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Energy Management

Efficiency, Uptime, Protecting People & Equipment

GEAPS EXCHANGE
KANSAS CITY • 2022

Matt Zabel

Faith Technologies

System Architect

FAITH TECHNOLOGIES®

A DIVISION OF FTI

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KANSAS CITY • 2022

Energy Management

Efficiency, Uptime, Protecting People & Equipment

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Agenda

- Background / quick audience poll
- Electric & Gas Bill overview
- What is a good starting point for an EMS at a grain facility & why?
- Problems that you can solve with the information from an EMS
- What to do if you find or suspect bad power quality?
- Energy Management System Payback

Matt Zabel – Quick Background

- Graduated from UW - Madison May 1999 BSEE
- Volunteered for 2 years in Eastern Europe
- Worked at Kimberly-Clark Corporation for 10 years
  - Automation Engineer / Technical Trainer / Project Leader
- Worked at SCA (now Essity) Tissue Mill for 2.5 years
  - Lead Electrical Engineer (Automation / Power)
- Faith Technologies – past 6 years
  - Senior Electrical Engineer – Traditional Electrical Engineer
  - Application Engineering Manager – Power Equipment
  - System Architect – Power Monitoring & Automation PM

Kimberly-Clark

SCA

FAITH TECHNOLOGIES

Quick Poll

1. How many of you monitor the gas or electrical usage at your facilities?
2. A few people – Why?
3. What are the biggest objections people in your organization have against investing in energy monitoring and management?

Electric Bills – Secondary Service

Electric Service for 07/23/18 to 08/21/18 (29 Days) - 22 Heating Degree Days / 198 Cooling Degree Days

On Peak Period : 9am to 9pm

Electricity

Meter Number.....PNXZT20541

On Peak

Actual Reading on 08/21/18..... 6326
Actual Reading on 07/23/18..... 6200
Difference..... 126
Meter Multiplier..... x 300

On Peak Electricity 37,800kWh

Total

Actual Reading on 08/21/18..... 16909
Actual Reading on 07/23/18..... 16584
Difference..... 325
Meter Multiplier..... x 300

Total Electricity 97,500kWh

Actual Maximum Demand (08/08/18 @ 19:45)
.....519.000kw
Actual On-Peak Demand (08/08/18 @ 19:45)
.....519.000kw

Total Usage Period : 07/23/18 to 08/21/18

Billed On-Peak Demand 519.000kw
Customer Demand 03/22/18 - 04/23/18
606.000kw
Hrs Use Dem Red
2.241000CR
((100 - 37,800 kWh / 519.000) * .083000)

Total Electricity for All Meters 97,500
Total On-Peak Electricity 37,800
Total Off-Peak Electricity 59,700

