Community Center at Buffalo Community Heat Pump Program

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Community Center at Buffalo Community Heat Pump Program

Final Report

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Notice

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Abstract

National Fuel commissioned Wendel to evaluate the feasibility of a community-style geothermal heat pump system for the Northland Workforce Training Center (Northland Center) and adjacent residential properties. This study explores four electrification options, analyzing their energy, greenhouse gas (GHG) reduction, and economic impacts, with a focus on transitioning to cleaner energy systems. The findings emphasize the potential of shared heating and cooling loads, particularly with Option 2, which balances cost-effectiveness and energy efficiency. The recommendations provide a strategic roadmap for phased implementation and infrastructure upgrades to align with Northland Centers's long-term sustainability and electrification goals.

Keywords

Building electrification, district thermal, district geothermal, geothermal, ground-source heat pump, life-cycle cost analysis, Northland Center

Acknowledgments

For questions regarding this report, please contact FlexTech@nyserda.ny.gov.

We hope the findings of this report will assist you in making decisions about energy efficiency improvements in your facility. Thank you for your participation in this program.

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Acronyms and Abbreviations

ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
CDD	cooling degree-day
COVID-19	coronavirus disease 2019
DEC	New York State Department of Environmental Conservation
EIA	U.S. Energy Information Administration
EPAct	Energy Policy Act of 2005
ft	feet
Gen 4	Generation 4
GHG	greenhouse gas
HDD	heating degree day, 65°F base temperature
HP	heat pump
HVAC	heating, ventilation, and air conditioning
IRA	Inflation Reduction Act
ITC	investment tax credit
kWh	kilowatt hours
LCC	life-cycle cost
LCCA	life-cycle cost analysis
mmBtu	million British thermal units
MT CO2e	metric ton of carbon dioxide equivalent
MW	megawatts
Northland Center	Northland Workforce Training Center
NYS	New York State
NYSERDA	New York State Energy Research & Development Authority
O&M	operation & maintenance
PTC	production tax credit
sq ft	square foot
VAV	variable air volume
VFD	variable frequency drive
VRF	variable refrigerant flow

Summary

National Fuel has engaged Wendel to develop a community-style heat pump system for the Northland Workforce Training Center (Northland Center) and the 11 residential buildings located on the adjacent Longview Avenue. The project aims to determine the feasibility of a geothermal heating and cooling system for a combined commercial and residential system. The Northland Center, a key initiative under the Buffalo Billion program, is the main focus of the study. This facility, encompassing 237,741 square feet (sq ft) and 11 residential buildings with a combined area of 13,894 sq ft, form the basis for analysis. The initial deliverable includes developing baseline conditions for the buildings, which involves a 25-year life-cycle cost (LCC) for existing equipment and utility bills. The study evaluates whether a community-style heat pump system can save energy and reduce greenhouse gas (GHG) emissions for the Northland Center and Longview Avenue.

S.1 Vision

National Fuel envisions a sustainable utility and energy system powered by clean energy while balancing reliability, economics, and efficiency.

S.2 Study Goals

The study provides detailed pilot information on a scalable community-style heat pump system to support fossil fuel reduction and future urban commercial and residential building electrification. It assesses new technology, capital costs, energy savings, and GHG reductions. The findings include guidance and procedures for implementing electrification at the Northland Campus and 11 residential buildings.

The study examines the challenges of building a centralized heat pump plant, identifies actionable steps that can be taken today, and outlines a strategic path forward. The main objectives of this scope are:

- Assessing the business case for a geothermal thermal heating and cooling system
- Delivering pilot data on scalable community-style heat pump systems for urban electrification
- Analyzing challenges and solutions for developing a centralized heat pump plant while outlining actionable steps and a strategic path forward

S.3 Methodology and Scope

The study evaluates the Northland Center and the 11 residential properties. It outlines steps to identify, develop, and implement a community heat pump system while balancing electrification with fiscal responsibility. The methodology includes:

- Conducting a full thermal hourly analysis to identify shared loads that reduce costs
- Facilitating working sessions with National Fuel and Wendel to define systems, financial assumptions, and constraints
- Considering utility rates, energy and emissions impacts, and financial analysis, including energy incentives, cost of carbon, and operations and maintenance (O&M) costs

The results aim to inform options for implementing of a community heat pump system at other properties. Key activities include:

- Reviewing utility rates for natural gas, hot water, chilled water, and electricity, from utility and district heating and cooling plants across the U.S.
- Applying a source-based method to analyze energy and emissions impacts using regional grid-level data
- Assuming the grid will supply the power required for any new loads

S.4 Evaluation of Electrification Methods

The study analyzed four potential electrification pathways, summarized in Table S-1, to illustrate the benefits and challenges of different approaches.

- **Option 1:** A comprehensive plan incorporating geothermal and heat pump systems to serve all 11 homes and the Northland Center, requires approximately 563 tons of capacity. A minimal heat source would provide backup.
- **Option 2:** A technically optimized solution that combines partial electrification with a heat recovery chiller and uses natural gas boiler systems as backup heating to reduce the system upgrade costs.
- **Option 3:** A targeted approach focusing on the 11 residential buildings only, replacing indirect-fired forced-air systems with hot water heating fan coil units. This option eliminates using natural gas in the homes but excludes the Northland Center.
- **Option 4:** A decentralized full electrification plan for only the 11 residential buildings using individual geothermal heat pump systems, eliminating natural gas for heating and reducing dependency on district heating and cooling infrastructure. Decentralizing the heating and cooling sources simplifies the overall system, promoting energy efficiency and cost savings.

Table S-1. Comparison of Electrification Community Heat Pump Options

Energy Conservation Measure	Nominal Tonnage	Quantity of Wells	Total Measure Cost ($)	Total Annual Savings ($)	Simple Payback Period
Option 1	563	375	$16,628,313	$62,769	264.9
Option 2	390	260	$13,490,173	$66,739	202.1
Option 3	38	25	$4,379,567	-$3,500	-1251.3
Option 4	66	44	$1,174,199	$387	3,035.8

S.5 Conclusion

The study outlines pathways to full electrification while providing short-term recommendations. Option 2 emerges as the most viable solution for the Northland Campus, leveraging shared loads across buildings to optimize costs and performance. Wendel has successfully implemented similar projects that use comparable setups and technologies. National Fuel should use these findings to select the best option that aligns with its goals and available resources. Depending on the priorities of the Northland Campus and National Fuel, each of the four electrification options presented in this study offers distinct benefits and challenges.

Given the significant financial requirements of these options, National Fuel should begin making decisions with future possibilities in mind. The company should develop a plan to integrate a hot water system for heating and cooling delivery and establish infrastructure plans to support future system needs. This approach would allow for a phased investment strategy enabling the gradual implementation of infrastructure projects aligned with National Fuel's long-term objectives.

For example, when routine end-of-life equipment replacements occur, Wendel recommends that homes receiving district heating and cooling upgrades be equipped to use mid-temperature water loops. This would prepare systems for more efficient water delivery and support future electrification. By replacing equipment with low- to mid-temperature hot water systems, National Fuel can adapt to the most effective technologies as they become available. Additionally, National Fuel should monitor emerging technologies that can help achieve its carbon reduction and electrification goals while lowering costs, equipment needs, and space requirements.

1 Facility Description

This section includes information and data for the following buildings included in this heat pump system study.

- Northland Workforce Training Center (Northland Center)
- 11 homes on Longview Avenue

Figure 1. Northland Workforce Training Center, Exterior View

The following buildings are part of the community heat pump proposal:

- Northland Center, 99 Longview Ave.
- 103 Longview Ave.
- 107 Longview Ave.
- 111 Longview Ave
- 115 Longview Ave.
- 119 Longview Ave.
- 123 Longview Ave.
- 127 Longview Ave.
- 131 Longview Ave.
- 135 Longview Ave.
- 143 Longview Ave.

These properties, located in Buffalo, NY, serve as residences except for the Northland Center, which provides training in the advanced manufacturing and energy market.

1.1 Northland Workforce Training Center

The Northland Center at 683 Northland Ave., Buffalo, NY 14211, is located on Buffalo's East Side. The center emerged from the 2019 transformation of a section of the historic Clearing Niagara Plant. It provides education and job training programs to individuals seeking career advancement and employment opportunities. Courses and certification programs span construction trades, healthcare, information technology, and hospitality. The center combines hands-on training, industry-recognized certifications, and job placement assistance to prepare students for workforce success.

Figure 2. Northland Workforce Training Center, Exterior and Lobby Views

1.2 Longview Avenue Homes

The project encompasses 11 traditional-style homes on the east side of Longview Avenue, located north of the Northland Center. Built in the early 20th century, these homes feature a mix of natural gas and electric appliances. The homes range in size from 900 to 1,600 square feet (sq ft) and typically include two floors and a basement.

Figure 3. Longview Avenue Homes, Aerial View

2 Utility Description

2.1 Northland Campus

This section includes utility data for the following buildings:

- Northland Workforce Training Center
- 11 homes on Longview Avenue

Figure 4. Typical Cooling Tower

Energy consumed at the Northland Center and Longview Avenue relies on two major sources: electricity and natural gas. Electricity, provided by National Grid, and natural gas, provided by National Fuel, are converted into usable energy for the buildings in this study. The transformation of purchased utilities (i.e., electric and natural gas) into usable utilities (i.e., chilled water and hot water) has inherent efficiency losses. Energy savings at the building level result in larger savings of purchased energy.

