Saranac Lake
District Energy System

Final Report | Report Number 24-07 | May 2023

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Saranac Lake District Energy System

Final Report

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Abstract

Many upstate New York communities rely on fuel oil and propane for heating needs. District geothermal systems can provide a novel solution for decarbonizing and electrifying these communities. This study discusses the feasibility of the proposed ambient temperature district energy system in the Village of Saranac Lake. The report includes utility analysis, energy modeling, and life-cycle cost analyses of the baseline and proposed systems as well as an overview of distributed energy resources. The proposed system would rely mainly on geothermal boreholes, with potential supplemental heat from sources including river heat exchange, dry coolers, and thermal storage. Ultimately, building electrification in the Village via water source heat pumps would offer both carbon and cost savings over current systems.

Keywords

ground loop heat exchanger, geothermal borefield, water source heat pump, district energy system, thermal network, building electrification, decarbonization

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Acronyms and Abbreviations

A	ampere
AC	alternating current
AHJ	Authority Having Jurisdiction
APA	Adirondack Park Agency
ASHP	Air-source heat pump
BCR	benefit-cost ratio
BESS	battery energy storage system
BOS	balance of system
Btu/hr-ft-°F	British thermal units per hour per foot per degree Fahrenheit
CAAS	charging as a service
CESIR	Coordinated Electric System Interconnection Review
CO_2e	carbon dioxide equivalent
DC	direct current
DCFC	direct current fast charging
DEC	New York State Department of Environmental Conservation
Delta T	change in temperature
DES	district energy system
DG	distributed generation
DOE	U.S. Department of Energy
DR	dimension ratio
EPC	energy performance contractor
ES	electrical substation

ESA	Endangered Species Act
EV	electric vehicle
FERC	Federal Energy Regulatory Commission
ft	foot/feet
GLHX	ground loop heat exchanger
GPM	gallons per minute
HP	horsepower or heat pump
HVAC	heating, ventilation, and air conditioning
IRA	Inflation Reduction Act
kBtu/h	kilo-British thermal units per hour
kV	kilovolt
kVa	kilovolt-ampere
kWh	kilowatt-hour
LCCA	life-cycle cost analysis
LF	linear foot
M&P	maintenance and protection
MBH	thousand British thermal units per hour
MMBtu	million British thermal units
NG	National Grid
NIST	National Institute of Standards and Technology
NPV	net present value
NYISO	New York State Independent System Operator
NYS	New York State
O&M	operation and maintenance
PCM	phase change material
PSE	Public Service Commission
PV	photovoltaic
RFP	request for proposal
SBC	system benefit charge
SC	service class
SEQRA	State Environmental Quality Review Act
SIR	Standardized Interconnection Requirements
sq ft	square feet
TB	transformer bank
TMY	typical meteorological year
USACE	U.S. Army Corps of Engineers
V	Volt
VDER	value of distributed energy resource
WSHP	water-source heat pump

Executive Summary

The passage of the Climate Leadership and Community Protection Act of 2019 (Climate Act) has sparked a renewed focus on how to decarbonize building heating at scale. By 2050, 85% of homes and commercial building space statewide will need to be electrified with energy efficient heat pumps. Converting existing buildings to electrified heating will be challenging, as will the aggregate effects on the electrical grid. This study offers an alternative solution to traditional electrification approaches by proposing a district energy system (DES) that would supply low-carbon heating to more than 800,000 square feet (sq ft) of office, multifamily, hotel, and retail space in downtown Saranac Lake.

The primary heat source would be ground heat exchangers with vertical geothermal borefields located under the Dorsey Street parking lot, the Main Street lot, the Police Department parking lot, and Riverside Park. As a secondary source, the system could take advantage of an existing local resource, Lake Flower. The lake empties into the Saranac River, which flows through the village. Although the water temperatures are generally cold or tepid, they are sufficiently high enough for water-source heat pumps (WSHP) to operate efficiently. The DES would create an interface with the lake outlet and exchange heat between the lake water and a separate distribution loop that would extend downtown.

The study included 70 potential customers in the downtown area as well as Petrova Elementary School, a future emergency services complex, and future Adirondack Park Agency (APA) building. The study estimated the design day heating load of the connected buildings served was estimated at 518,000 thousand British thermal units per hour (MBH) with the design day cooling load estimated at 193,000 MBH.

The study considered the alternative solution to individually electrifying buildings. Retrofitting with an air-source heat pump (ASHP) alternative is technically challenging due to the winter design conditions in Saranac Lake. Retrofitting with electric boilers is cost prohibitive due to high cost of operation.

The system's initial primary customers would be those with existing WSHP systems that could be easily connected to the DES, those geographically close to the first phase of distribution piping, and those whose building owners have shown the greatest support.

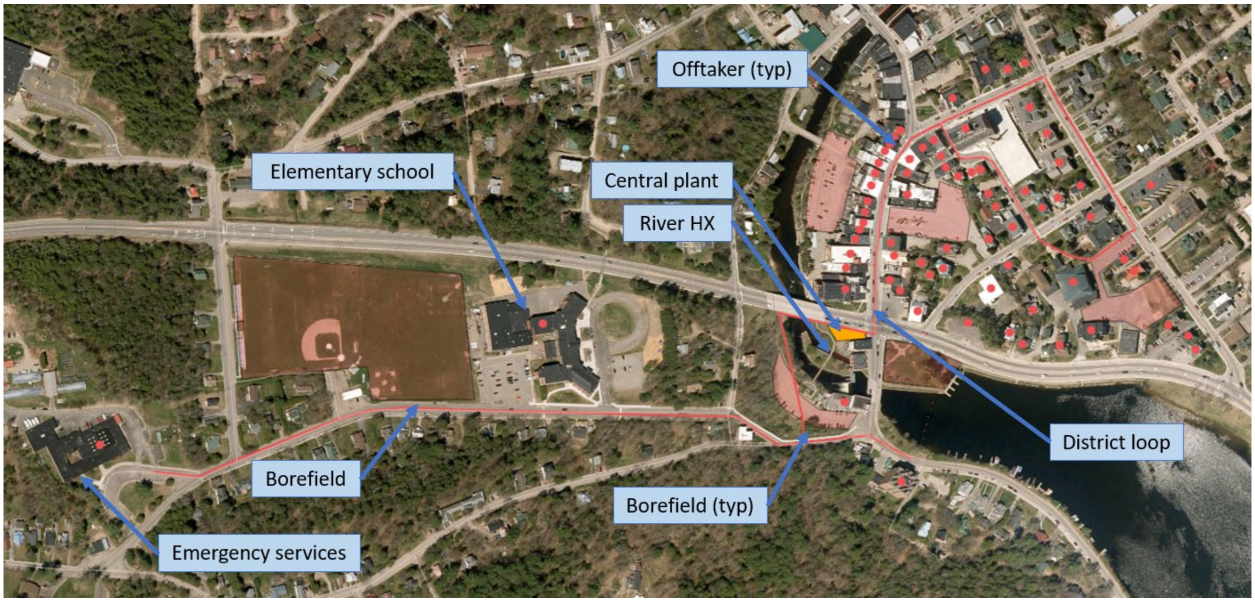
The project is estimated to incur a total development and construction cost of $45 million with projected building retrofit costs of $28 million; task 4 details the cost estimates and financial assumptions. The estimated 25-year net present value (NPV) of the system, including design and construction costs as well as direct benefits (e.g., avoided capital and operation costs of individual building owners, avoided delivered fuel and electric utility costs), totals $5.5 million. The study assumed the DES to be financed over 30 years. Financing for a large-scale municipal project is expected to have more favorable terms compared to financing individual building electrification heating, ventilation, and air conditioning (HVAC) upgrades.

Indirect benefits of the system include the Social Cost of the Carbon emissions avoided of the 25-year study period as defined by the New York State Department of Environmental Conservation (DEC). An NPV of $11.9 million in avoided carbon emissions was calculated, However, current law and market conditions do not offer an available avenue to monetize this value for the project's benefit.

The project will face several challenges, including coordinating with existing subsurface utilities, securing commitments from future customers, financing for customer retrofits, navigating permitting and regulatory requirements, and managing escalating construction costs. The detailed design study will focus on developing solutions to each of these challenges.

Figure ES-1. Aerial Site Overview

Source: CHA 2025



1 Establish Baseline Conditions

Describe the basis for a baseline condition and describe the characteristics of such baseline conditions.

Downtown Saranac Lake contains more than 800,000 square feet (sq ft) of commercial, residential, and government spaces within a compact area of approximately 37 acres. Few existing buildings contain water-source equipment. CHA has characterized the existing systems in aggregate after several site visits. Property tax records provided total floor area and space usage. The most predominant space use in buildings is small offices, followed by residential. This is because many downtown buildings are mixed-use, with commercial spaces on the ground floor and residential spaces on upper levels. National Grid is the electric utility serving the area, where users pay into the System Benefit Charge (SBC). Most buildings receive delivered fuel (fuel oil or propane) from Hyde Fuel Co., MX Fuels, or Suburban Propane. This study focused on identifying the buildings with existing systems that would be compatible with an ambient loop system, such as WSHPs, water cooled chillers, and low temperature hot water systems. Appendix B has building list and associated details including location, building type, and square footage.

Review at least the most recent 12 months of utility bills to the extent that they are made available by the building owners.

Building owners provided utility bills for six potential community buildings, spanning between January 2019 and February 2023. The utility bills are a sample of the buildings included in the study, comprising office space, midrise apartment, and restaurant space. The utility bills are a small sample of the community buildings and are used to model these building profiles accurately, as discussed later in this section of the report. Section 2.1 provides details on the provided utility data and a discussion of the reasonableness of the load profile estimation of usage.

Use utility profiles to estimate the baseline environmental footprint.

Using the NYS Department of Energy (DOE)'s greenhouse gas equivalencies calculator,[1] CHA calculated a baseline carbon dioxide (CO_2) equivalent footprint attributable to the New York Independent System Operator, Inc. (NYISO) electricity and to on-site propane and fuel oil consumption in 2022. Total cooling and heating consumptions are cumulative for all buildings and were determined from the estimated thermal load profiles developed. For this calculation, the assumption was that the heating for 70% of the buildings is supplied by fuel oil and the remaining 30% of the buildings by propane. Future emissions profiles for grid supplied electricity will be developed assuming a straight-line reduction in emissions from current levels to the stated 2040 goal of zero direct emissions from electricity production.

Table 1. Phase A Baseline Environmental Footprint, 2022

End Use	Energy (kWh)	Factor (metric tons/kWh)	Energy (MMBtu)	Factor (metric tons/MMBtu)	CO2e (metric tons)
Cooling	635,563	0.0001054	—	—	67
Heating, Fuel Oil	—	—	41,699	0.07414	3,092
Heating, Propane	—	—	17,871	0.06288	1,124
Total	**635,563**		**59,570**	—	**4,282**

Based on the New York State Department of Environmental Conservation (DEC), the social cost of carbon for 2023 is $126 per metric ton CO_2e. These phase A baseline emissions equate to an annual social cost of carbon of $539,532.

Develop baseline equipment costs.

An estimated heating, ventilation, and air conditioning (HVAC) equipment list was determined using satellite images to assist in estimating the type of equipment serving each potential connected building. Baseline equipment costs included new equipment costs for boilers and terminal units in addition to operation and maintenance (O&M) costs. Due to the age of building and available site information, CHA assumed that boilers provide the heating load for most buildings because they are a common heat source for buildings with delivered fuel. CHA based the heating replacement costs on engineering experience, estimated at $3.3 million, with cooling replacement costs estimated at $1.2 million. See Appendix C for the baseline life-cycle cost analysis (LCCA) for initial total cost and cost over the life of the equipment.

Estimate construction costs for replacement of existing HVAC with code-conforming in-kind equipment.

Replacement costs of the existing HVAC equipment is the same as the developed baseline equipment costs. To account for the fact that replacement will likely occur in the future, CHA applied an escalation rate of 2% per year as part of the baseline LCCA.

Establish electricity and thermal energy utility costs using published utility tariffs and/or existing data.

National Grid is the electric utility in the Saranac Lake area. Fuel oil is delivered by Hyde Fuel Co. and MX Fuels, and propane is delivered by Suburban Propane. CHA averaged the sample utility rates for the building information available and used the data to assess energy savings for the other connected buildings whose utility information is unknown. Section 1.5 details annual consumption, cost, and rates for the provided buildings. CHA estimated the annual electric cooling and thermal energy costs for all the community buildings using these average utility rates and the corresponding annual cooling and heating energy estimated from the thermal profiles.

Table 2. Phase A Baseline Annual Utility Costs

Energy Type	Utility Cost ($)
Existing Heating Energy	$1,638,185
Existing Cooling Energy	$85,165

Generate life-cycle cost for baseline consisting of maintaining the baseline energy system and operating it for a 25-year term.

LCCAs provide the cost of ownership of the baseline equipment over the life of the system. In this case, CHA used a life cycle of 25 years. The next section shows the costs incorporated into the LCCA, and Appendices B and C provide the details.

1.1 Electricity and Fuel Costs of System Operation

Previous sections discussed the annual electricity and fuel costs for all buildings. Projected electric and distillate fuel price indices over the LCCA were based on the National Institute of Standards and Technology (NIST) handbook, assuming a 3% general price inflation rate. The analysis also used a system efficiency degradation of 0.25% per year representing annual energy increases.

1.2 Operation, Maintenance, and Repair Costs

Boilers are more expensive to operate than water-source heat pumps (WSHPs) connected to a district energy system (DES). An outside vendor typically services boilers annually, and operating costs include chemicals and makeup water. For this study, chemicals and makeup water costs for boilers were considered negligible. An annual 3% escalation rate was used in the analysis.

1.3 Replacement Costs

Based on information from American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), boilers have a useful lifespan of 25 years, and it is reasonable to assume that the boilers are varying ages and would need replacement before year 25. To account for this, the assumption is that boiler replacements occur at a 10% annual rate. Cooling equipment, which is largely window air conditioners, is assumed to be replaced at an annual rate of 10%.

1.4 Net Present Value Analysis Results

The net present value (NPV) analysis provides a current value of the projected future total costs of ownership of the baseline systems in all buildings potentially connected to the proposed district system. This provides a single value in today's dollars so that it can be more readily compared to other scenarios (i.e., the proposed system) for business decisions. The NPV analysis shows existing systems have a baseline scenario of $42,233,000 using a discount rate of 7%. The baseline cash flows include cooling equipment and boiler replacement costs, O&M costs, and electric and fuel costs. Task 4 provides a net present value analysis for the WSHP compared to the existing equipment. The final project cost summary uses each variable's first cost. Appendix C shows the calculations of the NPV for the baseline scenario.

Develop a preliminary thermal model that will be used to size baseline and proposed heating/cooling plant equipment and energy source.

Heating and cooling loads were modeled using three approaches. For buildings with available utility information, models were reconciled to the specific building footprint and energy consumption. Most other buildings were modeled using DOE reference models of various building types. For the third category, which the DOE did not have reference models for, CHA developed typical buildings model.

DOE developed standard or reference energy models by aggregating thousands of the most common commercial buildings into building-type categories, age and construction, and climate zones to serve as an average representative dataset for energy efficiency research to assess new technologies. DOE's modeling approach and assumptions are as follows:[2]

- Used most populous cities in each climate zone
- Separated by post-1980 construction and pre-1980 construction
    - Differences between time periods are reflected in insulation values, lighting levels, and HVAC equipment types and efficiencies per ASHRAE 90.1

- Classified model inputs into four categories
  - Program (location, total area, occupancy, ventilation, operating schedule, etc.)
  - Form (number of floors, floor height, window fraction and location, shading, etc.)
  - Fabric (walls, roof, floors, infiltration, windows, internal mass, etc.)
  - Equipment (lighting, HVAC type, water heating, refrigeration, efficiency, controls)

Of the building types represented in the DOE models, six building types were considered for this study with most of the buildings falling into three main categories: stand-alone retail, small office, and full-service restaurant. Reference models used for the baseline were selected as "pre-1980" based on typical building age and construction in the Saranac Lake area. Table 3 lists the reference models used for the basis of the Saranac Lake buildings.

Table 3. Reference Building Types

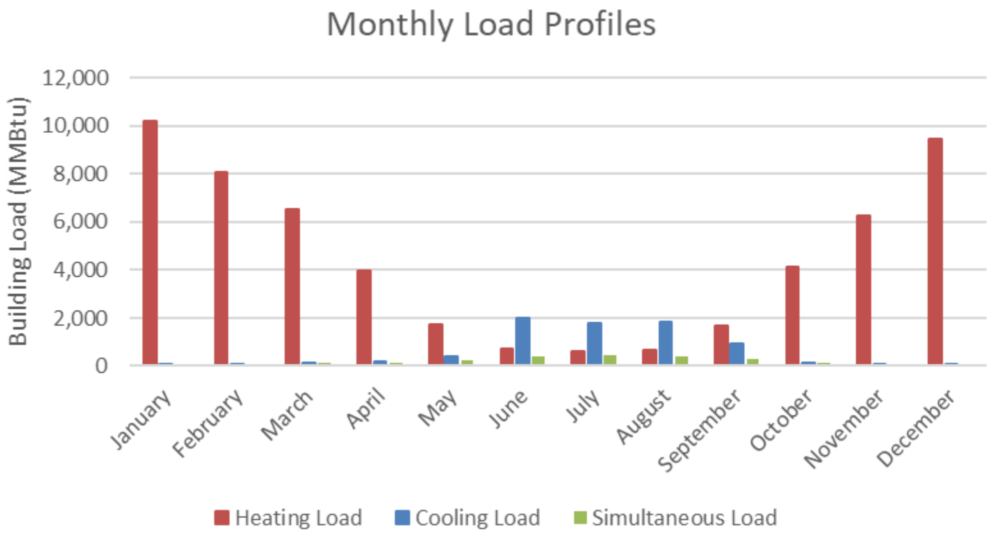
Source	Building Type	Floor Area (sq ft)	# Floors
DOE	Small Office	5,500	1
DOE	Stand Alone Retail	24,962	1
DOE	Midrise Apartment	33,740	4
DOE	Full-Service Restaurant	5,500	1
DOE	Primary School	73,960	1
DOE	Warehouse	52,045	1
CHA	Church	4,727	1
CHA	Residential	2,910	2

CHA transformed the reference models into energy models specific to this study for all potential buildings in the community DES using the following approach:

1. Select DOE models as reference buildings that most closely matched building construction/materials as the buildings in Saranac Lake and Climate Zone 6A based on ASHRAE 90.1.
2. Load the DOE model into Energy Plus software and verify model accuracy by inputting standard climate zone weather conditions and comparing energy usage to the reference model.
3. Perform 8,760 hourly simulations using Saranac Lake weather, including heating, cooling, and domestic hot water loads.
4. Apply space ratio to scale energy usages based on the buildings actual floor area compared to the DOE reference model. Some buildings contained multiple building types and the space ratio was applied proportionally (e.g., retail on ground floor and office space on upper floors).