Next Scheduled Meter Reading Date..... 09/20/18

Current Electricity Charges

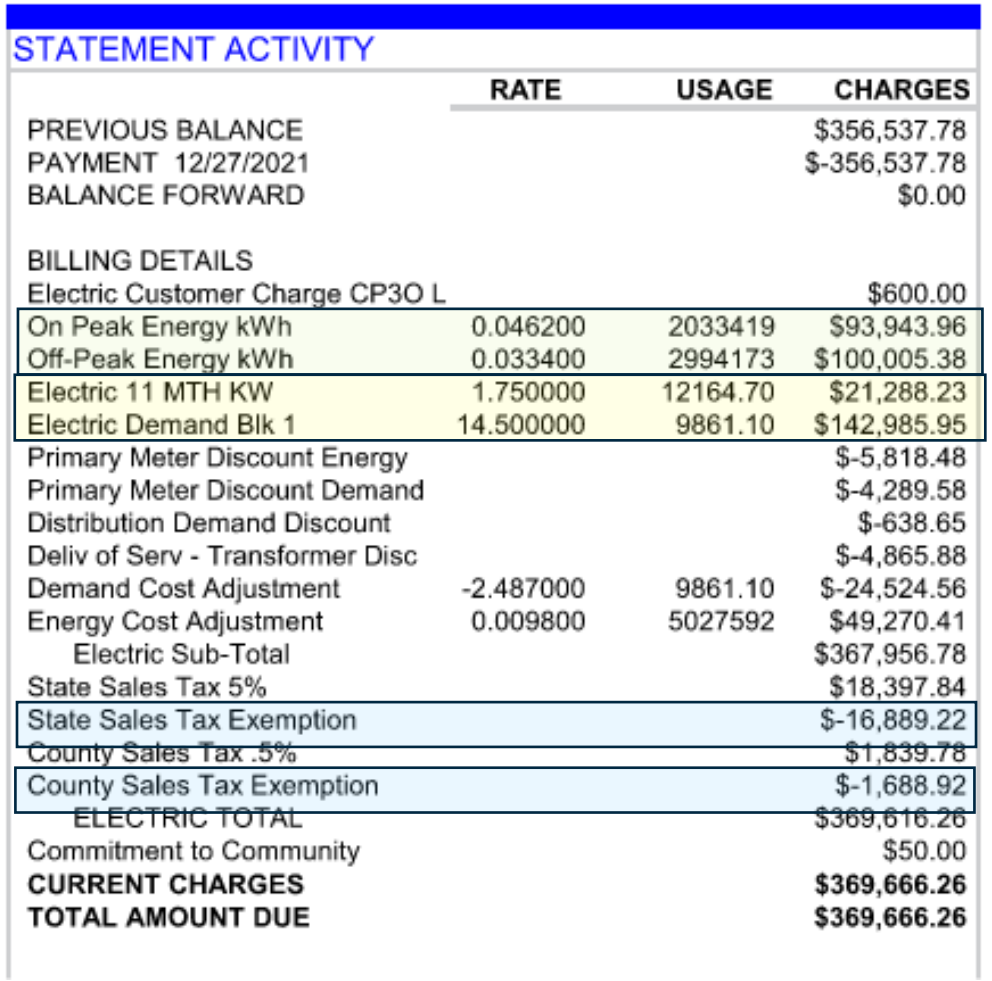
Gen Secondary Large TOU Demand - CG3 29 Days

Customer Demand Charge (606.00 kw x $1.850000/kw)	$1,121.10
On-Peak Demand Charge (519.00 kw x $13.800000/kw)	$7,162.20
Hours of Use Demand Credit (519.00 kw x $2.241000-/kw)	$1,163.08CR
Facilities (29 days x $1.125900/days)	$32.65
State Low-Income Assistance Fee	$31.59
2017 Tax Cut Credit (97,500 kWh x $0.000500-/kWh)	$48.75CR
Energy - Off Peak (59,700 kWh x $0.056220/kWh)	$3,356.33
Energy - On Peak (37,800 kWh x $0.078420/kWh)	$2,964.28
Fuel Cost Adjustment - On Peak (37,800 kWh x $0.002930-/kWh)	$110.75CR
Fuel Cost Adjustment - Off Peak (59,700 kWh x $0.002930-/kWh)	$174.92CR

Total Electricity Charges $13,170.65

- kW Demand Charges
- kWH Usage Charges
- Facilities Charges
- Other Taxes
- Other Credits

Electric Bills – Primary Service



STATEMENT ACTIVITY

	RATE	USAGE	CHARGES
PREVIOUS BALANCE			$356,537.78
PAYMENT 12/27/2021			$-356,537.78
BALANCE FORWARD			$0.00
BILLING DETAILS			
Electric Customer Charge CP3O L			$600.00
On Peak Energy kWh	0.046200	2033419	$93,943.96
Off-Peak Energy kWh	0.033400	2994173	$100,005.38
Electric 11 MTH KW	1.750000	12164.70	$21,288.23
Electric Demand Blk 1	14.500000	9861.10	$142,985.95
Primary Meter Discount Energy			$-5,818.48
Primary Meter Discount Demand			$-4,289.58
Distribution Demand Discount			$-638.65
Deliv of Serv - Transformer Disc			$-4,865.88
Demand Cost Adjustment	-2.487000	9861.10	$-24,524.56
Energy Cost Adjustment	0.009800	5027592	$49,270.41
Electric Sub-Total			$367,956.78
State Sales Tax 5%			$18,397.84
State Sales Tax Exemption			$-16,889.22
County Sales Tax .5%			$1,839.78
County Sales Tax Exemption			$-1,688.92
ELECTRIC TOTAL			$369,616.26
Commitment to Community			$50.00
CURRENT CHARGES			**$369,666.26**
TOTAL AMOUNT DUE			**$369,666.26**

- kW Demand Charges
- kWH Usage Charges
- Facilities Charges
- Other Taxes
- Tax Exemptions
- Other Credits