Appendix C has an existing system schematic. Table 1 summarizes the various heating, ventilation, and air conditioning (HVAC) systems used in the buildings and the relationship between building energy usage and the purchased energy needed to provide those utilities throughout the entire Northland Center.

Table 1. Heating, Ventilation, and Air Conditioning Systems by Building

Building	Size (sq ft)	Main HVAC System Type
Northland Center	237,741	Hot water boilers, Heat exchangers, Water sourced VRF heat pumps, water-cooled chillers, VAVs, and air handlers
Residences	13,894	Furnaces, boilers, window ac units, and fin tube radiators

2.2 Utility Analysis

National Grid and National Fuel bills provided data to establish baseline utility usage and costs for estimating potential energy savings. Fixed costs, such as customer charges, were removed, and demand and consumption costs were separated.

National Grid supplied electricity to all 12 buildings during the study period from January 2021 to December 2021, establishing a baseline for electric usage.

National Fuel supplies natural gas, which was similarly evaluated for the same timeframe. The reported natural gas usage, measured in therms, was converted to million British thermal units (mmBtu) using a thermal content assumption of 10 therms per 1 mmBtu.

Appendix B contains monthly consumption data and graphs. The selected baseline energy usage interval, from January 2021 to December 2021, was chosen because it represents the most recent data with minimal impact from the coronavirus disease 2019 (COVID-19) pandemic shutdowns. Due to unresponsiveness from residents, residential electric usage was estimated using data from the U.S. Energy Information Administration's (EIA) forms EIA-861 schedules 4A-D, EIA-861S, and EIA-861U, which provide average monthly consumption per customer in New York State. Table 2 summarizes the energy consumption for each facility in this study, based on utility data provided to Wendel and the stated assumptions.

Table 2. Annual Energy Consumption (2021)

Building name	FY 2021 Elec Usage (kWh)	FY 2021 Natural Gas Usage (mmBtu)
Northland Center	3,778,329	7,473
Residences	79,068	1,445
Total	3,857,397	8,918

2.3 Weather Normalization

This report incorporated 30-year weather data for Buffalo, NY, to estimate the energy savings anticipated from specific measures. The average annual heating degree-days (HDD) for this area are 6,692 HDD, while the average annual cooling degree-days (CDD) are 548 CDD. The weather data was sourced from the New York State Energy Research and Development Authority's (NYSERDA) website.

3 Electrification Options

The following electrification options are under consideration for the Northland Campus's heating and cooling systems across the 12 buildings in this study:

- Option 1: Full electrification, ~563 nominal tons
- Option 2: Partial electrification, ~390 nominal tons
- Option 3: Residential electrification, ~38 nominal tons
- Option 4: Independent residential electrification, ~66 nominal tons

Figure 5. Typical High Voltage Transmission Lines

3.1 Option 1: Full Electrification

Option 1 is an all-encompassing electrification plan that will allow for the heating and cooling of the 12 buildings in the study to be completely electrified. This plan uses a combination of geothermal wells and heat pumps. Existing natural gas boiler systems will provide redundant heating as a backup heating source.

The geothermal system will include approximately 375 wells with a total capacity of 563 tons located on Longview Avenue. A vacant lot on the west side of Longview Avenue has been identified for the wellfields, offering approximately 100,000 sq ft of space. A new building will be constructed in the southern area of the lot behind 82 Longview Ave. to house the equipment for the geothermal and heat pump systems.

The system will deliver hot and chilled water to all 12 buildings through interconnected piping. Modifications will allow direct hot water connections. Depending on the load of the connected buildings, the heat pump plant can operate in heat recovery mode, geothermal heat pump mode, or a combination of both.

Appendix C has a schematic of this option.

3.2 Option 2: Partial Electrification

Option 2 is an optimized technical solution that provides partial electrification of heating and cooling. This approach involves implementing both a geothermal and heat pump system as separate systems, sized to optimize run time and loading. This option uses the natural gas boiler systems as a backup heating source to reduce the overall cost of the system upgrade.

A heat recovery heat pump system will be housed in a new building constructed in the grassy area south of 99 Longview Ave. Geothermal wellfields will be installed in the parking lot of the Northland Center. The wellfield is estimated to have a total capacity of 390 tons, with approximately 260 wells.

This system will provide hot and chilled water to all 12 buildings through interconnected piping. Existing hot water boilers and district chilled water connections for variable refrigerant flow (VRF) systems will remain for redundancy and peak load conditions.

Appendix C has a schematic of this option.

3.3 Option 3: Full Residential Electrification

Option 3 focuses exclusively on full electrification of the 11 homes on Longview Avenue, with an approximate capacity of 38 tons. This option removes the Northland Center from consideration to highlight the differences in equipment requirements and economic impacts. This option will reduce the use of natural gas in the homes to zero since the forced-air systems would be replaced with hot water systems, and the hot water would come from an existing header fed from the cogeneration plant.

The geothermal system will include approximately 25 wells north of the new building south of 99 Longview Ave. Hot and chilled water will be distributed to all 11 homes through interconnected piping. Forced-air systems in the homes will be replaced with hot water systems, eliminating the need for natural gas.

District combined heat and power plant connections will supplement heating at the heat recovery heat pump. Existing steam or natural gas systems will be disconnected, and homes will be modified for direct hot water connections.

Appendix C has a schematic for this option.

3.4 Option 4: Independent Residential Electrification

Option 4 provides an alternate full electrification plan for the 11 homes by installing independent geothermal heat pump systems in each house. This option eliminates the reliance on district heating and cooling infrastructure, with a total capacity of approximately 66 tons.

Each home will have a geothermal heat pump system, with approximately four wells per home and approximately 44 wells. Systems will be installed in basements or utility rooms, providing heating and cooling for the individual homes, thereby reducing energy consumption and associated costs. Existing natural gas systems will be removed, and homes will undergo electrification upgrades and appliance electrification for compatibility with the new systems.

This decentralized approach focuses on overall system design while emphasizing energy independence for each home.

4 Electrification Constraints Overview

This section outlines the strategy for implementing electrification across the campus.

Figure 6. Typical Boiler Room

4.1 Overview

The study identifies several constraints to achieving full electrification of building heating systems. These include space constraints, electrical limitations, and the need for HVAC system upgrades. The study analyzes each constraint and proposes recommended actions to address these constraints.

One major constraint involves converting all HVAC equipment to low-temperature hot water systems instead of natural gas–reliant systems. Wendel has identified the reliance on natural gas systems at the Northland Center and the Longview Avenue homes as a key challenge. The study evaluates the costs and feasibility of converting campus buildings from natural gas to district hot water systems.

4.2 Northland Workforce Training Center

The Northland Center uses hot and chilled water from the main Northland Center water loops. Air handling units, VRFs, and heat pumps use chilled water for cooling, while air handling units, variable air volume (VAV) systems, and unit heaters use hot water for heating. Domestic hot water heat exchangers use the incoming hot water supply.

The absence of steam at the facility reduces electrification constraints. However, the limited availability of indoor space restricts the potential for new equipment.

Table 3. Northland Workforce Training Center Electrification Constraints and Mitigation Actions

System	Constraint	Action
Heating system	No constraint	Not applicable
Cooling system	No constraint	Not applicable
Humidification	No constraint	Not applicable
Domestic hot water	Gas water heater	Replace with HP or electric
Autoclaves and cage and glass wash	No constraint	Not applicable
Process cooling system	No constraint	Not applicable
Electrical system	No constraint	Not applicable
Physical space	Lack of available space indoors	Centralize heat pumps between buildings

4.3 Longview Avenue Residential Buildings

The Longview Avenue residential buildings use natural gas furnaces and boilers for heating. Residents use window units for cooling in three homes, while others lack cooling systems. Fin-tube radiators heat five homes, and forced-air furnaces heat eight homes. Residents also use natural gas for appliances, including hot water heaters, stoves, and clothes dryers.

Table 4. Longview Avenue Electrification Constraints and Mitigation Actions

System	Constraint	Action
Heating system	Natural gas furnace	Replace with fan coil unit
Cooling system	No constraint	Not applicable
Humidification	No constraint	Not applicable
Domestic hot water	Gas water heater	Replace with HP or electric
Stove	Gas stove	Replace with electric
Clothes dryer	Gas clothes dryer	Replacement with electric
Electrical system	Upgrade required	Electrical service upgrade
Physical space	Lack of available space indoors	Centralize heat pumps serving groups of buildings

Resident participation in the study was limited despite community stakeholder engagement efforts. Many residents were reluctant to replace natural gas appliances in their homes.

4.4 Geothermal Well Constraints

With geothermal wells serving as the primary heat source and heat sink for a future electrified system, the space required for geothermal fields becomes a significant constraint. This study identifies three locations for potential geothermal systems:

- Parking lot in front of Northland Center
- Green space south of 99 Longview Ave.
- Vacant lot west of Longview Avenue

These areas were selected in collaboration with National Fuel staff and Northland faculty, considering locations that could be dug up and replanted or paved over. Other potential areas were excluded due to significant anticipated costs, the presence of historical trees or landmarks, or preexisting underground infrastructure.

