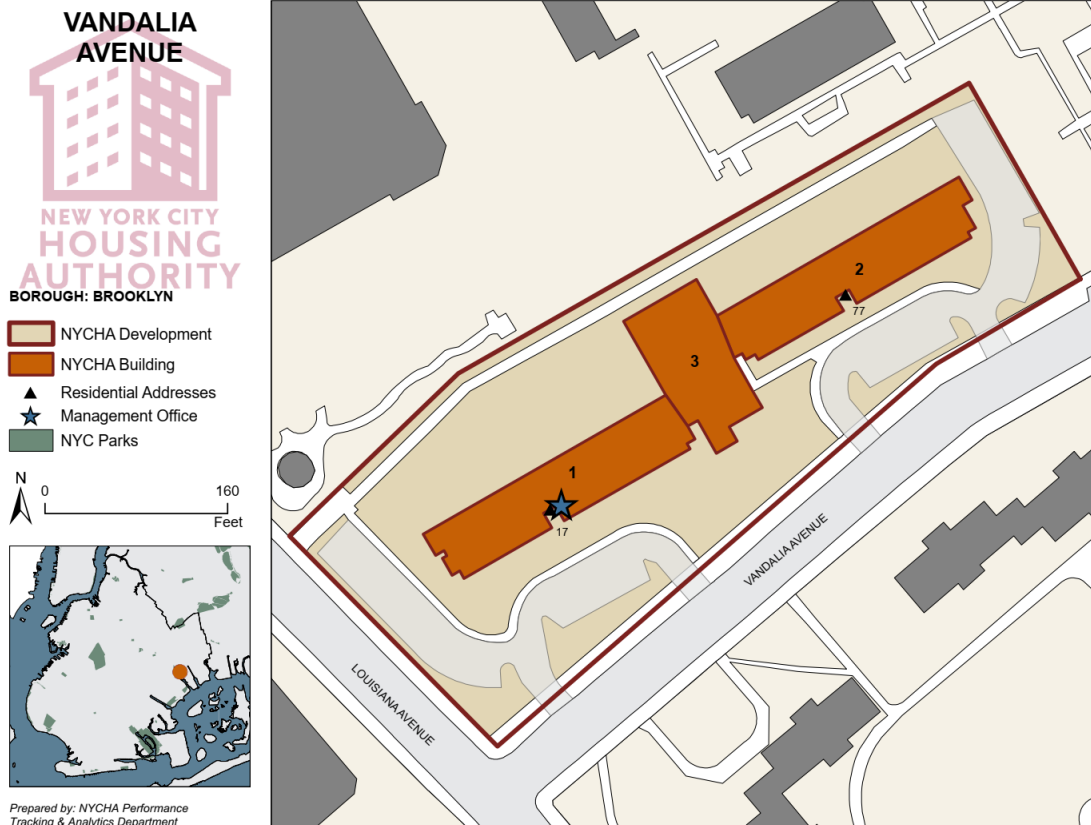


Case 22-M-0429

Scoping Study / PEER Review of Proposed U-TEN for Brooklyn NYCHA



September 01, 2023

Via email to:

**To: Hon. Michelle L. Phillips, Secretary
New York State Public Service Commission
Three Empire State Plaza
Albany, New York, 12223-1350**

E: secretary@dps.ny.gov



Ref: Scoping Study of Proposed U-TEN (Utility Thermal Energy Network) for Brooklyn DPS Case 22-M-0429 for NYCHA Housing

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Executive Summary

KEDNY Service Territory Thermal Energy Network Pilot for NYCHA’s Vandalia Avenue Houses

Egg Geo is providing a Peer Review for the subject thermal energy network pilot project proposed by National Grid/KEDNY for Brooklyn. This project was brought to our attention by Sane Energy Project. After careful consideration, we have taken this case because we have determined that there are opportunities to improve this project to be



compliant with the intent of the Utility Thermal Energy Networks Jobs Act for New York State.

According to the DPS Case 22-M-0429 filing dated January 9, 2023 (“Company proposal”), National Grid (KEDNY, or the Company) has identified the New York City Housing Authority (“NYCHA”) buildings located at 17, 47, and 77 Vandalia Avenue in Brooklyn (“KEDNY Pilot”) as the anchor customer for its thermal energy network pilot. The site consists of two 10-story apartment buildings and a low-rise community center, all totaling 335,000 square feet (“sf”). The NYCHA buildings currently utilize a central hot water boiler and central gas fired water heaters with storage tanks, with cooling provided by tenant-owned window air conditioning units. The selected site is within a Disadvantaged Community (DAC). KEDNY suggests that the pilot may seek to interconnect with nearby commercial buildings to balance the load profile. These commercial sites could include two buildings in a nearby strip mall on 11110 Flatlands Avenue and 430 Louisiana Avenue. The specific businesses in the strip malls are not named.

The total connected load of the KEDNY Pilot, including the two NYCHA residential buildings, community center, and the two commercial buildings adjacent to the property, is estimated in the proposal to serve 417,000 square feet. The high-level costs estimated by the Company for the KEDNY pilot for heating and cooling are \$67.7 million, and \$38.7 million for heating only. The annual operating costs for the KEDNY pilot after it is placed in service are estimated at \$135,000 for heating only.

