The Importance of Monitoring in Commercial GSHP Systems

Speaker:

Connor Dacquay / *GeoFease*

THE IMPORTANCE OF MONITORING
COMMERCIAL GSHP SYSTEMS

CONNOR DACQUAY Dr. Eng, PE, CGD

1-204-996-8133

cmdacquay@ecofease.com

OUTLINE

01 Background

02 Problem

03 Overview of Monitoring Systems

04 Key Metrics to Monitor

05 Key Features for Monitoring System

06 Case Studies

LEARNING OBJECTIVES

01 Learn how to measure a Btu

02 Learn a communication protocol for sending and receiving data

03 Understand differences between an integrated and fragmented system

04 Understand key features for monitoring systems

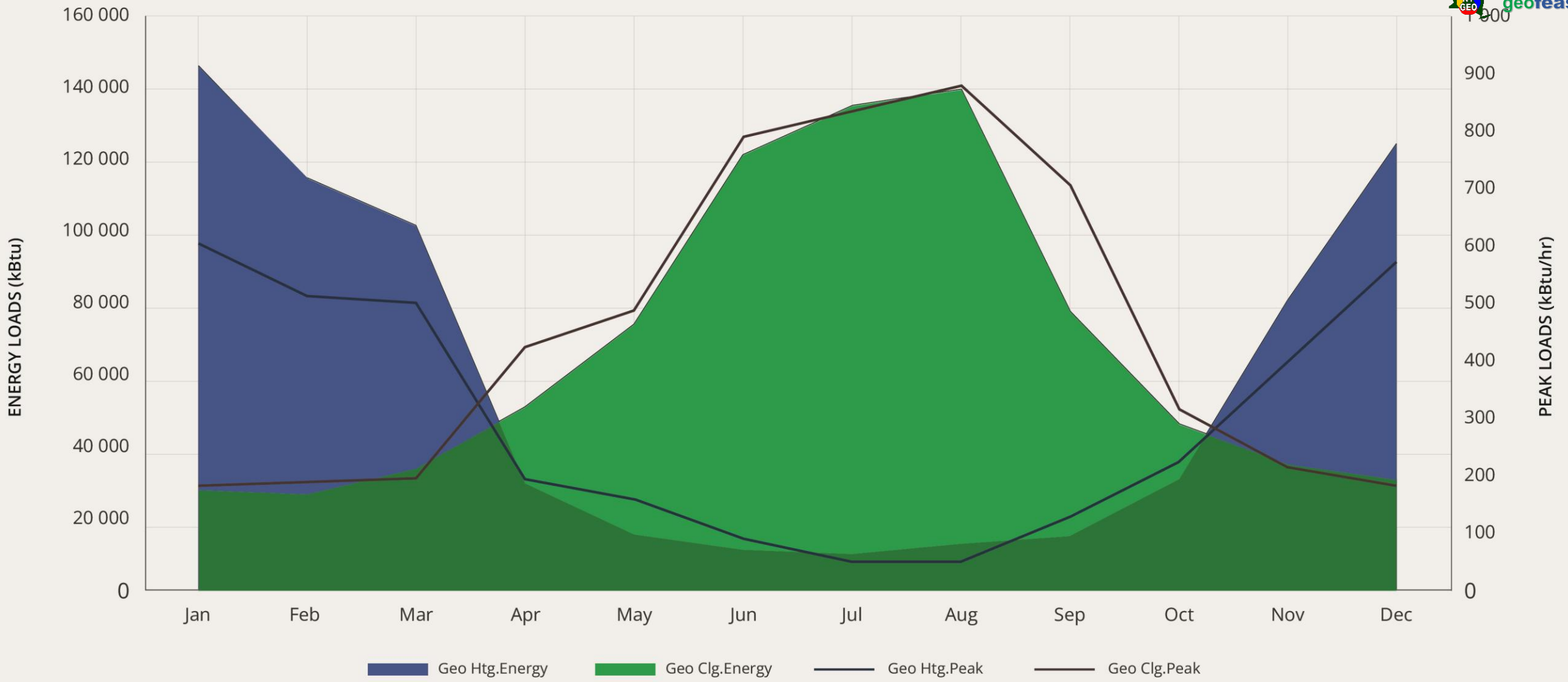
BACKGROUND

Colleagues and myself come from a background in commercial GSHP consulting

Through many forensic studies, we've seen repeated problems

MAIN PROBLEM

A significant number of commercial GSHP systems have encountered issues, and an even greater percentage are not operating at peak efficiency.



UNDERLYING PROBLEM #1

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 0.87 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

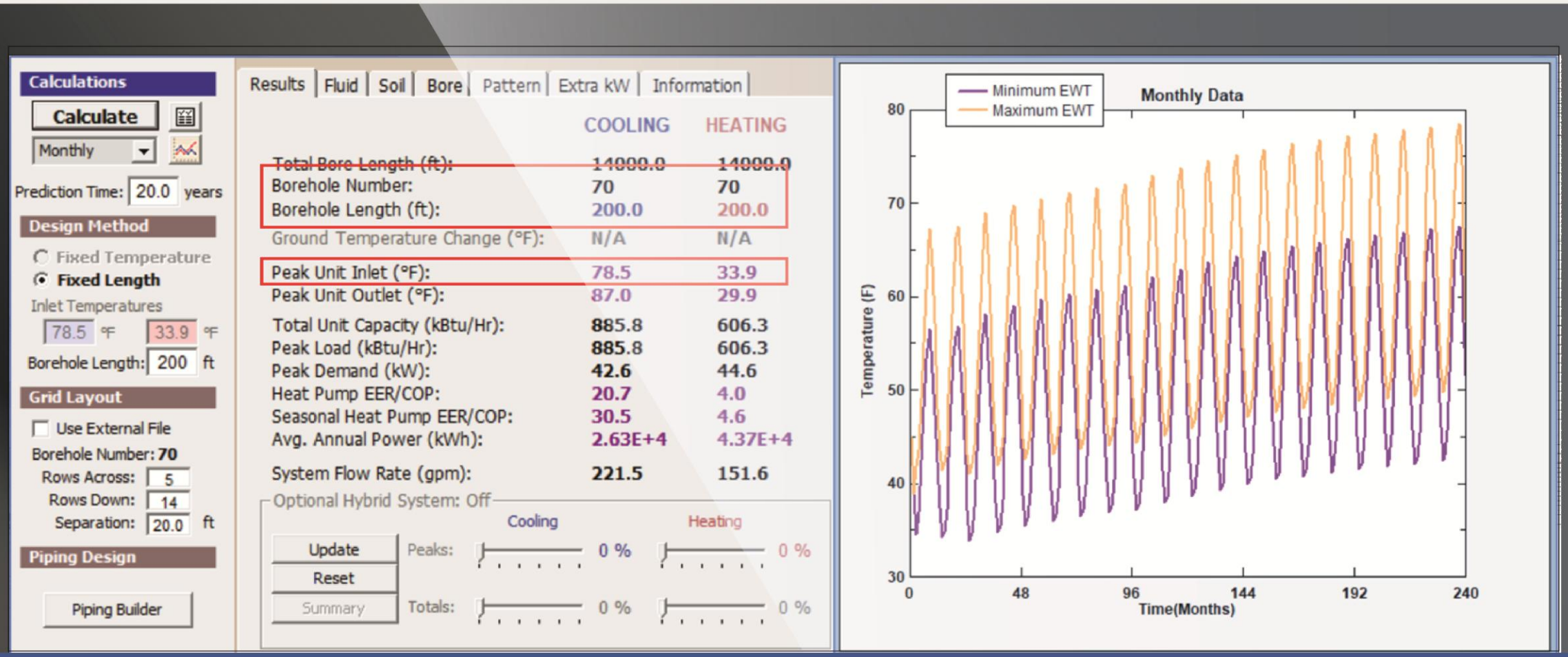
Formation Thermal Diffusivity ≈ 0.58 ft²/day

The undisturbed formation temperature was measured by lowering a temperature probe into the water filled U-bend prior to the start of the test.

