

Envisioning a “future-proof” refinery of the future



In his role as the senior director of the global refining industry, **MARCELO CARUGO** leads the refining programs with a team of experts across Emerson Process Management. He has 30 years of experience within the refining and petrochemical industries. His expertise includes the use of technology to improve plant economics, operations, regulatory compliance and reliability. Mr. Carugo holds an MS degree in electronic engineering from NUFFIC, The Netherlands, and an electronic engineering degree from the University of Buenos Aires.

Trying to predict how global refining markets will look in 2026 is a losing proposition. The only thing we can count on with any real certainty is uncertainty. Electric vehicles, alternative fuels, artificial intelligence, increased market volatility, political uncertainty and higher standards of living throughout the developing world are just a few of the trends that will shape the refining industry in the years to come. We can only speculate on the impact such an unprecedented pace of change will have 10 years out.

Since we can't predict the future, refiners will need to get better at preparing for the unknown. In other words, the refinery of the future will need to be “future-proof.”

We can get there by focusing on three primary operational and business goals:

- **Agility.** The refinery of the future will quickly switch between fuel and petrochemical product slates to take advantage of market demand and opportunities.
- **Reliability.** Top-performing refineries in 2026 will operate with virtually no downtime.
- **Shared Intelligence.** Successful future refineries will automate and simplify processes, enabling expertise and decision-making to be shared across multiple facilities.

With these three areas conquered, the refinery of 2026 will be ready for whatever challenges (and opportunities) that technological advances, market changes, and world events bring.

Agility. It's likely that nothing in the next 10 years will separate winners from losers more than the pursuit of business agility.

In the future, top-performing refineries will be prepared to take advantage of opportunities as soon as they occur, not weeks or months later. Market demand will determine feedstock and product slates in real time once business leaders are armed with integrated data analysis, from the crude source to the gas pump and everywhere in between. Just-in-time inventories will become the new norm once managers have access to supply chain data online.

Accomplishing these goals will mean tackling a host of new challenges. One of these challenges is designing production facilities capable of processing the full spectrum of different crudes, down to the heaviest and most corrosive. Being able to switch from one product slate to another, in response to market changes, might involve putting certain process units on hot standby to avoid wasting days starting up and shutting down. This would also lower

risk, since transient operations are the most frequent cause of safety incidents.

But building greater flexibility into the plant's front end will not be enough to ensure profitability in any market. Instead of producing only fuels, refineries will become multi-purpose conversion facilities able to help meet rising global demand for fibers and plastics. Operators will diversify by making a wide range of intermediary products in small batches, and by swinging quickly from fuels to petrochemicals. To handle all these output streams, a single refinery might need as many as 50,000 additional data points, each easily reconfigurable to accommodate different process conditions.

Reliability. Downtime, and the high costs that go with it, will become a thing of the past if the industry finally solves the problem of poor reliability. For example, “hot turnarounds” could eliminate the need to take process units out of service to repair or replace parts. By redesigning valves and other equipment to allow easier access to wearable components, crews will perform overhauls *in-situ* without interrupting production.

Dedicated online asset reliability networks are another promising development. These will give operators a virtual “dome of awareness” over their entire facilities, with the kind and quantity of information needed to execute condition-based maintenance strategies remotely. With the aid of self-diagnosing equipment and early alerts, maintenance managers will know about abnormalities far enough in advance to prevent any breakdown or upset from affecting production capacity.

Today, the average refinery is equipped to continuously monitor the health of less than 20% of its assets,

but in a decade it will monitor as much as 60% due to cost-effective wireless technology. Micro-sensors could even float along inside the product itself, transmitting up-to-the-second quality readings as they pass from one process unit to another.

Shared Intelligence. The nature of organizations will change fundamentally in the future. Onsite staff could shrink by 50% over the next 10 years. Soon, personnel might venture onsite only to carry out certain manual tasks. Decision-makers—management, operations, reliability, engineering and integrity functions—could be remotely linked to one or more plants, able to direct an entire fleet of refineries from a single, centralized operations theater.

Automation will continue to transform many of the routine jobs traditionally handled manually. Augmented-reality helmets with heads-up displays will allow maintenance crews to effectively bring the control room into the field. Robotic flying drones will sniff out fugitive emissions, search for hotspots, and identify piping and vessel integrity issues in hard-to-reach places.

These innovations will have

a dramatic impact on safety by identifying potential problems before they occur, and by minimizing the time workers spend in hazardous areas. Additional advances could include:

- Breakthroughs in chemical engineering might lead to catalysts that continually regenerate while the process keeps running.
- Machine learning might make it possible for plants to “absorb” operator knowledge and adapt to changing conditions instantaneously.
- As technology improves, refiners could one day be able to automatically start up and shut down process units without manual intervention, helping further increase safety.
- Refineries might soon be able to recycle almost all of the waste they create, and new carbon capture and sequestration methods could forever change the way producers handle regulatory compliance. By 2026, flares and waste water dumps could be outdated.

Achieving such progress might seem like a tall order, but the fact is that much of the knowledge and technology

needed to realize this future-proof vision already exists today.

For example, information technology has progressed in recent years to the point of allowing businesses to remotely access huge amounts of data and to leverage expertise no matter where it is. As a result, refiners are beginning to integrate their operations in ways that take advantage of big data insights and new collaborative techniques.

In addition, recent improvements in human centered design are already making it easier to operate with fewer experts onsite, wireless instrumentation is becoming widely used throughout the industry, and some refiners are starting to employ remote control drones to gather needed measurements.

To reserve a seat at the table in 2026, refiners should move to adopt and integrate innovations now, rather than take a wait-and-see approach. Prospering in the face of uncertainty often means challenging the status quo. Overcoming resistance to change will become even more crucial as world events reshape the industry.

After all, as someone once said, the future belongs to those who are willing to prepare for it today. **HP**