The three identified locations provide approximately 166,000 sq ft of green space, which equates to approximately 1,000 tons of potential geothermal capacity. The optimized Option 2 uses 60,000 sq ft and 390 tons of the available capacity.

This capacity estimate assumes a maximum well depth of 500 feet (ft). Addressing the risks associated with drilling near-surface shale layers and implementing precautions is essential to ensure the safety of the community and the environment. Potential changes to permits and regulations may soon allow deeper well depths.[1,2] With these changes, National Fuel could achieve greater geothermal capacity within the same green space.

[1] An act to amend the environmental conservation law, in relation to exempting certain geothermal boreholes at depths beyond five hundred feet from certain requirements, New York State Senate Bill S6604, 2023–2024 Regular Sessions. (2023)

[2] An act to amend the environmental conservation law and a chapter of the laws of 2023 amending the environmental conservation law relating to exempting certain geothermal boreholes at depths beyond five hundred feet from certain requirements in relation to regulation of certain closed-loop boreholes installed for the purpose of facilitating geothermal heating or cooling system, New York State Assembly Bill A8565, 2023–2024 legislative session. (2024)

5 Campuswide Electrification Strategy

5.1 Northland Campus Long-Term Electrification Strategy

This section provides an overview of the long-term strategic approach for the electrification of the Northland Campus. See Figure 1 for a photo of the building.

The Northland Center and adjacent residential buildings in eastern Buffalo, NY, present an opportunity for electrification. National Fuel can apply the strategies identified in this study to electrify all nearby buildings. Regardless of the electrification approach, all equipment must be converted from natural gas to hydronic hot water heating systems.

5.2 Strategy

Expanding the electrification strategy to additional neighborhoods in Buffalo, NY, requires a detailed assessment of feasibility and approach. The study recommends implementing Generation 4 (Gen 4) heat pump systems to electrify neighborhoods incrementally through smaller, phased projects over several years. The assessment must evaluate whether upgrades to the current electric grid are necessary to support the expanded system. Identifying and addressing existing electric grid constraints hindering geothermal upgrades will also inform this expansion strategy.

The electrical utility provider must coordinate efforts to complete necessary electrical grid upgrades before implementing broader electrification initiatives. In addition to the primary service additions associated with the proposed geothermal heat pump plants, individual residential customers will require service upgrades to accommodate the increased load, assuming they replace existing gas appliances with electrical alternatives. (Appendix E contains detailed information regarding the electrical requirements for each option and the impact on residential clients.)

A Gen 4 system centralizes the distribution of low-temperature hot and chilled water from a plant to connected facilities. This system requires upgrading all buildings to accommodate low-temperature hot water systems. The central plant will include heat pumps, pumps, and geothermal wellfield connections. Wendel identifies the amount of geothermal energy that can be produced in densely populated areas as a limitation of this system. Supplementing geothermal systems with other renewable energy sources should address this limitation.

Ensuring redundancy and reliability requires including contingency measures to provide consistent heating service to connected clients. Emergency power generation equipment must provide power during outages until grid power is restored. The first three options include condensing hot water boilers, which support design day and emergency operations. Operating condensing boilers requires significantly less power than the proposed heat pumps, reducing the size of the required emergency generator. The estimates for the four proposed options do not currently include emergency generator costs.

The city of Buffalo cannot feasibly convert all systems to electrification simultaneously. A phased approach is necessary to gradually transition neighborhoods to fully electrified operations while ensuring the electric grid can support the increased demand.

6 Incentives Assessment and Analysis

This section evaluates the financial incentives available to offset the costs of implementing the proposed heat pump options. Two primary federal tax programs, the Business Energy Investment Tax Credit (ITC) and the §179d Energy Efficient Commercial Building Deductions provide significant opportunities to reduce the upfront investment required for electrification projects.

Figure 7. Atrium of Northland Training Center

6.1 Overview

The New York State (NYS) Clean Heat Program collaborates with utilities to provide various incentives for energy efficiency improvements. In addition, two primary federal tax programs help offset upfront costs for the proposed heat pump options: the Business Energy ITC and the §179D Tax Deduction. However, businesses cannot claim incentives from both programs simultaneously. This study assumes a 40% ITC tax credit, less than the maximum 50% incentive available.

6.2 Business Energy Investment Tax Credit

The Inflation Reduction Act (IRA) introduced the Business Energy ITC to incentivize businesses to invest in renewable energy systems. This federal credit provides a percentage-based direct payment to businesses installing solar, wind, geothermal, fuel cell, or other renewable energy systems. Although the final rules for the direct-pay credit are pending, the preliminary structure assumes a 30% base incentive, with several bonus adders that can increase the total credit.

Key incentive components include:

- Base incentive (6%) for all energy projects
- Multiplier incentive (30%) for projects meeting one or more of the following:
    - Generates less than 1 megawatt (MW) of power or thermal capacity
    - Uses prevailing wage and apprenticeship programs
- Additional bonus adders (+10% each):
    - Domestic product compliance:
        - Requires all iron, steel, and manufactured goods to be produced in the U.S. This adder is considered obtainable with proper specifications written for the project.
        - Waivers may apply for products unavailable domestically
    - Energy community or low-income location:
        - Includes projects located in energy communities, on brownfields, in low-income communities, or Indigenous land
        - Excludes production tax credit (PTC) eligibility
    - Serving low-income housing:
        - Requires at least 50% of the financial benefits of electricity produced by the facility to benefit households meeting one of the following criteria:
            - Income below 200% of the federal poverty line
            - Income below 80% of the area’s median gross income
- Reductions and maximums
    - Projects using tax-exempt financing face a 15% reduction in the total credit.
    - If all conditions are met, the total ITC can reach up to 70% of the project cost.

6.3 179D Tax Deduction

The Energy Policy Act of 2005 (EPAct) created the §179D Energy Efficient Commercial Building Deduction to encourage energy-efficient design for new and renovated commercial buildings. This deduction targets HVAC, lighting, and building envelopes. Both commercial building owners and designers (e.g., engineers and architects) of government-owned buildings or tax-exempt facilities can claim this deduction.

Key incentive components include:

- Prevailing wage incentive:
    - Projects meeting prevailing wage and apprenticeship requirements start with a $2.50 per sq ft deduction
    - Each additional percentage of energy reduction compared to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Reference Standard 90.1 increases the deduction by $.10 per sq ft, up to $5.00 per sq ft
- Nonprevailing wage incentive:
    - Projects not meeting prevailing wage standards start with a $.50 per sq ft deduction
    - Each additional percentage of energy reduction increases the deduction by $.02 per sq ft, up to $1.00 per sq ft

Importantly, the §179D deduction cannot be taken with the ITC.

Appendix A. 25-Year Life-Cycle Cost Assessment

This appendix presents a 25-year life-cycle cost assessment (LCCA) for the four electrification options Wendel evaluated. The analysis reviews operational and capital costs, projected energy and maintenance expenses, and potential savings from incentives and carbon tax reductions.

This section outlines the overview, methodology, and results of the LCCA.

Figure A-1. Hot Water Boilers at Northland

A.1. Overview

Wendel evaluated four electrification options, each with distinct advantages and disadvantages. One of National Fuel's goals is to implement a financially feasible option. The 25-year LCCA forecasts costs and savings over the project's life. The analysis considers operational and capital costs or savings, escalation of energy and maintenance costs, and financing costs.

A.2 Inputs and Assumptions

The 25-year LCCA incorporates several inputs and assumptions to project the financial performance of each option. These inputs include lending terms, O&M costs, capital and operation cost avoidance, potential incentives, and carbon tax savings.

Wendel estimated O&M costs for each option based on the quantity and capacity of the proposed new equipment. The assessment excludes capital and operational cost avoidance values because all existing equipment is associated with customer-owned and -operated facilities.

Escalation rates associated with energy costs, O&M costs, and carbon tax are included in the inputs and summarized in each LCCA. These rates estimate how costs may increase during the 25-year analysis.

An optional analysis evaluates the impact of carbon tax savings and the potential cost savings through the increased use of existing campus cogeneration assets. This analysis applies a carbon tax of $121 per metric ton of carbon dioxide equivalent (MT CO2e) based on the 2022 New York State Department of Environmental Conservation (DEC) Value of Carbon Guidance. Wendel also calculated the overall district hot water rate impact from using waste heat that would otherwise go uncaptured.

A.3 Method and Results by Option

Wendel assessed the implementation of each of the four options, calculating all costs and savings over a 25-year period. The analysis provided a simple payback period, guiding National Fuel in selecting the most effective electrification strategy for the studied buildings. Costs are expected to increase by the time project execution begins.

- **Option 1** was analyzed with a $15 per million British thermal units (mmBtu) rate for chilled water and hot water production supplied to the Northland Center and 11 residential buildings. This option, the most expensive option evaluated, provides sufficient heat pump and geothermal wellfield capacity to meet nearly all of the connected facilities' heating and chilled water loads. Although its savings align with Option 2, Option 1 incurs the highest upfront costs.
- **Option 2** was also analyzed with a $15 per mmBtu rate for chilled water and hot water production supplied to the Northland Center and 11 residential buildings. This option offers the greatest savings at a lower cost than Option 1. However, peak heating loads require supplemental support from natural gas-condensing hot water boilers.