Figure 1 illustrates the aggregated monthly load profiles. The highest monthly load occurs in January for heating and June for cooling. The DES approach has minimal simultaneous load as shown, limited largely by the cooling load. Heat removed from buildings with cooling loads can offset a portion of the heating load during the shoulder months. No buildings in this district configuration have a substantial amount of heat rejection, and therefore the load flattening is minimal. The small amount of load flattening is due to the increased efficiency of the system. Attracting buildings that have more substantial heat rejection, such as a data center or grocery store, could provide system benefit during the heating seasons.

Figure 1. Phase A Monthly Load Profiles



Design of the proposed system is based on hourly load profiles during design days. Hourly profile graphs for all buildings combined across the entire year can be found in the load profile calculations in Appendix A. Hourly variation of the design days and the week containing the design day are more useful in demonstrating peak operation. Table 4 summarizes the energy consumption, peak loads, and average loads during design days and weeks for heating and cooling. The reliance in the baseline methodology of using DOE reference buildings tends to overstate the magnitude of the peak load due to building warm up for commercial buildings because the models are defined using similar occupancy and usage schedules. In practice, the warm-up periods of buildings vary in start times, duration, and intensity to accommodate for differences in business hours. Therefore, peak loads aggregated by the following models are conservatively estimated.

Table 4. Phase A Design Loads

Metric	Design Week	Design Day
Total Heating (MMBtu)	2,218	518
Total Cooling (MMBtu)	432	193
Peak Heating Load (MBH)	30,083	
Peak Cooling Load (MBH)	18,079	
Avg Heating Load (MBH)	13,200	21,598
Avg Cooling Load (MBH)	2,575	8,033

Figures 2 and 3 represent the hourly load variation for all buildings during design weeks. While several building types are included in the profile, the needs of commercial buildings tend to drive the peaks due to their relative size and load density.

Figure 2. Design Week Load Profiles (Heating)

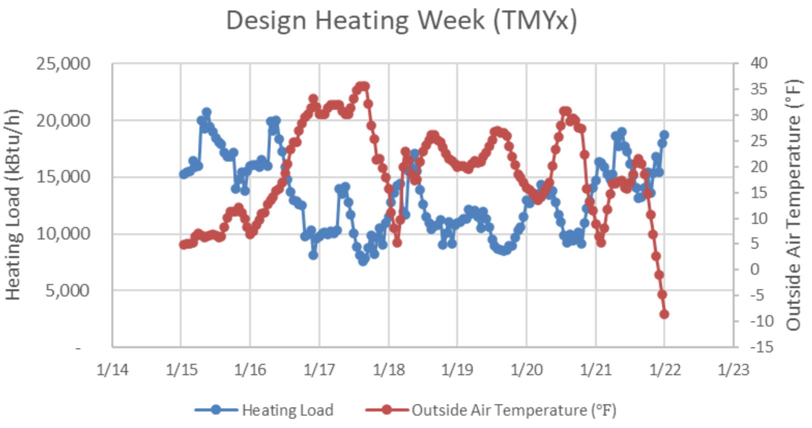
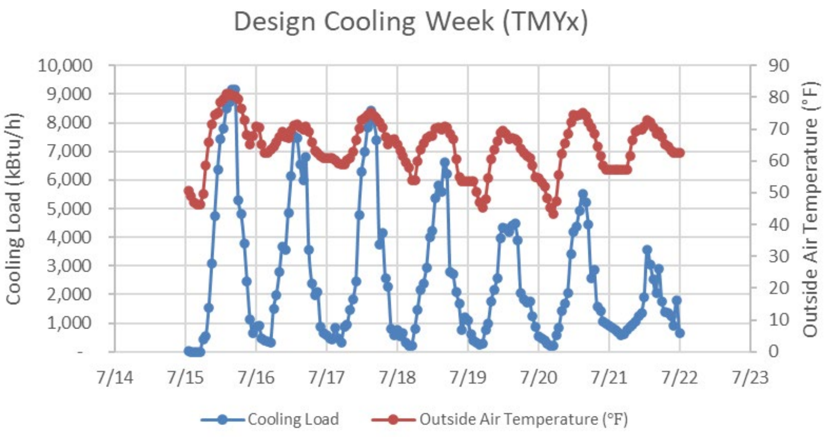


Figure 3. Design Week Load Profiles (Cooling)



Figures 4 and 5 represent the hourly load variation for all buildings during design days. Peak heating load occurs in the morning at 8:00 a.m. around a typical morning warm-up cycle for commercial buildings. An increase in cooling load generally occurs during typical occupancy hours for commercial buildings as well, with the peak load occurring during the late afternoon.

Figure 4. Design Day Load Profiles (Heating)

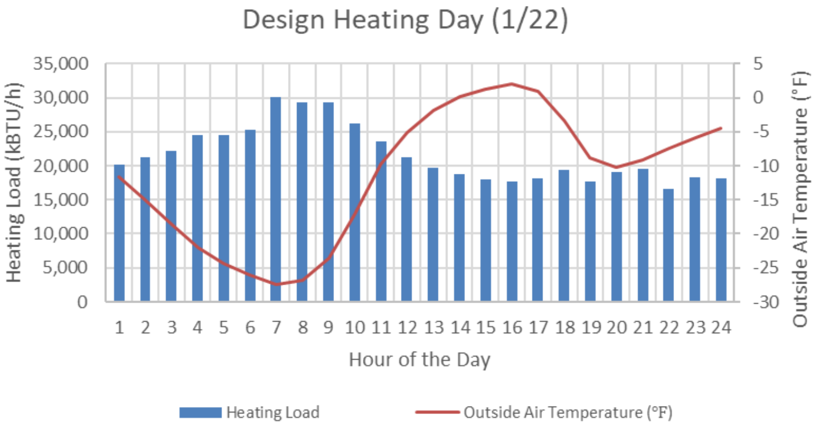
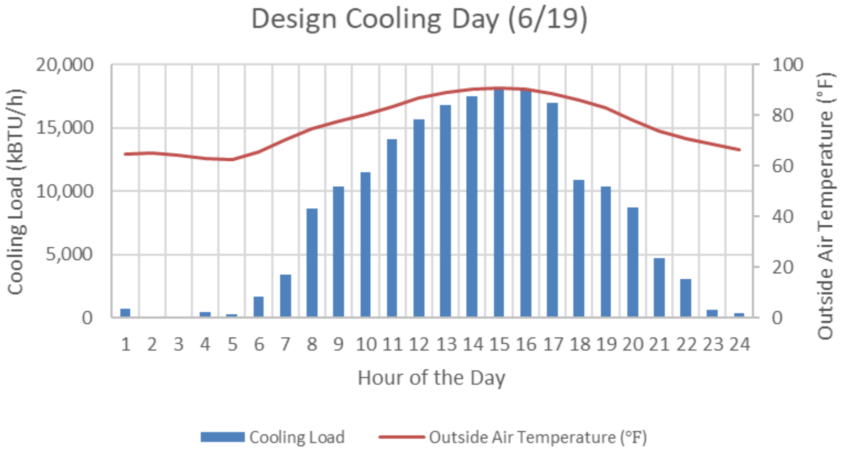


Figure 5. Design Day Load Profiles (Cooling)



1.5 Utility Analysis

To assist with cost estimates, utility bills spanning from January 2019 through February 2023 were collected for six buildings within the proposed community. Electricity is supplied and delivered by National Grid, propane is delivered by Suburban Propane, and fuel oil is delivered by Hyde Fuel Co. and MX Fuels.

Although the utility bills represent a small sample of buildings, they are useful in comparing the model-predicted energy usage with actual energy usage. Individual buildings may have unique factors influencing energy usage that can deviate from the model. For this study, a conservative approach was used to ensure the energy model errs on the side of understating energy use, resulting in a more conservative in the resulting cost/benefit analysis.

1.5.1 Electricity

Approximately 12 months of data was available, although some buildings had a month or two missing from the provided data. Table 5 shows annual consumption totals and blended electric rates for each building.

Table 5. Total Annual Electric Utility Usage

Building	Annual Consumption (kWh)	Annual Cost ($)	Blended Rate ($/kWh)
DeChantal Apartments	492,600	$51,484	$0.10
Village Offices	66,364	$7,650	$0.12
Police Department & 17 Main St.	176,080	$16,299	$0.11
Saranac Free Library	56,927	$8,724	$0.15
Waterhole Music Lounge	20,733	$3,946	$0.19

From these bills, the average blended electric rate was calculated to be $0.134 per kilowatt-hour (kWh).

1.5.2 Delivered Fuel

As with the electricity data, approximately 12 months of data was available, although some buildings had a month or two missing from the provided data. Table 6 shows annual consumption totals and fuel costs for each building.

Table 6. Total Annual Fuel Usage

Building	Fuel Type	Annual Consumption (MMBtu)	Annual Cost ($)	Rate ($/MMBtu)
DeChantal Apartments	FO #2	3,583	$81,737	$22.82
Village Offices	FO #2	1,260	$21,077	$16.73
Police Department & 17 Main St.	FO #2	957	$14,959	$15.63
Saranac Free Library	FO #2	307	$10,534	$34.31
Rice Furniture	FO #2	509	$14,375	$28.28
Waterhole Music Lounge	FO #2	217	$6,394	$47.36

From the annual consumption and costs on these bills, the average delivered fuel rate was calculated to be $27.50 per million British thermal unit (MMBtu).

2 Develop Energy Profile

Hourly building energy model of building archetypes based on DOE reference buildings. Assumed system configurations will be modified as needed to reflect system types found in target building types.

The preliminary thermal model developed in Section 2.0 is an hourly energy model based on DOE reference buildings and includes variables such as climate zone, space type definition and assignment, and scaling based on building square footage. Load profiles were represented as the total monthly energy consumption, hourly loads over the span of a design week, and hourly loads over the span of a design day.

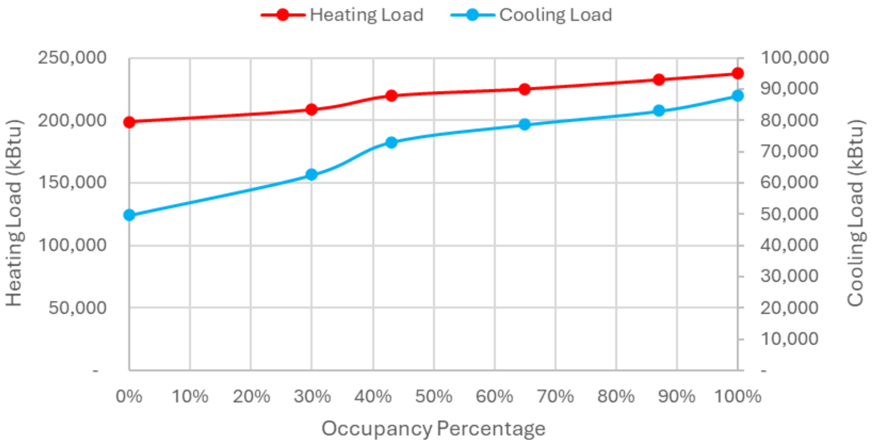
Utility bill reconciliation and scaling of loads on a square foot basis used to model a large number of individual buildings.

Six building owners in the proposed community provided utility bills ranging from January 2019 through February 2023, which were used to reconcile the heating and cooling consumption for buildings modeled individually. (Table 5 summarizes the electric bills, and Table 6, the fuel bills.) All buildings using the DOE reference models were scaled based on square footage and space type.

Determine the sensitivity of office building profiles to occupancy rates through running the typical office and multifamily building energy models with variable occupancy profiles.

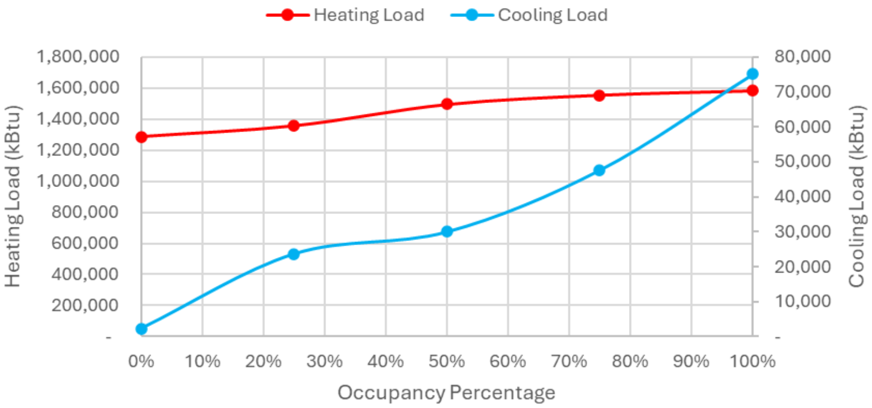
A sensitivity analysis was performed based on altering occupancy rates in two building types: Pre-1980 small office and pre-1980 midrise apartment. Occupancy rates from 0% to 100% were modeled by varying the number of occupied floors in the building model. Unoccupied floors were modeled with a constant setback temperature, minimal ventilation, lighting and plug loads turned off, and no internal heat gain from people or equipment. Figure 6 illustrates the impact of occupancy percentage on heating and cooling loads for each building type assessed.

Figure 6. Load versus Occupancy Percentage (Small Office, Pre-1980)



The small office building with the pre-1980 construction has a 16% decrease in heating load for a fully unoccupied scenario. A significant amount of heating is still required to overcome envelope losses. Occupancy has a greater effect on cooling load, although the magnitude is much less than the heating load, which can be attributed not only to the lower occupied cooling setpoint, but also to lower internal heat gains for lighting, plug loads, and people.

Figure 7. Load versus Occupancy Percentage (Midrise Apartment, Pre-1980)



In comparison, the pre-1980 midrise apartment building has similar trends to the small office building for heating and cooling as the occupancy percentage decreases. The envelope requires a substantial amount of heating even when the building is unoccupied. However, the cooling load is almost nonexistent at the unoccupied scenario, suggesting that most of the cooling is due to internal gains including people, lighting, and plug loads.

Define future potential phasing and associated load profiles for those buildings. Create aggregate thermal profiles per phase as applicable, and for the entire development at full build-out.

Buildings were grouped into different phases based on type of building and location to optimize load density and capital costs. The buildings were grouped (phased) by considering:

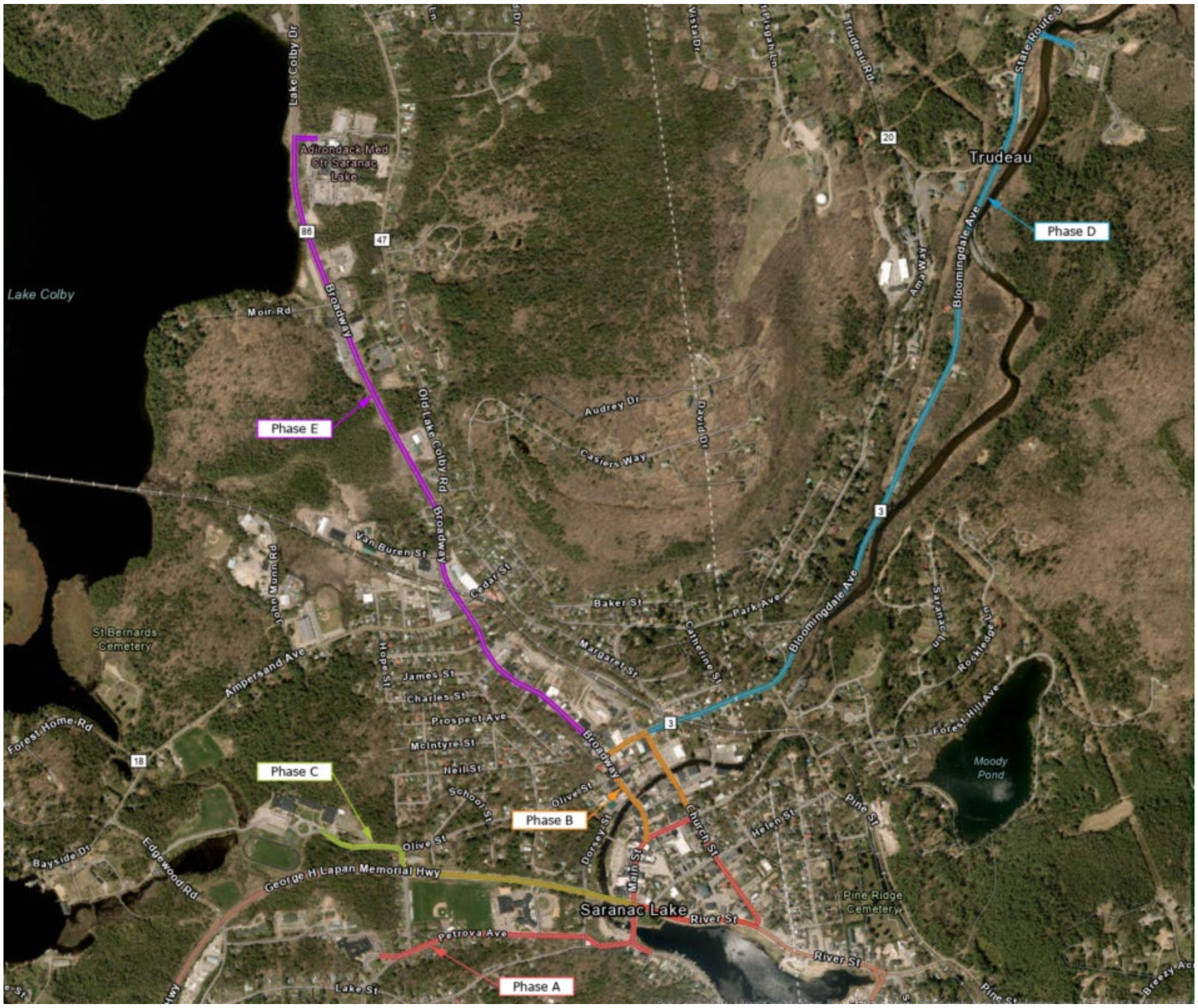
- Proximity from potential heat sources
- Proposed distribution main piping route
- Additional branch loops off the main

Figure 8 illustrates the five-phase approach proposed for project implementation, which includes:

- Phase A: Downtown Saranac Lake along the proposed main distribution pipe
- Phase B: Broadway, across Bloomingdale Avenue to Church Street, along additional distribution branch loops
- Phase C: Saranac High School
- Phase D*:* NYS Route 3 to the Wastewater Treatment Plant
- Phase E: Broadway to Adirondack Medical Center

Please note that this report focuses on Phase A only. The financial analysis for the remaining phases will be completed following Phase A approval.

