CARRIER'S DIGITAL SOLUTIONS

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Digital Solution Growth Leader for North America

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Agenda

- Carrier Service – Connected capabilities
- Abound – as the industry is evolving, we have a solution!
- Digital service capabilities
- Abound Net Zero Management dashboards and reports

SOLUTIONS THAT MATTER.

CONFIDENCE THAT INSPIRES.

Carrier is the leading global provider of healthy, safe, sustainable and intelligent buildings!

Let’s discuss how we are digging deeper into equipment and building data than ever before to…

- Put our customers first
- Protect our planet
- All while inspiring and empowering our people.

Industry Challenges Needing a Solution

BUILDINGS OF YESTERDAY

BUILDINGS OF TOMORROW

Disclaimer: The product information provided is for general guidance only. For details, contact your Carrier representative.

The Problem

Impact of HVAC operations

Building energy consumption
~40% energy use by HVAC

Energy efficient buildings affect health
HEALTHfx Study: $5.8 bn in health and climate benefits (2000-16)

Energy efficient buildings affect productivity
COGfx study: Enables ~26% higher cognitive scores

Complexity in optimizing HVAC O&M

Multi-disciplinary technologies

Multiple brands of equipment

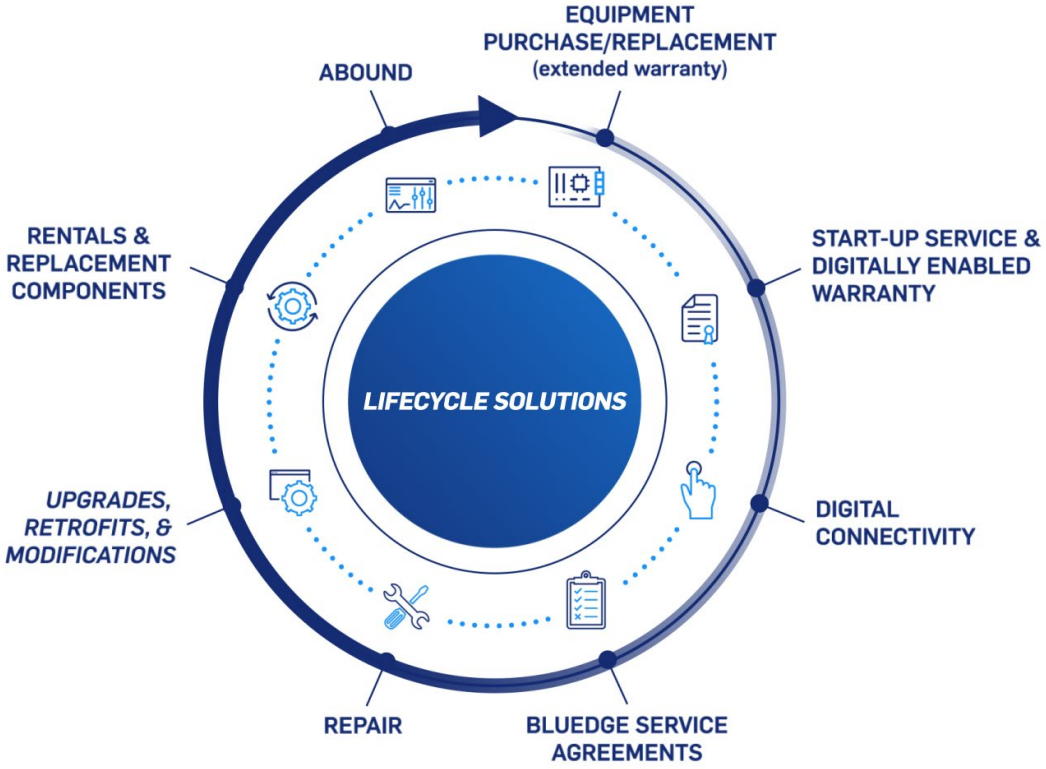
Numerous O&M processes

Different personas involved

Digital and AI can be used to overcome the complexity involved

Our Service Mission
Is to be your one-stop-shop across your HVAC lifecycle

- Provide you with **best-in-class service** as the leading OEM for Building Controls and commercial HVAC equipment
- Be your #1 partner in **implementing intelligent climate solutions**
- Offer **next-gen digital capabilities** for **greater visibility** into building system health and performance



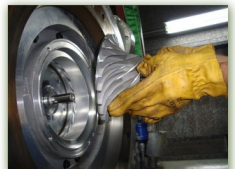
Service & Aftermarket Scope

Operations & Maintenance



- BluEdge Service Agreement
- Abound HVAC Performance platform
- Chiller plant operations
- Value-added services
- Technical training

Repair & Upgrades



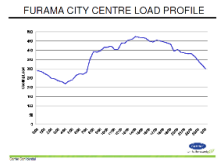
- Emergency repair
- Chiller overhaul
- VFD retrofits

Parts & Rental



- Chiller & pump rental
- Emergency response
- Spare parts

Retrofit & Solutions

- Health check
- Plant optimization / BMS
- Performance guarantee
- Modernization / upgrades

We have an extensive experience servicing major heating, ventilation and cooling manufacturer's equipment.

AIR & WATER-COOLED CHILLERS, PACKAGED UNITARY EQUIPMENT, AIR HANDLING UNITS, COOLING TOWERS, BUILDING CONTROLS, HEAT EXCHANGERS, BOILERS, SPLIT SYSTEMS, PUMPS, VARIABLE REFRIGERANT FLOW (VRF)

Carrier

Abound – Digital Platform

Carrier's Suite of Connected Solutions

Gathers performance data from disparate systems, equipment, and sensors, so you have a single source of truth for making quick assessments and confident decisions.

Visualize

Provides a clear view of all your building systems—across your entire building portfolio—in one intuitive interface

Analyze

Unites disparate data and identifies anomalies in real time, so you can
resolve issues quickly

Optimize

Provides actionable insights and recommended solutions so you can…
take action to make buildings more efficient, comfortable, and sustainable and provide occupants with increased confidence in their indoor environments

Carrier

What is Abound?

Abound Healthy Air

Customer Problem

How do I optimize my building for the health and productivity of its occupants?

Abound Occupant Assistant

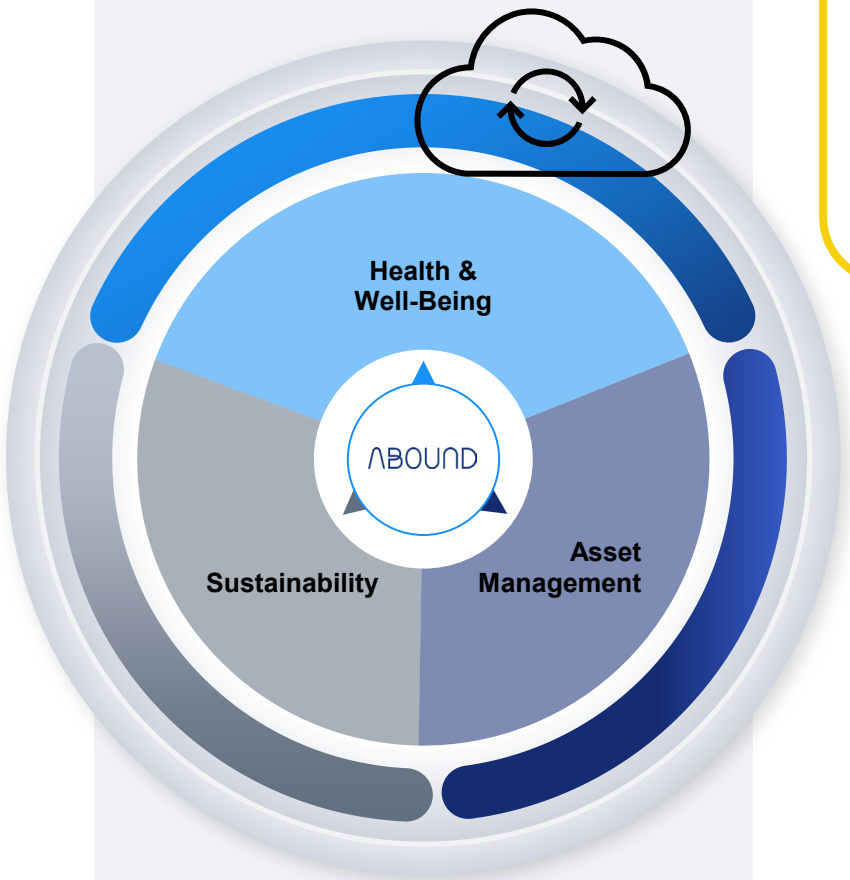
Customer Problem

How do I enhance the productivity of my workforce or increase tenant experience?

Abound Net Zero Management

Customer Problem

How do I optimize my HVAC and energy systems to reduce energy consumption and ensure alignment to our ESG goals?



Abound HVAC Performance

Customer Problem

How do I maximize HVAC uptime, limit maintenance issues, and reduce unplanned repairs?

Abound Predictive Insights

Customer Problem

How do I enhance building asset management for cost reduction, comfort improvement, and advanced data analysis?

\+ More in development…

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DIGITAL SERVICE CAPABILITIES

What it means to Connect with Carrier

24/7 Continuous Monitoring of your Equipment

- Enabled by multiple Carrier Command Centers around the world

Alarm Monitoring, Notifications, and Remote Diagnostics

- Real-time notifications on critical/high-risk alarms with proactive measures*

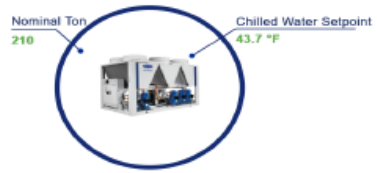
Analytic Reports and Proactive Insights

- Periodic reports containing predictive insights to help prevent major failures

Chiller Reports

Digital Health Report

Chiller Design



Avg. Comfort Index

Run Hours this period

Total Run Hours	109.0
Min. Daily Runtime (hrs)	2.0
Avg. Daily Runtime (hrs)	5.5
Max. Daily Runtime (hrs)	7.0
Number of start/stops	392

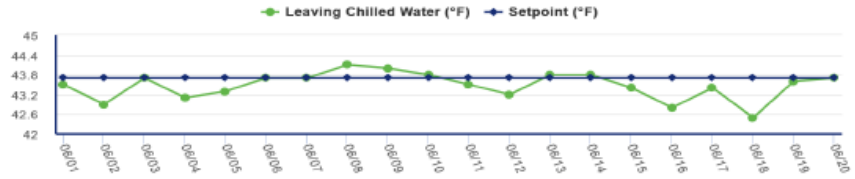
Chiller Performance Summary

Avg. Chiller Capacity	21.5 %
Total Run Hours (Life Time)	3006
Avg. Setpoint	43.7 °F
Avg. Entering Chilled Water Temp	50.5 °F
Avg. Leaving Chilled Water Temp	43.5 °F
Avg. Outdoor Air Temp	53.7 °F
Max. Outdoor Air Temp	62.0 °F
Min. Outdoor Air Temp	48.4 °F

Alert/Alarm Summary

Number of Alarms	0
Number of Alerts	0
Time in Normal Mode	100.00%
Time in Alarm Mode	0.00%
Time in Alert Mode	0.00%

Leaving Chilled Water And Setpoint



This summary report is intended to provide an overview of your chiller's performance and operating results. Contact your Carrier Service representative for additional guidance, details, optimization strategies or service recommendations.