- **Option 3** was evaluated with a $21 per mmBtu rate for hot water production supplied only to the 11 residential buildings. This option includes a small geothermal heat pump plant to heat hot water exclusively for the 11 residential buildings. Its financial performance suffers due to limited revenue generation, making it the least favorable option among the first three. However, this analysis highlights the advantages of integrating geothermal heating plants across commercial and residential clients to diversify loads and improve financial outcomes.
- **Option 4** was evaluated based on natural gas savings for each resident at a rate of $8 per mmBtu. This option uses independent geothermal heat pump systems for each of the 11 residential buildings, eliminating the need for district heating and cooling infrastructure. While this option generates no hot water revenue, it reduces natural gas consumption for each resident, enhancing energy independence. Decentralizing the heating and cooling sources simplifies the overall system. Although the installation costs may be lower than centralized systems, long-term savings from reduced natural gas use and increased energy efficiency make this option an attractive and sustainable choice for homeowners.

Appendix B. Utility Analysis

Building Name:	Northland Workforce Training Center
Address:	683 Northland Ave
	Buffalo, NY 14211
Facility Area:	237,741 sq.ft.

Date:	3/22/2023
Utility Company:	National Grid
Acct. No.:	72399-53128
Rate:	SC3-Frontier Region

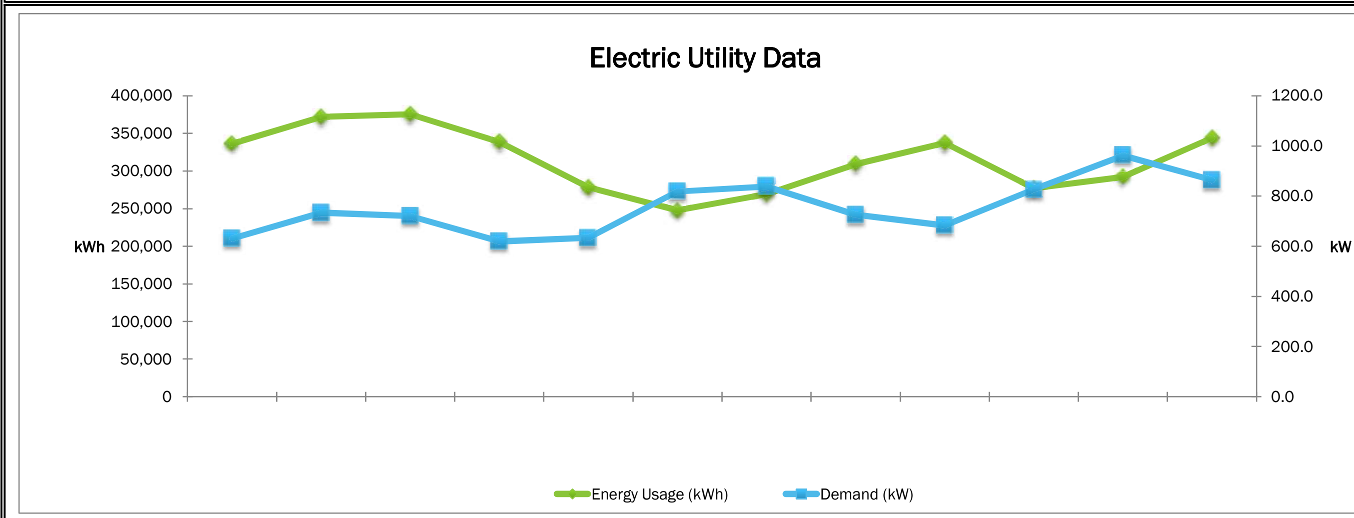
ANNUAL ELECTRIC UTILITY DATA

Billing Year	Billing Month	Customer Charge	A Demand Total (kW)	B Demand Cost	C Usage Total (kWh)	D Usage Supply Cost	E Usage Delivery Cost	F Total Cost	G Billing Days	H Load Factor
2021	Jan	$866.46	630.7	$2,478.65	336,206	$12,874.23	$2,657.16	$18,876.50	31	0.72
2021	Feb	$866.46	734.4	$2,886.20	371,886	$19,021.31	$2,682.29	$25,456.26	28	0.75
2021	Mar	$866.46	720.0	$2,813.57	375,401	$9,284.18	$2,251.59	$15,215.80	31	0.70
2021	Apr	$829.46	619.2	$2,047.45	338,759	$9,379.17	$2,498.61	$14,754.69	30	0.76
2021	May	$829.46	633.6	$3,202.15	278,479	$11,174.40	$1,964.30	$17,170.31	31	0.59
2021	Jun	$829.46	817.9	$4,133.61	247,867	$16,251.22	$1,702.97	$22,917.26	30	0.42
2021	Jul	$829.46	838.1	$4,233.02	269,454	$20,682.11	$1,432.39	$27,176.98	31	0.43
2021	Aug	$829.46	725.8	$3,499.99	309,177	$25,560.29	$1,976.22	$31,865.96	30	0.59
2021	Sep	$829.46	682.6	$3,338.82	337,437	$17,593.87	$2,360.70	$24,122.85	31	0.66
2021	Oct	$829.46	826.6	$4,058.60	277,173	$17,356.85	$2,260.81	$24,505.72	31	0.45
2021	Nov	$829.46	961.9	$4,930.40	292,271	$20,345.19	$2,506.29	$28,611.34	30	0.42
2021	Dec	$829.46	864.0	$4,353.65	344,219	$18,799.58	$1,601.17	$25,583.86	31	0.54
Avg./Totals:		**$10,064.52**	**754.6**	**$41,976.11**	**3,778,329**	**$198,322.40**	**$25,894.50**	**$276,257.53**	**365**	0.57

Table Formulas:

Hours per Month (h) = G x 24
Total Cost (F) = B + D + E
Load Factor (H) = C / (A x h)

Summary	
Energy Intensity (kWh/sq.ft.):	15.89
Cost Intensity ($/sq.ft.):	$1.16
Blended Cost (inc.demand) / kWh:	$0.073
Avg. Cost / kW:	***$4.64***
Avg. Cost / kWh:	***$0.0593***



Building Name:	Residential Homes	Date:	3/22/2023
Address:	Longview Avenue	Utility Company:	National Grid
	Buffalo, NY 14211	Acct. No.:	N/A
Facility Area:	13,894 sq.ft.	Rate:	SC-1 Frontier Region

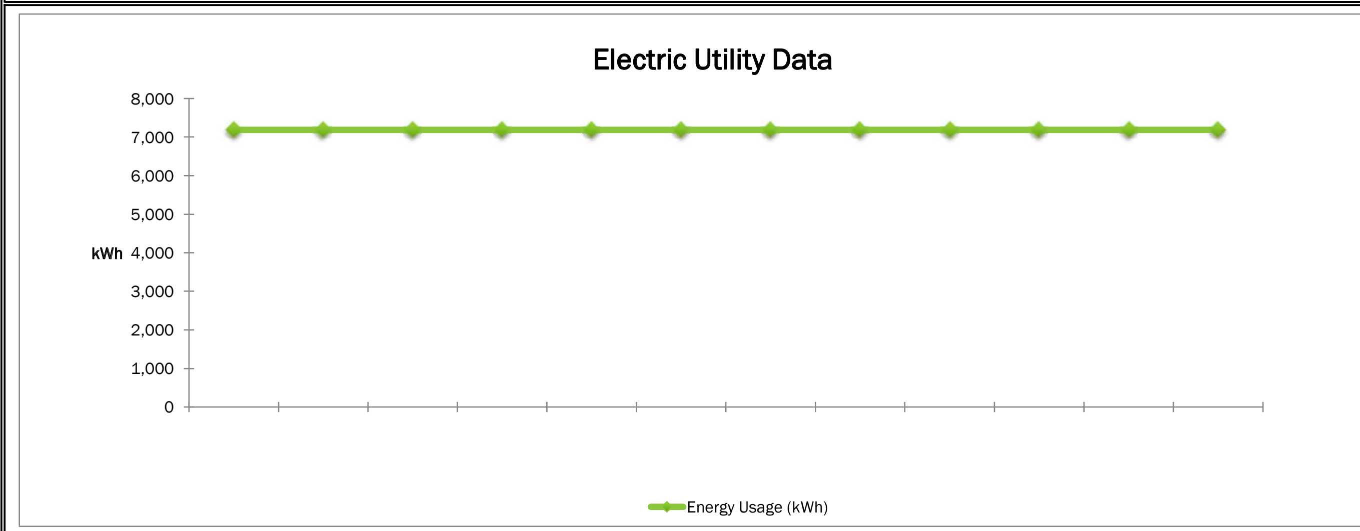
ANNUAL ELECTRIC UTILITY DATA

Billing Year	Billing Month	Customer Charge	A Demand Total (kW)	B Demand Cost	C Usage Total (kWh)	D Usage Supply Cost	E Usage Delivery Cost	F Total Cost	G Billing Days	H Load Factor
2021	Jan	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
2021	Feb	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	28	N/A
2021	Mar	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
2021	Apr	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	30	N/A
2021	May	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
2021	Jun	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	30	N/A
2021	Jul	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
2021	Aug	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	30	N/A
2021	Sep	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
2021	Oct	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
2021	Nov	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	30	N/A
2021	Dec	N/A	N/A	N/A	7,188	$0.00	$116.70	$116.70	31	N/A
Avg./Totals:		**N/A**	**N/A**	**N/A**	**86,256**	**$0.00**	**$1,400.40**	**$1,400.40**	**365**	N/A

Table Formulas:

Hours per Month (h) = G x 24
Total Cost (F) = B + D + E
Load Factor (H) = C / (A x h)

Summary	
Energy Intensity (kWh/sq.ft.):	6.21
Cost Intensity ($/sq.ft.):	$0.10
Blended Cost (inc.demand) / kWh:	$0.016
Avg. Cost / kW:	***N/A***
Avg. Cost / kWh:	***$0.0162***



Building Name: Northland Workforce Training Center
Address: 683 Northland Ave
Buffalo, NY 14211
Facility Area: 237,741 sq.ft.

