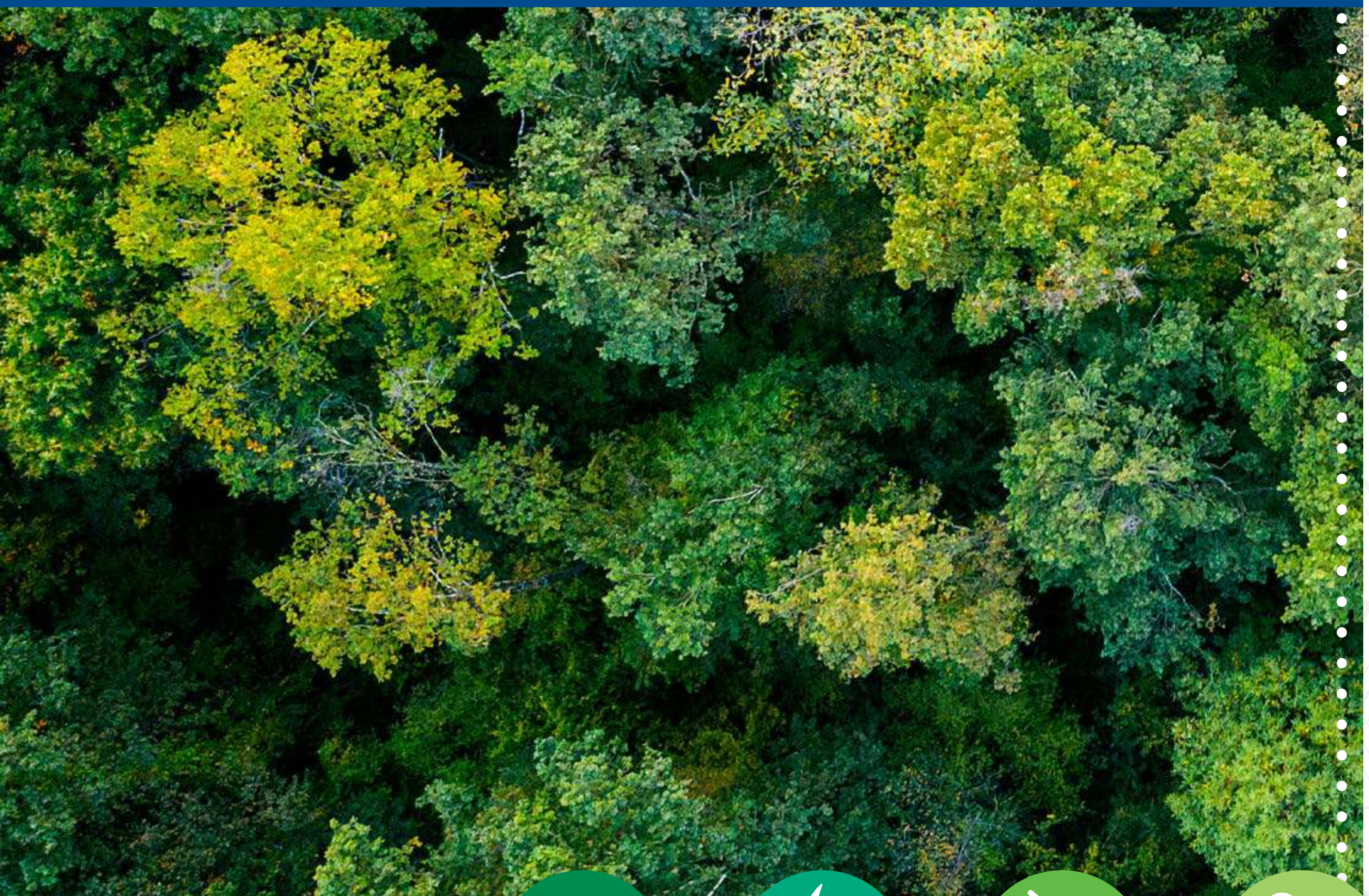
Turning Sustainability Concepts Into Actionable Solutions

A practical guide for process manufacturers

EMERSON

Start monitoring energy usage and taking steps toward reaching your plant's sustainability goals today.



One topic that seems to be very prevalent lately is sustainability, defined by all the things companies say they are doing to make themselves more sustainable. As a result, there are as many definitions of what sustainability means as there are companies. But what hands-on efforts should be going on to fulfill meaningful goals? In this guide we will bring a practical focus to process manufacturers by showing meaningful and realistic ways to put concepts into practice.