Figure 8. Phasing Map



Develop a preliminary electric model, which will be used to forecast increases of electric load attributable to the proposed heating/cooling plant equipment.

The anticipated electric load increase at the central plant for Phase A is estimated at 580 kilowatts (kW). The electric load is inclusive of three downtown distribution pumps and two pumps to serve the Petrova Avenue branch. Including an electric boiler backup would dramatically increase the load.

In addition, a generator should be considered for running the loop pumps to keep circulation during emergency situations.

3 Determine Optimal Energy Source and Develop Conceptual Design

Explore the technical and economic viability of using clean thermal energy resources consisting of the air, ground source vertical boreholes (either as dedicated boreholes or as incorporated within thermal foundation piles), ornamental fountains, surface water bodies, flowing wastewater, and solar thermal energy, whether standalone or in combination, as potential thermal sinks and/or sources (hereinafter "thermal sinks/sources").

3.1 Vertical Bore Closed-Loop System

Vertical boreholes provide a passive source of heat and heat rejection from the ground.

A 495-foot (ft)-deep bore is proposed to stay within the DEC's 500-ft regulations for deep wells. Deeper wells are possible and have been attempted elsewhere, however current regulatory restrictions create barriers by treating them as oil and gas wells with additional permitting and escrow accounts. Relief may be available to the escrow requitements for municipally-owned borefields.

- Borehole layout
  - Spacing of 20 ft on center in a grid pattern for boreholes typically provides an optimal trade-off between land area and performance. However, in land-constrained areas, a staggered spacing, 15 ft on center, can be effective for siting additional boreholes in the same fixed area.
- Geology
  - A thermal conductivity test has not been completed at this time; however, a test bore is planned for a site in Ray Brook, NY, four miles southeast of Saranac Lake.
- Grout
  - A graphite enhanced bentonite will provide a minimum thermal conductivity of 1.2 British thermal units per hour per foot per degree Fahrenheit (Btu/hr-ft-°F).

3.2 Lake Flower Outlet

A municipally-owned hydroelectric generating facility supplies fossil fuel-free electricity and is located on a dam at the mouth of the Saranac River. The outlet of the turbine is a 20-ft-wide concrete channel, with 2 ft of concrete on either side. The flow does not freeze due to its constant movement, but it is anticipated to be 33°F–35°F during peak winter conditions.

Two approaches were evaluated to quantify the potential heat add from the river:

1. **Indirect heat transfer**

   Indirect heat transfer through plate-and-frame heat exchangers was explored as a possibility to simplify the permitting process. The challenge with the approach is that due to the low approach temperatures, only limited heat could be absorbed. A scenario that used a WSHP to send 25°F chilled glycol to the heat exchanger could only absorb 300 MBH of heating per 2-ft H x 15-ft W x 20-ft L. Approximately four 20-ft sections could fit readily downstream of the hydro generator, which would give 1,200 MBH of absorption and a total heating capacity of about 1,500 MBH from the heat pump. Limited information was available about the magnitude and variability of the flow and more investigation is needed to verify the concept. If DEC approves the proposed configuration and the cost is shown to be lower than the equivalent ground heat exchanger capacity cost, it may be a viable option to provide a small portion of the system capacity. Part of the choice for siting the pump station was that it be proximate to the river in case the river heat exchange was an available option.

2. **Direct exchange**

   An alternate approach could take water directly from either the outlet channel or a point within the turbine generator house to access the flow directly. Exchanging heat directly with the river allows a much higher magnitude of heat transfer than indirect transfer. This approach has a much higher permitting threshold because it would require a suction inlet in the flow as well as a diffuser outlet downstream of the intake. Although reliable information on the magnitude and consistency of the flow as not available, historical data from previous Federal Energy Regulatory Commission (FERC) permit applications indicate that the flow was likely in the 5,000–10,000 gallons per minute (gpm) range. As detailed information is obtained, if the amount of heat and ability to access it is at a lower cost per MBH of capacity than geothermal boreholes, pursuing this further would be worthwhile.

Potential ground loop heat exchanger (GLHX) sites.

These six open areas in and around downtown Saranac Lake provide capacity for Phase A borefields:

1. Dorsey Street lot, village owned
2. Police Department lot, village owned
3. Petrova Elementary School fields, district owned
4. Main Street lot, privately owned
5. St. Bernard’s Church lot, privately owned
6. Riverside Park, village owned

The map in Figure 9 shows the locations of sites, highlighted in red, identified for the installation of vertical bores. The number on the map corresponds to the previous numbered list. Six sites for vertical bores and one river water heat exchange site were identified. Importantly, Riverside Park may have historic foundations under the park that would impact drilling logistics. Currently, the preferred locations for the borefields are Dorsey Street lot, Police Department lot, St. Bernard's Church lot, and Petrova Elementary School fields.

Figure 9. Potential Ground Loop Heat Exchanger Locations

Define the conceptual design, including estimation of whether these clean energy resources could adequately meet instantaneous peak load without causing long-term thermal imbalance (i.e., year-after-year thermal accumulation or year-after-year thermal depletion) in the ground source borehole resources.

3.3 Overview

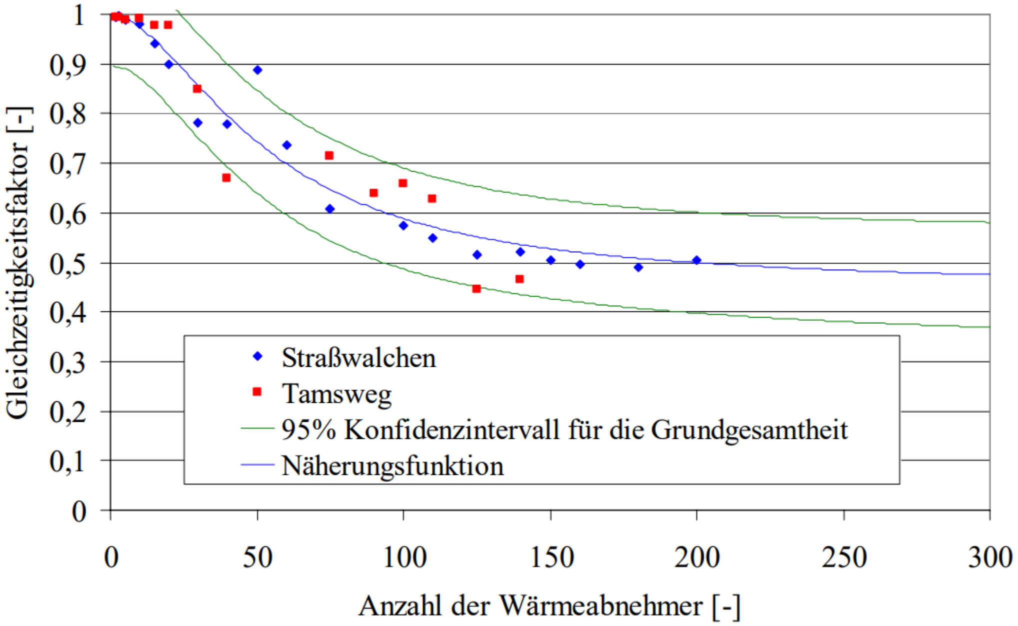
The design criteria for the central plant are to extract and reject heat from the distribution loop to the borefield and river water heat exchangers. The potential resources are those indicted earlier. The central plant location is proposed as a new building on Main Street, the village-owned parcel just north of 23 Main St.

3.3.1 Preferred System Design

Based on two Austrian district heating systems, Straßwalchen and Tamsweg, Winter et al.[3] described the diversity factor or simultaneity that the system sees when connected for a number of customers varying between 2 and 200. From this equation, the diversity factor for 70 buildings was determined to be about 66%, using a diversity factor of 75% to be conservative.

From the modeled building profiles, the summed peak heating load for Phase A is 34,000 kBtu/h. Applying this diversity factor gives a system peak heating load of 26,000 kBtu/h.

Figure 10. Trend for Calculating the Simultaneity Factor Depending on Number of Customers



The system is heating dominant and will need to maintain an annual thermal balance. One approach is to connect an electric boiler or ASHP to run in the winter to supplement the heating load. Alternatively, dry coolers could be installed and used in the summer to take the warm ambient air, transfer it to the geothermal loop through the dry cooler coils, and pump that heat into the borefield. To balance the loads on an annual basis, the dry coolers would need to be sized for 860 tons according to estimates, running only at times when the ambient temperature is warmer than the loop temperature. Importantly, the dry coolers will need a large area on which to be sited; preliminary sizing requires three 290-ton units at 34 ft × 9 ft each.

The distribution pumps are sized at 8,000 gpm with 125 ft of head. Four 125-horsepower (hp) pumps would provide 8,000 gpm of flow with N+1 redundancy to serve the downtown section of the system. Three additional 200-hp pumps would provide 120-ft head with N+1 redundancy to serve the Petrova Avenue branch with borefields at the police department and elementary school.

The proposed system will require additional electric load for the pumps and dry coolers. Electric power for the new loads would be supplied by a 4160 volt (V) service. Review of the National Grid records for the feeder indicates 33% of the 454 ampere (A) capacity used in the summer. Currently the peak load from the plant is estimated at 964 kilovolt-amperes (kVA), which would require 134 A at 4160 V.

3.3.2 Preferred System Design: Distribution System

The system's distribution piping would consist of dimension ratio (DR) 11 gauge high-density polyethene (HDPE) piping, with the main pipe ranging from 16 inches to 18 inches in diameter. The piping would be direct buried in a crushed stone base with no insulation required due to the working temperature of the fluid. Uninsulated pipes would most likely result in a loss of useful heating energy in the winter, but this would be partially offset by an increase in beneficial heat rejection during summer conditions. The route would use pipes buried below the frost line and backfilled with stone and clean fill. Surface conditions would be restored to their preconstruction state.

Figure 11 indicates the preferred route to serve these downtown Saranac Lake buildings is Main Street, Academy Street, Church Street, and River Street with a branch crossing the river to Lake Street to serve the elementary school and emergency services complex on Petrova Avenue and housing authority on Kiwassa Road.

Figure 11. Preferred Routing Option

3.3.3 Two-Pipe versus One-Pipe Distribution

Distribution systems fall into two categories similar to building-level distribution: a variable primary system requires two distribution pipes that provide a consistent supply temperature to customers and then return to a central location, or a primary-secondary configuration. In the primary-secondary configuration, a primary loop is routed to each load and source point, where each connection requires a close-coupled pumping connection. The hydraulic separation between the different loops reduces the size of the distribution pumps, as much of the pressure loss has been distributed to pumps located at the customer sites. These systems are often referred to as one-pipe systems. In a two-pipe distribution, each customer has a similar change in temperature (Delta T) as the system loop, whereas in a one-pipe system, the system loop Delta T is distributed along the system, so the supply temperature continues to change temperature further along the distribution loop.

Many ambient loop systems take advantage of one-pipe distribution to lower the installation costs. The marginal equipment performance difference between a couple of degrees of loop temperature is minimal. The customer side looks a bit different because an additional pump is required to pull flow from the main header and then inject it back into the main after flowing through a heat exchanger. Often to make the single pipe work, a longer length is required because the route needs to create a full loop, whereas a two-pipe system already has a supply-and-return and can have small branches directly to customers.

Looking at a sample 16-inch line in an urban area, CHA estimated the cost for two-pipe distribution at $1,325 per linear foot (LF), whereas a similar one-pipe system was estimated at $1,250 per LF. Therefore, a 9% savings will result if a similar piping length can be used. This scenario offers an opportunity for a system that includes a hybrid of both one-pipe and two-pipe distribution; this can be further studied during detailed design. The cost estimate of the project assumes a two-pipe distribution.

Evaluate the level of required redundancy to provide system resiliency.

Emergency power would be provided by one 600-kW generator, which would be sufficient to run the three downtown distribution pumps and two Petrova Avenue distribution pumps. In emergency mode, the pumps would still circulate water throughout the borefields to exchange heat with the ground and circulate water throughout the loop to serve the connected buildings. The loop could either be allowed to run at the lower temperature or arrangements could be made with certain offtakers to provide reserve heating capacity from their equipment. The approach would depend on the time of year and the type of buildings connected. Most non–mission-critical buildings could operate with a temporary derate of their equipment. Importantly, currently no inpatient healthcare buildings are located near the distribution system. Nevertheless, arrangements for backup heat at the building level could be made if that building type were to be included in the system.

Analyze and determine the available capacity during a year of each type of resource available to leverage as thermal sinks/sources.

The primary resources being leveraged as the thermal sinks/sources are geothermal borefields. Table 7 shows the proposed borefields, assuming boreholes spaced 20 ft on center and assuming 200 LF per ton, the proposed borefields are shown in the table below.

Table 7. Thermal Resources

Resource	Borehole Quantity	Capacity (tons)	Capacity (kBtu/h)
Dorsey Street	112	277	4,155
Petrova Elementary	457	1,129	16,940
St. Bernard Church	84	208	3,120
Police Department	48	119	1,785
	701	**1,733**	**26,000**

These four borefields have the capacity to provide peak heating for Phase A of the system; the Petrova Elementary School borefield will be a cornerstone for the system, and it has space for additional boreholes. This summary displays only the thermal resources needed to meet peak heating load.

Assess the implications of thermal storage, either at a centralized activity, at numerous disparate locations, or both.

In the overall system sizing, peak heating capacity is at a premium value. While peak heating could be met by implementing a demand response program to turn on customer boilers during peak heating events, another approach would be to incorporate thermal storage into the system. Various approaches to thermal storage were reviewed with a leading manufacturer. Based on cost, ice storage as a heating medium was the preferred approach. Phase change materials (PCMs) were investigated because of some inherent advantages to storing heating at a temperature higher than 32°F, but the material is still fairly expensive and has a stored energy density roughly half that of water, requiring additional storage space. Ice storage would need to be paired with a water-to-water heat pump, energy available elsewhere would be used to melt ice, which the heat pump would then freeze at a later time, rejecting the heat of fusion and compression to the loop and providing heating to the connected buildings. If a river water solution is found to be viable, thermal storage could be used to further expand its capacity because the river resource would be always available and may have additional value as a trickle charge and dispatchable capacity. This concept will be explored later in the design study.

Assess the implications of sizing the clean thermal energy resource as first-call to meet a fraction of the overall thermal load up to an economically optimal point. Supplement with a conventional thermal system as second-call to be able to meet the highest demands.

Due to the high cost of delivered fuels, the system will ideally not rely on propane or fuel oil. However, the high heating loads in the North County necessitate some means of meeting peak demand. CHA estimated that for 122 hours of the year (1.4%), the heating load is higher than 20,000 kBtu/h; meeting these peak hours by some other means could decrease the required borefield size by 23%. One option would be to inject heat or offset system heating usage using existing on-call boilers from users such as DeChantal Apartments and Hotel Saranac. A financial incentive would be provided to these customers for the use of their boilers at a rate high enough to offset fuel costs.

Determine the optimal number and site layout of the ground loop heat exchanger.

CHA chose the four proposed GLHX sites based on available undeveloped real estate and proximity to offtakers. Downtown Saranac Lake has a few parking lots that could be used as sites for boreholes. Additionally, river heat exchange can be added in the future to increase loop capacity, using the turbine outflow channel where water has already been screened to remove any debris or wildlife. This could potentially reduce the number of boreholes and therefore the project capital costs.

With the exception of the St. Bernard’s Church parking lot, the village of Saranac Lake or other public entity owns all preferred proposed locations. For the privately-owned lot, a legal framework of how to lease the space underneath existing parking lots has yet to be determined.

Identify any subgrade infrastructure that would impact bore field design.

Minimal utilities or subgrade infrastructure exists at the proposed borefields sites. Coordination with the village of Saranac Lake and borefield property owner will be occur during design.

Analyze proposed system to obtain hourly intervals representing at minimum an 8,760-hour continuum and integrate results for display as monthly/annual energy consumption profiles.

The central plant concept and preferred system design included equipment sizing options based on the district characterization. Appendix A, the District Central Plant Calculator, illustrates the pump energy for the hourly load profile and expands the profile to the required hourly heat absorption or rejection for the district loop.

The quantity and rated size of pumps in the system design determined the pump speed and resulting pump demand. Figures 12 and 13 illustrate the monthly and annual energy consumption profiles of the various proposed system components.

Figure 12. Monthly Proposed System Energy

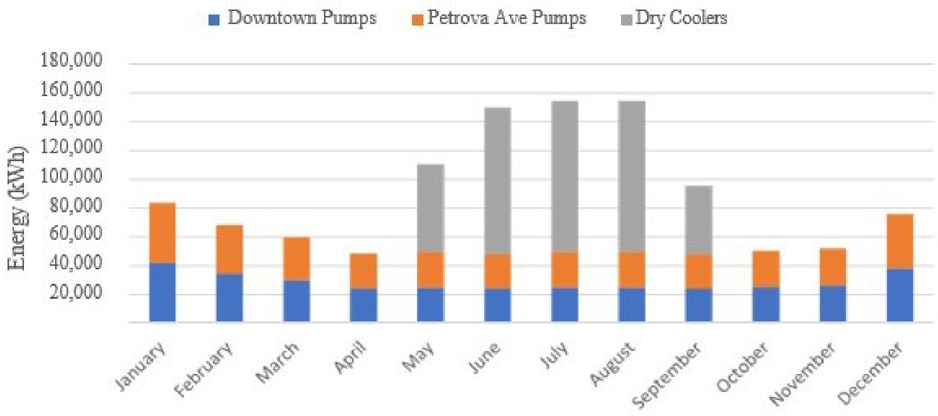
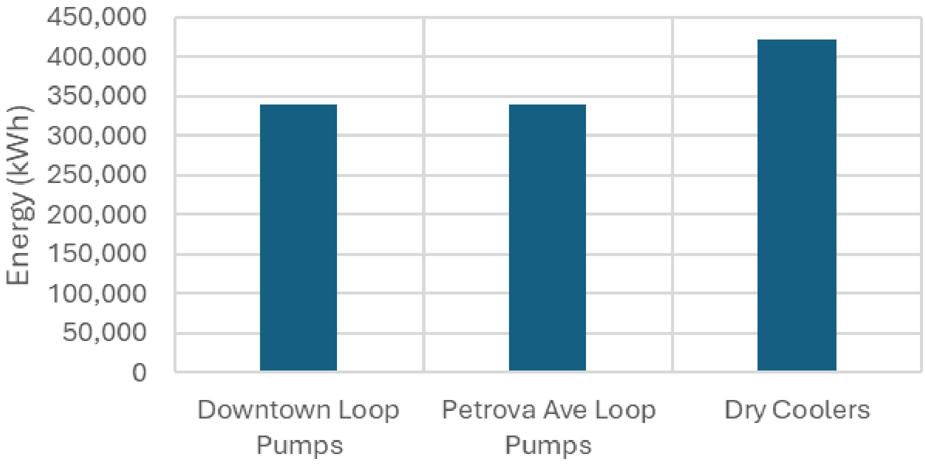


Figure 13. Annual Proposed System Energy



Integrate baseline system and desired mechanical system alternatives for comparison.

