

"Raising the Grade"

*Managing energy, power quality,
and reliability at Canada's
largest university.*



UNIVERSITY OF TORONTO

Introduction



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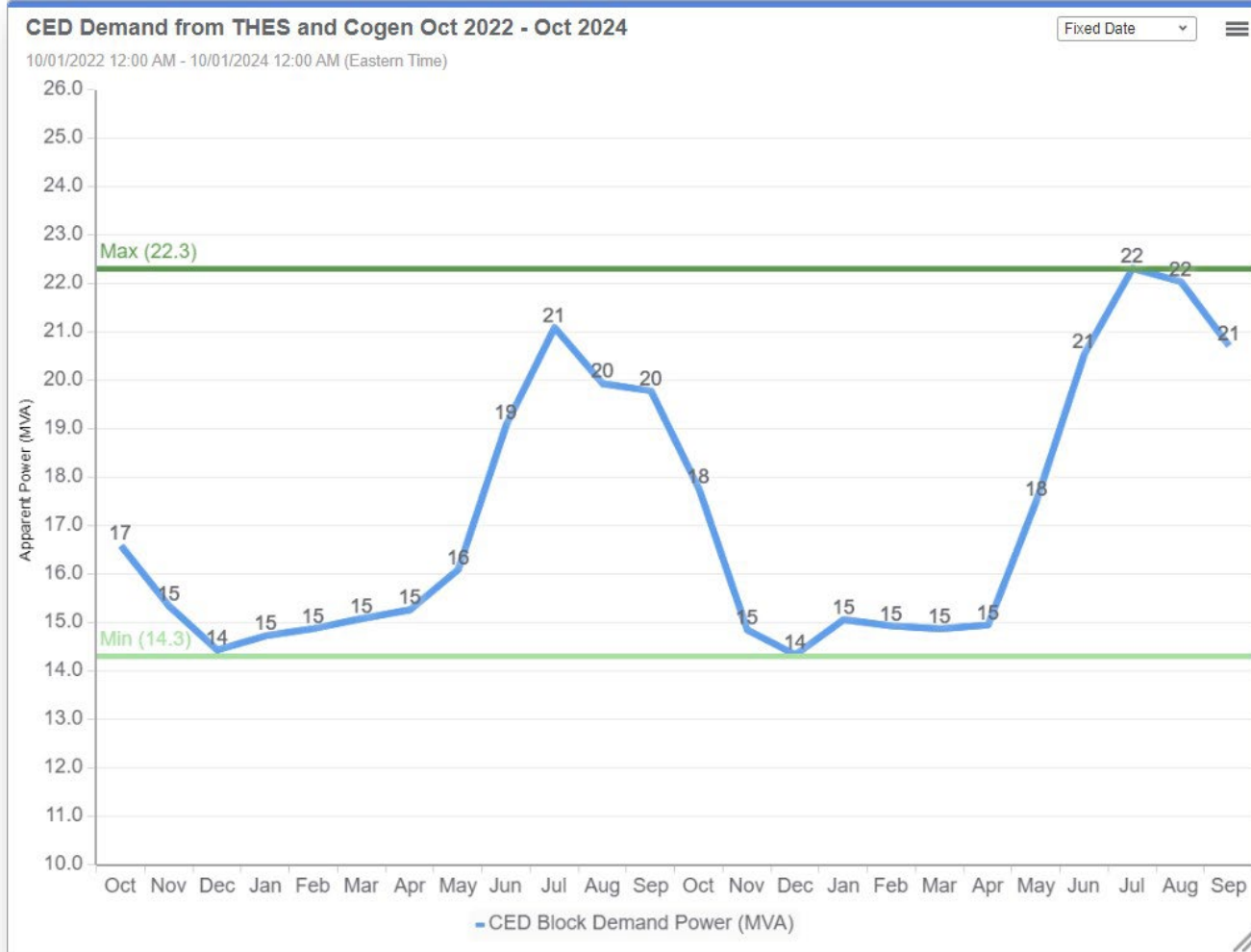
Utilities & Building Operations (UBO)

Quick Facts about St. George Campus



- Founded in 1827 (197 Years old)
- Canada's largest University
- Composed of 130 buildings
- (totaling 14 million sq.ft)
- Located in the heart of Toronto, Canada
 - Bloor Street, Queens Park, College Street, Spadina Ave
- Nearly 100,000 people learn, work and conduct research

Fun Electrical Facts about St. George Campus



- The CED is the Fifth largest Customer for **Toronto Hydro-Electric System Limited (THESL)**
- Over 70 substations on campus
- High Voltage Distribution 4.16kV, 13.8kV, 27.6kV (some satellite locations).
- Low Voltage Distribution 600V/347V, 480V/277V, 416V/240V, 208V/120V
- From October 2022 to October 2024 the Central Electrical Distribution (CED) Distributed on average a demand **14.3 MVA - 22.3 MVA**.
 - This does exclude separately fed THES buildings.

Fun Electrical Facts about St. George Campus



Largest transformer rating is a 4 MVA @ 13.8kV:4.16kV (we have 4 of these).



Natural Gas Cogen at CED that generates a consistent ~5.5 MVA (up to 6.4 MVA).

