



ACCELERATING  
INNOVATION

# **1-1884 Impact Instrumentation Can Have on Reducing Energy Intensity in the Refining and Chemical Industries**

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## Important Reminders

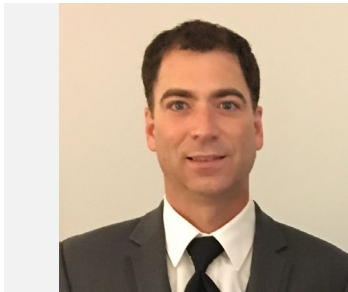
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# Energy Reduction Opportunities In Refining and Chemical

Wouldn't it be better if you  
could improve energy usage

up **15%**

\*Customers have seen energy savings of over \$15M  
with an EMIS as part of an energy reduction program

# Agenda

**Overview of Opportunities to Reduce Energy in Chemical**

**Fired Heaters and Boilers**

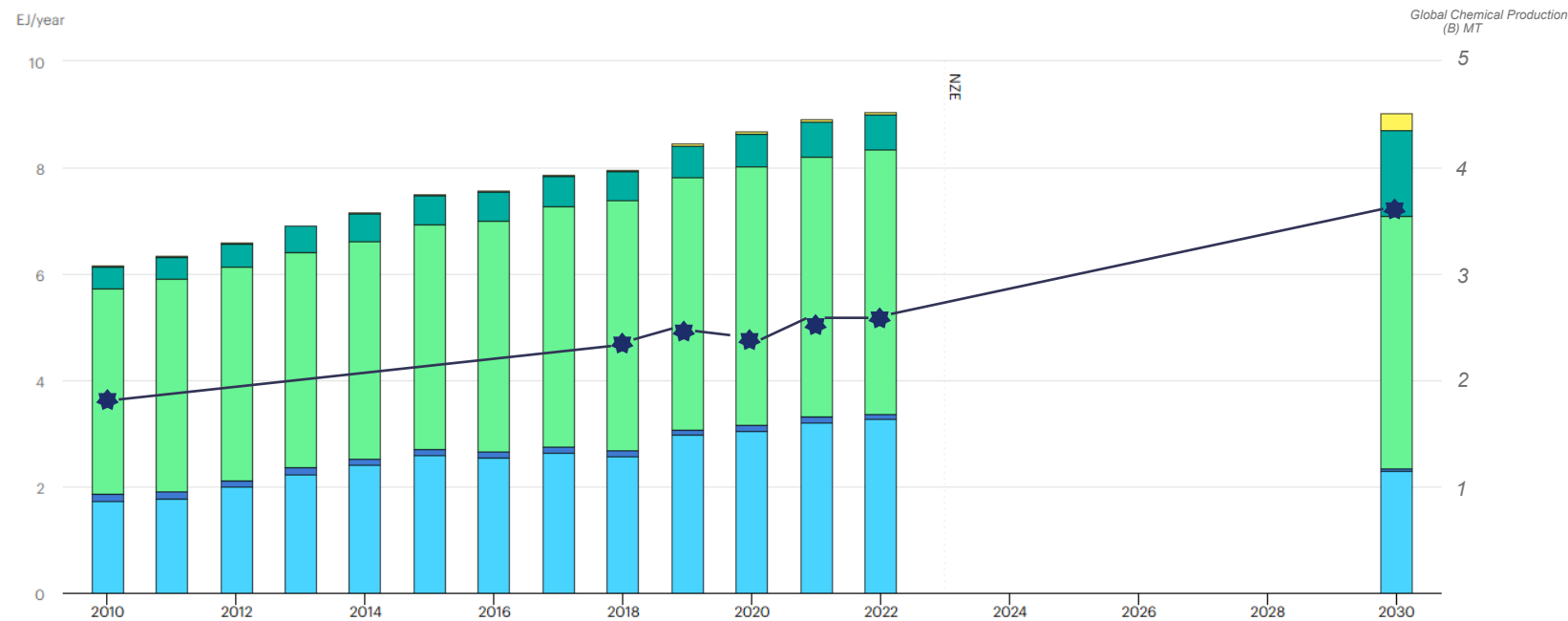
**Steam Distribution**

**Distillation Columns**

**Heat Exchangers**

**Energy Management Systems**

# Process energy for primary chemical production, 2010-2030



● Coal ● Oil ● Gas ● Electricity ● Bioenergy

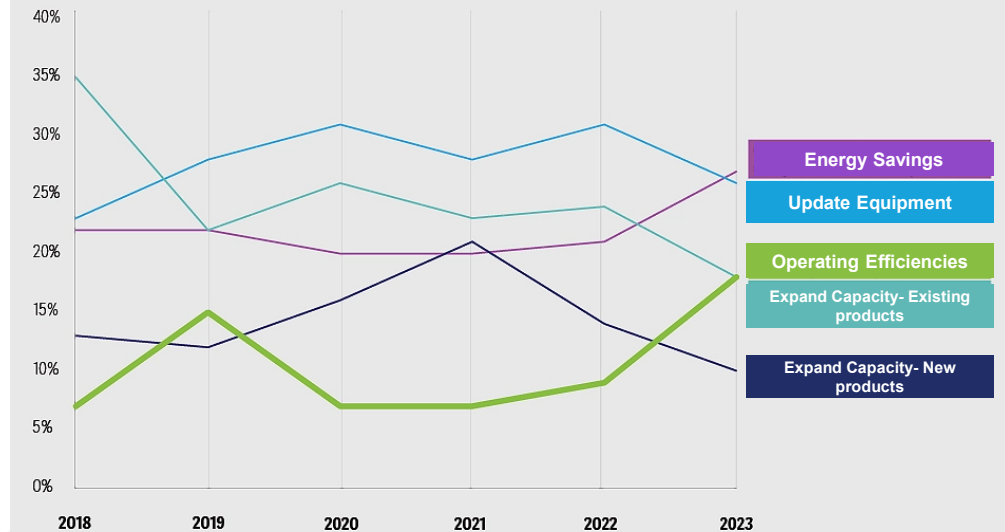
IEA (2023), Process energy for primary chemical production, 2010-2030, IEA, Paris <https://www.iea.org/data-and-statistics/charts/process-energy-for-primary-chemical-production-2010-2030>, License: CC BY 4.0  
Global Chemical Production data sources: Deloitte / CEFIC

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Figure 3

The percentage of companies surveyed that identified 'improving operating efficiencies' as a key motivation for capital investment doubled between 2022 and 2023

Percentage of companies



Source: American Chemistry Council, Business of Chemistry 2024.

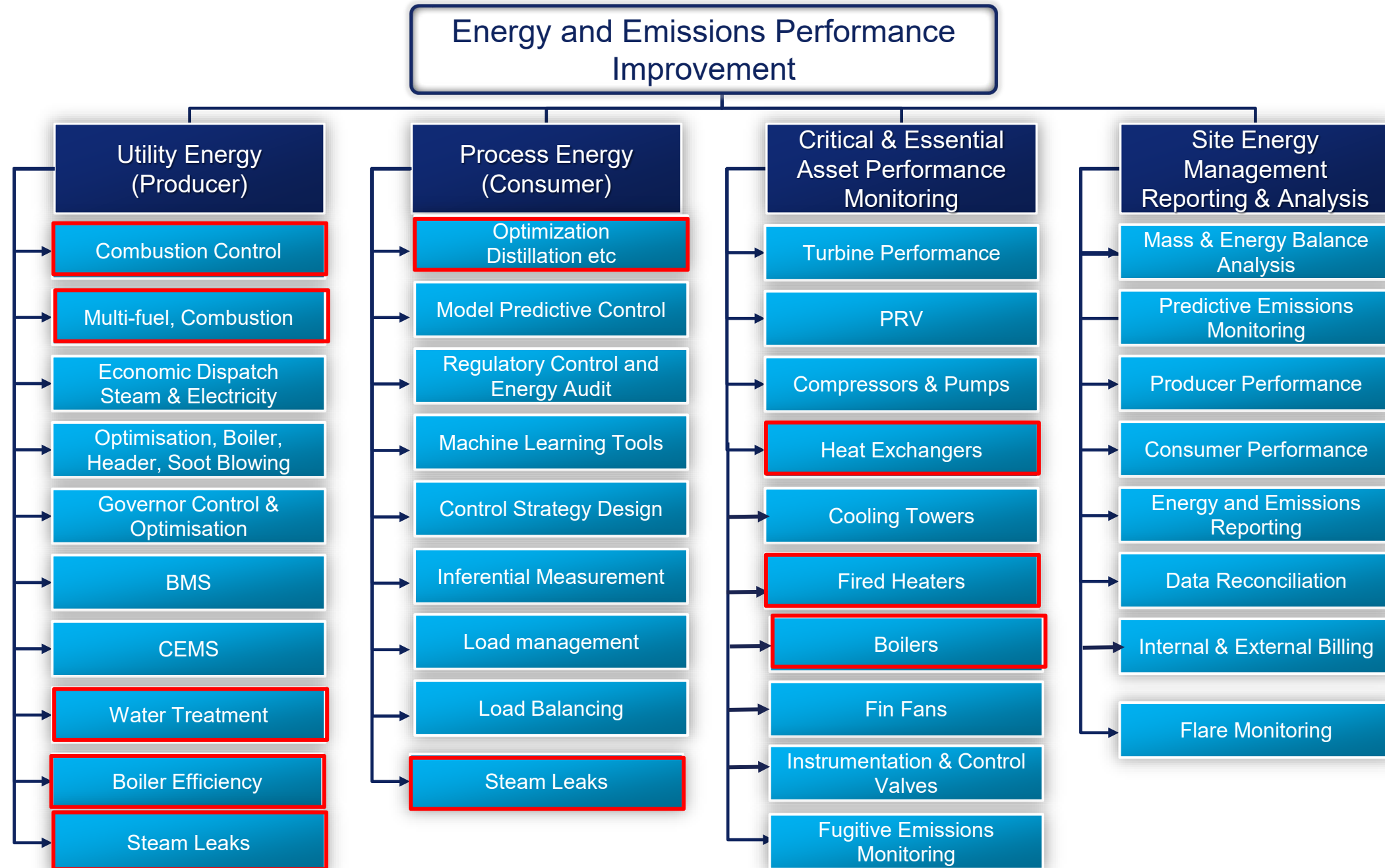
Deloitte | [deloitte.com/us/en/insights/research-centers/center-energy-industrials.html](https://deloitte.com/us/en/insights/research-centers/center-energy-industrials.html)

**Energy Savings has been reported as the highest key motivation for capital investment**

“To meet the 2030 targets the chemical industry needs to drive a 32% improvement in energy intensity at a 3.5% CAGR ”

As there is a direct relationship between energy and emissions, reducing one, reduces the other

