NY-GEO 2024

APRIL 8-9 | ALBANY NY

Incorporating Geothermal Domestic Hot Water in a Multifamily Building

Presenters: Jens Ponikau, AI, CGD / Buffalo Geothermal
Johannes Rosemann / Buffalo Geothermal

DESIGN TRACK - CEU CREDIT ELIGIBLE - 4:00 PM

Incorporating Geothermal Domestic Hot Water in a Multifamily Building

Jens Ponikau CGD

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Principal, Buffalo Geothermal LLC

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Vice President of Operations

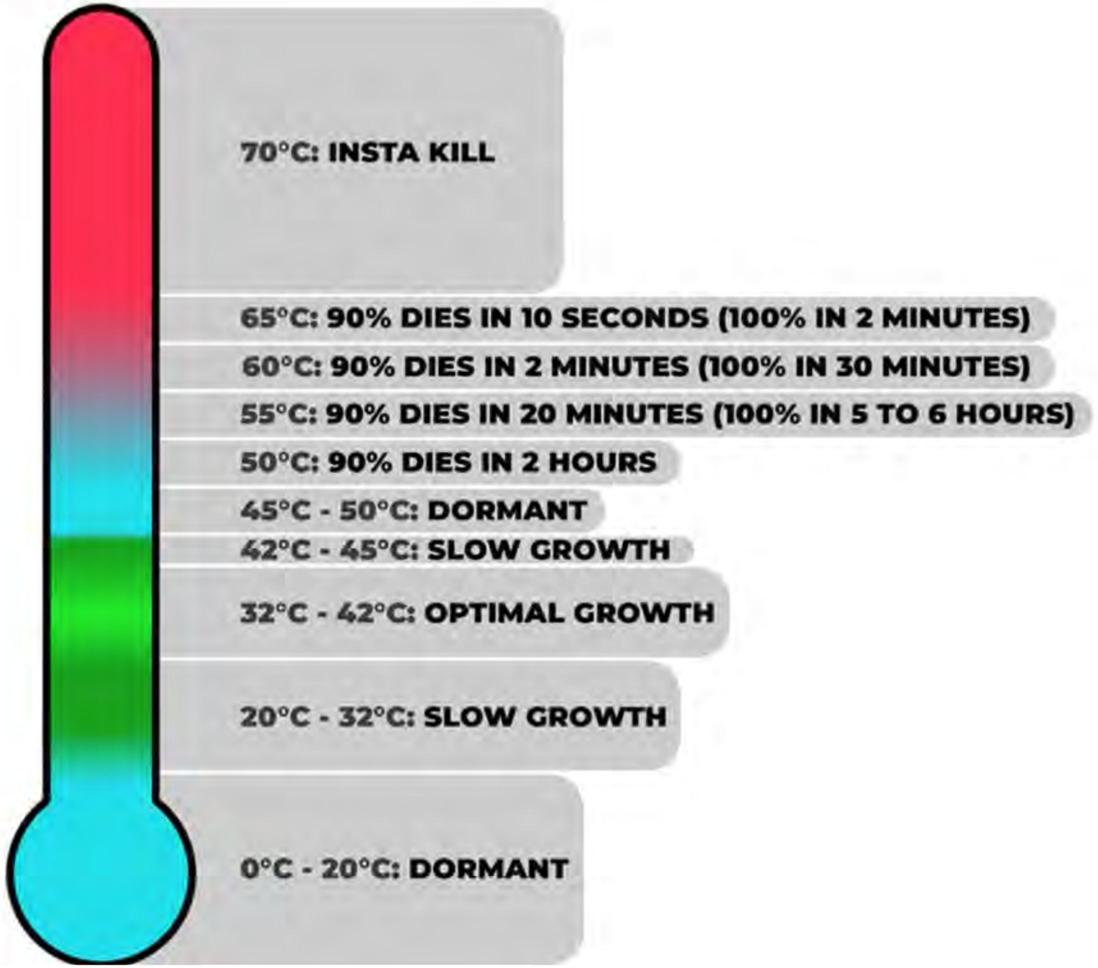
Mechatronics Engineer

Buffalo Geothermal LLC

Legionella

So What Temperature Should Water Be Stored At?

When it comes to water store temperature, here are the facts.



Guidance – Not Code! Not Required!

Growth Conditions - Temperature

Effect	Source 1	Source 2	Source 3	Source 4
Growth Range	77°F - 113°F	68°F - 122°F		
Ideal Growth Range	90°F - 108°F	95°F - 115°F	77°F - 108°F	77°F - 115°F
Survives but does not grow	118°F - 122°F	>122°F		>122°F
90% Kill Rate	122°F in 18 - 124 min	122°F in 120 min		
	140°F in 2 min	140°F in 2 min		
LDB dies almost immediately	158°F	158°F	160°F - 170°F	
Dormant	< 68°F	< 68°F		

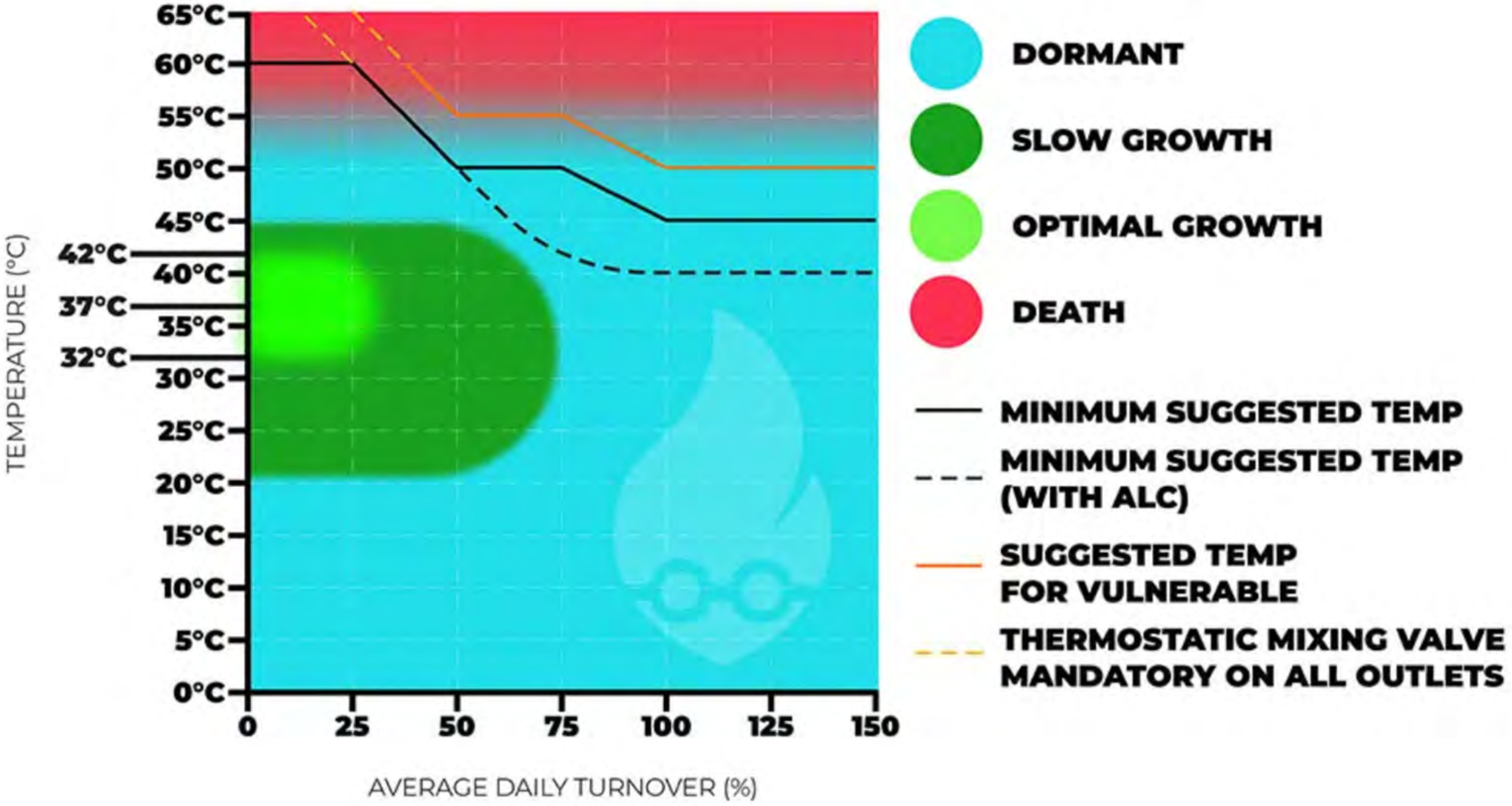
Source 1: Legionella and the prevention of legionellosis, WHO 2007

