8 Heat Pumps - Only 5 or 6 are actually used
• Heating Loads = 378,100 BTU/h
• Cooling Load – 37 tons
• 1 Supply Well 305 ft. deep
• 2 Diffusion Wells 305 ft. deep
Lion House at the Bronx Zoo (Standing Column)

• Total Building Area – 40,000 sq. ft.
• Heating & Cooling Capacity – 1,057,000 BTU/h, 56 tons cooling
• 5 Standing Column Wells 1,500 ft. deep
• Operating Flow Rate = 108 gpm per well
• Number of heat pumps – 6 units
Snug Harbor Museum
Heating and Cooling Loads
(Closed Loop)

• 16,800 sq. ft. building, 2 levels
• Heating Load 1,114,400 Btu/h, cooling load – 91.5 tons
• Loop Field – 32 boreholes at 500 ft. depths
  (8 groups of 4 boreholes)
• 5 heat pump units
Snug Harbor
Staten Island Museum (Building A) at Snug Harbor
Snug Harbor, Staten Island
National Grid Case Study Overview of Pilot

Owen Brady-Traczyk


Please see youtube video: https://youtu.be/W74xbFB0XVw
District Geothermal Pilot

June 9, 2020
Riverhead, NY Geothermal Pilot – Overview

Test and learn pilot approved in 2016 rate case

- 55+ retirement community with homes located 1000'-1500' from gas network
- 10 homes connected to a 30-ton common loop field beginning in Dec 2017
  - No central pumping
  - Replaced kerosene and propane heating systems
- Energy efficiency upgrades were made in some homes, typically based on the vintage of the home
- Close coordination with NYSERDA & PSE&G-LI for installation, system impacts, EM&V and incentives
- All system costs paid for by the project
  - Participants paid $21.66/month, which is the minimum gas customer charge for LI
Riverhead, NY Geothermal Pilot – Results

Project was successful and utility ownership merits further investigation

- Load diversity resulted in a peak load that was 80% of nominal load
  - Shared loop capacity could have been reduced by 20% compared to individual loops
- Met year-round heating and cooling needs for these customers
- Could potentially be a viable alternative to expanding gas infrastructure
- Customers experienced positive qualitative benefits
  - Improved indoor air quality
  - Reduced equipment noise
  - More consistent temperature in the home
- Customers saved 43% compared with previous heating and cooling systems
Con Edison Aspirations and Intentions for a District Geothermal Study

Christine Cummings and Nickolas Hellen
Con Edison District Energy Study and Pilot

• Agreement reached in Case 19-G-0066
  – Milestones over the three years
  – Dovetails with other initiatives the company is pursuing
  – Collaboration with the Mayor’s Office of Sustainability

• Part of the Company’s overall commitment to the cleaner energy future
Framework for the Study/Pilots

• Examine the feasibility of deploying geothermal district energy systems in the Company’s service territory as an alternative to replacing cast iron/unprotected steel

• Benchmarking

• All else equal, focus on LMI or environmental justice

• At least two locations (one in NYC and one in Westchester).
Progress

- Company is doing its own analysis using customer and company infrastructure information
- Viewed as an opportunity for the company
- Next steps are to hire consulting engineer to size the loops
- Working internally to leverage existing skill set
  - Customer Engagement
  - Engineering
  - Construction
  - Project Management
  - Energy Efficiency
Group Discussion
Exploratory Meeting – District Thermal

Adjourn

June 9, 2020