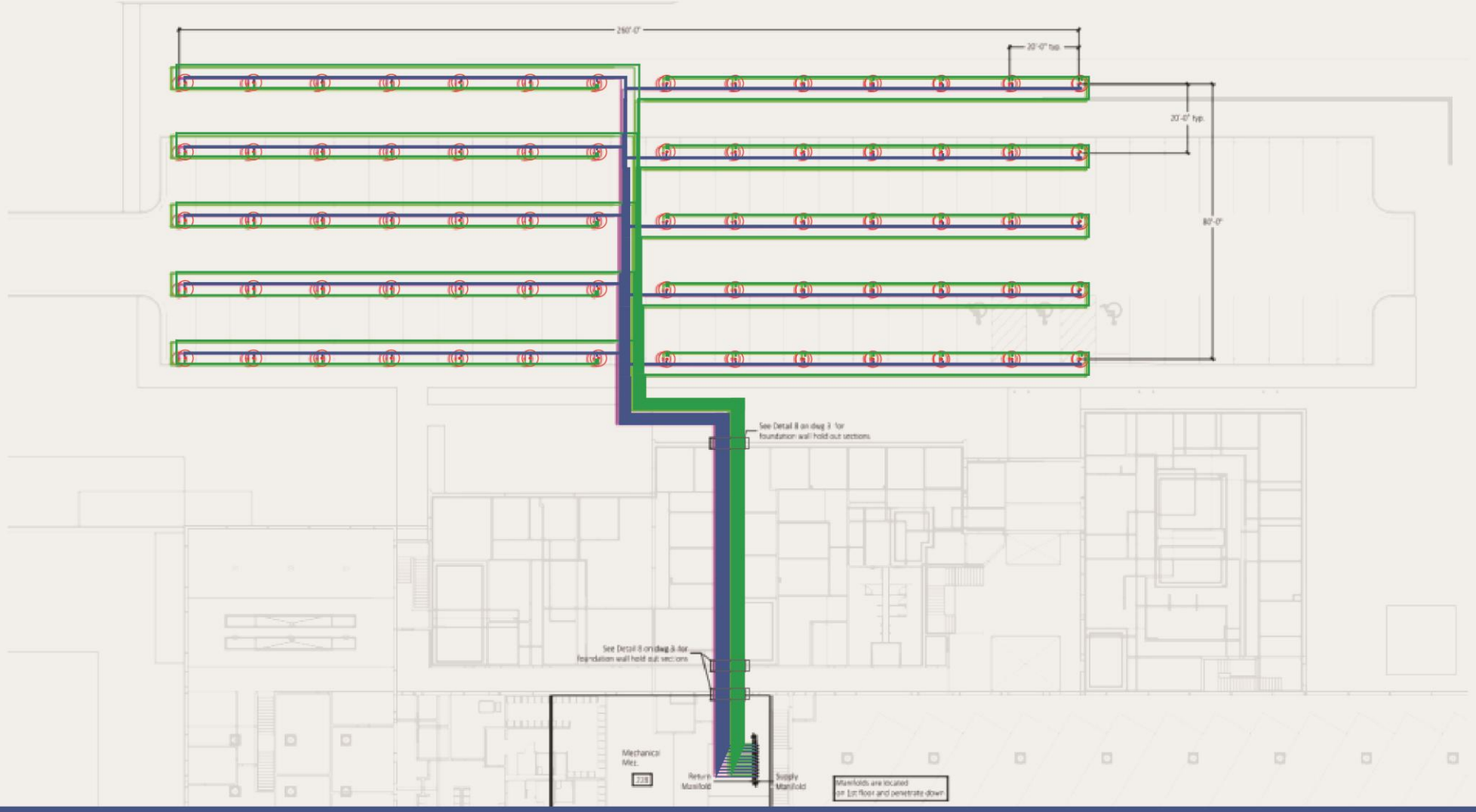
Undisturbed Formation Temperature = 46.5-47.3°F, 46.8°F average

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length.

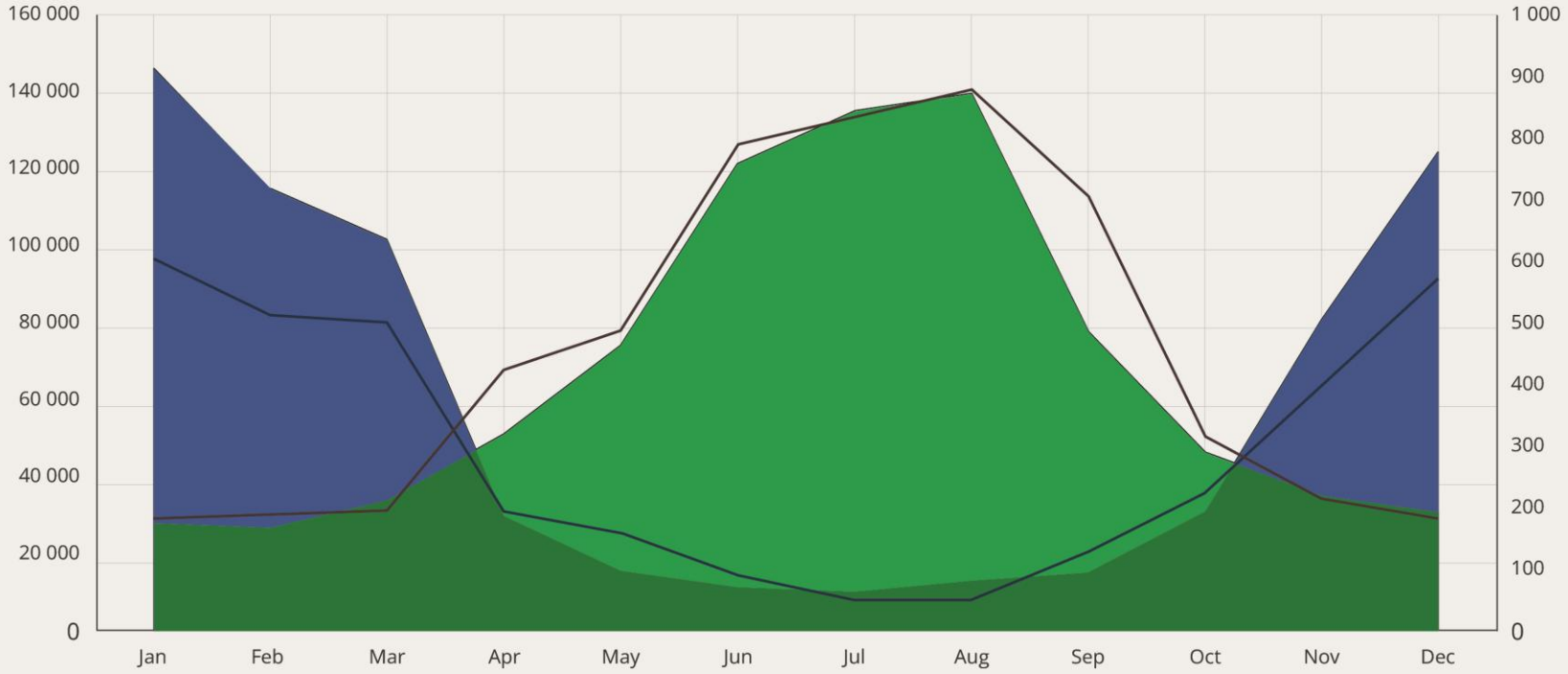
UNDERLYING PROBLEM #1



UNDERLYING PROBLEM #1



UNDERLYING PROBLEM #1



Static models used for dynamic systems

01

Lack of engineering feedback with GSHP designs

02

UNDERLYING PROBLEM #1

UNDERLYING PROBLEM #2

Lack of communication between mechanical engineer and controls contractor during commissioning