Source 2: OSHA Technical Manual, Section III, Chapter 7

Source 3: ASHRAE Guideline 12-2000

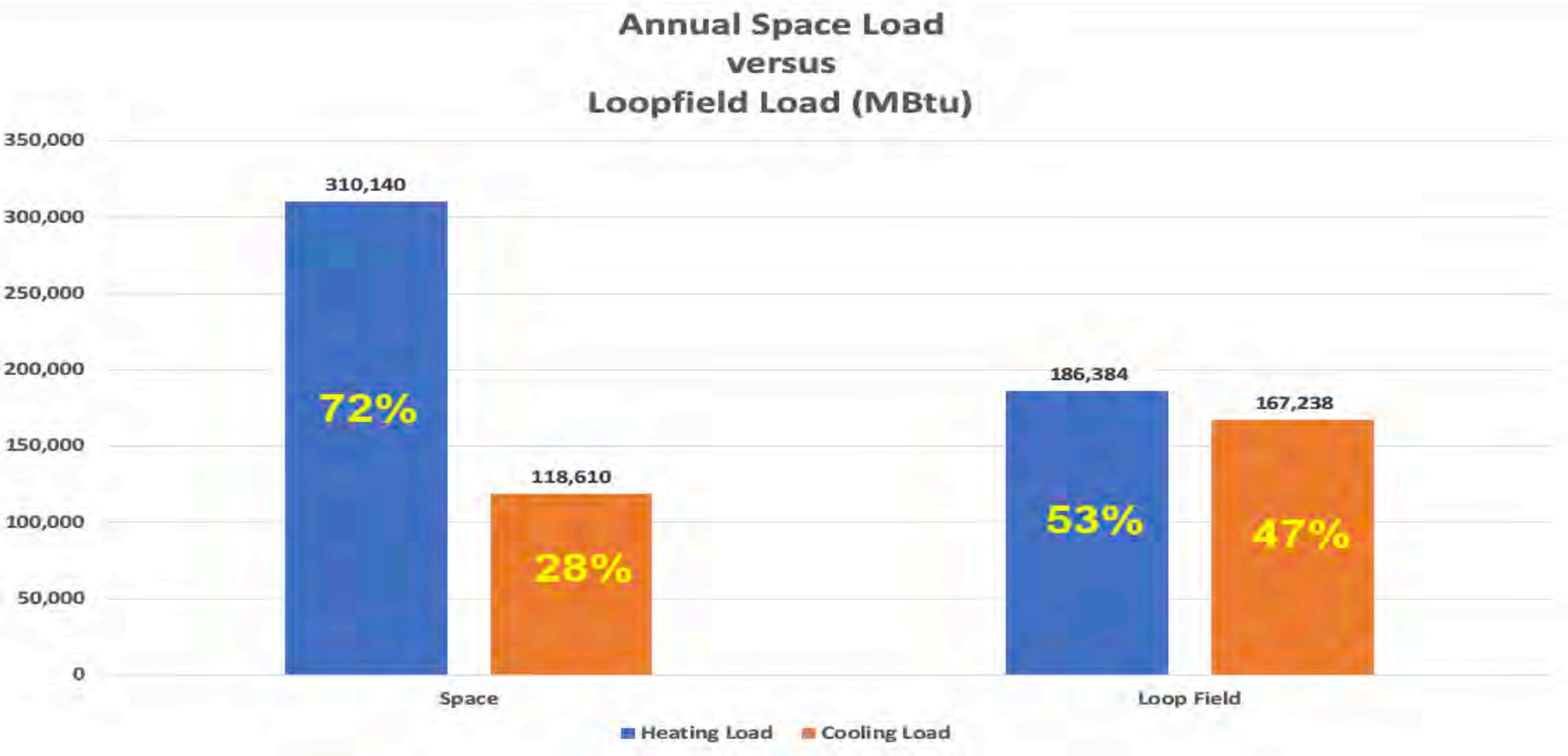
Source 4: Attachment III, Hospital-associated Legionellosis, NYSDOH 2005

