Decarbonization of Process Industry & Next Generation Materials for Sustainability

Decarbonization Opportunities in a Capital Constraint Era with Plantweb Insights

Marcio Donnangelo | Global BDM Refining and PetChem, Pervasive Sensing

Wee Chek, Yeaw | APAC Plantweb Insight Analytic Product Manager

Decarbonization Opportunities in a Capital Constraint Era with Plantweb Insights

Wee Chek, Yeaw

AP Plantweb Insight Analytic Product Manager

Wee Chek, Yeaw is a Product Manager for the Plantweb Insight Analytics of Emerson Plantweb Digital Ecosystem. Previously, he held various technical position in major multinational automation companies implementing state of the art Industrial IoT Solution focusing on optimizing process operation in plant across Asia Pacific.

He has over 19 years of industrial automation experiences and hold a Master of Business Administration degree from Victoria University Australia and B.Eng (Hon) from University of Leeds, England.

Agenda

Setting goals for an effective decarbonization program requires smart sensors and data intelligence. Get the opportunity to learn how to bring typical off-grid equipment online, such as PRVs and Steam Traps, and find out about decarbonization opportunities using Plantweb Insight analytics..

Decarbonization Opportunities in a Capital Constraint Era with Plantweb Insights

Marcio Donnangelo

Global BDM Refining and PetChem, Pervasive Sensing

Marcio Donnangelo is the global business development with Emerson and specializes in Wireless technologies and digital transformation to help customers to achieve Top Quartile performance and meet Sustainability goals. He is an electrical engineer with 30 years of field experience, applying automation solutions across multiple business segments, including petroleum refining, petrochemical, food & beverage, pulp & paper, automotive, material handling and others.

Marcio has authored articles published in Chemical Engineering Magazine, Hydrocarbon Engineering, Hydrocarbon Process Magazines. Marcio has been collaborator of the 4C-HSE annual Environmental Conference for the past 9 years and was recently nominated for a board member position. He studied at FEI, the industrial engineering university, ETI Lauro Gomes and is a technologist and former R&D collaborator from Laboratório de Subsistemas Integráveis of Politecnica Institute/USP

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Agenda

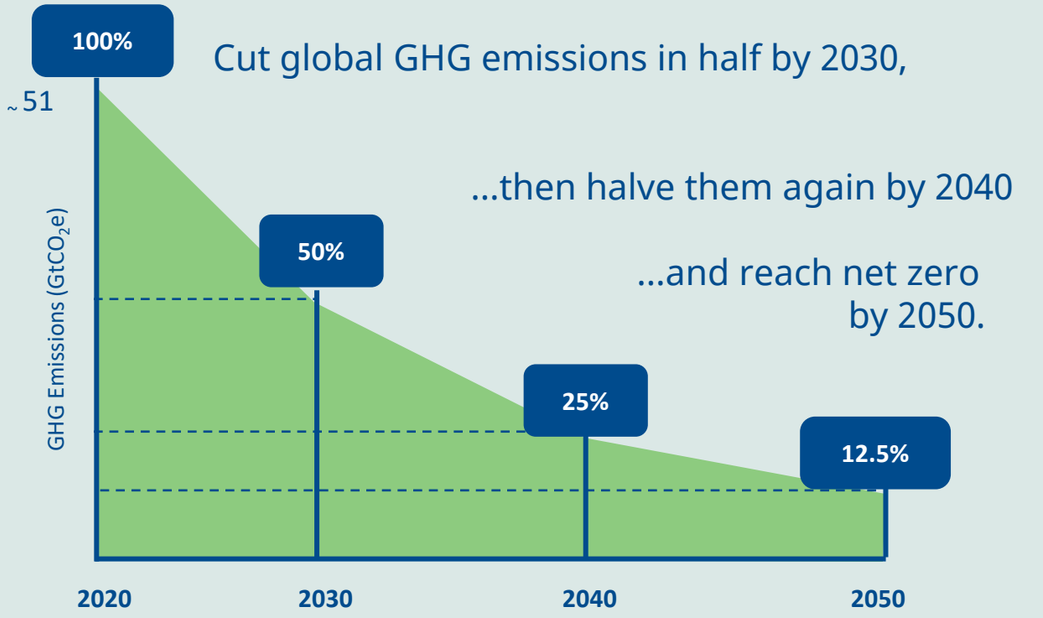
Setting goals for an effective decarbonization program requires smart sensors and data intelligence. Get the opportunity to learn how to bring typical off-grid equipment online, such as PRVs and Steam Traps, and find out about decarbonization opportunities using Plantweb Insight analytics..

Achieving a 1.5 °C planet will require the fastest economic transition in history, but the journey has already begun…

THE WORLD HAS A GOAL

The Paris Agreement sets out a global framework to avoid dangerous climate change by limiting global warming to **well below 2°C and pursuing efforts to limit it to 1.5°C.**

For this happen, the world must **halve emissions every decade:**



Cut global GHG emissions in half by 2030,

…then halve them again by 2040

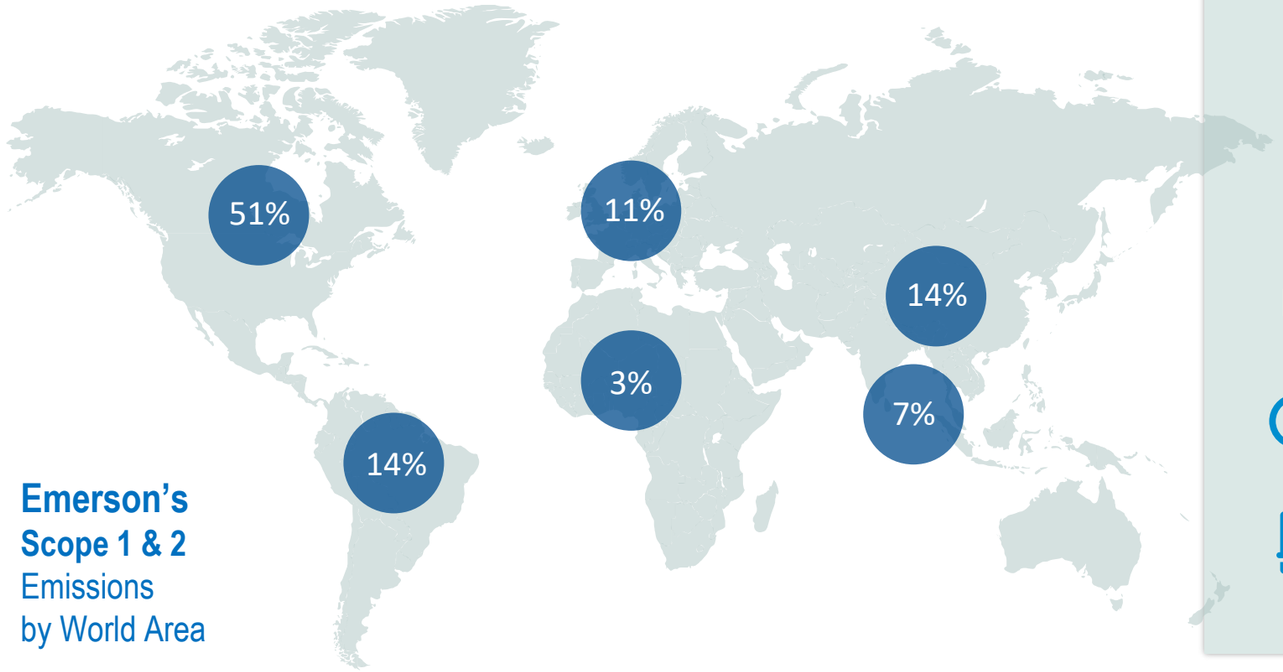
…and reach net zero by 2050.

Adapted from EXPONENTIAL ROADMAP 1.5

Our journey so far…

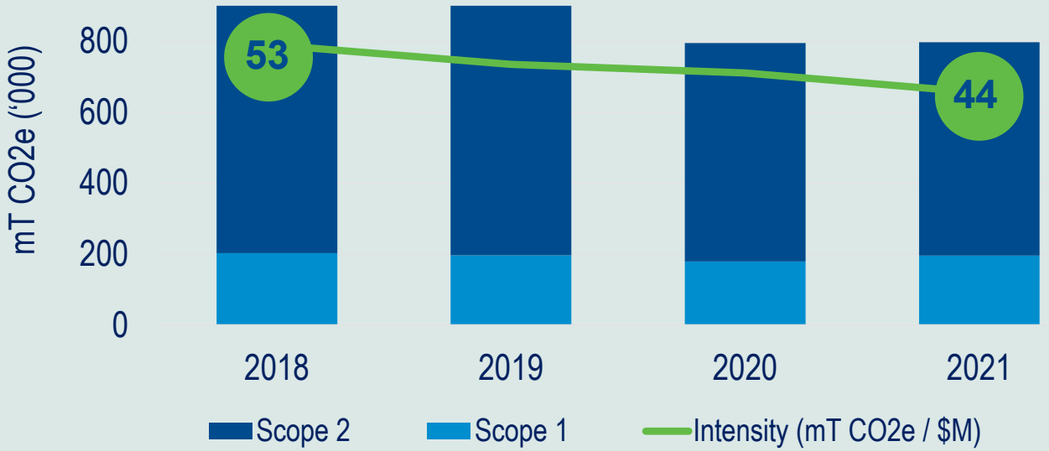
In 2019, Emerson committed to reduce GHG emissions by **20%** normalized to sales by 2028 from 2018

FY21 | Scope 1 & 2 Emissions **797,000 $mTCO_2e$**



Emerson's Scope 1 & 2 Emissions by World Area

Emerson's Scope 1 & 2 Emissions Progress



Emissions Intensity (measured in $mTCO_2e$ / $) ↓ **17%** from 2018

Energy Treasure Hunts

- HVAC Setback
- LED Lighting
- Equipment Shutdown
- Compressed Air Optimization
- Building Control Systems

Renewable Energy

- Renewable Electricity Contracts
- On-site Renewable Energy Generation

Plantweb Insight is an Application Package Focusing on Monitoring the Health of Plant Assets