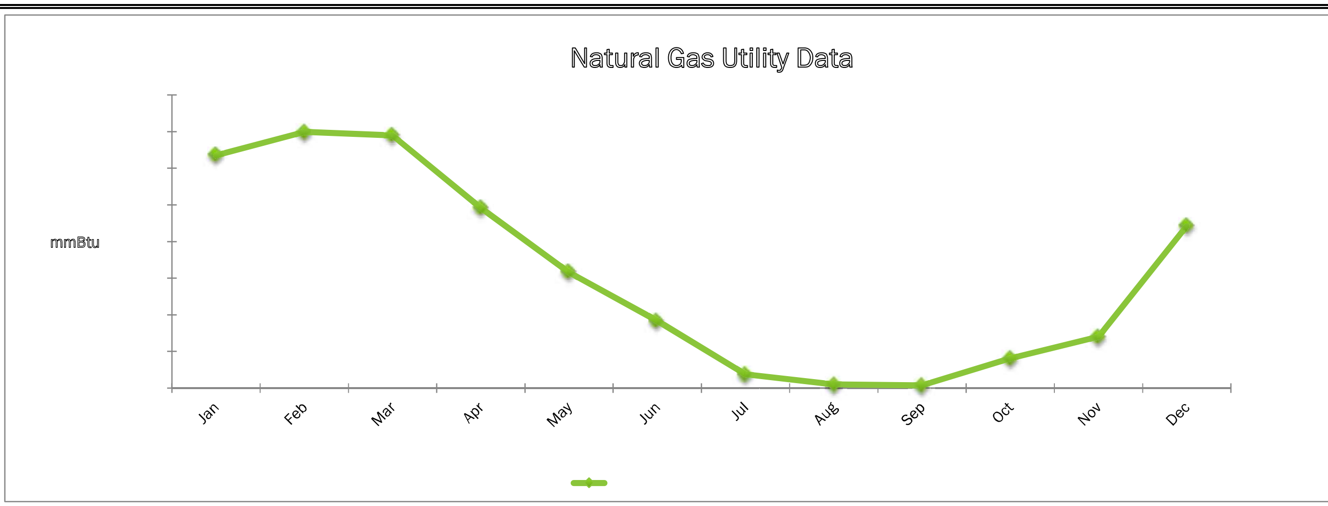
Date: 3/22/2023
Utility Company: National Fuel
Acct. No.: N/A
PoD ID: N/A
Rate: N/A

ANNUAL FUEL UTILITY DATA

Billing Year	Billing Month	Customer Charge	A Natural Gas Usage (Therms)	B Fuel Oil #2 Usage (Gal)	C Propane Usage (Gal)	D Usage Supply Cost	E Usage Delivery Cost	F Total Cost	G mmBtu Equivalent	H Billing Days
2021	Jan	N/A	1,270	N/A	N/A	$2,120.74	$0.00	$2,120.74	127.01	31
2021	Feb	N/A	1,399	N/A	N/A	$2,325.32	$0.00	$2,325.32	139.86	28
2021	Mar	N/A	1,379	N/A	N/A	$2,297.13	$0.00	$2,297.13	137.89	31
2021	Apr	N/A	983	N/A	N/A	$1,730.10	$0.00	$1,730.10	98.32	30
2021	May	N/A	632	N/A	N/A	$1,226.90	$0.00	$1,226.90	63.20	31
2021	Jun	N/A	368	N/A	N/A	$849.98	$0.00	$849.98	36.78	30
2021	Jul	N/A	76	N/A	N/A	$430.13	$0.00	$430.13	7.56	31
2021	Aug	N/A	21	N/A	N/A	$351.86	$0.00	$351.86	2.07	30
2021	Sep	N/A	16	N/A	N/A	$344.27	$0.00	$344.27	1.55	31
2021	Oct	N/A	163	N/A	N/A	$560.30	$0.00	$560.30	16.27	31
2021	Nov	N/A	281	N/A	N/A	$733.48	$0.00	$733.48	28.08	30
2021	Dec	N/A	885	N/A	N/A	$1,621.10	$0.00	$1,621.10	88.47	31
	Avg./Totals:	**N/A**	**7,471**	**N/A**	**N/A**	**$14,591.31**	**$0.00**	**$14,591.31**	**747.06**	**365**

Table Formulas:
mmBtu Equivalent (G) = Natural Gas Therms (A) / 10
mmBtu Equivalent (G) = Fuel Oil #2 Gallons (B) x 0.14
mmBtu Equivalent (G) = Propane Gallons (C) x 0.096
Total Cost (F) = D + E

Summary	
Energy Intensity (mmBtu/sq.ft.):	0.0031
Cost Intensity ($/sq.ft.):	$0.06
Avg. Cost / therm:	*$1.95*
Avg. Cost / Gal of Fuel Oil:	*N/A*
Avg. Cost / Gal of Propane:	*N/A*
Avg. Cost / mmBtu:	*$19.5317*



Building Name: Residential Homes
Address: Longview Avenue
Buffalo, NY 14211
Facility Area: 13,894 sq.ft.

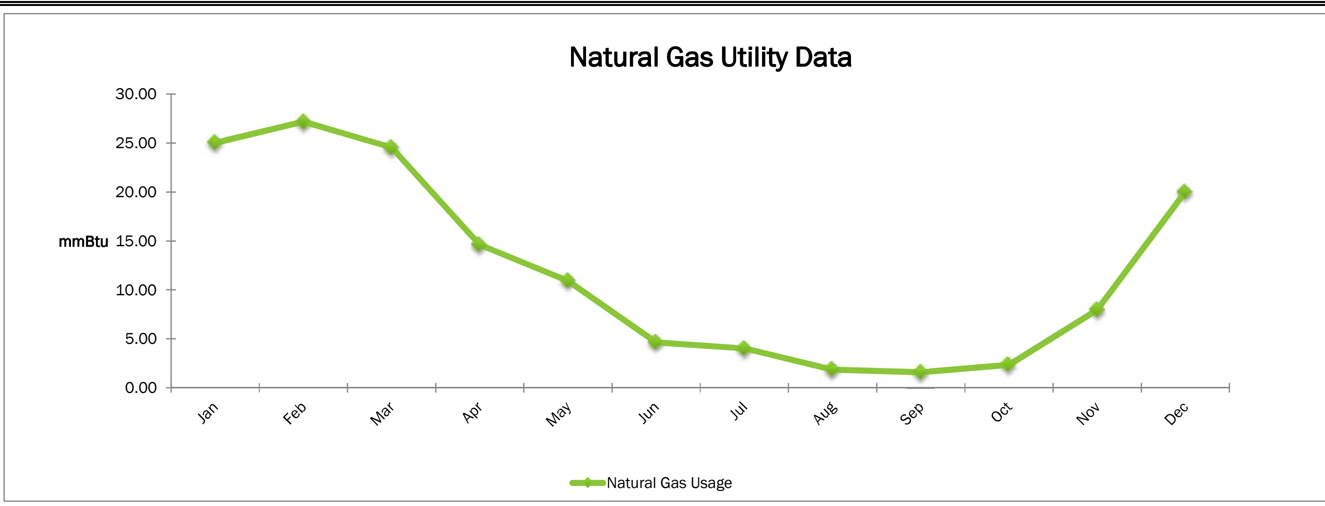
Date: 3/22/2023
Utility Company: National Fuel
Acct. No.: N/A
PoD ID: N/A
Rate: N/A