# Energy and Emissions Improvement with Emerson Automation Solutions



What to Measure



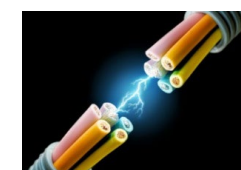
Water



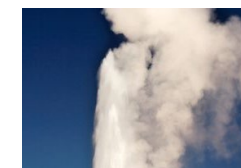
Air



Gas (Fuel)



Electricity

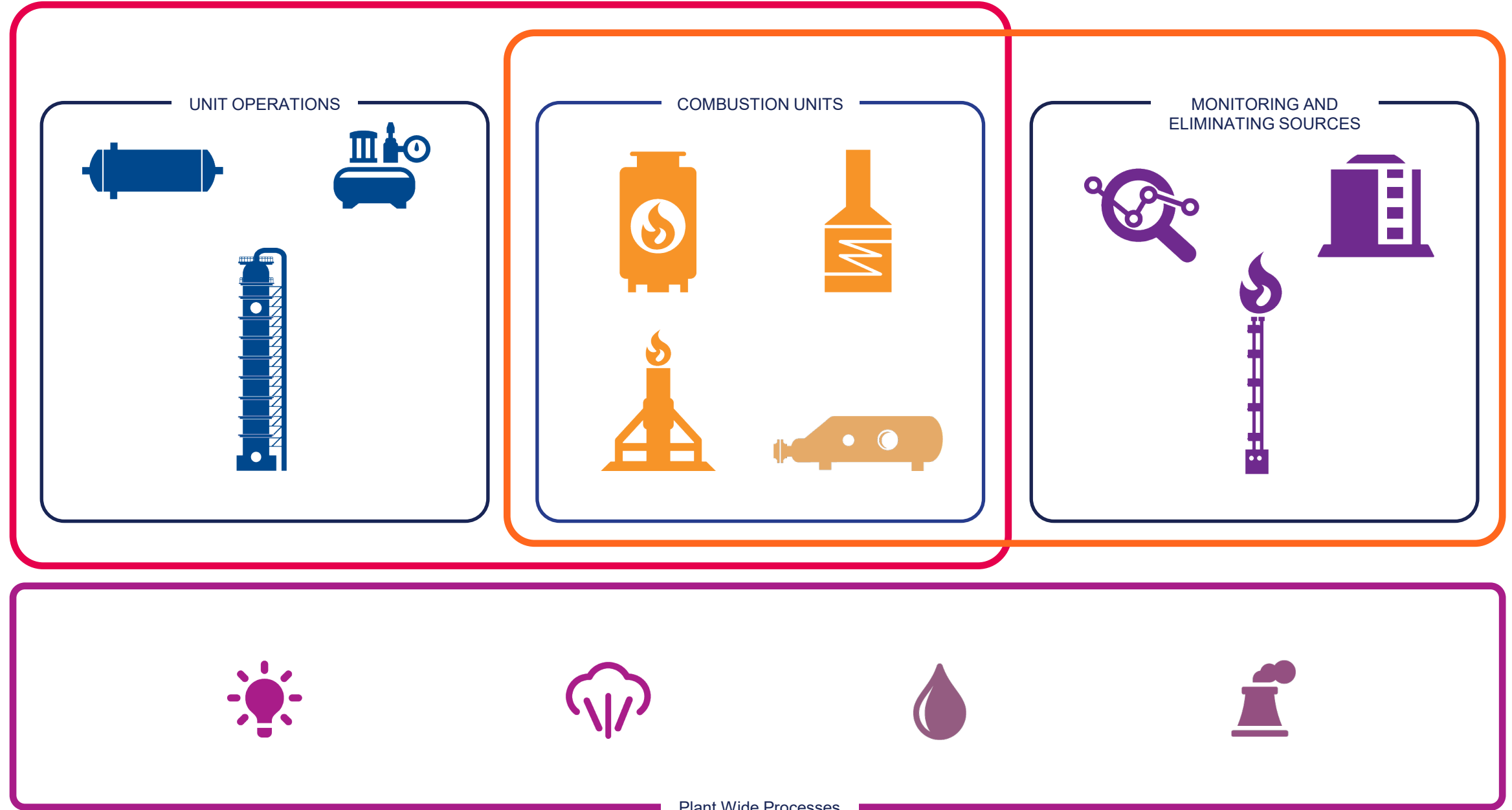


Steam

WAGES

# Chemical Industry – Energy and Emissions

Effective process automation at the unit operation level is an essential component of any comprehensive strategy for improving energy efficiency and reducing carbon dioxide (CO<sub>2</sub>) emissions associated with chemical industry plants and facilities..



INDUSTRY CHALLENGES

EMERSON

# Fired Heater Operational Challenges

ENERGY CONSUMPTION

EMISSIONS & ENVIRONMENTAL

IMPROVE SAFETY

X

UP TO  
**50%** of the operating budget is typically spent on energy

Fired heaters account for 37% of the U.S. manufacturing energy use. Traditional volume-based control schemes and undetected changes in fuel gas composition can result in up to \$250K USD in increased fuel consumption.

VIEW SOLUTIONS

# Operating Challenges with Fired Heaters and Boilers

Fired heaters are generally one of the largest consumers of energy.



Difficulty maintaining operating expertise and skillset for manual control intervention

More stringent regulatory requirements to reduce Carbon footprint

Lack of automation of air supply in natural draft heaters, fuel quality variation and unreliable analyzer measurements make efficiency difficult to achieve

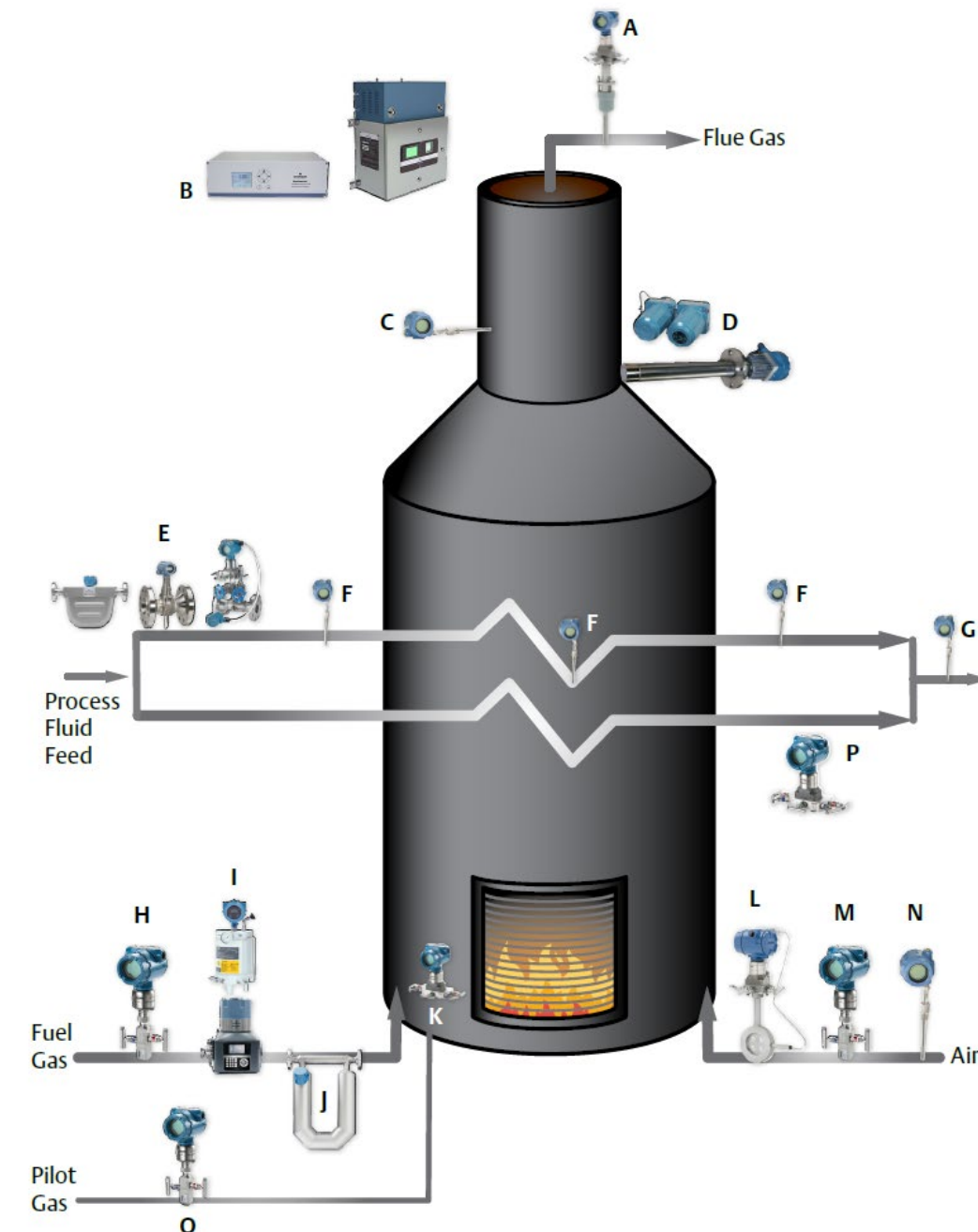
Have to achieve the right amount of excess air to ensure complete burning of fuel and to maintain a safety margin

Use of high levels of excess air can increase emissions drastically. A 2% O<sub>2</sub> increase can result in a 25-30% increase in NO<sub>x</sub> emissions