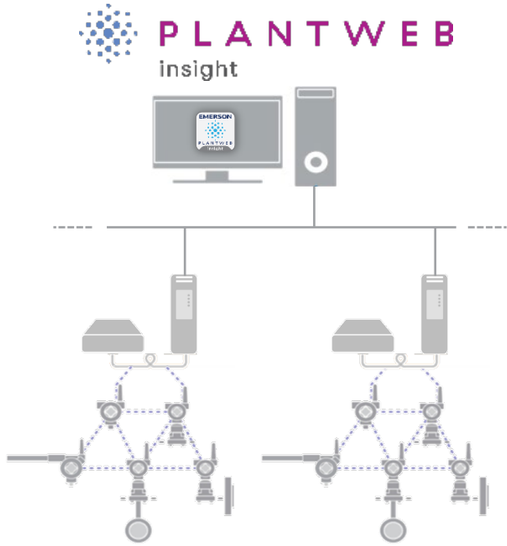
PLANTWEB INSIGHT

Easy-to-use analytics and dashboards turn raw data into actionable information

RELIABILITY | SAFETY | ENERGY | EMISSIONS | PRODUCTION | MAINTENANCE

Known Solutions to Known Problems

- ***Abnormal Situation*** Identification
- Pre-Packaged ***Analytics***
- Optimized for ***Wireless Devices***
- ***Independent*** of Host System and Historian
- Simple, ***Actionable,*** Web Based Interface
- Fast ***Return on Investment***



STEAM TRAP	PRESSURE RELIEF DEVICE	PUMP	HEAT EXCHANGER	AIR COOLED HEAT EXCHANGER	COOLING TOWER	NETWORK MANAGEMENT	POWER MODULE	INLINE CORROSION	NON-INTRUSIVE CORROSION	LOCATION	CONNECTED LIGHTING
Identify Steam Trap Failures Instantly	***Know When PRD is Open and Closed***	***Predictive Health Monitoring***	***Predictive Health Monitoring***	***Predictive Health Monitoring***	***Monitor Efficiency and Water Consumption/ Quality***	***Wireless Network Management***	***Transmitter Battery Monitoring***	***Inline Corrosion***	***Non - Intrusive Corrosion***	***Location Awareness***	***Connected Lighting***
Acoustic	Acoustic Pressure	Pressure Temperature Vibration Level	Temperature Pressure Flow	Temperature Pressure Vibration		All Wireless Gateways and Devices	All Wireless Devices	Inline Corrosion Sensors	Non- Intrusive Corrosion Sensors	Location Anchors Personnel Tags	Mercmaster Connect LED Motion Sensor

You Can’t Improve What You Don’t Measure

PERVASIVE SENSING

Innovative sensing strategies for cost-effective monitoring and optimization, enabling improved operational visibility to solve new problems

BUILDING ON THE INDUSTRY’S BROADEST SENSING PORTFOLIO

IN-LINE CORROSION

NON-INTRUSIVE CORROSION & EROSION

VIBRATION

NON-INTRUSIVE TEMPERATURE

VALVE POSITION

LOCATION

ACOUSTIC

RADAR LEVEL

LEVEL SWITCH

DISCRETE

PRESSURE GAUGE

FLOW TOTALIZER

TOXIC GAS

Next Gen Gateway

POWER MODULES

THUM ADAPTER

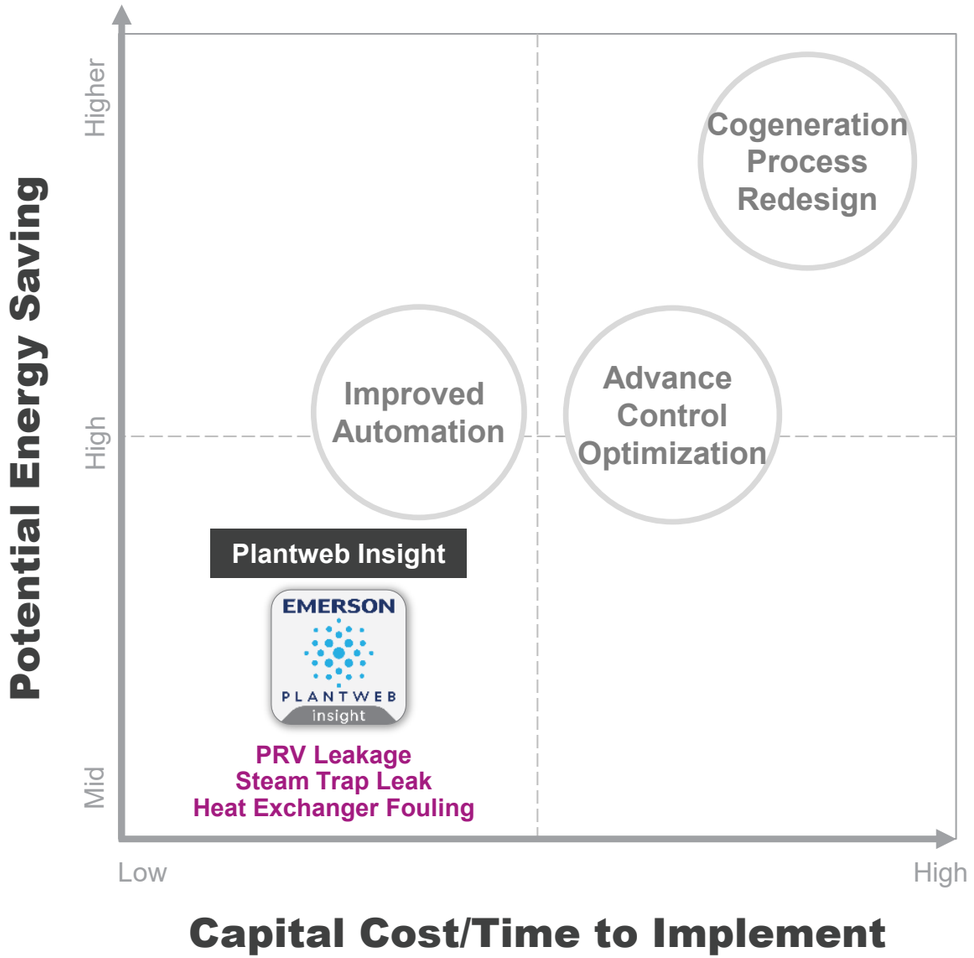
PRESSURE

TEMPERATURE

CONNECTED LIGHTING

Real-Time Monitoring with Wireless and Plantweb Insight Creates Substantial Opportunities for High Value Savings and Fast ROI

Figure 1 : Energy Investment Option



Insight Application | **Analysis by Emerson**

Application	Real Time Insight	Annual Saving ($M)	Payback Period
Steam Trap Monitoring	Energy waste and emissions	$0.4 - $0.6	7 months
Pump Monitoring	Cavitation, pump health	$0.5 - $0.6	11 months
Pressure Gauge Monitoring	Process pressure, gauge health	$0.4 - $0.6	12 months
Heat Exchanger Monitoring	Fouling and efficiency	$2.7 - $3.6	3 months
Cooling Tower Monitoring	Efficiency and health	$0.3 - $0.5	4 months
PRV Monitoring	Emissions and leaks	$2.4 - $3.2	6 months
Air Cooled Heat Exchanger	Fan health and fouling	$0.9 - $1.1	13 months
Corrosion Monitoring	Pipe integrity	$5.5 - $6.5	6 months
Safety Shower	Instant trigger indication	Per incident	Safety
	Total	**$15M+ Saving/Year**	**6 Months**

* This chart is based on a 250,000-bpd refinery analysis by Emerson

Decarbonization App

Decarbonization Opportunity with Plantweb Insight Analytics

Achieve Top Quartile Performance Requires Digital Transformation

- **Top Quartile**
  - The primary customer-owned objective, tied to key business KPIs

- **Project Certainty and Operational Certainty**
  - Emerson's methodologies for helping customers achieve Top Quartile performance

- **Plantweb digital ecosystem**
  - Emerson's portfolio of Technologies, Software, & Services that enables digital transformation

PLANTWEB

- **Digital Transformation**
  - The strategy of integrating digital capabilities into an organization to improve performance

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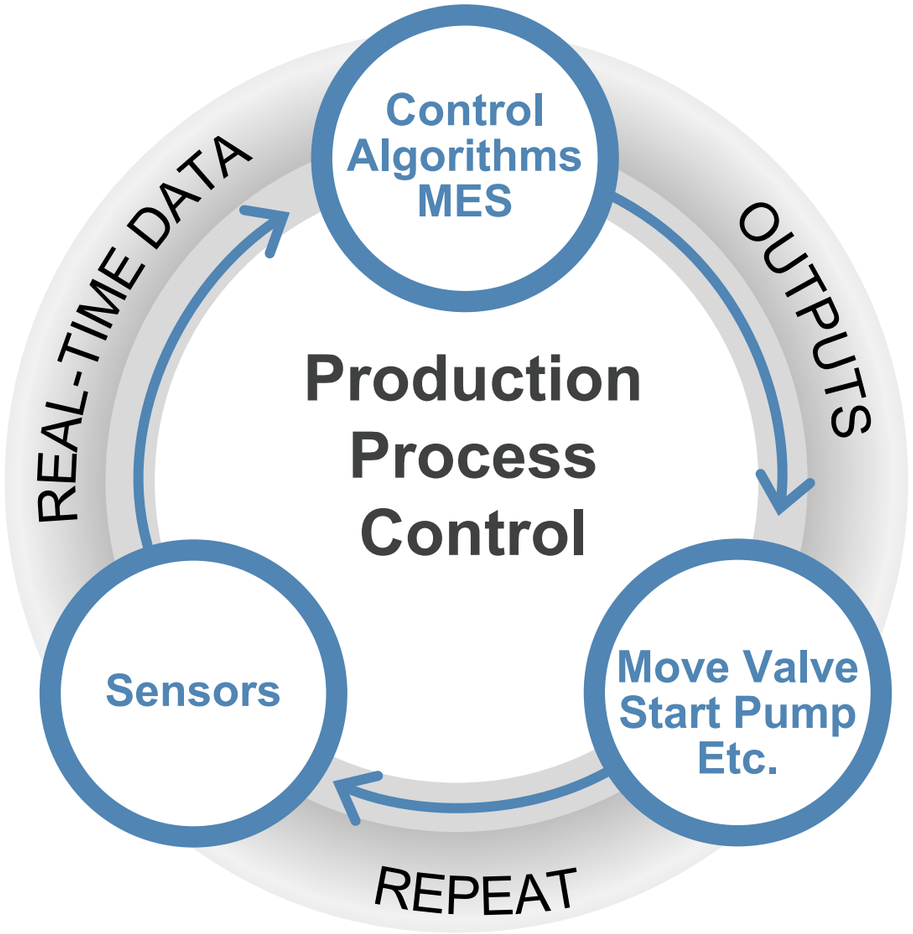
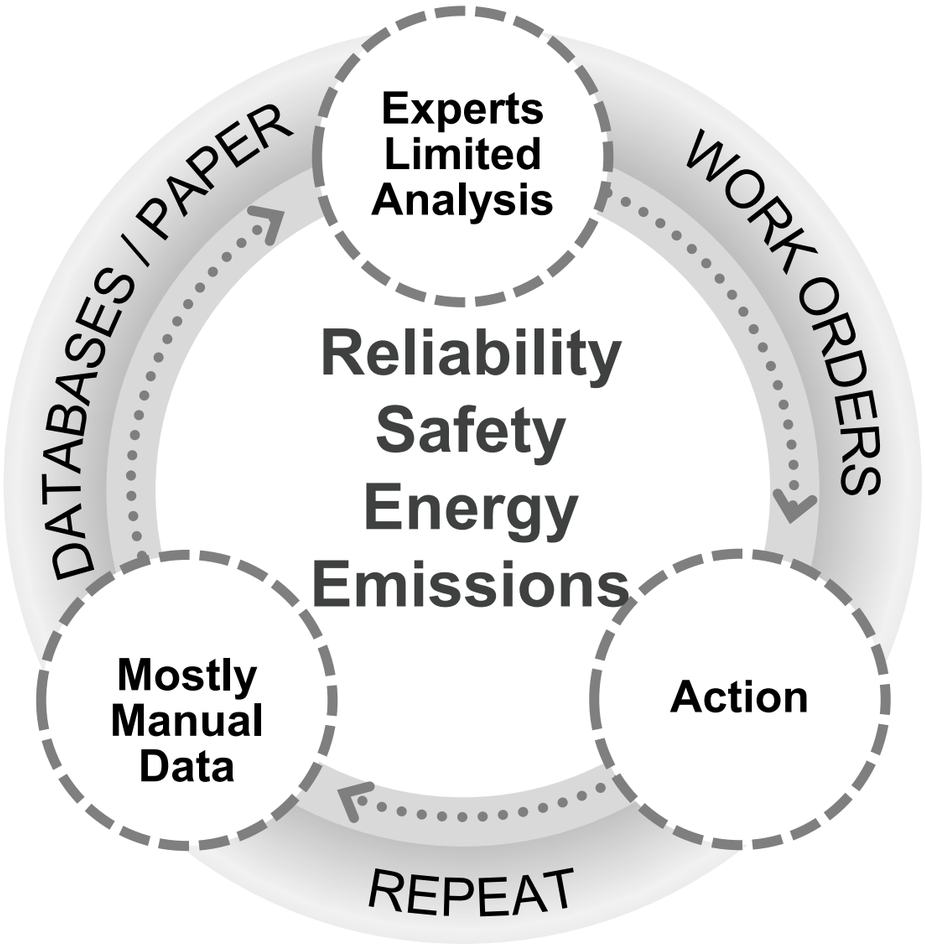
Large Opportunity for Companies to Achieve & Sustain Top Quartile Operational Performance Beyond Core Process Control