ANNUAL FUEL UTILITY DATA

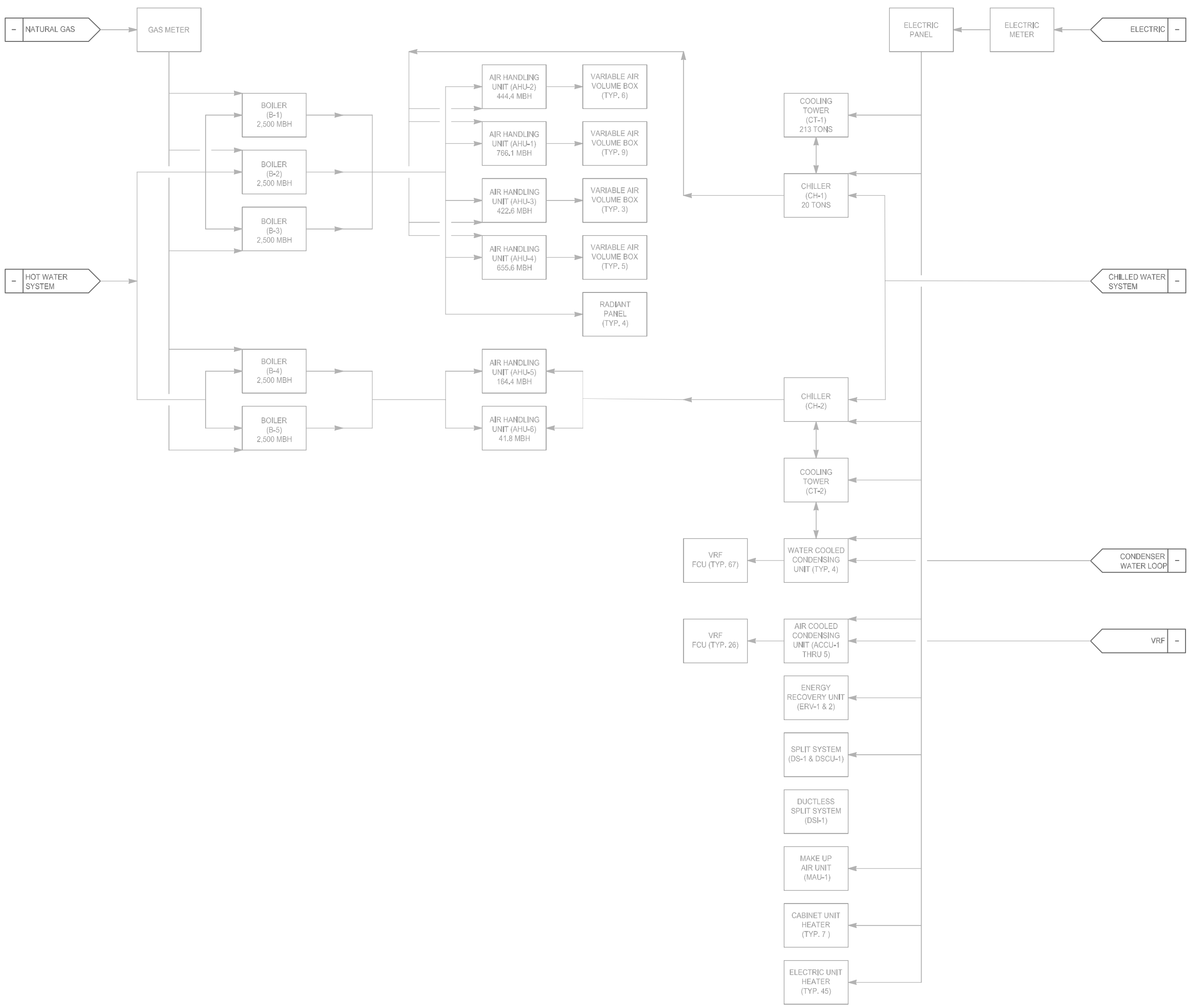
			A	B	C	D	E	F	G	H
Billing Year	**Billing Month**	**Customer Charge**	**Natural Gas Usage (Therms)**	**Fuel Oil #2 Usage (Gal)**	**Propane Usage (Gal)**	**Usage Supply Cost**	**Usage Delivery Cost**	**Total Cost**	**mmBtu Equivalent**	**Billing Days**
2021	Jan	N/A	250	N/A	N/A	$1,420.81	N/A	$1,420.81	25.00	31
2021	Feb	N/A	272	N/A	N/A	$1,548.57	N/A	$1,548.57	27.17	28
2021	Mar	N/A	245	N/A	N/A	$1,417.19	N/A	$1,417.19	24.53	31
2021	Apr	N/A	146	N/A	N/A	$1,054.55	N/A	$1,054.55	14.61	30
2021	May	N/A	109	N/A	N/A	$778.38	N/A	$778.38	10.92	31
2021	Jun	N/A	46	N/A	N/A	$523.03	N/A	$523.03	4.62	30
2021	Jul	N/A	40	N/A	N/A	$472.95	N/A	$472.95	4.02	31
2021	Aug	N/A	18	N/A	N/A	$286.01	N/A	$286.01	1.83	30
2021	Sep	N/A	16	N/A	N/A	$234.52	N/A	$234.52	1.57	31
2021	Oct	N/A	23	N/A	N/A	$365.21	N/A	$365.21	2.33	31
2021	Nov	N/A	80	N/A	N/A	$859.90	N/A	$859.90	7.96	30
2021	Dec	N/A	200	N/A	N/A	$1,774.89	N/A	$1,774.89	20.03	31
	Avg./Totals:	**N/A**	**1,446**	**N/A**	**N/A**	**$10,736.01**	**N/A**	**$10,736.01**	**144.59**	**365**

Table Formulas:
mmBtu Equivalent (G) = Natural Gas Therms (A) / 10
mmBtu Equivalent (G) = Fuel Oil #2 Gallons (B) x 0.14
mmBtu Equivalent (G) = Propane Gallons (C) x 0.096
Total Cost (F) = D + E

Summary	
Energy Intensity (mmBtu/sq.ft.):	0.0104
Cost Intensity ($/sq.ft.):	$0.77
Avg. Cost / therm:	*$7.42*
Avg. Cost / Gal of Fuel Oil:	*N/A*
Avg. Cost / Gal of Propane:	*N/A*
Avg. Cost / mmBtu:	*$74.2491*



Appendix C. Process Flow Diagrams



NORTHLAND WORKFORCE TRAINING CENTER

1 EXISTING BUILDING SYSTEMS
SCALE: NOT TO SCALE

National Fuel

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

NORTHLAND CENTRAL

SCHEMATIC

wendel
Centerpointe Corporate Park
375 Essjay Road, Suite 200
Williamsville, NY 14221
www.wendelcompanies.com
p:716.688.0766 f:716.625.6825
WENDEL ENGINEERING P.C.

NO.	REVISIONS	DATE

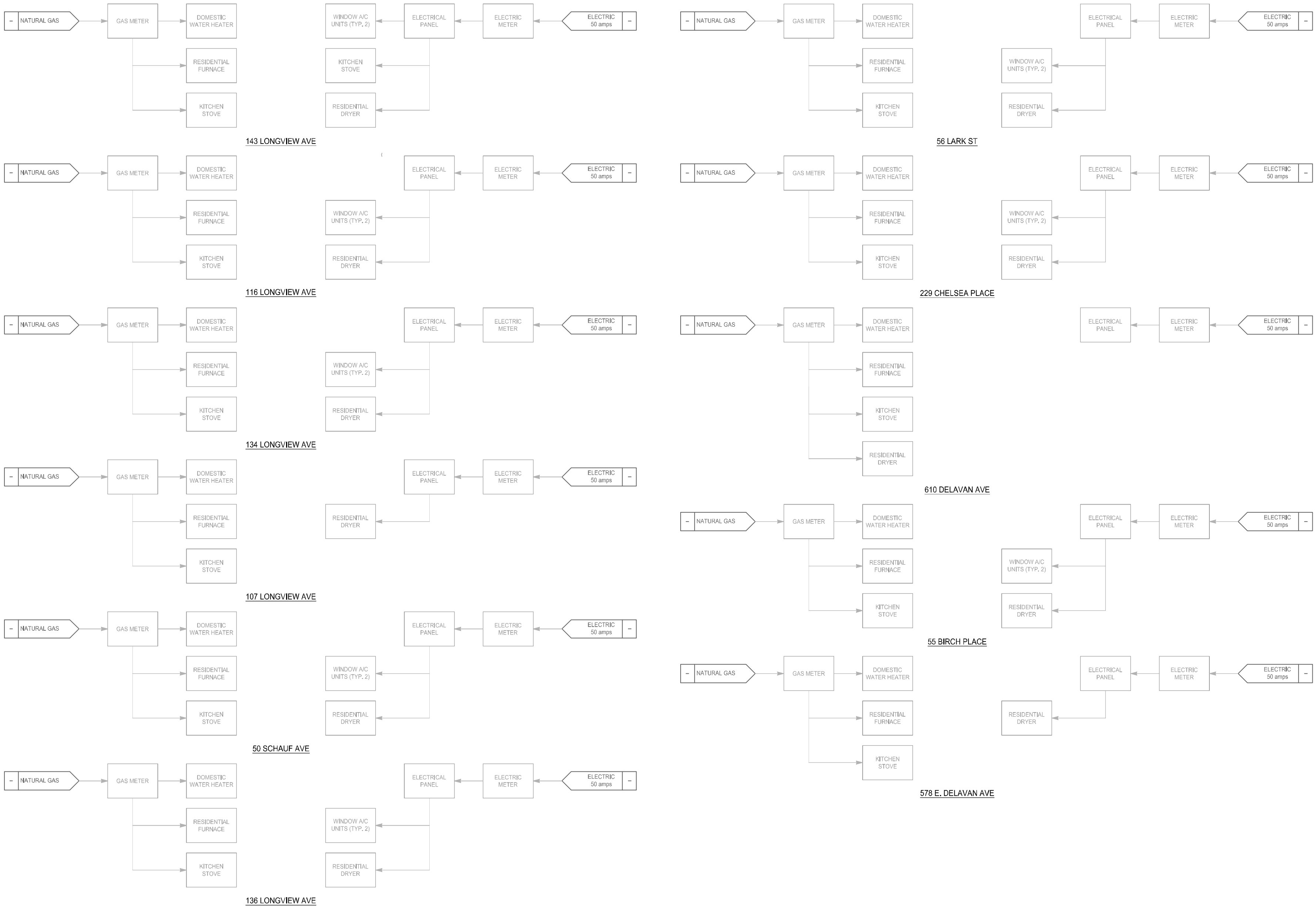
DWG. TITLE

EXISTING NORTHLAND CENTRAL SYSTEMS

0 1" 2"
GENERIC SCALE BAR
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING. IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE 09-08-2022
SCALE AS NOTED
DWN. MMK CHK. MJB
PROJ. No. 402811
DWG. No.