Traditionally, applying sustainability to manufacturing tries to determine if a company, operating as it is, can continue indefinitely. For example, a sustainable lumber company must ensure that it has sufficient forest land for a new tree to be planted and grow to maturity to replace every tree that it cuts down. Otherwise, it will eventually run out of trees.

In recent years, this analysis has taken on global proportions. Sustainability does not simply mean running out of immediate resources. Every company must consider how its activity contributes to changing global conditions. A prime example is routine use of fossil fuels and their contribution to greenhouse gases, with resulting climate change. It extends into a variety of other areas, such as water resources, toxic emissions, and even excessive use of plastics.

Companies wanting to make changes often end up confused, trying to get a handle on what is being demanded of them by stakeholders. How does a facility put "reduce carbon footprint" into practice? Often the goals are vague, and the tools misunderstood or simply unavailable.

- Is there a KPI for carbon footprint?
- Are there new and different things we need to be measuring?
- Do we have the budget to undertake any implementations, or is this going to channel funds away from other areas?
- How will we know if we're making sufficient progress?

Fortunately, all the solutions suggested in this guide have the additional benefit of reducing operating costs, so they pay for themselves even before considering the benefits to sustainability programs by:

- Reducing process waste
- Improving process efficiency
- Reducing energy consumption and resulting greenhouse gas emissions
- Reducing water and air contamination
- Improving maintenance efficiency for lower costs and improved equipment availability.

Whatever the motivation for launching a sustainability program, the results should be rewarding in multiple ways.

Digital transformation and sustainability

Running in parallel to sustainability discussions is the push for digital transformation. This is the strategy of integrating digital capabilities into a process manufacturing facility, and even the entire organization, to improve performance. Fortunately, the concepts and goals of digital transformation and sustainability work hand-in-hand.

The first step in sustainability programs is to determine where the largest potential gains can be found. However, in many cases the data to understand the starting point is not available, as these may come from measurements typically not used for process control or monitoring.

Therefore, implementations often start by deploying new sensors around the plant to monitor variables to determine a baseline, or to monitor asset energy consumption and condition. We will discuss how this works in specific applications in a moment, but for now, assume that deployment requires adding new sensors, such as acoustic sensors to steam traps and pressure relief valves, temperature sensors to heat exchangers, and vibration sensors to pumps.

Traditional method calls for wired sensors, which is a very costly and time-consuming approach as the cost of cabling and integration of the signals into the existing system will typically outweigh the cost of the sensors by more than double. Moreover, adding sensors is only the beginning since the raw data must be interpreted to get valuable insights and KPIs that can be used for sustainability programs. Extensive system integration services are often necessary to create appropriate data handling, and new human machine interface design work is typically needed to record and present the data so teams can understand and use it.

Digital transformation technologies change the picture entirely. It is still necessary to install sensors on the physical asset, but each of these now have a self-contained power supply and communicate via *Wireless*HART® to a host system, so no cables need be installed at all. The *Wireless*HART network integrates seamlessly with the facility's larger Wi-Fi and Ethernet networks (Figure 1), so sending the data into the business network is much simpler and more efficient.

