Metering and Monitoring Plan for the Flagg Loop Geothermal Network in Framingham, MA

This report describes the metering and monitoring strategy for geothermal networks as developed for the Flagg Loop in Framingham, MA. This report is a product from the Budget Period 1 (BP1) "Planning and Design" of the Community Geothermal Heating and Cooling (CGHC) grant awarded by the Department of Energy (DOE) to HEET. The partner organizations of this project are: Eversource Energy- the Deployment Partner; the City of Framingham - the Municipal Partner, Salas O'Brien - the Design Partner, and HEET, the main recipient. HEET is a non-profit with a mission to drive systems change through an ethical and efficient thermal energy transition

The metering and monitoring system was designed to include all necessary data to calculate the extent of synchronous and asynchronous load cancellation observed on hourly, daily, and seasonal scales. By analyzing these load cancellations, the efficiency and reliability of the geothermal system can be improved. Additionally, the system design will help optimize seasonal and thermal performance through strategic operation and thermal storage. This involves the careful management of energy flows to ensure the system operates efficiently across different seasons, balancing heating and cooling demands.

Key components of this optimization strategy include the installation of BTU meters, pump power meters, and temperature sensors, which are crucial for accurately monitoring system performance. These instruments provide real-time data on energy usage, flow rates, and temperature variations, enabling precise adjustments to maintain optimal performance. Tables 1 and 2 serve as a reference, outlining critical data points to be collected, their significance, and the methods for measurement and collection. The data points include ground loop water supply temperatures, flow rates, and delta T (temperature difference) over time, which help determine appropriate seasonal variations and assess the need for supplemental heating and cooling equipment. Additionally, data on the cost and time required to charge the wellfield, ground loop water flow, and the addition of make-up water/glycol provide insights into operational efficiency and maintenance needs.

The team ensured that the design incorporated comprehensive monitoring and data collection strategies. This enables accurate tracking of system performance and identification of any issues that may arise during operation. These accomplishments reflect significant progress made during the initial phases of the project, setting a strong foundation for future work.

Table 1. Eversource Geothermal Network Monitoring Data Points

Data Point	Significance & Learning	How Measured / Collected
Ground loop water supply temperatures (°F) to buildings; seasonal variations	Determine appropriate and acceptable seasonal variations in wellfield temperatures given customer-side equipment requirements	Btu and temperature meters on the ground-loop heat exchanger's supply and return connections; heat flows and temperatures logged and stored every hour throughout operational life of project
Ground loop water supply temperatures (°F) to buildings; year-over-year comparisons	Assess the need for supplemental heating and cooling equipment (i.e. cooling tower and boiler) in order to maintain the effectiveness of the ground loop throughout its operational life	Btu and temperature meters on the ground-loop heat exchanger's supply and return connections; heat flows and temperatures logged and stored every hour throughout operational life of project
Ground loop delta T (°F) between return and supply over time	Study the allowable tolerance for delta T based on customer's equipment ratings, performance, etc.	Btu and temperature meters on the ground-loop heat exchanger's supply and return connections; heat flows and temperatures logged and stored every hour throughout operational life of project
Cost / time required to charge the wellfield (if needed to balance the wellfield temperature)	Best practices for cost-effectively, sustainably charging the wellfield (e.g., during nighttime off-peak hours if an electric boiler on a TOU rate structure)	Boiler trends (supply/return temperatures, fire rate, flow) logged on an hourly basis and stored throughout operational life of project
Ground loop water flow (GPM) over time	Assess the flow requirements of the system during varying climate conditions; identify any central flow imbalances (i.e., leaks)	Flow meters on the ground-loop heat exchanger's supply and return connections; water flows (GPM) logged and stored every hour throughout operational life of project
Addition of make-up water/glycol (gallons) over time (if required due to leaks, flushing, etc.)	Assess the typical volume and cost requirements of keeping the system full of working fluid	Consumption meter (gallons) on the make-up system; log of glycol purchases, if applicable

Run-time and electricity consumption (hours and kWh) of central loop infrastructure	Better understand the operational load profile and cost of the central pumping system	Trends programmed for each central pump
Cost of customer building-side HVAC installation (maximum, minimum, median, average)	Better understand (and, in the future, advise on) the cost to install or retrofit existing customer-side HVAC systems to function with a community ground loop; understand cost range across system types	Log using invoiced cost for each customer's system
Cost of annual customer-side preventative maintenance and unscheduled repairs	Better understand (and, in the future, advise on) the customer-side maintenance and repair costs to be incurred when connecting to a community ground-loop	Log using invoiced cost for each customer's system
Amount of water quality impact / scale buildup (from both Company and customer sides of loop)	Understand the tendency of scale to occur and whether condenser water should be provided directly to customers or via a heat exchanger; determine who would own the heat exchanger	Monthly water quality tests (PPM, scale, etc.) in two locations within the central loop as well as at two randomly selected customer connections
Occupant comfort / space conditioning	Understand customers' satisfaction levels with the GSHP condenser water service	Surveys
Timeframes	Better understand time requirements for customer acquisition, equipment and labor procurement, and construction activities across a range of installation types	Information logged during course of project management

Table 2. Eversource Geothermal Network Monitoring Topic Areas

Topic Area	Data Points to Collect
Validate Installation and Costs	System installation costs Ongoing O&M costs
Customer Acceptance	Customer Satisfaction surveys Customer comfort
Carbon Reductions	Emissions reductions

	System Performance
Technology Performance	System Performance Changes in customer energy consumption
Cost Savings	Changes in customer heating and cooling costs