# Emerson Measurement Solutions Around Fired Heaters and Boilers

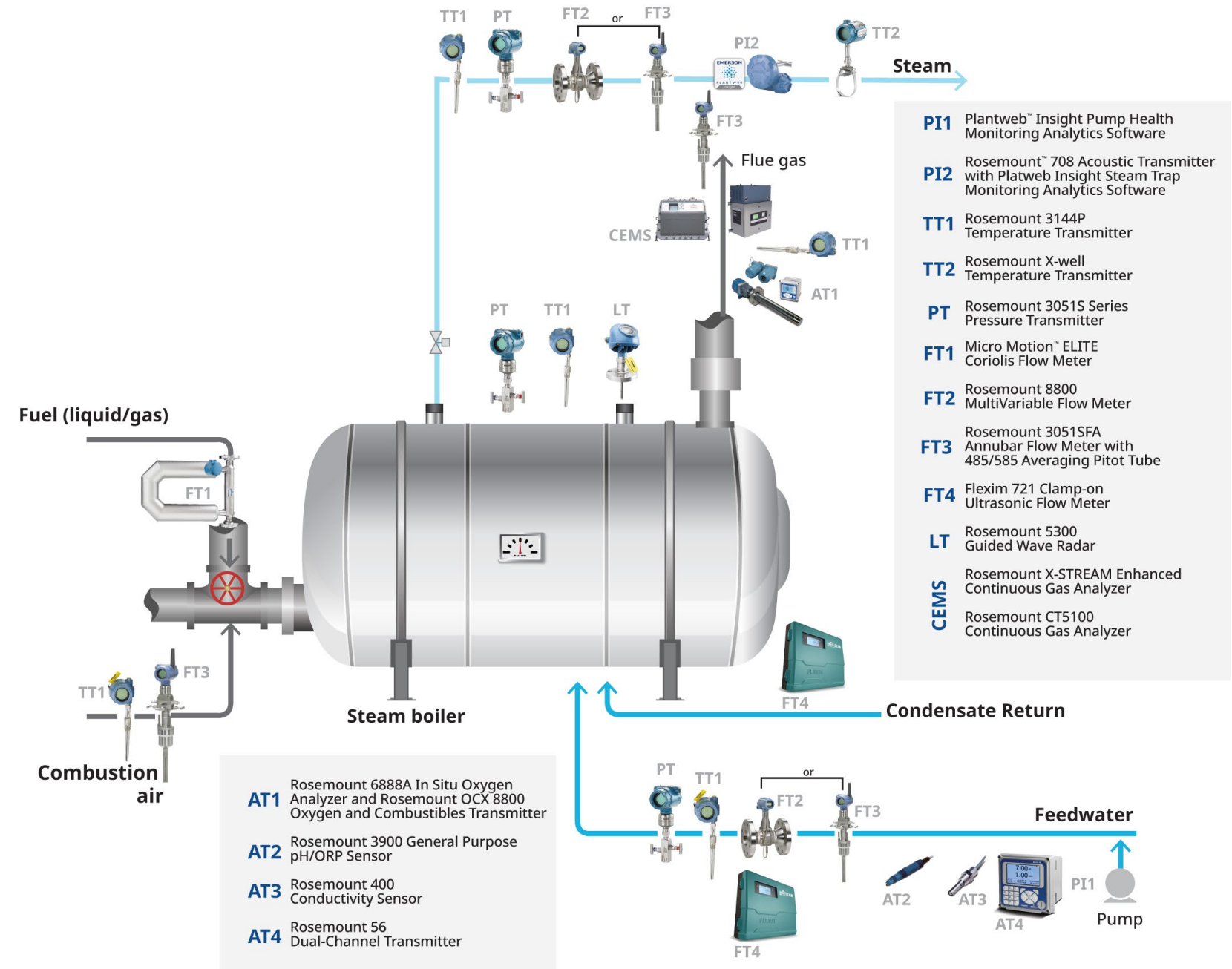
## Emerson's' Fired Heater Solutions

- Burner Management System (BMS) using Safety Instrumented System (SIS)
- **Fuel flow and fuel BTU measurement**
- Air flow measurement by direct instrument or pressure drop across heater
- Air damper actuation and position measurement
- **Excess Oxygen measurement**
- Emission Monitoring
- Optimized combustion control with fuel Btu compensation
- Flame stability detection
- Automatic start-up and shut-down routines
- Product charge and temperature optimization
- Asset monitoring functionality with predictive maintenance alerts



# Measurement Solutions Applications Agenda

- Fuel flow and fuel BTU measurement
- Air flow measurement by direct instrument or pressure drop across heater
- Excess oxygen measurement
- Emission Monitoring
- Optimized combustion control with fuel Btu compensation
- Flame stability detection
- **Water quality**



# Traditional Combustion Control Methods

## Traditional Control Methods

- Feedback controller from the process outlet temperature controller
- Cascade loop using pressure or volumetric control of the fuel gas
- Problematic with rapid changes in fuel gas consumption due to:
  - Unit upsets
  - Changes in process conditions
  - New sources that dump into fuel gas header

## New Recommended Practice

- Mass based fuel gas measurement for control

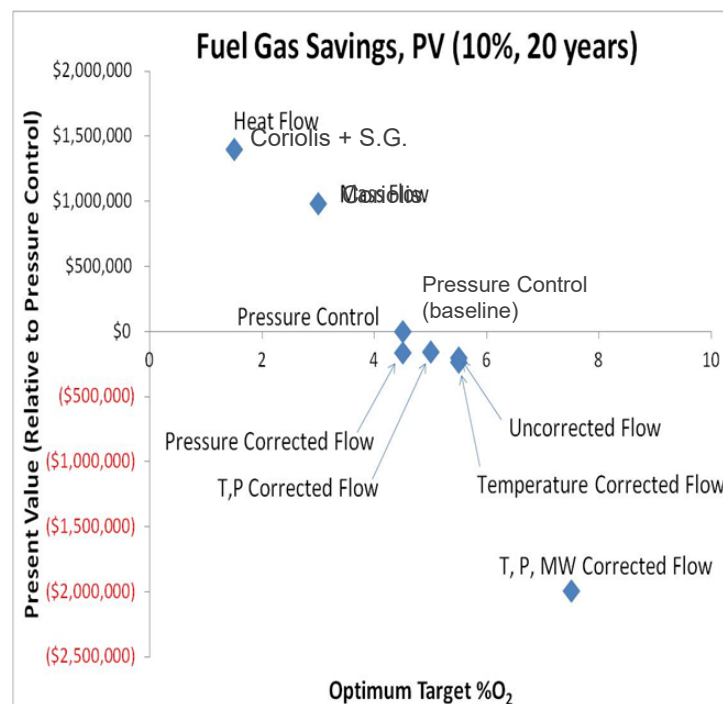
Components	Gas 1	Gas 2
Inerts	3.6	2.5
C1	90.7	85.9
C2	4.5	8.5
C3	0.8	2.3
C4s	0.3	0.7
C5s	0.1	0.1
Energy Content		
BTU/lb	22,218	22,294
BTU/scf	1035	1108

Variability	
By mass	0.17%
By volume	3.34%
Reduction	19.6X

# Stabilized Combustion with Coriolis Meters

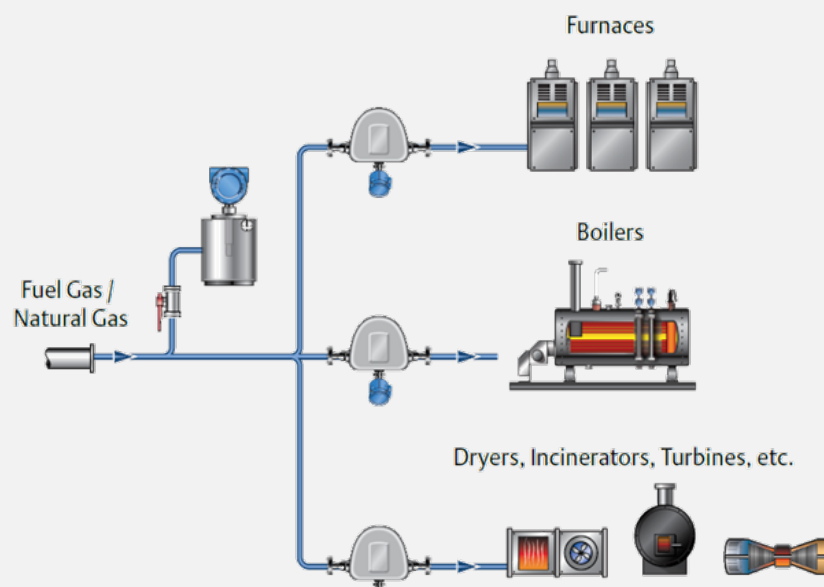
## Operational Challenges

- Fuel gas composition varies, resulting in different air requirements for combustion



## Value Enabler

Use Micro Motion Coriolis Meters for mass-based control of fuel gas to reduce stabilize control and operate more efficiently



## Impact on Operations



Improve safety by stabilizing fired heater operation and avoid trips during rich fuel conditions



Increase energy efficiency and reduce NOx emissions by Operating with less excess air



Accurately and easily report fuel gas consumption for regulatory reporting

**Typically, \$250K- \$1M NPV savings per heater compared to volumetric-based control schemes**

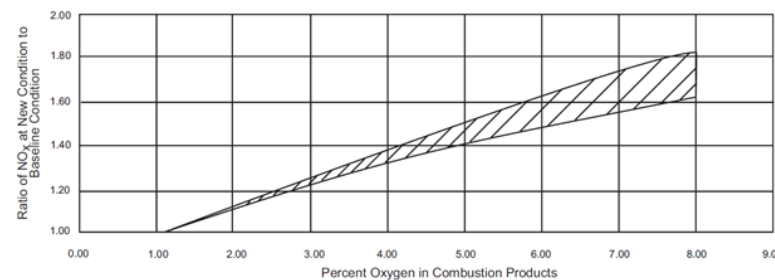
# Energy & Combustion Control Improves Reliability, Minimizes Emissions and Ensures Safety

## Problem

- Fired heater/boiler instability due to inconsistent fuel gas composition
- Unstable combustion leads to:
  - Higher energy costs
  - Increased emissions
  - Safety issues due to furnace trips

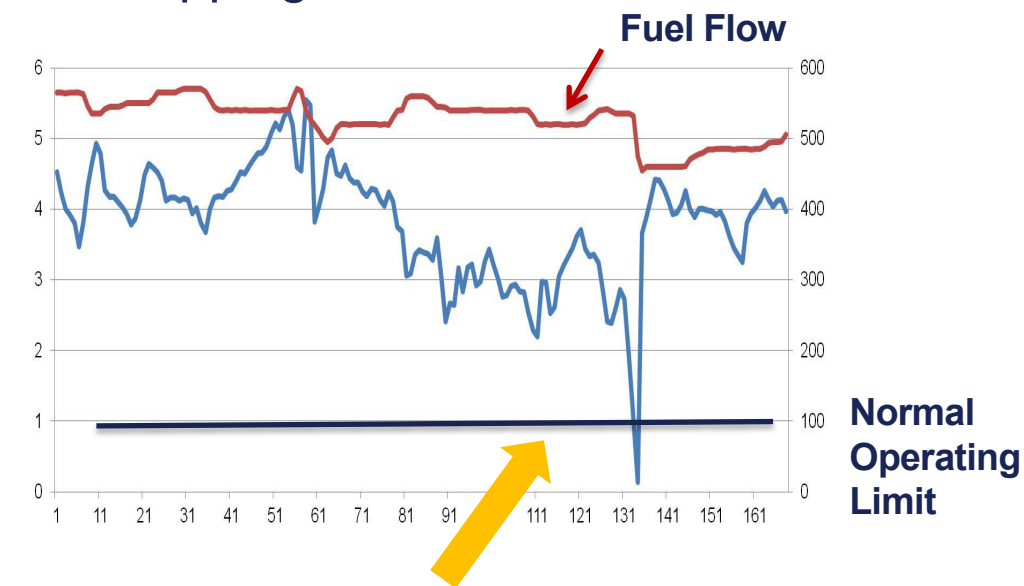
## O<sub>2</sub> High

- Safer
- Less energy efficient
- Increased emissions
- 2% O<sub>2</sub> increase could lead to 25-30% emission increase



## O<sub>2</sub> Low

- Substoichiometric combustion resulting from composition sudden change
- Tripping risks