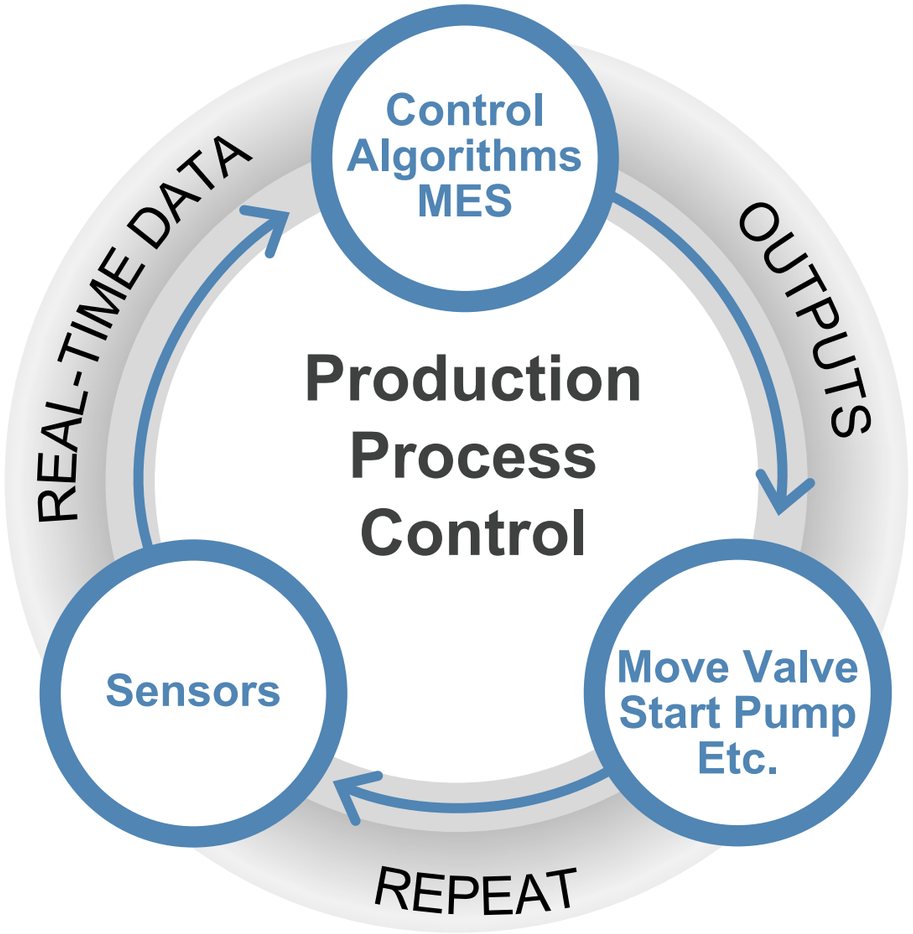


Frequently Closed Loop



Frequently Open Loop

Large Opportunity for Companies to Achieve & Sustain Top Quartile Operational Performance Beyond Core Process Control



Frequently Closed Loop

Moving to Closed Loop

* Focused on Equipment and Assets

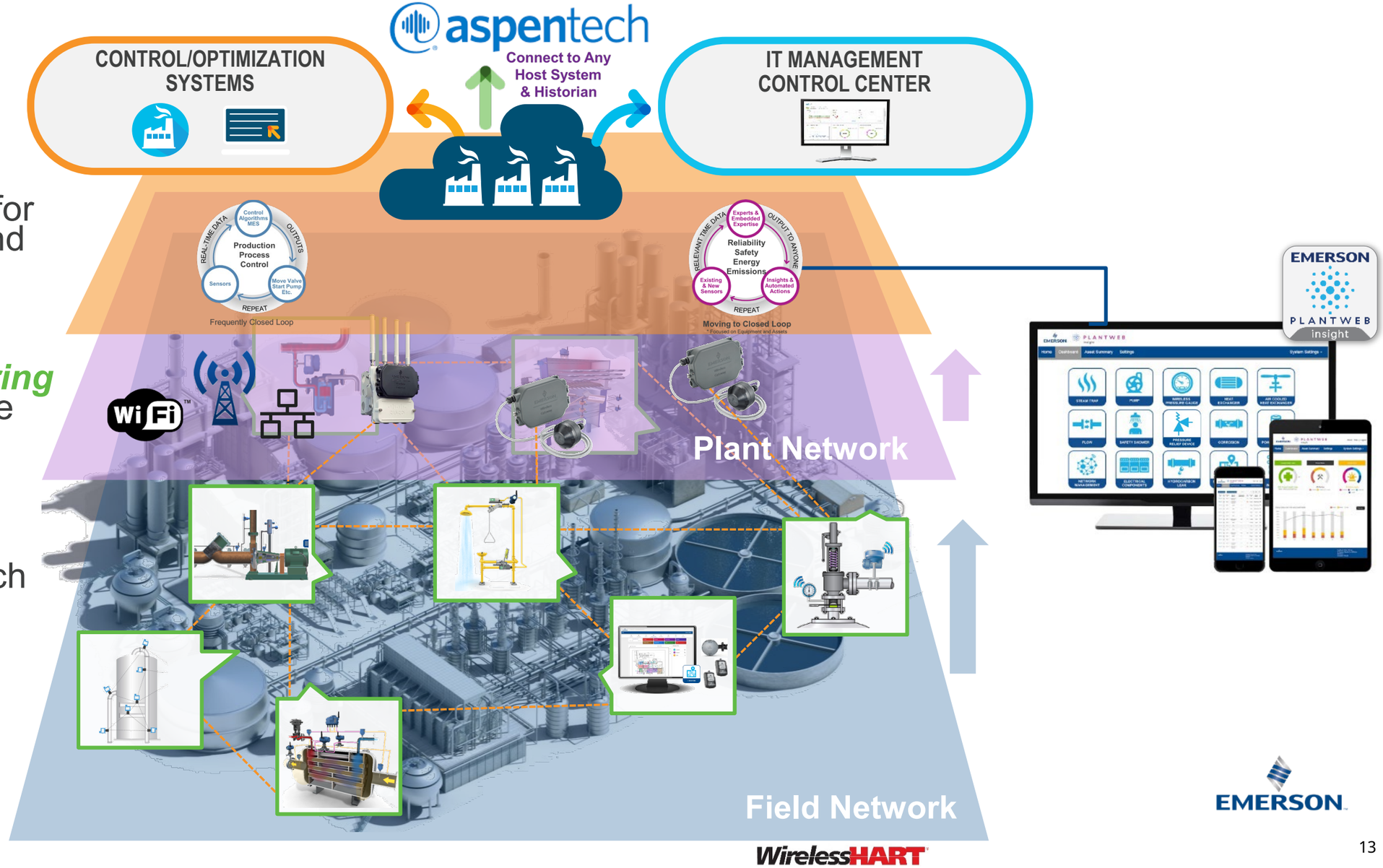
Emerson Solution to Answer Equipment and Asset Monitoring Challenges

Analytic tools create ***actionable insights*** for informed decisions and maintenance prioritization

Continuous monitoring approach leads to the most effective and successful results

Wireless provides a cost-effective approach with high reliability

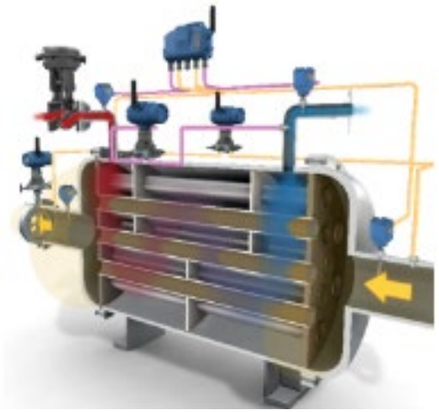
Field Sensors transmitters make installation quick and easy