The proposed heating-only model is unusual for a technology which provides and balances both heating and cooling. Immediately prior to making this filing, National Grid’s consultant’s analysis reported, as noted above, that the cost of providing heating and cooling to the NYCHA buildings is estimated at over \$67.7 million, compared to an estimate of slightly over \$38 million if heating only is provided to the NYCHA buildings. The Company states that this is due to the considerable internal upgrades that would be required to add cooling to these specific buildings, specifically to replace the risers. National Grid originally had intended to propose both heating and cooling for all buildings. Considering the significant costs for upgrading the NYCHA buildings, National Grid believes it will be preferable to only include heating for the NYCHA buildings. National Grid said that it will work with NYCHA to determine what solutions and energy efficiency incentives may be available and preferable to ensure that residents have efficient, cost-effective energy systems to meet their needs. We note that National Grid’s upstate projects include both heating and cooling at much lower estimated costs (Fig. 1).

Table 1. Summary of Thermal Pilots

Project Name	Tons	Square Footage	Total Estimated Cost (\$M)
NMPC – City of Troy	550	317,000	\$12.270 ³
NMPC – City of Syracuse	2,000	1,200,000	\$66.754
KEDNY – NYCHA			
a) Cooling and Heating	520	417,000	a)\$67.7
b) Heating only	1500		b)\$38.7

Figure 1. Summary of National Grid’s Proposed Thermal Pilots Source: National Grid Utility Thermal Energy Network Pilot Proposals January 9, 2023,

Egg Geo also reviewed responses from the Company to questions posed by the DPS in correspondence dated April 3, 2023 (“April 3 response to DPS questions”), which provided some clarification to the original proposal but also raised additional questions.

Egg Geo sent a letter to the New York Public Service Commission at the beginning of August that outlines our intention to provide this peer review/study to address some items that will improve this offering. In the pages of this study, we show that this project does not presently meet the minimum criteria to be considered a thermal energy network (TEN). Additionally, the report and subsequent updates submitted by the Company lack information detailing the existing equipment, the hydronic distribution system, and the geo-exchange bore field details.

We have determined that, with so many variables that have not been properly vetted, KEDNY should provide the information herein missing as identified, so that it can be considered and addressed. We also recommend that the Public Service Commission and NYCHA request this information.

Building and Climate Modeling

There are several inconsistencies in the building area described in the Company's proposal. We noted a discrepancy between NYCHA facilities space (apartments and community center):

- Page 6 says 335K sf, and
- Page 22 says 370K sf.

The Company’s April 3 response to DPS questions confirmed the 335,000 sf number to be correct.

In our attempts to discern the heat gain and loss analysis for the building we noted that the space heating and cooling unit assumptions are extreme:

- Heating only: 417,000 sf/520 tons = 800 sf/ton.

- Heating and cooling: 417,000 sf/1500 tons = 278 sf/ton

The more efficient an HVAC system is, and the better the building envelope, the greater the number of square feet that can be heated or cooled by the system. 800 sf/ton is a fairly good number for conventional HVAC, but a right-sized heat pump system should exceed 1,000 sf/ton. The 278 sf/ton projection for both heating and cooling is very low.

There is good reason to suppose that part of the discrepancy we note is due to a hurried submission by the Company that may not have been fully reviewed. For example, on page seven of the Company's proposal, we note the language that National Grid used to qualify the \$68 million heating and cooling estimate:

Immediately prior to making this filing, National Grid's consultant's analysis revealed that providing heating and cooling to the NYCHA buildings is estimated at over \$67.7 million compared to an estimate of slightly over \$38 million if only heating is provided to the NYCHA buildings. (Emphasis ours)

The April 3 response to DPS questions provides a breakdown of estimated peak loads, and includes domestic hot water production (DHW), that modifies the original Company proposal as shown below:

- Heating only: 417,000 sf/485 tons (excluding DHW) = 860 sf/ton.
- Heating and cooling: 417,000 sf/370 tons = 1,127 sf/ton

The updated heating only value is similar to the original proposal while the heating and cooling is now in line with what should be anticipated.

It is not clear if the \$38 million estimate includes the cost of alternative cooling systems that would be required, such as the window air-source heat pumps (ASHP) that NYCHA and NYSERDA have been developing through the Clean Heat for All Challenge. These ASHPs also provide heat, so their use would duplicate the TEN heating function, albeit less efficiently and with exposure to weather. It is also unclear if residents would bear the cost for operating the air conditioners.

A narrative or description that reveals exactly what type of heating and cooling distribution equipment is currently in use at the property is not available. We ask that information be made available. This information will help determine conclusively what heating and cooling units could be specified by the Company for this pilot project.

Table 16. Estimated Annual GHG Emissions of Current Heating and Cooling Systems for the KEDNY Geothermal Pilot Site

Current Systems			
Type	Value (Heating)	Value (Cooling)	Unit
Natural Gas Usage	8,356	0	MMBTU / year
Electricity Usage	104	68	MWh / year
Natural Gas – CO ₂ e Emissions	445	0	MT CO ₂ e / year
Electricity – CO ₂ e Emissions	30	20	MT CO ₂ e / year
Total	475	20	MT CO ₂ e / year

Figure 2. Natural gas consumption and emissions at site (Company Submission)

Since existing building loads are not clear for this project, we considered the NG (Natural Gas) & GHG (Greenhouse Gas) data from the table above (Fig. 2). To confirm, we calculated using the Building Efficiency Systems Tool (BEST) to get a block load that includes heat gain and loss for typical apartment buildings in this region. The results of those block load calculations do not align with the projections provided by the National Grid. Apartments in this region typically require 500 – 750 sf/ton.