Legionella growth and amount: Function of temperature and water usuage



Loop Field Performance

Space Load versus Loop Field Load

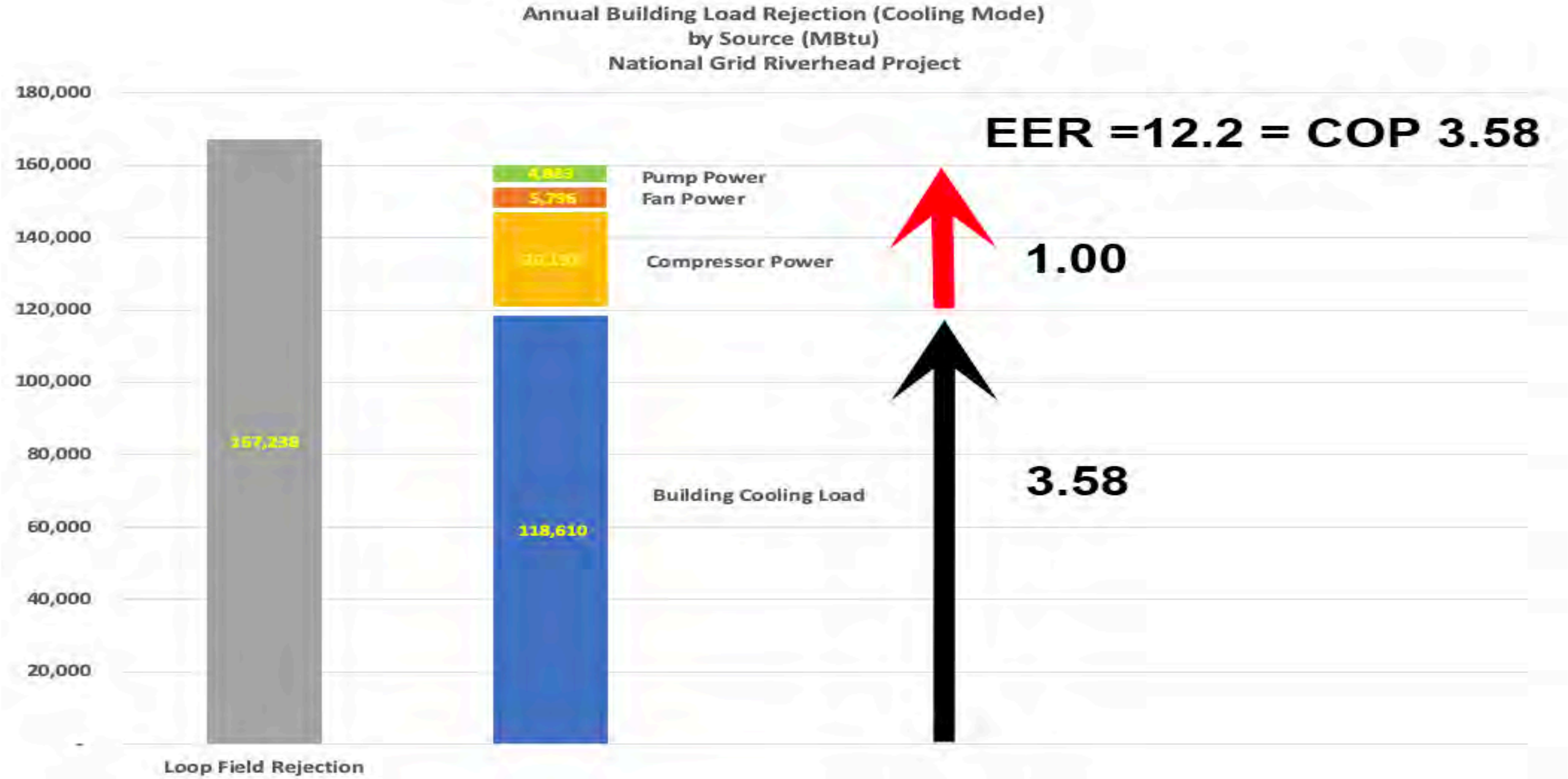


Source of Heat Delivered

In Heating Operation

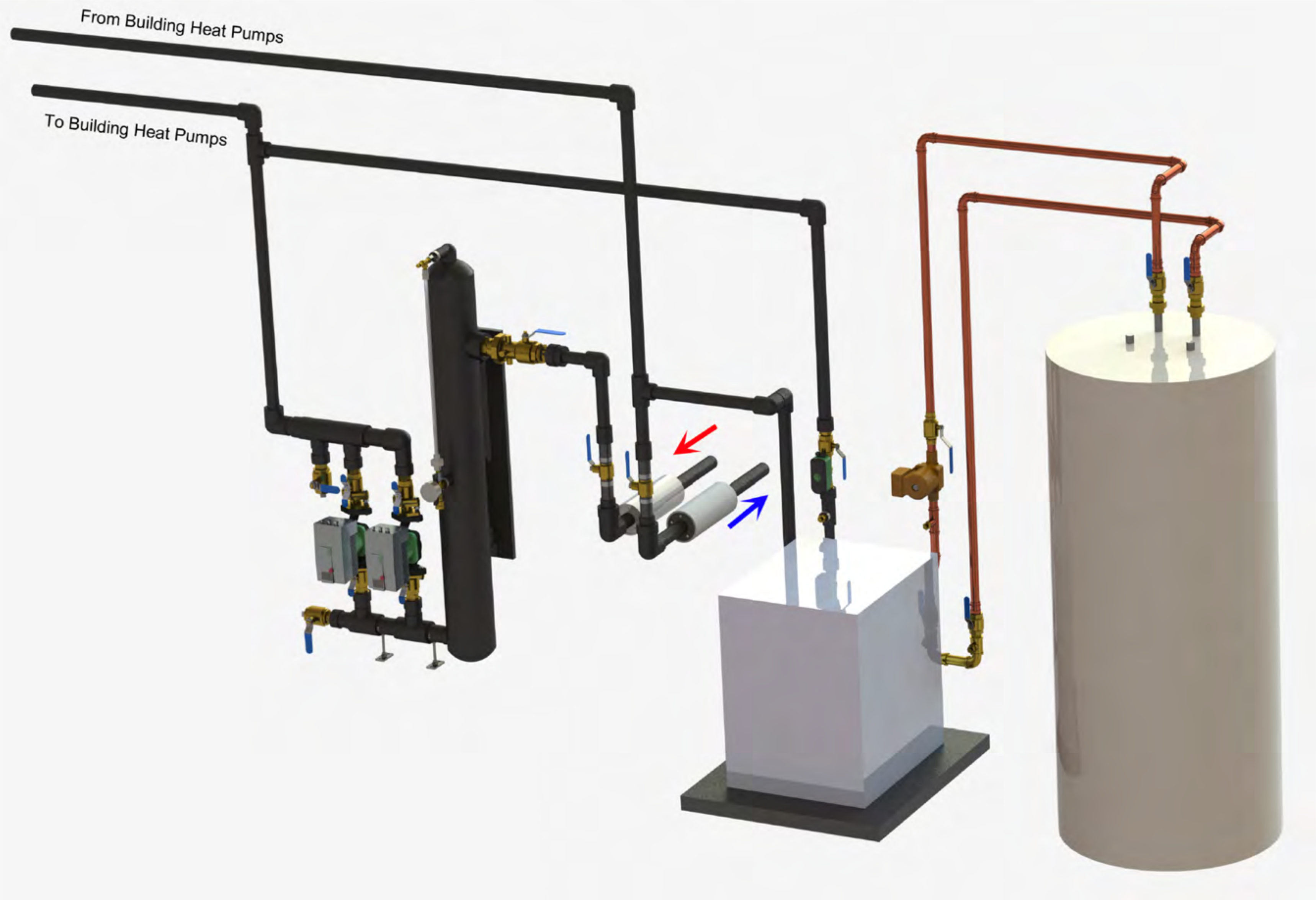
Source of Heat Rejected

In Cooling Operation (simplified)



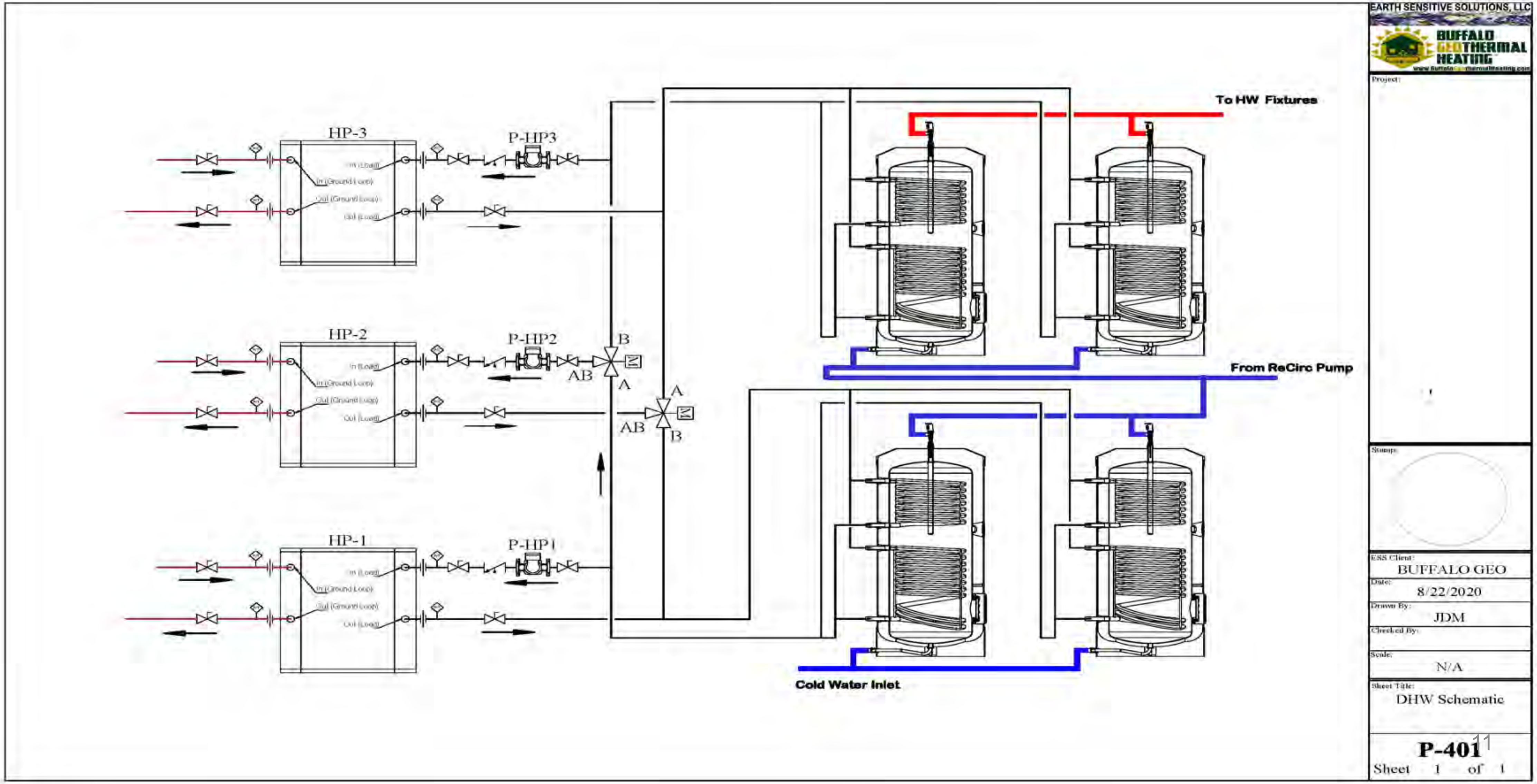
Lockport Housing Authority Autumn Garden Complex

8 Apartment Lockport Housing DHW Design

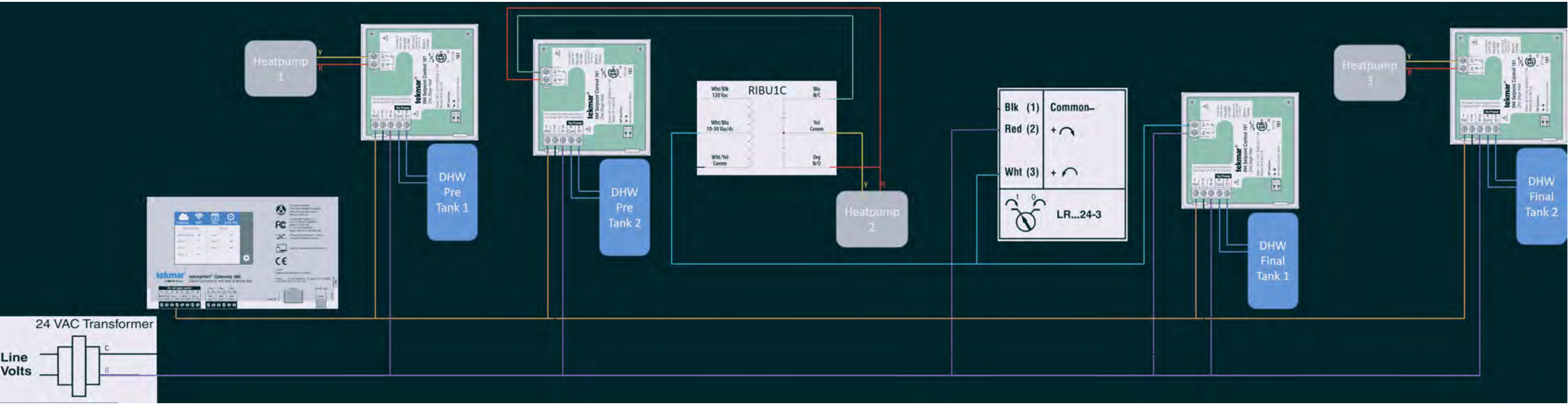


Zero Emission - PIERCE ARROW BUILDING BUFFALO NY

DHW design Pierce Arrow Building
120 Apartments, 1 Restaurant



Control Design DHW Pierce Arrow, Buffalo NY



Geothermal DHW System
High Temperature Heat Pumps (front, +140 degree F) with Storage Tanks (background)
Pierce Arrow Building, Buffalo NY