Key Drivers for ROI and Sustainability Benefit Calculation

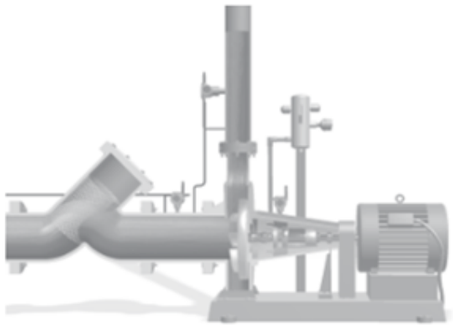
HEXs

- Energy
- Capacity



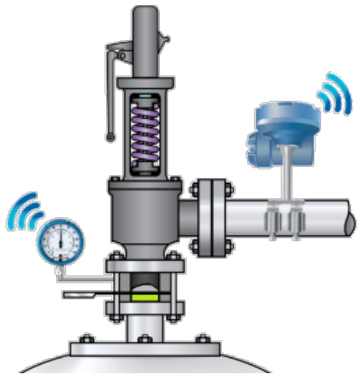
Pumps

- Maintenance
- Operation



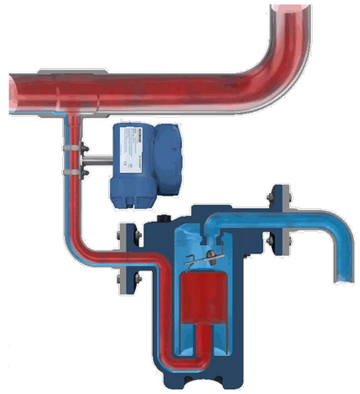
PRVs

- Capacity
- Energy



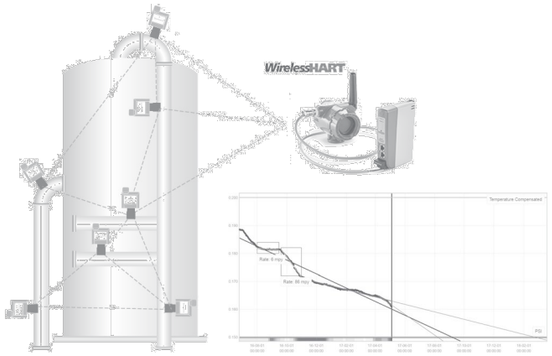
Steam Traps

- Energy
- Steam Quality



Corrosion

- Availability
- Crude Opportunity



ROI and Sustainability Benefits for Thailand Refineries & Petrochem

v4.23.04

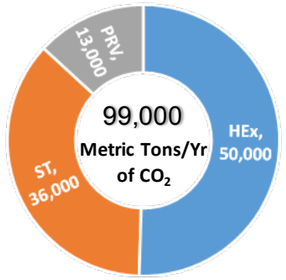
Thailand Refineries - Multiple Sites

Est. Financial Benefit $39.3M

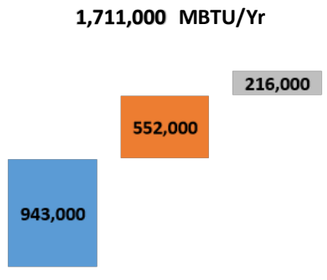
Refinery Configuration	
Crude Unit (bpd)	**842,250**
Vacuum Unit (bpd)	235,380
FCC (bpd)	88,272
Reformer (bpd)	109,893
Coker (bpd)	16,983
Hydrocracker (bpd)	65,573
Hydrotreaters (bpd)	503,945
Alkylation (bpd)	0
Aromatics (bpd)	0
Isomerization (bpd)	26,346
Lubes (bpd)	0
Alsphalt (bpd)	7,171
Deasphalting (bpd)	0
Offsites (bpd)	0
Hydrogen (MMcfd)	0
Sulfur (t/d)	474
Amine Units (bpd)	*842,250*
Sour Water Stripper (bpd)	*842,250*
Utilities (bpd)	*842,250*
Energy Cost, $/ MMBTU	**$ 6.00**

Sustainability Benefits

Process Unit GHG Avoidance Due to Monitoring



Energy Loss Recovery $10.3M



Average Process Unit Fuel and Steam Energy	110,400,000 MBTU/Yr
Average Process Unit Fuel and Steam Energy	2%

Estimated Customer's Benefit		
Total	**$**	**39,310,000**
HEx	*$*	*8,630,000*
Pumps	*$*	*3,990,000*
PRV	*$*	*4,070,000*
ST	*$*	*5,530,000*
Corrosion	*$*	*17,090,000*

Petrochem / Ethylene

STEAM TRAP CALCULATOR

	Site Data: Ethane	Propane	Naphtha
Feed Nameplate Capacity in Metric Ton/Year (MT/Y)	3	0	2
MBTU Cost	$ 6.00	$ 6.00	$ 6.00

	Total Energy to Produce Steam		
MBTU/Year (Associated Energy with Steam to Run the Process)	7,527,181	-	10,798,488
MBTU/Year (Energy Required to Produce Steam)	9,775,560	-	14,024,011

MBTU/Year Recovery	**420,000**
Savings/Year due to Energy Recovery	**$ 2,500,000**
Metric Tons of CO2/Year (GHG)	**30,000**

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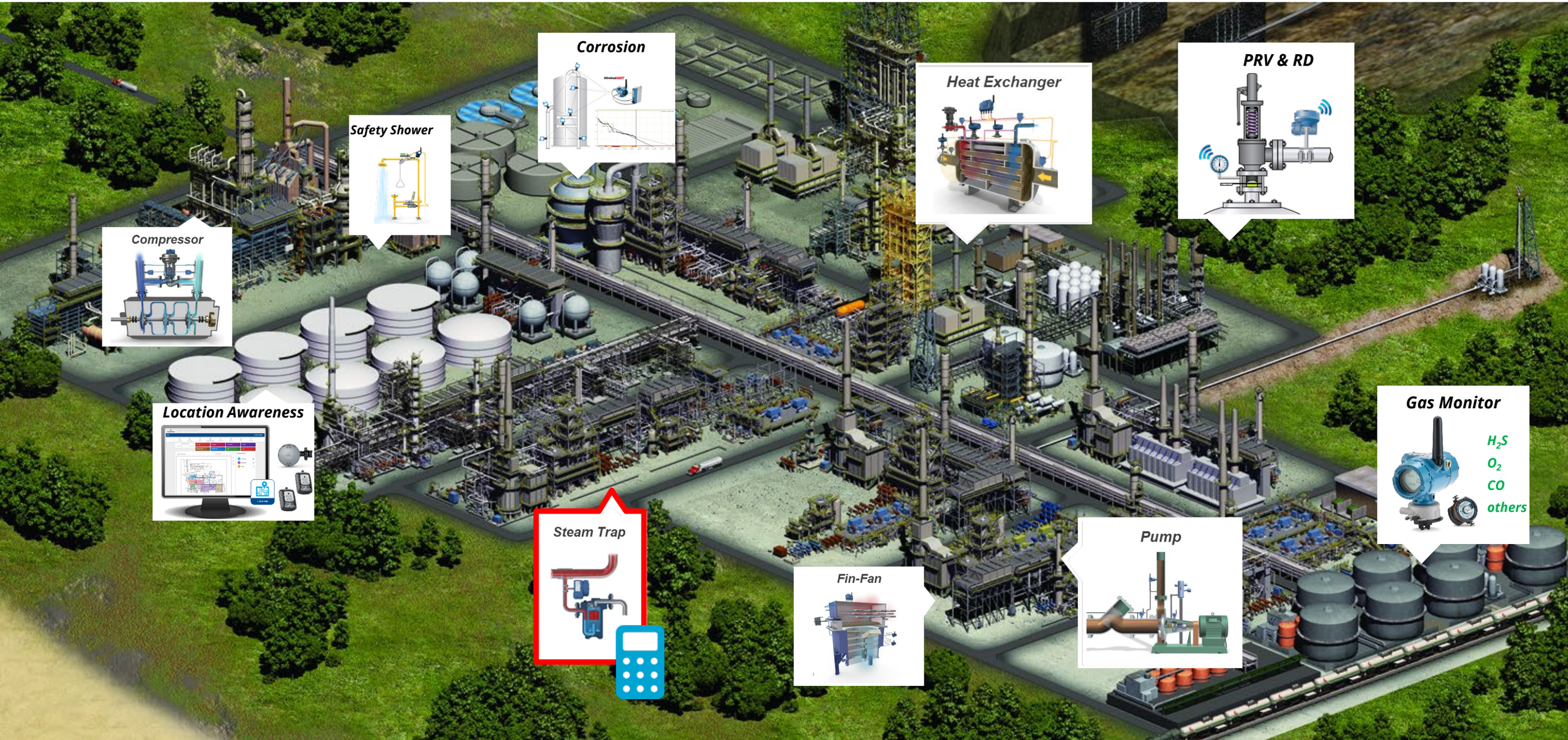
Steam Traps
Frequent Open Loops: Typical Pervasive Sensing Applications for Refineries



Steam Trap Calculation Assumptions

Rosemount 708 Wireless Acoustic Transmitter

- Fast and easy to install and maintain
  - Directly mount without cutting or changing pipe configuration
  - No calibration
  - ***Non-intrusive*** steel band mounting
  - Intrinsically safe power module with ***10+ year battery life***
  - FM and CSA Class 1 Div 1 approvals
  - ***WirelessHART*** communication