Fun Electrical Facts about St. George Campus

					
QTY: 138 PM8000	QTY: 101 PM5560	QTY: 49 PM7650	QTY: 25 ION9000	QTY: 11 ION8650	QTY: 2 ACCESS 9610

6 other types compose the remaining 8 devices

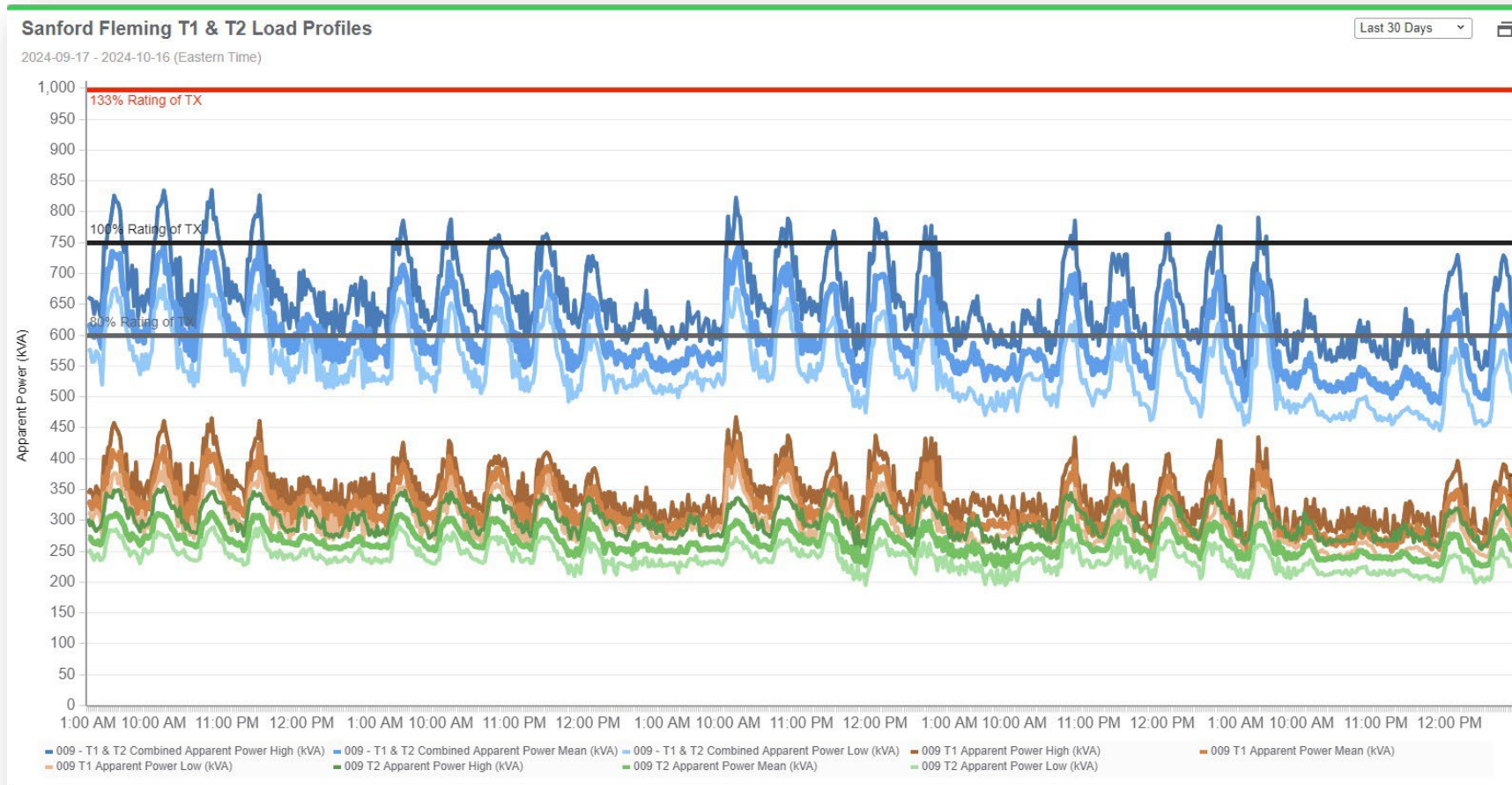
- Power Monitoring Expert (PME)
- Monitoring a total of 334 Devices
 - 12 Different Types.

Dashboard - Transformer(s) NRG Consumption and Load Profile



- Dashboards Monitor, Per Building
 - Transformer Energy (NRG) Consumption (kWh)
 - Transformer Load profile (kVA)

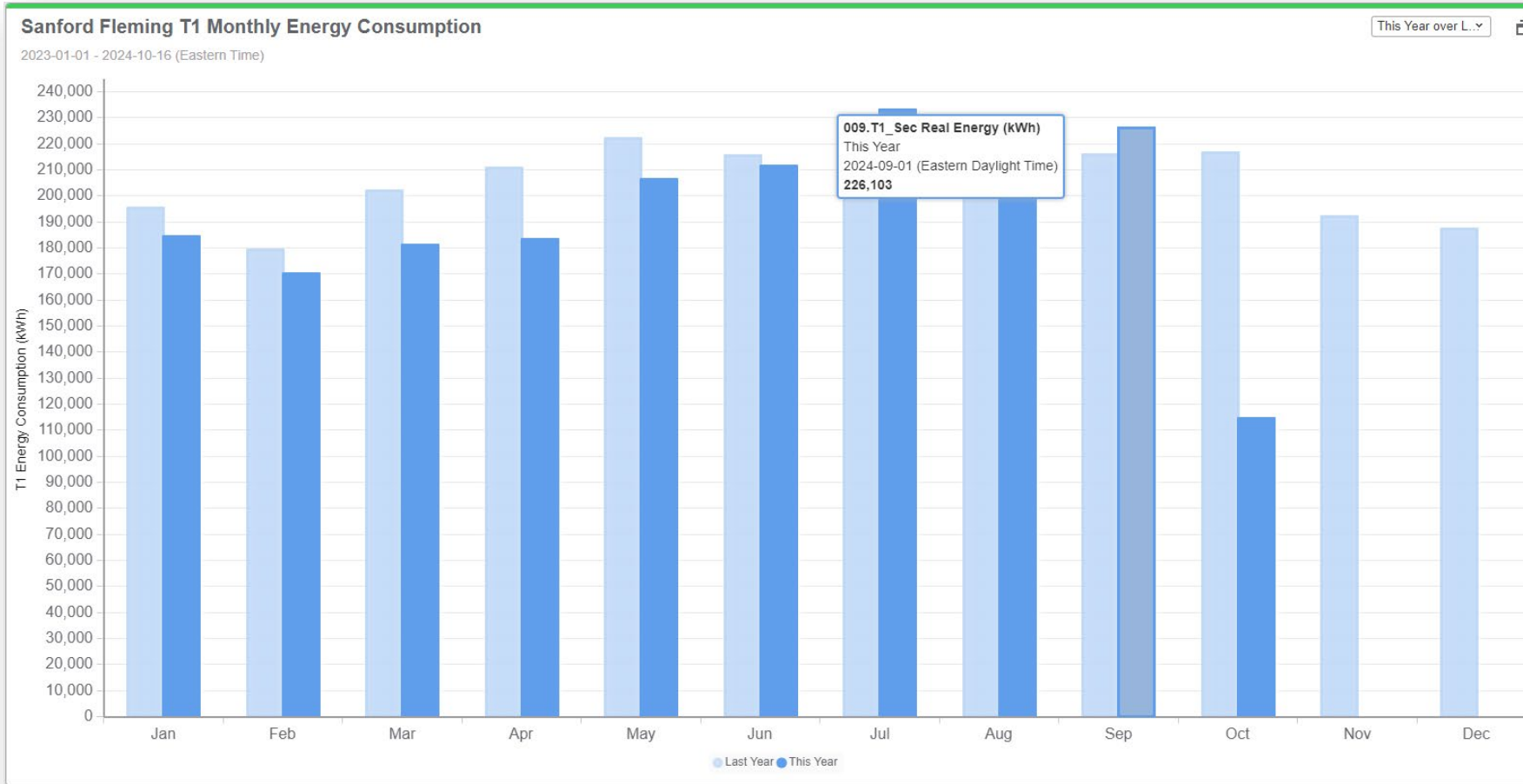
Dashboard - Transformer(s) Load Profile



- Transformer Load Profile
- High, Mean, Low Profiles to show operating range
- Target Lines placed at 80%, 100%, 133% rating of transformer.