NYCHA Jackson Houses

Waterfurnace NXW prototype

System

Status	Normal
Operation	Test Mode
Method	AquaStat

Current Setpoints

Control Temp (°F)	46.3
Mode	Heat

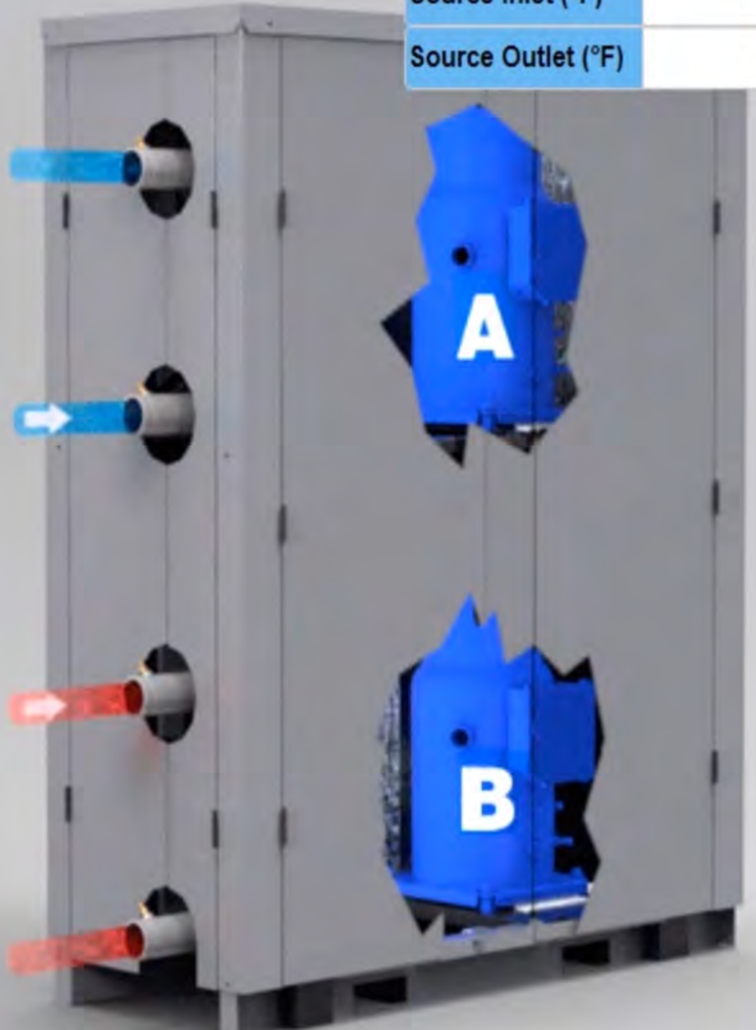
Current Temperatures

Load Inlet (°F)	46.3
Load Outlet (°F)	153.4
Source Inlet (°F)	30.7
Source Outlet (°F)	24.3

Chiller #1

Model

Serial



Circuit A

Status	Active
Operation	Normal

Refrigeration

Disch Press (psig)	473.6	Sat (°F)	129.8
Liquid Line (°F)	94.9	SC (°F)	-34.7
Suct Press (psig)	75.0	Sat (°F)	18.1
Suct Temp (°F)	28.0	SH (°F)	9.9

Electrical

Est Power (kW)	17.5
Comp Run Hrs	118.9

Circuit B

Status	Active
Operation	Normal

Refrigeration

Disch Press (psig)	438.5	Sat (°F)	123.9
Liquid Line (°F)	85.2	SC (°F)	-38.7
Suct Press (psig)	74.7	Sat (°F)	17.9
Suct Temp (°F)	26.8	SH (°F)	8.9

Electrical

Est Power (kW)	16.6
Comp Run Hrs	119.6

HydroLink2
AURORA

Waterfurnace NXW Prototype 410a

Refrigeration

Disch Press (psig)	438.5	Sat (°F)	123.9
Liquid Line (°F)	85.2	SC (°F)	-38.7
Suct Press (psig)	74.7	Sat (°F)	17.9
Suct Temp (°F)	26.8	SH (°F)	8.9

Electrical

Est Power (kW)	16.6
Comp Run Hrs	119.6

Refrigeration

Disch Press (psig)	473.6	Sat (°F)	129.8
Liquid Line (°F)	94.9	SC (°F)	-34.7
Suct Press (psig)	75.0	Sat (°F)	18.1
Suct Temp (°F)	28.0	SH (°F)	9.9

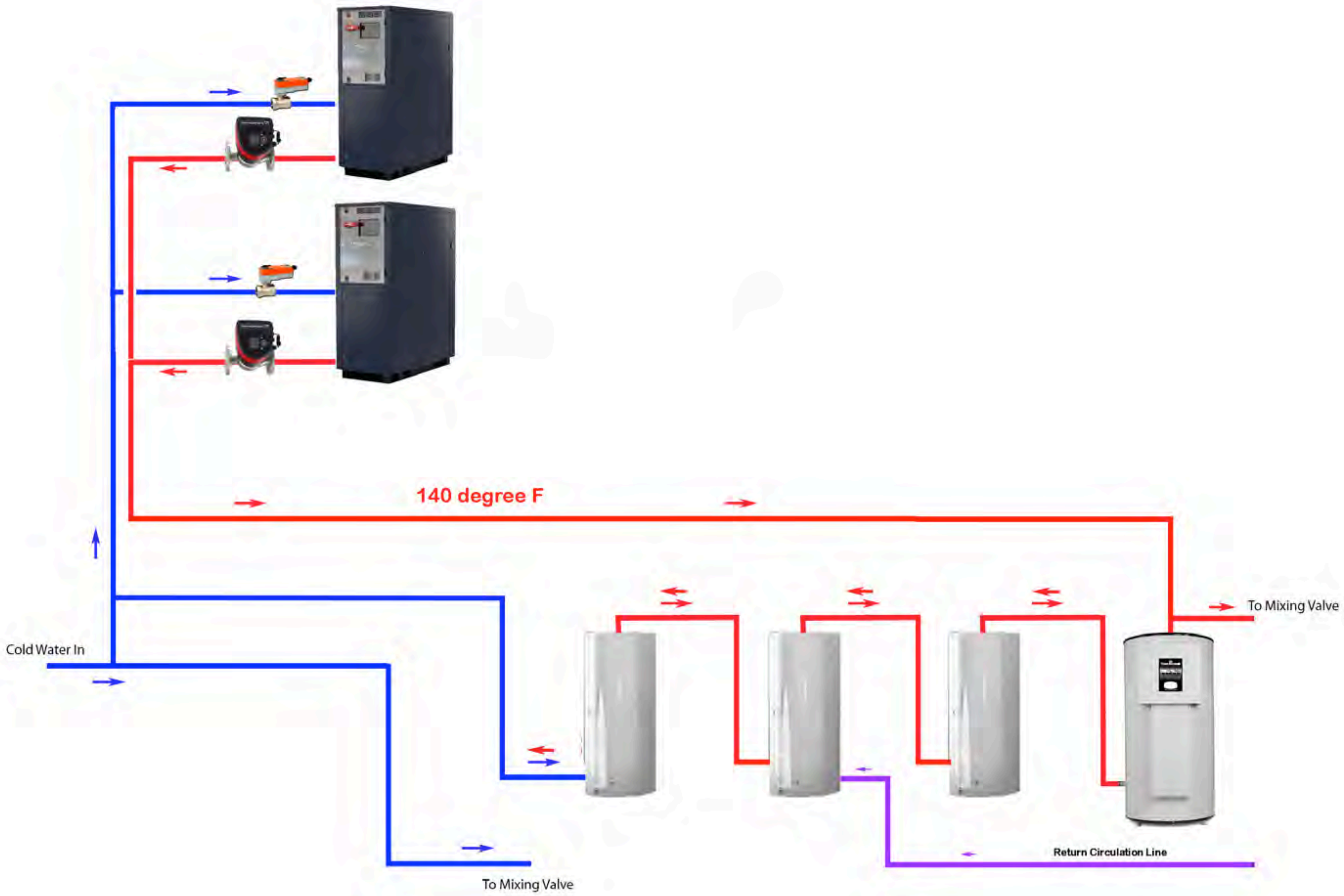
Electrical

Est Power (kW)	17.5
Comp Run Hrs	118.9

Current Temperatures

Load Inlet (°F)	46.3
Load Outlet (°F)	153.4
Source Inlet (°F)	30.7
Source Outlet (°F)	24.3

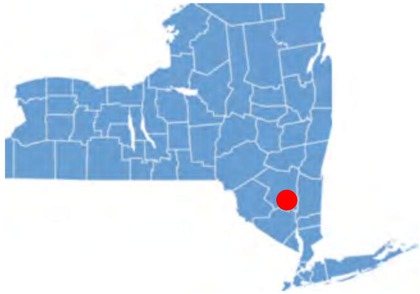
NYCHA DHW Design



Importance of Zero Place

NEW YORK STATE OF OPPORTUNITY. | Buildings of Excellence Award Winner

- Zero Place was a winner of NYSERDA's first-ever Buildings of Excellence award in 2019
- Reference project for the State of NY to assess the effectiveness of combining heating/cooling (HVAC) and domestic hot water (DHW) in a single building-wide geothermal system.
- NYSERDA monitors Geo and DHW by 3rd party
- Will inform policy Makers regarding means to achieve NY state's goal of economy-wide carbon neutrality by 2050.