We noted that the wintertime heating load compares to the summertime cooling load favorably in that the load diversity will improve overall performance of the systems. This is the primary purpose for matching residential loads with commercial loads. The residential customers could use the waste heat from the commercial properties in real time (Fig. 3). Annual load diversity is good, but not sufficient or acceptable when there are so many other opportunities around the Vandalia NYCHA buildings.

Energy Exhausted from Commercial Buildings is piped to Residential Structures



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Figure 3. Waste heat from commercial properties is piped to residential spaces that need heat in the wintertime.

Without a diversified load (meaning a load that has different usage characteristics from the anchor property), the geothermal exchanger will take the entire wintertime heating load without any other source of waste heat from adjacent properties. This project should only be commissioned as a pilot when at least one commercial property with a properly diversified load has been identified and the owners of that property have provided a written commitment to participate in the project. That could be any number of adjacent commercial properties, which would enjoy substantial savings in heating and cooling costs by connecting with the TEN. Such a commitment is required to meet the definition of a Thermal Energy Network (TEN).

Our modeling simulations show that whether the buildings are designed with distributed heat pumps, or they use a central heat pump design with distributed fan coils, the cooling load peak demand is like the heating peak as shown in Figure 4. This is critical as it shows that the heating demand is manageable as the cooling demand for the building regarding the electrical peak capacity needed for the central heating and cooling system.

Distributed heat pump systems have a modular geothermal heat pump at every location where there is a heating apparatus presently operating. Each would be in the same location and footprint as the present heating apparatus.

With the fan coil system, these have a central geothermal heat pump that distributes chilled water through one pipeline, and heated water through another line to each of the buildings fan coils, providing the opportunity for simultaneous heating and cooling. The fan coils have independent heating and cooling coils. A third pipe comes out of the fan coils (or distributed heat pumps) that drains the condensate down to the building catchment system.

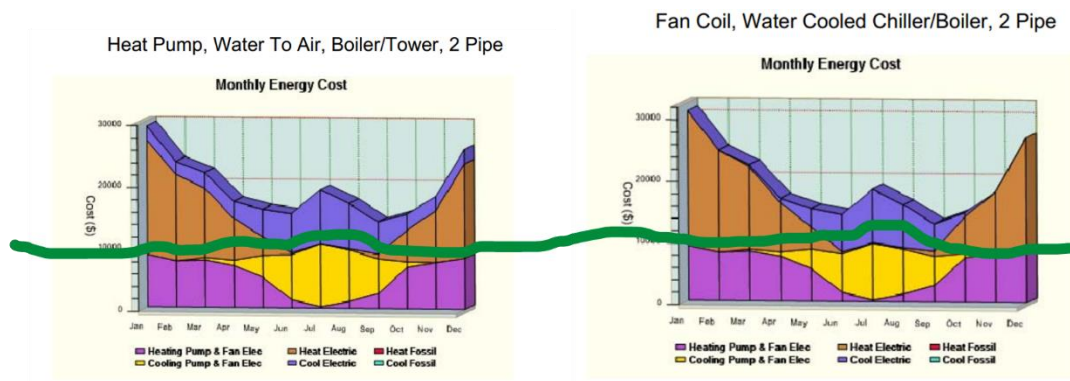


Figure 4. Heat pump vs Fan Coils. We ran simulations in BEST for the GHPs (Geothermal Heat Pumps) in all apartments, and the central GHPs with apartment fan coils. Either way, the cooling load looks like the heating peak (Heating Lavender; Cooling Yellow). The green line shows that energy demand from the geothermal solutions is levelized.