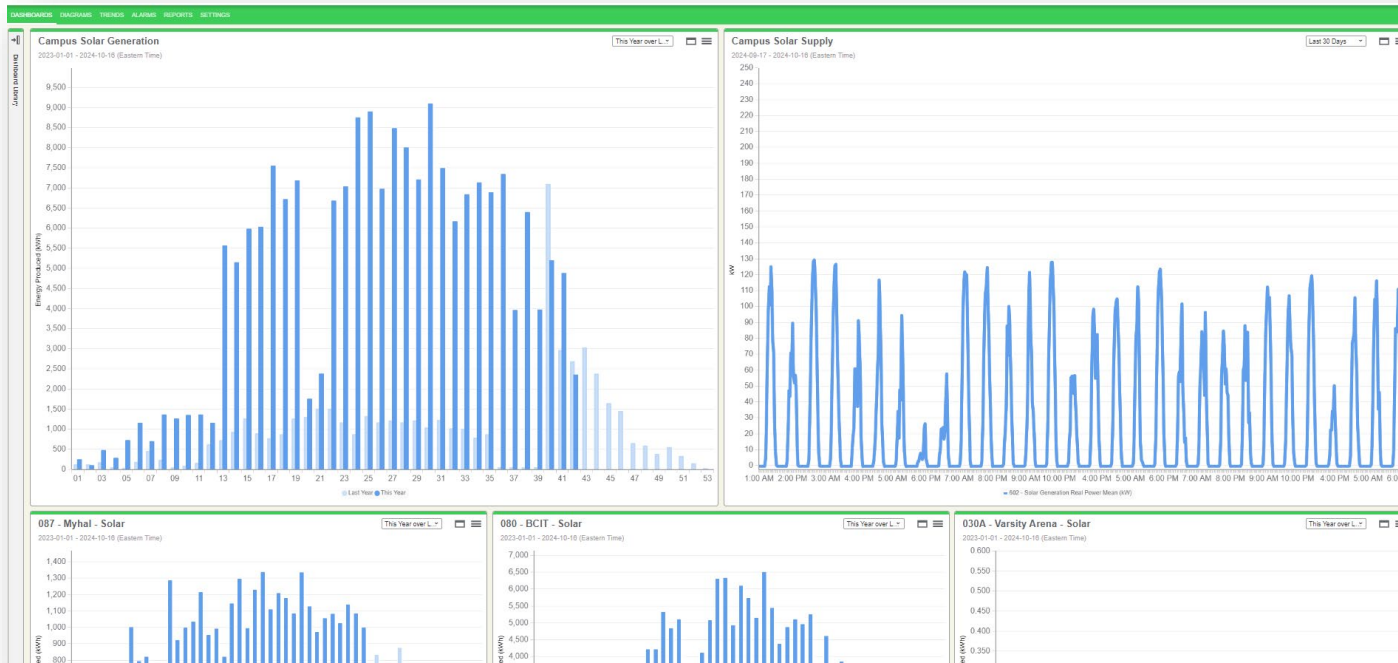
High
Mean
Low

Dashboard - Transformer(s) NRG Consumption



- Energy Consumption
- Monthly Period
 - Data is recorded into spreadsheets for internal billing.
- Comparison from current year to previous year

Dashboard - Solar Power Monitoring

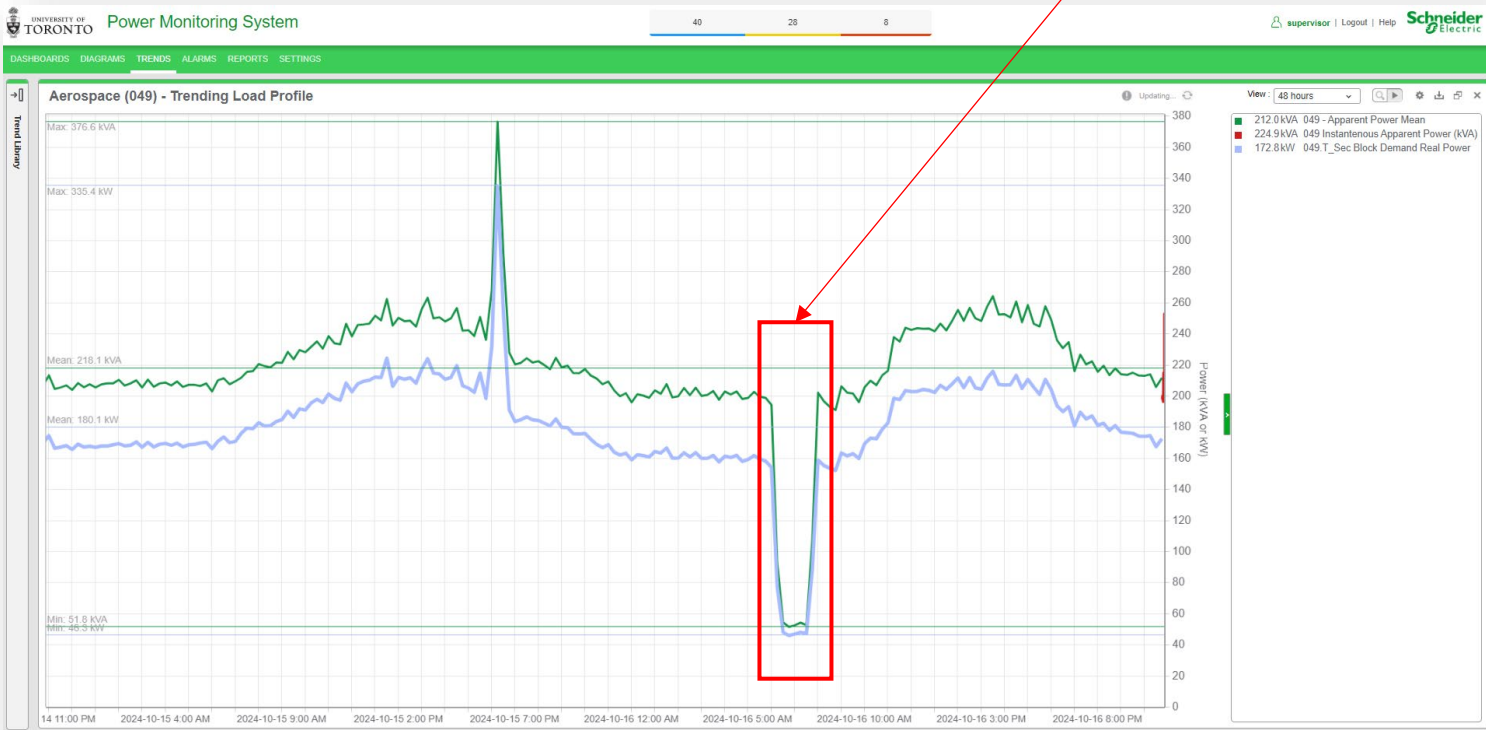


- Monitoring Photovoltaic Systems (PV)
- Solar Capacity across Campus -> 435kW [Sustainability Annual Report 2022](#)
 - Solar Capacity anticipate to double after UTL PV System is Completed [Sustainability Annual Report 2023](#)