Digital Inspection Report

OVERVIEW

Chiller Operation Check

Operation check was done when CH-01 was running at greater than 90% load which occured for 200 hours.

68 F ° Avg. Temp

86% Load

Jan 6, 8:14am – Feb 28, 11:50pm (*data sampled every 15 min)

< 70% | 70.1% – 85% | > 85%

Parameter	Normal Range	% Hours in/out of Range (Avg Value)
Evaporator Entering Water Temp.	## - ##	100% 4.4
Evaporator Leaving Water Temp.	40.5 °F – 43.5 °F	100% 4.4
Evaporator Ref. Temp.	> 37 F	100% 4.4
Evaporator Approach*	< 2 F	100% 4.4
Condenser Entering Water Temp.*	## - ##	78% 4.4 4.1
Condenser Leaving Water Temp.	< Setpoint + 2.5 F	100% 4.4
Condenser Approach*	<4 F	16% 3 14
Oil Sump Temp.	< 165 F	100% 125
Oil Pump Delta Pressure*	> 25 Psi	71% 30 24
Compressor Winding Temp.*	< 130 F	100% 4.4
Motor Temp*	<15% OR 93 C - 115 C	100% 4.4
Thrust Bearing Temp*	< 167 F	96% 4.4
L1, L2, L3 Supply Voltage*	= 460 +/- 5%	100% 123
Compressor Super Heat	> 6.1 F	100% 4.4
Compressor Discharge Temp.	< 125 F	100% 4.4
Condenser Ref. Temp.	< 99 F	39% 4.4 4.6

Alarm Summary

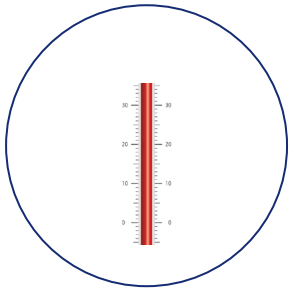
Category	Quantity	Action by Carrier
Alert	2	0
le	1	1
	3	3

Most Recent Alarm and Alert

Description	Time	Type	Text
Starts limit exceeded	Feb 12, 4:45 PM	Prestart Alert	Excessive compressor starts (8 in 12 hours)
High motor temperature	Feb 26, 12:45 PM	Prestart Alert	Comp Motor Winding Temp ## exceeded limit of ##

Chiller Analytic Reports

Each Analytic Report Focuses on Three Main Areas



SYMPTOMS

DEGRADATION & SEVERITY

ENERGY & COST EFFECT

Evaporator Health Example:

Symptoms:

- High Evaporator Approach.
- Low Evaporator Refrigerant Pressure.
- Low Evaporator Refrigerant Temp
- Increased Pressure drop in the evaporator water circuit.

Degradation & Severity:

- Decreased Efficiency.
- Decreased heat transfer rate
- Increased evaporator degradation factor.

Energy & Cost Effect

- Increased Chiller power consumption.
- Reduction in capacity impacting the leaving ChWT.

Types of Analytic Reports

Water Cooled Analytic Reports

1. Condenser Health
2. Chiller Refrigerant leak
3. Compressor Health (Centrifugal)
4. VFD Report
5. Evaporator Health
6. Electrical Health

Air Cooled Chiller

1. Chiller Refrigerant leak
2. Condenser Coil Health
3. Condenser Health (Chemical / steam cleaning)
4. Evaporator Health

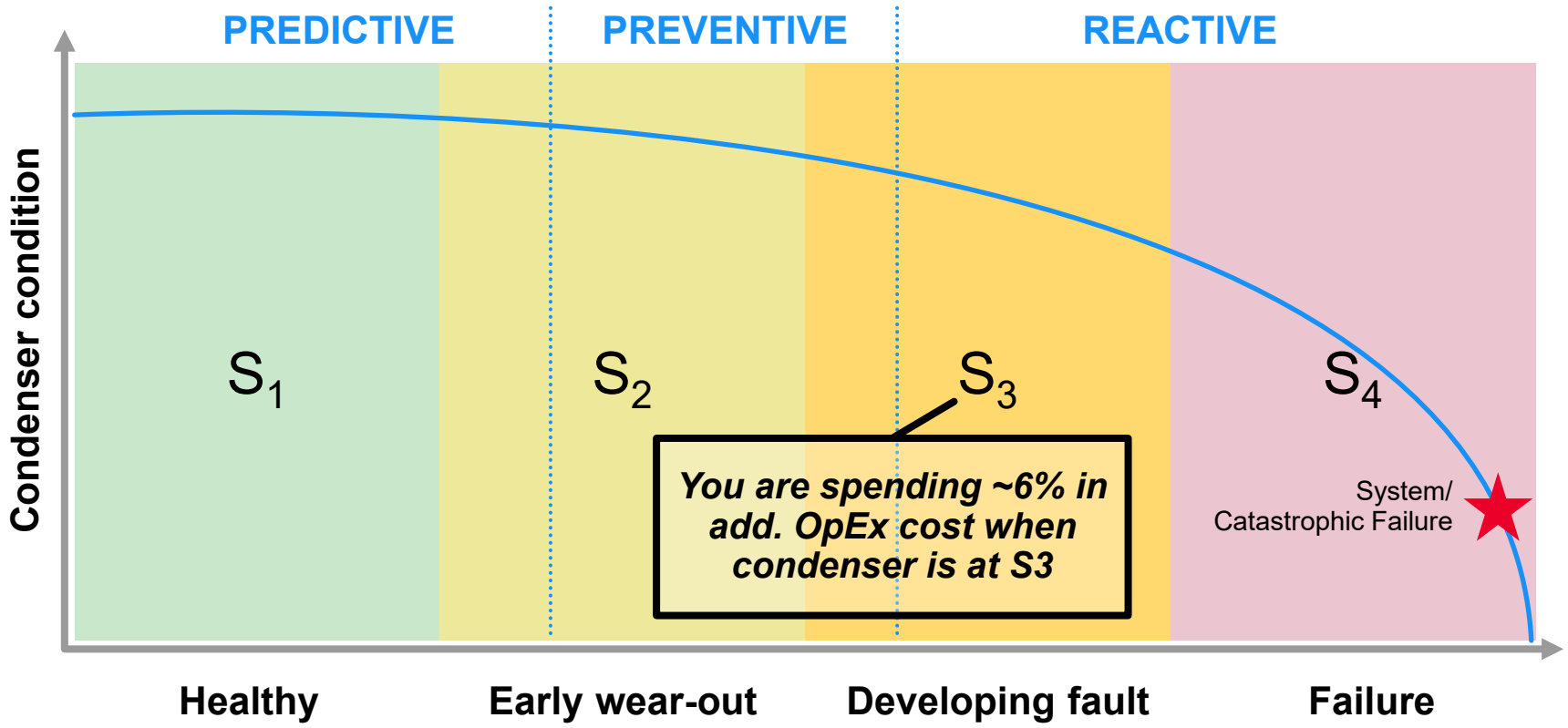
More Under Development!

1. Compressor Health (Screw)
2. Annual Shutdown
3. VFD Health
4. Condenser Tube Replacement
5. PIC 6 Upgrade (19 Series)
6. PIC 6 Upgrade (From touch pilot and HMI)
7. PIC6 Upgrade (From ProDialog)
8. Auto tube cleaning (Ball / Brush type)
9. Motor Terminal Replacement*
10. Revarnish Stator Coil*
11. Control Power Transformer Replacement*
12. Chiller Replacement Planning
13. Chiller Plant Recommendations

1. Compressor Health (single)
2. VFD Health
3. Evaporative Cooling Upgrades
4. Annual Shutdown
5. Condenser Fan VFD
6. PIC6 Upgrade (HMI display)
7. Anti Corrosion coating
8. Electrical Health
9. Motor Terminal Tube Replacement
10. Revarnish Stator Coil
11. Control Power Transformer Replacement
12. Chiller Replacement Planning

Analytic Reports for Operational Savings!

EXAMPLE - CONDENSER FOULING | Condenser fouling is one frequently observed example where we can save you money



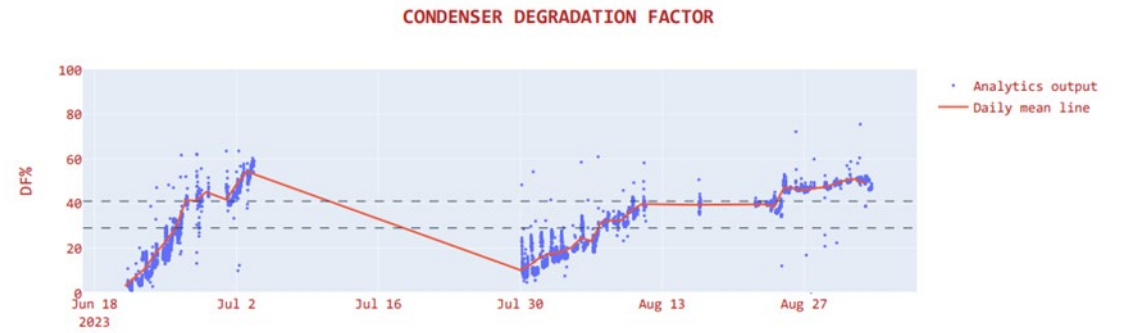
Increase in electricity cost as equipment condition worsens