Distribution System Hydraulic Modeling

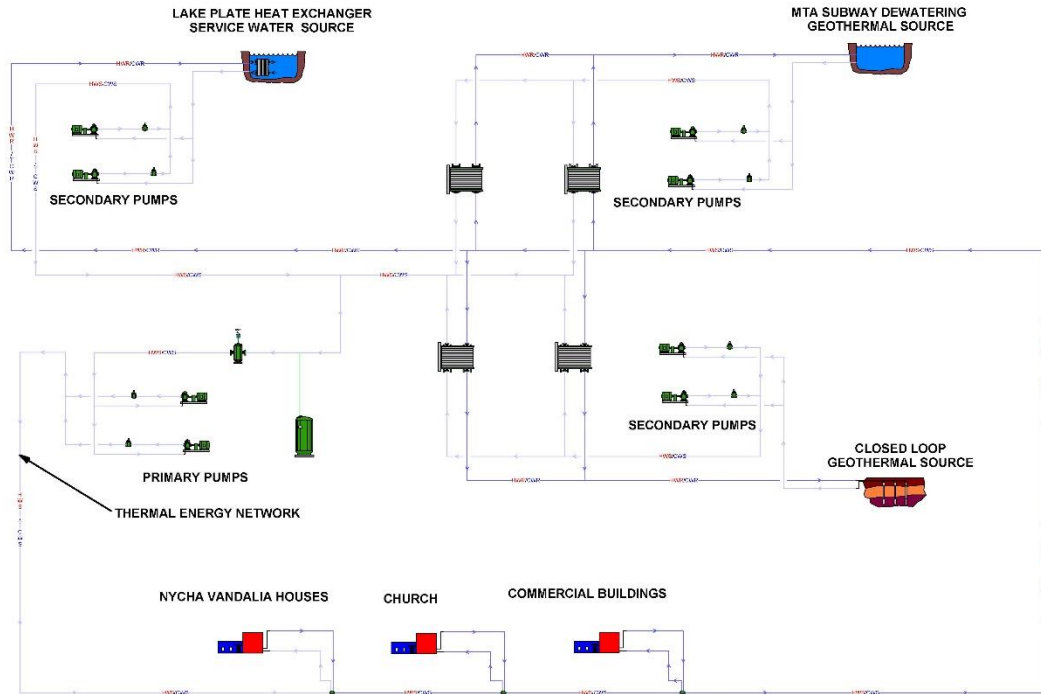


Figure 5. MTA Dewatering and Surface Water Exchange offer two remarkable opportunities for geothermal exchange

The Vandalia Avenue NYCHA facility is located in an area rich with thermal sources and sinks that could be used to develop an exemplary thermal energy pilot. For example, the NYC Transit Authority (NYCTA) of the MTA pumps large quantities of groundwater on a daily basis to dewater around two nearby subway stations. The pumped water is discharged into the tidal canal east of the Vandalia Avenue NYCHA facility. We have created a sample hydronic distribution concept (Fig. 5 above), similar to other projects we have designed in New York, that shows this relationship. We suggest the Company engage MTA to utilize this potential thermal resource.

In addition, a standard surface water plate exchanger configuration, ideally located in the tidal channel west of the facility, would allow a significant reduction in geothermal boreholes needed on the project, eliminating the need for so many boreholes and substantially reducing the cost of the project (Fig. 5 above). Finally, the project is located adjacent to the city's 26th Ward Wastewater Resources Recovery Facility (WRRF) where

thermal exchange using Wastewater Energy Transfer (WET) could easily be implemented (not shown in Fig 5).

Our engineers and scientists have a reasonable degree of certainty that even if the entire system had to be replaced with a new networked geothermal heating and cooling system in the buildings, the pricing shared by the Company is unusually high, probably due in part to the pricing of a bore-field that likely was designed to handle the entire heating load with little or no diversity.

Integrated Piping Solutions

Most existing buildings are designed with reverse return piping systems that require two pipes for heating and two pipes for cooling along with a condensate drain line. This amounts to five total pipes for cooling and heating distribution system. With an integrated piping system such as shown in the schematics below (Fig. 6), only one pipe is needed for the cooling circuit and one pipe for the heating circuit. Including the condensate drain line as indicated in the in the third image below (Fig. 7) brings the total number of pipes to three.