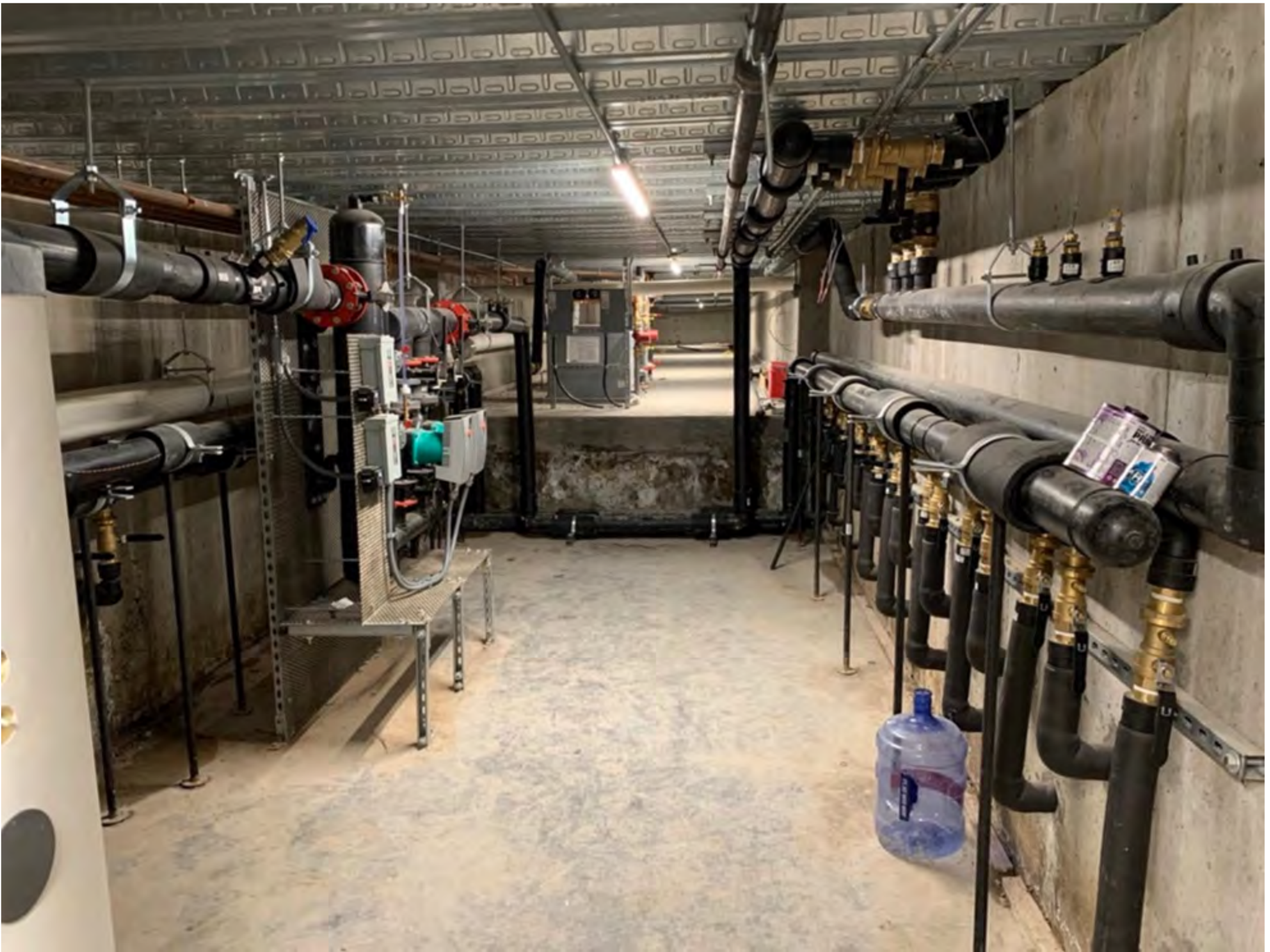


ZerOPlace

- **Mixed use, net-zero energy building**
  - **46 residential units**
  - **5 affordable housing units**
  - **6 Retail space: 8,000 sqft**
- **100% privately financed**

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeothermalHeating.com

Geothermal System: Integrated HVAC and DHW



- The heart of Zero Place’s pioneering innovations
- Ground-source Heat Pump (GSHP) System provides 100% Space Heating, Cooling and Domestic Hot Water (DHW)
- NO BACKUPS
- Summary
  - Common Loop Field for all Space Conditioning and DHW
  - central flow station with variable speed, high-efficiency pumps
  - Unitary ERV systems for each Dwelling

COP

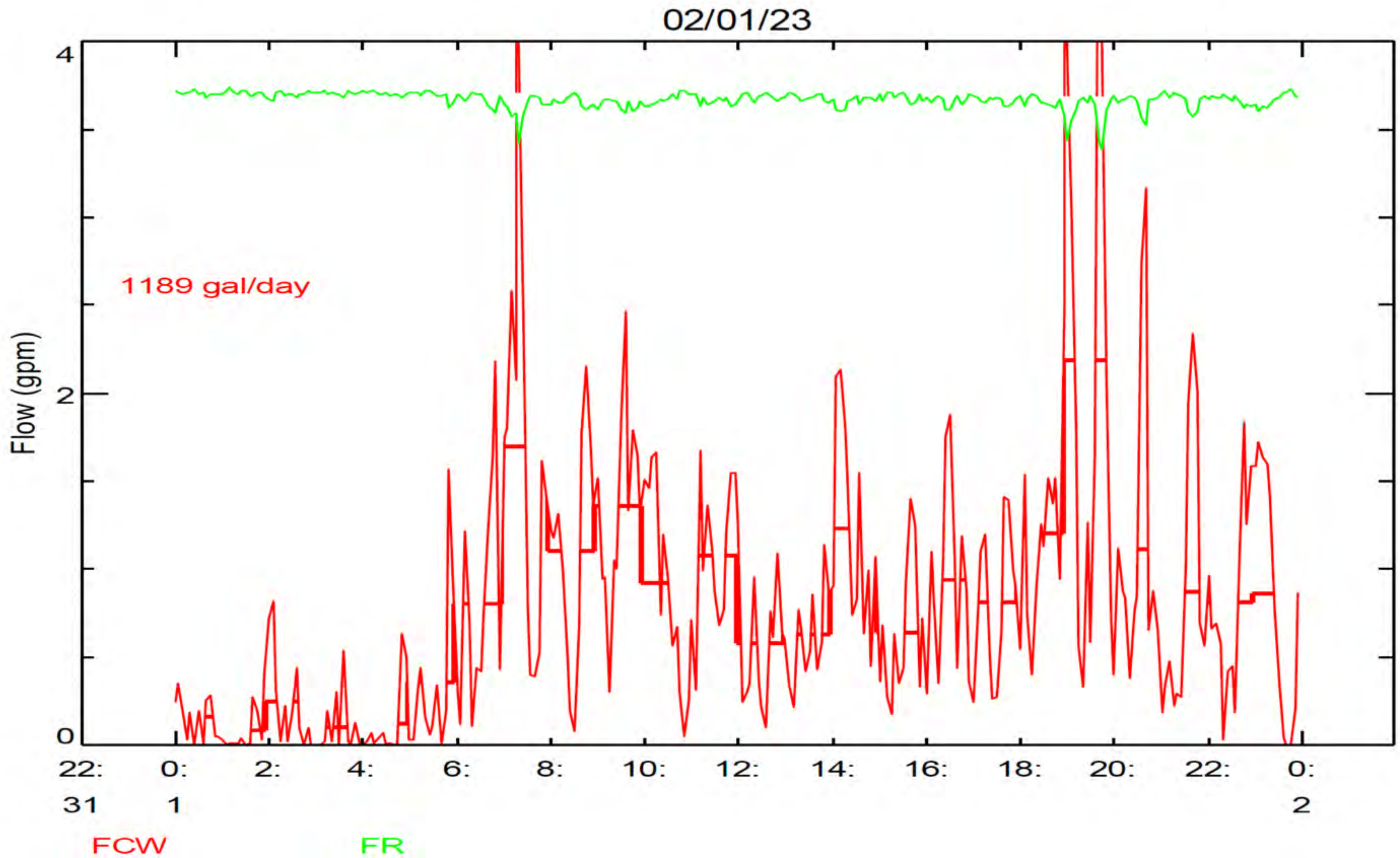
- The average annual COP is 3.7 for WWHP2 on pre-heat tank and 3.0 for WWHP1 on the final tank.
- The annual average COP for both units is 3.3, based on measured data.

- WWHP2 serves the pre-heat tank
  - has a lower inlet temperature of 90-105°F.
  - COP near 3.6
  - Runs longer and cycles less often

- WWHP1 serves final stage tanks and has an inlet temperature near 120°F. It cycles frequently to hold the final tank at the 125°F set point (cutout).
- summarizes the daily performance of the DHW System (tables for other periods are available in Appendix B). The measured heat delivered (QHW) is shown along with the measured heat loss from the recirculation loop (QR). The percent recirculation losses, are typically 30%, or an average of about 10-15 MBtu/h – consistent with losses measured at other multifamily sites
- WWHP1 final tank COP near 2.8.