Gas Bills

Gas Service
Gas Med Coml & Ind Firm GCg-F Cg-FM

Meter 484491	Actual Reading 09/29/2021	24168	
	Actual Reading 08/27/2021	-23913	
		255	
	Meter Constant	x 1.047	
	Total Gas Use	266.99 CCF	
	267 CCF x 1.048 BTU = 279.8 Therms		
Local Distribution Service			
Daily Fixed Charge	33 Days at $4.93150		$162.74
Distribution Charge	279.8 Therms at $0.07920		$22.16
Gas Supply Acquisition Service	279.8 Therms at $0.02530		$7.08
Gas Supply Service			
Natural Gas Cost	279.8 Therms at $0.53480 (4/33 Days)		$18.14
Natural Gas Cost	279.8 Therms at $0.51710 (29/33 Days)		$127.15
Other Service Charges/Credits			
2017 Tax Cut-Deferred Tax Credit	279.8 Therms at -$0.00320		-$0.90
		Subtotal:	**$336.37**
		Gas Service Total:	**$336.37**

- Cost per Therm
- Distribution Charge
- Gas Acquisition or PGA (Purchased Gas Adjustment)
- Other Taxes
- Other Credits
- **Not shown** – Peak usage cost, sometimes called Reservation Charge

Typical EMS Systems

"What"

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Energy Management Software

Energy Management Software gives you usable info on your electrical & other energy use data and allows you to pass that data onto other systems as needed.

- How much energy am I using in various parts of my facility and when?
- Where can I grow my electrical usage with the infrastructure I have?
- Do I have similar pieces of equipment using different amount of energy?
- What was going on with the utility yesterday at 4:00 pm?
- How much gas or electricity do I use per 10,000 bushels?
- Do I have power quality issues? What kind?
- What did our 400 Amp breaker see when it tripped?
- How much solar am I generating vs. my site usage?
- Will my generator support my typical site loads?

Energy Management – New Facility

480 V from
MV XFRMR

Main

PQM

Monitoring Software

As needed:
- Generators
- ATSs
- UPSs

Facility Network

Switchboard Breakers

Gas Meters

Energy Management – Power Quality Meter

480 V from
MV XFRMR

Main

PQM

Monitoring Software

As needed:
- Generators
- ATSs
- UPSs

Facility Network

Switchboard Breakers

Gas Meters

Energy Management – Power Quality Meters

Power quality meters help the user to:

- Historically track & trend power usage to optimize power usage
- Alarm for outages and be notified of acute or underlying electrical issues to prevent down time
- Historically track & trend power quality at major connection points like the service entrance to protect equipment
- Understand system harmonic distortion to protect equipment
- Capture waveforms of poor power quality or utility events to diagnose outage reasons
- Some devices detect fault direction (did the grid or something in this building cause the outage?)
- Understand future system expansion capacity

Energy Management – Connected Breakers

480 V from
MV XFRMR

Main

PQM

Monitoring Software

As needed:
- Generators
- ATSs
- UPSs

Facility Network

Switchboard Breakers

Gas Meters

Energy Management – Connected Breakers

Connected Breakers help the user to:

- Historically track & trend power usage to optimize power usage and how facility power is used in production or by load type
- Understand future system expansion capacity
- Alarm for outages and be notified of acute or underlying electrical issues to prevent down time
- Monitor breaker status, settings, and (coming soon) predict remaining lifespan to drive safety and uptime
- Monitor breaker trip settings and alarm when they are changed

These devices make the most sense to install when you purchase a new switchboard. Retrofits are costly and detailed.

Energy Management – Gas Meters

480 V from
MV XFRMR

Main

PQM

Monitoring Software

As needed:
- Generators
- ATSs
- UPSs

Facility Network

Switchboard Breakers

Gas Meters

Energy Management – Gas Meters

Gas Meters at various points in the system help the user to:

- Historically track, trend, & optimize gas usage
- Understand future system expansion (flow capacity)
- Track gas usage on dryers compared to the volume put through
- Identify when processing variables impact gas usage

Energy Management – New Facility

480 V from
MV XFRMR

Main

PQM

Monitoring Software

Facility Network

Switchboard Breakers

Gas Meters

As needed:

- Generators
- ATSs
- UPSs

Energy Management – UPS / ATS / GENs

Network-connected Generators, UPS, and ATS units help the user to:

- Track & trend how much power is flowing through the devices
- Track and alarm status changes, faults, and battery levels (UPS)
- Ensure that they have the needed back up power for critical applications – even in peak operating conditions
- Understand where your power is coming from during utility outage

Energy Management – Lower Levels

If you have something critical downstream that you want to measure, single or multi-point meters can be installed at lower levels as well.