Early detection through **Digital Inspections**

Leads to minimizing operating cost and reducing chance of catastrophic failure

HVAC Performance Analytics in Action

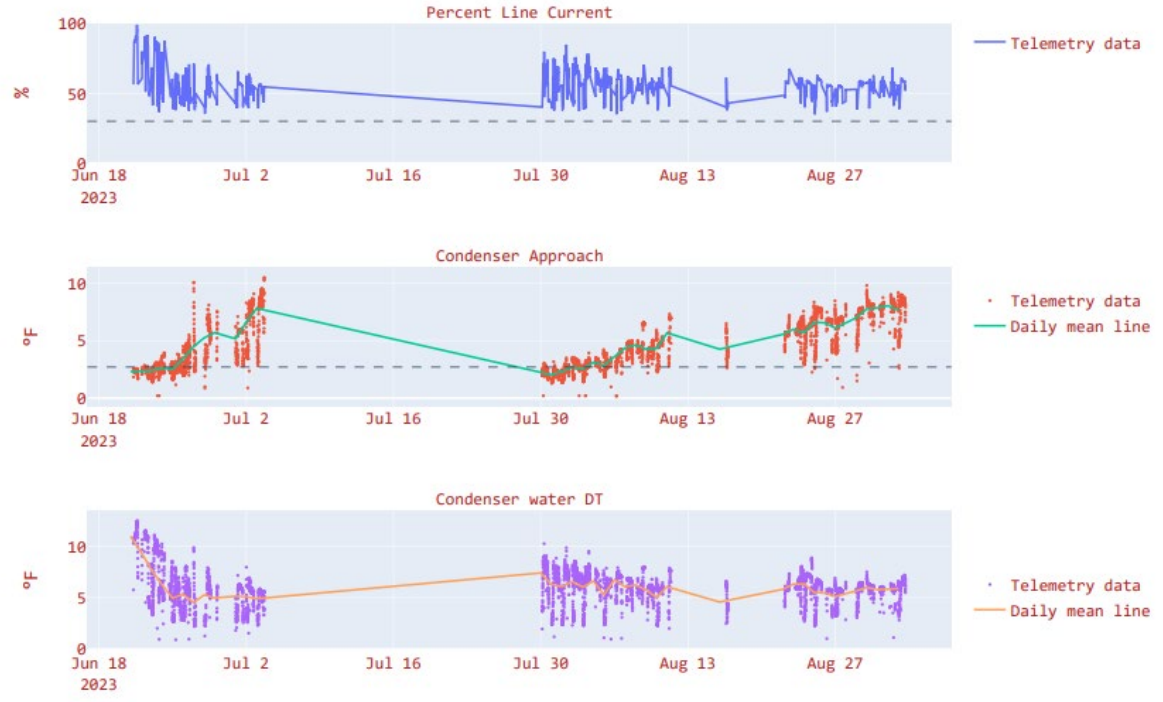
Condenser Health Report



Comments:

The Condenser Degradation factor has increased.

- Degradation is the primary metric which is considered to determine the efficiency of the chiller.
- The review of operating experience indicated that chillers experience aging degradation and failures.
- The primary aging factors of concern for chillers include vibration, excessive temperatures and pressures, thermal cycling, chemical attack, and poor-quality cooling water.



Comments:

1.The Condenser approach (°F) is high.

2. Condenser Water Temperature Difference is stable, indicating no condenser side water loss.

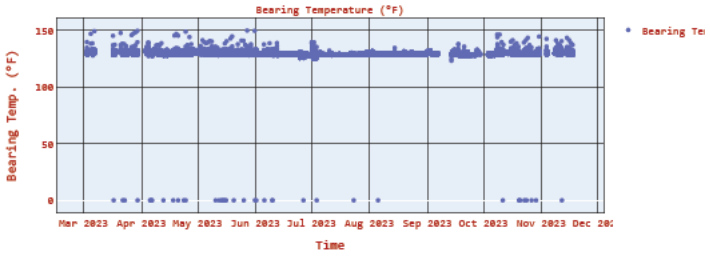
Compressor Health Report

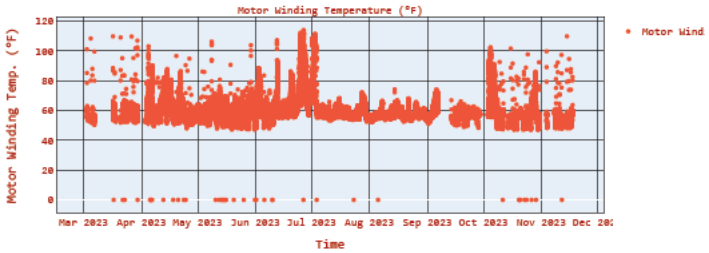
COMPRESSOR HEALTH REPORT

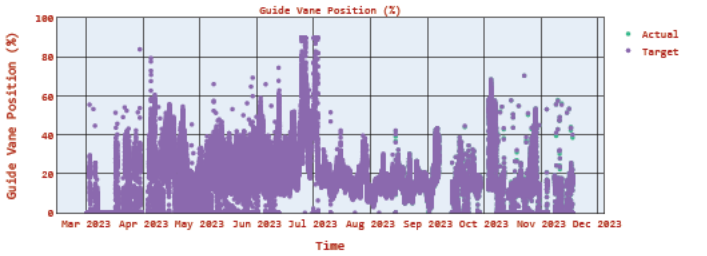
CHILLER DETAILS	
Location Name	Penn State St Joes Hospital
Site Address (Region)	2500 Bernville Rd, Reading, PA 19605
Chiller Number	3805Q71730
Year of Manufacturing	2005
Chiller Runhours	75259
Model Number	19XR7071555EJS64S
Report Duration	2023-03-01 to 2023-11-17

SUMMARY	
Performance Factor (%)	Inefficient
Surge Counts	No surge counts
Oil PD	Normal
Oil Sump Temperature	Normal
Bearing Temperature	Normal

COMPRESSOR PARAMETERS







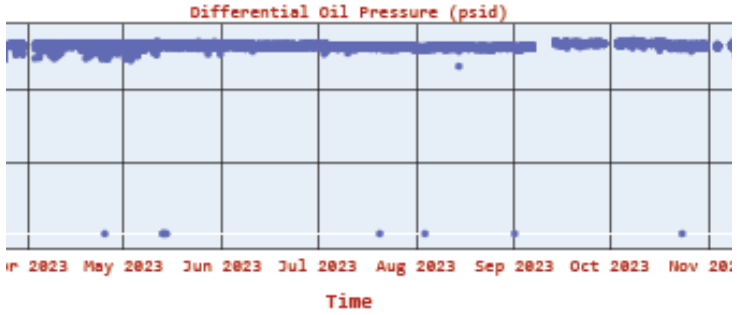
COMMENTS

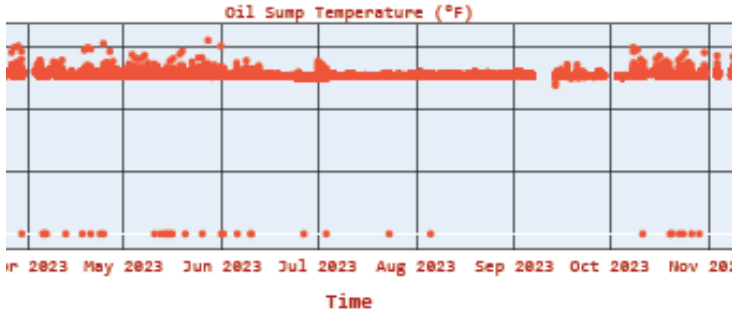
factor indicates that the compressor is not operating efficiently.

using performance factor is to evaluate degradation of performance over time

ication of the degradation is evaluated in the next section.

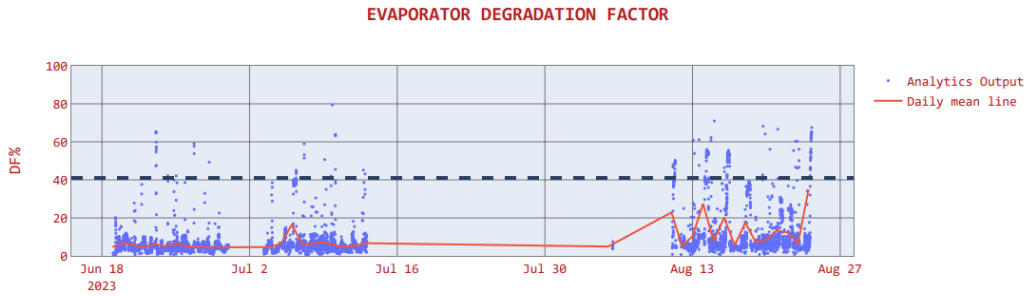
OIL CIRCUIT ANALYSIS





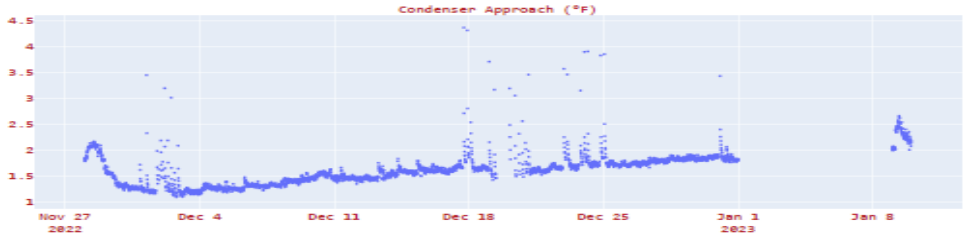
Refrigerant Leak Report

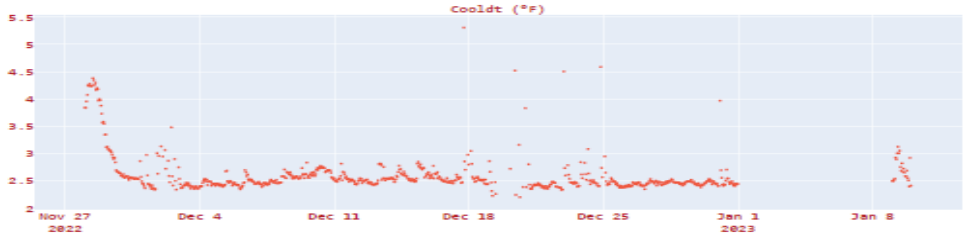
Additional Report Inferences



Comments:
The Evaporator Degradation factor has increased.

- Degradation is the primary metric which is considered to determine the efficiency of the chiller.
- The review of operating experience indicated that chillers experience aging degradation and failures.
- The primary aging factors of concern for chillers include vibration, excessive temperatures and pressures, thermal cycling, chemical attack, and poor-quality cooling water.
- Evaporator effectiveness indicated ability to absorb or transport the heat.