UNDERLYING PROBLEM #3

01 Insufficient training for building operators

02 Lack of user-friendly management tools

03 Staff turnover causes critical knowledge gaps

SOLUTION

Use monitoring systems purpose built for engineers and building operators

OVERVIEW OF MONITORING SYSTEMS

01

Hardware

02

Communication interfaces

03

Data routing, collection and storage

04

Software

BTU METER

- Flow meter
- Temperature sensors

POWER METER

- Amperage
- Voltage

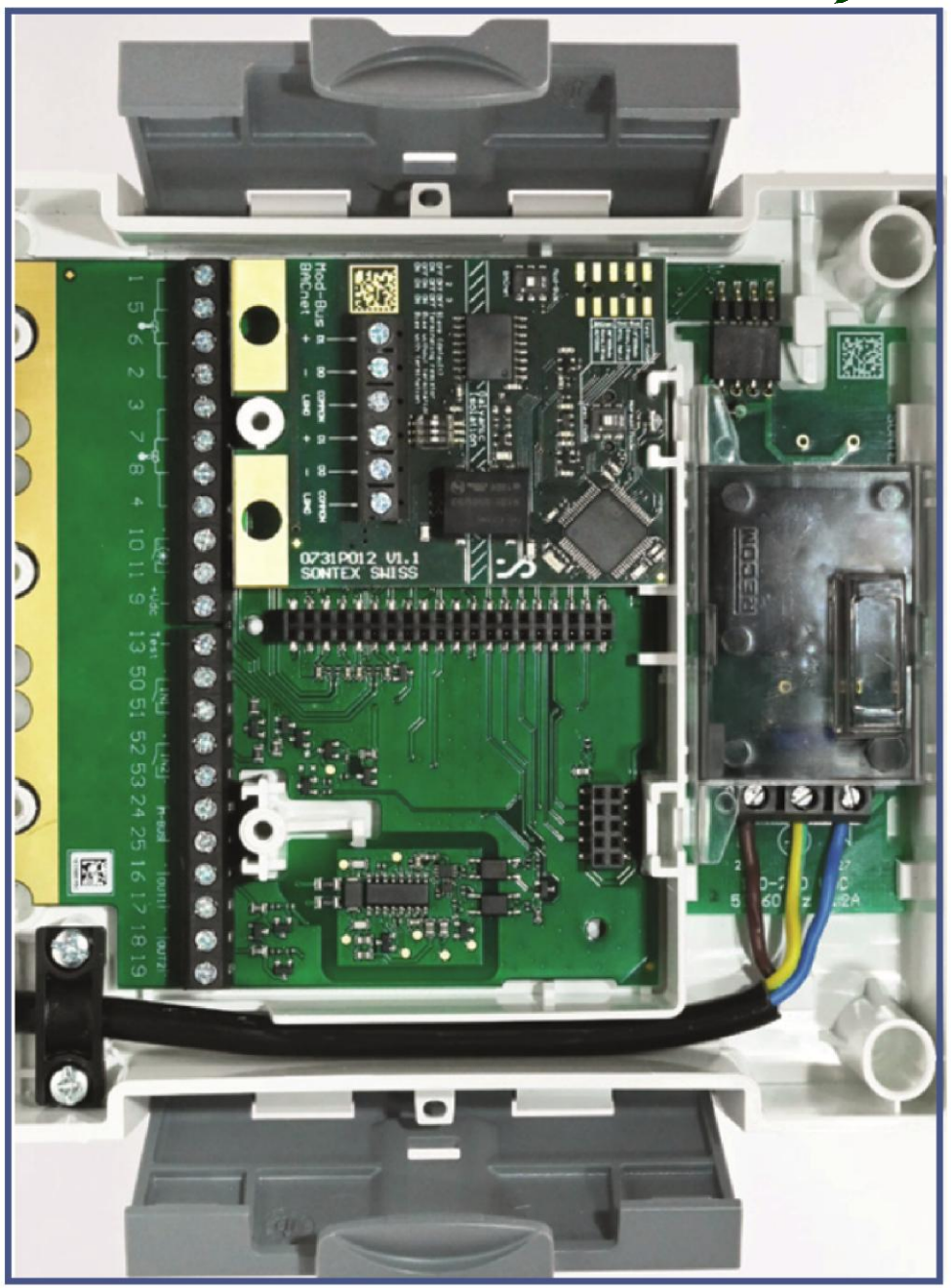
PRESSURE

- Water
- Refrigerant

01 HARDWARE

02 COMMUNICATION INTERFACES

- BACnet and MODBUS are communication protocols
- MS/TP is for BACnet and RTU is for MODBUS
- Ethernet, RS232, and RS485 are communication methods for physical connection
- Wi-Fi enabled for wireless communication method