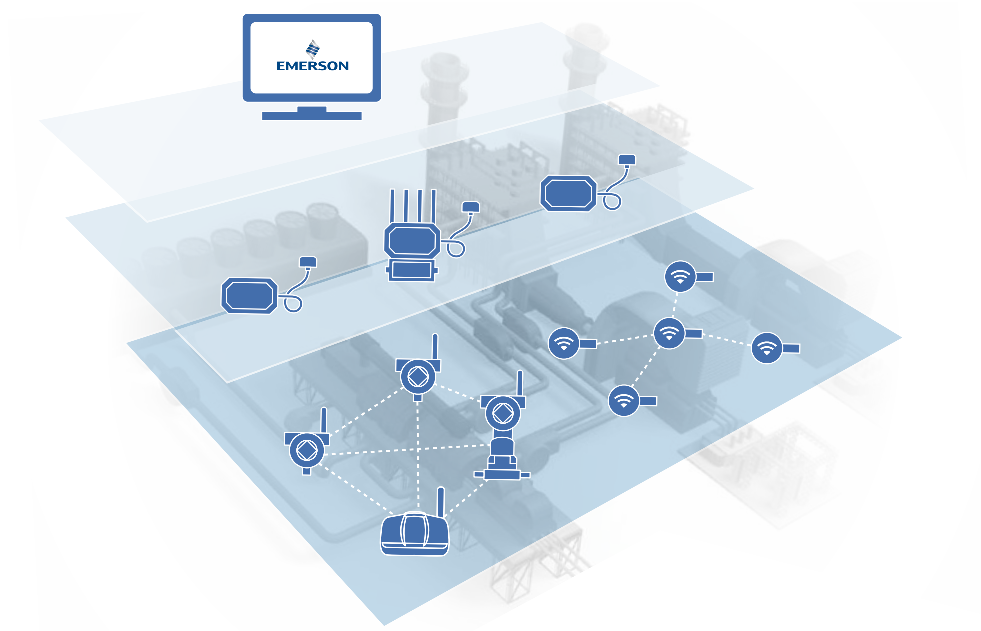


Figure 1: The ability to deploy WirelessHART devices makes analysis platforms, such as Emerson's Plantweb™ Insight, far easier to implement.

Preconfigured data analysis tools (Figure 2) collect raw sensor data, process it, and present it to the reliability and maintenance teams via interactive dashboards. This OT information also integrates with IT systems, extending to the cloud and corporate networks.

Figure 2: Plantweb Insight provides a wide range of preconfigured digital tools that are intuitive and easy to adapt for the kinds of applications described in this guide

Configuration requirements are minimal, and in most cases, no system integration assistance is necessary. This approach reduces costs and speed of implementation for process plants for a fast ROI, and it is also a basic building block of sustainability programs, and one of the key technical elements that make everything work.

Sustainability of *Wireless*HART

One measure of sustainability is reduced consumption of resources, and *Wireless*HART has a major advantage over traditional device-level networks in this area. Conventional networking using current loops means every field device has its own cable running from wherever it may be located, all the way to the I/O point of the automation host system. Given the size of many plants, and even individual production units, this may be thousands of feet, multiplied by hundreds and even several thousand individual devices. This often means millions of feet of cabling, supported by trays (Figure 3) and intermediate marshalling points.

Figure 3: Process plants depend on miles of cable and all the support structures, representing a huge investment in overhead.

All that cable consumes volumes of copper, aluminum, steel, PVC, PE, and other materials, produced from oil feedstocks and mined metals (Figure 4). In addition, all the labor for design, transport, installation, and maintenance must be considered.

Eventually, when the plant is dismantled, all the cabling will also require disposal. *Wireless*HART networks reduce the need for cabling, along with all the other materials and labor, by 70% or more. The applications discussed here use it frequently, contributing to improved sustainability.

Selecting applications

Short of major plant reconfigurations, incremental sustainability projects generally aim at reducing energy consumption, improving efficiency, reducing emissions, and reducing process waste. Often a single project results in multiple benefits at once. Some projects extend equipment life through more effective maintenance, which can also reduce safety and environmental incidents.

Most companies can legitimately say they are doing improvement projects like these all the time, and they were doing them long before anybody mentioned sustainability. The difference today is where the tipping point is placed to decide if a project proceeds or not. Naturally, the desire to achieve the greatest bang-for-the-buck still applies. Any company will want to attack the worst bad actors first, but as a facility moves down the list, the decision of how far to go will likely change.

A few years ago, the calculation of tolerating a slightly less-efficient fired heater against performing an upgrade or buying a new one may have stayed with the status quo. Now, those situations are becoming harder to ignore. In many cases, the equation will likely change thanks to new technologies, like those suggested here, that can be implemented at lower cost. Improvements may not be nearly as expensive as they once were, and sustainability improvements can further tilt the balance.

For the remainder of this e-book, we'll look at six specific suggestions of where companies can begin improving long-term sustainability while also reducing operating costs. None of these affect the process directly, so production continues as it always has.

1 STEAM TRAPS

SUSTAINABILITY GAINS

- More efficient energy use
- Reduced boiler fuel consumption
- Maintenance improvement

STEAM TRAPS

CHALLENGE:
Avoiding Serious Energy Loss and Equipment Damage

At some point, after steam has done its work, it condenses back into water. A steam trap separates liquid condensate from the steam and sends it back to the boiler as feedwater. This separation action has enormous impact on overall energy efficiency, and it also protects equipment. If a trap doesn't remove condensate fast enough, liquid may back up into steam passages and damage equipment.