Typical applications:

1. Key process equipment
2. High-tech devices
3. Compressors

Energy Management – Retrofit

480 V from
MV XFRMR

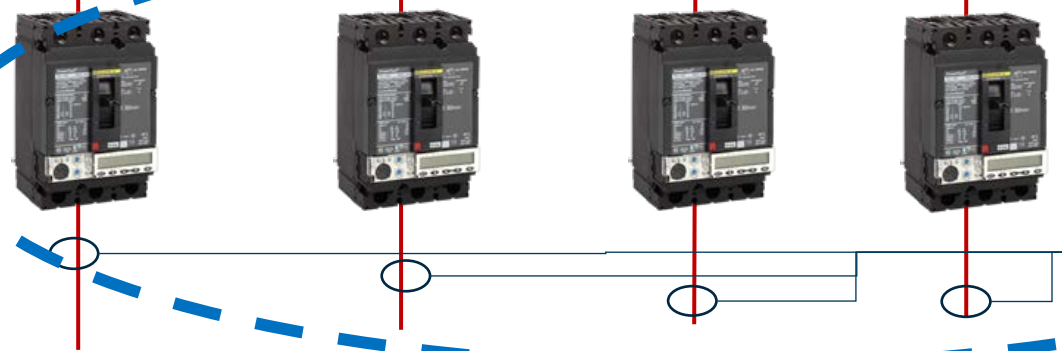
Main

PQM

Monitoring Software

As needed:
- Generators
- ATSs
- UPSs

Facility Network



Multi-circuit Meter

Gas Meters

Energy Management – Multi-Circuit Meter

Multi-circuit meters help the user to:

1. Historically track & trend power usage to optimize power usage
2. Understand system expansion capacity
3. Alarm for outages and acute or underlying electrical issues to prevent down time
4. Understand how facility power is used in production or by load type

Multi-circuit meters are a cost-effective way to retrofit existing sites or design for switchboards that will change in the future.

Energy Management – Retrofit

When retrofitting existing switchboard equipment in your facility, multi-circuit meters can be installed with pre-work and a 12-hour outage.

If lead times and budgets are tight, this is a value option to meter your **brand-new** switchboard as well. You will give up breaker health & setting tracking, but still be able to monitor loads and alarm for breaker trips and loads near tripping.

For sites with large feeds, where we can't look at conductors beforehand, Rogowski coils (Rope CTs) can be used.

Quick Poll

Many folks think “Capital is tight for my new facility or expansion – I’ll just install that later.”

Why is that harder than it sounds?

- Downtime
- Install / Outage Costs
- Operations Budgets
- People Power

Problems these systems help solve

"Why"

Value for your facility operations

When a customer acts on the information, an Energy Management System will help them optimize their energy usage, reduce unplanned outage occurrences, drive sustainability goals, and protect the equipment attached to their electrical system.

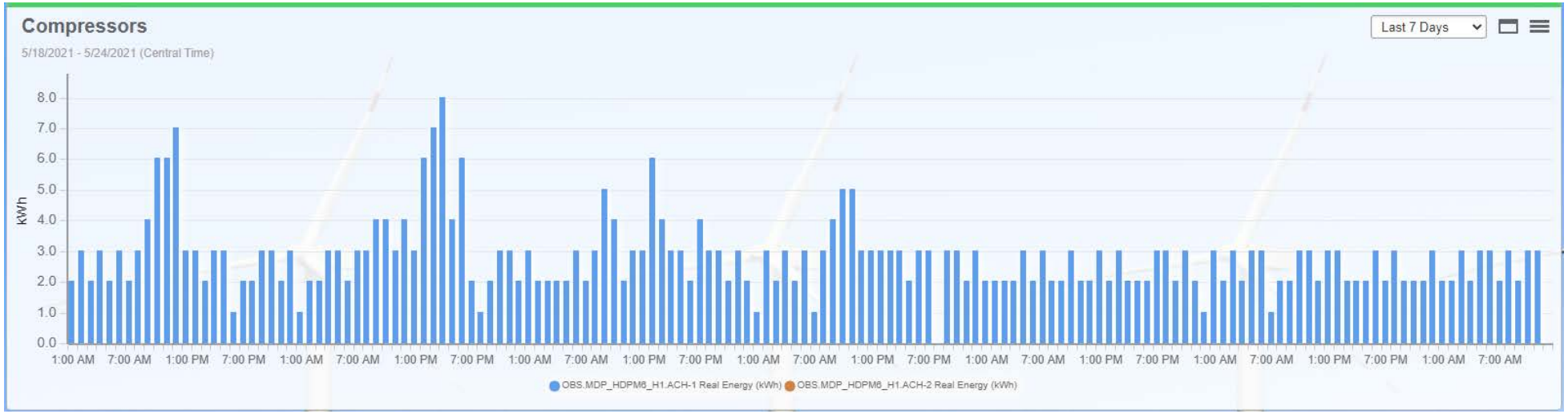
Audience Poll (Show of Hands)