Trends

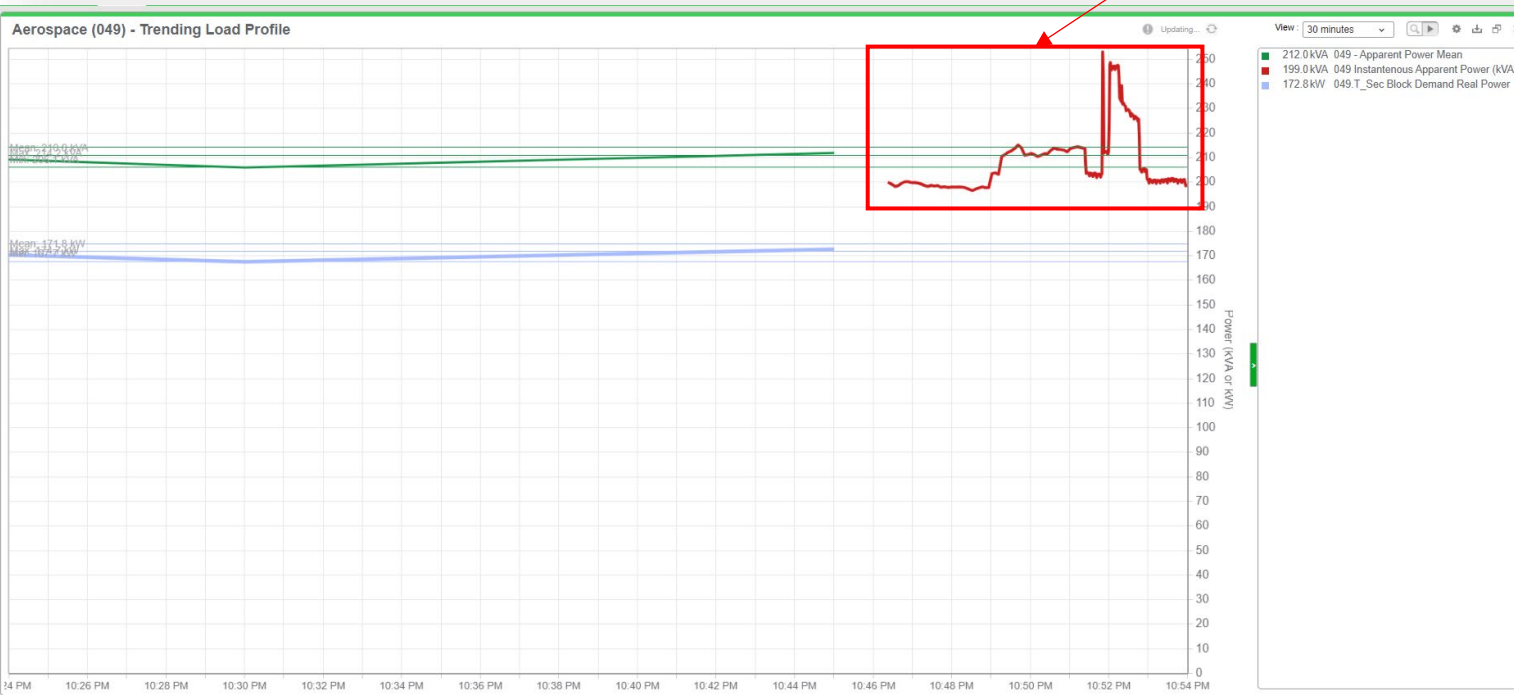
Power Outage



- For quick data analysis (easy to setup)
- Multiple PME device sources
- Checking for power outages
- Reviewing building demand, voltages, currents

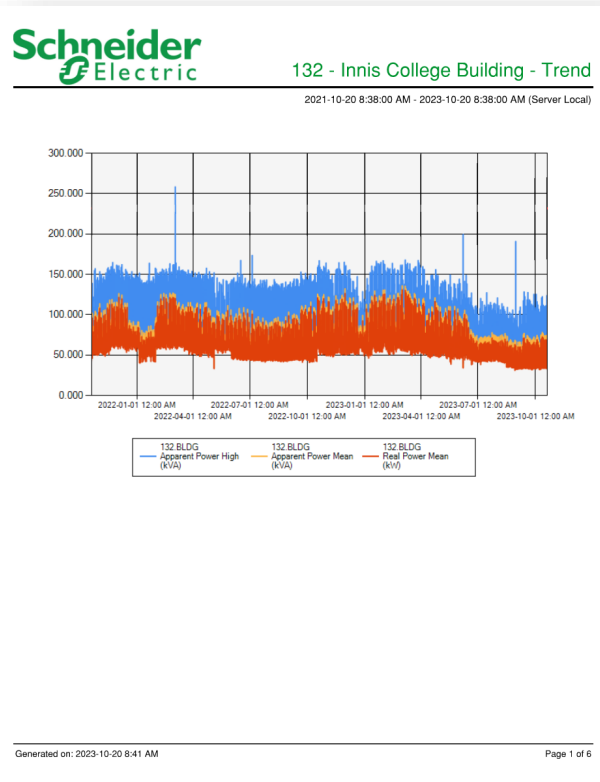
Trends

Live Data

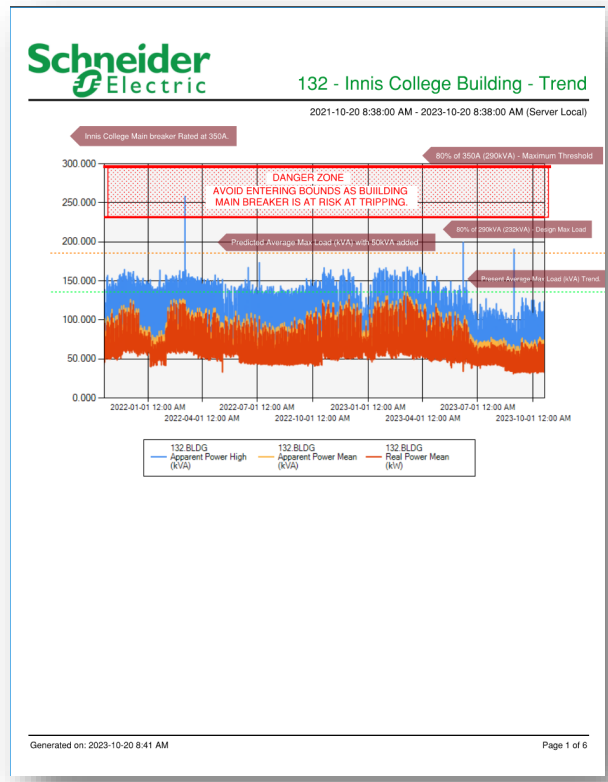


- Live, instantaneous readings
- Great for reviewing load restoration during switching