Functionally, a steam trap is a valve that opens and closes automatically in response to process conditions. All designs therefore have some moving parts and a seating surface. Unfortunately, steam is not always clean, so it's possible for scale to form in the system, which can break free and be carried by the steam and condensate. Such particles have an uncanny ability to come to rest in problematic spots, such as valve seats or mechanisms.

A steam trap fails in one of two ways: it sticks open and releases steam, or it sticks closed and doesn't permit condensate release. Inspectors on plant rounds checking traps generally classify them by diagnosis:

- Visible steam leak—major mechanical failure
- Too hot—releasing steam directly into the condensate line
- Too cold—stuck closed and no condensate is being released
- Just right—releasing warm condensate.

A recent study suggests that 18 percent of steam traps in a large chemical manufacturing facility fail each year, resulting in wasted energy costs up to $16,000 per trap. Given the few human maintenance inspectors in most plants today, a better option is needed.

Most steam traps do not release condensate continuously. Under normal conditions and if sized correctly, all steam trap designs open intermittently and discharge condensate in slugs. During a release, steam traps transmit noise through the adjacent piping. An acoustic transmitter mounted on the pipe adjacent to a steam trap (Figure 4) detects this ultrasonic noise. It hears the cycling, and an algorithm learns the characteristic activity for each trap. Each device sends data via *Wireless*HART to a central analysis platform, where operators monitor how all steam traps equipped with acoustic transmitters are performing.

Figure 4: Emerson's Rosemount™ 708 Wireless Acoustic Transmitter provides visibility into steam trap operation and condition by analyzing ultrasonic noise signatures.

Dashboards indicate (Figure 5) which steam traps are working correctly, and which are in a failure mode. The software estimates lost energy and resulting costs at any time. Maintenance personnel see at a glance which steam traps need attention, and then plan activities appropriately.

Figure 5: A Plantweb Insight dashboard designed for steam traps alerts the maintenance team as to which are working correctly, and which are inoperative.

2 PRESSURE RELIEF VALVES

SUSTAINABILITY GAINS

- Reduce product loss
- Improve overall efficiency for the unit
- Maintenance improvement

PRESSURE RELIEF VALVES

CHALLENGE:
Poor Performance Equals Product Loss

Any pressurized system will have a pressure-relief mechanism to let internal pressure escape before it overcomes the equipment's mechanical strength. Pressure relief valves (PRVs) may use fine-tuned springs to open at very specific pressure setpoints, or they can be pilot-operated to improve stability.

Conventional PRVs are useful in situations where overpressure incidents are common, or even routine, since they re-seal themselves when the pressure recedes. If working correctly, no maintenance action is necessary to resume normal operation. Monitoring the condition and activity of PRVs should be a part of normal plant operation, but there are no mechanisms within a PRV capable of sending information to an automation system. Monitoring a PRV borrows from traditional maintenance techniques: listening.

An acoustic monitoring device, the same as used with steam traps, mounts directly on a pipe adjacent to a PRV (Figure 6). It captures ultrasonic frequency sounds made by valve action transmitted directly through the metal. A closed PRV is easy to detect because it makes no noise since nothing is flowing. But when the system pressure exceeds the setpoint, it opens, releasing the contents—either liquid, gas, or a mixture of both. The acoustic monitor reports the resulting noise to the automation system.

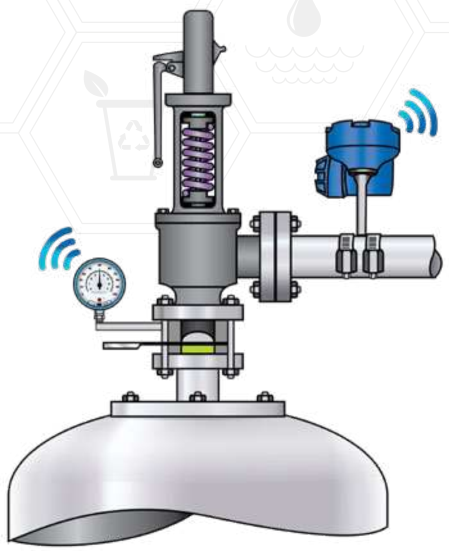


Figure 6: Mounting Emerson's Rosemount 708 Wireless Acoustic Transmitter next to a PRV allows it to send data via WirelessHART to the maintenance team. This indicates when a valve is leaking.