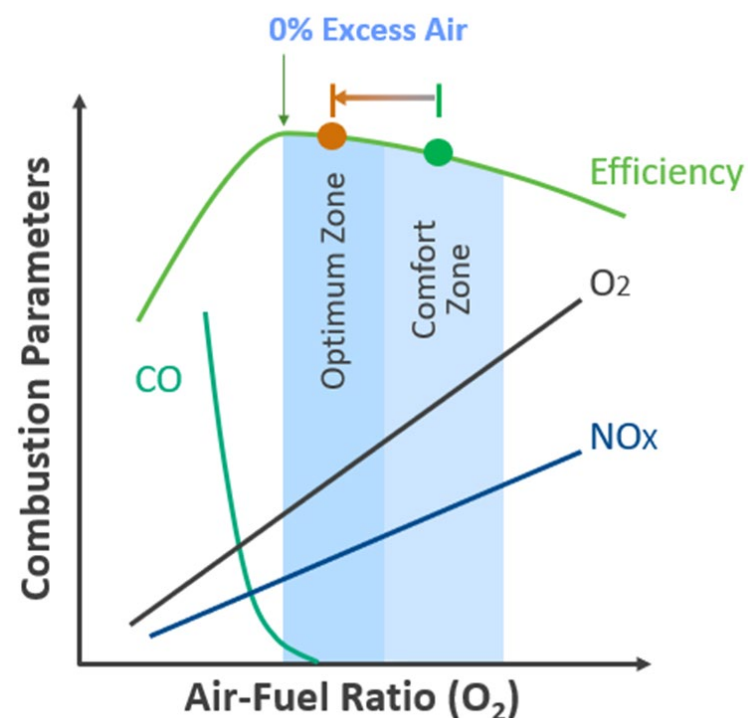


Rapid increased air demand may cause %O<sub>2</sub> to drop below boundary condition (e.g. NOL)

# Accurately Measure Oxygen /CO in the Stack

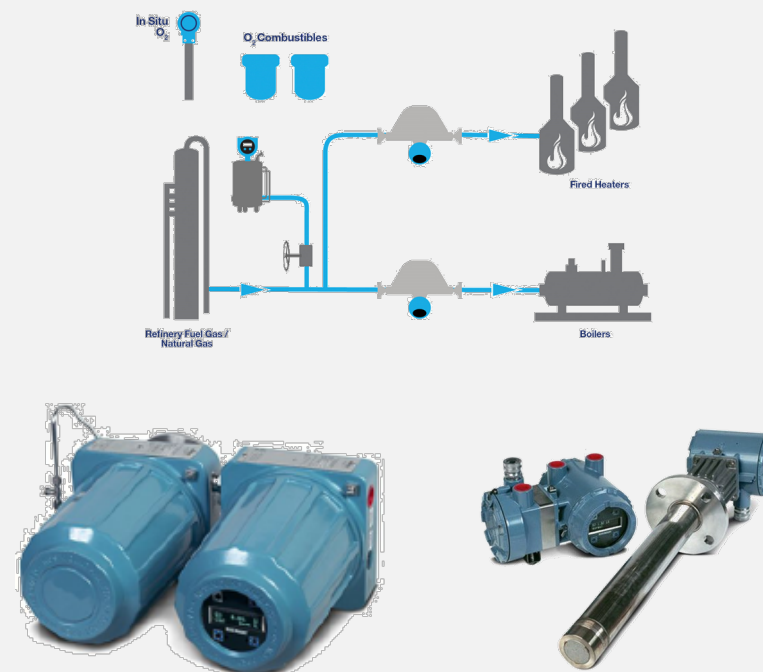
## Operational Challenges

- Measure of combustion efficiency
- Lack of effective instrumentation to continuously and rapidly measure O<sub>2</sub> and CO presents safety risks during fuel rich conditions



## Value Enabler

Continuously and accurately monitor oxygen and the combustibles in flue gas using the Rosemount 6888 in-situ analyzer or the OCX 8800 O<sub>2</sub> and CO<sub>E</sub> Transmitter



## Impact on Operations



Reduce maintenance, eliminate sampling systems, and perform online calibrations



Reduce NO<sub>x</sub>, CO, and CO<sub>2</sub> emissions and **improve efficiency by maintaining target oxygen levels** in the stack (Feedback Control)



Improve measurement accuracy with new variable insertion option permits ideal placement of probe and characterizing stratification across large ducts

2% reduction in O<sub>2</sub> ( from 4%-2%) led to a 24% improvement in fuel savings

INDUSTRY CHALLENGES

# Steam System Inefficiencies

Poorly controlled combustion results in wasted energy and excess CO2 emissions

UP TO

**15%**

of energy is wasted  
in a typical steam  
system

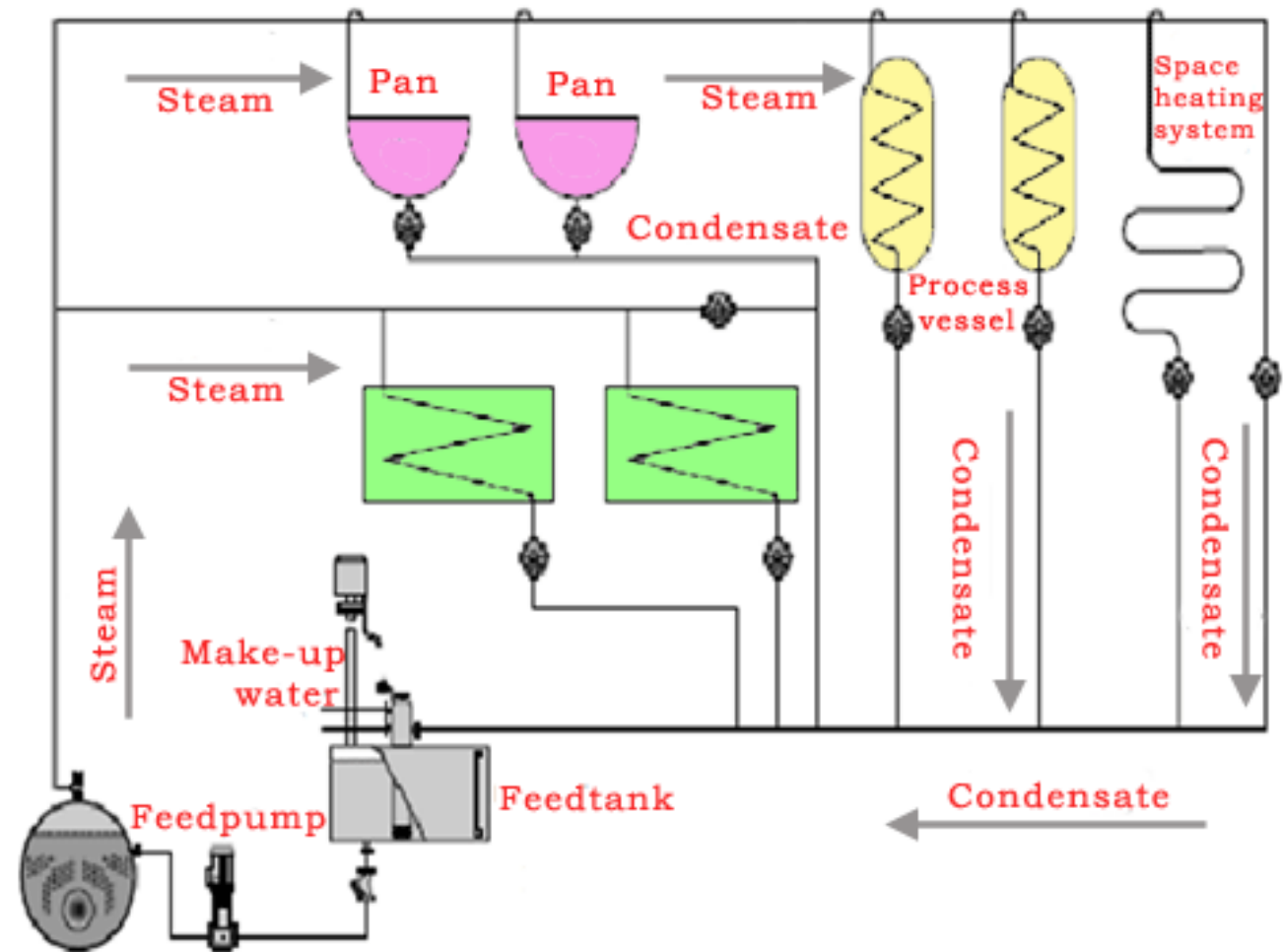


STEAM SOLUTIONS

EMERSON

# Steam Distribution System

- Maximize return of condensate
- **Use of multivariable transmitters**
- **Improved steam density calculations**
- **Proper steam trap maintenance**
- Uncertainty of measurements
- Unmeasured streams and uncontrolled valves
- PSV Monitoring

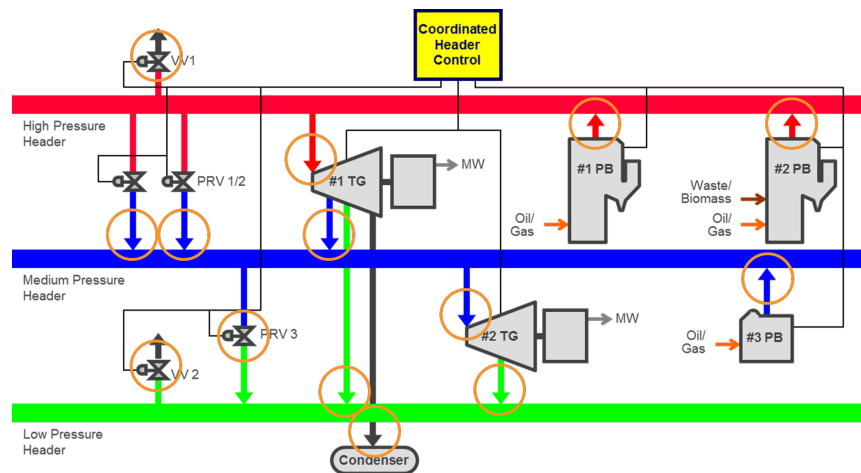


Basic Steam Distribution

# Steam System Optimization

## Operational Challenges

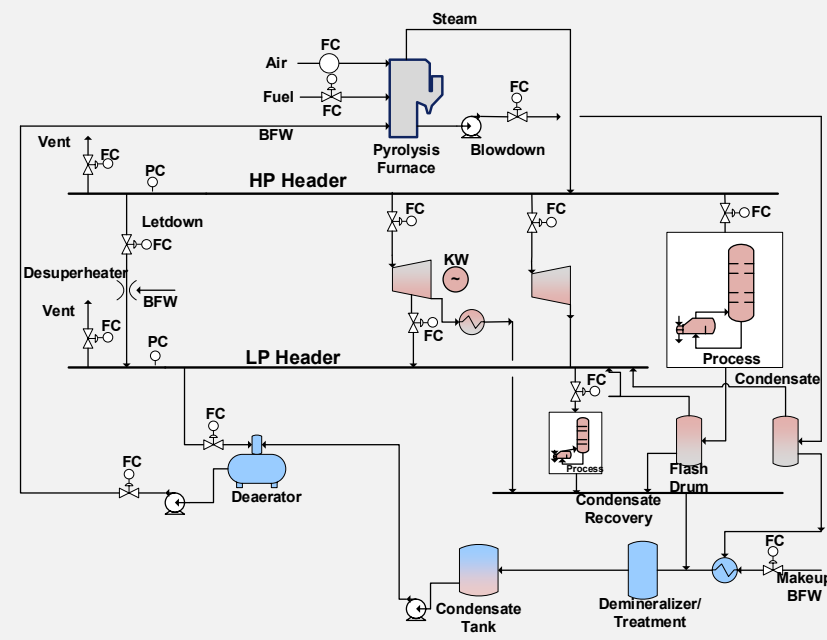
- Low steam header pressure can trip a plant
- Steam demand can change dramatically and quickly
- Multiple, different boilers used to manage total steam supply
- Boiler efficiency changes with load
- Faulty steam traps create losses
- Inability to track consumption and losses
- High energy consumption