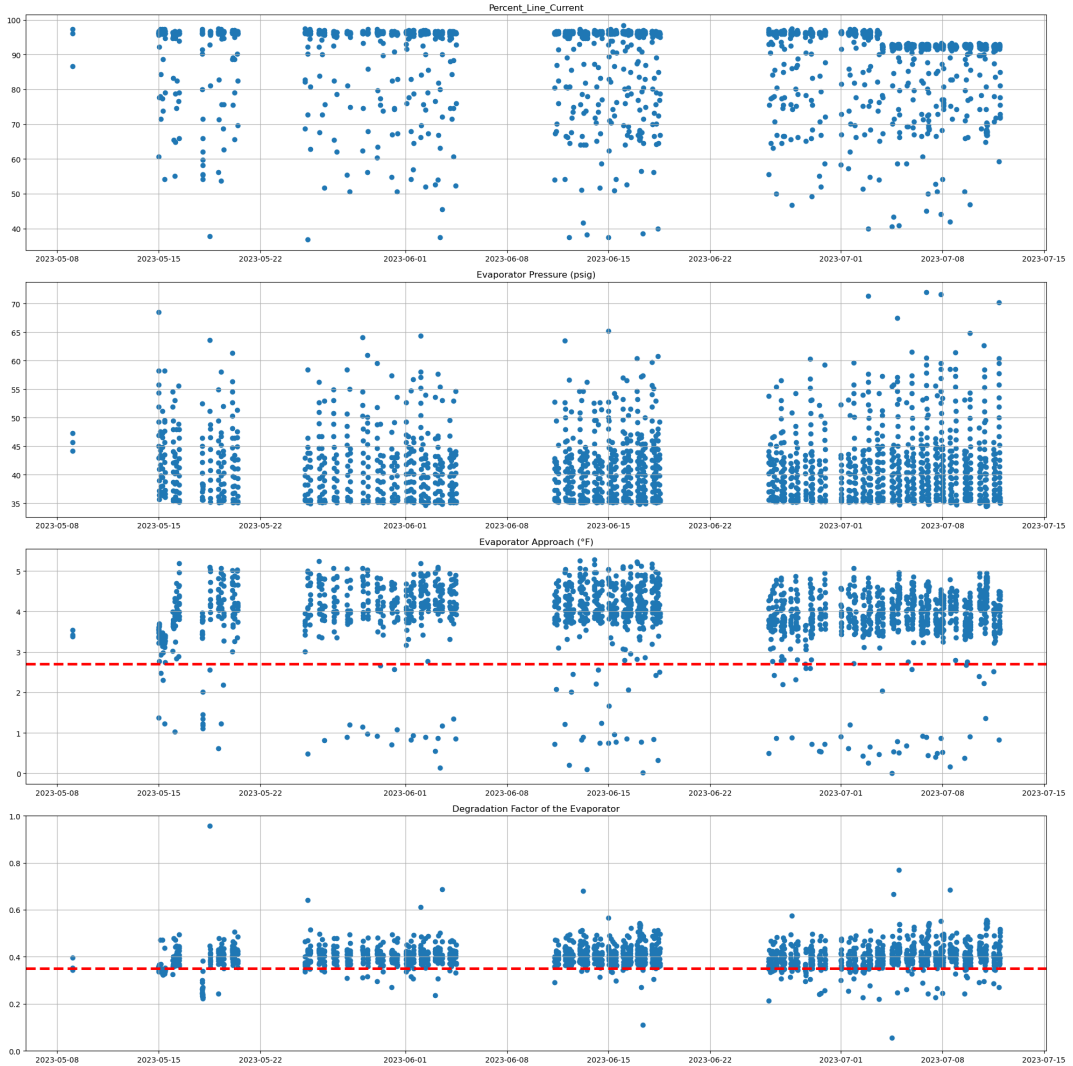


COMMENTS
1. There was a decreasing trend in the evaporator pressure.
2. The evaporator approach was high.
3. The condenser approach had an increasing trend.
4. The leaving chilled water temperature is steady over the time.
5. The fault belongs to S3 category.

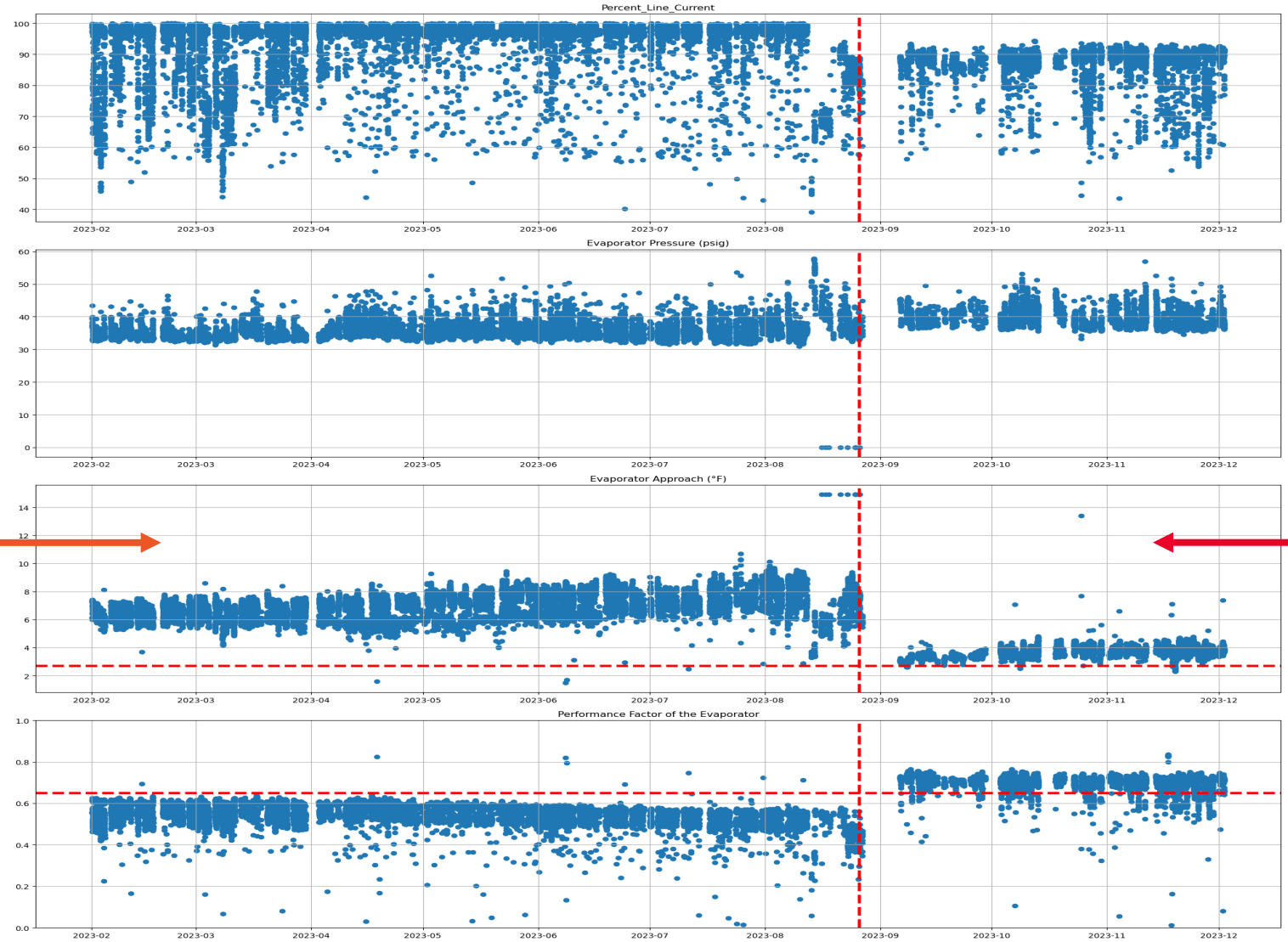
Evaporator Health Symptoms

- The **evaporator approach** is **high** and reflects a value above 3°F.
- The **degradation factor** of the evaporator is **high** with a value greater than 0.35.
- The **evaporator pressure** is showing a decreasing trend**.**
- The chilled water temperature difference is stable, indicating **no water loss.**

Field	Record
Chiller Business Key	45QQ6
Report Duration	2022-11-01 to 2023-07-11
Chiller Model Number	19XR-PIC3



Field Verified Case Study: Chiller XR3

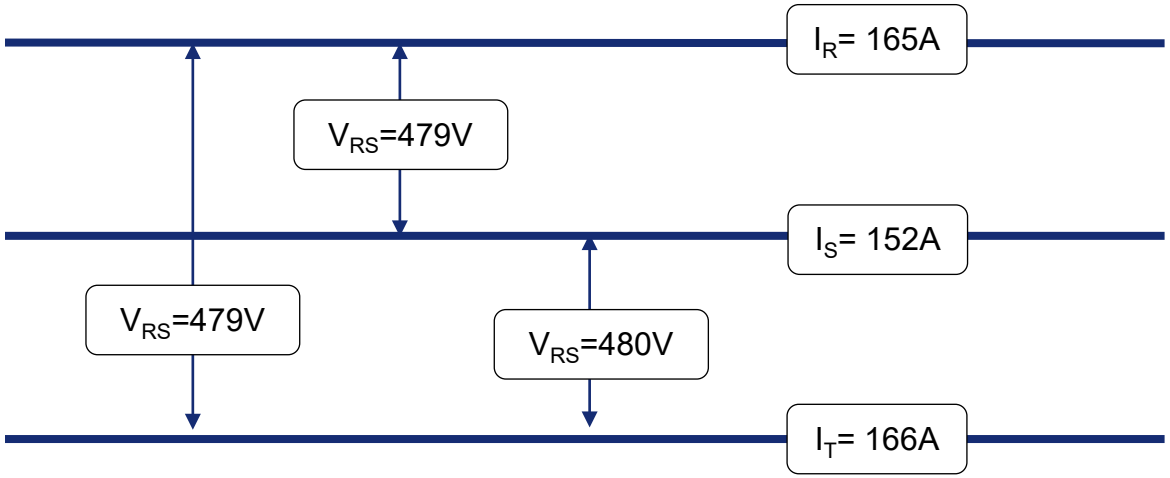


BEFORE CLEANING

AFTER CLEANING

Electrical Health (Unbalance)