If the system pressure is sufficiently relieved, the valve should close and seal itself again, and the noise will cease. Data from the acoustic monitor reports the time the discharge began and ended via a graphic dashboard (Figure 7), while giving some indication of how serious the discharge was based on the amplitude of the noise.

Figure 7: A Plantweb Insight dashboard designed for PRVs times releases, and it also alerts the maintenance team if the valve does not close completely after a release.

One of the problems many plants face is incomplete resealing. Overpressure incidents are often related to process upsets, stirring up particulates in vessels and pipes, which are blown out with the contents. Something lodged in the valve seat may keep it from closing entirely, leaving it in a perpetually "simmering" state, releasing product that must be handled by the unit's pollution control systems.

When this happens, it may take hours or days for operators to realize there is a problem, and to pinpoint just where it might be happening in a complex system. An acoustic monitor hears the simmering, even if it is very minor. The monitor reports immediately if a given PRV has fully reseated after an incident, so maintenance can decide when to address the situation.

3 COOLING TOWERS

SUSTAINABILITY GAINS

- Reduce energy consumption
- Reduce water use
- Improve overall efficiency for the unit
- Maintenance improvement

COOLING TOWERS

CHALLENGE:
Mechanical Problems Reduce Efficiency

Facilities with large-scale thermal processes, such as a steam turbine, may need the extensive heat dissipation capabilities of cooling towers (Figure 8). These are especially complex since they require heavy ambient air flow drawn by fans, combined with large volumes of circulating water. Most installations use a bank of individual units so capacity can be adjusted to match process demand.

Figure 8: Cooling towers need monitoring because they have complex and often troublesome blower systems, in addition to fluid handling equipment.

Like other complex installations, adding a series of monitoring sensors to cooling towers helps increase reliability and enhances their effectiveness. Ideally, any installation should be equipped with a full complement of instrumentation (Figure 9), including

- Supply, makeup, blowdown, and recirculation water flow
- Air, cooling water supply, and return water temperatures
- Cooling water basin level
- Water conductivity and pH.

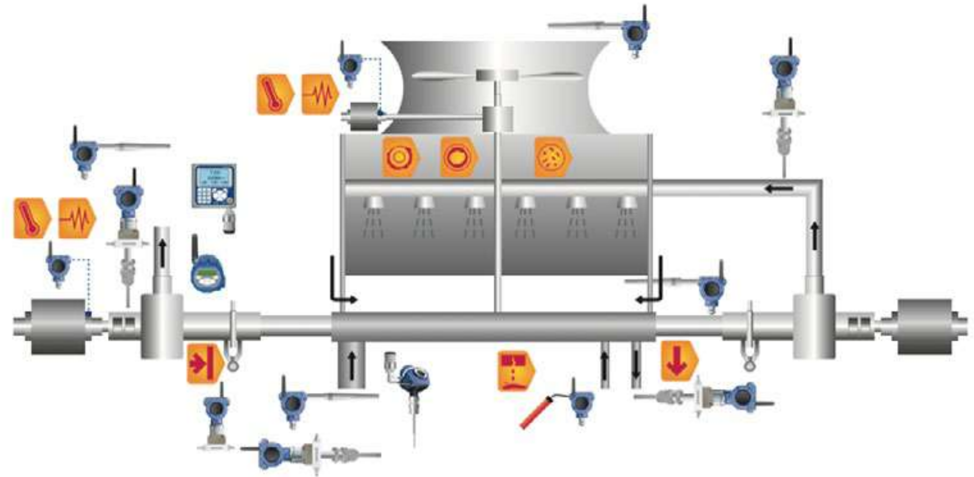


Figure 9: The volume of variables involved with a cooling tower calls for a large number of monitoring sensors and instruments.

With data from these instruments (Figure 10), it is possible to determine the efficiency of a specific cooling tower section and tell if there is internal buildup, or a fouling of liquid or air passages. There are other sensors, including vibration and bearing temperature, which monitor the motors and gearboxes driving fans or pumps. These warn of developing mechanical problems, allowing corrective action to be taken in advance of failure.

Figure 10: A Plantweb Insight dashboard designed for cooling towers monitors the mechanical systems, plus temperature differentials and pressures for the fluid-handling functions.