## Value Improvement Practice

### Emerson Steam System Solutions

- Wireless, pressure, temperature, flow, corrosion and acoustic steam trap leak detection solutions to monitor steam use and minimize losses
- High-performance instrumentation, control valves and APC for stable, robust operation



## Impact on Operations



Reduced steam header pressure variability by 50%



Reduced energy per unit of steam from loading the most efficient boilers



Real-time automatic adjustment to best cost position improves steam/utility costs 1–3%



5–20% reduction in vented/letdown steam

# Maintain Boiler Feedwater Quality to Improve Performance

## Operational Challenges

- Impurities in boiler feedwater lead to scale deposits resulting in poor heater transfer, higher fuel costs, and overheating of tubes
- Heat exchanger leaks result in an increased contamination of boiler feedwater

## Value Enabler

Use Rosemount 56 Analyzer with 400 Conductivity and 3900 pH Sensors to control boiler water chemistry.

Use Rosemount 400 Contacting Conductivity and 3900 ORP Sensors to improve reverse osmosis filter reliability.

Use Rosemount 400 Contacting Conductivity to detect heat exchanger leaks early.

## Impact on Operations



Reduce environmental footprint by optimizing fuel usage



Keep conductivity within acceptable limits by automating blowdown and makeup water valves with the dual channel 56 analyzer



Reduce risk of acid corrosion of boiler tubes



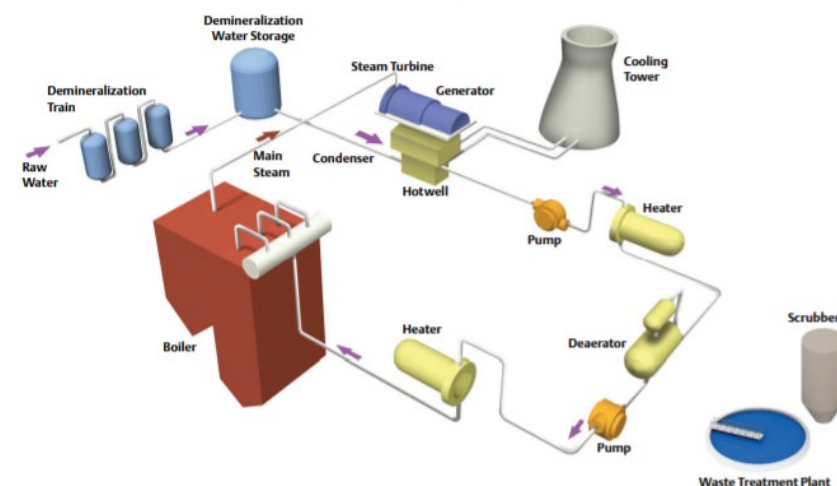
Early detection of leaks lowers potential feedwater treatment cost



Lower operating expense through measurement of membrane efficiency with conductivity



Increase membrane service life by ensuring complete disinfection of feedwater



# Improved Energy Balance With Mass Steam Measurement

## Operational Challenges

- Proper measurement and monitoring solutions accurately measure and optimize steam distribution
- The energy content of steam is a function of the steam mass
- Steam is compressible, therefore a change in pressure changes the density
- Traditional measurements require multiple devices and a computational devices or controller

## Value Enabler

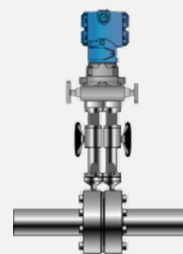
### Broad Portfolio of steam measurement solutions

Temperature and pressure compensation capability provides steam mass flow measurement

Wired / Wireless solutions

Conditioning orifice for tight spaces

Non-wetted sensor vortex



**3051 SMV**  
Compensated dP



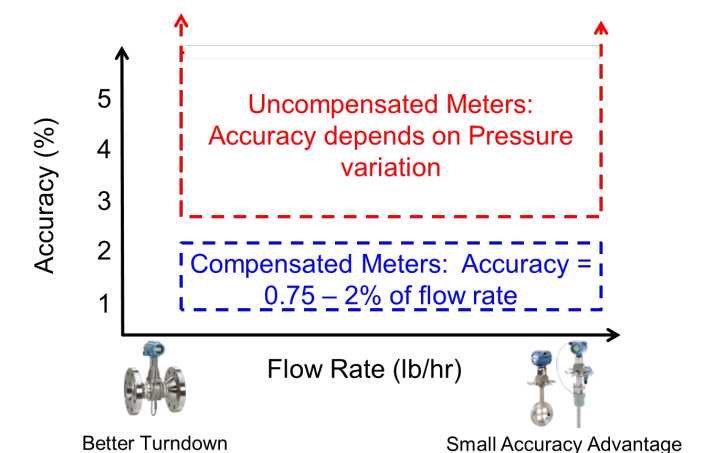
**8800D**  
Compensated Vortex

## Impact on Operations

### Mass Flow delivers:

- Better control of combustion
- Better mass & energy balance
- Reduced process variability
- Meaningful quantity measurement of compressible fluids

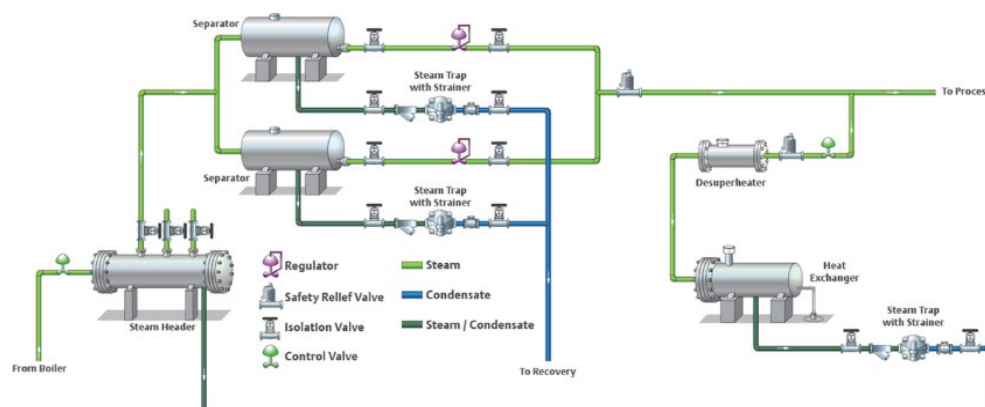
**... especially important in gas or steam flow!**



# Improve Steam Usage Monitoring With Wireless and Non-Intrusive Measurements

## Operational Challenges

- Missing steam measurements needed for **steam balance and allocation**
- Difficult to install additional measurement points due to cost space, or accessibility
- Unable to identify sources of wasted steam






## Value Enabler

Use the Rosemount 3051SFC/Compact Annubar/Conditioning Orifice Wireless Differential Pressure Transmitter, Flexim USM, and X-Well

- Easily add steam flow measurements needed for allocation or steam balance purposes



## Impact on Operations

- 
 Reduce installed costs by 40–60% compared to wired installations
- 
 Improve steam energy balance by easily adding additional measurement points
- 
 Reduce installation cost with non-intrusive ultrasonic flow and temperature sensors to add missing points

# Detecting Steam Leakage Through PRV/PSV's and Steam Traps To Reduce Energy Losses

## Operational Challenges

### Unknown Lost Energy Through PSV's And Steam Traps

- Steam traps are typically audited once a year and repaired if failures are detected
- As many as 30% of steam traps may be out of service when audits are being performed
- Plants are left vulnerable for long periods of time with a lack of visibility
- On-line monitoring of steam traps has traditionally been deemed cost-prohibitive or too difficult

## Value Enabler

### Detect PSV and steam trap releases in real-time

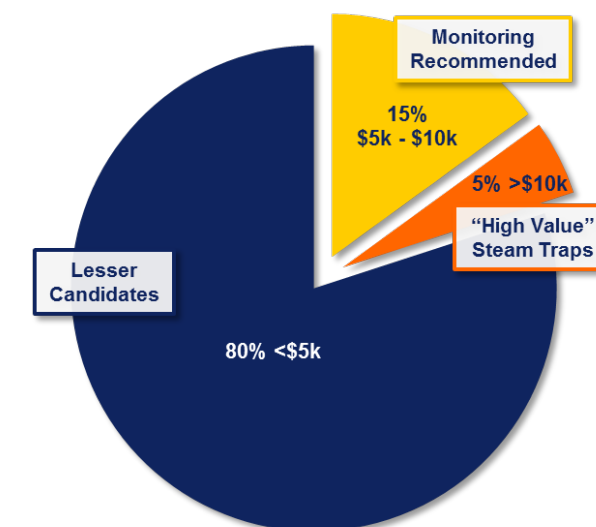
- Comprehensive monitoring through non-intrusive wireless acoustic transmitters
- Monitor sensors with analytics software to detect and record events



## Impact on Operations

- Quickly identify which steam traps are malfunctioning
- Improved visibility into total steam losses from steam traps
- Customer monitored 187 steam traps and found 25% were failing(1)
- Payback 1 year(1)

Steam Traps by Failure Cost



## Balancing separation efficiency versus energy consumption

### ENERGY CONSUMPTION

UP TO

**40%** of energy used can be from distillation processes

### COLUMN FLOODING

UP TO

**8** hours to stabilize a column after a flooding event

### PRODUCT QUALITY

MORE THAN

**7%** production loss due to over-purification and uses 12% excess steam

### ENVIRONMENTAL CONDITIONS

UP TO

**7%** excess energy used due to unmanaged ambient temperature swings



# Distillation Automation and Control Optimization

## Operational Challenges

- Varying feed rate and composition
- Underperforming loops
- Lack of proper measurements
- Over-purification or quality “giveaway”
- Distillation columns can limit production and operate against difficult-to-measure constraints