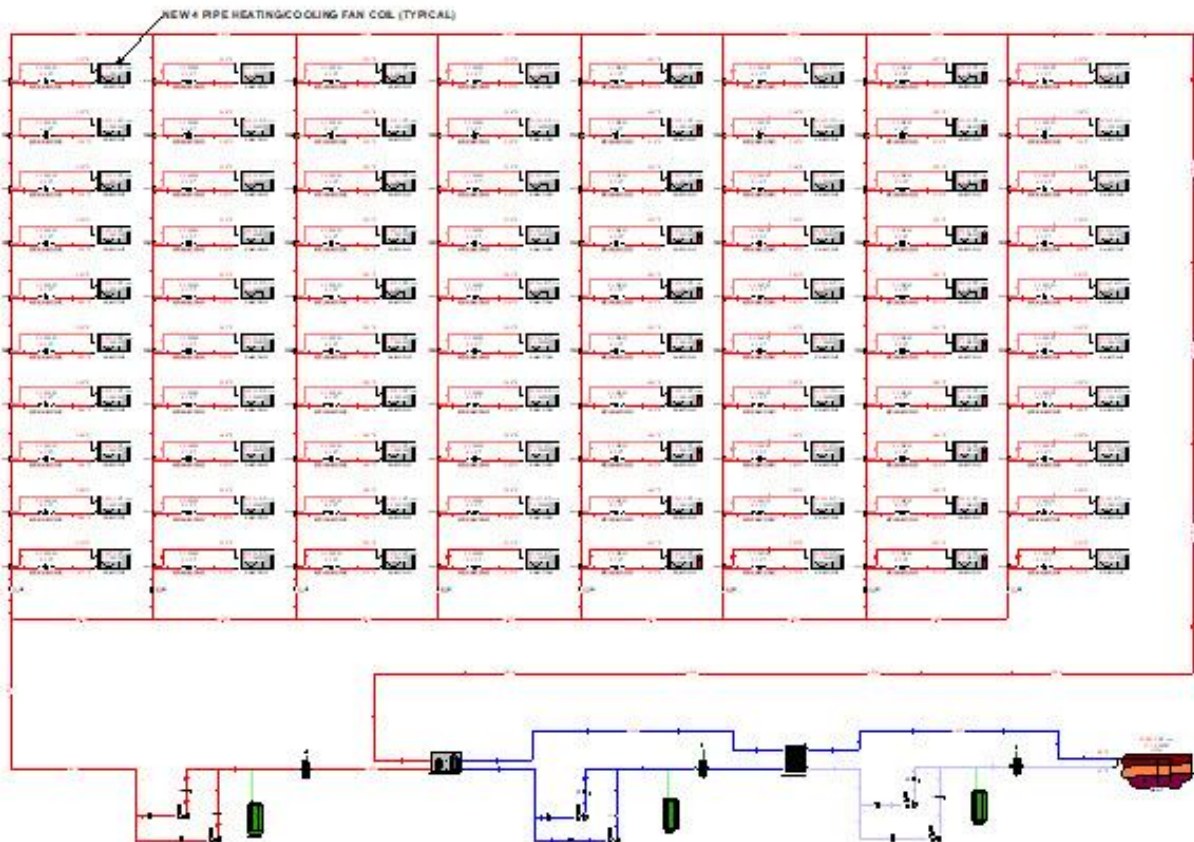


Figure 6. Heating configuration for project (theoretical); single new pipe

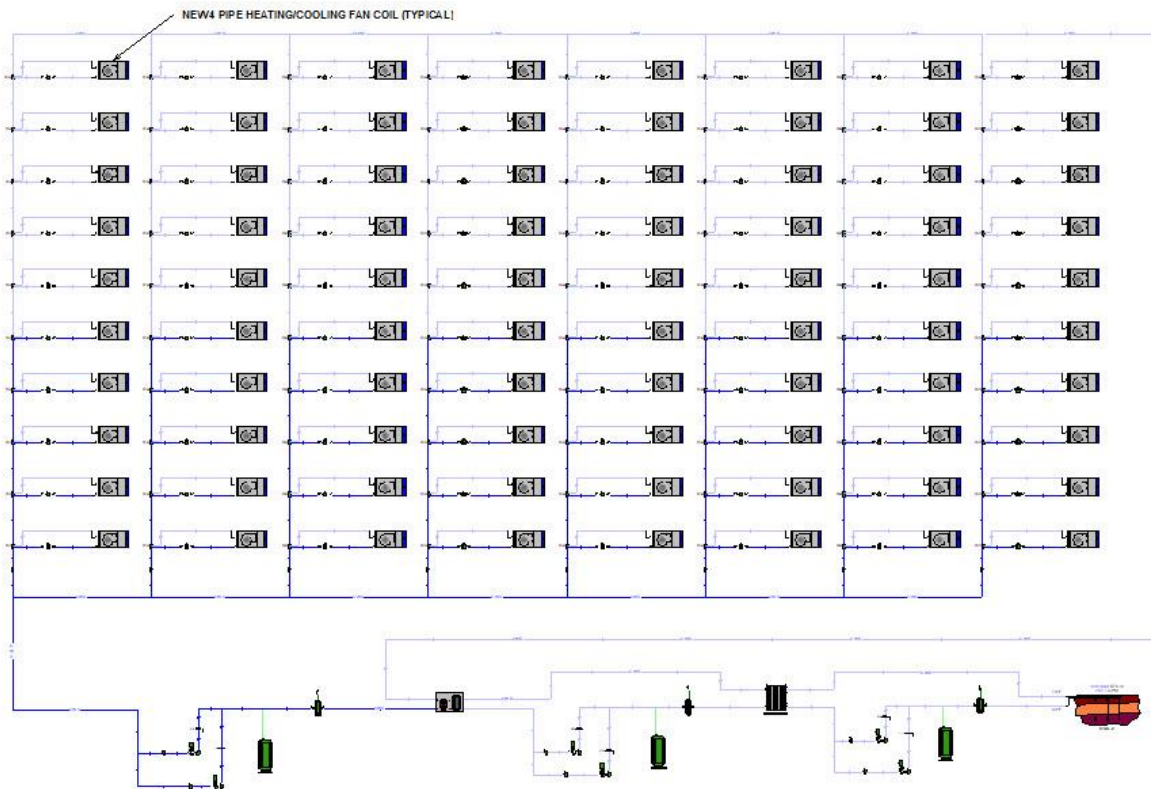
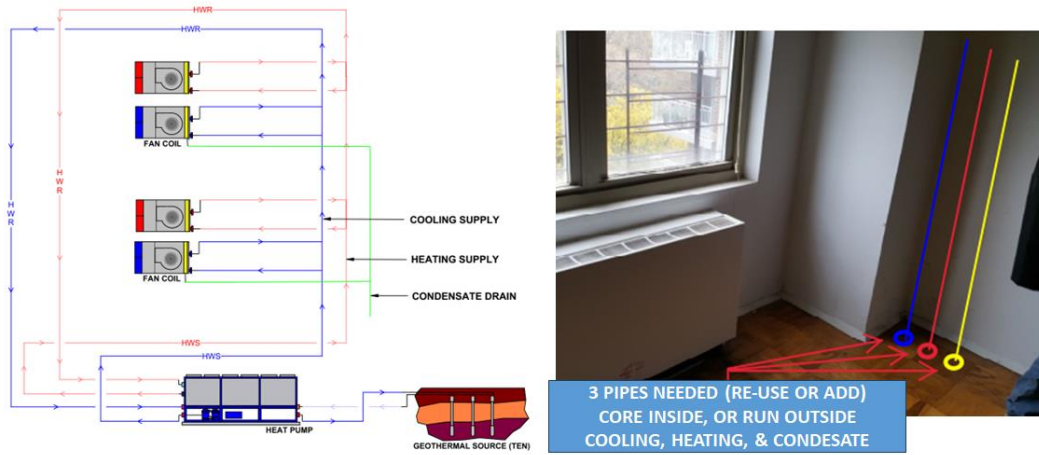