1. How many of you experience breaker trips and faults in your facility? How many of you experience the same trip or fault multiple times before it is fixed?
2. How many of you have equipment like drives that seem to fail more often than they should?
3. How many of you have corporate sustainability leads that want energy usage information at your facility?
4. How many of you have experienced an outage at your facility due to an electrical issue inside your facility?
5. Does anyone here track kWH / Bushel processed?
6. How many of you might install solar or other distributed energy generation in the next few years?

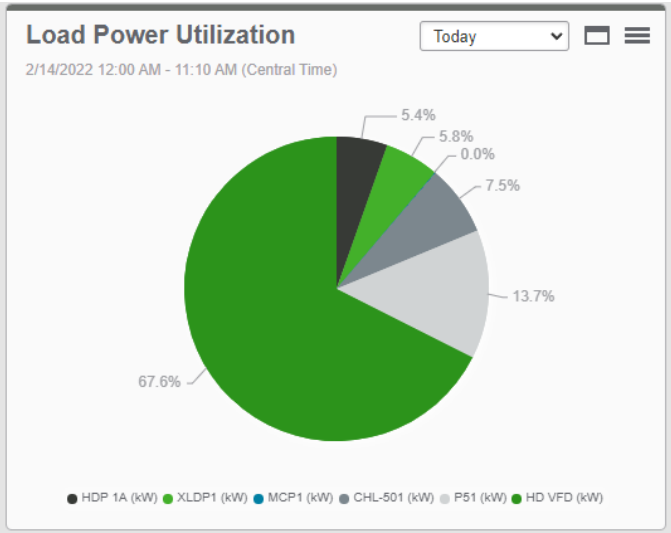
Problem Solving – Drive Efficiency

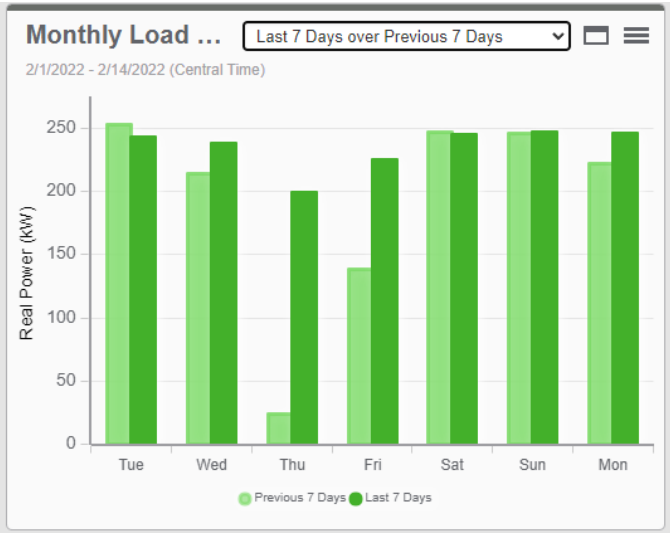
By metering & trending energy usage, users can save 3-10% of their energy costs. All facilities have an energy hog to find.