Reports



Apply Notes relevant to Project



- Viewing long term (> 1 year) trending data.
- Provide reports to project design team for building load profile data.
- We add notes on top of the report to provide guidance
 - Example: temporary power at Innis college

Waveform Capture

UNIVERSITY OF TORONTO Power Monitoring System

40 46 8

DASHBOARDS DIAGRAMS TRENDS ALARMS REPORTS SETTINGS

Device Diagram Change Date Range Show Waveforms

080.PV

Timestamp	Cause	Cause Value	Effect	Effect Value	V1 Waveform	V2 Waveform	V3 Waveform	I1 Waveform	I2 Waveform	I3 Waveform	
10/3/2024 8:23:28.784 AM	Sag/Swell 1	Disturbance End	Voltage Disturbance State	Normal	-	-	-	-	-	-	Select all
10/3/2024 8:23:28.709 AM	-	-	-	-	--	--	--	--	--	--	Select all
10/3/2024 8:23:28.701 AM	Disturbance Direction Detection 1	Analysis Done	Disturbance Direction Detection 1	Disturbance Direction Detected - Upstream - Medium Confidence	--	--	--	--	--	--	Select all
10/3/2024 8:23:28.701 AM	Sag/Swell 1	Disturbance Start	Voltage Disturbance State	Disturbance	-	-	-	-	-	-	Select all

Device Diagram Change Date Range Show Table Compare Waveforms... Export Waveform...

080.PV

Display Mode: bmp, bwp, bwp

Analysis Mode: Region, Cursor

Channels: V1, V2, V3, I1, I2, I3

Trigger Time: 8:23:28.700 AM

Disturbance Information: V2: 78.0%, 83.0 ms 1

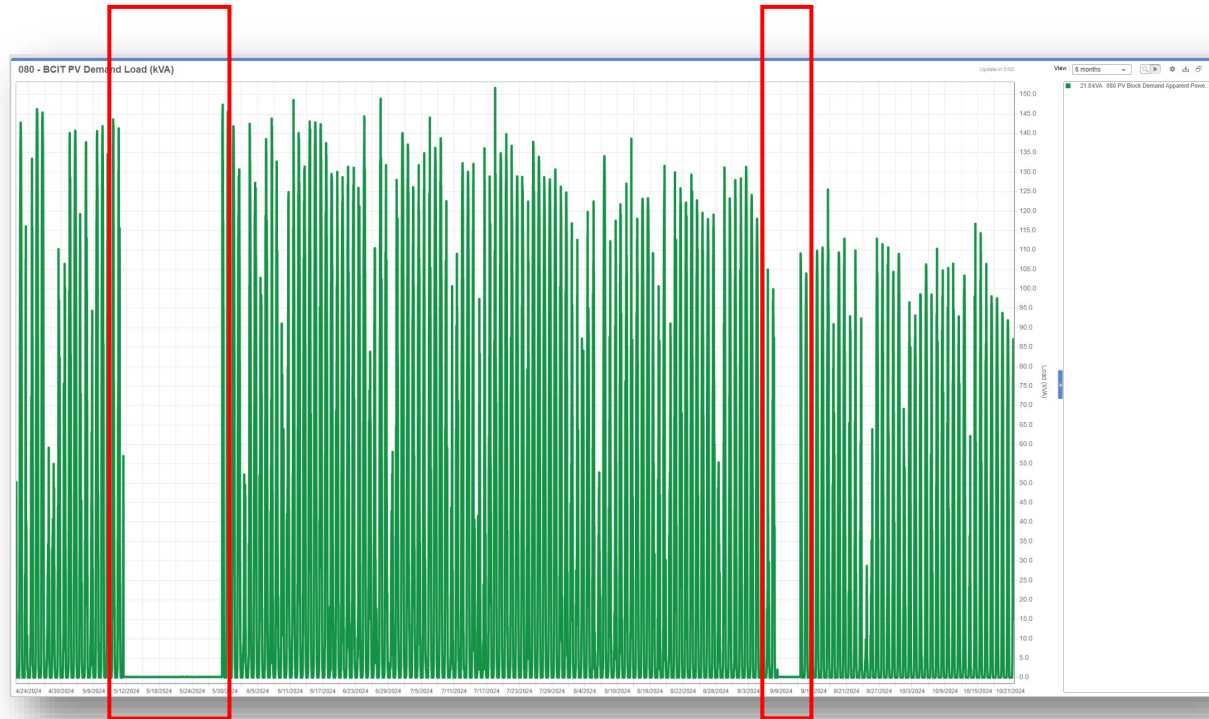
Advanced Options

Disturbance Captured

Diagrams > Power Quality > Disturbances

- Lists all disturbances and waveforms that have been captured.
- Shows timestamp and length of PQ events
- Direction of disturbance (upstream vs. downstream).
- Good for preliminary basic PQ Waveform analysis