DATA ROUTING 03

- REMOTE VS. LOCAL STORAGE
- BACKUP & INTERNET OUTAGES
- STORAGE CAPACITY
- FREQUENCY OF DATA COLLECTION

04 SOFTWARE

DATA ORGANIZATION & ANALYSIS

GRAPHICAL INTERPRETATION

REPORTING & NOTIFICATIONS

KEY METRICS TO MONITOR

Ground heat exchanger

01

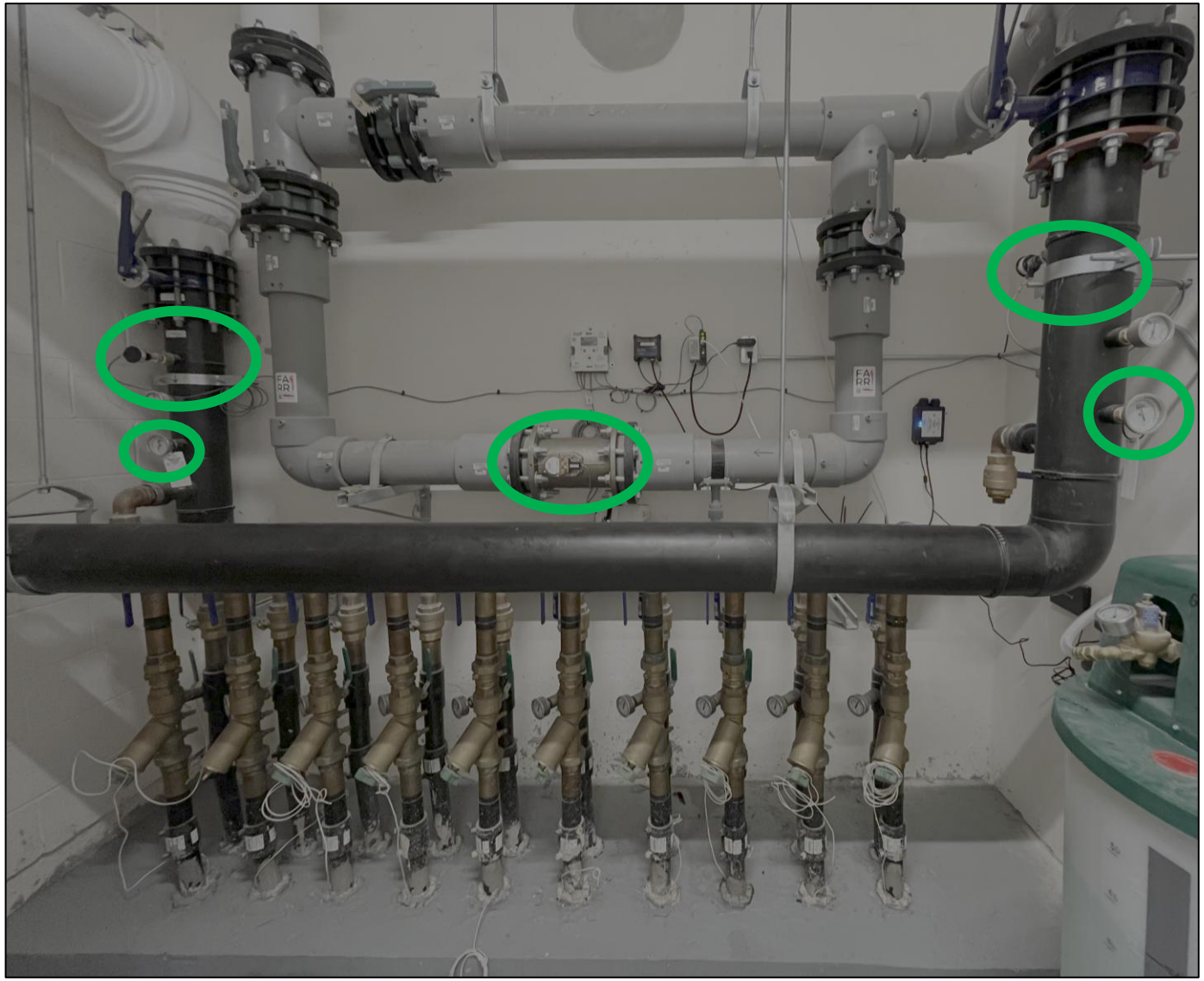
Energy sources

02

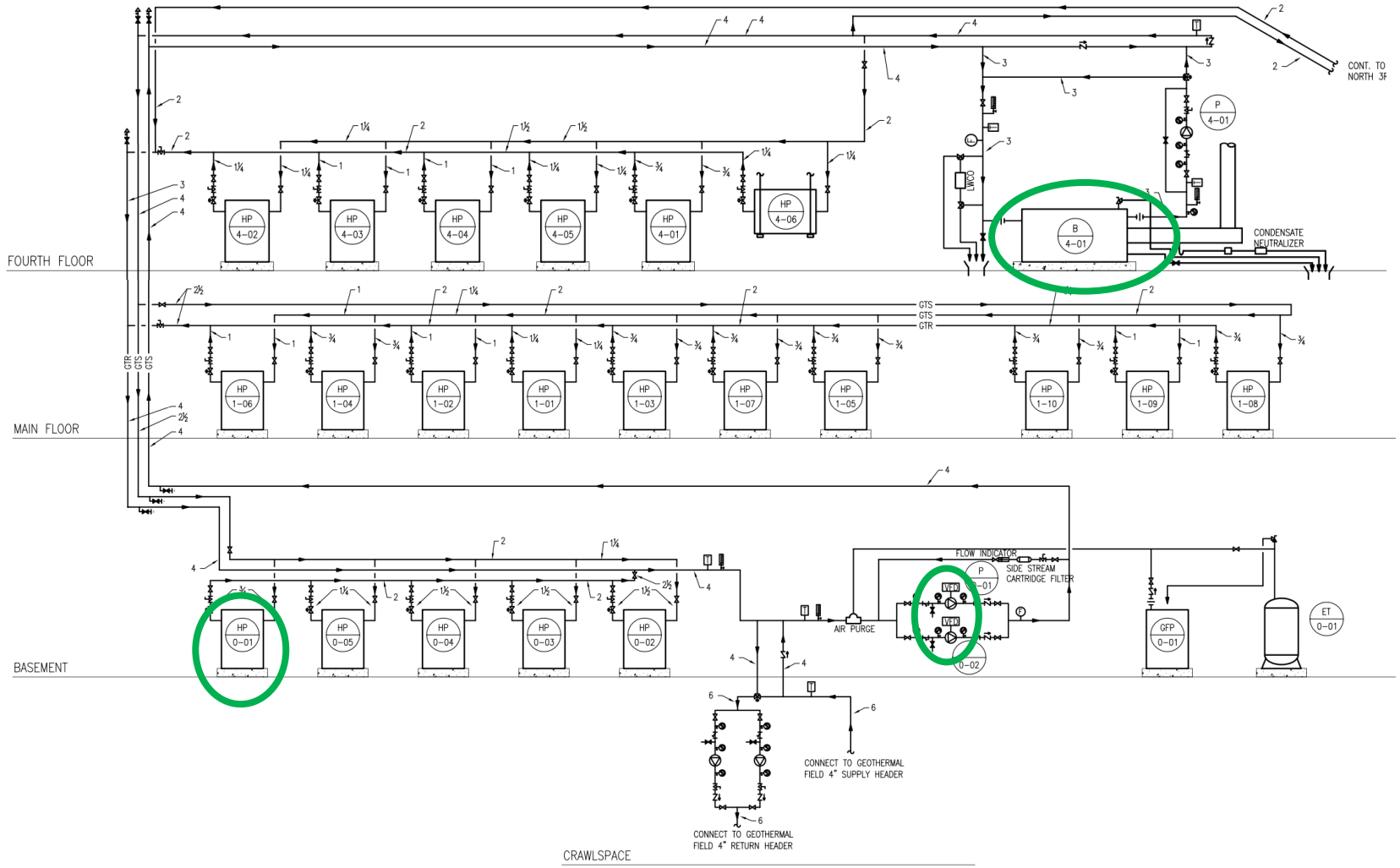
Mechanical equipment

03

GROUND HEAT EXCHANGER

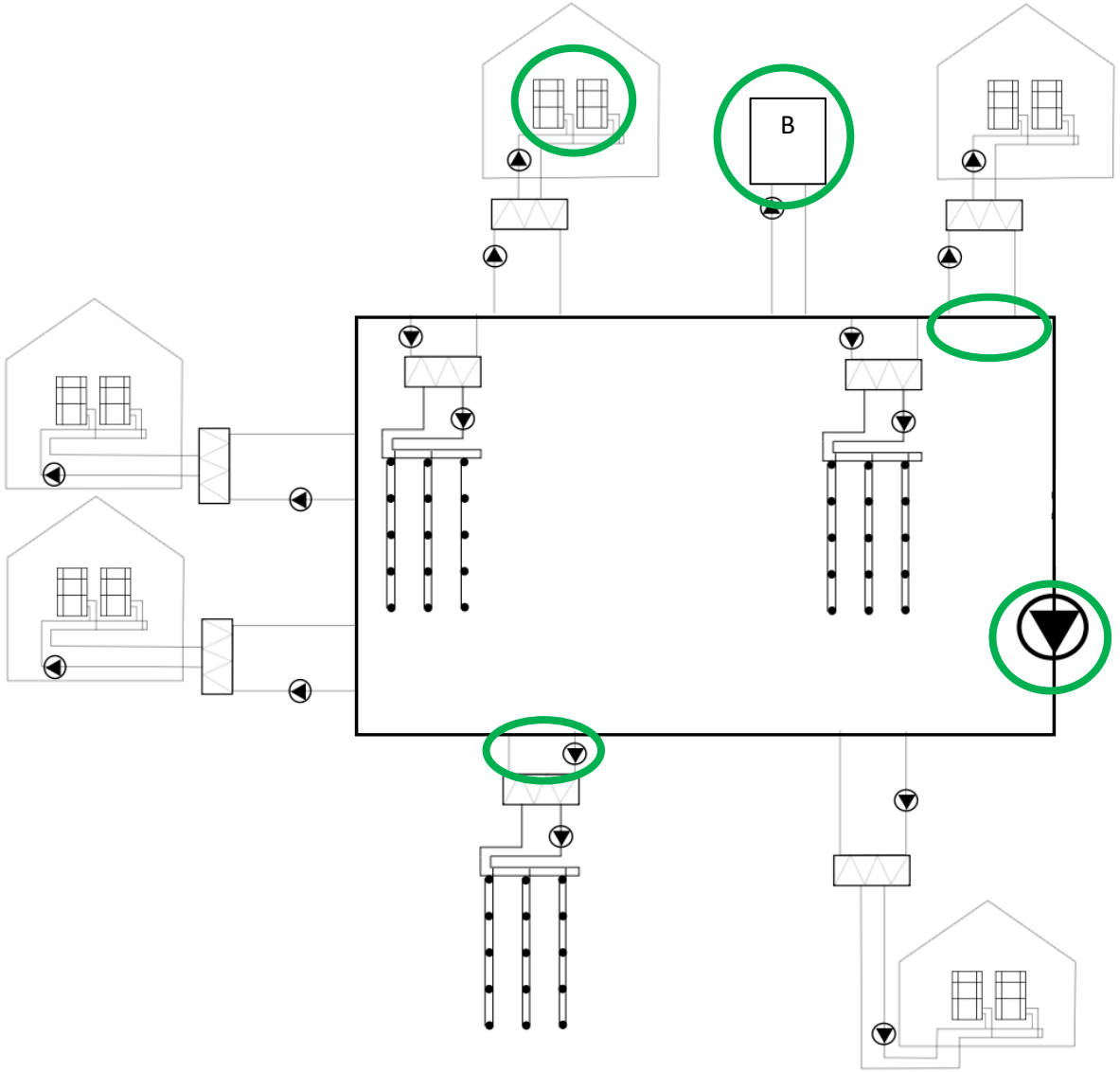


MECHANICAL EQUIPMENT



1 M4.8AB GEOTHERMAL PIPING SCHEMATIC
SCALE: NTS

DISTRICT ENERGY SYSTEMS



OUT OF THE WOODS?