4 HEAT EXCHANGERS

SUSTAINABILITY GAINS

- Reduce energy consumption
- Improve product throughput
- Improve overall efficiency for the unit

HEAT EXCHANGERS

CHALLENGE: *Fouling Kills Efficiency and Reduces Flow*

Any type of heat exchanger, whether liquid-to-air or liquid-to-liquid, has a transfer capacity limit based on the amount of cooling surface area available, and the heat conductivity of the internal pipes or plates. This capacity gets degraded by a universal problem: fouling. Particulates carried by the fluid streams deposit on the internal surfaces, and heat conductivity declines in proportion to the thickness of the deposits. Fouling from either side of the exchanger, and potentially both, quickly reduces heat transfer rates, and therefore efficiency.

Determining how efficiently a heat exchanger is operating depends on measuring a list of critical variables. Ideally, any installation should be equipped with this minimum complement of instrumentation (Figure 11):

- Process fluid temperature differential (inlet compared with outlet) and flow
- Transfer fluid temperature differential and flow (for liquid-to-liquid designs)
- Cooling air temperature and flow (for air-cooled designs)

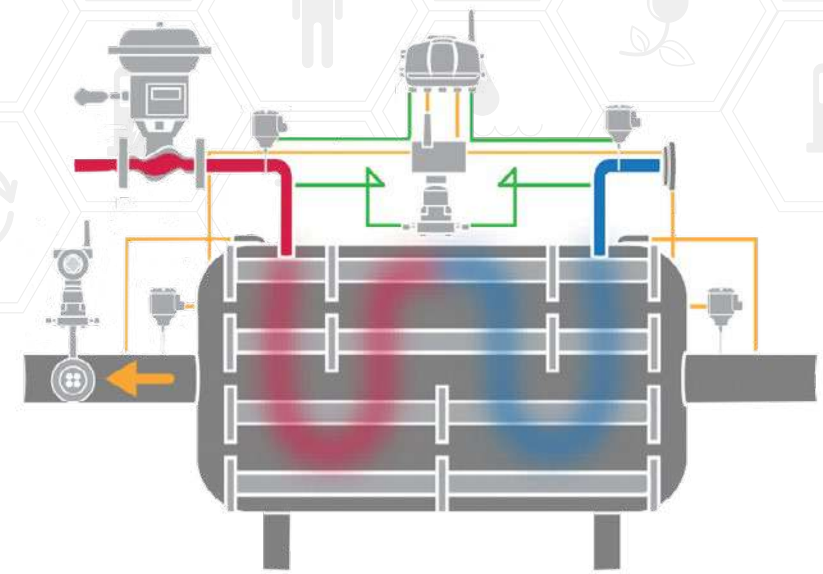


Figure 11: Effective evaluation of heat exchanger performance and condition requires a set of instruments monitoring critical variables..

With the values from these instruments, it is possible to determine how much heat is actually being transferred, and therefore overall efficiency. If these basic measurements are not already part of the installation, they should be the first to be added. There are many options for instruments which mitigate the costs and complexity.

*Wireless*HART-based transmitters are available for all heat exchanger measurement applications:

- Temperature instruments can be added to the process fluid and transfer fluid pipes without any penetrations. These sensors read through the pipe wall (Figure 12) and measure the interior fluid temperature accurately, regardless of ambient conditions.
- If it is practical to use conventional temperature sensors, a single transmitter sends data from up to four sensors on one wireless signal.
- Reading differential pressure (DP) across the process fluid inlet and outlet determines when fouling is beginning to accumulate, or if there is a leak in any heat exchanger tubes.

Figure 12: Emerson's Rosemount X-well™ technology reads the temperature inside a pipe without the need for a penetration. It sends data via WirelessHART.

Data generated by these instruments goes to analytics applications purpose-built for heat exchangers (Figure 13), making them easy to install, configure and use. Algorithms look for conditions such as fouling by watching changes in the measurement points, and display results on preconfigured dashboards.

HEAT EXCHANGERS

CHALLENGE:
Fouling Kills Efficiency and Reduces Flow

Figure 13: A Plantweb Insight dashboard designed for heat exchangers monitors operational changes that indicate the first signs of fouling or internal leaking, along with other efficiency indicators.

Using data from the basic instruments combined with process fluid characteristics (heat of vaporization, inlet/outlet vapor fraction, etc.), the analytics program generates actionable information:

- Overall heat exchanger health
- Fouling factor
- Fouling rate
- Heat duty
- Duty error
- Lost energy costs
- Heat transfer coefficient
- Cleaning recommendations

It also helps identify abnormal situations and responds by sending alarms when certain conditions are met, such as a when fouling crosses a threshold. These findings are presented using the dashboards, with detailed data just a few clicks away, allowing technicians to drill down anytime it is necessary.