Waveform Capture

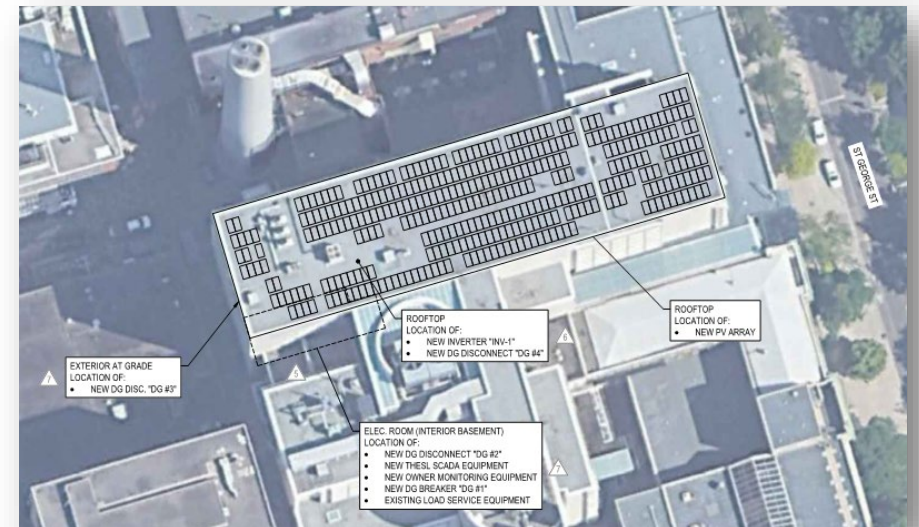


PV System Outage Period 1

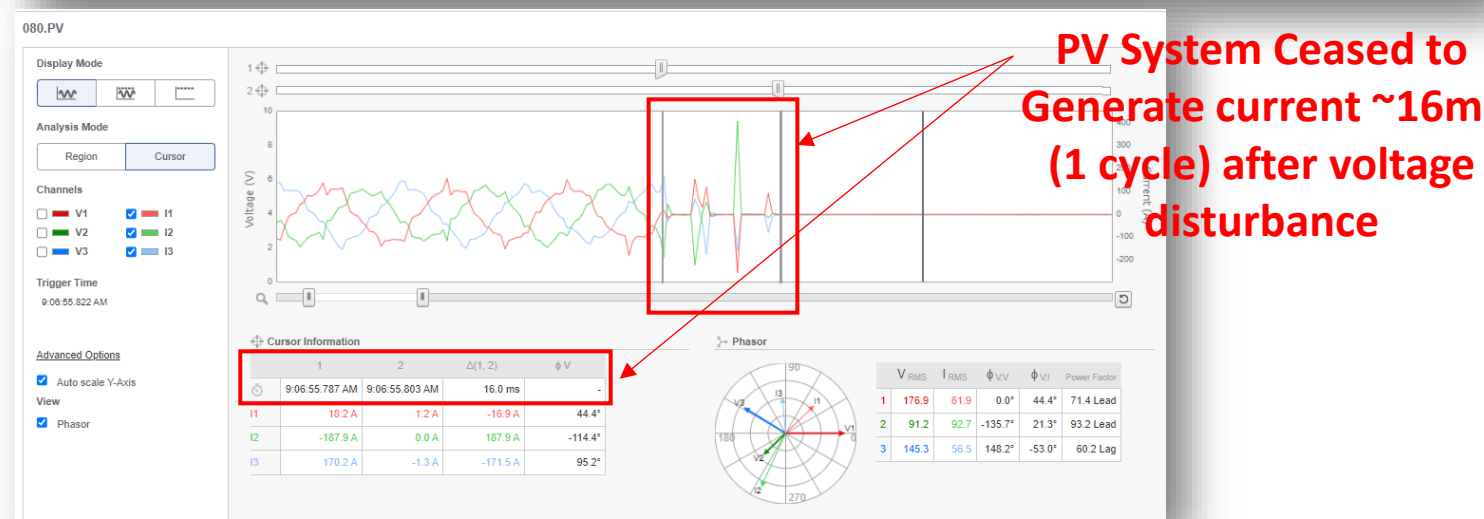
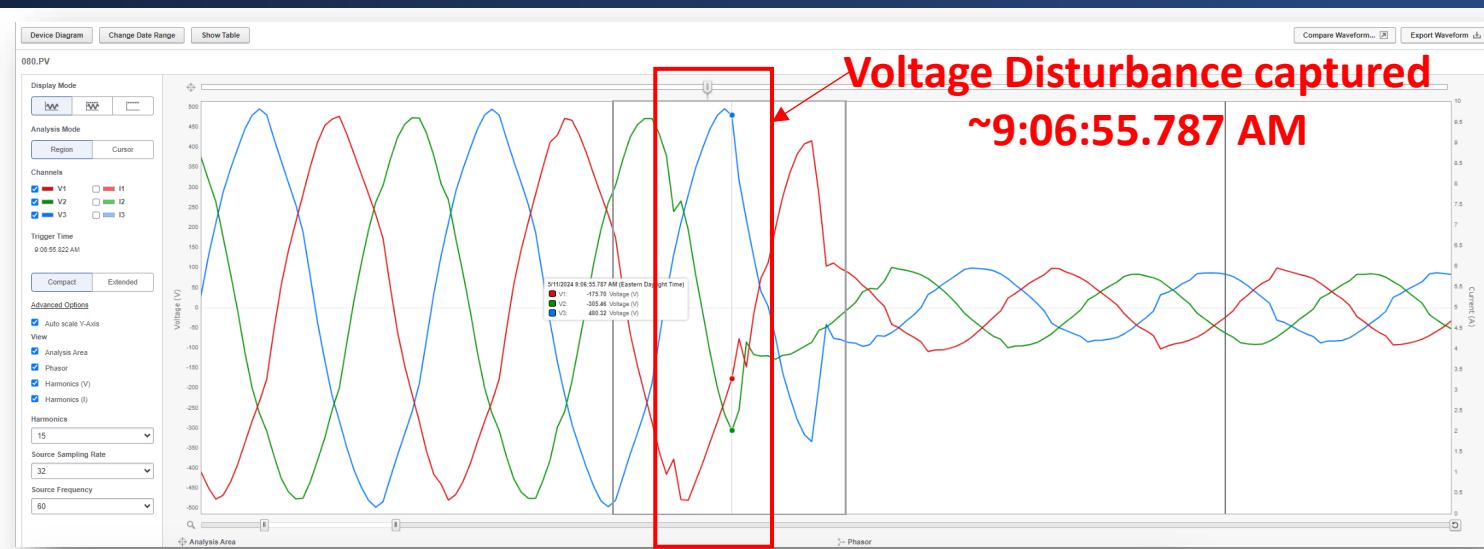
PV System Outage Period 2

Problem:

- A relatively new PV System at St. George Campus was intermittently ceasing power generation.
- The output breaker would trip, without the system providing feedback for reason of trip.



Waveform Capture



- Fortunately, there was a PM8000 installed that was recording for PQ events
- PV System Outage Period 1 was assessed to determine a voltage sag event was present.
- Undervoltage Relay (27) was theorized to be present within the protection scheme.
- IEEE 1547 “cease to energize” procedure during undervoltage/overvoltage events.

Waveform Capture



Further Investigations:

- Output breaker was a Schneider PowerPacT J Frame
- Breaker is equipped with a Schneider Undervoltage trip (27) accessory (P29406).
- The Undervoltage trip does not come with a time delay, and instantly trips
- System does not come with an automatic reclosing scheme.



Undervoltage Trip (MN)
H-, J-, and L-Frame

Instantaneously opens the circuit breaker when the under-voltage trip supply voltage drops to a value between 35% and 70% of its rated voltage. Closing is allowed when the supply voltage of the undervoltage trip reaches 85% of rated voltage.