Baseline operational costs, baseline heating and cooling equipment were determined either through known data or estimated using building category and fieldwork. A building survey using satellite images was performed to assist in identifying the type of equipment serving each building and thus the system type. Boilers primarily provide the heating load for each building since boilers are a common heat source for older buildings with delivered fuel. Boilers are commonly used as the primary heating source in older buildings that rely on delivered fuel, thus they were assumed to fulfill the heating requirements for each building.

The system alternative to the baseline and preferred systems is a fully electrified heating system. In order to fully electrify buildings' heating systems, ASHPs are not a feasible solution. The design heating temperature in Saranac Lake is -18°F and ASHPs, even cold climate models that can operate down to -20°F, derate losing both capacity and efficiency at these temperatures. Although ASHPs can be used for supplemental heating, perhaps to existing fuel oil boilers, they are unfavorable choices for full electrification. Thus, all buildings are assumed to replace fuel oil boilers in kind with electric boilers for the standalone electrification alternative. Appendix C shows the alternative equipment model.

Determine energy impact for each system alternative.

A primary energy impact of the system alternatives to the existing system is that delivered fuel consumption will be eliminated and replaced with electrification. For existing systems using fuel oil or propane boilers and heat pumps, the corresponding demand of the existing equipment is subtracted from demand of the alternative electric boiler to estimate the demand increase of the alternative electrification scenario. Using electric boilers to electrify the system, and the corresponding demand increase, would have significant impact on grid infrastructure, projected at 5.6 megawatts (MW).

Energy impact of the preferred system for the central plant equipment includes central plant loop pumps and building heat pump demand. Dry cooler demand will occur at off-peak hours because usage will be in the summer. The anticipated added load is estimated at 1.9 MW.

4 Perform Economic and Financial Analysis

Estimate associated annual utility and operating costs for the community heat pump system solution.

The central plant is expected to have an annual usage of 1,100,000 kWh based on the electric profile of the loop pumps and dry coolers. The central plant will most likely fall under National Grid's SC-3 large customer rate structure, although this is subject to change based on National Grid's evaluation. Electrical costs of approximately $147,000 were estimated based on the blended rate of $0.134 per kWh, which is approximately the rate for primary transmission [13.2 kilovolt (kV)] customers. The rate is dominated by the demand costs as defined in the rate structure. Ultimately, the rate charged the central plant may need to be negotiated with National Grid. Or, potentially, the village's hydroelectric turbine may be able to power the system. Additionally, equipment O&M cost is estimated at $100,000 annually for a full-time operator and maintenance activities.

Define the high-level projected construction costs for the preferred system capacity and distribution piping route.

Appendices F and G show the high-level projected constructed costs and include a 3,000-sq-ft central plant construction with electrical, water, and sanitary services, connection to the river heat pump, direct-buried piping distribution, expansion tank and other equipment, and controls. The underground distribution piping is the most direct route to serve 70 potential customers in the downtown area in the full project buildout scenario.

Table 8. Full Project Buildout, Opinion of Probable Cost

Item	Opinion of Cost
Central Plant	$2,390,000
Dry Coolers	$1,000,000
Generator	$400,000
Distribution Piping	$7,724,000
Mobilization	$500,000
M&P of Traffic	$500,000
Erosion Control	$100,000
Geothermal Borefields	$9,716,000
District Connections to Customer Bldgs	$2,555,000
Construction Subtotal	**$24,885,000**
Construction Contingency	$6,868,000
Engineering Design and Planning	$12,890,000
Total Project Cost	**$44,643,000**

Identify equipment near the end of its life cycle and develop a high-level avoided cost model, including schematic-level construction cost estimates for each option.

The Main Street loop is shown as the initial phase of Phase A because of its proximity to the primary borefield and the proposed pump house location. The initial cost would include the Dorsey Street lot, Police Department lot, and St. Bernard's Church lot borefields, serving the Harrietstown Housing Authority, Saranac Lake Police Department, Village offices, future Adirondack Park Agency (APA building, Rice Furniture, Waterhole Music Lounge, Madden's Transfer & Storage, and Hotel Saranac.

Table 9. Initial (Main Street) Project Buildout, Opinion of Probable Cost

Item	Opinion of Cost
Central Plant	$2,390,000
Dry Coolers	$1,000,000
Generator	$400,000
Distribution Piping	$2,639,000
Mobilization	$166,667
M&P of Traffic	$166,667
Erosion Control	$33,333
Geothermal Borefield	$3,643,000
District Connections to Customer Bldgs	$572,000
Construction Subtotal	**$11,011,000**
Construction Contingency	$3,039,000
Engineering Design and Planning	$5,704,000
Total Project Cost	**$19,754,000**

The next construction phase for Phase A involves extending the loop to Church Street and Academy Street. Additional customers at this stage may include St. Bernard's Church and DeChantal Apartments.

Table 10. Secondary (Academy Street) Buildout, Opinion of Probable Cost

Item	Opinion of Cost
Distribution Piping	$2,437,000
Mobilization	$166,667
M&P of Traffic	$166,667
Erosion Control	$33,333
Geothermal Borefield	$0
District Connections to Customer Bldgs	$523,000
Construction Subtotal	**$3,327,000**
Construction Contingency	$918,000
Engineering Design and Planning	$1,723,000
Total Project Cost	**$5,968,000**

The final stage of construction for Phase A is continuing the piping route across the river to Petrova Avenue, which has sizable offtakers and thermal resources. Included in this branch are the Petrova Elementary School and emergency services building, as well as connecting all remaining downtown customers along the loop.

Table 11. Final (Petrova Avenue) Buildout, Opinion of Probable Cost

Item	Opinion of Cost
Distribution Piping	$2,649,000
Mobilization	$166,667
M&P of Traffic	$166,667
Erosion Control	$33,333
Geothermal Borefield	$6,072,000
District Connections to Customer Bldgs	$1,460,000
Construction Subtotal	**$10,548,000**
Construction Contingency	$2,911,000
Engineering Design and Planning	$5,464,000
Total Project Cost	**$18,923,000**

Estimated equipment service life, associated maintenance costs, and replacement costs of the proposed system configuration.

The new equipment in the central plant is expected to have a 25-year or longer service life, so replacement costs were not included in the NPV analysis. Central plant maintenance costs are included within the O&M costs detailed in Table 12.

Develop financial metrics including payback, and return on investment (ROI) utilizing projected inflation, energy escalation, and discounts rates.

Financial feasibility from the Village's perspective is important for developing a strong business case. However, implementation will have significant clean energy impacts to the greater community, which is a benefit that cannot be directly monetized by the developer under current state policy. Thus, the financials have been separated into the developer, customer, and community perspectives to illustrate the financial benefits for all stakeholders.

The Village likely has access to 0% interest bonds to fund its portion of project. The project may also qualify for DOE's Innovative Clean Energy Loan Guarantee Program, which provides loans at a 0%-2% interest rate based on project credit rating.

The discount rate describes the ROI available on alternative investments of comparable risk. Municipal, state, and federal government projects are generally analyzed at a 3% discount rate. The Village has stated that it uses a 1.5% discount rate for projects. Customer financing was analyzed at a 7% discount rate, which is typical for commercial projects.

Through the revolving line of credit concept discussed below, this model assumes that the customer retrofit costs will be funded using zero-interest loans borrowed from the Village's revenue from previous years.

The 25-year NPV analysis uses these assumptions:

- Fuel oil inflation of 3% per NIST handbook
- Electricity inflation of 3% per NIST handbook
- General inflation of 3%
- Village discount rate of 1.5%
- Customer discount rate of 7%
- Interest rate of 0% for 30 years for central plant and distribution pipe investment
- Interest rate of 0% for 30 years for customer retrofit projects
- Thermal energy cost of $0.098 sq ft per month with an inflation rate of 3%
- Dry coolers will be replaced after 20 years
- Inflation Reduction Act of 2022 (IRA) tax credit applied at 40% of project cost
- NYSERDA Category B & C funding awarded for system design and construction

Table 12 shows the project costs from the developer's perspective, in this case the Village. A benefit-cost ratio (BCR) greater than 1.0 indicates that the project has a positive NPV.

Table 12. Net Present Value, Developer Perspective

	NPV (25 Year)
Costs	
Project Financing	$15,811,000
IRA Tax Credit (40%)	—
NYSERDA Category B & C Award	—
Central Plant Electric Consumption	$4,657,000
Central Plant O&M	$2,998,000
Total Costs	**$23,466,000**
Direct Benefits	
Thermal Energy Revenue from Customers	$27,398,000
Total Direct Benefits	**$27,398,000**
Net Direct Benefits	**$3,932,000**
BCR	1.17

Table 13 provides a sensitivity analysis for the financial rate of borrowed capital and developer's discount rate and the resulting NPV. The largest positive NPV signifies the most financially feasible solution. As stated in the assumptions above, the project uses a 1.5% developer discount rate and a 0% finance rate.

Table 13. Sensitivity Analysis of Finance Rate versus Discount Rate

25-year Developer Net Present Value, in Thousands.

Finance Rate	**Discount Rate**					
	1.5%	2%	2.5%	3%	3.5%	4%
0%	**$3,932**	$3,601	$3,300	$3,026	$2,777	$2,550
0.5%	$2,779	$2,512	$2,271	$2,052	$1,854	$1,673
1%	$1,569	$1,371	$1,192	$1,031	$886	$754
1.5%	$305	$177	$63	-$37	-$127	-$207
2%	-$1,015	-$1,069	-$1,114	-$1,152	-$1,184	-$1,209
2.5%	-$2,389	-$2,365	-$2,340	-$2,312	-$2,283	-$2,253
3%	-$3,815	-$3,712	-$3,613	-$3,517	-$3,425	-$3,337

The customer retrofit costs, in Table 14, assume that all noncompatible buildings (i.e., buildings with neither existing WSHPs nor water-cooled cooling equipment), will be retrofit with WSHPs. The proposed retrofits increase the value of the systems by providing both cooling and heating to buildings.

National Grid's existing infrastructure will most likely allow for electrifying individual buildings downtown. Electrical upgrades may be necessary at the customer level if customers do not have enough spare electrical capacity to supply power to heat pumps. However, this will remain uncertain until more information becomes available on a case-by-case basis.

The IRA will provide a 40% tax credit for customer retrofit projects and an opportunity for additional incentives through National Grid's Clean Heat Statewide Heat Pump Program to assist customers financing HVAC retrofit projects. The utility incentives have not been included in this financial analysis.

Table 14. Net Present Value, Customer Perspective

	NPV (25 Year)
Costs	
Customer Retrofits	$6,286,000
IRA Tax Credit (40%)	—
Customer O&M	$8,808,000
HVAC Electric Utility Cost	$10,950,000
Thermal Energy Cost	$14,457,000
Total Costs	**$40,501,000**
Direct Benefits	
Avoided Customer Equipment Recondition	$7,788,000
Avoided O&M	$1,252,000
Customer Energy Savings	$33,193,000
Total Direct Benefits	**$42,233,000**
Net Direct Benefits	**$1,732,000**
BCR	1.04

Table 15 provides a sensitivity analysis showing how changes in the inflation rate of fuel oil and customer discount rate affect the resulting NPV. The largest positive NPV signifies the most financially feasible solution. As stated in the assumptions above, the project uses a 7% customer discount rate and a 3% fuel oil inflation rate.

Table 15. Sensitivity Analysis of Fuel Oil Inflation versus Discount Rate

25-year Customer Net Present Value, in Thousands.

	Discount Rate					
Fuel Oil Inflation Rate	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**
2%	-$4,021	-$3,290	-$2,672	-$2,146	-$1,696	-$1,310
3%	$2,512	$2,265	$2,074	$1,928	$1,817	**$1,732**
4%	$10,135	$8,729	$7,580	$6,639	$5,866	$5,228
5%	$19,045	$16,261	$13,977	$12,096	$10,542	$9,253

Perform carbon reduction calculations based on baseline and proposed low-carbon solution.

In 2020, the DEC issued a social cost of carbon guide for policy decisions, setting the calculated value at $126 per metric ton of CO_2e for 2023 in 2020 dollars.[4]

Table 16. Net Present Value, Community Perspective

Indirect Benefits	
Carbon Reduction Social Benefit	$11,858,000
Total Indirect Benefits	$11,858,000
Net Direct + Indirect Benefits	$17,522,000
BCR	1.27

Specify a preferred business model and determine the annual costs to the site owner over the term of such arrangement.

The selection of a business model for large infrastructure projects including DES should mitigate several types of risk including objectives risk (governance structure), design risk (selection of technologies and equipment), construction risk (procurement, scheduling), operational risk (commissioning, maintenance), demand/market risk (customer acquisition, rate structure), and financial risk (ROI). A preferred business model will not only mitigate these various risks but also implement control impact the project's financing structure.

Various business models are available, ranging from completely publicly owned (i.e., public utilities or municipal department-run entities) to completely privately-owned, with a range of hybrid forms in between, including concessions, joint ventures, and special purpose vehicles. A review of the literature indicates that common business models for district energy systems include public sector ownership and operation; public sector ownership with operation by a private energy company or utility operation; cooperative ownership; and private sector ownership and operation through an existing energy utility or a new energy services firm. The choice of business model will affect both the cost of capital and the overall financing structure. Importantly, district energy systems are not only large and complex engineering projects, but also dynamic businesses that are subject to change, innovation, and operating/market risk. Once established, the Saranac Lake DES business could evolve in response to new opportunities and changing circumstances arise, potentially altering the initial business case.

The preferred business model has the Village of Saranac Lake assuming responsibility for operating and maintaining the thermal production and all related system components. Costs and benefits would be based on the square footage of each unit, with adjustments made for costs customers incurred for any building retrofit necessary for connection. The monthly cost per square foot would be calculated to ensure that annual expenses would not exceed current utility costs.

Funding from NYSERDA Program Opportunity Notice (PON) 4614 Category B and C programs and from the IRA tax credit is expected to decrease the total capital expenditure for the Village.

Public funds could be used to defray costs to facilitate customer acquisition because connection will require system retrofit for most buildings. In the early years, there may be subsidized (reduced) thermal energy rates to increase customer adoption rates. This would increase the length of time it would take for the Village to realize any revenue generation; public debt may be used to establish a reserve account to cover these temporary shortfalls. For example, Vancouver created a rate stabilization reserve for its Southeast False Creek Project. This fund acted as a revolving line of credit to fund system development in early years, stabilize rates, and cover cumulative financial losses in the system's early years, which were then repaid from revenues in later years. Public sector loans enable the recovery of initial capital investments as DES rates increase over time, especially if the customer base or future energy prices grow at rates higher than initially forecast, thereby generating increased revenue from DESs.

The literature suggests that using flexible public debt instruments is preferable to direct grants and local tax subsidies. Public debt has several advantages, including the potential to recapture and recycle funds, which can then be used for expanding the system or developing new DES projects. It also creates opportunities to access and leverage a larger range of funding sources.

Additional planning and research are needed to determine the details of the business model and financing structure necessary to meet the capital requirements of the Saranac Lake DES. However, any strategy will require a pool of flexible and patient capital to finance long-term system capital investment.

5 Perform Assessment of Additional Technologies

Analyze the potential project value improvement and/or mitigating and/or exacerbating implications and technological and economic feasibility of additional technologies into a community heat pump system.

Solar photovoltaic (PV), battery energy storage systems (BESS) and electric vehicle (EV) charging infrastructure were the additional technologies considered to enhance project value and assess economic feasibility. With an emphasis on electrification and decarbonization, the increase in electricity consumption can be offset by installing solar PV and BESS in strategic locations as well as EV charging infrastructure to support the project's goals.

5.1 Local Electric Grid Infrastructure Capacity

Discuss with the local electric utility the capacity of the local electric grid infrastructure to serve the project site(s) potentially increased electric load.

The analysis used National Grid PV hosting capacity map to analyze the available capacity on the substation serving the project area. The project area is primarily served by two substations, Raybrook electrical substation (ES) transformer bank (TB) 1 and Lake Colby TB 2, and Table 17 details the local feeder level hosting capacity for PV.

Table 17. National Grid Solar Photovoltaic Hosting Capacity

Substation Name	Feeder	Local Voltage (kV)	Local Max Hosting Capacity (MW)	Feeder DG Connected (MW)	Feeder DG in Queue (MW)
Ray Brook ES TB 1	36_24_83951	13.2	10.0	0.36	0.04
Lake Colby TB 2	36_24_92758	13.2	0.10	1.67	0.05

Based on the distributed generator connected in these substations, only the Ray Brook ES TB1 substation has existing capacity to connect with distributed energy resources such as solar PV.

