

REINVENTING



REFINING

Robert Ohmes, Tracy Sadowski, and Scott Sayles, Becht, consider how operators can ensure operational performance and cost effectiveness amid a new energy reality.

Refining is not going away. But the nature of refining, and what it means to be a successful operator, is changing. Across the industry, refiners are being reshaped by decarbonisation policy and evolving product demand, all while under persistent

capital pressure. Together, these forces are driving consolidation and raising technical complexity in an environment with little tolerance for inefficiency. While the total number of refineries worldwide may decline as emissions are reduced through renewable fuels and electrification,

new and highly efficient greenfield refineries in emerging markets are raising competitive pressure for every remaining barrel.

To survive, refiners must shift away from defending legacy volume and toward margin-driven, flexible operations with strong cost discipline (Figure 1).

Rethinking the refinery operating model

The traditional top-down, command-and-control refinery model is no longer sufficient. Changes in work culture following the pandemic, coupled with technological advances like real-time simulation and remote diagnostics, have created a new operational paradigm.

Modern refineries must now be connected – technically, digitally, and commercially – to broader market signals and decision systems. With distributed teams and continuously available data now the standard, operating teams need tools that enable fast, cross-functional decisions. These tools must also provide secure access to information and help teams anticipate changing conditions.

It is no longer enough to simply invest in new assets and infrastructure. Today's highest-performing refiners focus on squeezing more value from what they already

have by lowering cost structures and adapting to shifting crude and product slates. This requires tighter alignment between commercial intent and operational execution.

What low-cost producers do differently

Low-cost producers look beyond uptime or throughput as measures of success. They focus relentlessly on margin per barrel and the ability to respond quickly when market conditions shift. Execution is grounded in data rather than instinct.

True competitive advantage in refining comes from being both operationally excellent and innovative. Leading-edge operators embed digital tools directly into daily workflows and introduce new technologies deliberately rather than all at once. Even as they innovate, they maintain discipline around cost control and safety performance. These refiners sit at the top-right of the competitiveness matrix (Figure 2), combining agility with resilience. In contrast, some refiners remain static efficient – high on operational execution but slow to adopt change – while still others are fragile disruptors, testing new ideas without the structure to support them. Traditional models, low on both axes, are increasingly vulnerable. The refiners gaining share are those who blend discipline with agility to evolve both what and how they operate.

Based on experience supporting hundreds of refinery sites worldwide, these behaviours are consistent among top performers:

- Use digital twins to align actual performance for planning and highlighting margin leakage.
- Evaluate capital decisions through a commercial-operational lens rather than mechanical need alone.
- Build cross-functional systems to connect planning and execution to economic outcomes.
- Invest in energy intensity and emissions reduction only where return is clear.
- Enable flexible operations through targeted infrastructure upgrades.
- Maintain execution discipline while introducing innovation at a controlled pace.
- Treat people and culture as levers for change by aligning training with decision authority.

The impact of these behaviours is evident in day-to-day operations across the industry. A North American refinery was struggling with persistent operational limits and a set of assets that were no longer performing as expected. Leadership also lacked confidence that capital was being directed to the highest-value opportunities.

A structured opportunity-framing effort helped reset priorities. Process simulation was paired with detailed walkthroughs by site experts to identify improvement options across the facility. Each opportunity was assessed for its economic impact and practicality before being aligned to the site's broader objectives. The subsequent ranked

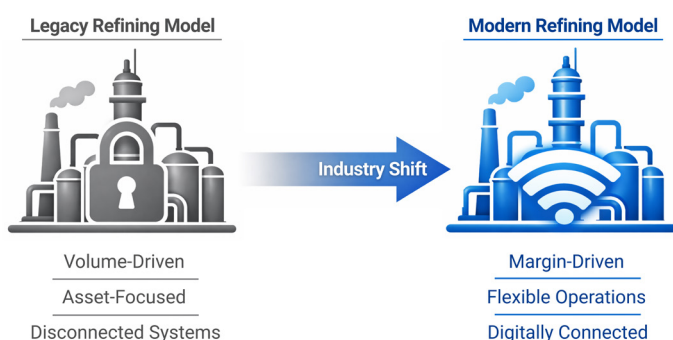


Figure 1. The shift from legacy to modern refining.