Figure 7. Cooling configuration for project (theoretical); single new pipe

There appears to be ample space in the structures for a hydronic heating and chilled water system to provide simultaneous heating and cooling to the property. The schematic above (Fig. 7) suggests a configuration that needs three pipes in total for heating and cooling (Fig. 8). Integrated Piping Systems (IPS) require less pipe and labor, and more importantly they are self-balancing. This allows the installation of the piping system in stages on a per riser basis since the system does not have to be balanced all at once. This limits the disruption to the tenants and gives more flexibility to the installing contractor.

3 Pipe System for Central Heating and Cooling



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Figure 8. Example of a retrofit for residential towers located in the Bronx (using a single pipe system)

Ground Loop Simulation

Based on the heat gain and loss analysis from our block load model, there appears to be no obvious reason to exclude cooling from this project. In addition, the cost of heat pumps that provide only heating versus heat pumps that provide both heating and cooling is similar.

We modeled the estimated required size of a borehole array over 20 years for a similar sized project. In a heating only scenario, as can be seen in Fig. 9 below, the continual depletion of thermal energy from the earth dramatically affects the ground loop exchanger size and requires a vastly larger bore field array compared to the heating + cooling scenario (Fig. 10). This is due to the lack of seasonal load diversity.

	Heating + Cooling	Heating Only
Total Depth of Boreholes Required (ft)	64,909	179,665
Number of Boreholes Required (sized to 300 ft)	217	599
Total Square Feet Needed for Borehole Array	90,000	250,000

Figure 9. A comparison of two scenarios: Heating + Cooling & Heating Only

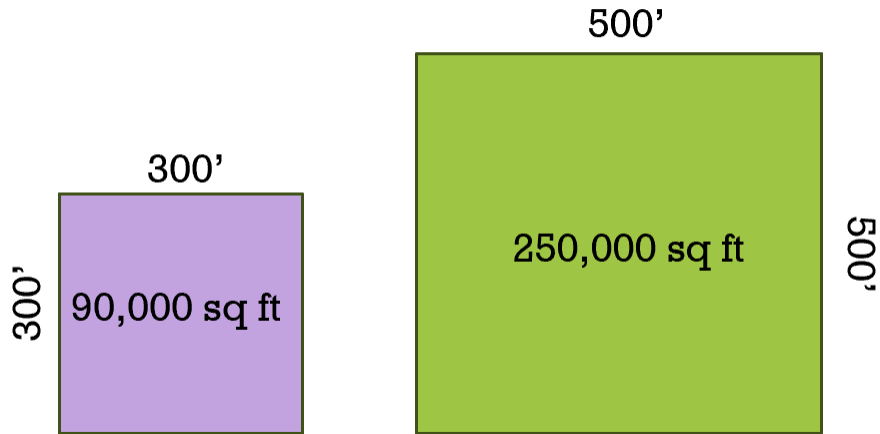
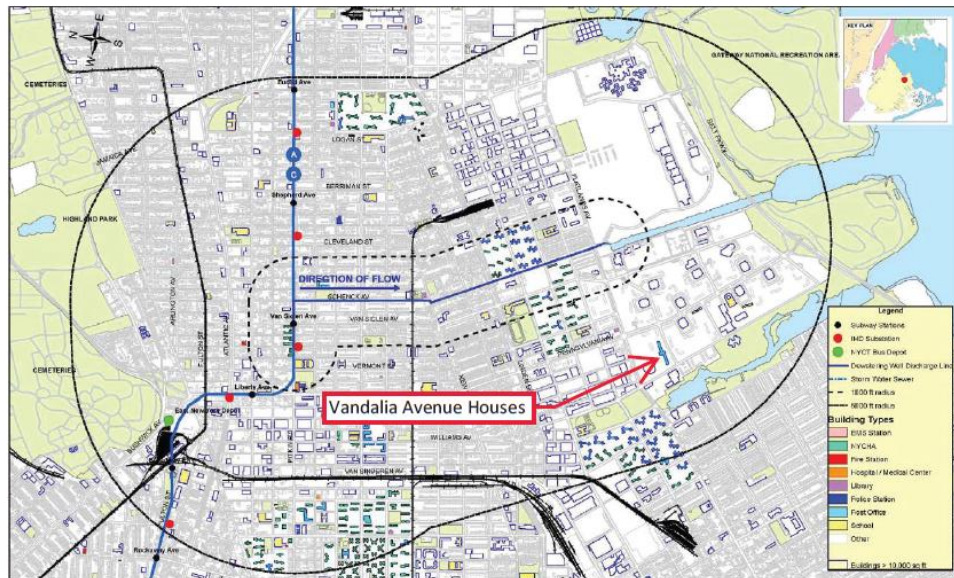


Figure 10. A comparison of the earth surface area needed for the *heating + cooling scenario (left) or heating only (right)*

There are several thermal sources and sinks that were not a part of the Company’s proposal that will save considerable costs on this project.