3rd Party Devices: Battery Chargers

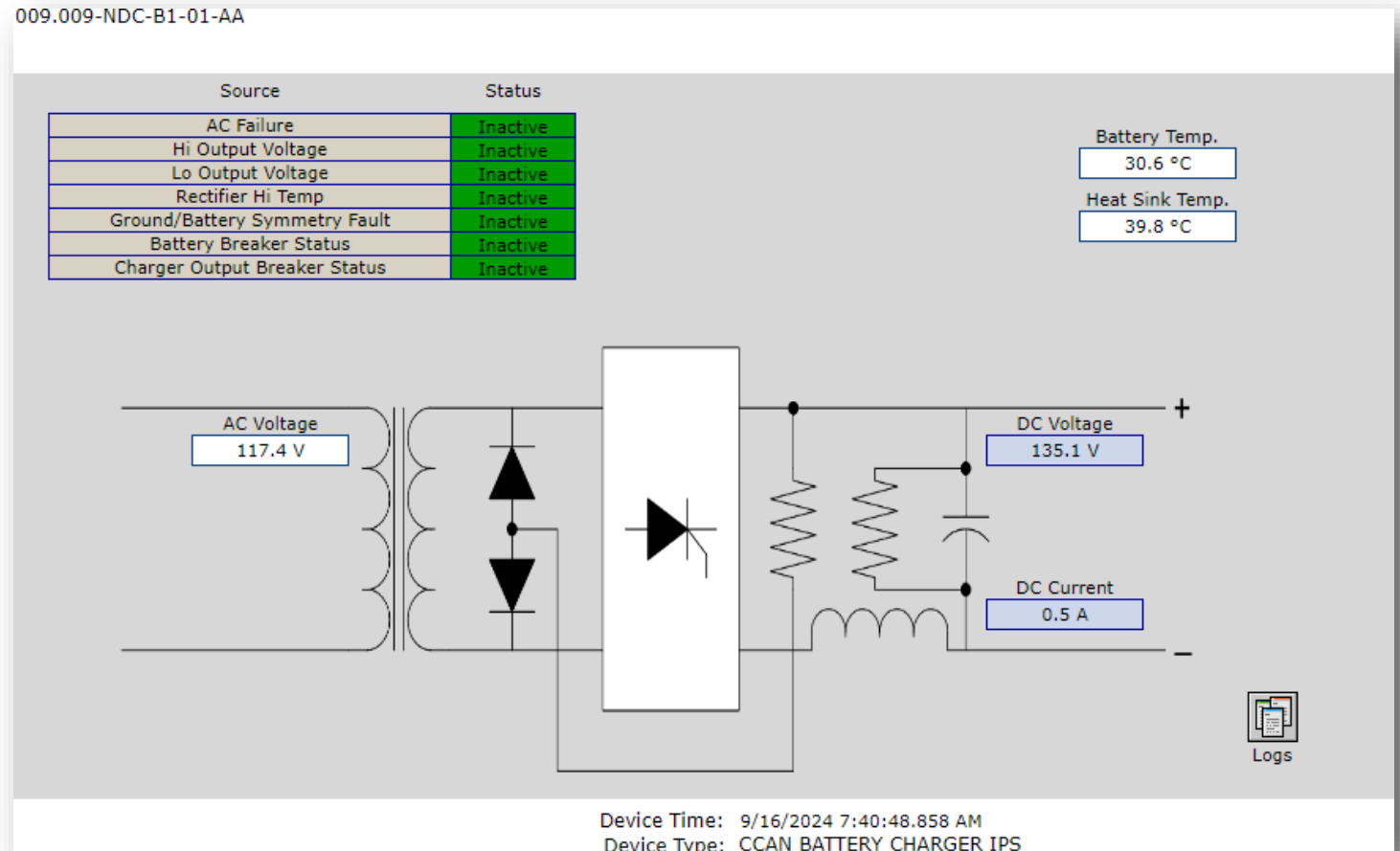


- Real-time monitoring of 3rd party devices over Modbus
- Logging of analog data values.
- Configuration of setpoint-based software alarms

3rd Party Devices: Battery Chargers



009.009-NDC-B1-01-AA



Device Time: 9/16/2024 7:40:48.858 AM
Device Type: CCAN BATTERY CHARGER IPS

3rd Party Devices: Battery Chargers

47 sec ago

AC Failure – Output Status 001

General Setpoint

009.009-NDC-B1-01-AA

[Acknowledge](#) (1 occurrences)

8/19/2024 9:29:38.383 AM

1

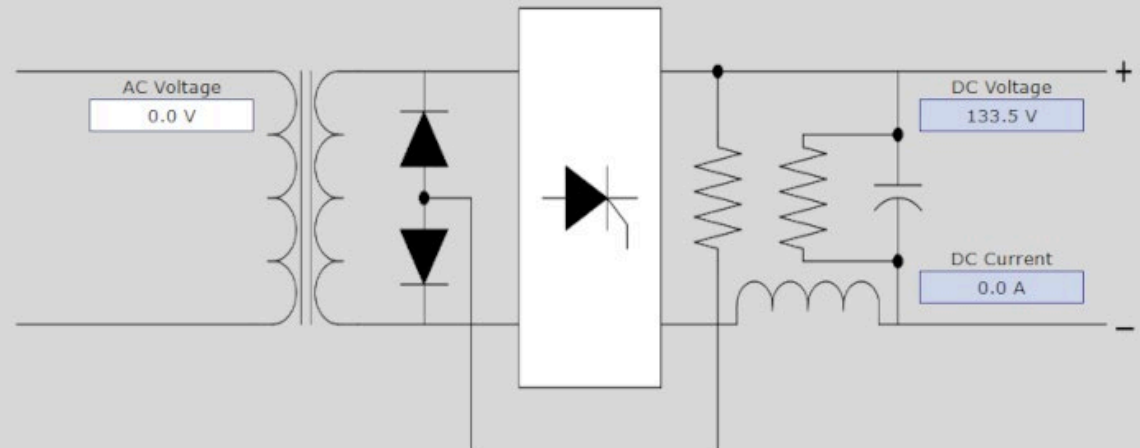


009.009-NDC-B1-01-AA

Source	Status
AC Failure	Active
Hi Output Voltage	Inactive
Lo Output Voltage	Inactive
Rectifier Hi Temp	Inactive
Ground/Battery Symmetry Fault	Inactive
Battery Breaker Status	Inactive
Charger Output Breaker Status	Inactive