Daily Hot Water Use Profile on February 1, 2023 – A Typical Day

Figure 24. Daily Hot Water Use Profile on February 1, 2023 – A Typical Day



Daily Ground Loop Loading versus HP Energy Use

(both WSHPs and WWHPs)

Figure 19. Daily Ground Loop Loading versus HP Energy Use (both WSHPs and WWHPs)

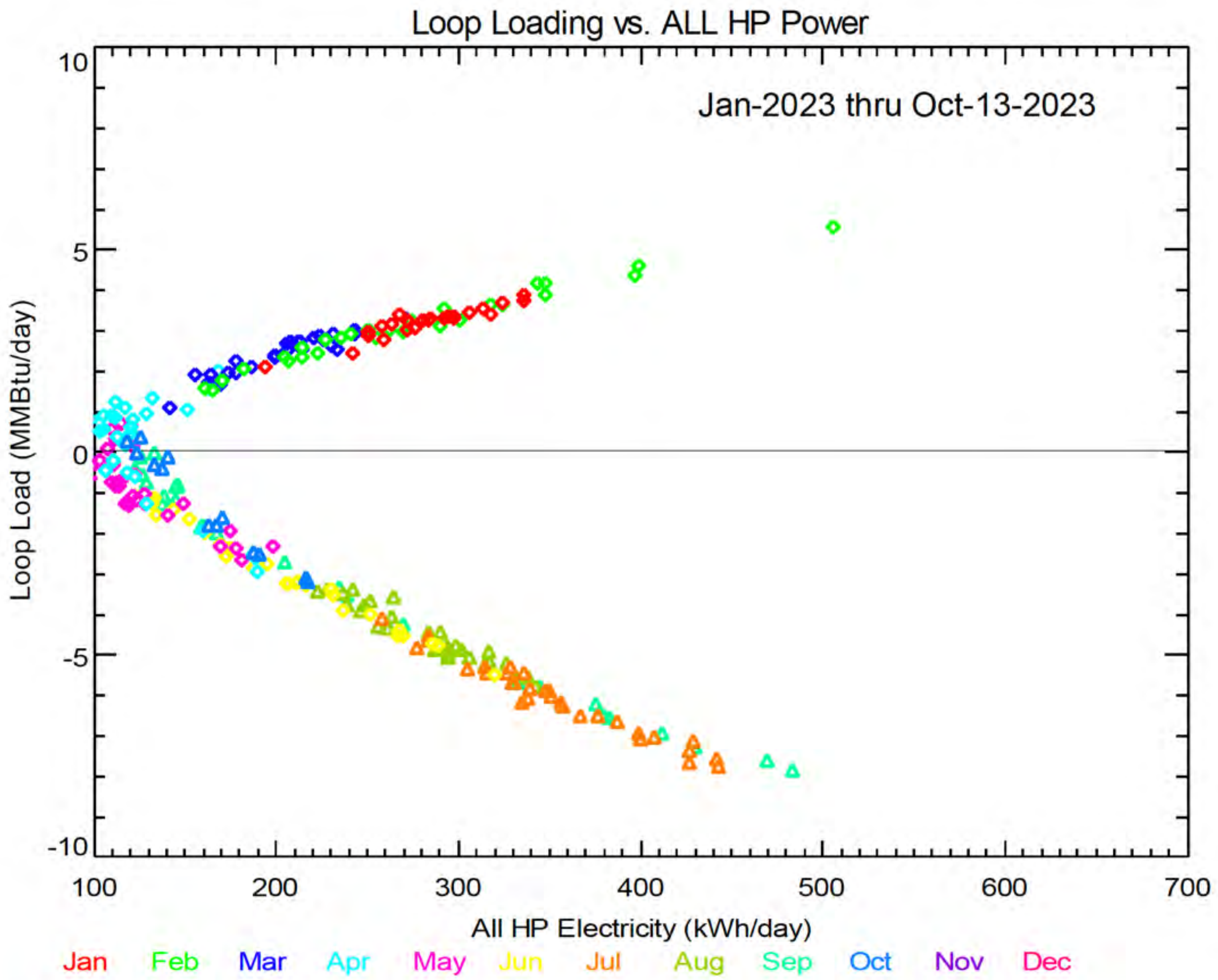
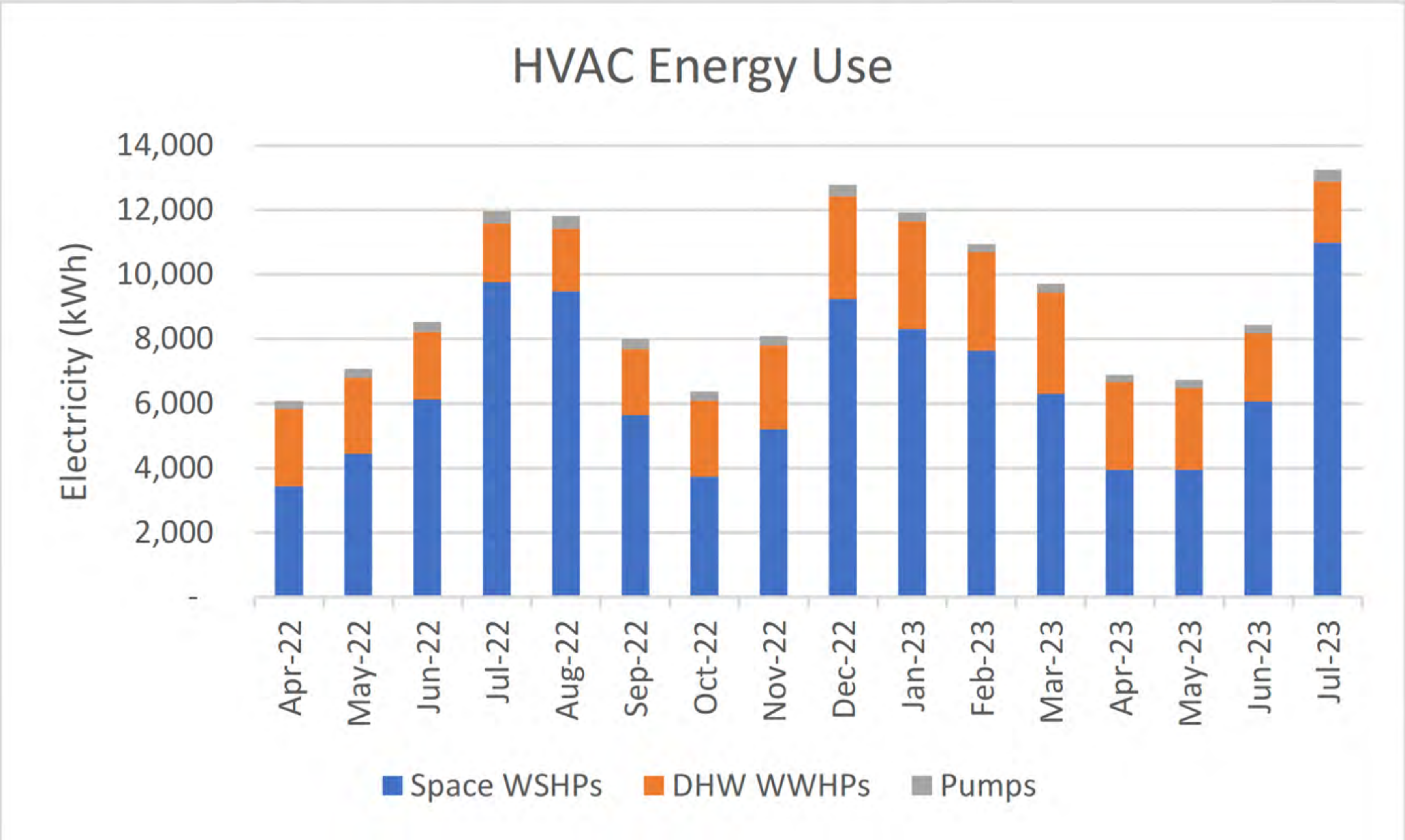
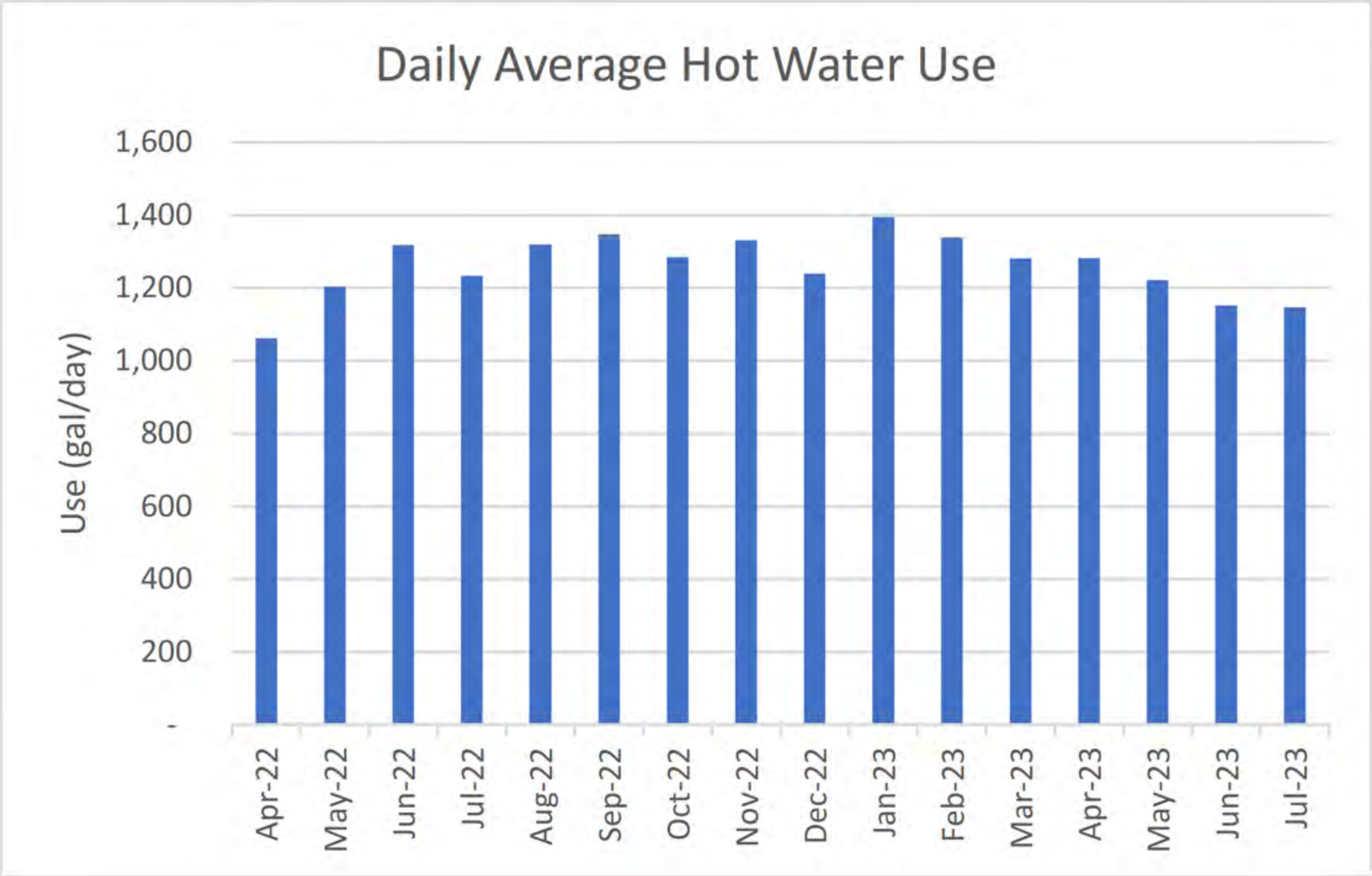