An example



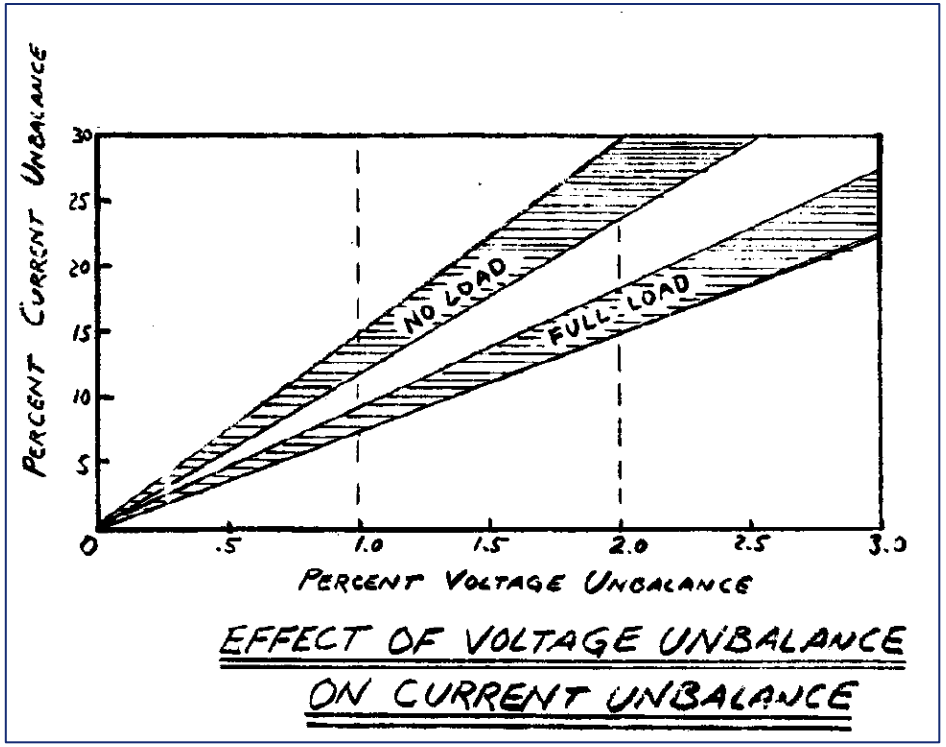
NEMA Definition of Current Unbalance

I_{avg} = (165 + 152 + 166) / 3 = 161

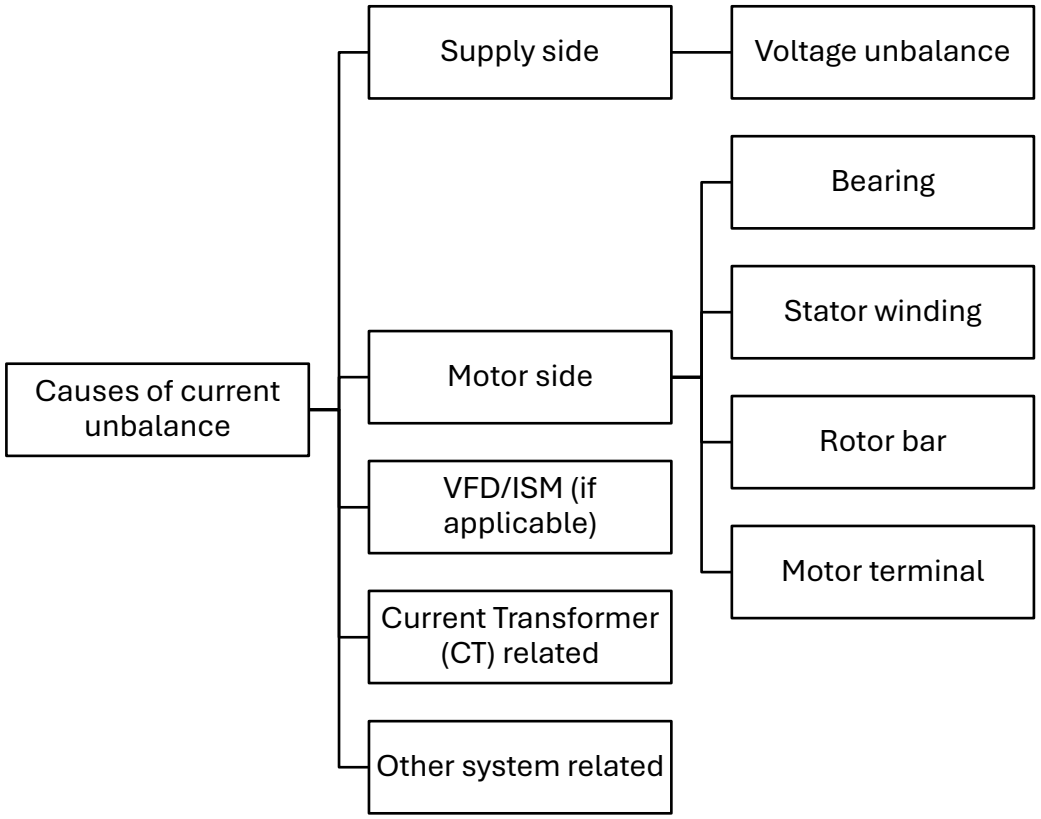
Current Unbalance (I_U)= 5.59%

Maximum deviation from mean

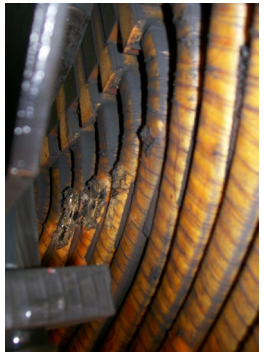
= max{ |165 – 161| , |152 – 161|, |166- 161|}
= max{|4| , |-9|, |5|}
= 9
Current Unbalance (I_U) = (9/161) *100 = 5.59%



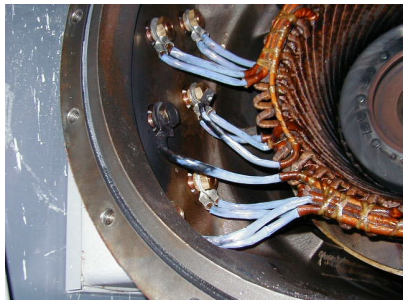
What Causes Current Unbalance?



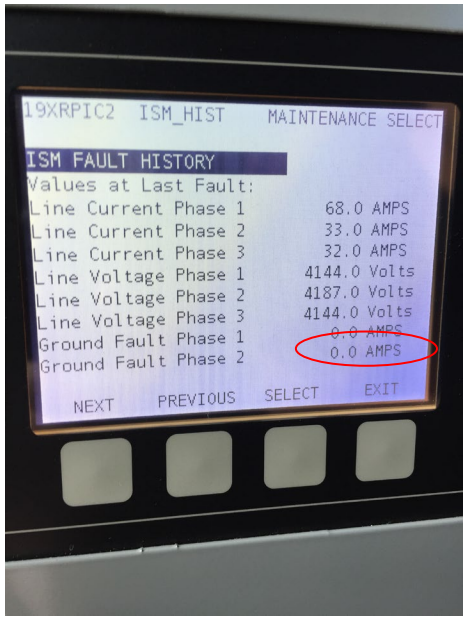
Broken connections



Insulation failure



Winding Damage



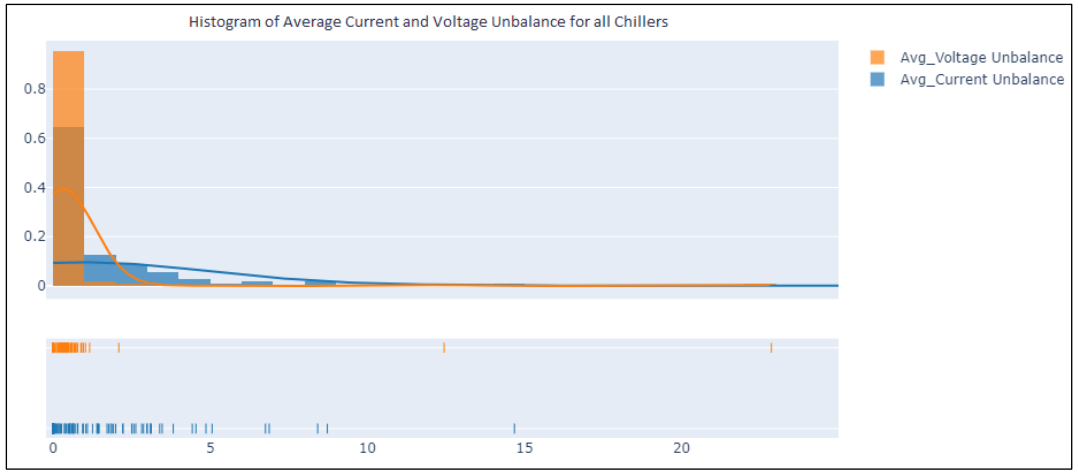
An example of ~53% current unbalance while voltage unbalance is <1%.

Detection Method

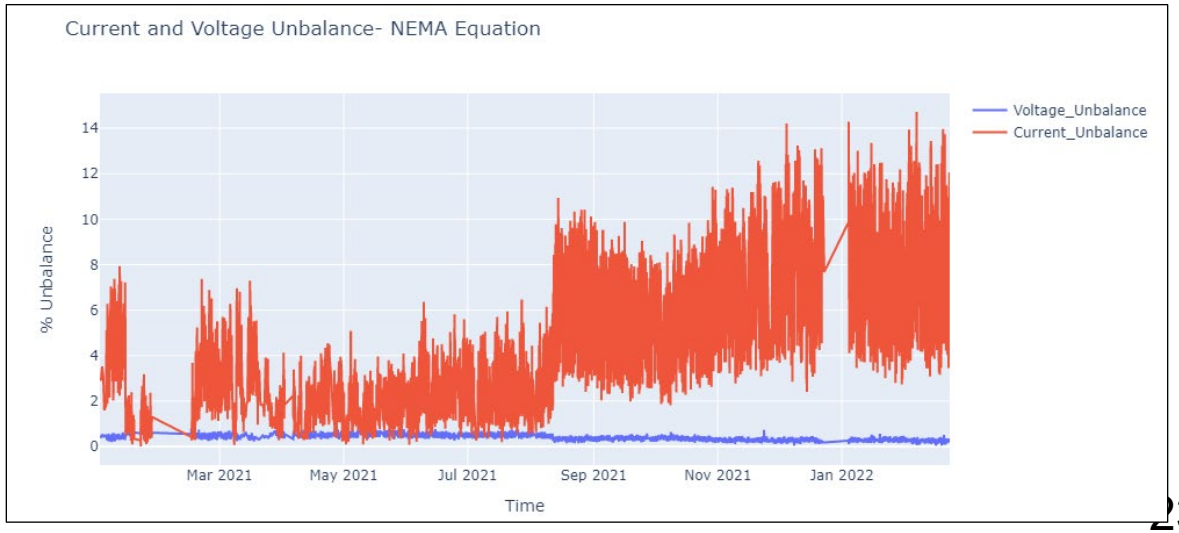
Step-1: Pick chillers with all three-line voltage and current in telemetry

Subsystem	Causes	Variables in telemetry data
Supply side	Voltage unbalance	Line_Current_Phase_1 Line_Current_Phase_2 Line_Current_Phase_3 Line_Voltage_Phase_1 Line_Voltage_Phase_2 Line_Voltage_Phase_3 Percent_Line_Current
Motor side	Bearing	Bearing_Temp
	Stator winding	Comp_Motor_Winding_Temp
	Rotor bar	-
	Motor terminal	-
VFD (if applicable)	-	vfdFaultCode

Step-2: Calculate current and voltage unbalances



Step-3: Identify chillers with abnormal current unbalance



23

HOW CONNECTIVITY WORKS

How it Works

BLUEDGE

ABOUND
HVAC Performance

1. Chiller is connected

2. Carrier IoT platform stores and trends equipment data

3. Carrier Command Center provides continuous monitoring of connected chillers. Monitors for critical alarms and connection status.