5.2 Conceptual Solar Photovoltaic Design

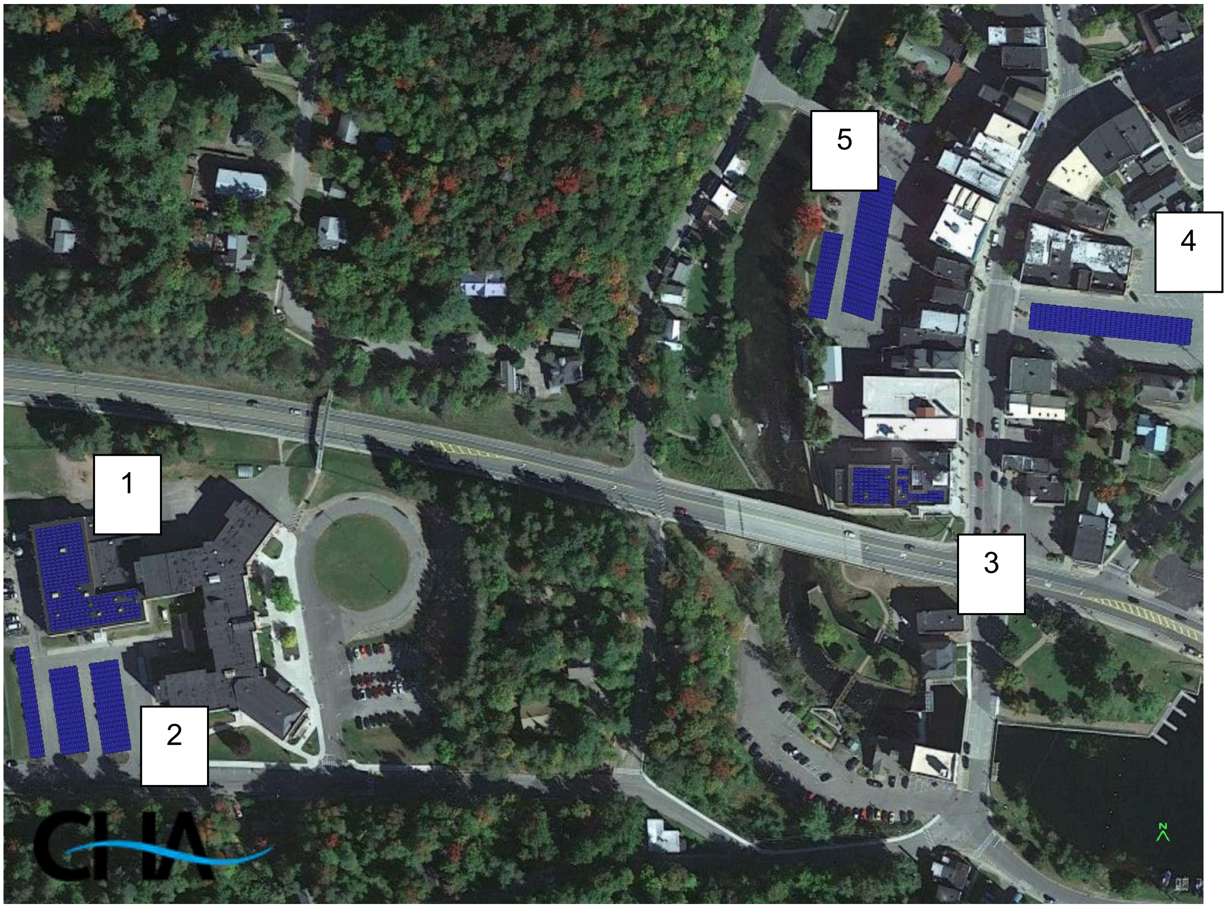
Determine available rooftop/ground-mount area for solar PV.

The following five locations were identified in the project area for installing solar PV arrays:

1. Petrova Elementary School roof
2. Petrova Elementary School parking lot

3. Village office building roof
4. Main Street parking lot
5. Dorsey Street parking lot

Figure 14. Potential Solar Photovoltaic Locations



Note that the elementary school and village offices are served by the Lake Colby substation, which currently lacks solar PV hosting capacity. Further evaluation is required to explore potential interconnection opportunities with the Ray Brook substation from these locations.

Calculate optimum district solar PV capacity and electricity production.

Using on a solar PV model developed in Helioscope, Table 18 shows the district's solar PV capacity and annual electricity production.

Table 18. Solar Photovoltaic System Metrics

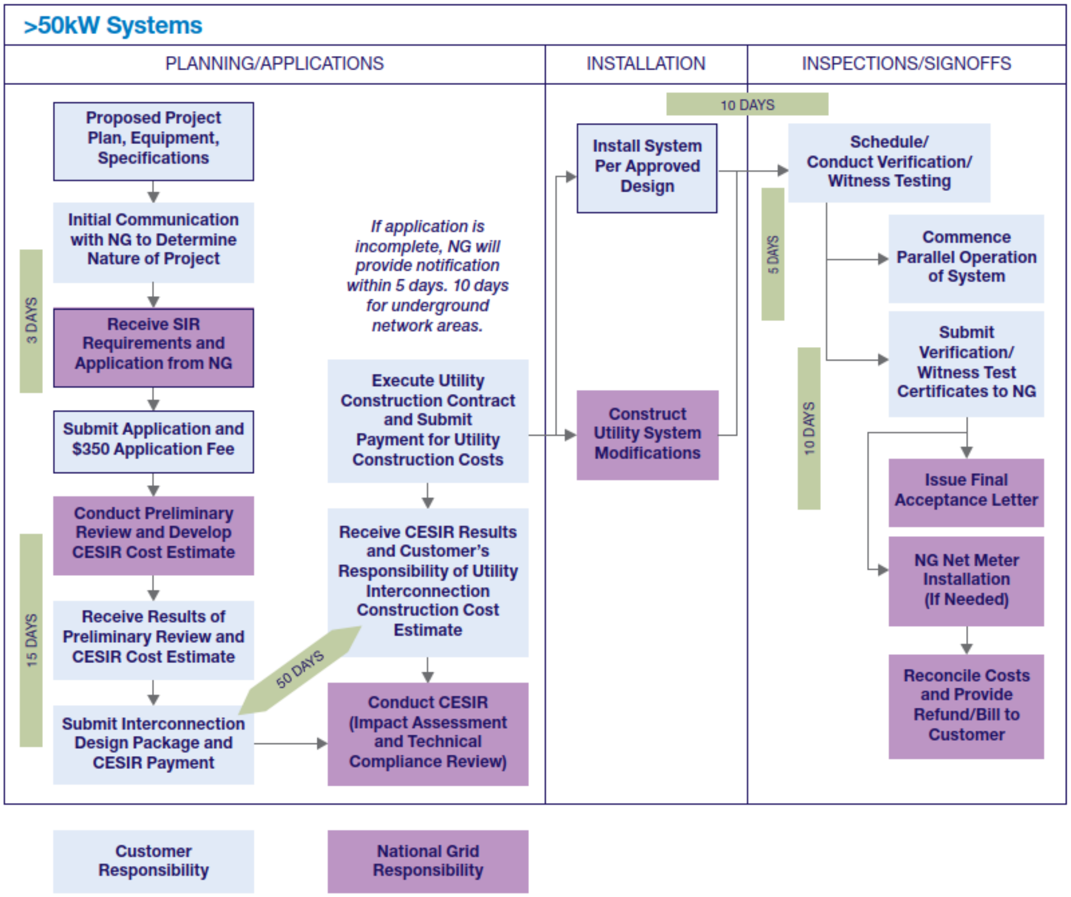
Capacity	Electricity Production
Module DC Nameplate	893.3 kW
Inverter AC Nameplate	730 kW
Load Ratio (DC/AC)	1.22
Annual Production	962,663 kWh

Evaluate regulatory requirements to interconnect solar PV system.

Projects ranging from 50 kW to -5 MW seeking interconnection in National Grid areas in New York State must complete the Complex Application Process. Detailed steps for completing the process can be found on the National Grid website.[5]

Figure 15. National Grid Application Process

Source:
"Interconnection Process > 50 kW." National Grid. gridforce.my.site.com/servlet/servlet.FileDownload?file=0150W00000BtrZ0



This project intends to register for net metering and register the interconnection of these systems to the same account as the DES account so that the energy produced by the PV panels offset the energy consumption from the DES. If this arrangement is not feasible, the energy production will be sold back to the grid at the value of distributed energy resource (VDER) rates. A VDER model calculation projected potential VDER rates for this project, estimated at approximately $0.09 per kWh in 2023, decreasing to $0.08 by 2045.

Provide preliminary installation budgets for PV panels.

Table 19 illustrates the preliminary cost estimate CHA developed for the solar PV identified above.

Table 19. Solar Photovoltaic Cost Estimate

Cost Component	Estimated Preliminary Cost
1. Hardware and Materials Cost	
1.1 PV Modules	$740,000
1.2 Inverters	$200,000
1.3 Carport System	$350,000
1.4 BOS	$250,000
2. Development Costs	
2.2 Interconnection Infrastructure & Costs	$200,000
2.3 Installation Labor	$430,000
2.4 Predevelopment/Origination Costs	$120,000
2.5 Design & Engineering Costs	$120,000
3. Other BOS Cost Elements	
3.1 Contingency	$130,000
3.2 EPC Overhead	$280,000
3.3 Profit	$80,000
Total Costs	**$2,900,000**

Provide quantification of the potential energy and environmental benefits.

From the solar PV model, the annual generation capacity of the solar PV was calculated to be 962,663 kWh per year. According to the U.S. DOE's eGrid,[6] the consumption of one kWh of electricity in Upstate New York leads to the emission of 0.00010615 metric tons of CO_2e. Using this number, the total environmental benefit solar PV leads to the avoidance of 102.2 tons of CO_2e.

5.3 Electric Vehicle Charging

As a designated Clean Energy Community, Saranac Lake is committed to impactful actions for a more sustainable community, including the installation of two Level 2 EV chargers for public use in a municipal lot and purchased a plug-in hybrid vehicle for daily operations. Additionally, Hotel Saranac has installed two Level 2 EV chargers available free of charge to the public, and seven other Level 2 EV chargers are available in Saranac Lake, outside the scope of this project.

Estimate the number and type of EV chargers that are economically and technically feasible to serve the population at the project site.

Saranac Lake has a population of approximately 5,000 residents in 2,400 households.[7] Assuming a 10% EV adoption rate per household, the region can expect approximately 240 EVs. According to New York State's EV-to-charging-outlet ratio of 16 for publicly available charging stations,[8] the Village would require a minimum of 15 EV chargers strategically placed throughout the area to accommodate EV owners needing public charging facilities. Ideal locations for these EV chargers would include downtown streets and public parking lots with the highest pedestrian traffic.

Given that patrons of downtown businesses typically park for an average of 2 to 4 hours, it would be necessary to install a combination of Level 2 and Level 3 chargers. Both substations serving this area have adequate EV load capacity headroom to accommodate this mix, as indicated in the table below.

Assuming that patrons of downtown businesses typically park for an average of 2 to 4 hours, installing a mix of both Level 2 and Level 3 chargers would be required. Both the substations serving this area have sufficient EV load capacity headroom to accommodate this mix, which Table 20 illustrates.

Table 20. Substation Electric Vehicle Load Capacity Headroom

Substation Name	Feeder	Local Voltage (kV)	EV Load Capacity Headroom (MW)
Ray Brook ES TB1	36_24_83951	13.2	7.50
Lake Colby TB2	36_24_92758	13.2	6.37

An EV charging energy consumption simulation was conducted using HOMER Grid software to estimate the potential energy consumption and associated costs for operating EV chargers. The simulation model assumed the installation of twelve Level 2 chargers and four Level 3 chargers. The following assumptions were incorporated in the simulation model:

- **Level 2 chargers**
    - Charger output: 19.2 kW
    - Number of chargers: 12
    - Average number of charging sessions per day: 24
    - Charging usage interval: 6:00 a.m.–10:00 p.m., everyday
    - Primary charger users: Sedans and SUVs
- **Level 3 chargers**
    - Charger output: 150 kW
    - Number of chargers: 4
    - Average number of charging sessions per day: 10
    - Charging usage interval: 6:00 a.m.–10:00 p.m., everyday
    - Primary charger users: Pickup trucks

Table 21. Electric Vehicle Modeling Results

	Sessions per year	Annual energy served (kWh)	Utilization Factor (%)
Level 2	6,610	548,733	27.2
Level 3 DCFC	4,439	176,052	4.2
Total	**11,049**	**724,786**	**21.4**

Based on National Grid's service class (SC) 3 tariff, the annual total utility cost (i.e., consumption, demand, and fixed charges) for these EV chargers are estimated to be $46,000.

Evaluate the potential economic risks and benefits of using EV "charging as a service" business model.

The "charging as a service," or continuous access and availability service (CAAS) model, presents both benefits and risks for Saranac Lake.

- **Benefits**
    - The diversity of downtown businesses encourages patrons to spend extended periods in the area, making it an optimal location for chargers. This would attract multiple CAAS providers to bid and offer competitive services in this location.
    - Installing EV charging infrastructure has significant upfront costs. Turnkey installation prices for Level 2 chargers range from $10,000 to $15,000 per plug, and Level 3 chargers range from $45,000 to $50,000 per plug. The CAAS model does not impose an upfront cost for the Village; providers assume responsibility for charger maintenance and uptime, which determines their revenue.

  - The Village is a potential environmental justice area with multifamily housing and no existing EV charging infrastructure. CAAS can deliver that benefit to the community without upfront investment.
- **Risks**
  - The Village will not have input into the cost of the service to customers because this is still an unregulated industry, which has the potential for prices to be high. The cost of electricity will significant affect the rate structure for the customers. In recent years, increased electricity rates have resulted in increased rates at the charging stations.

Using the CAAS model, the Village can realize the many benefits, which outweigh the associated risks, by issuing a public request for proposal (RFP) soliciting competitive bids to provide charging services to the area residents and tourists.

5.4 Battery Energy Storage

Evaluate the technical and economic feasibility of pairing electric battery storage with solar PV installation.

Based on the load profiles modeled for the district geothermal loop, the pumps were sized with three 125 HP pumps and two 200 HP pumps. To provide BESS backup for this load, including auxiliary loads from the central plant building (i.e., lighting, HVAC, and controls), the BESS would need to

be at least 700 kW to cover to entire load. The most common discharge durations for commercially available behind-the-meter lithium-ion BESS is four hours, and therefore the BESS would be sized between 700 kW and 2,800 kWh.

Given these expected peak loads, the tariff structure for the account serving the central plant load is expected to be SC3 (Large General). The demand charge for the SC3 tariff is $11.38 per kW. While implementing a BESS could potentially reduce demand charges, the high installation costs of BESS coupled with the relatively low demand charges and no time-of-use rates mean that no economic advantage would be realized by using BESS in this project. The primary benefit of BESS would be providing fossil-fuel–free backup for the DES for four hours.

Analyze the value proposition of pairing battery energy storage with available community distributed generation or VDER tariffs.

The project does not plan to co-locate BESS and solar PV due to the proposed locations of the solar PV and the geothermal central plant location. As mentioned in section 5.2, the intention of the solar PV is to be net-metered to offset the district geothermal consumption from the loop pumps or be sold back to the grid for revenue from VDER tariffs.

Estimate the forecasted future scenario annual environmental footprint (at minimum the carbon dioxide equivalent, CO_2e, footprint attributable to energy consumed from all sources including grid-supplied electricity, and if feasible also the site-emitted criteria pollutants).

The estimated annual energy consumption is approximately 1.1 million kWh. The solar PV is estimated to produce 962,663 kWh, which would offset 87.5% of the DES consumption. The remaining 137,000 kWh would be responsible for 14.5 tons of CO_2e emissions annually.

6 Conduct Permitting and Regulatory Review (Identify Hurdles and Challenges)

Identify authorities having jurisdiction (AHJs) and the associated permitting and approvals required.

A project of this magnitude and complexity will require permits and approvals from federal, state, and local government agencies and departments. This section outlines permit requirements and identifies the government agencies responsible for issuing them.

6.1 Federal Requirements

Section 9 of the federal Endangered Species Act (ESA) prohibits any person from harm any endangered or threatened species[9]. "Harm" is broadly defined to include habitat modifications that could injure a species by significantly impairing its essential activities such as feeding or breeding (see 50 C.F.R. § 17.3). However, the U.S. Fish & Wildlife Service, a division of the U.S. Department of the Interior, may issue permits for otherwise lawful activities that may impact an endangered or threatened species or their habitat.

If any of the project's construction activities might impact a federally listed endangered species along the proposed route, the project operator must apply for a permit or re-route the project to avoid the protected area. Currently, whether the project will affect regulated species is unknown, and further investigation will need to occur during later development phases.

6.2 State Requirements

Although this project will require several state permits and approvals, the exact number and type will depend on the project's final design and its chosen route.

Any excavation or pipeline installation along or within the NYS Route 3 right-of-way will require a highway work permit from the New York State Department of Transportation.

The State Environmental Quality Review Act (SEQRA) requires all New York State and local government entities approving, funding, or undertaking discretionary actions must assess the environmental impacts of those actions. All potential impacts must be evaluated to identify which may be significant, followed by a further evaluation to determine whether such impacts are unavoidable or if they can be mitigated to the extent that they are no longer significant. Projects of considerable size or extensive scope will generally require the preparation of an environmental impact statement (EIS), which details potential impacts and proposed mitigation methods to assist agencies' decision-making by detailing potential.

In situations involving multiple permitting jurisdictions and agencies, SEQRA allows for the designation of a single lead agency to coordinates feedback from all agencies and manages the review process to issue findings that must be considered during the remaining permit processes. No permits or approvals may be issued for a project until the SEQRA review process has been completed. Currently, which government entities would be involved in SEQRA review or declare themselves lead agency is unknown, although the Village of Saranac Lake would most likely be involved to some degree.

New York State, through authorization from the U.S. Environmental Protection Agency, manages the State Pollutant Discharge Elimination System (SPDES) program for all point source discharges into surface and groundwater within the State. The project has three phases with SPDES implications: construction, operations, and discharge of the water following thermal harvesting. The discharge of the water following thermal harvesting will most likely garner the greatest level of scrutiny from DEC, depending on the final temperature of the water and its ultimate destination. New York State has specific regulations governing "thermal discharges," which may affect water body temperatures. CHA anticipates that the project sponsor or developer would responsible for securing the required SPDES permits.

The Village of Saranac Lake is designated as a hamlet under APA land use regulations. Most projects fall under local review and do not require a permit from the APA. The proposed project will most likely not require APA review. However, work involving the river for the installation of a heat exchanger will require permits from DEC Region 5 and the U.S. Army Corps of Engineers (USACE) New York District. The magnitude of the in-water work will determine the extent of the permitting effort but the following can be expected:

- Article 15 Protection of Waters Permit (DEC)
- Section 401 Water Quality Certification (DEC)
- Nationwide or Individual Permit under Section 10 of the 1899 Rivers and Harbors Act and Section 404 of the Clean Water Act

Obtaining the required permits would involve preparing a joint permit application with supporting documentation and concurrence as necessary regarding the presence or absence of state and federally listed threatened and endangered species, as well as and historic and archaeological resources.

6.3 Local Requirements

The Village of Saranac Lake falls within two counties, Franklin and Essex, and three towns, Harrietstown, St. Armand, and North Elba. The project's initial phase (Phase A) will be located entirely within the Town of Harrietstown and Franklin County. During the DES project, the following regulatory and procedural steps must be addressed:

- **Zone change**
  Depending on the location of the central plant, the DES project may require a zone change approved by the local legislature to accommodate a commercial or industrial facility. The zoning map from February 2023[10] indicates that the expected location of the central plant near NYS Route 3 is zoned District E-2, which does not permit industrial land use. However, with a site plan review, the parcel could house a public utility facility. The E-2 zoning district does not specify minimum yard setbacks, and the maximum lot coverage will be determined during site plan review. All structures in the district require a minimum shoreline setback of 50 ft unless otherwise noted.
- **Building permits**
  Construction of any structure within a municipality requires a building permit. Such permits are ministerial (nondiscretionary), but typically require an inspection on completion by the local code's office. Municipalities may offer expedited review of building permits as a nonfinancial incentive for existing building owners to connect to the DES, although the exact location of existing underground infrastructure, particularly within public rights-of-way, is not known and limited information is available. Therefore, installing the DES project's distribution infrastructure (underground piping) will require construction permits and extensive coordination with the state, county, village, and National Grid authorities.
- **Site plan approval**
  The central plant will typically require site plan approval by the local planning board to ensure compliance with the local zoning requirements and maintain the aesthetic concerns of the neighborhood.
- **Excavation work**
  The town of Harrietstown will have to issue a street and sidewalk opening permit for any excavation or pipeline installation along or within the street right-of-way.
- **Estimated permitting timelines**
  Provide an estimated timeframe for permitting approval.