Figure 10. Monthly Electric Use Breakdown for Mechanical Systems

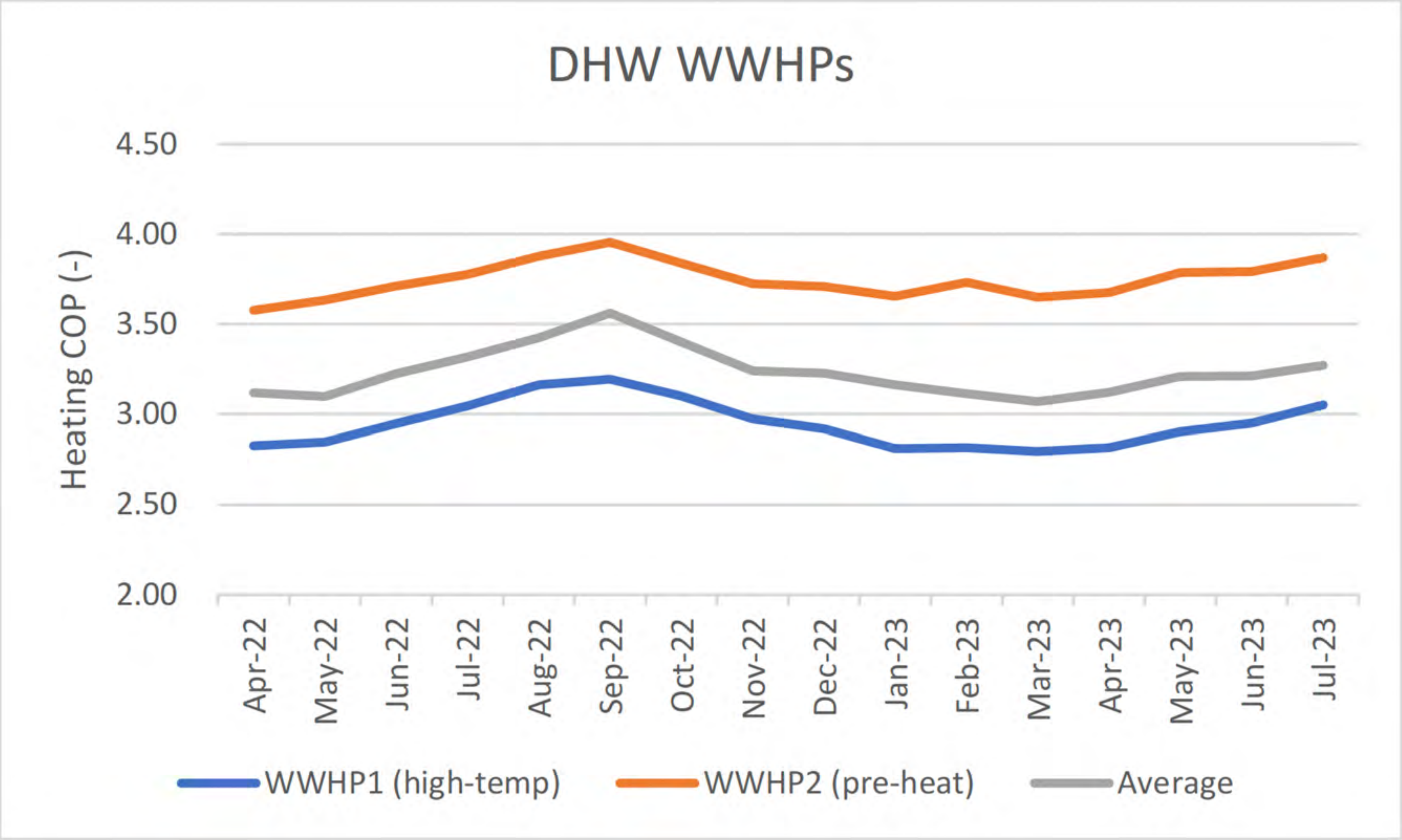


Temperatures and WWHP Operation on February 1, 2023 – A Typical Day

Figure 11. Monthly Average Hot Water Use



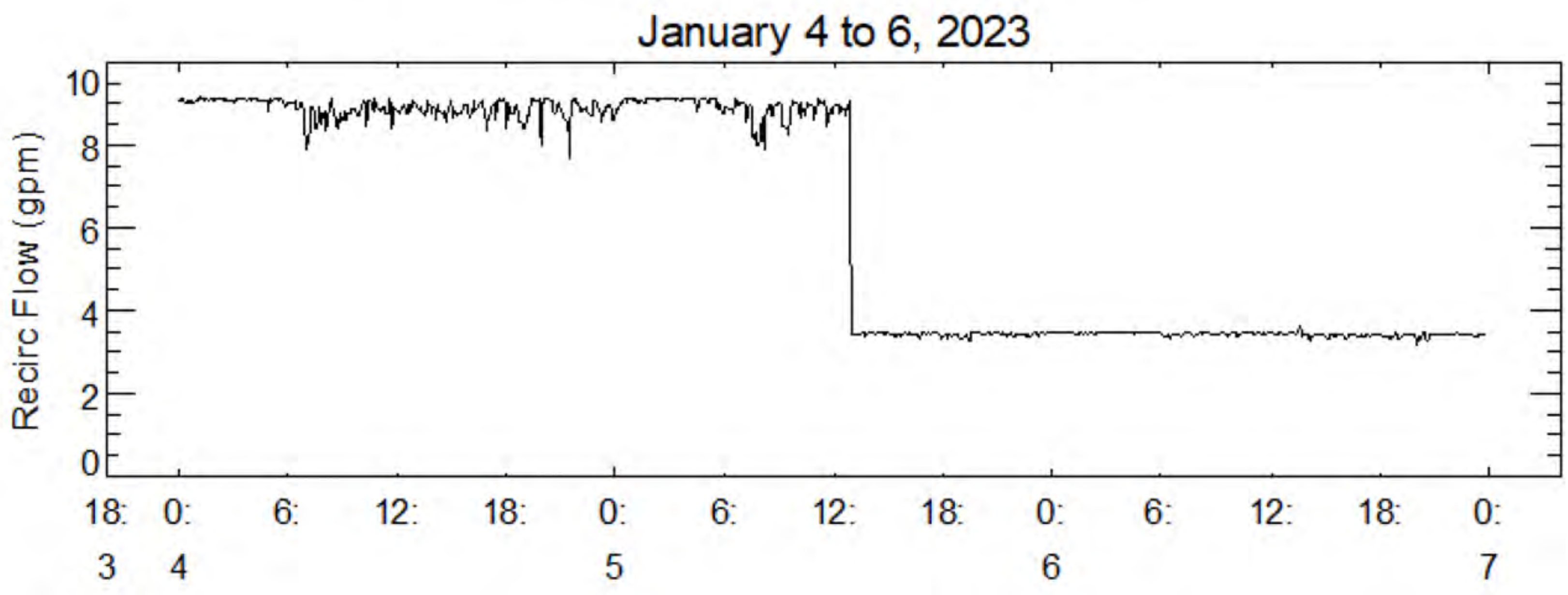
Monthly Predicted COPs for WWHP1 and WWHP2 Compared to the Measured Average (Gross) COP