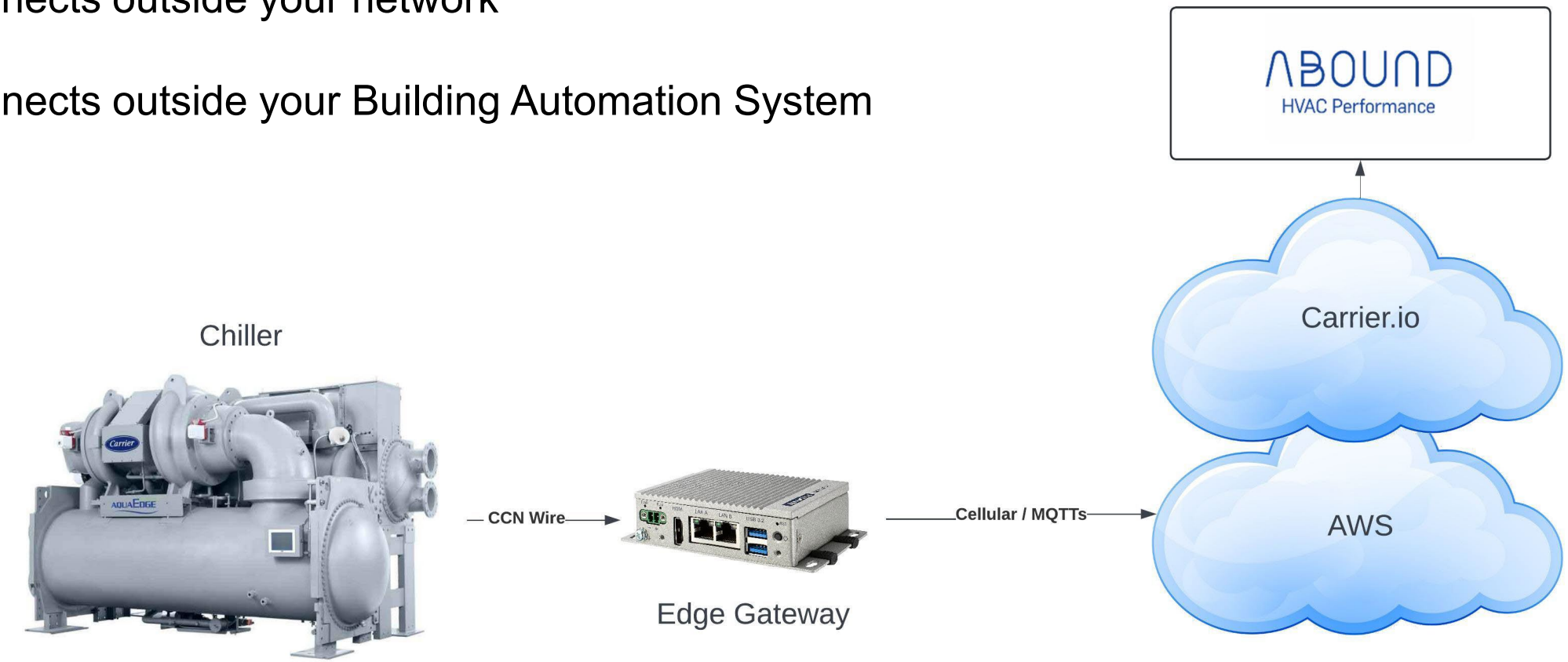
4. Handoff process – Customized with you and your local Carrier service team.

Nearly 40,000 chillers connected globally, with another 25,000 up for connection in 2024

*Based on conditions

How It Works?

- Connects outside your network
- Connects outside your Building Automation System



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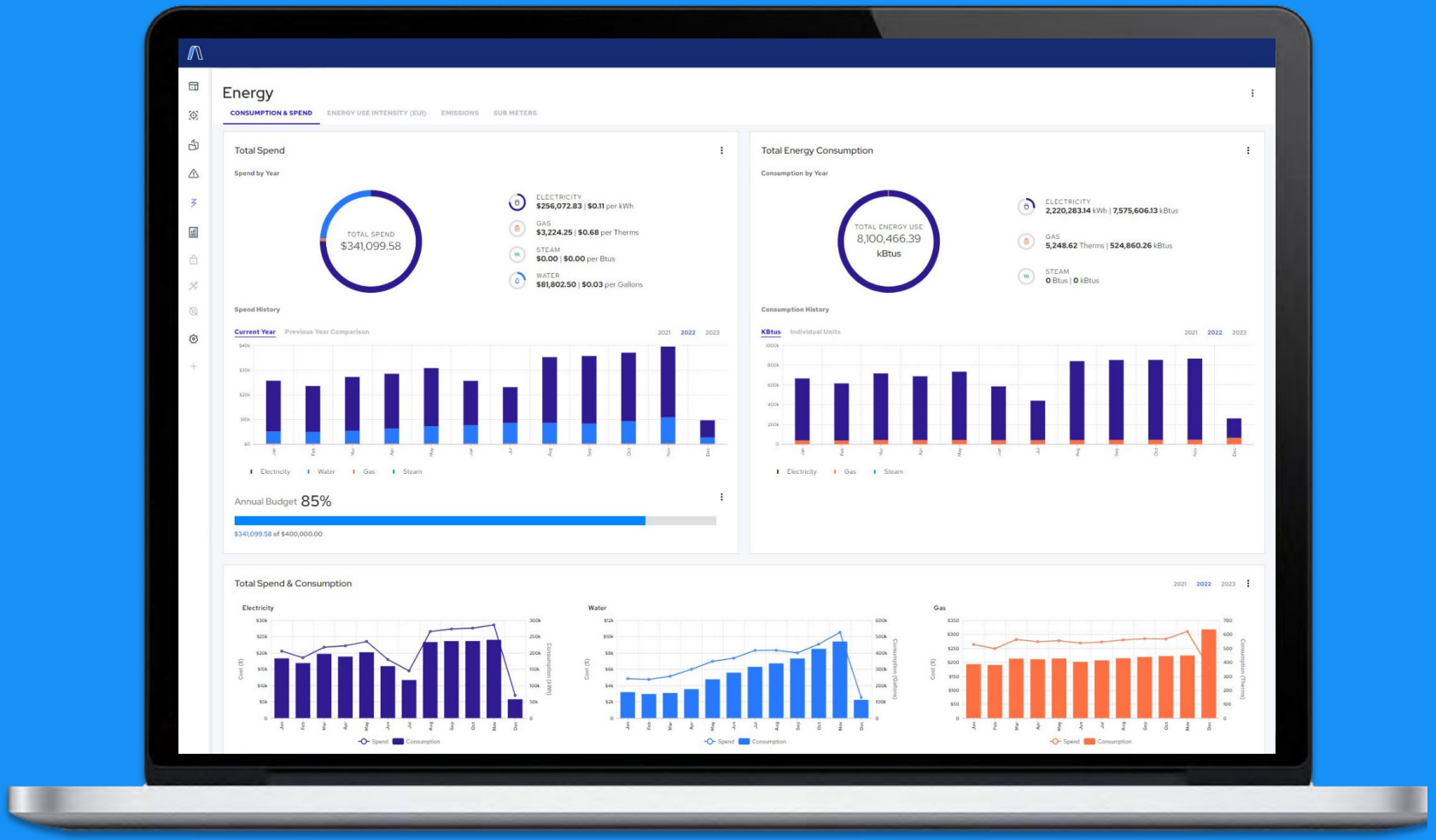
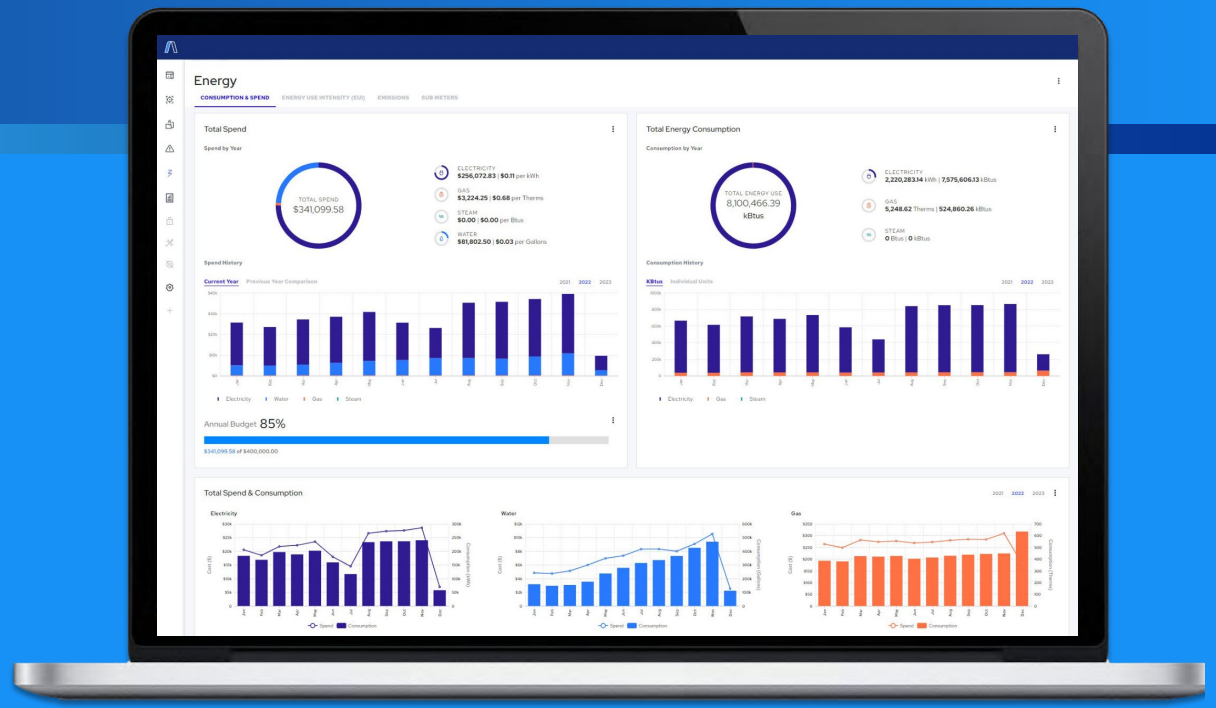
NET ZERO MANAGEMENT