01

Manual processes are inefficient, error-prone, and not scalable

02

Fragmented systems reduce data visibility and hinder accountability

03

Insufficient data storage limits long-term trend analysis and insights

PROBLEM WITH CONVENTIONAL TOOLS

Ground Source Heat Pumps (GSHPs) represent just 2% of the HVAC market

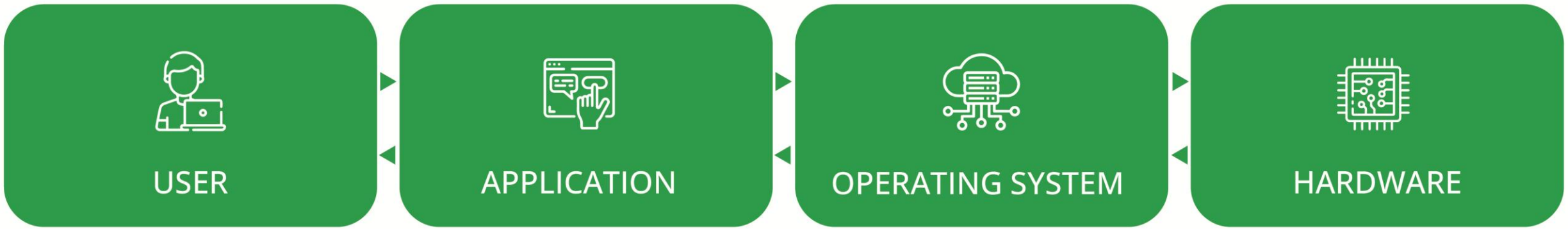
Current monitoring solutions are not scalable for widespread adoption

Scalable growth requires automated, user-friendly solutions

PROBLEM WITH CONVENTIONAL TOOLS

FRAGMENTED SOLUTIONS LIMIT:

- Data accessibility
- Performance accountability
- Design and performance feedback

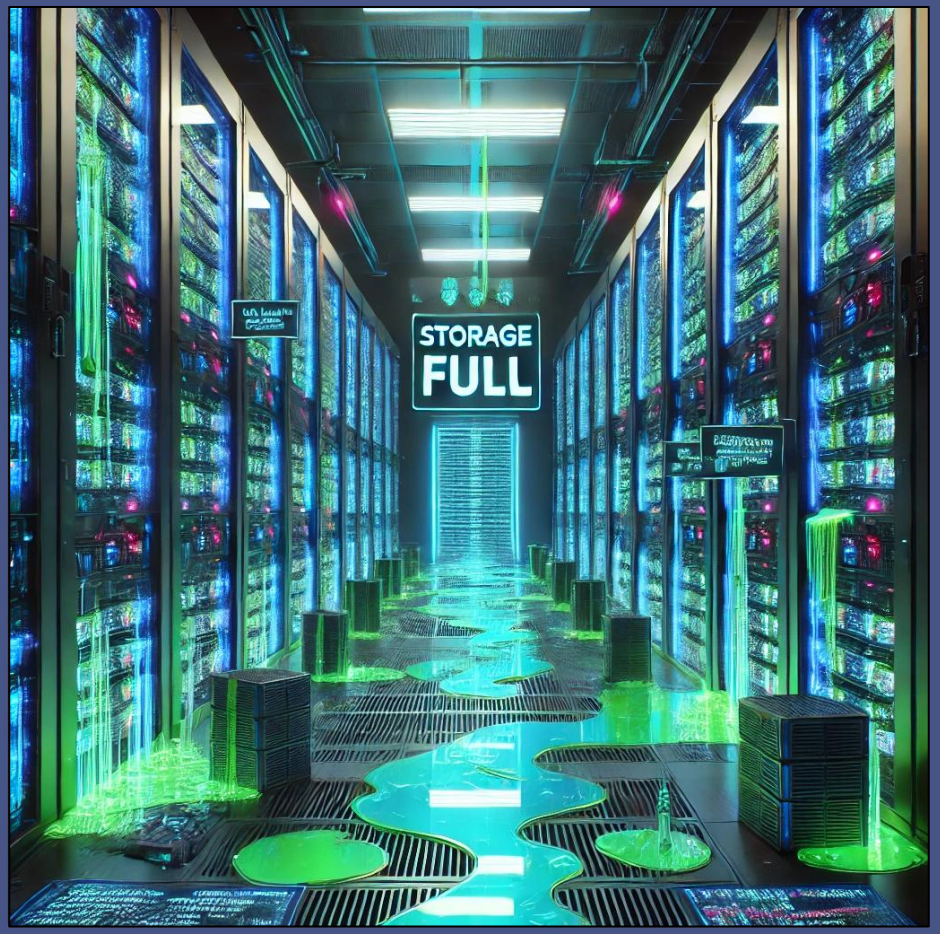


PROBLEM WITH CONVENTIONAL TOOLS

LIMITED STORAGE PREVENTS LONG-TERM ANALYSIS

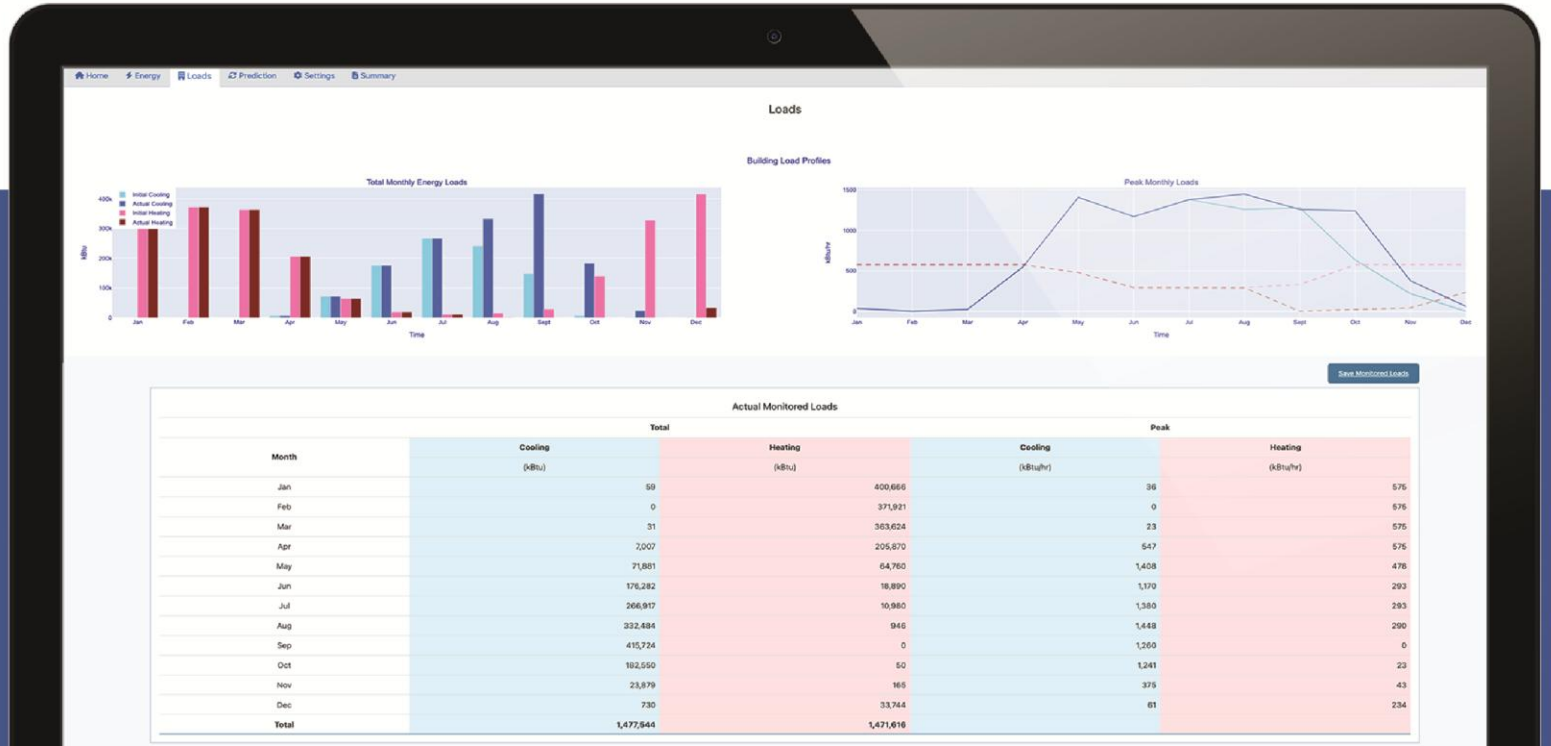
TYPICAL SYSTEMS ONLY RETAIN 2 MONTHS OF DATA

NO HISTORICAL DATA HINDERS PERFORMANCE OPTIMIZATION



KEY FEATURES FOR MONITORING SYSTEMS

Easy to use dashboards and apps	Automated notifications & reporting	Building operator manual and training