The timeframe for permitting approval will be dependent on specific permits required and the review process of the AHJs, which often do not have set timeframes. Permitting requirements will become more apparent during the project's detailed design stage, and the AHJs should be engaged in the process as early as possible to avoid potential critical path delays.

Identify any potential risks for additional permitting restrictions or delays where this type of project is not contemplated adequately within current rules or processes and/or there is rulemaking in progress.

The financial analysis for the DES project was based on assumptions regarding energy costs, emission reduction values, incentives, finance rates, inflation rates, and scoping-level cost estimates. These variables were developed to predict future conditions. However, recent the economic climate has seen increases in real inflation, interest rates, energy costs, and material lead times. Supply chain disruptions for construction materials have extended construction timelines. If these instabilities persist over the long term, the financial analysis may need to be reevaluated.

Customer enrollment and participation are critical for ensuring project viability. The project phasing should include an initial group of offtakers that can be connected with the least amount of construction cost (minimum viable). Generally, offtakers near the central plant, large thermal loads capable of load-flattening, and new construction projects will offer the highest cost-benefit advantages. Depending on the funding source, a proof of concept may need to be established with a defined initial phase milestone before proceeding subsequent phases and customer enrollment.

Identify any additional unique regulatory obstacles to the project as they relate to the distribution of non–utility-generated electricity and thermal energy, including those related to, but not limited to, the following:

- Utility franchise rights
- Issues attributable to the preferred business model
- Project phasing
- Regulatory proceedings still to be determined

Regulatory obstacles will be dependent on the final business model and implementation partner responsible for construction. As with any community or district heat pump project, the sponsor or developer of the Saranac Lake DES project must secure easements to install underground distribution piping, which includes approvals to cross property lines, streets, and existing utility. The Saranac Lake DES will require approvals for drilling because the system will require geothermal bore holes for its operation.

The development of the Saranac Lake DES may benefit from co-location of distribution piping with the planned water main replacements to be installed in Main Street. While co-location would result in significant cost savings, it would require extensive coordination with, and support from, the state and local authorities, and it presents a unique regulatory obstacle for the DES project. Associated risks will likely take the form of both additional time and costs for organization staff and legal professionals to procure rights and coordinate construction activities. These expenses may exceed those typically accounted for in routine project contingencies.

Recent New York State legislation amending the state's Public Service Law now authorizes investor-owned utilities to own and operate thermal energy networks, and has therefore removed one of the regulatory obstacles to the Saranac Lake DES project. The Utility Thermal Energy Network and Jobs Act, which Governor Hochul signed in July 2022, also charges the Public Service Commission (PSC) with initiating proceedings to support and regulate thermal energy network development. Specifically, the PSC is required to:

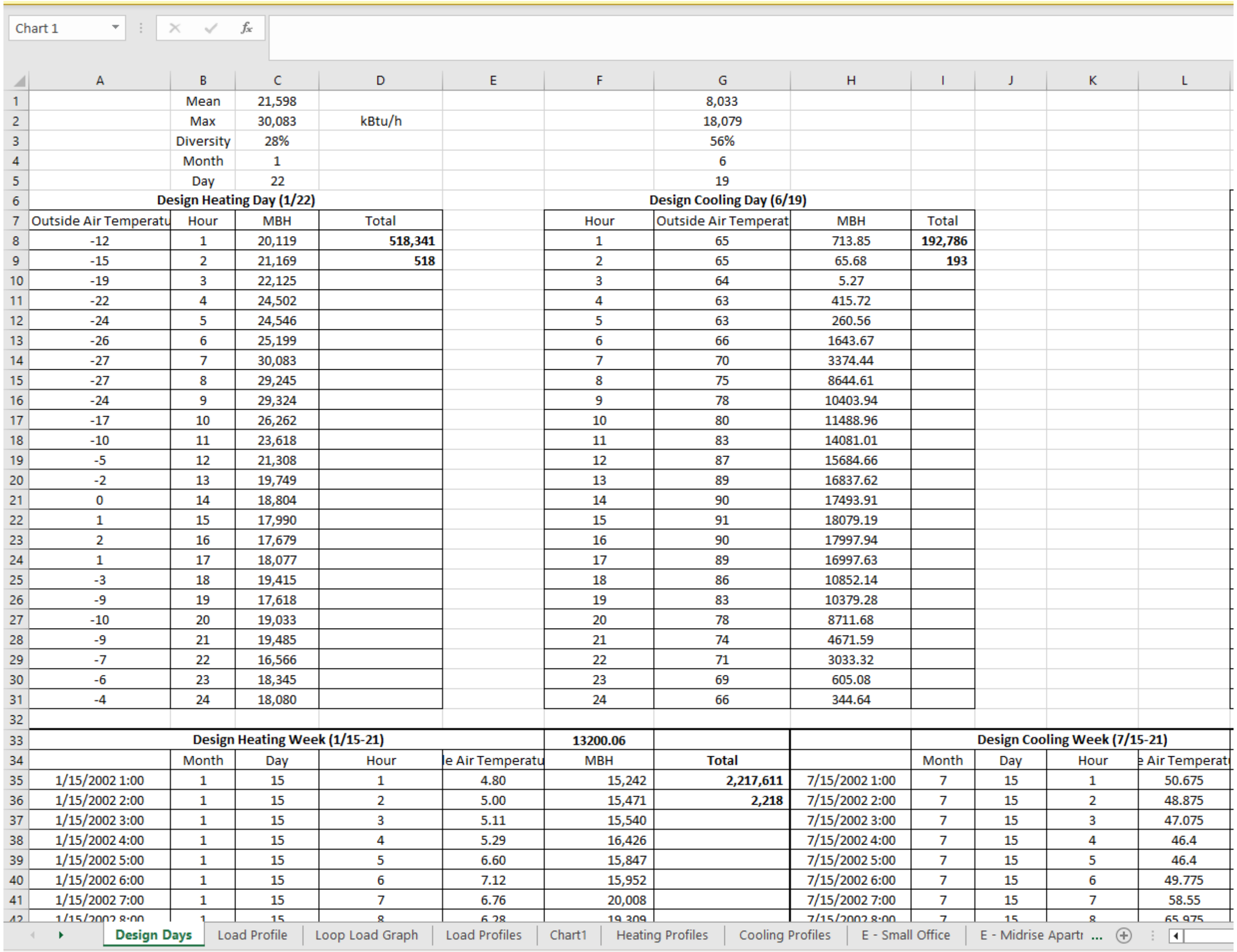
- Direct utilities to commence thermal energy network pilot programs in every utility territory in the State.
- Develop a regulatory structure to expand thermal energy network deployment; coordinate activities among utilities, other market participants, and public entities; and ensure consumer protection.
- Formulate labor policies to develop and maintain a highly-skilled and well-paid thermal energy network workforce, integrating existing state labor policies and programs where appropriate.
- Exempt small-scale, non–utility-owned thermal energy networks from PSC regulation.
- Enable fair market access rules for utility-owned thermal energy networks to accept low-emissions thermal energy produced by third parties, and otherwise foster market competition that benefits consumers and supports State emissions-reduction goals.

Currently, the specifics of these regulations are not known, which may affect the development of the Saranac Lake DES, specifically with regard to identifying a project sponsor or developer. The timeline of the PSC regulatory process will play an important role in determining the outcome. Issues such as customer service requirements, operating standards, and potential government-mandated price ceilings expected in the forthcoming regulations will most likely affect the project's business model and level of perceived risk for potential equity investors and debt providers.

Another noteworthy regulatory obstacle for the Saranac Lake DES is the creation of a policy mechanism to require customers to pay the Social Cost of Carbon for their emissions through a tax, penalty, or carbon trading scheme. While this issue is not unique to the Saranac Lake DES, the project is sensitive to such policies and any incentives available to the sponsors or developers of low-carbon DES projects. The DEC has adopted a Social Cost of Carbon to guide policy decisions, with a 2023 central value of $126 per metric ton of CO_2e. However, what actions the State’s Climate Action Council may take to implement such policies more broadly and their potential effect on private market investments is unknown.

Appendix A. Load Profiles

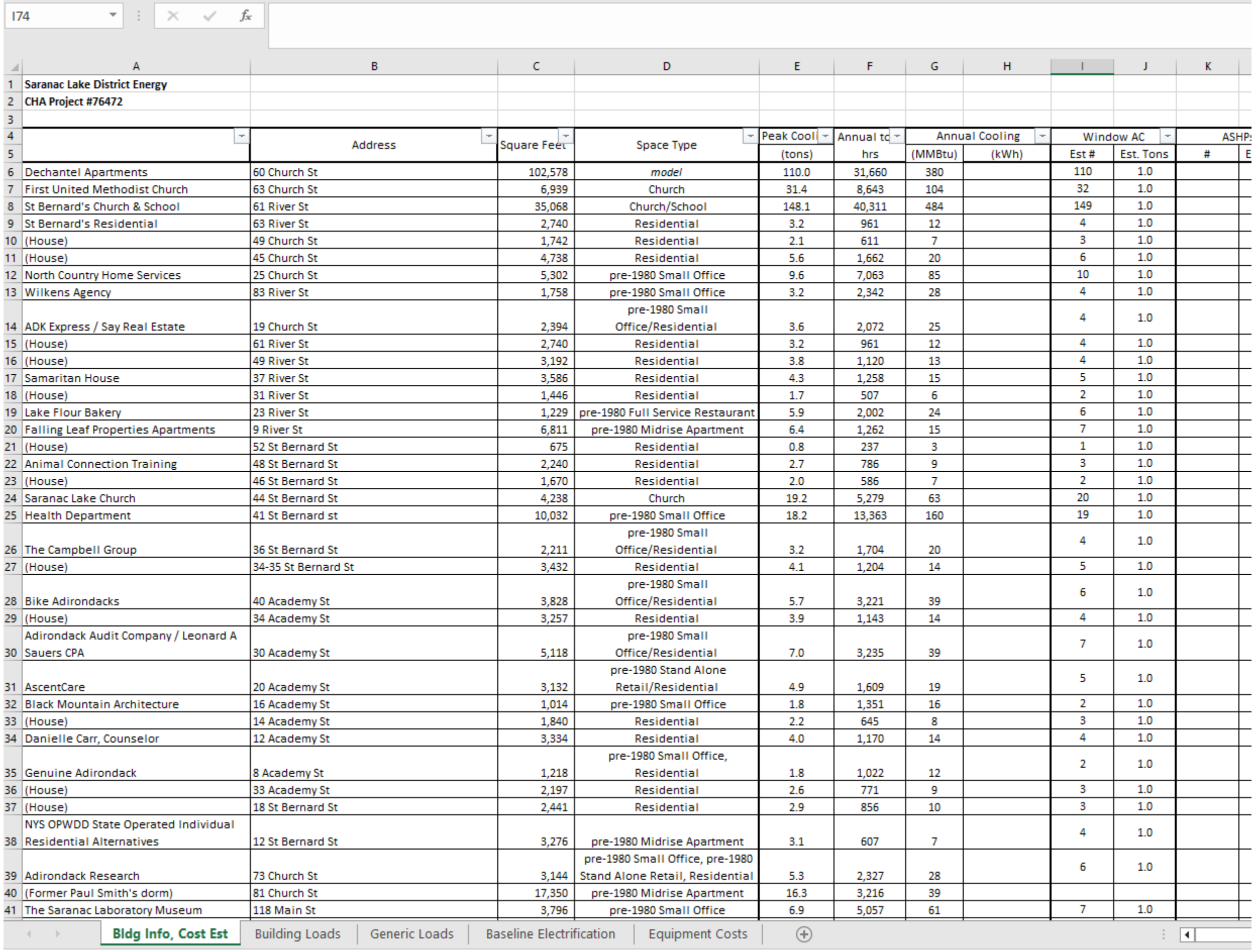
Figure A-1. Load Profiles



	A	B	C	D	E	F	G	H	I	J	K	L
1		Mean	21,598				8,033					
2		Max	30,083	kBtu/h			18,079					
3		Diversity	28%				56%					
4		Month	1				6					
5		Day	22				19					
6	**Design Heating Day (1/22)**					**Design Cooling Day (6/19)**						
7	Outside Air Temperatu	Hour	MBH	Total		Hour	Outside Air Temperat	MBH	Total			
8	-12	1	20,119	**518,341**		1	65	713.85	**192,786**			
9	-15	2	21,169	**518**		2	65	65.68	**193**			
10	-19	3	22,125			3	64	5.27				
11	-22	4	24,502			4	63	415.72				
12	-24	5	24,546			5	63	260.56				
13	-26	6	25,199			6	66	1643.67				
14	-27	7	30,083			7	70	3374.44				
15	-27	8	29,245			8	75	8644.61				
16	-24	9	29,324			9	78	10403.94				
17	-17	10	26,262			10	80	11488.96				
18	-10	11	23,618			11	83	14081.01				
19	-5	12	21,308			12	87	15684.66				
20	-2	13	19,749			13	89	16837.62				
21	0	14	18,804			14	90	17493.91				
22	1	15	17,990			15	91	18079.19				
23	2	16	17,679			16	90	17997.94				
24	1	17	18,077			17	89	16997.63				
25	-3	18	19,415			18	86	10852.14				
26	-9	19	17,618			19	83	10379.28				
27	-10	20	19,033			20	78	8711.68				
28	-9	21	19,485			21	74	4671.59				
29	-7	22	16,566			22	71	3033.32				
30	-6	23	18,345			23	69	605.08				
31	-4	24	18,080			24	66	344.64				
32												
33	**Design Heating Week (1/15-21)**					**13200.06**			**Design Cooling Week (7/15-21)**			
34		Month	Day	Hour	le Air Temperatu	MBH	**Total**		Month	Day	Hour	e Air Temperat
35	1/15/2002 1:00	1	15	1	4.80	15,242	**2,217,611**	7/15/2002 1:00	7	15	1	50.675
36	1/15/2002 2:00	1	15	2	5.00	15,471	**2,218**	7/15/2002 2:00	7	15	2	48.875
37	1/15/2002 3:00	1	15	3	5.11	15,540		7/15/2002 3:00	7	15	3	47.075
38	1/15/2002 4:00	1	15	4	5.29	16,426		7/15/2002 4:00	7	15	4	46.4
39	1/15/2002 5:00	1	15	5	6.60	15,847		7/15/2002 5:00	7	15	5	46.4
40	1/15/2002 6:00	1	15	6	7.12	15,952		7/15/2002 6:00	7	15	6	49.775
41	1/15/2002 7:00	1	15	7	6.76	20,008		7/15/2002 7:00	7	15	7	58.55
42	1/15/2002 8:00	1	15	8	6.28	19,309		7/15/2002 8:00	7	15	8	65.975