Dashboard View Provides an Umbrella View of the Entire Asset Class

Dashboard

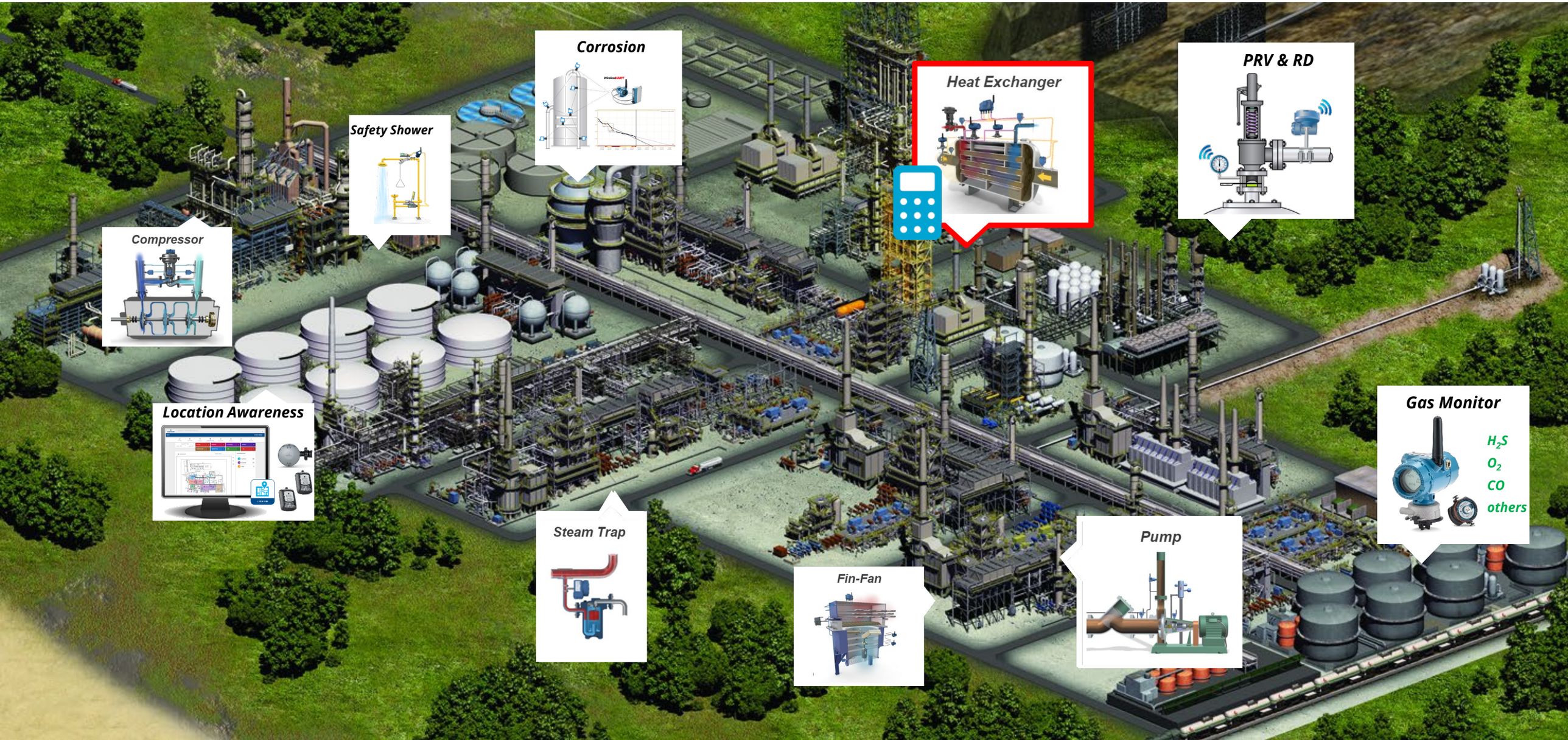
Aggregated view into the status of all assets

Quickly identify any steam traps requiring attention

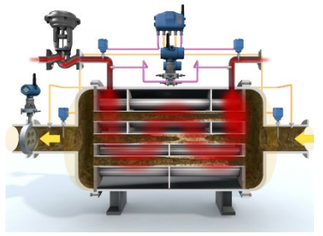
Track impact with key performance objectives around energy costs and emissions

Gain historical knowledge with a brief trending of past health

Heat Exchangers
Frequent Open Loops: Typical Pervasive Sensing Applications for Refineries



Critical Heat Exchangers Priority



General Assumptions*:

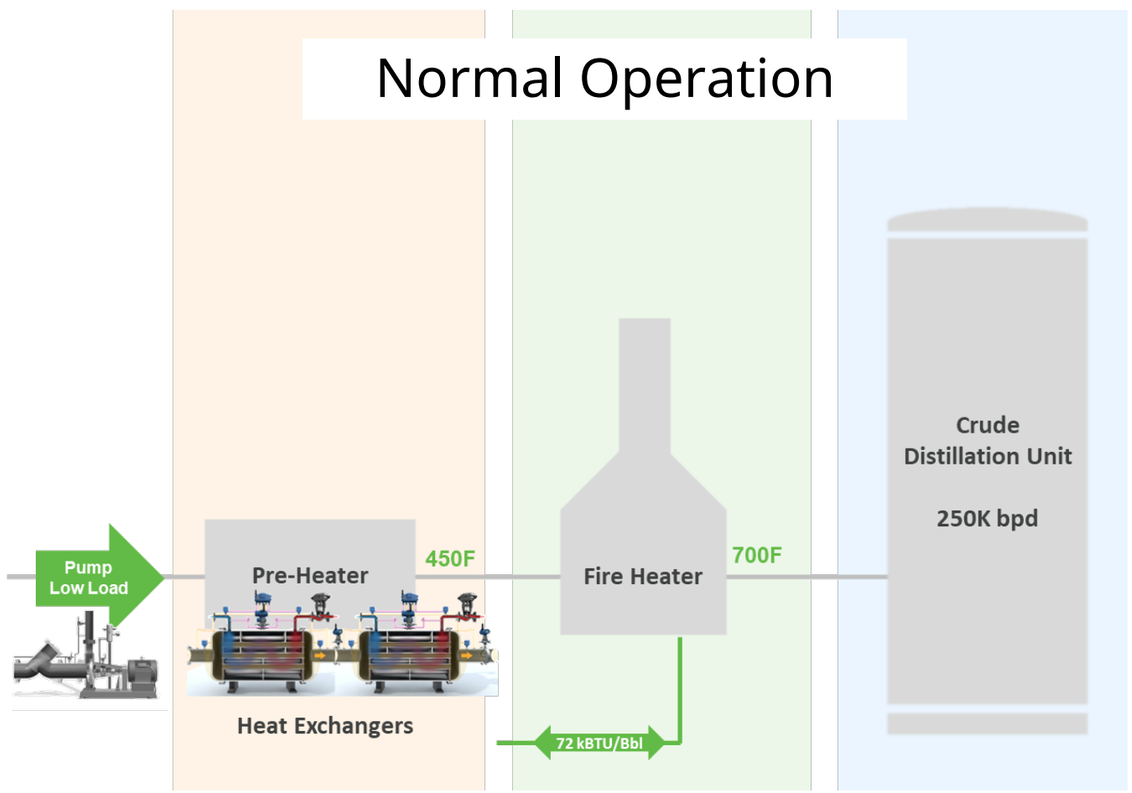
- Energy Cost = $6/MBTU
- Fire heater efficiency = 80%
- Time the unit is at maximum capacity = 25%
- Fuel Needed (kBTU/Bbl)
  - Energy to process a barrel

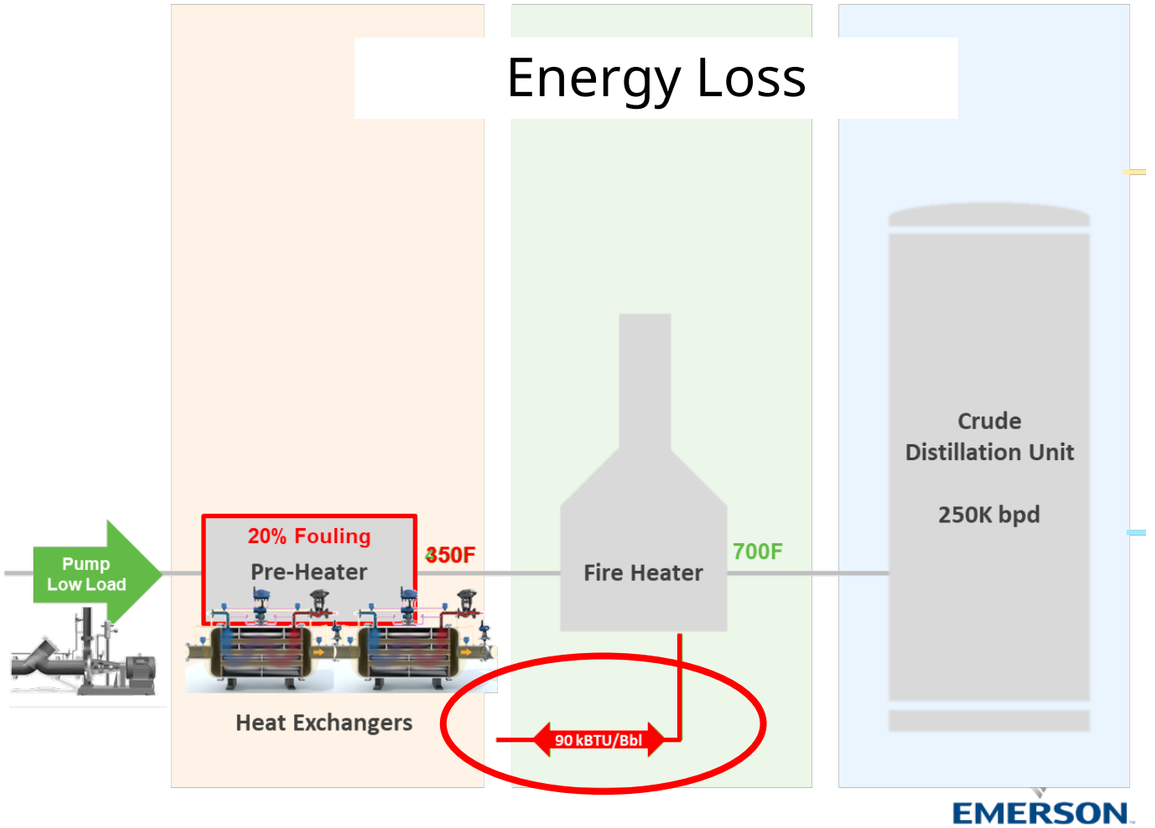
  (* Energy Use in Petroleum Refinery – Energy Research & Development Administration)
- Baseline: 80 Heat Exchangers for typical 250Kbpd refinery

*Can be re-accessed for your refinery

Crude Heat Exchanger	Priority
OVERHEAD-CRUDE EXCHANGER	
CRUDE- CIRCULATING DIESEL EXCHANGER	
DESALTED CRUDE - HVGO+MVGO+AGO PRODUCT EXCHANGER	
DESALTED CRUDE-DIESEL PRODUCT EXCHANGER	
PREFLASHED CRUDE-CIRCULATING DIESEL EXCHANGER	