TRACK AND ANALYZE MONTHLY ENERGY USE



NET ZERO MANAGEMENT

TRACK AND ANALYZE MONTHLY ENERGY USE



Abound Net Zero Management Value

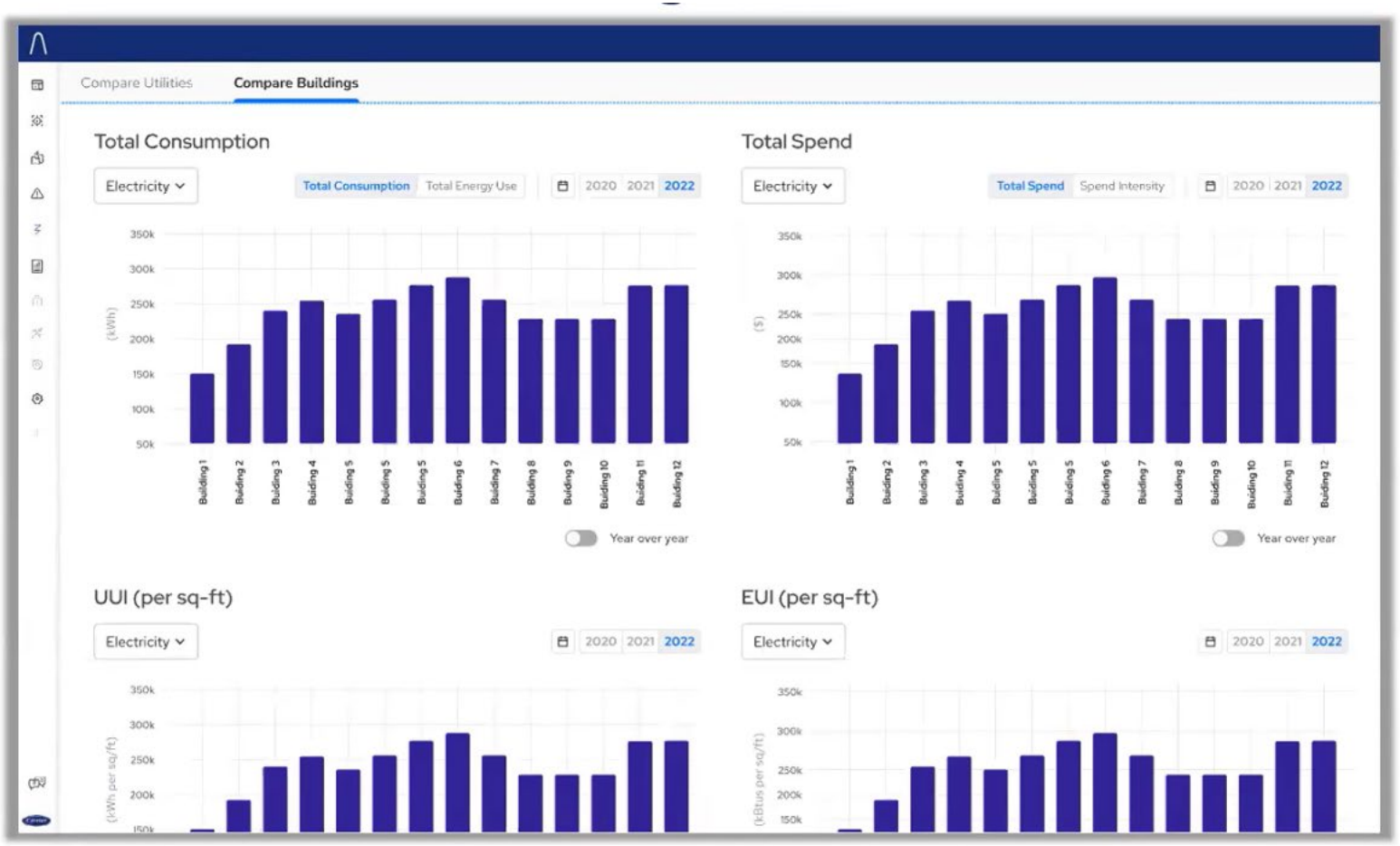
Outcomes Delivered

- **Track and analyze** monthly energy use
- **Benchmark your goals.** Compare before/after for major projects and renovations
- **Compare** against Energy Star
- **Proactively identify** conservation measures
- **Automatically calculate** and convert energy usage data to GHG emissions
- **Report Greenhouse gas Emissions**
- **Enable Measurement & Verification**

Savings Realized

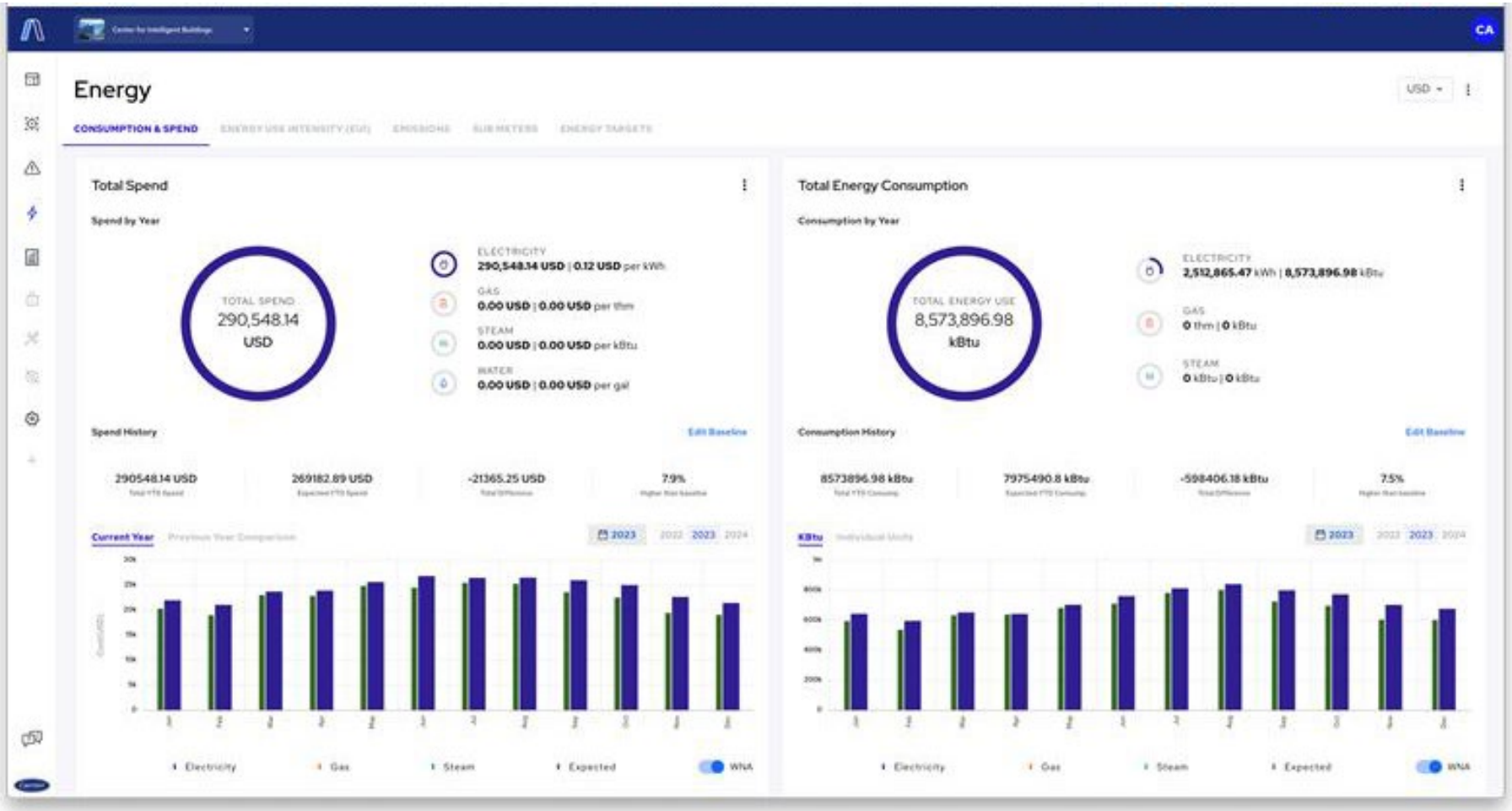
- **Increase productivity** by quickly and easily reporting and archive Energy Usage and Net Zero information
- **Identify poorly performing buildings**
  - Water
  - Electric
  - Gas
  - Steam
- **Decrease Energy Consumption**
- **Identify poorly performing assets** for energy reduction strategies

Portfolio View



- View and Evaluate across your building portfolio
- Total use intensity
- Compare total consumption across buildings
- How much energy is used per square foot
- Where might you need a more in-depth building audit?

Isolate weather's impact on energy analysis



Measure

- View typical costs of building energy data vs. affects of external weather conditions, like changes in temperature, humidity, etc.

Evaluate

- Compare HVAC equipment energy performance across a portfolio of buildings over time
- Calculate avoided costs to better track your performance