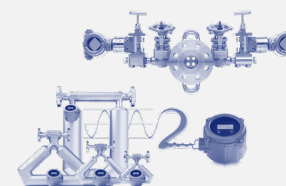


## Value Improvement Practice

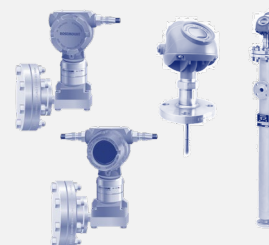
### Implement Industry Best Practice Distillation Controls and Instrumentation



HIGH PERFORMANCE VALVES



RELIABLE, ACCURATE FLOW INSTRUMENTATION



HIGH PERFORMANCE LEVEL CONTROL



FIELD-MOUNTED ON-LINE ANALYZERS

## Impact on Operations

Improved control stability that allows for minimum reflux ratios while maintaining on-spec products



Up to 10% in reduced energy consumption



7% increase in throughput



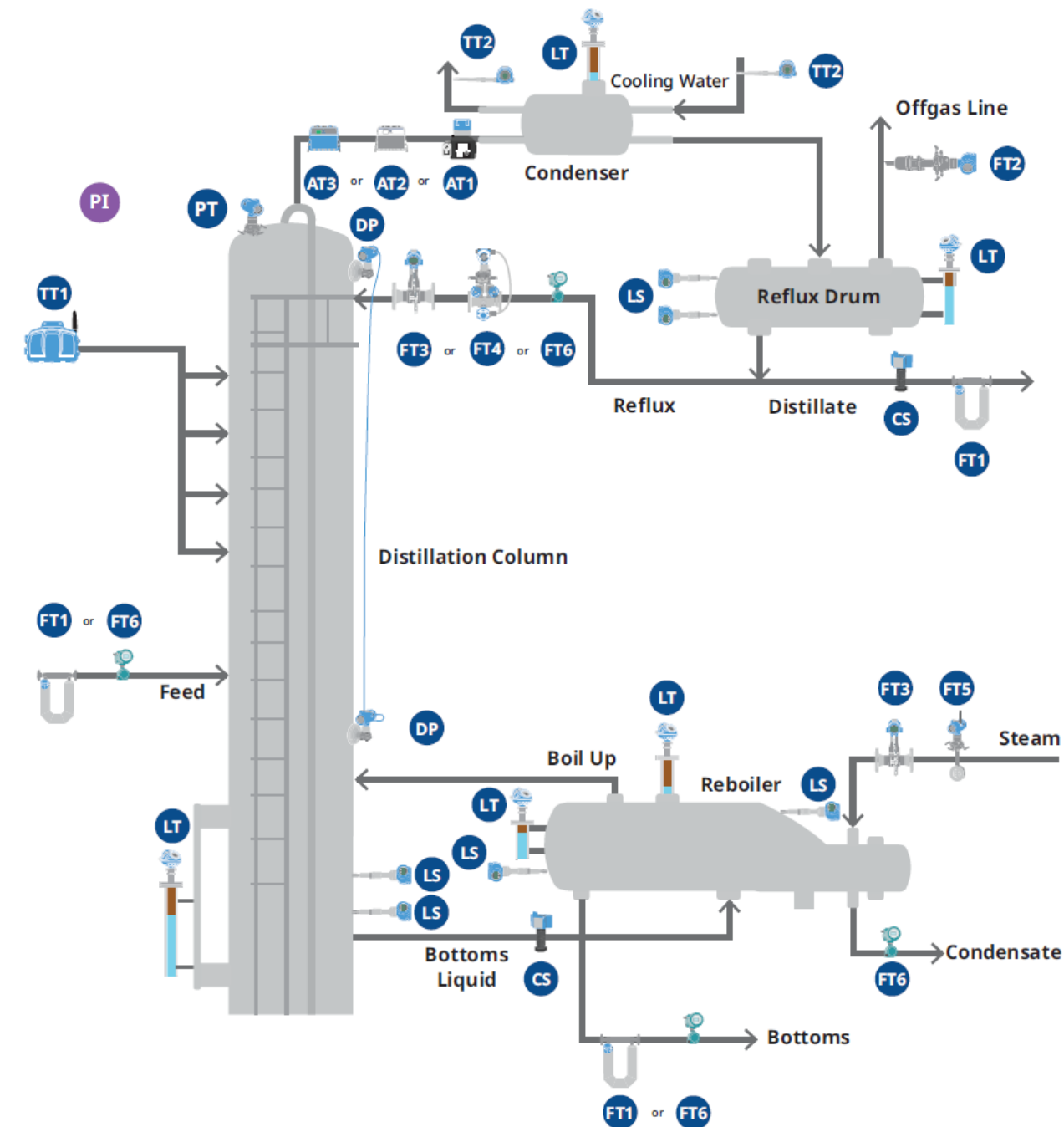
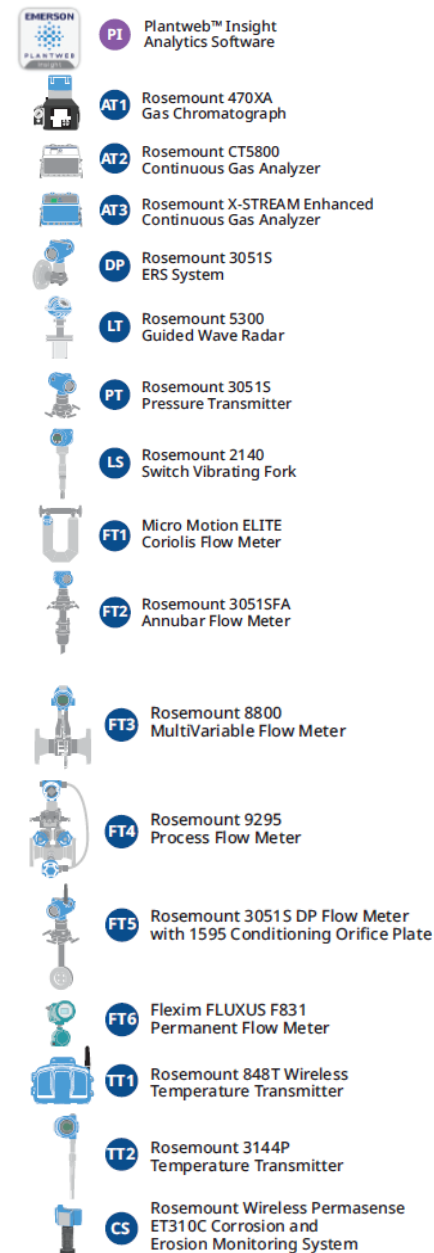
Eliminate upsets from poor loop performance



Improved product quality and reduced quality giveaways

# Emerson Distillation Measurement Capabilities

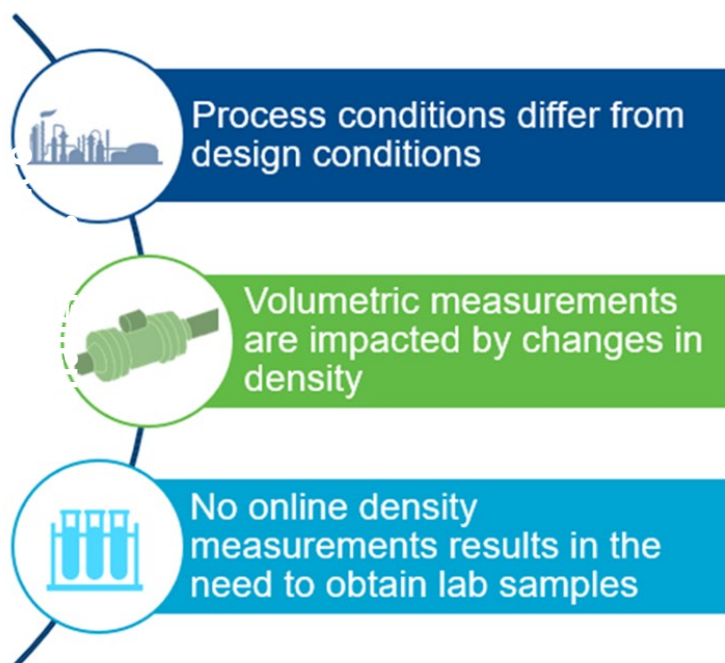
- Control temperature profile across the column with multipoint temperature transmitter
- Improve pressure measurement with ERS
- Column level, reboiler level control, and reflux level
- Improved mass balance with Coriolis
- Corrosion monitoring for improved safety
- Improve quality and prevent over purification with overhead gas composition monitoring
- Overfill prevention with point level detection



# Optimize Efficiency and Yields with Improved Mass Flow Measurements

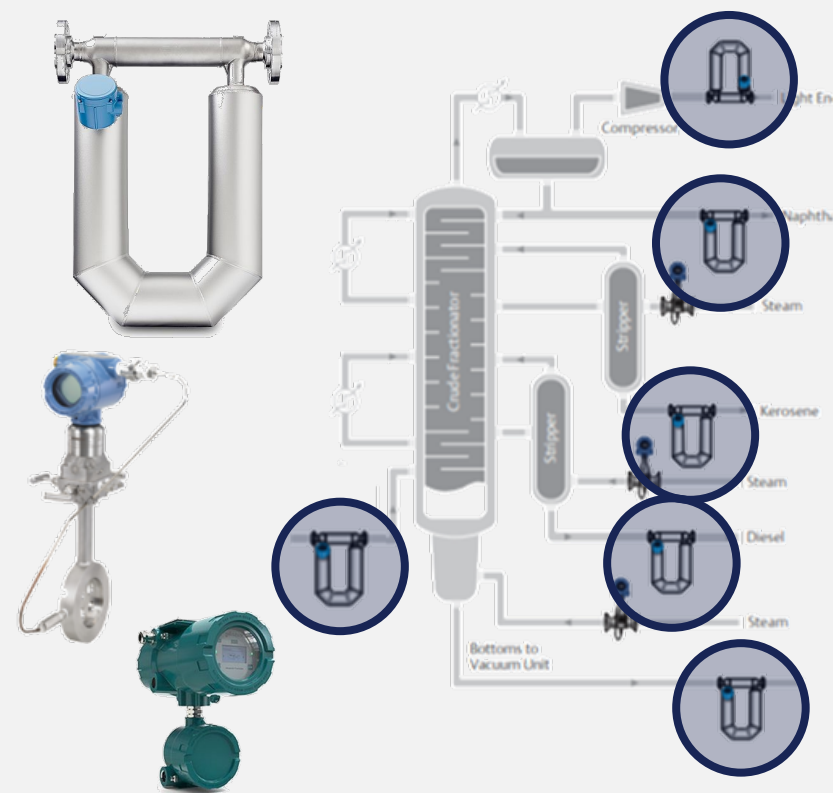
## Operational Challenges

- Accurate unit mass balance of the distillation process is needed to increase yields and improve efficiency
- Volumetric measurements increase uncertainty






## Value Enabler

Use Coriolis flow meters to accurately measure tower cut point flows despite changes in process conditions or fluid properties.