Appendix B. Baseline Equipment Costs

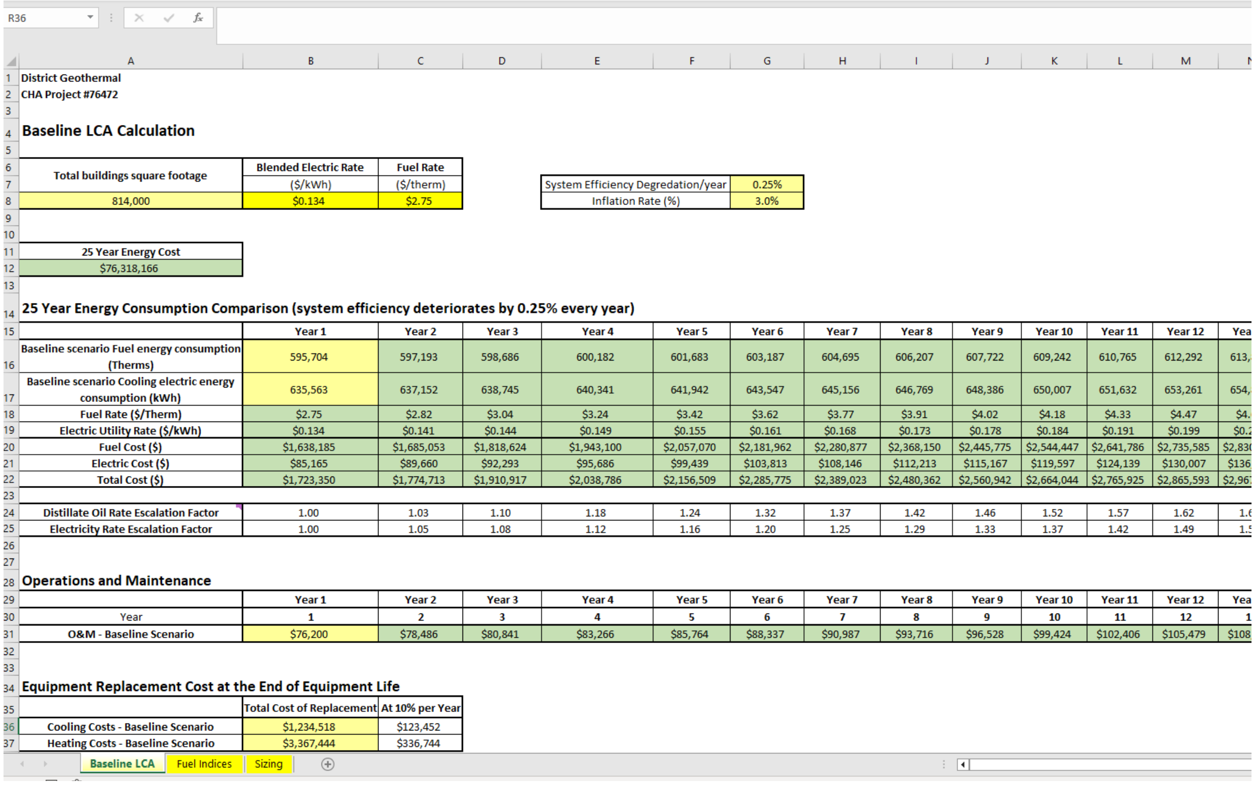
Figure B-1. Baseline Equipment Costs



	A	B	C	D	E	F	G	H	I	J	K	
1	**Saranac Lake District Energy**											
2	**CHA Project #76472**											
3												
4		Address	Square Feet	Space Type	Peak Cool	Annual tc	Annual Cooling		Window AC		ASHP	
5					(tons)	hrs	(MMBtu)	(kWh)	Est #	Est. Tons	#	E
6	Dechantel Apartments	60 Church St	102,578	*model*	110.0	31,660	380		110	1.0		
7	First United Methodist Church	63 Church St	6,939	Church	31.4	8,643	104		32	1.0		
8	St Bernard's Church & School	61 River St	35,068	Church/School	148.1	40,311	484		149	1.0		
9	St Bernard's Residential	63 River St	2,740	Residential	3.2	961	12		4	1.0		
10	(House)	49 Church St	1,742	Residential	2.1	611	7		3	1.0		
11	(House)	45 Church St	4,738	Residential	5.6	1,662	20		6	1.0		
12	North Country Home Services	25 Church St	5,302	pre-1980 Small Office	9.6	7,063	85		10	1.0		
13	Wilkens Agency	83 River St	1,758	pre-1980 Small Office	3.2	2,342	28		4	1.0		
14	ADK Express / Say Real Estate	19 Church St	2,394	pre-1980 Small Office/Residential	3.6	2,072	25		4	1.0		
15	(House)	61 River St	2,740	Residential	3.2	961	12		4	1.0		
16	(House)	49 River St	3,192	Residential	3.8	1,120	13		4	1.0		
17	Samaritan House	37 River St	3,586	Residential	4.3	1,258	15		5	1.0		
18	(House)	31 River St	1,446	Residential	1.7	507	6		2	1.0		
19	Lake Flour Bakery	23 River St	1,229	pre-1980 Full Service Restaurant	5.9	2,002	24		6	1.0		
20	Falling Leaf Properties Apartments	9 River St	6,811	pre-1980 Midrise Apartment	6.4	1,262	15		7	1.0		
21	(House)	52 St Bernard St	675	Residential	0.8	237	3		1	1.0		
22	Animal Connection Training	48 St Bernard St	2,240	Residential	2.7	786	9		3	1.0		
23	(House)	46 St Bernard St	1,670	Residential	2.0	586	7		2	1.0		
24	Saranac Lake Church	44 St Bernard St	4,238	Church	19.2	5,279	63		20	1.0		
25	Health Department	41 St Bernard st	10,032	pre-1980 Small Office	18.2	13,363	160		19	1.0		
26	The Campbell Group	36 St Bernard St	2,211	pre-1980 Small Office/Residential	3.2	1,704	20		4	1.0		
27	(House)	34-35 St Bernard St	3,432	Residential	4.1	1,204	14		5	1.0		
28	Bike Adirondacks	40 Academy St	3,828	pre-1980 Small Office/Residential	5.7	3,221	39		6	1.0		
29	(House)	34 Academy St	3,257	Residential	3.9	1,143	14		4	1.0		
30	Adirondack Audit Company / Leonard A Sauers CPA	30 Academy St	5,118	pre-1980 Small Office/Residential	7.0	3,235	39		7	1.0		
31	AscentCare	20 Academy St	3,132	pre-1980 Stand Alone Retail/Residential	4.9	1,609	19		5	1.0		
32	Black Mountain Architecture	16 Academy St	1,014	pre-1980 Small Office	1.8	1,351	16		2	1.0		
33	(House)	14 Academy St	1,840	Residential	2.2	645	8		3	1.0		
34	Danielle Carr, Counselor	12 Academy St	3,334	Residential	4.0	1,170	14		4	1.0		
35	Genuine Adirondack	8 Academy St	1,218	pre-1980 Small Office, Residential	1.8	1,022	12		2	1.0		
36	(House)	33 Academy St	2,197	Residential	2.6	771	9		3	1.0		
37	(House)	18 St Bernard St	2,441	Residential	2.9	856	10		3	1.0		
38	NYS OPWDD State Operated Individual Residential Alternatives	12 St Bernard St	3,276	pre-1980 Midrise Apartment	3.1	607	7		4	1.0		
39	Adirondack Research	73 Church St	3,144	pre-1980 Small Office, pre-1980 Stand Alone Retail, Residential	5.3	2,327	28		6	1.0		
40	(Former Paul Smith's dorm)	81 Church St	17,350	pre-1980 Midrise Apartment	16.3	3,216	39					
41	The Saranac Laboratory Museum	118 Main St	3,796	pre-1980 Small Office	6.9	5,057	61		7	1.0		

Appendix C. Baseline Life-Cycle Cost Analysis

Figure C-1. Baseline Life-Cycle Cost Analysis



District Geothermal
CHA Project #76472

Baseline LCA Calculation

Total buildings square footage	Blended Electric Rate ($/kWh)	Fuel Rate ($/therm)
814,000	$0.134	$2.75

System Efficiency Degredation/year	0.25%
Inflation Rate (%)	3.0%

25 Year Energy Cost
$76,318,166

25 Year Energy Consumption Comparison (system efficiency deteriorates by 0.25% every year)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Yea
Baseline scenario Fuel energy consumption (Therms)	595,704	597,193	598,686	600,182	601,683	603,187	604,695	606,207	607,722	609,242	610,765	612,292	613,
Baseline scenario Cooling electric energy consumption (kWh)	635,563	637,152	638,745	640,341	641,942	643,547	645,156	646,769	648,386	650,007	651,632	653,261	654,
Fuel Rate ($/Therm)	$2.75	$2.82	$3.04	$3.24	$3.42	$3.62	$3.77	$3.91	$4.02	$4.18	$4.33	$4.47	$4.
Electric Utility Rate ($/kWh)	$0.134	$0.141	$0.144	$0.149	$0.155	$0.161	$0.168	$0.173	$0.178	$0.184	$0.191	$0.199	$0.
Fuel Cost ($)	$1,638,185	$1,685,053	$1,818,624	$1,943,100	$2,057,070	$2,181,962	$2,280,877	$2,368,150	$2,445,775	$2,544,447	$2,641,786	$2,735,585	$2,83
Electric Cost ($)	$85,165	$89,660	$92,293	$95,686	$99,439	$103,813	$108,146	$112,213	$115,167	$119,597	$124,139	$130,007	$136
Total Cost ($)	$1,723,350	$1,774,713	$1,910,917	$2,038,786	$2,156,509	$2,285,775	$2,389,023	$2,480,362	$2,560,942	$2,664,044	$2,765,925	$2,865,593	$2,96

Distillate Oil Rate Escalation Factor	1.00	1.03	1.10	1.18	1.24	1.32	1.37	1.42	1.46	1.52	1.57	1.62	1.
Electricity Rate Escalation Factor	1.00	1.05	1.08	1.12	1.16	1.20	1.25	1.29	1.33	1.37	1.42	1.49	1.

Operations and Maintenance

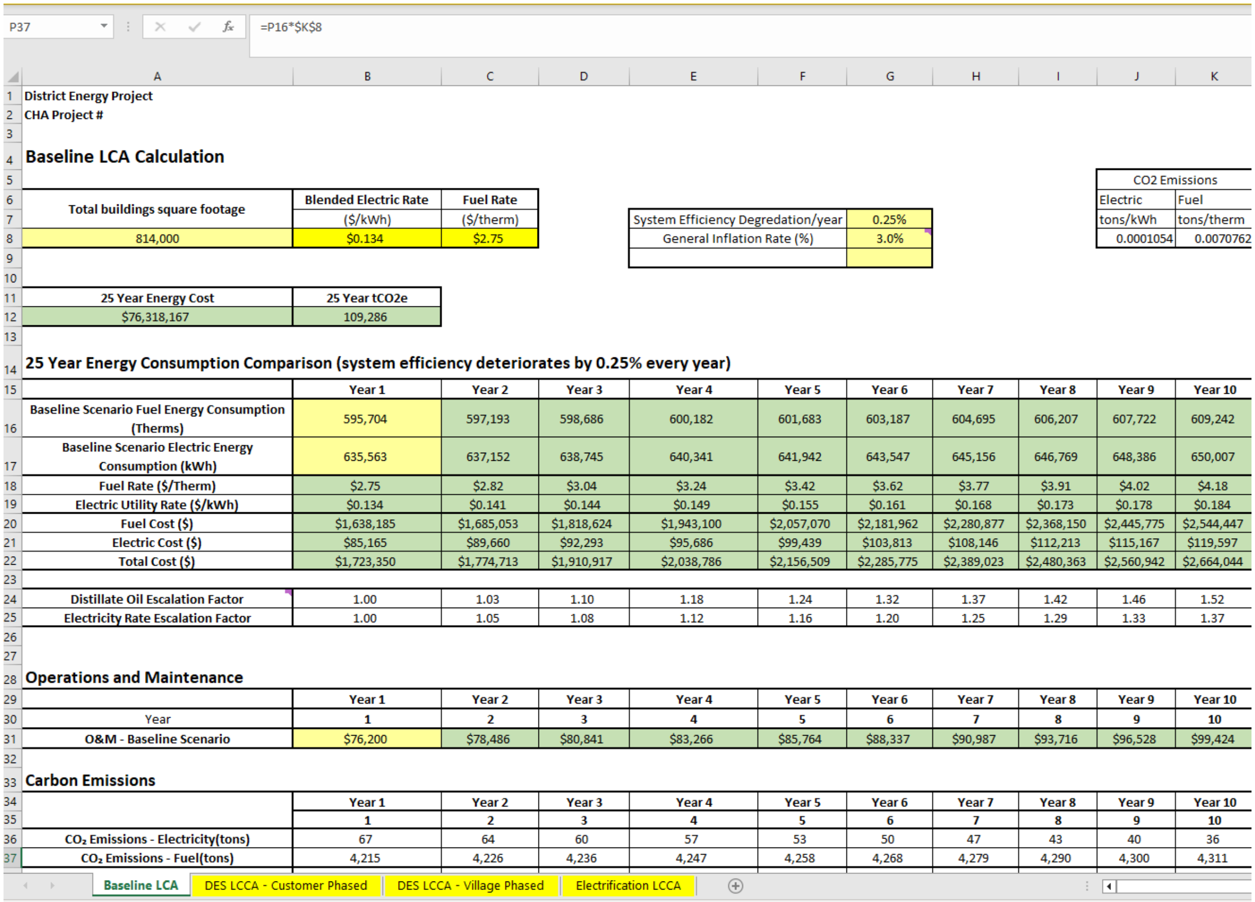
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Yea
Year	1	2	3	4	5	6	7	8	9	10	11	12	1
O&M - Baseline Scenario	$76,200	$78,486	$80,841	$83,266	$85,764	$88,337	$90,987	$93,716	$96,528	$99,424	$102,406	$105,479	$108

Equipment Replacement Cost at the End of Equipment Life

	Total Cost of Replacement	At 10% per Year
Cooling Costs - Baseline Scenario	$1,234,518	$123,452
Heating Costs - Baseline Scenario	$3,367,444	$336,744

Appendix D. District Energy Systems Life-Cycle Cost Analysis

Figure D-1. District Energy Systems Life-Cycle Cost Analysis



District Energy Project
CHA Project #

Baseline LCA Calculation

Total buildings square footage	Blended Electric Rate ($/kWh)	Fuel Rate ($/therm)
814,000	$0.134	$2.75

System Efficiency Degredation/year	0.25%
General Inflation Rate (%)	3.0%

CO2 Emissions	
Electric	Fuel
tons/kWh	tons/therm
0.0001054	0.0070762

25 Year Energy Cost	25 Year tCO2e
$76,318,167	109,286

25 Year Energy Consumption Comparison (system efficiency deteriorates by 0.25% every year)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Baseline Scenario Fuel Energy Consumption (Therms)	595,704	597,193	598,686	600,182	601,683	603,187	604,695	606,207	607,722	609,242
Baseline Scenario Electric Energy Consumption (kWh)	635,563	637,152	638,745	640,341	641,942	643,547	645,156	646,769	648,386	650,007
Fuel Rate ($/Therm)	$2.75	$2.82	$3.04	$3.24	$3.42	$3.62	$3.77	$3.91	$4.02	$4.18
Electric Utility Rate ($/kWh)	$0.134	$0.141	$0.144	$0.149	$0.155	$0.161	$0.168	$0.173	$0.178	$0.184
Fuel Cost ($)	$1,638,185	$1,685,053	$1,818,624	$1,943,100	$2,057,070	$2,181,962	$2,280,877	$2,368,150	$2,445,775	$2,544,447
Electric Cost ($)	$85,165	$89,660	$92,293	$95,686	$99,439	$103,813	$108,146	$112,213	$115,167	$119,597
Total Cost ($)	$1,723,350	$1,774,713	$1,910,917	$2,038,786	$2,156,509	$2,285,775	$2,389,023	$2,480,363	$2,560,942	$2,664,044

Distillate Oil Escalation Factor	1.00	1.03	1.10	1.18	1.24	1.32	1.37	1.42	1.46	1.52
Electricity Rate Escalation Factor	1.00	1.05	1.08	1.12	1.16	1.20	1.25	1.29	1.33	1.37

Operations and Maintenance

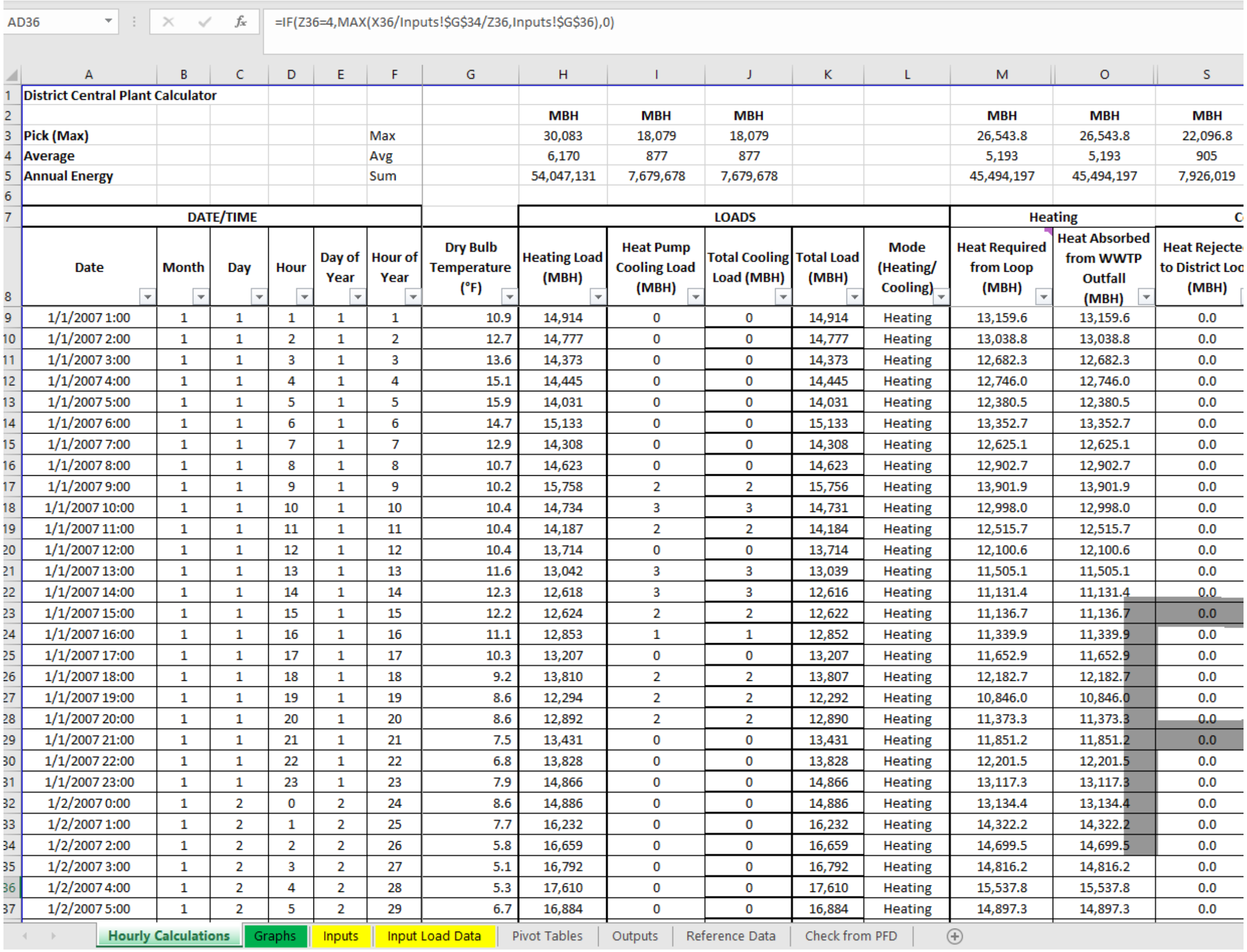
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Year	1	2	3	4	5	6	7	8	9	10
O&M - Baseline Scenario	$76,200	$78,486	$80,841	$83,266	$85,764	$88,337	$90,987	$93,716	$96,528	$99,424

Carbon Emissions

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
	1	2	3	4	5	6	7	8	9	10
CO_2 Emissions - Electricity(tons)	67	64	60	57	53	50	47	43	40	36
CO_2 Emissions - Fuel(tons)	4,215	4,226	4,236	4,247	4,258	4,268	4,279	4,290	4,300	4,311