Energy Loss Recovery





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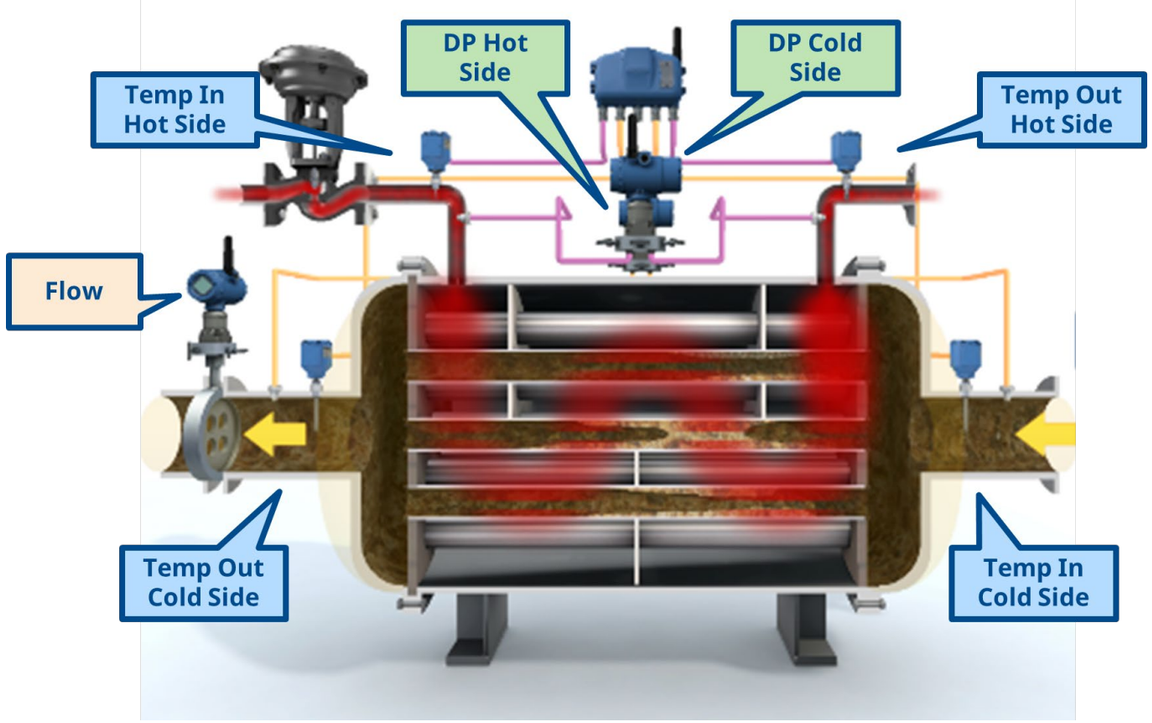
HEx Monitoring



	Temperature				Flow		Differential Pressure	
	Cold-Side		Hot-Side					
	Inlet	Outlet	Inlet	Outlet	Cold-Side	Hot-Side	Cold-Side	Hot-Side
Cold-Side High Inlet Temp	X							
Cold-Side Low Outlet Temp		X						
Hot-Side Low Inlet Temp			X					
Hot-Side High Outlet Temp				X				
Cold-Side Low Flow					X			
Hot-Side Low Flow						X		
Cold-Side DP							X	
Hot-Side DP								X
Cold-Side Exchanger Fouling	X	X	X	X	X			
Hot-Side Exchanger Fouling	X	X	X	X		X		
Cold-Side Heat Duty	X	X			X			
Hot-Side Heat Duty			X	X		X		
Heat Duty Error	X	X	X	X	X	X		
Cold-Side Cost of Degradation	X	X	X	X	X			
Hot-Side Cost of Degradation	X	X	X	X		X		
Cold-Side Cleaning Required	X	X	X	X	X		X	
Hot-Side Cleaning Required	X	X	X	X		X		X
Cold-Side Cleaning Required (no DP)	X	X	X	X	X			
Hot-Side Cleaning Required (no DP)	X	X	X	X		X		

Dashboard View Provides an Umbrella View of the Entire Asset Class

Dashboard

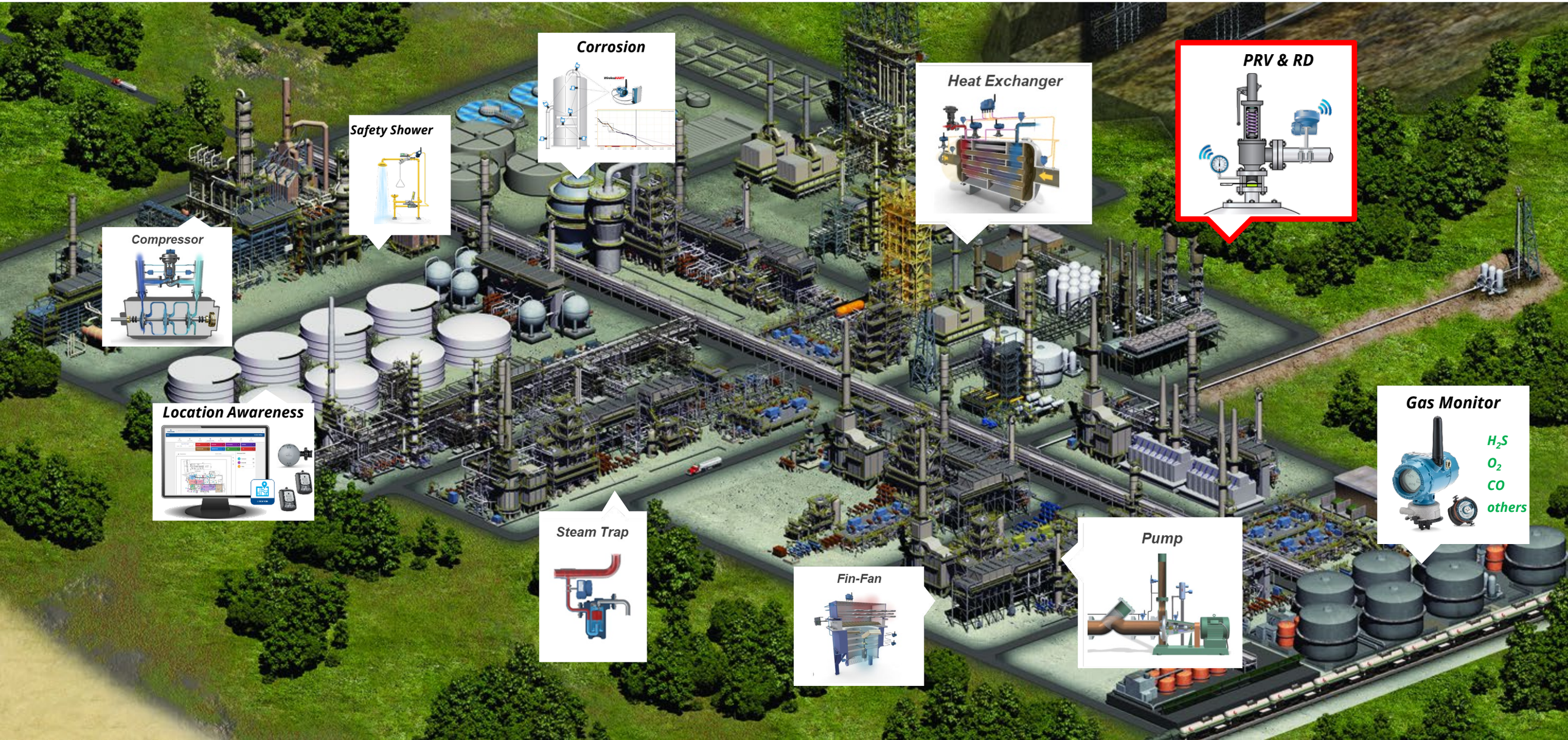
Aggregated view into the health of all assets

Quickly identify the overall health of assets and any critical heat exchangers requiring attention

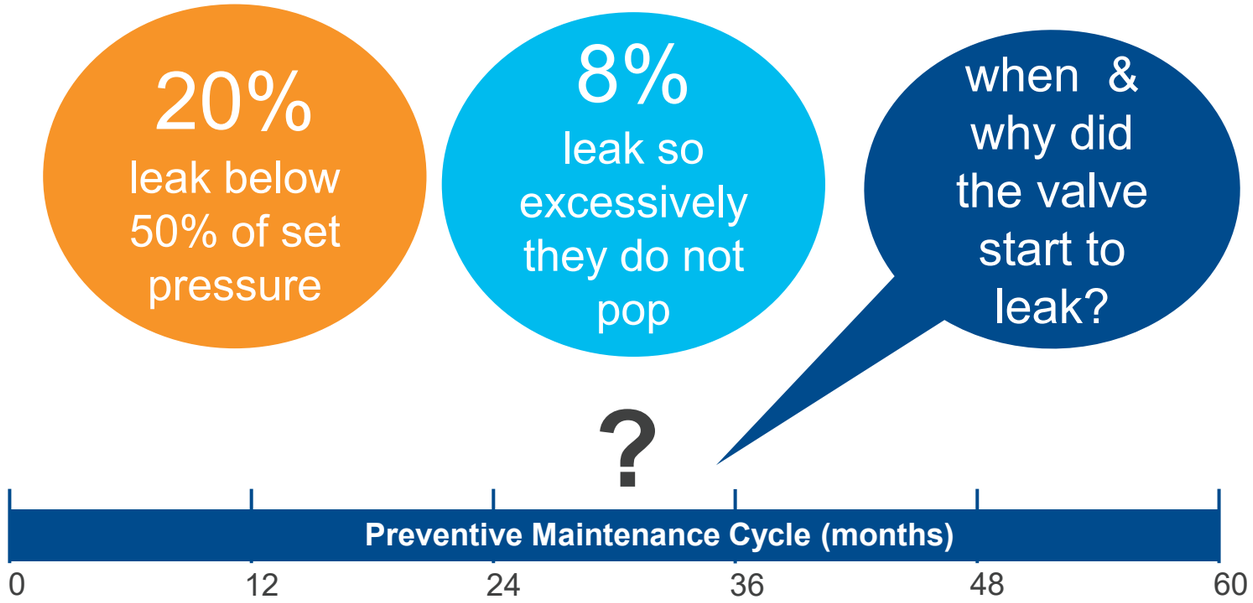
Recognize business impact in terms of lost energy costs

Gain historical knowledge with a brief trending of past health

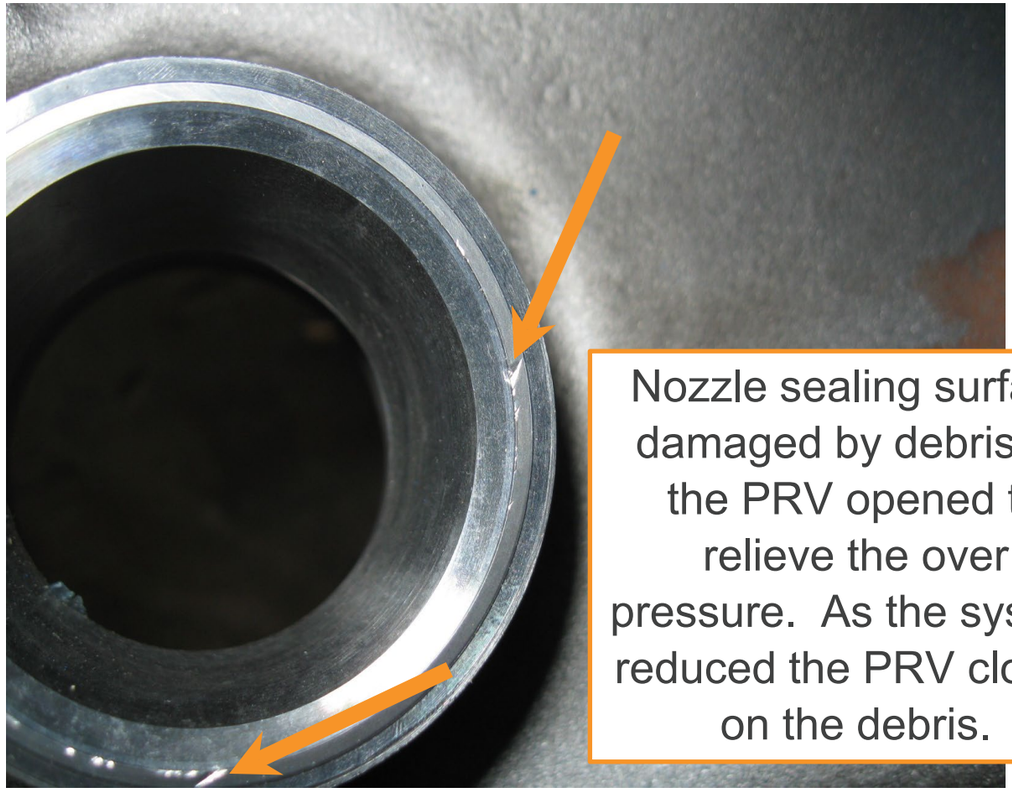
PRVs
Frequent Open Loops: Typical Pervasive Sensing Applications for Refineries