5 | CORROSION MONITORING

SUSTAINABILITY GAINS

- Major positive impact on personnel and plant safety
- Avoidance of environmental incident
- Maintenance improvement

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CORROSION MONITORING

CHALLENGE:
Verifying Equipment Safety

For plant operators, corrosiveness should be viewed as a process variable, but in the past there has been little instrumentation available to characterize its impact on equipment. Fortunately, this situation has improved with the advent of sophisticated online metal-thickness monitoring systems.

The effect of corrosion depends on the nature of the process fluid, operating parameters such as flow rate and temperature, and the metallurgy of the pipe and vessel walls. Obviously, the metallurgy is fixed for all practical purposes, and in most facilities, it is not consistent across different areas and process units. There may be a variety of alloys used in different areas, installed at different times, and in varying states of health with respect to pipe thickness.

There is one technique that determines the actual condition of piping and vessel walls in real time. An ultrasonic sensor (Figure 14), permanently mounted on the outside of a pipe, reads the actual metal thickness continuously. It sends data via *Wireless*HART to a central collection and analysis point. Naturally, such a sensor must be exceptionally precise since changes happen slowly. In this case, the sensor detects and quantifies a change of as little as 2.5 microns.

Figure 14: Rosemount Wireless Permasense Corrosion and Erosion Monitoring Systems provide a continuous wall thickness measurement, with data sent via WirelessHART.

Operators can view the wall thickness readings in real time (Figure 15), measured in inches or millimeters, and these readings are historized in Plantweb Insight software, making it possible to see what a specific value was at any point in the past. Connection to the plant historian or process control system allows personnel to correlate process changes to corrosion, providing the information needed to improve operations, while avoiding loss of containment due to unrealized corrosion risk.

Figure 15: Metal loss due to corrosion is rarely uniform. Wireless corrosion data can indicate operational periods when loss is particularly severe or more benign.

Just as a pressure transmitter can warn when the equipment is past a safe value, a thickness sensor can trigger an alarm when the wall thickness has reached a safety threshold. This is an important function, but the ability to watch metal loss over time provides even deeper insight into the process, and assists with all other corrosion mitigation strategies, such as determining the ideal rate for addition of corrosion inhibitors.