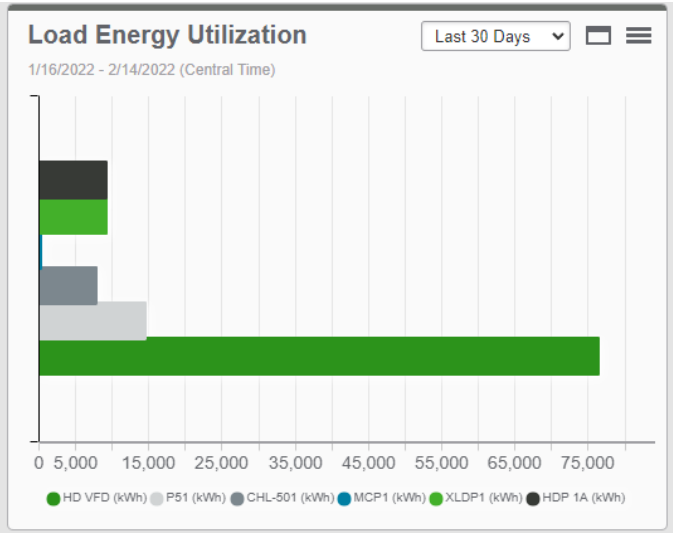
- Lower kWH
- Lower Peaks



Problem Solving – Drive Efficiency







Breaker Loading Insights

Last Update: 2/14/2022 11:14:53 AM Update in 0:07

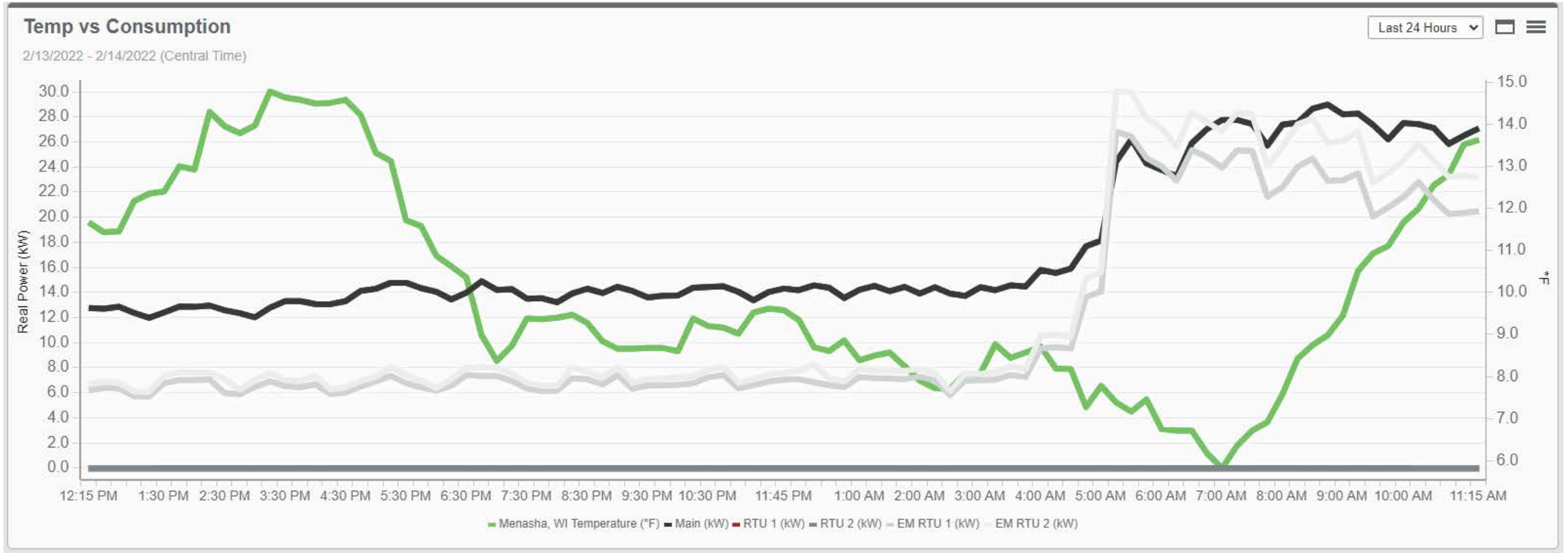
Sources	Real Energy Into the Load ...	Real Power (kW)	Reactive Power (kVAr)	Apparent Power (kVA)	Voltage L-L Avg (V)	Current Avg (A)	Power Factor
MiddletonRNG.CHL-501	8,146	33	25	41	494	48	-80.0
MiddletonRNG.HD_VFD	79,964	166	131	212	491	248	-78.4
MiddletonRNG.HDP_1A	15,169	10	4	11	495	6	-93.0
MiddletonRNG.MCP1	696	1	1	1	494	0	-47.0
MiddletonRNG.P51	14,624	36	27	44	494	50	-80.0
MiddletonRNG.XLDP1	13,041	13	1	13	494	17	-100.0

Problem Solving – Drive Efficiency

Current conditions at
Appleton-Outagamie (KATW)
Lat: 44.26°N Lon: 88.52°W Elev: 869ft.