An average closed loop borehole provides a finite amount of **annual** energy exchange, and the costs per borehole can add up fast. It is estimated that this project could save millions of dollars by considering some of the alternative sources and sinks described herein.



State Map Source:
NYC Department of Information Technology and Telecommunications (www.nyc.gov)
November 2007 (concept Buildings Layer - Jan 2010)

Figure 11. Figure 21 from NYCTA Feasibility Study for the Beneficial Re-use of Groundwater Extraction from New York City Transit Deep Wells and Well Points. Call outs added by Egg Geo.

As such, we are submitting some concepts for subway (MTA) water discharge exchange, surface water thermal exchange, and infrastructure exchange with Wastewater Energy Transfer (WET) from NYC's 26th Ward Wastewater Resources Recovery Facility. Other hydronic infrastructure components found may be acceptable to transfer energy into or out of the buildings. The preceding image (Fig. 11) is from NYCTA Feasibility Study for the Beneficial Re-use of Groundwater Extraction from New York City Transit Deep Wells and Well Points. The subway dewatering outfall into the tidal canal adjacent to the east of the NYCHA Vandalia Avenue buildings is an excellent thermal resource, similar to the wastewater effluent outfall as a resource for the Company's own NMPC UTEN (Utility Thermal Energy Networks) Syracuse project, shown in the image below (Figure 12). Figure 13 is an aerial photograph showing the location of the NYCTA outfall and the city's WRRF in proximity to the Vandalia Houses site.

Standardized closed loop pricing for the boreholes identified as the solution by the Company likely accounts for a substantial portion of the \$38 million base price indicated. A cursory review of other thermal source and sink strategies reveals that boreholes may not be needed. The subway and surface water options shared will be a fraction of the total cost of a borefield.



Figure 12. The effluent outfall example from the NMPC UTEN Syracuse pilot project.



Figure 13. NYCHA Vandalia Houses (17, 47, and 77 Vandalia Avenue, Brooklyn) and NYC Transit Authority Subway Dewatering Discharge Line, and the NYCDEP Wastewater Resources Recovery Facility

Cost Estimates for Thermal Energy Network utilizing Available Sources and Sinks

We estimate that the entire project will cost less than \$40,000,000 for heating and cooling with central geothermal heat pumps and fan coils in each apartment. Using MTA and surface water exchange will further reduce these costs as it will reduce or eliminate the need for a geothermal bore field. Wastewater Energy Transfer (WET) can further help to reduce thermal loads for Domestic Hot Water (DHW), heating, and cooling by exchanging thermal energy with the wastewater as it leaves the apartment complex. We have not added this opportunity to our cost figures. We recommend it be added on the next iteration.

Summary - Rebuttal Report

In summary, based on our review of this project, we formally question the findings of the KEDNY Pilot proposal, submitted January 9, 2023. Egg Geo Used data publicly available including:

- National Grid's TENs proposal (January 9, 2023)
- New York City's response to National Grid TENs comment (May 1, 2023)
- National Grid's response to DPS Request for Information (April 3, 2023)
- Sane Energy's comments on KEDNY TEN proposal (April 5, 2023)
- Comments submitted on behalf of Building Decarbonization Coalition, Alliance for a Green Economy (AGREE), Sierra Club Atlantic Chapter, New York League

of Conservation Voters, and The Alliance for a Greater New York (ALIGN) (July 10, 2023)

Our team reviewed KEDNY’s proposal and subsequent revisions, a response from New York City, Sane Energy Project’s response, and the comments submitted on behalf of the Building Decarbonization Coalition (BDC) to review this project.

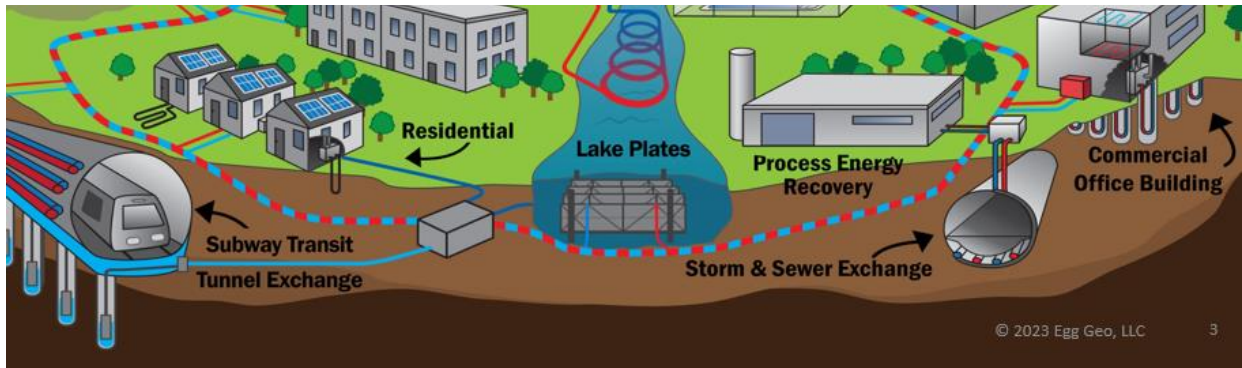


Figure 14. Subway, Surface Water, & Wastewater exchange opportunities must be vetted.