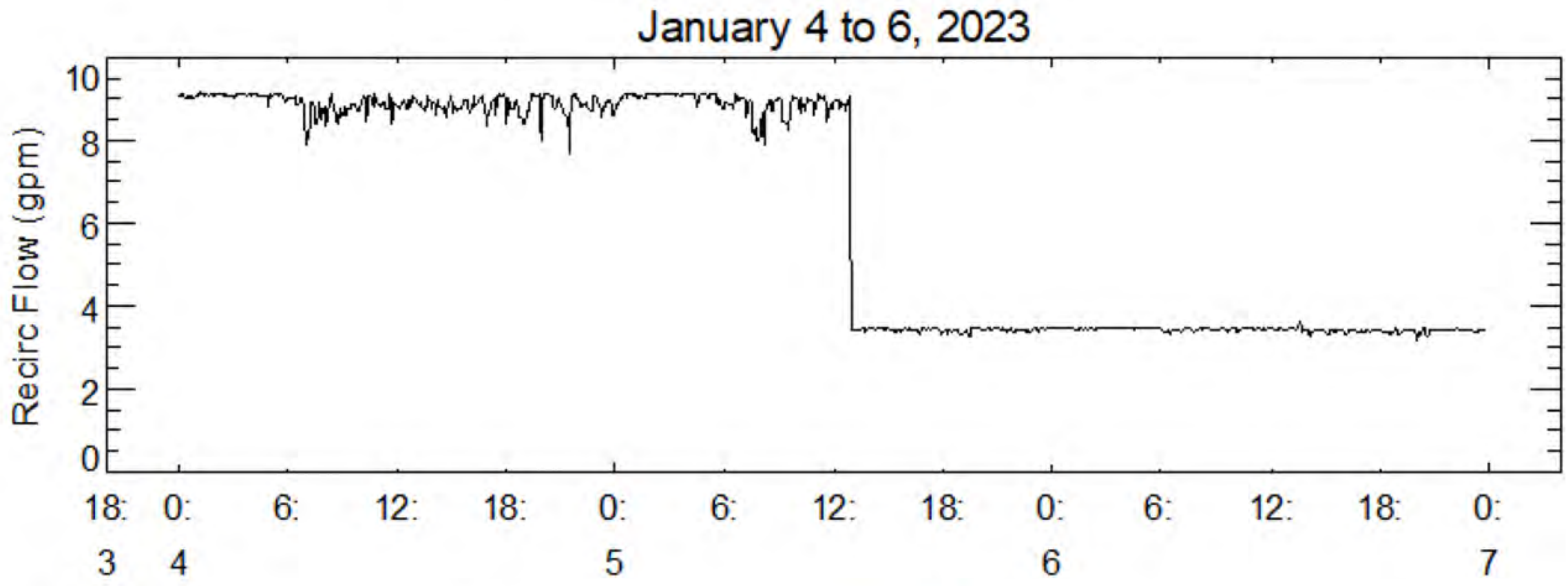
Cumulative Occurrences of Hot Water Flow for Different Periods
0.13 gpm peak usage per apartment

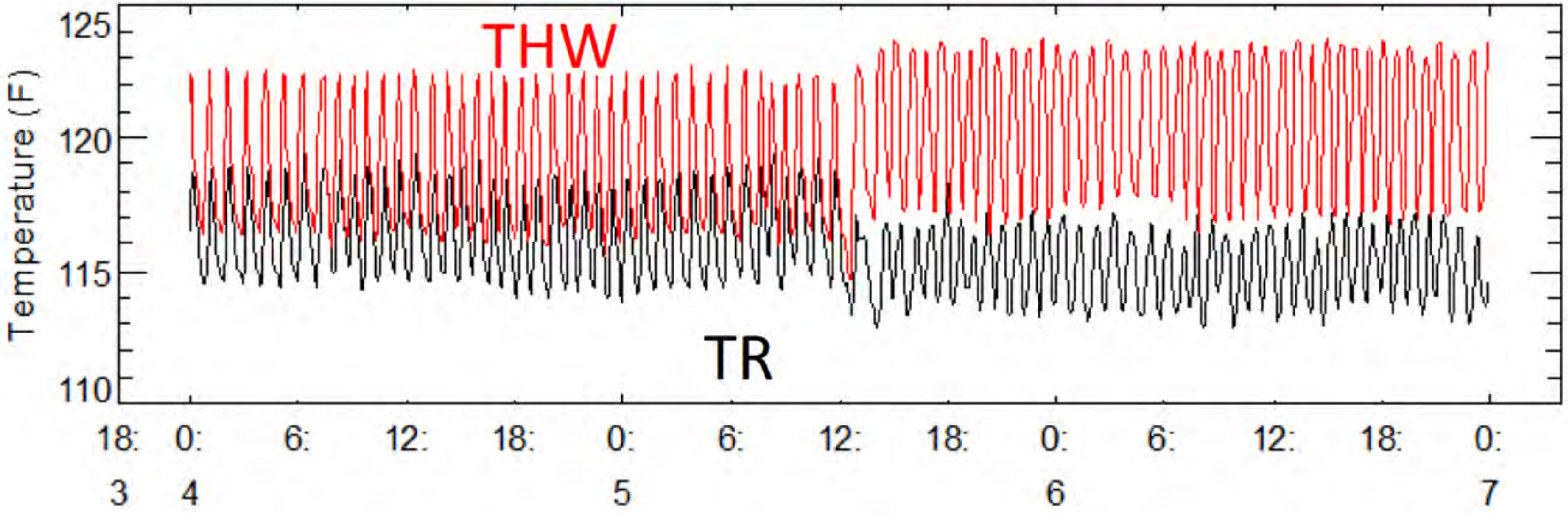
Cumulative Occurrence	PARTIAL OCCUPANCY Jan to May 2022 Flows (gpm)	FULL OCCUPANCY Jun to Oct 2022 Flows (gpm)	FULL OCCUPANCY Jun 2022 to Oct 2023 Flows (gpm)
90%	1.5	2.3	2.3
99%	3.7	4.5	4.3
99.9%	5.4	6.2	6.1
99.99%	7.1	8.0	7.7
Maximum recorded	30.4	9.1	21.5

Impact of Reduced Recirculation Flow on January 5, 2023



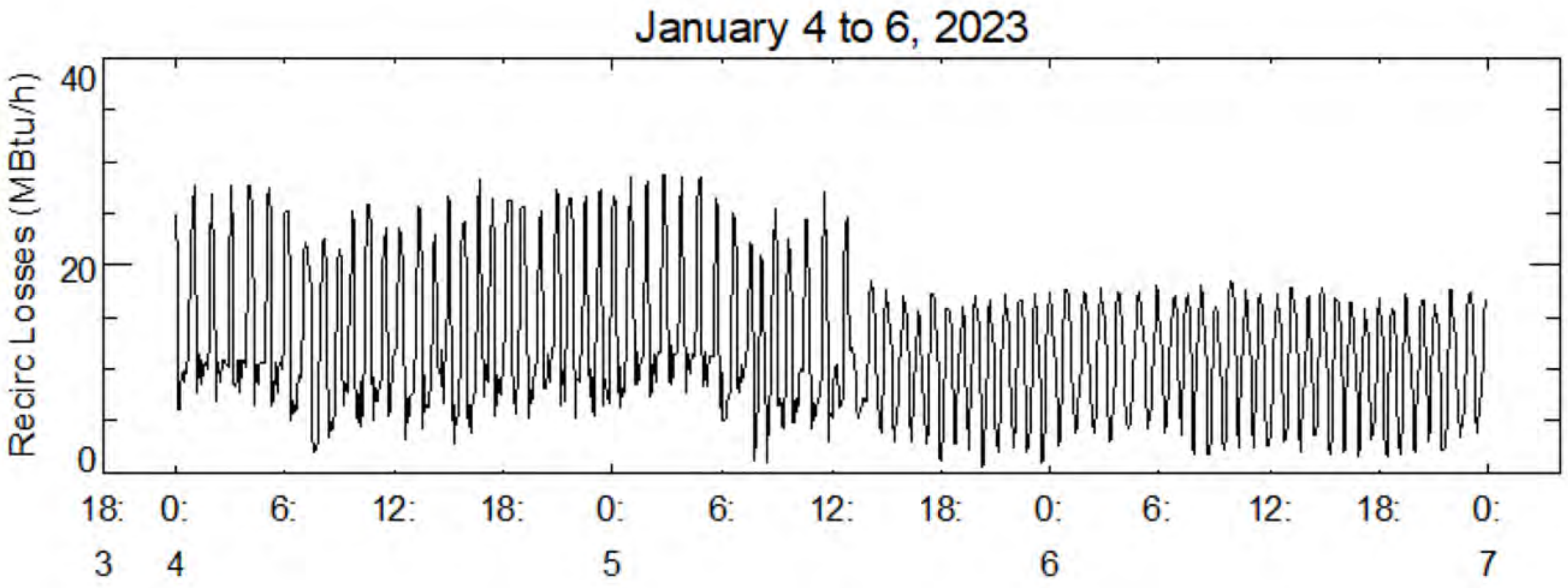
Impact of Reduced Recirculation Flow on January 5, 2023





11% efficiency gain for DHW!

- The thermal losses from the recirculation loop decreased from
  - 331.9 MBtu/day on January 4 to
  - 256 MBtu/day on January 6
  - by about 23%.
- The Net COP for DHW increased by 11%.



Summary Hot Water

- 140F DHW is possible with evolved DHW design and heat pumps
  - Is it necessary?
- Staging the DHW water tanks can significantly increase efficiency
- DHW integrations significantly decreases the loop field size in multifamily buildings in NYS
- Always cooling dominated

- DHW equipment is free!
- Due to the loop field cost savings!

Summary Hot Water

- Attention needed to DHW design and cold water disrupting stratification.

- Large efficiency gains possible with smart design and single pass through. Smart controls needed.

Questions

- What is the requirement for DHW temperatures in New York State?
- How to prevent growth of Legionella?
- How does residential and commercial DHW generation differ?
- Why is 140F the current threshold of the refrigerant circuit?
- What are tricks in DHW design to allow 140F in the storage tanks?
- What are the future technologies to advance DHW production?

Objectives

- The lecture / presentation will focus on the challenge of designing and installing Domestic Hot Water systems in multifamily buildings, and to integrate them in the same system which does space heating and air conditioning.
- The audience shall understand standardized design aspects, which will be given by example, which are necessary to grow geothermal DHW production to utility scale.
- Participants shall discuss on how to enhance efficiency and resilience of multifamily DHW generation

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