Month	Total Cooling (kBtu)	Total Heating (kBtu)	Peak Cooling (kBtu/hr)	Peak Heating (kBtu/hr)
Jan	59	400,666	36	575
Feb	0	371,921	0	575
Mar	31	363,624	23	575
Apr	7,007	205,870	547	575
May	71,881	64,760	1,408	478
Jun	176,282	18,890	1,170	293
Jul	266,917	10,980	1,380	293
Aug	332,484	946	1,448	290
Sep	415,724	0	1,260	0
Oct	182,550	50	1,241	23
Nov	23,879	165	375	43
Dec	730	33,744	61	234
Total	1,477,644	1,471,616		

DASHBOARDS

Time-based insights across
DAYS / WEEKS / MONTHS / YEARS

Intuitive interface designed for building managers

Actionable feedback tailored for designers and engineers

AUTOMATED NOTIFICATIONS & REPORTING

Automation is essential for scaling the GSHP industry

Provides actionable suggestions for efficiency improvements

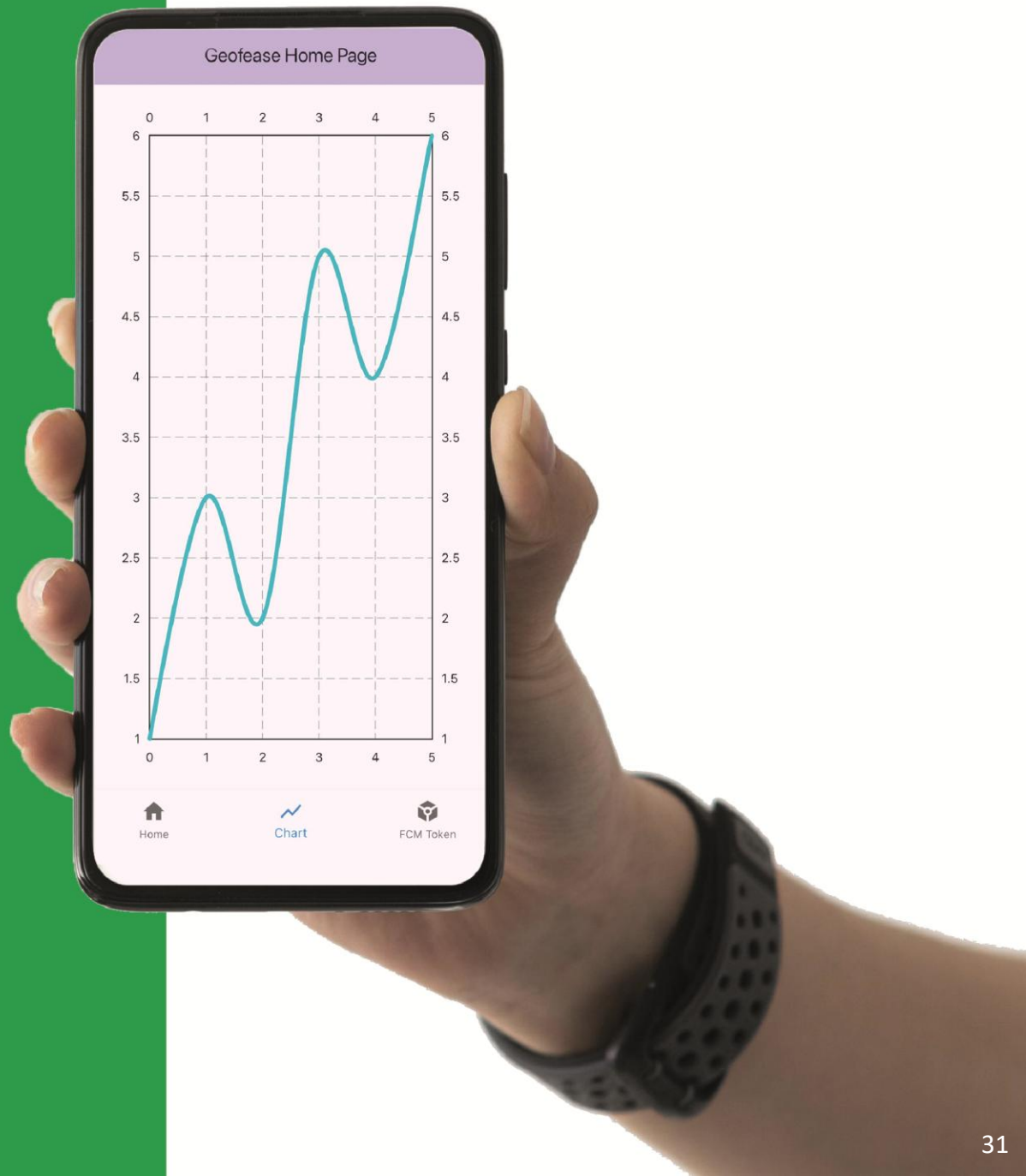
Includes setup notifications—distinct from daily BMS alerts

BUILDING OPERATOR MANUAL

01 Typical GHX operating temperatures and flow rates

02 Standard pump operation parameters for GHX systems

03 Backup equipment setpoints and expected run times



QUESTION & ANSWER CHECKPOINT

CASE STUDIES

01 CONDOS IN TORONTO, ON

02 SENIOR'S HOME IN NORTHERN ON

03 OFFICE IN WINNIPEG, MB

04 APARTMENTS IN ALBANY, NY

05 APARTMENTS IN CORINTH, NY

CONDOS IN TORONTO, ON

40 bores @
600 ft

01

Water-to-air heat pumps
in suites

02

Natural gas boiler for
DHW heating

03

"I switched the boiler to do the heating instead of the geothermal so it will work better"

SENIOR'S HOME IN NORTHERN ON

01 32 bores @ 500 ft

02 Water source VRF heat pumps

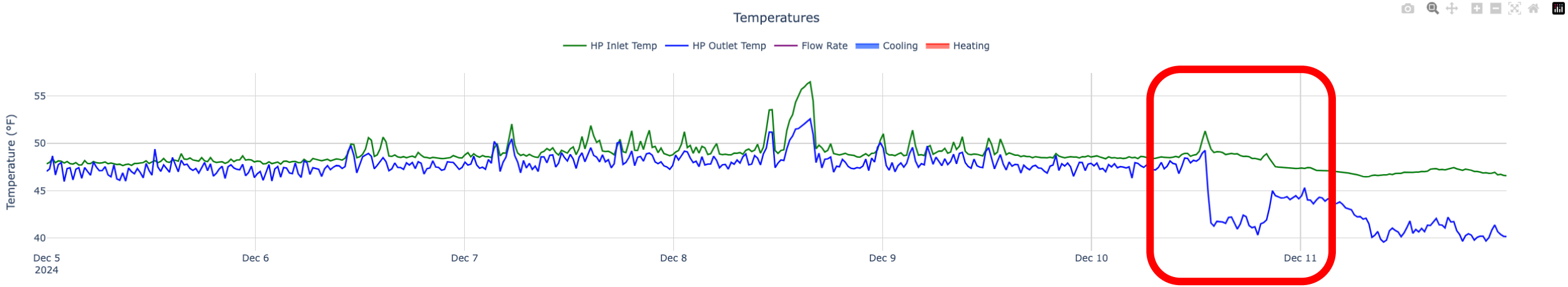
03 Electric boiler for back-up heating

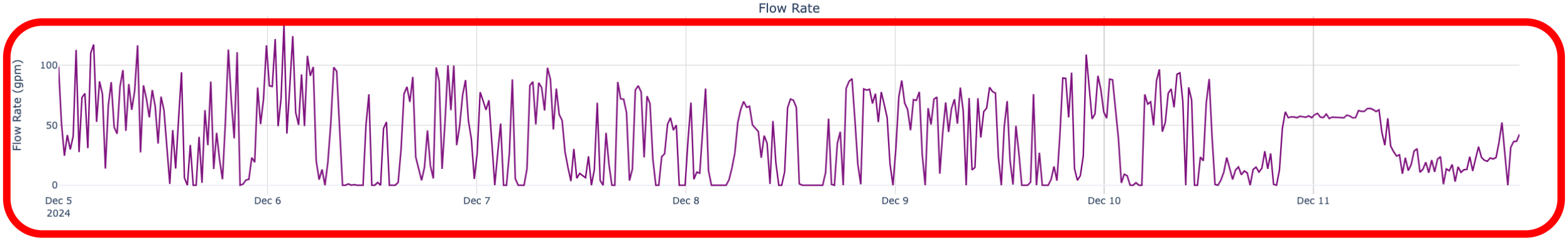
Home | Energy | Loads | Prediction | Controls | Settings | Summary