6 INDUSTRIAL LIGHTING

SUSTAINABILITY GAINS

- Reduce energy consumption
- Maintenance improvement

INDUSTRIAL & HAZARDOUS AREA LIGHTING

CHALLENGE:
Unregulated Waste of Electric Energy

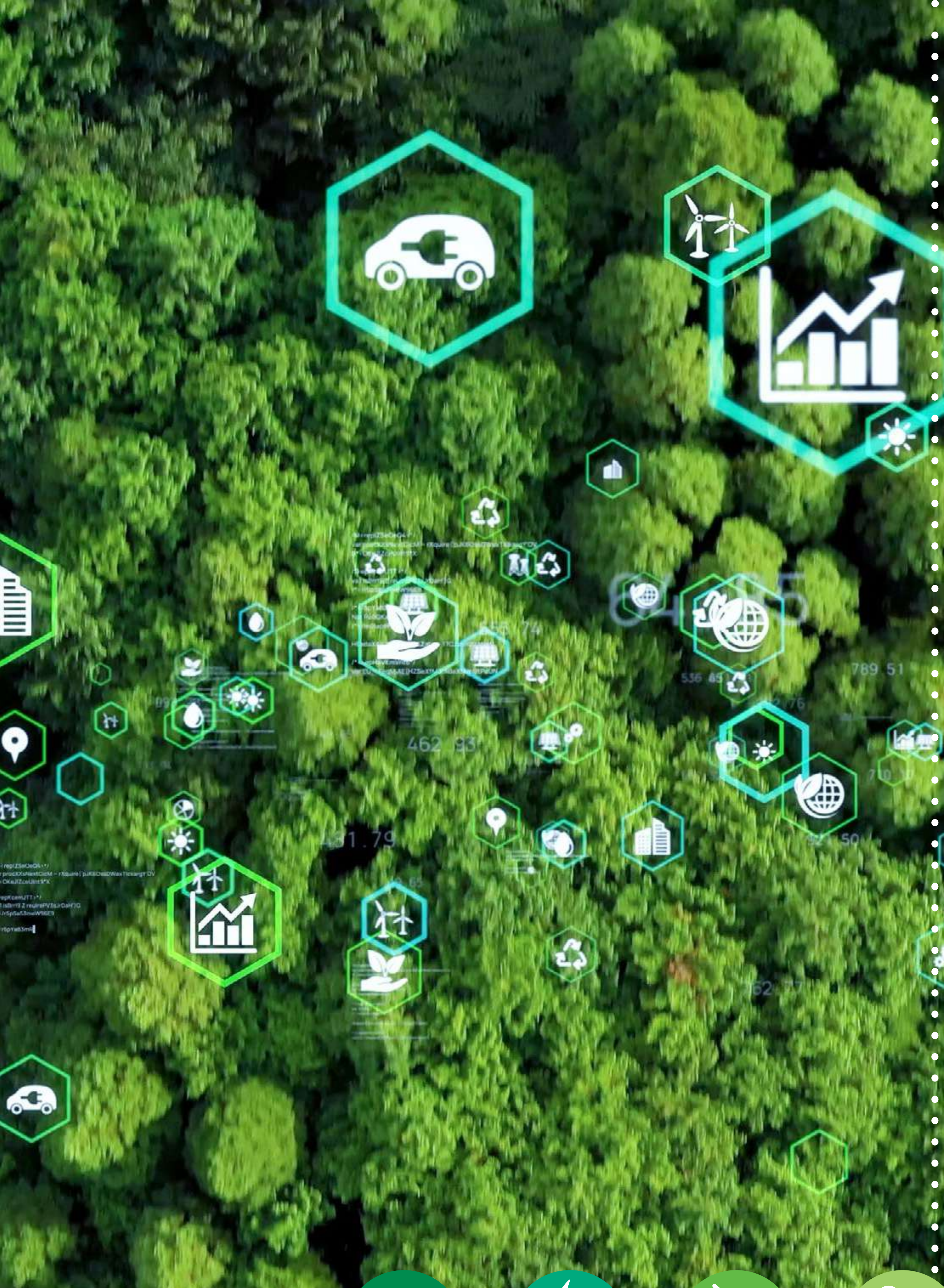
To a frugal homeowner, few things are more blatantly wasteful than leaving lights on in unoccupied rooms. This simple concept is frequently ignored on an enormous scale at many process manufacturing facilities where lights throughout all areas stay on continuously, regardless of activity or time of day. In some cases, this stems from old metal-halide high-intensity discharge (HID) lamps, often deployed in hazardous areas. These require some warm-up time, so they are simply never turned off. When this waste is multiplied across hundreds, or even thousands, of fixtures, the amount of power consumed is enormous. And the cost of replacing so many bulbs when their useful life is consumed so quickly becomes burdensome.

Facilities can reduce energy consumption and maintenance needs while enhancing safety for harsh and hazardous locations with new smart LED fixtures. These require up to 70% less energy than an HID fixture for equivalent light output, but they can turn on and off instantly, governed by motion detectors (Figure 16), timers, and ambient light detectors. These fixtures communicate via *Wireless*HART, so they can be activated remotely, report the periods when they are on, and send diagnostic information on their condition to maintenance.

Figure 16: Appleton™ Mercmaster™ Connect LED Luminaires are more efficient than HID lights, and each fixture can be controlled individually to save energy.

Data can be collected and analyzed just like any other smart field device, showing exactly how much power is being consumed for lighting (Figure 17), along with its impact on sustainability metrics over a historical period. This approach has a side benefit of also providing a rough picture of activity within a facility, particularly at night, as lights respond to people moving around.

Figure 17: The Plantweb Insight Connected Lighting application monitors individual fixtures, and it aggregates system performance to capture overall energy use.



Emerson Can Help You Reach Your Sustainability Goals

In the same way Emerson has been working to improve its internal sustainability performance, we are here to provide technologies, solutions, and expertise to support your decarbonization and environmental sustainability efforts. And, as just discussed, these types of projects typically also increase overall profitability.

The projects described here deliver benefits because they use technologies—such as Plantweb Insight, *Wireless*HART, and pervasive sensing solutions—to deliver results that positively impact all company stakeholders, surrounding communities, and the global environment.

For more information, visit Emerson.com/PlantwebInsightSustainability

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