EXISTING



1 EXISTING BUILDING SYSTEMS
SCALE: NOT TO SCALE

National Fuel

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

NORTHLAND CENTRAL

SCHEMATIC

wendel
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Williamsville, NY 14221
www.wendelcompanies.com
p:716.688.0766 f:716.625.6825

WENDEL ENGINEERING P.C.

NO.	REVISIONS	DATE

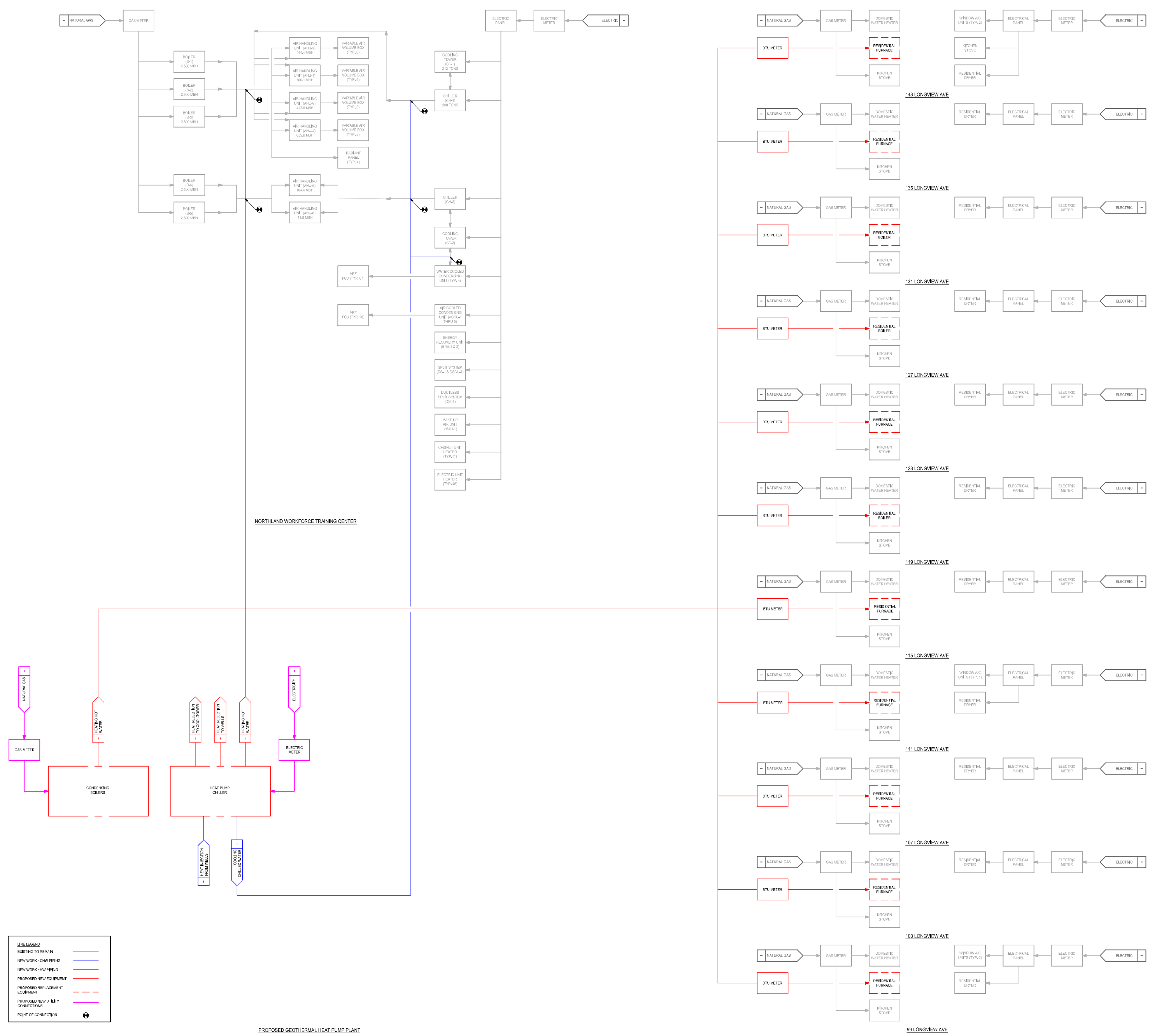
DWG. TITLE

EXISTING RESIDENTIAL SYSTEMS

0 1" 2"
GENERIC SCALE BAR
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING. IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE 09-08-2022
SCALE AS NOTED
DWN. MMK CHK. MJB
PROJ. No. 402811
DWG. No.

EXISTING



(1) PROPOSED HEAT PUMP SYSTEM
SCALE: NOT TO SCALE

National Fuel

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

NORTHLAND CENTRAL
683 NORTHLAND LLC
BUFFALO, NY 14211

PROCESS FLOW DIAGRAM

wendel
Centerpointe Corporate Park
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Williamsville, NY 14221
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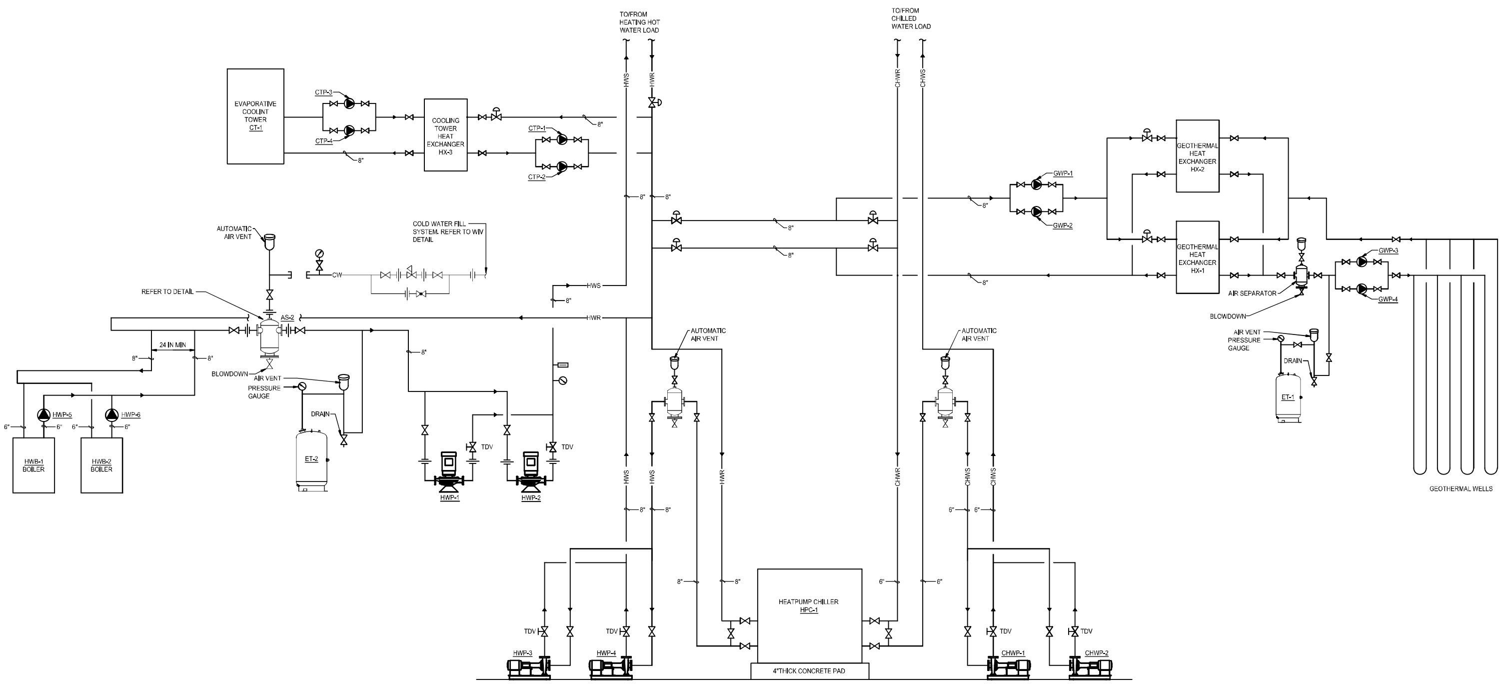
WENDEL ENGINEERING P.C.