## Impact on Operations

-  Improve unit mass balance closure
-  Improve data quality to make better process control and optimization decisions reducing energy usage
-  Meet target operating plan for yields

# Improve Distillation Tower Performance with ERS

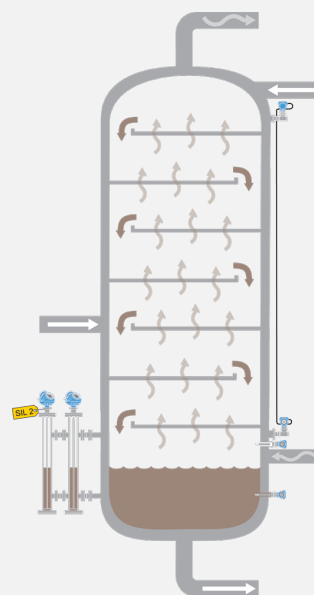
## Operational Challenges

- DP across distillation columns needed to detect and prevent choking, flooding and fouling of trays
- DP with capillary and remote seals requires complicated impulse lines prone to erratic outputs due to environmental effects
- Traditional DP requires constant maintenance of complicated steam tracing system
- Long capillary systems reduce system response time





## Value Enabler

### Rosemount 3051S ERS System

- Links two 3051S pressure sensors electronically for DP measurement
- Stable and repeatable measurement without capillary and temperature drift



## Impact on Operations

-  Accurate prediction of tower choking/fouling
-  Cut response time by more than 90% for improved control and reduced energy usage
-  Reduce maintenance on impulse lines
-  Eliminates steam tracing and steam trap usage lowering energy cost

# OXEA Improves Distillation Tower Performance with ERS

*Acetate Distillation for Production of Various Esters*

## CHALLENGES

- Harsh process conditions and corrosion caused frequent seal failures
- Multiple shutdowns to replace the entire balanced seal system
- DP with capillary and remote seals required complicated impulse lines prone to erratic outputs due to environmental effects
- Long capillary systems reduce system response decreasing performance of the distillation column

## SOLUTION

- Rosemount ERS DP Level System
- Links two 3051S pressure sensors electronically for DP measurement
- Stable and repeatable measurement without capillary and temperature drift
- Simplified installation when corrosion requires replacement with no process shutdown required

## KEY EMERSON TECHNOLOGY

- Rosemount ERS

Region: *Europe* | Industry: *Chemical*



## PROVEN RESULTS



**Reduced maintenance time** by 40%



**Reduced replacement cost** by 40%



**Increased throughput**, production cycles



**Increased unit efficiency** by 10%

# Monitor Contaminants and Final Purity

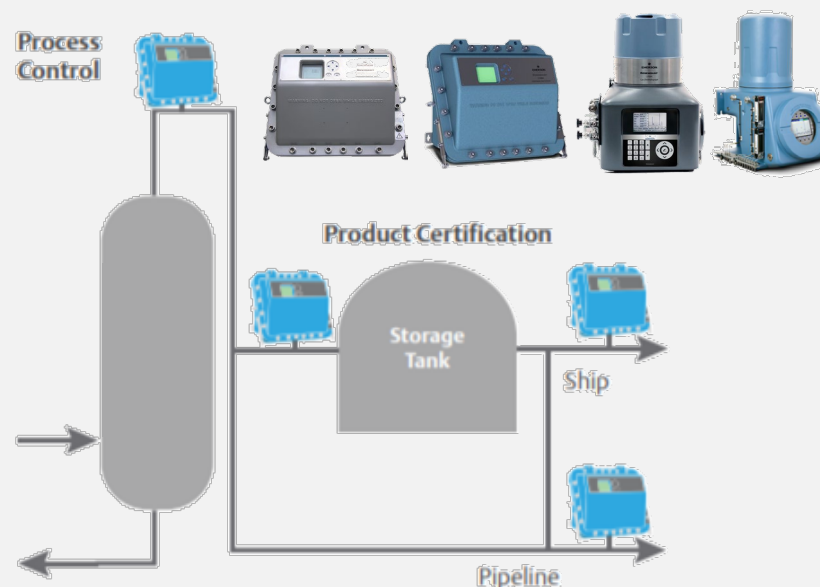
## Operational Challenges

- Meet desired product quality specifications and avoid off-spec product
- 7% production loss due to over-purification and uses 12% excess steam
- Ensure feed is contaminant free
- Minimize recycle of off-spec product wasting energy

## Value Enabler

Use Rosemount CT5800 Quantum Cascade Laser Analyzer or X-STREAM gas analyzer or Rosemount 470X/700XA Gas Chromatograph strategically placed to monitor distillation quality.

Laser and hybrid analyzer options



## Impact on Operations



Operate columns closer to target as apposed to running higher than required quality



Reduce energy use by continuous quality control

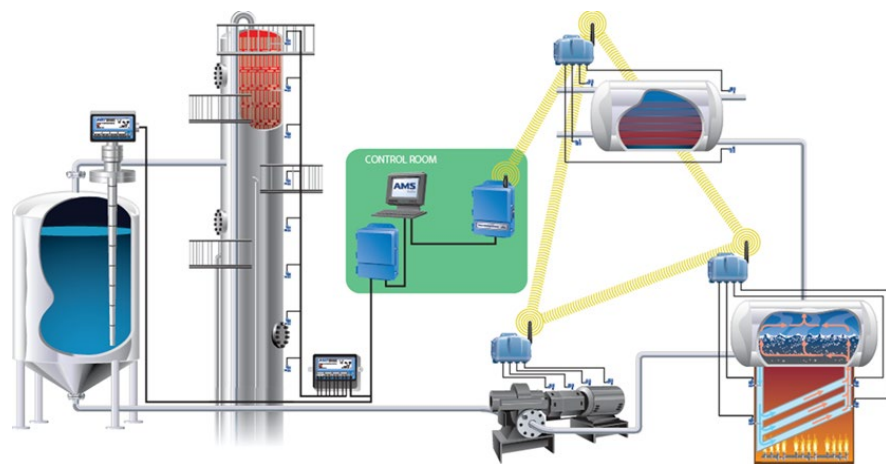


Real-time purity monitoring prevents catalyst poisoning and recycling due to off-spec product

# Improve Column Temperature Profile Accuracy

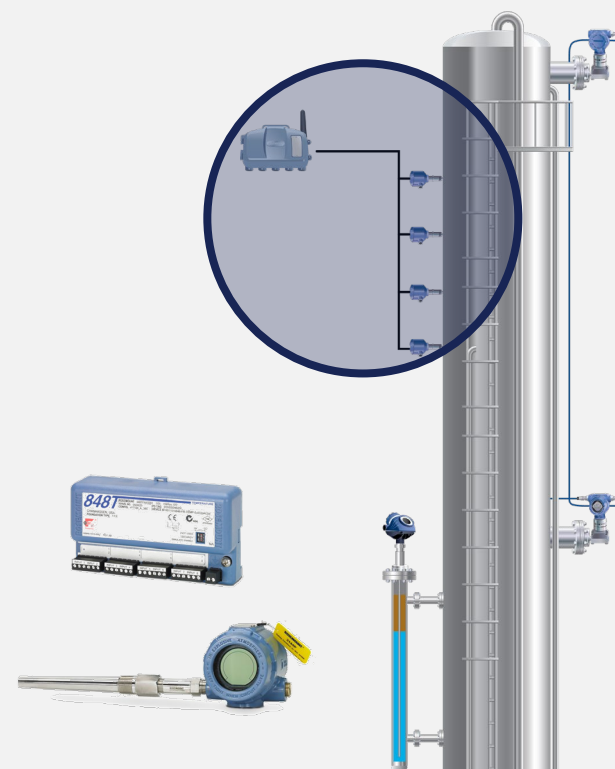
## Operational Challenges

- Distillation columns have several temperature measurements in proximity to measure column profile
- Long sensor wiring runs are susceptible to drift giving unreliable information
- Inaccurate profile measurement reduces efficiency of the column wasting energy



## Value Enabler

Use Rosemount 848T High Density and 3144P Temperature Transmitters to measure column temperature profiles and tray composition.



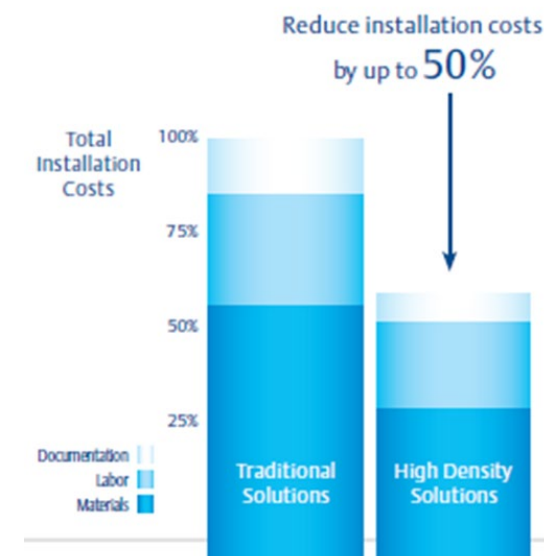
## Impact on Operations



Improve temperature measurement reliability and control with sensor matching and hot backup



Know inferred composition for top and bottoms product for improved separation



High Density, Real Savings

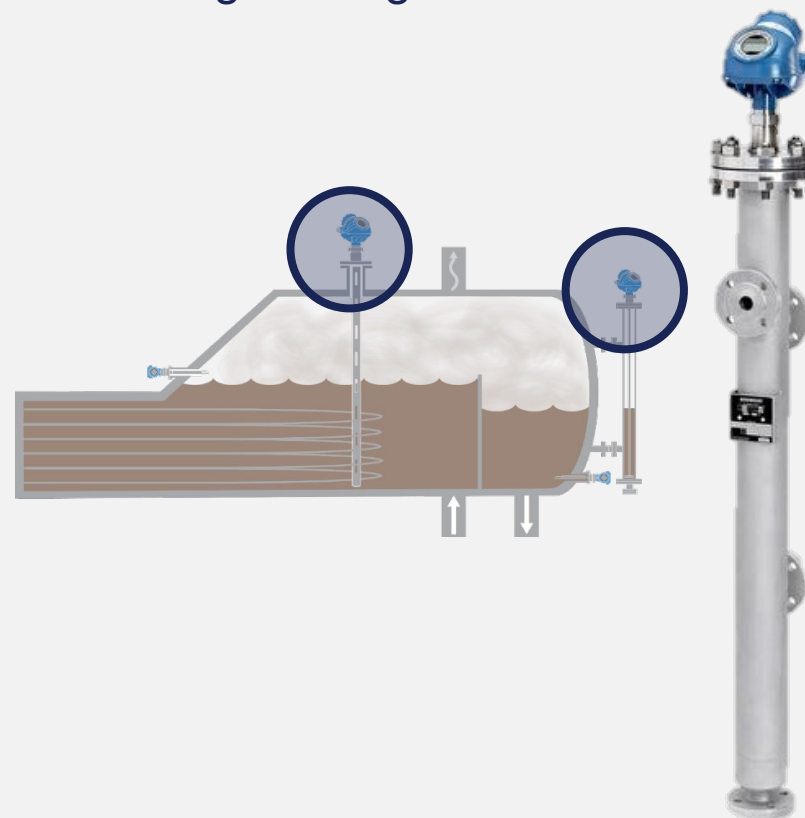
# Improve Energy Efficiency with Accurate Reboiler Drum Level Control