Mostly Cloudy
12°F

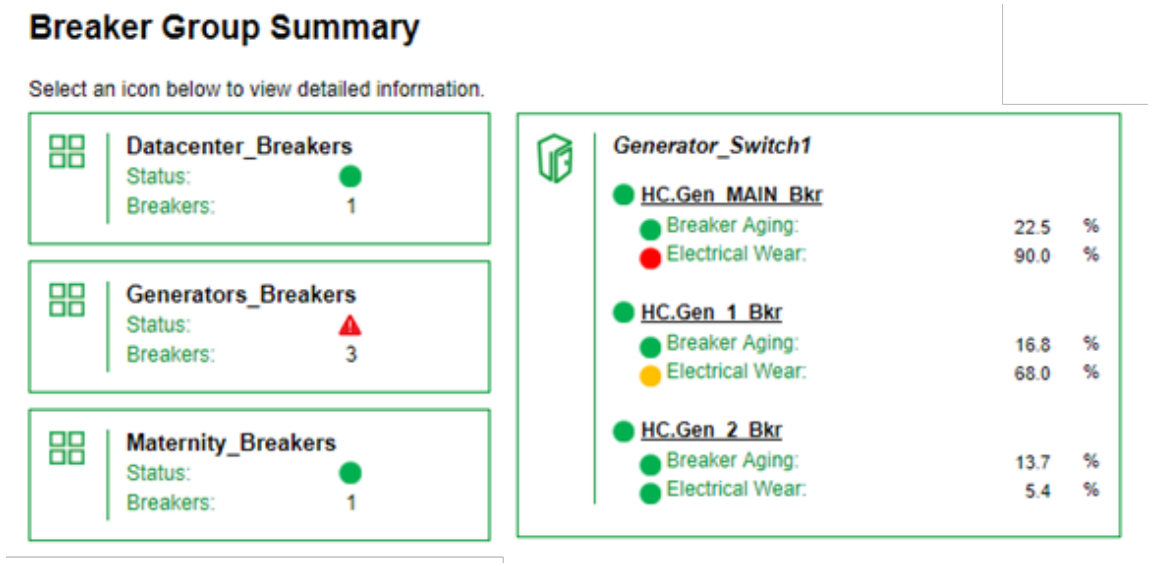
Humidity	73%
Wind Speed	W 3 mph
Barometer	30.23 in
Dewpoint	5°F (-15°C)



Problem Solving – Avoid Unplanned Outages

- Alarm for high current before the breaker trips
- Monitor your circuit breaker health

Name	Type	Source
HiHi Alarm – HiHi Alarms	Over Current	SmokyHills.2LR_C026_028
Hi Alarm – Hi Alarms	Over Current	SmokyHills.2LR_C026_028
HiHi Alarm – HiHi Alarms	Over Current	SmokyHills.2LR_C026
HiHi Alarm – HiHi Alarms	Over Current	SmokyHills.2LR_C028