Energy

< December 11 2024 > Go

Day | Week | Month | Quarter | Year | Lifetime





Vertical ground heat exchanger

Water-to-air heat pumps

Electric baseboard heaters for back-up

OFFICE IN WINNIPEG, MB

Home | Energy | Loads | Settings | Summary

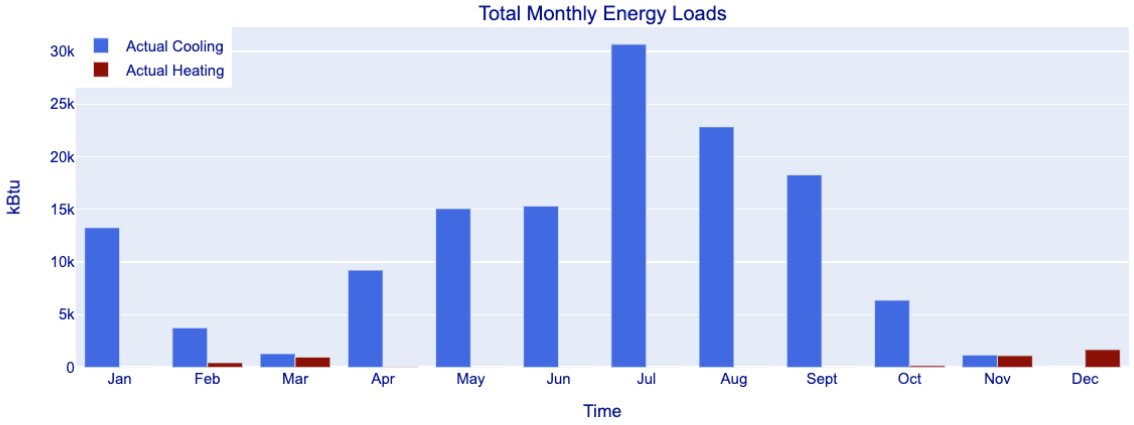
Energy

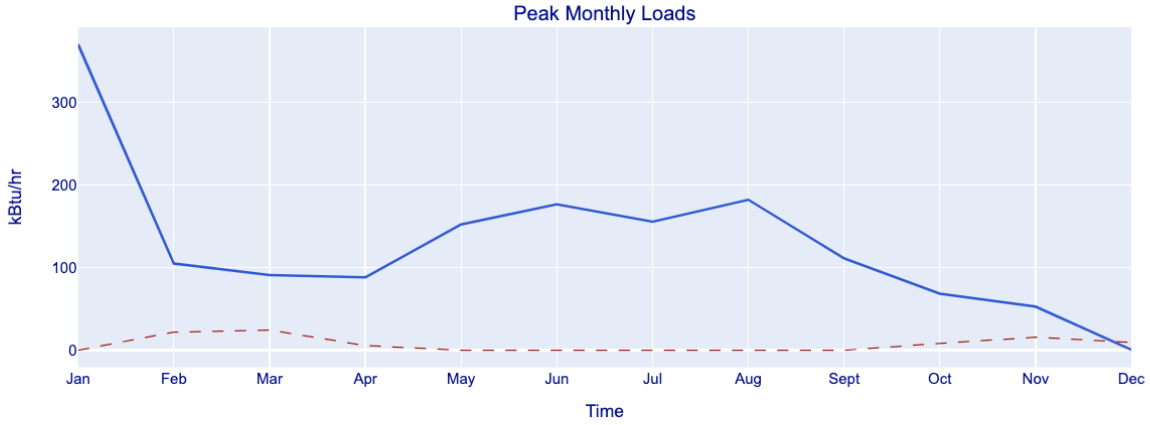
< February 14 2025 > Go

Day | Week | Month | Quarter | Year | Lifetime

Loads

Building Load Profiles





Actual Monitored Loads

Month	Total		Peak	
	Cooling (kBtu)	Heating (kBtu)	Cooling (kBtu/hr)	Heating (kBtu/hr)
Jan	13,260	0	371	0
Feb	3,748	436	105	22
Mar	1,292	968	91	24
Apr	9,229	56	88	6
May	15,068	0	152	0
Jun	15,316	0	177	0
Jul	30,674	0	156	0
Aug	22,835	0	182	0
Sep	18,272	0	111	0
Oct	6,369	161	68	8
Nov	1,168	1,110	53	16
Dec	2	1,680	1	10
Total	**137,233**	**4,411**		

APARTMENTS IN ALBANY, NY

01 32 bores @ 500 ft

02 Water-to-air heat pumps in suites

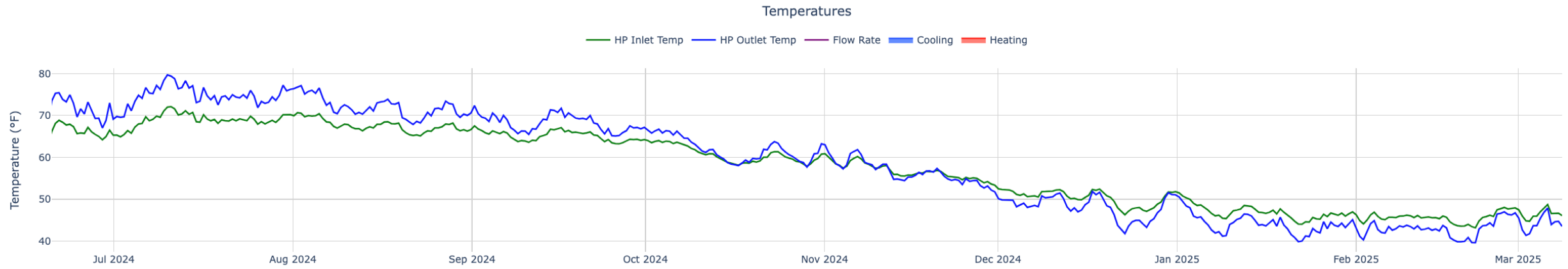
03 CO2 heat pump for DHW heating

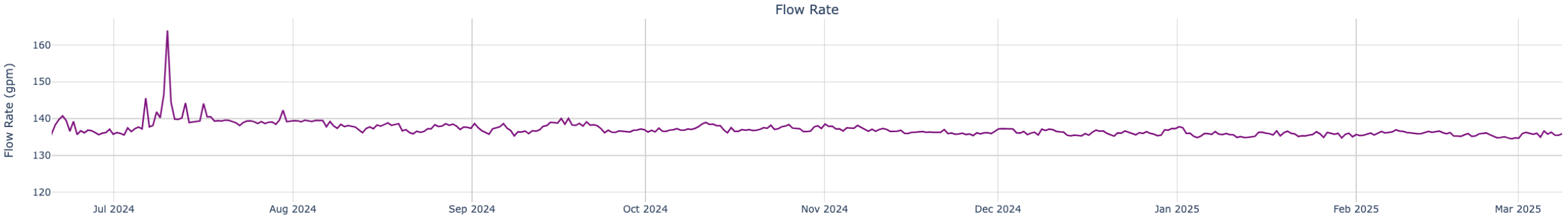
Home | Energy | Loads | Prediction | Settings | Summary