PRV - Undetected and Unreported Relief Events Often Occur



**10,000 PRV pre-test service records from Large North America Refining Complex*
***Source: Crosby & Anderson Greenwood service group (Emerson)*



Nozzle sealing surface damaged by debris as the PRV opened to relieve the over pressure. As the system reduced the PRV closed on the debris.

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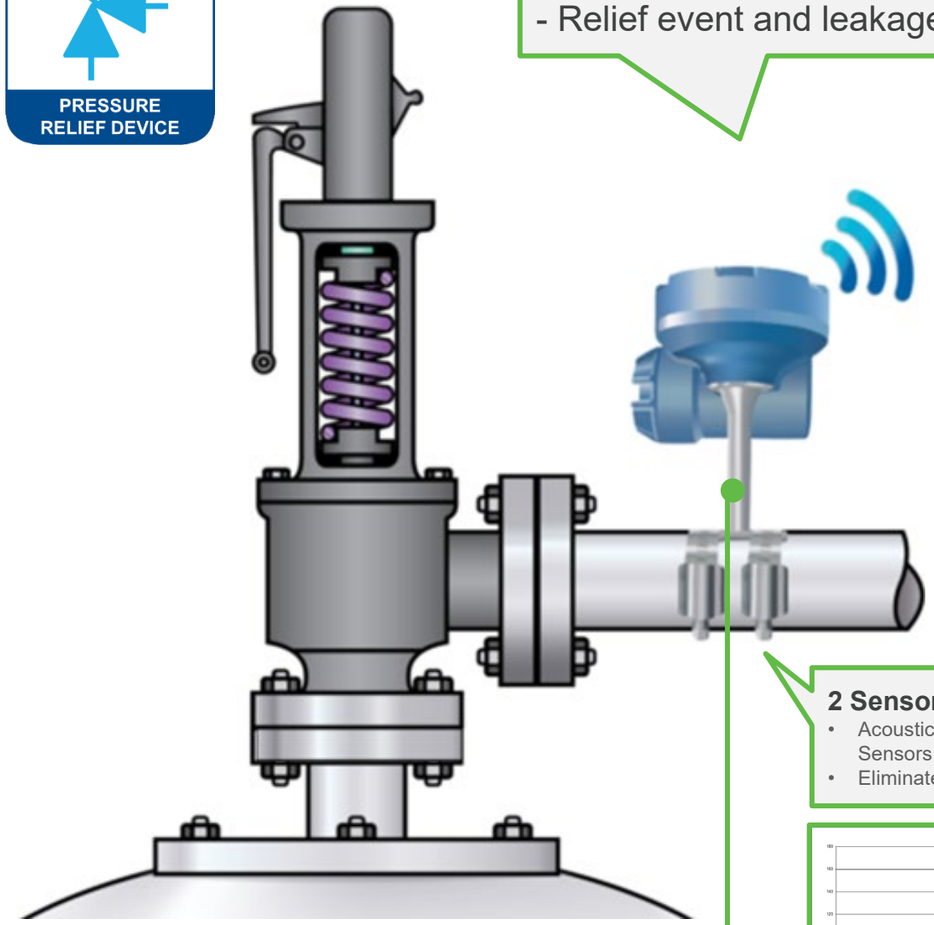
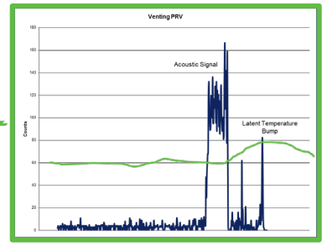
PRV Monitoring Solution

PRESSURE RELIEF DEVICE

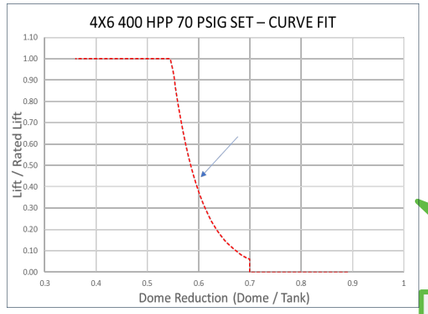
PRV Flow Detection
- Any Valve
- Relief event and leakage detection



2 Sensors, 1 Transmitter
- Acoustic and Temperature Sensors
- Eliminate False Positive

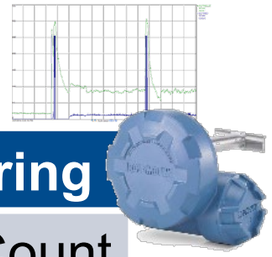


PRV Relief Detection
Pilot Operated PRVs



Volumetric Release
Calculated with PRV lift measuring the differential pressure between inlet and dome and valve capacity

Plantweb Insight Provides the Strategic Interpretation and Analysis Needed to Prioritize Maintenance and Make Informed Decisions

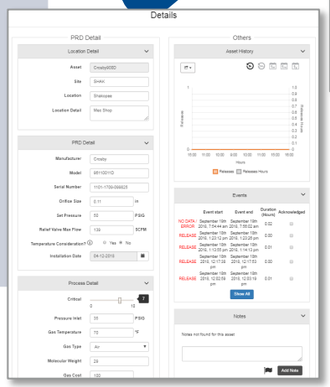


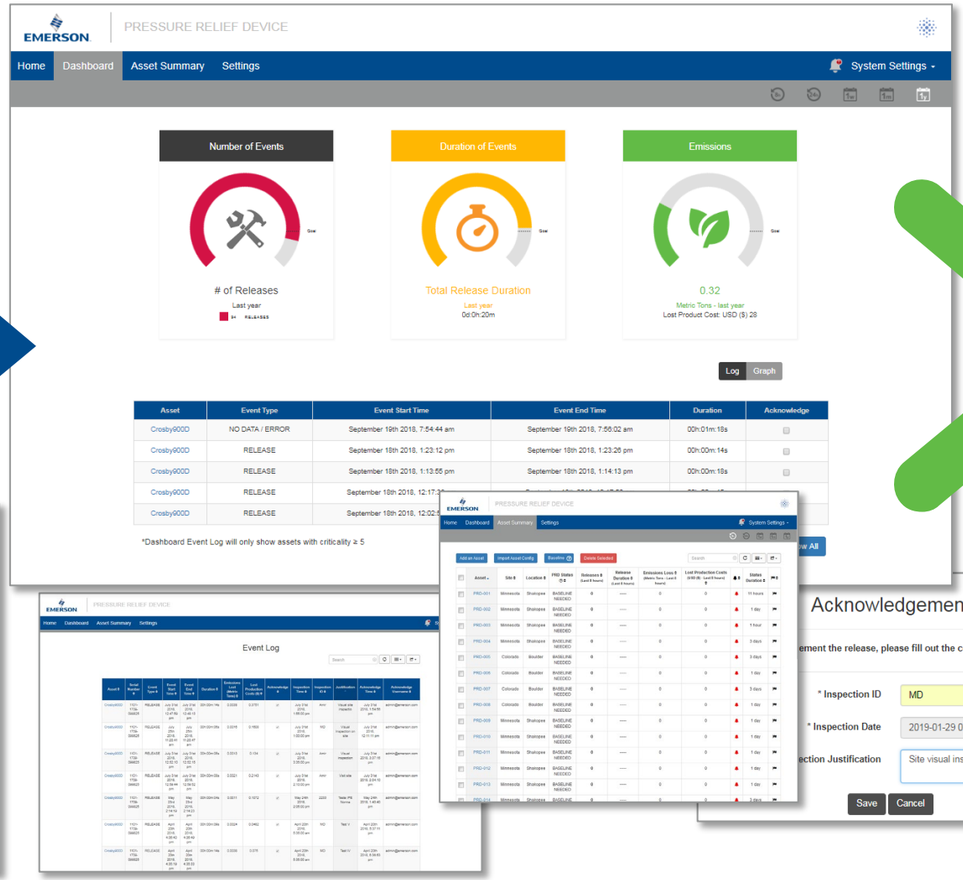
PRV Monitoring

- Acoustic Count
- Temperature

PRV Information

- Type
- Line Size
- Orifice Size
- Pressure Inlet
- Material Cost





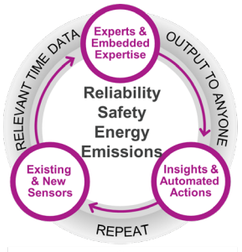
Actionable Information

- Event:
  - ✓ Alert
  - ✓ Acknowledgement
- KPIs
  - ✓ Production Loss
  - ✓ Excess Emissions

Pre-Built Analytics in Plantweb Insight Allow Simple Interpretation Including Alerts to Abnormal Situations and Conditions

Moving to Closed Loop

Frequently Open Loop



Moving to Closed Loop
* Focused on Equipment and Assets

Results from the 69 Acoustic Monitors

Mostly Manual Data → **Problems by Type** → Existing & New Sensors

Experts Limited Analysis → **Challenges** → Experts & Embedded Expertise

- RV reseated after de-pressured: 5
- Leaking RVs (rebuilt) 6
- Leaking RVs (replaced): 6
- Others: 3