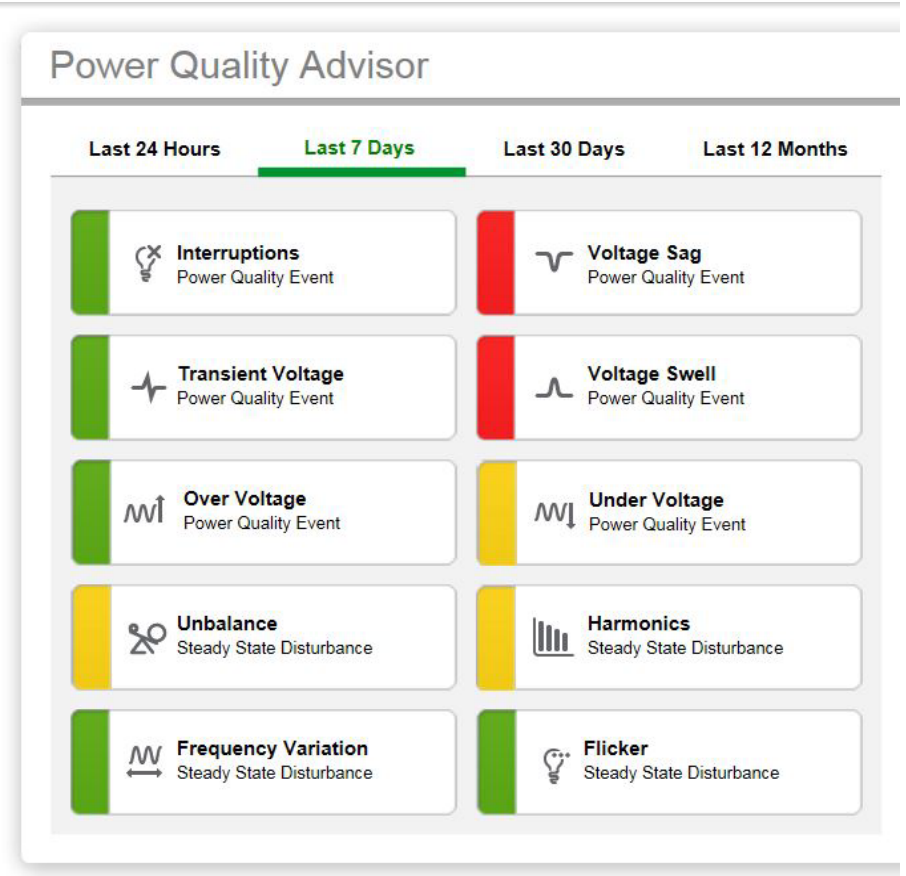


Problem Solving – Protect your people & equipment

- Have the information needed to prevent trip recurrences
- Find power quality issues that damage your equipment and could cause downtime.
- Alarm when breaker settings are changed

Trip Settings

	Enable	Coefficient	Pickup (amps)	Delay (sec)
Long time/Overload (Ir)	On	NA	600	2.0
Short Time (Isd)	On	6.0	3,600	0.00
Instantaneous (Ii)	On	2	900	NA



Problem Solving – Power Quality Issues

- The first time you have a power quality issue in the history of your facility, a PQM pays for itself.

- Signs you are having power quality issues:
  1. Drives & LED light fixtures prematurely failing
  2. Equipment stopping for no apparent reason
  3. Lights flickering
  4. Damage to computer equipment
  5. Poor power factor

Problem Solving – Power Quality Issues

What should you do if you think you have a power quality issue?

1. If you have a PQM onsite, work with your maintenance or engineering team to analyze what causes there might be.
2. If you don't have those items, many companies can come in and provide you a power quality study as a service. They'll provide recommendations to:
   - Lower system harmonic distortion
   - Rebalance your loads
   - Prop up voltage during sags
   - Correct electrical power factor

Energy Management → Future-Ready

- Know where you can expand with existing electrical distribution or gas piping
- Allow you to be proactive when it comes to defending your up time
- Have the data you need for future solar, wind, or combined heat and power units.
- Provide data to help your company meet its sustainability goals

Return on Investment

Return on Investment

Financial benefits that are gained by an energy management system:

1. Energy use reduction or optimization (3-5%)
2. Elimination of downtime (at least 2 hours a year)
3. Protection of operating equipment by diagnosing power quality issues (0.25% - 0.5%)

With a Service Level Agreement, we are seeing a typical ROIC of:

A. **~2 years for food, industrial, and hospital facilities**
B. ~3 years for multi-use and office facilities
C. ~4 years for smaller clients and schools

Facilities with very low utility rates, very low usage, or one large electrical consumer tend to have longer ROI timelines.

Sample Return on Investment - Greenfield

Food facility - $146,905 all in budget (adder vs. unconnected)

- (3) 480 Volt utility services, each with a PQM added
- 24 circuit breakers upgraded for energy monitoring
- Energy management software and full engineering commissioning

Benefits - $92,255 / year

- 3.5% Energy Savings - $56,254 / year (WI rates)
- 2 hours of downtime - $20,000 / year
- 0.4% equipment saved - $16,000 / year

Return on investment – 28 months

- Assumes ½ savings of energy in year 1
- ROI includes service costs for the system
- **After 5th year, $162,529 in the green**

Sample Return on Investment - Brownfield

Food facility - $173,078 all in budget

- (3) 480 Volt utility services, each with a PQM added
- 24 circuit breakers monitored with multi-circuit metering
- Energy management software and full engineering commissioning
- Cost of the outage to facility and production - **$30,000**

Benefits - $87,255 / year

- 3.5% Energy Savings - $56,254 / year (WI rates)
- 1.5 hours of downtime - $15,000 / year
- 0.4% equipment saved - $16,000 / year

Return on investment – 34 months

- Assumes ½ savings of energy in year 1
- ROI includes service costs for the system
- **After 5th year, $134,709 in the green**

Questions?

Thank you for attending!

I am happy to answer questions and discuss your facility.

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