Battery Temp.
30.0 °C

Heat Sink Temp.
38.8 °C






Device Time: 8/19/2024 9:26:30.234 AM
Device Type: CCAN BATTERY CHARGER IPS

3rd Party Devices: Battery Chargers

009.009-NDC-B1-01-AA ← Back to Volts/Amps

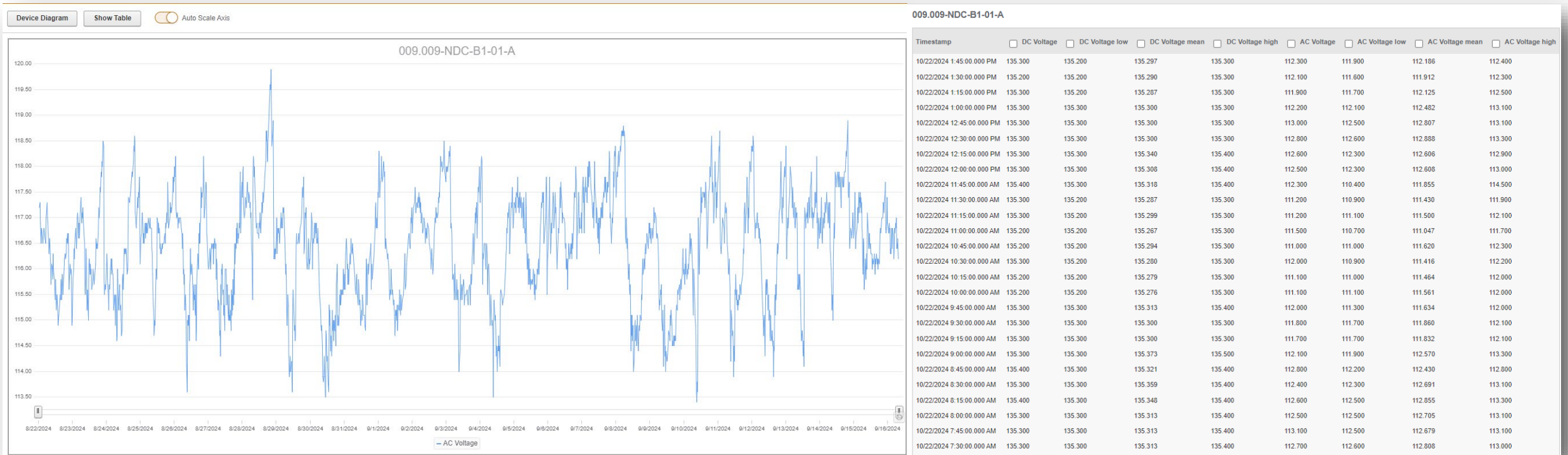
Historic Data Logs

Trending

- Voltage 
- Rectifier Current 
- Temperatures 

Device Time: 10/21/2024 3:10:14.243 PM
Device Type: CCAN BATTERY CHARGER IPS

3rd Party Devices: Battery Chargers

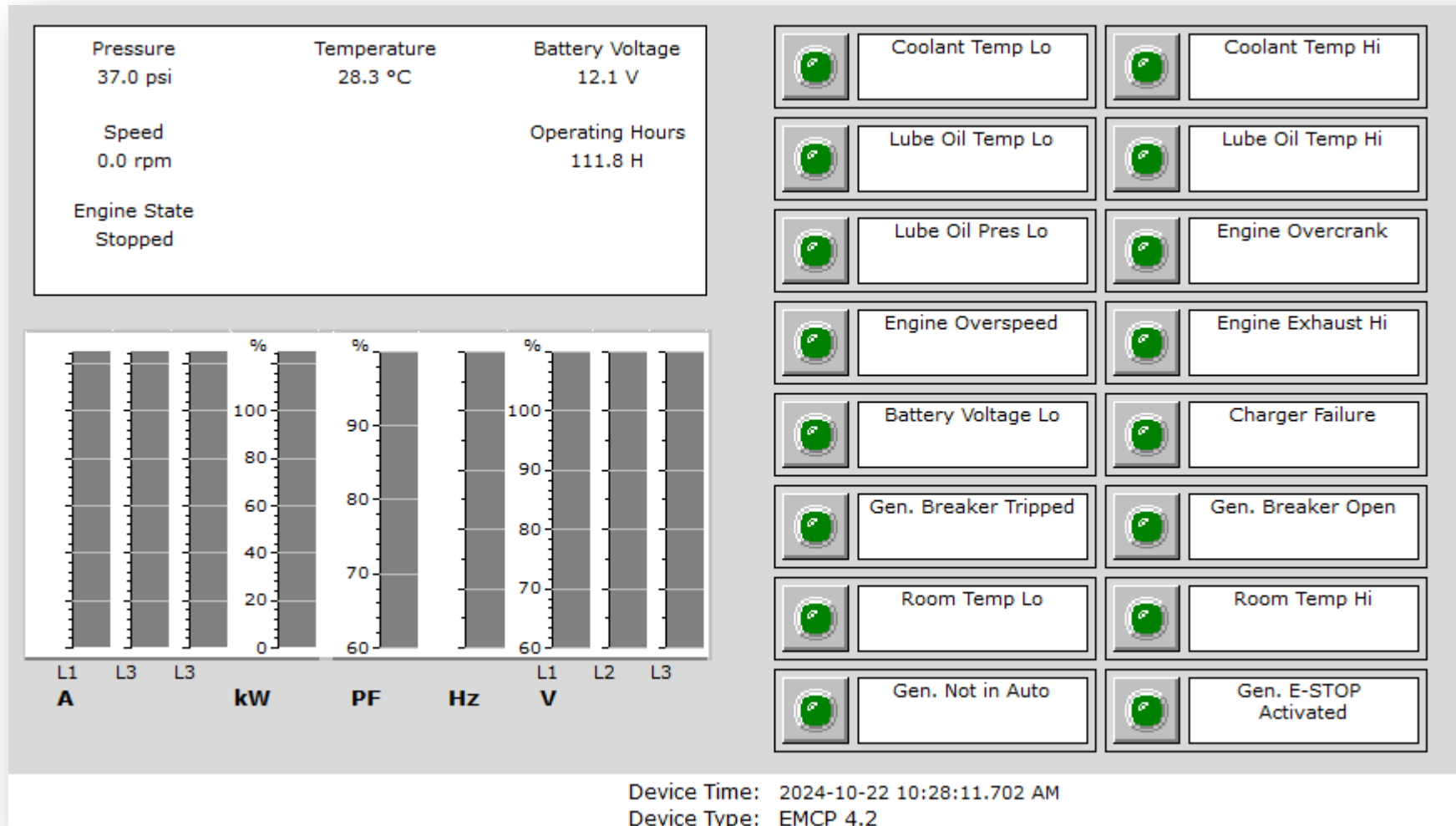


3rd Party Devices: Emergency Generators



- Life Safety equipment
 - Exhaust Fans
 - Elevators
 - Fire Prevention Systems
- Non-Life Safety Equipment
 - Data Centers
 - Refrigeration
 - Research equipment

3rd Party Devices: Emergency Generators



Assessment of PME

PROS

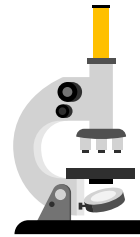
- Easy plug and play solution for Schneider electric meters
- Very good support staff via the Digital Service Plan
 - [PME – Schneider Electric Community](#)
- Power Advisor feature
- PQ event and waveform captures are detailed
- Web Application is User friendly.

CONS

- PME is not very friendly to other manufacturer devices
 - Limits features such as waveform capture (ION protocol is proprietary, not open source).
- Alarm management is an overwhelming task (hanging alarms)
 - Custom measurements don't always appear when creating software alarms (Important for 3rd party device monitoring).
- PME doesn't come with all the "modules" included providing full functionality of application.
 - IE: Notification module, Data Exchange
- Issues with specific meter:
 - PM8000s/ION9000s do not have waveform captured enabled by default.
 - PM8000s/ION9000s during power outages may not always capture the waveforms prior to device shutoff.
 - PM5560s have communication dropout issues.

Final Thoughts

- PME has drastically improved system visibility on campus
- Faster F&S response times
- Capability of PQ analysis
- Improved billing process
- Improved data sharing with project teams



Thank you!



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