Observed 200 lifts over 15 month

- Post Activation Report is required each time a RV lifts

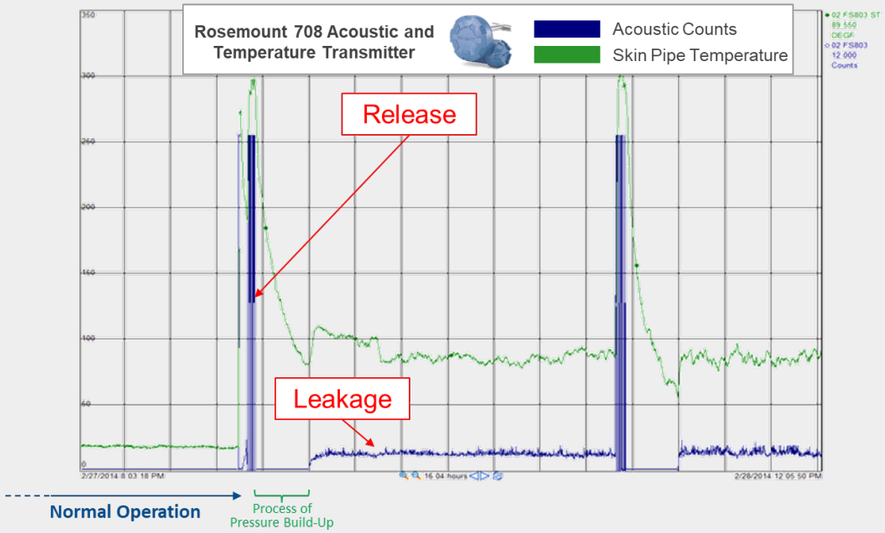
20 problems were identified and resolved

Action → **Result from Actions** → Insights & Automated Actions

"The acoustic data shows when we are operating outside of operation limits, and now we have more confidence to increase throughput of the units"

US Refinery

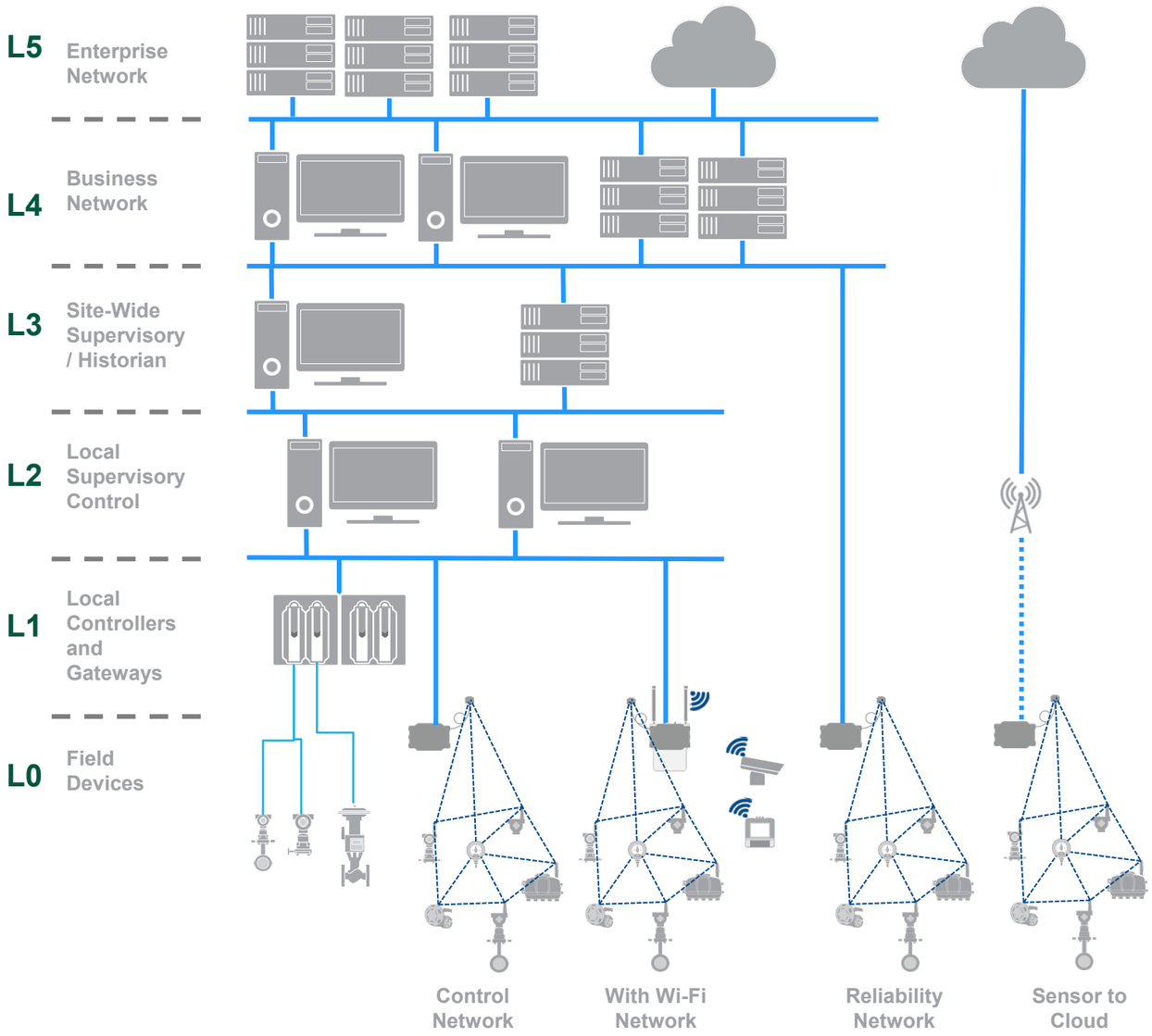
"Over time, all these actions combined have a significant impact on reducing the total H2S and hydrocarbon flow to the flare"



The ability to **pinpoint bad actor**, save weeks and even months of product losses

- Slow or intermittent releases
- Broken or stuck-open PRVs

Recommended Network Architecture



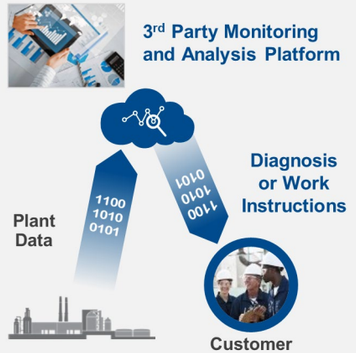
Data is Not the Rare Commodity Expertise Is!

Local Experts
Automation Network

Centralized Expertise
On Premise or Off Premise

Customer Center
Integrated Operations Center
Monitoring and Diagnostics Center

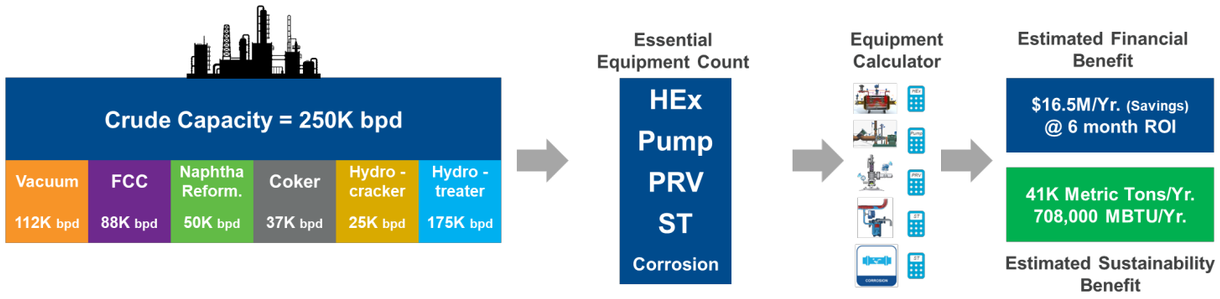
3rd Party Expert Services
Off Premise and/or Cloud Hosted



Connecting the Data to the Experts, Unlocking the Promise of Digital Transformation

How to Get Started

1) Set a meeting with local Emerson representative to get a customized report



2) Validate assumptions, and share your feedback

Unit	PRV TAG	PRV Type	Line Pressure	Process Type	Gas or Liquid	*Wireless*HART Infrastructure
A	101	PRV	300 psia	H_2S	Gas	Yes
A	102	PRV + RD	300 psia	H_2S	Gas	Yes
A	103	PRV	300 psia	H_2S	Gas	Yes
A	104	PRV	300 psia	H_2S	Gas	Yes

3) Meet with Emerson Refining team to discuss:

- ✓ Calculation Model Review
- ✓ Re-access Assumptions
- ✓ Recommendations
- ✓ Priority Plan

EMERSON

Making History With Wireless:
Solving Customer Problems With The Right Products And Expertise

51 EMERSON WIRELESS PRODUCTS
AVAILABLE TODAY

16+
BILLION OPERATING HOURS

PROVEN INTEGRATION WITH ALL
11 MAJOR AUTOMATION SUPPLIERS

12YRS
OF WIRELESS INNOVATION

OPERATING IN
146
COUNTRIES

45,000+
WIRELESS NETWORKS OPERATING GLOBALLY

11 CONSECUTIVE YRS OF WINNING

WIRELESS INFRASTRUCTURE CATEGORY 2009-19: CONTROL READERS' CHOICE AWARDS

4100+
EMERSON WIRELESS EXPERTS

7 SOLUTIONS FOR PLANT OPERATIONS

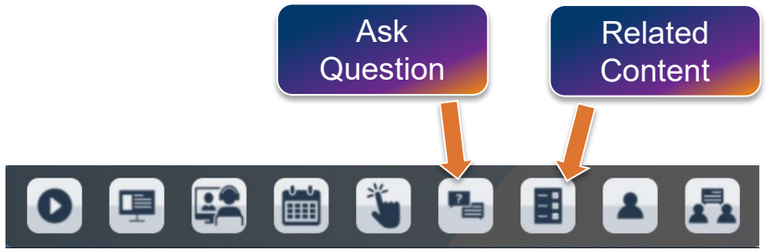
INCLUDING MOBILITY, BRIDGING, TRACKING, SAFETY, DATA BACKHAUL AND VIDEO

Conclusion: Decarbonization Opportunities in a Capital Constraint Era with Plantweb Insights

Summary

- Many possible investment can be made to reduce energy with differing costs and impact ranging from reducing steam leak to installing cogeneration unit with very high cost.
- Plantweb Insight combine with Pervasive Sensing fall into low capital cost range with saving that are typically midrange.
- The Decarbonization Opportunity with Plantweb Insight are Heat Exchanger Monitoring, Pressure Relief Valve Monitoring & Steam Trap Monitoring

Have a Question or Need More Information?



Where to Get More Information

Link

Plantweb Digital Ecosystem
Wireless For Digital Transformation
Heat Exchanger Monitoring
Pressure Relief Valve Monitoring
Steam Trap Monitoring

Product Datasheet:

Plantweb Insight Brochures
Plantweb Insight Datasheet