Appendix E. District Central Plant Calculator

Figure E-1. District Central Plant Calculator



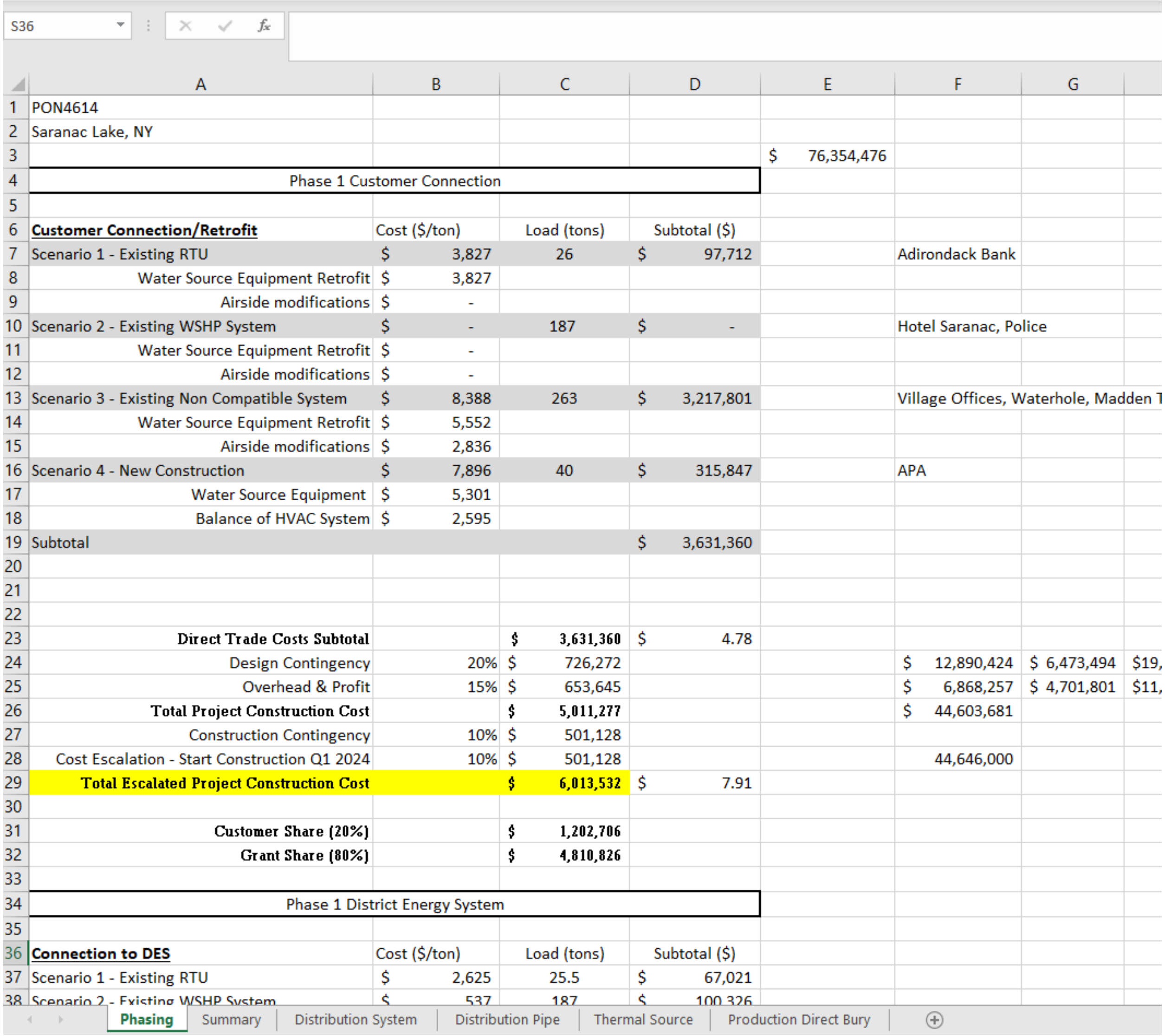
AD36

=IF(Z36=4,MAX(X36/Inputs!$G$34/Z36,Inputs!$G$36),0)

	A	B	C	D	E	F	G	H	I	J	K	L	M	O	S
1	**District Central Plant Calculator**														
2								**MBH**	**MBH**	**MBH**			**MBH**	**MBH**	**MBH**
3	**Pick (Max)**					Max		30,083	18,079	18,079			26,543.8	26,543.8	22,096.8
4	**Average**					Avg		6,170	877	877			5,193	5,193	905
5	**Annual Energy**					Sum		54,047,131	7,679,678	7,679,678			45,494,197	45,494,197	7,926,019
6															
7	**DATE/TIME**							**LOADS**					**Heating**		**C**
8	**Date**	**Month**	**Day**	**Hour**	**Day of Year**	**Hour of Year**	**Dry Bulb Temperature (°F)**	**Heating Load (MBH)**	**Heat Pump Cooling Load (MBH)**	**Total Cooling Load (MBH)**	**Total Load (MBH)**	**Mode (Heating/ Cooling)**	**Heat Required from Loop (MBH)**	**Heat Absorbed from WWTP Outfall (MBH)**	**Heat Rejecte to District Lo (MBH)**
9	1/1/2007 1:00	1	1	1	1	1	10.9	14,914	0	0	14,914	Heating	13,159.6	13,159.6	0.0
10	1/1/2007 2:00	1	1	2	1	2	12.7	14,777	0	0	14,777	Heating	13,038.8	13,038.8	0.0
11	1/1/2007 3:00	1	1	3	1	3	13.6	14,373	0	0	14,373	Heating	12,682.3	12,682.3	0.0
12	1/1/2007 4:00	1	1	4	1	4	15.1	14,445	0	0	14,445	Heating	12,746.0	12,746.0	0.0
13	1/1/2007 5:00	1	1	5	1	5	15.9	14,031	0	0	14,031	Heating	12,380.5	12,380.5	0.0
14	1/1/2007 6:00	1	1	6	1	6	14.7	15,133	0	0	15,133	Heating	13,352.7	13,352.7	0.0
15	1/1/2007 7:00	1	1	7	1	7	12.9	14,308	0	0	14,308	Heating	12,625.1	12,625.1	0.0
16	1/1/2007 8:00	1	1	8	1	8	10.7	14,623	0	0	14,623	Heating	12,902.7	12,902.7	0.0
17	1/1/2007 9:00	1	1	9	1	9	10.2	15,758	2	2	15,756	Heating	13,901.9	13,901.9	0.0
18	1/1/2007 10:00	1	1	10	1	10	10.4	14,734	3	3	14,731	Heating	12,998.0	12,998.0	0.0
19	1/1/2007 11:00	1	1	11	1	11	10.4	14,187	2	2	14,184	Heating	12,515.7	12,515.7	0.0
20	1/1/2007 12:00	1	1	12	1	12	10.4	13,714	0	0	13,714	Heating	12,100.6	12,100.6	0.0
21	1/1/2007 13:00	1	1	13	1	13	11.6	13,042	3	3	13,039	Heating	11,505.1	11,505.1	0.0
22	1/1/2007 14:00	1	1	14	1	14	12.3	12,618	3	3	12,616	Heating	11,131.4	11,131.4	0.0
23	1/1/2007 15:00	1	1	15	1	15	12.2	12,624	2	2	12,622	Heating	11,136.7	11,136.7	0.0
24	1/1/2007 16:00	1	1	16	1	16	11.1	12,853	1	1	12,852	Heating	11,339.9	11,339.9	0.0
25	1/1/2007 17:00	1	1	17	1	17	10.3	13,207	0	0	13,207	Heating	11,652.9	11,652.9	0.0
26	1/1/2007 18:00	1	1	18	1	18	9.2	13,810	2	2	13,807	Heating	12,182.7	12,182.7	0.0
27	1/1/2007 19:00	1	1	19	1	19	8.6	12,294	2	2	12,292	Heating	10,846.0	10,846.0	0.0
28	1/1/2007 20:00	1	1	20	1	20	8.6	12,892	2	2	12,890	Heating	11,373.3	11,373.3	0.0
29	1/1/2007 21:00	1	1	21	1	21	7.5	13,431	0	0	13,431	Heating	11,851.2	11,851.2	0.0
30	1/1/2007 22:00	1	1	22	1	22	6.8	13,828	0	0	13,828	Heating	12,201.5	12,201.5	0.0
31	1/1/2007 23:00	1	1	23	1	23	7.9	14,866	0	0	14,866	Heating	13,117.3	13,117.3	0.0
32	1/2/2007 0:00	1	2	0	2	24	8.6	14,886	0	0	14,886	Heating	13,134.4	13,134.4	0.0
33	1/2/2007 1:00	1	2	1	2	25	7.7	16,232	0	0	16,232	Heating	14,322.2	14,322.2	0.0
34	1/2/2007 2:00	1	2	2	2	26	5.8	16,659	0	0	16,659	Heating	14,699.5	14,699.5	0.0
35	1/2/2007 3:00	1	2	3	2	27	5.1	16,792	0	0	16,792	Heating	14,816.2	14,816.2	0.0
36	1/2/2007 4:00	1	2	4	2	28	5.3	17,610	0	0	17,610	Heating	15,537.8	15,537.8	0.0
37	1/2/2007 5:00	1	2	5	2	29	6.7	16,884	0	0	16,884	Heating	14,897.3	14,897.3	0.0

Appendix F. Opinion of Probable Cost

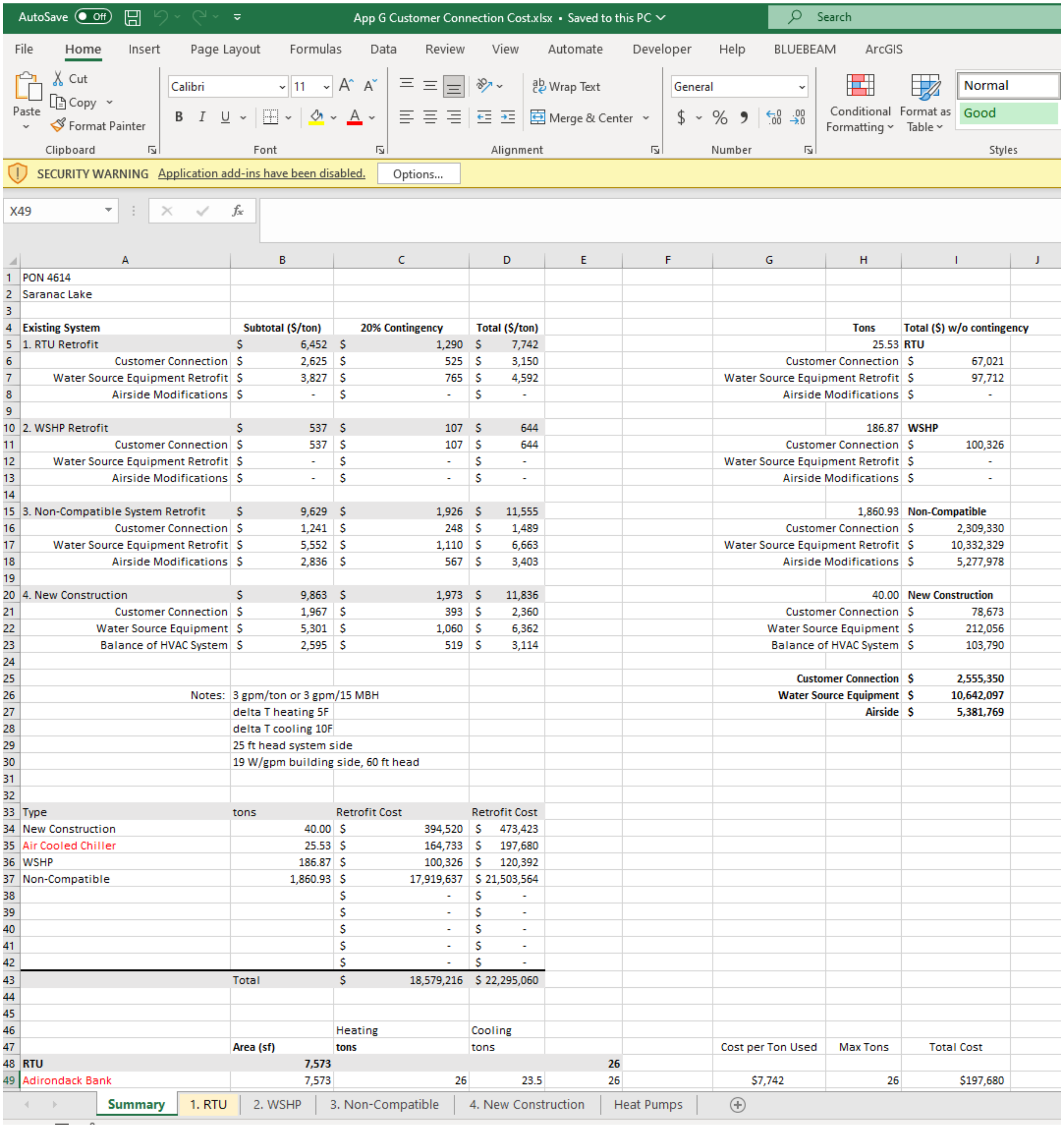
Figure F-1. Opinion of Probable Cost



	A	B	C	D	E	F	G	
1	PON4614							
2	Saranac Lake, NY							
3					$ 76,354,476			
4	Phase 1 Customer Connection							
5								
6	**Customer Connection/Retrofit**	Cost ($/ton)	Load (tons)	Subtotal ($)				
7	Scenario 1 - Existing RTU	$ 3,827	26	$ 97,712		Adirondack Bank		
8	Water Source Equipment Retrofit	$ 3,827						
9	Airside modifications	$ -						
10	Scenario 2 - Existing WSHP System	$ -	187	$ -		Hotel Saranac, Police		
11	Water Source Equipment Retrofit	$ -						
12	Airside modifications	$ -						
13	Scenario 3 - Existing Non Compatible System	$ 8,388	263	$ 3,217,801		Village Offices, Waterhole, Madden T		
14	Water Source Equipment Retrofit	$ 5,552						
15	Airside modifications	$ 2,836						
16	Scenario 4 - New Construction	$ 7,896	40	$ 315,847		APA		
17	Water Source Equipment	$ 5,301						
18	Balance of HVAC System	$ 2,595						
19	Subtotal			$ 3,631,360				
20								
21								
22								
23	**Direct Trade Costs Subtotal**		**$ 3,631,360**	$ 4.78				
24	Design Contingency	20%	$ 726,272			$ 12,890,424	$ 6,473,494	$19,
25	Overhead & Profit	15%	$ 653,645			$ 6,868,257	$ 4,701,801	$11,
26	**Total Project Construction Cost**		**$ 5,011,277**			$ 44,603,681		
27	Construction Contingency	10%	$ 501,128					
28	Cost Escalation - Start Construction Q1 2024	10%	$ 501,128			44,646,000		
29	**Total Escalated Project Construction Cost**		**$ 6,013,532**	$ 7.91				
30								
31	**Customer Share (20%)**		**$ 1,202,706**					
32	**Grant Share (80%)**		**$ 4,810,826**					
33								
34	Phase 1 District Energy System							
35								
36	**Connection to DES**	Cost ($/ton)	Load (tons)	Subtotal ($)				
37	Scenario 1 - Existing RTU	$ 2,625	25.5	$ 67,021				
38	Scenario 2 - Existing WSHP System	$ 537	187	$ 100,326				

Appendix G. Customer Connection Cost

Figure G-1. Customer Connection Cost



	A	B	C	D	E	F	G	H	I	J
1	PON 4614									
2	Saranac Lake									
3										
4	**Existing System**	**Subtotal ($/ton)**	**20% Contingency**	**Total ($/ton)**				**Tons**	**Total ($) w/o contingency**	
5	1. RTU Retrofit	$ 6,452	$ 1,290	$ 7,742				25.53	**RTU**	
6	Customer Connection	$ 2,625	$ 525	$ 3,150				Customer Connection	$ 67,021	
7	Water Source Equipment Retrofit	$ 3,827	$ 765	$ 4,592				Water Source Equipment Retrofit	$ 97,712	
8	Airside Modifications	$ -	$ -	$ -				Airside Modifications	$ -	
9										
10	2. WSHP Retrofit	$ 537	$ 107	$ 644				186.87	**WSHP**	
11	Customer Connection	$ 537	$ 107	$ 644				Customer Connection	$ 100,326	
12	Water Source Equipment Retrofit	$ -	$ -	$ -				Water Source Equipment Retrofit	$ -	
13	Airside Modifications	$ -	$ -	$ -				Airside Modifications	$ -	
14										
15	3. Non-Compatible System Retrofit	$ 9,629	$ 1,926	$ 11,555				1,860.93	**Non-Compatible**	
16	Customer Connection	$ 1,241	$ 248	$ 1,489				Customer Connection	$ 2,309,330	
17	Water Source Equipment Retrofit	$ 5,552	$ 1,110	$ 6,663				Water Source Equipment Retrofit	$ 10,332,329	
18	Airside Modifications	$ 2,836	$ 567	$ 3,403				Airside Modifications	$ 5,277,978	
19										
20	4. New Construction	$ 9,863	$ 1,973	$ 11,836				40.00	**New Construction**	
21	Customer Connection	$ 1,967	$ 393	$ 2,360				Customer Connection	$ 78,673	
22	Water Source Equipment	$ 5,301	$ 1,060	$ 6,362				Water Source Equipment	$ 212,056	
23	Balance of HVAC System	$ 2,595	$ 519	$ 3,114				Balance of HVAC System	$ 103,790	
24										
25								**Customer Connection**	**$ 2,555,350**	
26	Notes:	3 gpm/ton or 3 gpm/15 MBH						**Water Source Equipment**	**$ 10,642,097**	
27		delta T heating 5F						**Airside**	**$ 5,381,769**	
28		delta T cooling 10F								
29		25 ft head system side								
30		19 W/gpm building side, 60 ft head								
31										
32										
33	Type	tons	Retrofit Cost	Retrofit Cost						
34	New Construction	40.00	$ 394,520	$ 473,423						
35	Air Cooled Chiller	25.53	$ 164,733	$ 197,680						
36	WSHP	186.87	$ 100,326	$ 120,392						
37	Non-Compatible	1,860.93	$ 17,919,637	$ 21,503,564						
38			$ -	$ -						
39			$ -	$ -						
40			$ -	$ -						
41			$ -	$ -						
42			$ -	$ -						
43		Total	$ 18,579,216	$ 22,295,060						
44										
45										
46			Heating	Cooling						
47		**Area (sf)**	tons	tons			Cost per Ton Used	Max Tons	Total Cost	
48	**RTU**	**7,573**			**26**					
49	Adirondack Bank	7,573	26	23.5	26		$7,742	26	$197,680	

Endnotes

[1] "Greenhouse Gas Equivalencies Calculator," US Environmental Protection Agency (EPA), www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[2] In-depth model details can be found in the report titled "U.S. Department of Energy Commercial Reference Building Models of the National Building Stock," www.nrel.gov/docs/fy11osti/46861.pdf

[3] Winter, Hauslauer, Obernberger. "Untersuchungen der Gleichzeitigkeit in kleinen und mittleren Nahwärmenetzen." 2001, www.verenum.ch/Dokumente/2001_Winter-Gleichzeitig.pdf

[4] "Estimating the Value of Carbon: Two Approaches" (Albany: NYSERDA and Resources for the Future, January 2021), 6. The $126-per-metric-ton figure assumes a 2% discount rate and reflects the average of modeled results.

[5] "NY Business—Interconnection Process," *National Grid Distributed Generation,* September 15, 2021, gridforce.my.site.com/s/article/NY-BUSINESS-Interconnection-Process

[6] "Emissions & Generation Resource Integrated Database (eGRID)." U.S. Environmental Protection Agency (EPA), www.epa.gov/egrid

[7] "Saranac Lake, NY Demographics." Point 2, www.point2homes.com/US/Neighborhood/NY/Saranac-Lake-Demographics.html

[8] "What Is the Ideal Ratio of EVs to Charging Stations?" evadoption*,* April 8, 2019,, evadoption.com/what-is-the-ideal-ratio-of-evs-to-charging-stations/

[9] 16 U.S.C. § 1538.

[10] "Village of Saranac Lake Zoning Map," February 2023, ecode360.com/attachment/SA0109/SA0109-106c%20Zoning%20Map.pdf

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