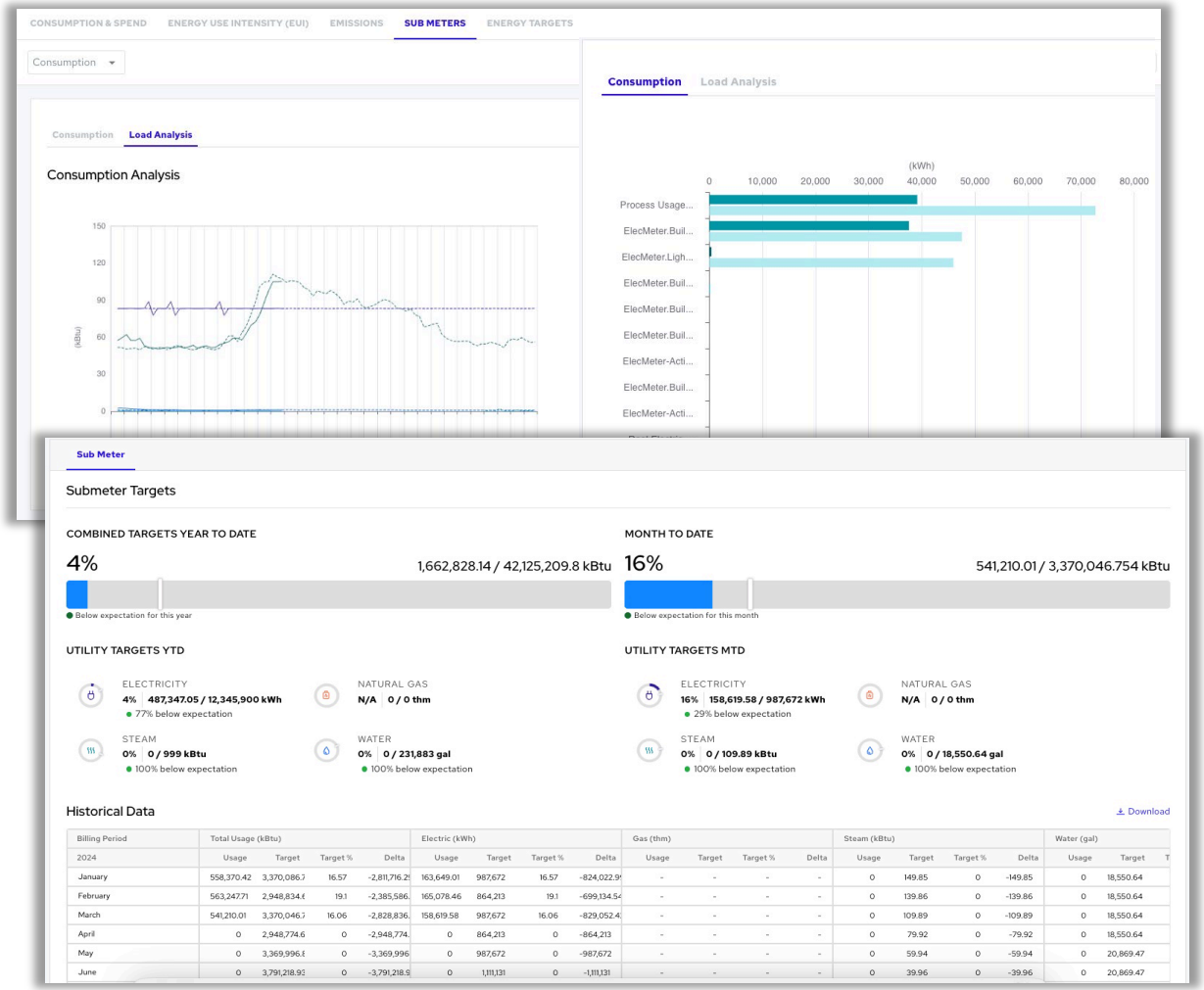
Take Action

- Optimize HVAC systems to improve overall energy performance

Carrier

Carrier

Utilize submeter data to analyze energy costs



Measure

- View real time energy performance and identify trends with precision monitoring

Evaluate

- Benchmark energy usage within buildings or across portfolios

Take Action

- Create custom dashboards and reports; improve compliance and reporting
- Optimize HVAC systems to improve energy performance and reduce costs

Measure

- Set annual building performance targets
- Identify when over or under monthly and yearly budget goals

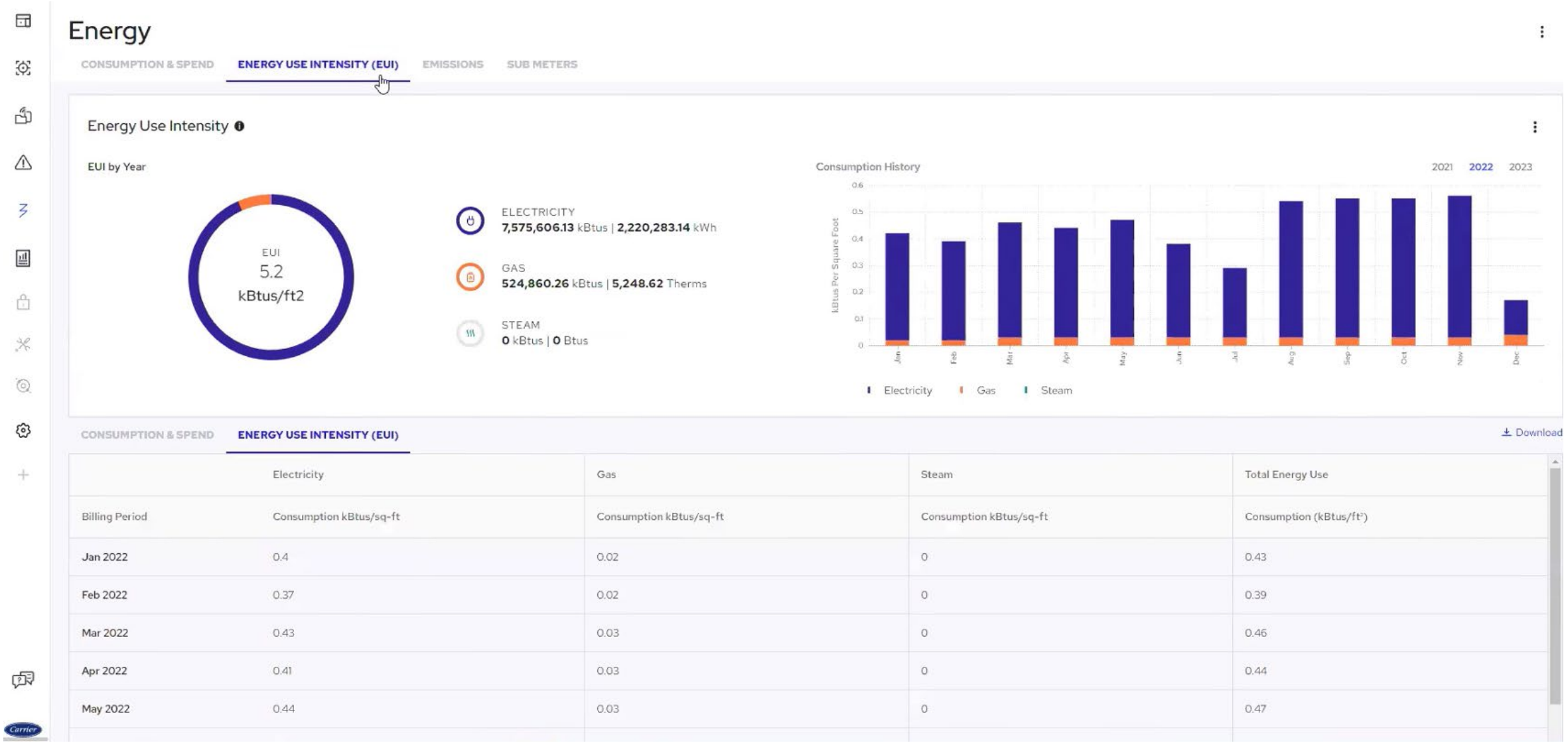
Evaluate

- Track energy conservation goals vs. compliance with performance standards, external benchmarks, or budgets

Take Action

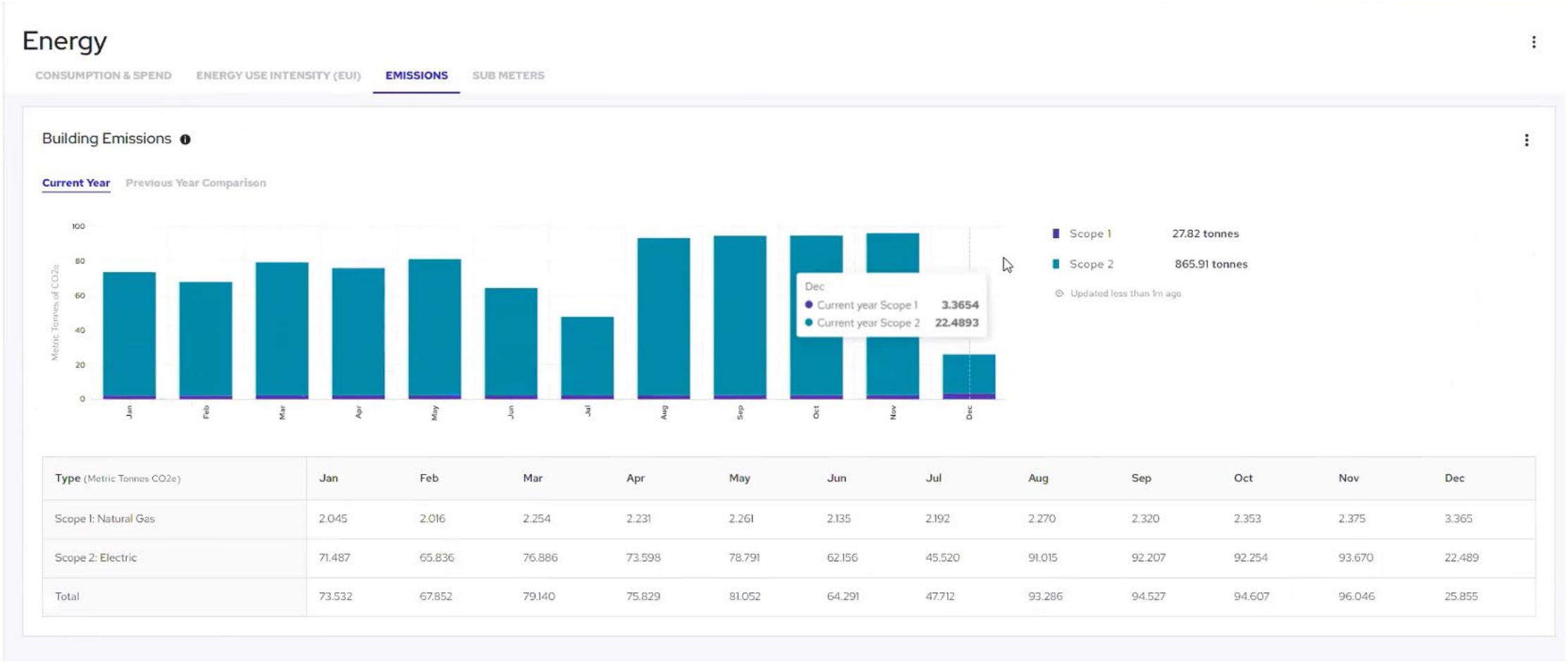
- Optimize HVAC systems to improve overall energy performance

Energy Use Intensity



	Electricity	Gas	Steam	Total Energy Use
Billing Period	Consumption kBtus/sq-ft	Consumption kBtus/sq-ft	Consumption kBtus/sq-ft	Consumption (kBtus/ft²)
Jan 2022	0.4	0.02	0	0.43
Feb 2022	0.37	0.02	0	0.39
Mar 2022	0.43	0.03	0	0.46
Apr 2022	0.41	0.03	0	0.44
May 2022	0.44	0.03	0	0.47

Emission Data View



Type (Metric Tonnes CO2e)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scope I: Natural Gas	2.045	2.016	2.254	2.231	2.261	2.135	2.192	2.270	2.320	2.353	2.375	3.365
Scope 2: Electric	71.487	65.836	76.886	73.598	78.791	62.156	45.520	91.015	92.207	92.254	93.670	22.489
Total	73.532	67.852	79.140	75.829	81.052	64.291	47.712	93.286	94.527	94.607	96.046	25.855