Energy

< March 9 2025 > Go

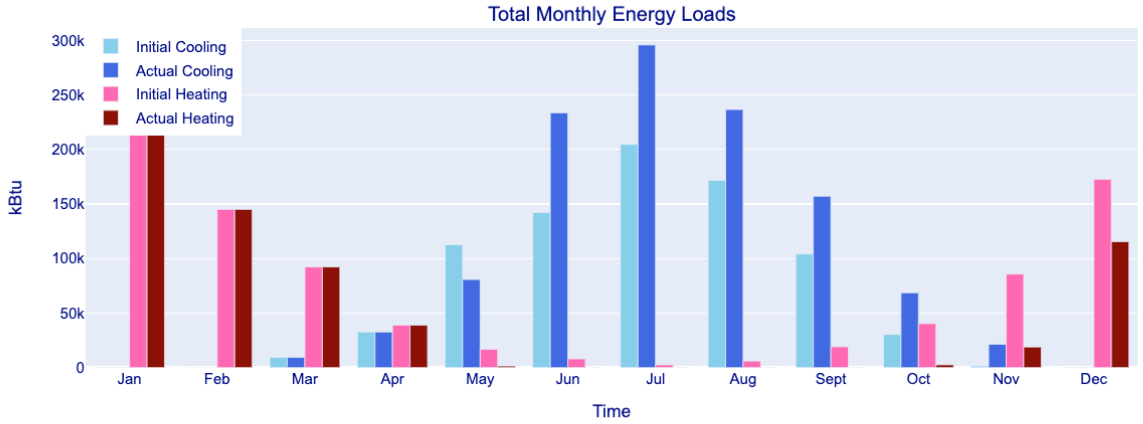
Day | Week | Month | Quarter | Year | Lifetime

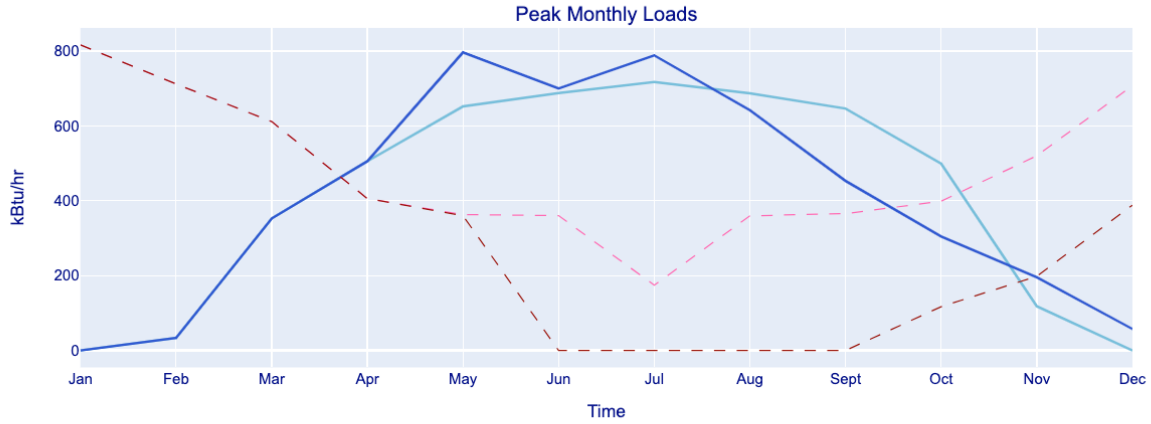


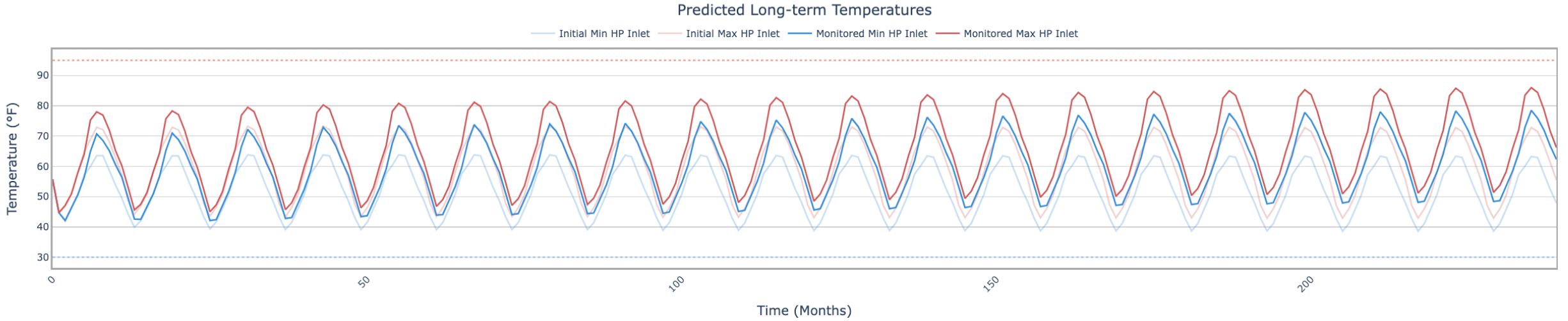


Loads

Building Load Profiles







APARTMENTS IN CORINTH, NY

28 bores @
500 ft

01

Water-to-air heat pumps
in suites

02

CO2 heat pump for
DHW heating

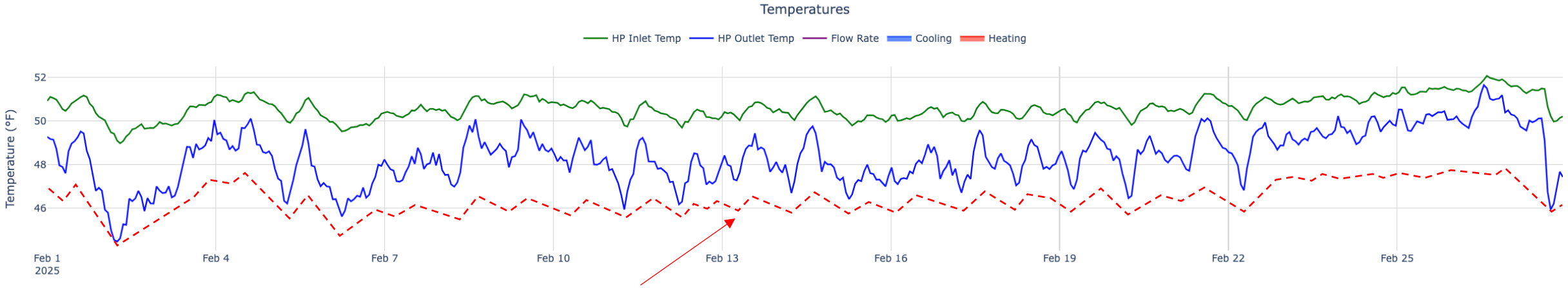
03

Home | Energy | Loads | Prediction | Settings | Summary

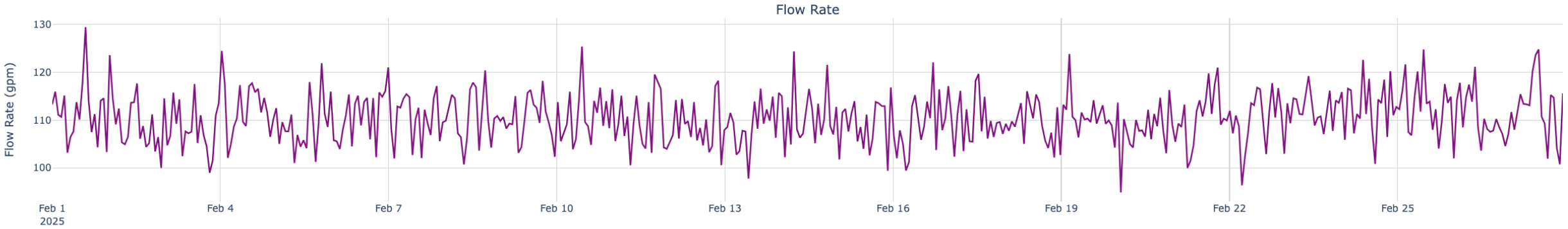
Energy

< February 2025 > Go

Day | Week | Month | Quarter | Year | Lifetime



Reduced flow rate to achieve 4 – 5°F ΔT



LEARNING OBJECTIVES

01 What are the two types of sensors needed to measure Btu's?

02 Name one communication protocol?

03 What is the difference between a fragmented and integrated system?

04 Name one key feature of a monitoring system

THANK YOU!

CONNOR DACQUAY Dr. Eng, PE, CGD

1-204-996-8133

cmdacquay@ecofease.com