PROPOSED NORTHLAND CENTRAL AND RESIDENTIAL SYSTEMS

DATE	09-08-2022
SCALE	AS NOTED
DWN.	GHS
CHK.	MJB
PROJ. No.	402611
DWG. No.	

PROPOSED



1 HEATPUMP PLANT PIPING SYSTEM SCHEMATIC
SCALE: NO SCALE

National Fuel

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

NORTHLAND CENTRAL

SCHEMATIC

wendel
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375 Essjay Road, Suite 200
Williamsville, NY 14221
www.wendelcompanies.com
p:716.688.0766 f:716.625.6825
WENDEL ENGINEERING P.C.

NO. REVISIONS DATE

DWG. TITLE

GEOTHERMAL PLANT PIPING SCHEMATIC

0 1" 2"
GENERIC SCALE BAR
SCALE BAR SHOWN IS TWO INCHES ON THE ORIGINAL DRAWING. IF NOT TWO INCHES ON THIS SHEET, ADJUST ACCORDINGLY

DATE 09-08-2022
SCALE AS NOTED
DWN. MMK CHK. MJB
PROJ. No. 402811
DWG. No.

PLANT

Appendix D. Codes and Regulations

Appendix D | Codes & Regulations

- Codes & Regulations
    - Overview
    - Code impacts
    - Regulations

OVERVIEW

The four electrification options presented by Wendel each contain portions that are required to comply with 2020 New York State Building, Energy, and Mechanical codes. There may be special permits required based on the options outlined.

Code Impacts

The energy code outlines the equipment minimum efficiency required for installation, the equipment would need to be classified as a chiller and table C403.3.2(7) would be applicable. This outlines the required kW/ton at several equipment capacities. Pump efficiencies and system controls are outlined in the energy code as well.

Building code would outline requirements for any building construction that would house the equipment. These would be standard requirements that also trigger compliance with energy code regarding wall and roof insulation (C402). The building may require sprinkler protection, there are several requirements listed in the building code that will need to be determined at the time of design to verify if any exceptions apply to eliminate the need for sprinklered protection.

Regulations

The New York state Department of Environmental Conservation (NYDEC) Division of Water (DOW) regulates wells up to 500 feet depth. Once the project moves into further stages it would need to be determined through test well drilling what the well heat rejection would be and potential depth required. The recommendation would be to ensure the depth does not go over the 500 feet mark to eliminate the special permitting required for these depths.

Determination on subsurface ownership rights would need to be resolved. If the subsurface rights are not owned the necessary parties would need to be involved and this may include the Bureau of Land Management (BLM) would then be involved in the permitting and potential leasing of the subsurface.

Site disturbances for distribution piping as well as the erection of a building would trigger Storm Water Pollution Prevention Plan for the entire area of the project. This requires a separate permit and approval process.

Appendix E. Electrical Report

Electrical Service Summary

BUILDING: Option #1 - New Heat Pump Plant

SERVICE VOLTAGE: 480 V

Equipment	Rated Current	Rating Type	Equipment Voltage	QTY	PROJ. LOAD (AMPs) @ 480 Volts
Multistack Heat Pump Chiller | 420 tons	711	MCA	480	1	711
Boilers | BMK-4000	20	FLA	480	2	40
Cooling Tower | Evapco AT 214-3G9	15.2	FLA	480	1	15.2
Hot Water Pumps | 5 HP	7.6	FLA	480	2	15.2
Hot / Gylcol / Condenser Water Pumps | 15 HP	21	FLA	480	10	210
Chilled Water Pumps | 25 HP	34	FLA	480	2	68
Hot Water Pumps | 40 HP	52	FLA	480	2	104
Future Capacity	200	FLA	480	1	200
Misc. Electrical | Outlets, Lighting, Controls, Etc.	50	FLA	480	1	50
Projected Electrical Capacity		Total Proj. Additional Amps 480V			1413.4

NEW PLANT - EXISTING SERVICE NOT APPLICABLE

Electrical Service | Project Impact		
Total Capacity	Current Load	Required Service @ 480 Volts
0	0	2,000

Electrical Service Summary

BUILDING: Option #2 - New Heat Pump Plant

SERVICE VOLTAGE: 480 V

Equipment	Rated Current	Rating Type	Equipment Voltage	QTY	PROJ. LOAD (AMPs) @ 480 Volts
Multistack Heat Pump Chiller | 420 tons	711	MCA	480	1	711
Boilers | BMK-4000	20	FLA	480	2	40
Cooling Tower | Evapco AT 214-3G9	15.2	FLA	480	1	15.2
Hot Water Pumps | 5 HP	7.6	FLA	480	2	15.2
Hot / Gylcol / Condenser Water Pumps | 15 HP	21	FLA	480	10	210
Chilled Water Pumps | 25 HP	34	FLA	480	2	68
Hot Water Pumps | 40 HP	52	FLA	480	2	104
Future Capacity	200	FLA	480	1	200
Misc. Electrical | Outlets, Lighting, Controls, Etc.	50	FLA	480	1	50
Projected Electrical Capacity		Total Proj. Additional Amps 480V			1413.4

NEW PLANT - EXISTING SERVICE NOT APPLICABLE

Electrical Service | Project Impact		
Total Capacity	Current Load	Required Service @ 480 Volts
0	0	2,000

Electrical Service Summary

BUILDING: Option #3 - New Heat Pump Plant

SERVICE VOLTAGE: 480 V

Equipment	Rated Current	Rating Type	Equipment Voltage	QTY	PROJ. LOAD (AMPs) @ 480 Volts
Multistack Heat Pump Chiller | 50 tons	103.5	MCA	480	1	103.5
Boilers | 400 MBH	5	FLA	480	2	10
Hot Water Pumps | 5 HP	7.6	FLA	480	2	15.2
Hot / Gylcol / Condenser Water Pumps | 5 HP	7.6	FLA	480	6	45.6
Chilled Water Pumps | 5 HP	7.5	FLA	480	2	15
Hot Water Pumps | 5 HP	7.5	FLA	480	2	15
Future Capacity	100	FLA	480	1	100
Misc. Electrical | Outlets, Lighting, Controls, Etc.	50	FLA	480	1	50
Projected Electrical Capacity		Total Proj. Additional Amps 480V			354.3

NEW PLANT - EXISTING SERVICE NOT APPLICABLE

Electrical Service | Project Impact		
Total Capacity	Current Load	Required Service @ 480 Volts
0	0	500

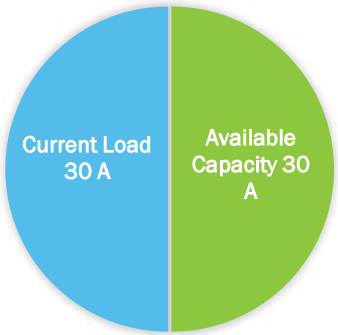
Electrical Service Summary

BUILDING: Option #1 - 3 - Residential Upgrades

SERVICE VOLTAGE: 120/240 V

Equipment	Rated Current	Rating Type	Equipment Voltage	QTY	PROJ. LOAD (AMPs) @ 480 Volts
Furnace / Boiler	8	FLA	120	1	8
Electric Stove / Range	33	FLA	240	1	33
Electric Dryer	23	FLA	240	1	23
Electric DHW Heater	19	FLA	240	1	19
Total Proj. Additional Amps 120/240V					83

Projected Electrical Capacity



Electrical Service | Project Impact		
Total Capacity[1]	Current Load[1]	Required Service @ 120/240 Volts
60	30	200

Note: 1. Assumed values for service size and current load of typical home in area.

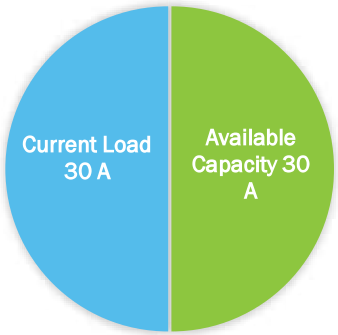
Electrical Service Summary

BUILDING: Option #4 - Residential Upgrades

SERVICE VOLTAGE: 120/240 V

Equipment	Rated Current	Rating Type	Equipment Voltage	QTY	PROJ. LOAD (AMPs) @ 480 Volts
Water Source Heat Pump	35	FLA	120	1	35
Geothermal Circulating Pumps | 3 HP	15	FLA	240	1	15
Electric Stove / Range	33	FLA	240	1	33
Electric Dryer	23	FLA	240	1	23
Electric DHW Heater	19	FLA	240	1	19
Total Proj. Additional Amps 120/240V					125

Projected Electrical Capacity



Electrical Service | Project Impact		
Total Capacity[1]	Current Load[1]	Required Service @ 120/240 Volts
60	30	200

Note: 1. Assumed values for service size and current load of typical home in area.

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and support to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

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