Using accepted engineering and construction rubrics, we determined that the pilot project has many opportunities to improve in scope and performance. We found the pricing to be confusing, and the application of advanced hydronic concepts was not apparent. We studied alternate geothermal exchanger concepts that may provide an increased benefit in price reduction for this project.

Summary Narrative

Some Challenges in this project are also Some of the Greatest Opportunities.

Procuring accurate MEP (Mechanical, Electrical, and Plumbing) plans and job site photos of existing conditions is a challenge; they were not available to us. Onboarding partner properties (commercial buildings) takes time and effort, sometimes amounting to dozens of hours and multiple emails, letters, and visits, as well as presentations to the proposed partner properties. Letters of commitment need to be procured for this project from (potential) partner properties.

Providing cooling in the interest of human health and safety and in compliance with ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) 62.1 (commercial) can be addressed through this process. The alternative suggested in KEDNY’s proposal of through-the-wall appliance type air conditioners is not acceptable as it violates one of the tenets of a TEN—namely, reuse of waste heat from HVAC systems. It is not evident that upgrading electrical power for the proposed systems would be needed.

Cooling is essential. With temperatures increasing due to global warming, [L.A. City Council voted](#) on May 31, 2023, to mandate air conditioning in all rental units. New York and other cities are certain to follow and create similar legislation. According to [NYC 2023 NYC Heat-Related Mortality Report Summary](#), heat contributes to the deaths of about 350 New Yorkers, on average, each year during the warm season of May through September. July accounts for the greatest share of heat-exacerbated deaths, and the average daily maximum temperature in July has increased by about 5°F in the past five decades.

The opportunities to overcome these challenges exist for most of the points shared. Procurement of accurate plans as well as numerous job site photos would provide tremendous opportunities to look at alternatives to improve this proposal. The Company can engage and secure the cooperation of neighboring properties for diversity of load on this project. Additionally, the Company can use this project to demonstrate interagency cooperation (MTA, NYCDEP, etc.) and show that it is committed to meeting CLCPA requirements.

With the knowledge that the Company, NYCHA, and the Public Service Commission are vitally concerned for the health and safety of the tenants, the need to provide cooling units as part of this effort is incontrovertible. The suggested solution of using through the wall air conditioners is altogether inappropriate. The company must use the waste heat from air conditioning, which is not possible with air source heat pumps. The opportunity to reclaim this waste heat is abundant and efficient within the scope of a balanced thermal energy network system. A well-designed NYCHA Vandalia Avenue TEN pilot can be replicated by other NYCHA properties and meet the requirement for safe indoor summer temperatures, while reducing the summer spikes in demand for electricity caused by conventional HVAC, saving money and preventing blackouts.

Finally, the opportunity to properly upgrade the electrical system in these buildings has come. If it is determined that the building needs 220-volt service in each apartment, it should be done in a pilot project such as this. *This is not the time to go with an inferior solution.* As the mandate for building electrification and decarbonization is here to stay, it would be better to realize the best upgrade solutions. However, we note that in this case, the fan-coil solution has merit. Fan coils would not necessarily need any electrical upgrades; in any case, the apartments need central cooling, and will thus need a condensate drain system.

Much of a building's energy goes down the drain. Waste Energy Can Be Recovered.



Let's Get HVAC Out of the Sewer

Wastewater thermal extraction technology has come of age



RECYCLING ENERGY: The SHARC Wastewater Energy Exchange System exchanges energy with waste water that would otherwise flow down the drain. The result is a limitless supply of thermal energy available for space conditioning and domestic hot water heating. PHOTO COURTESY OF INTERNATIONAL WASTEWATER SYSTEMS INC.

November 14, 2018
Lynn Mueller, founder and CEO of International Wastewater Systems Inc. (IWS), has been involved in wastewater thermal extraction for some time

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Figure 15. Wastewater Energy Transfer (WET) can provide enough energy for the Domestic Hot Water (DHW) needs of a building and supplement the cooling and heating.

We estimate that the entire project will cost less than \$40,000,000 for heating and cooling with central geothermal heat pumps and fan coils in each apartment. Using MTA and surface water exchange will further reduce these costs as it will reduce or eliminate the need for a geothermal bore field. Wastewater Energy Transfer can further help to reduce thermal loads for Domestic Hot Water (DHW), heating, and cooling by exchanging thermal energy with the wastewater as it leaves the apartment complex. We have not added this opportunity to our cost figures. We recommend it be added on the next iteration.

In summary, we recommend the Company explore all variations of thermal exchange and networking of buildings together with integrated piping systems and the latest technological advancements. The utilization of Wastewater Energy Transfer and other infrastructure related opportunities to move heat around a thermal energy network are virtually limitless. We recommend that the company task an engineering firm that will properly vet these opportunities, ensuring cooling, heating, and domestic hot water be made available to the families that reside in these apartments.

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End of Peer Review