## Operational Challenges




- Reduced heat transfer efficiency
- Low level can risk exposure of tubes to excessive heat that can cause tube damage, unplanned shutdown
- Density and dielectric can fluctuate with changes in pressure and temperature
- Level measurement have historically been made using DP level transmitters that require the use of wet legs

## Value Enabler

Use Rosemount 5300 Guided Wave Radar with Dynamic Vapor Compensation for accurate level readings during load variations



## Impact on Operations

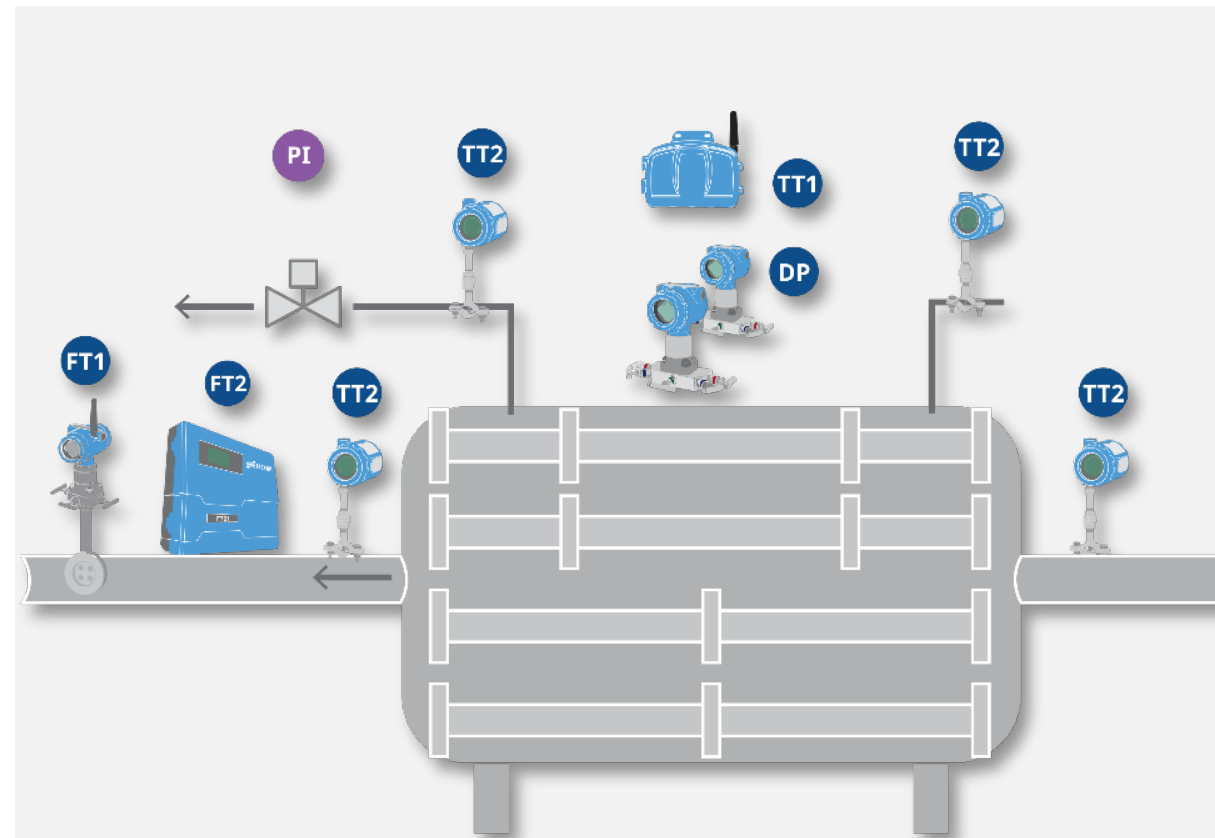
-  Improve energy efficiency by accurate control of the reflux ratio
-  Reduce maintenance due to elimination of wet legs
-  Stabilize level indication during start-up, shutdown, and when loads fluctuate

# Heat Exchanger Monitoring Solutions

## Operational Challenges




- Lack of data on heat exchanger performance
- 90 percent of heat exchangers experience fouling no insight to predict heat exchanger fouling rates
- Only a 2% reduction in throughput from a restriction can result in 10% wasted energy
- Can result in 1 million USD per year in wasted energy per plant
- Unnecessary scheduled maintenance

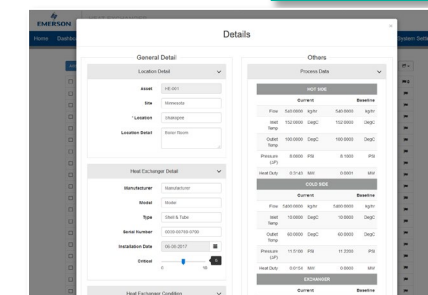
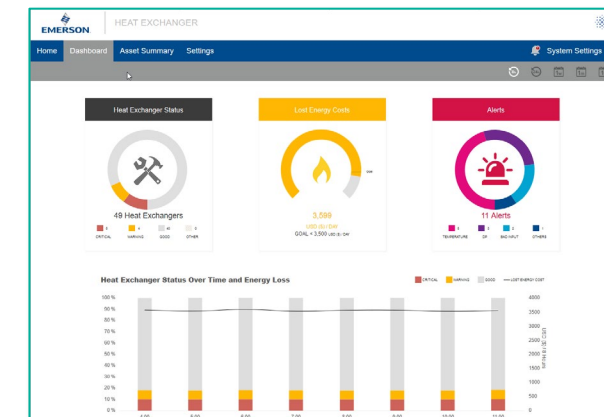
## Value Enabler



- Measures **flow** clamp-on ultrasonic or wireless DP flow
- Wireless DP and clamp on temperature **supply and return lines**
- **Plantweb Insight Software** monitors performance, fouling rate for maintenance

## Impact on Operations

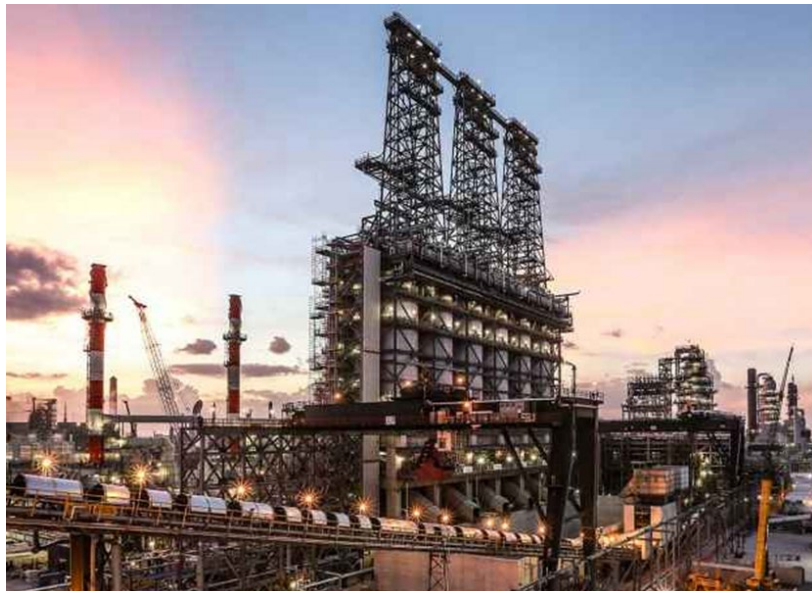
-  Reduce maintenance on heat exchangers by up to 15%
-  Typical payback of six months for critical exchangers
-  Reduce energy losses by 10 to 25%



# Site-Wide Energy Monitoring

## Operational Challenges

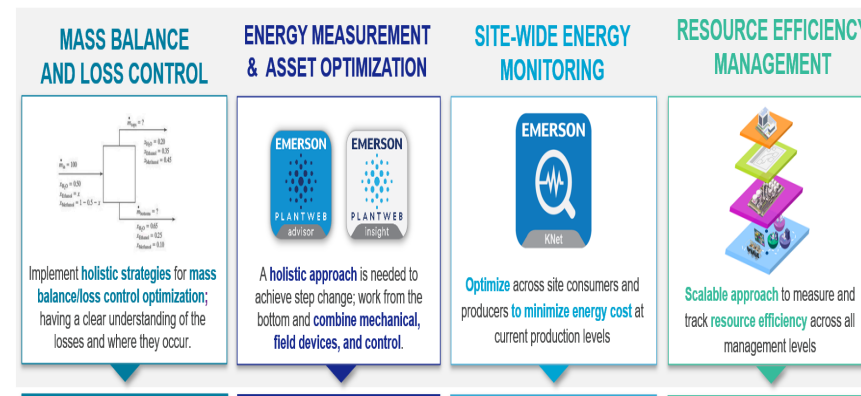
- High energy operations costs
- Lack of visibility on inefficient assets and processes
- No real-time energy consumption data



## Value Improvement Practice

Make an **Energy Management Information System** a critical part of your overall improvement plan

- Early detection of poor performance
- Effective performance reporting
- Support for decision making
- Identification and justification of energy projects



## Impact on Operations



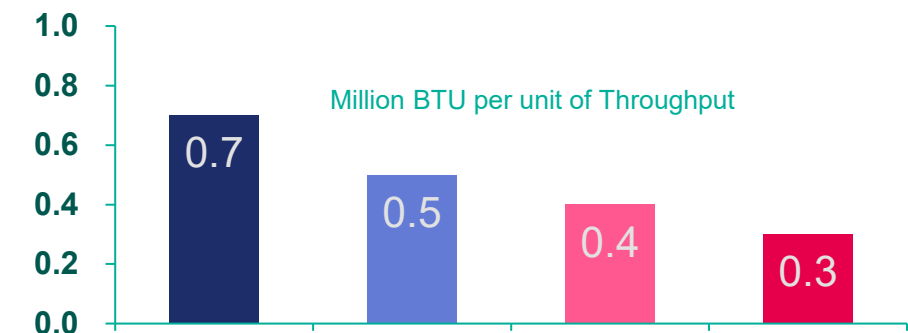
**5-15%** reduction in total site energy usage



**Energy Savings**  
Over \$15M savings with an EMIS as part of an energy reduction program



**Top Quartile Performer**  
Improved energy intensity





EMERSON EXCHANGE 2025

ACCELERATING  
INNOVATION

# Thank You