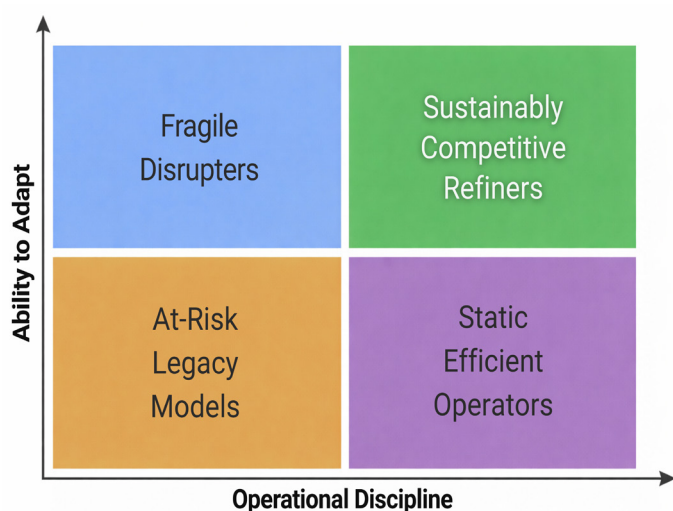


Figure 2. Refinery competitive matrix.

opportunity list gave leadership the confidence needed to move forward with a focused set of high-impact initiatives for immediate development.

Problem framing as a discipline

The key to capital effectiveness and performance improvement is clear problem definition. In many cases, a single bad actor unit or cost centre cannot be blamed for performance limitations; rather, issues arise due to misaligned systems or information gaps.

Low-cost producers challenge assumptions early and translate ideas into economic terms before committing significant resources. Large programmes are broken down into executable scopes that can be justified individually. These producers approach site decisions with a structured problem-framing model that creates clarity and alignment while supporting prioritisation.

The value of disciplined problem framing becomes especially clear in decarbonisation efforts. A Canadian upgrader had aggressive CO₂ reduction targets but lacked a practical roadmap that fit within site constraints. A focused analysis quantified achievable energy and emissions reductions. The study examined steam systems and furnace performance along with opportunities for heat recovery, ultimately identifying 11 initiatives representing 100 000 - 125 000 tpy of CO₂e reductions. These options were prioritised and positioned for inclusion in the site's capital planning process.

Digital tools to drive real-time margin capture

A refinery's competitive advantage increasingly depends on how well it can track and respond to commercial conditions in real time. Static plans and monthly reconciliations no longer provide sufficient insight.

Digital twins allow operating teams to monitor site performance against the linear programming (LP) and validate yield targets as conditions evolve. When deviations occur, teams can respond before margin is lost. Integrating planning data with operational feedback means that teams can make real-time adjustments to improve performance.

The impact of real-time digital alignment is most visible when planning assumptions drift away from operating reality. At one refinery, margin leakage persisted because feed blend assumptions no longer matched actual tower performance. After introducing a simple LP-based digital twin, planners and operators were able to review performance together each day, which enabled on-spec yield and recovered missed margin.

Other facilities have applied the same principles at broader scale. A US Gulf Coast refinery lacked visibility into how daily operations aligned with the LP model. Building a digital twin of the LP and aligning daily actuals to plan through real-time dashboards exposed gaps in crude blending and product yields. The approach strengthened margin accountability and embedded continuous LP execution across teams.

More advanced efforts have focused on digital maturity rather than isolated tools. Another Gulf Coast refinery recognised that while its physical assets were in good condition, it lacked the digital maturity needed to track performance against margin and sustainability targets. A digital readiness assessment linked the site's reliability goals to its commercial priorities. From that foundation, asset-level KPIs and improved energy tracking helped align operations with commercial objectives while also enabling more consistent sustainability reporting.

Enabling decarbonisation through integration readiness

Many refiners and upgraders are evaluating carbon capture or renewable fuel integration but are not fully prepared for the operational impact of these projects. Early screening of site systems – including balance of plant, utilities, and control strategy – is essential to avoid stranded capital or underperformance.

This readiness challenge has surfaced repeatedly in CCS evaluations. In one case, a European refinery sought an unbiased comparison of carbon capture technologies for integration with its hydrogen plant. A feasibility study benchmarked multiple technology licensors using a unified scoring model. The review assessed technical fit and economic performance in the context of site constraints to identify the most appropriate technology and configuration for the refinery's specific operating profile. Separately, a North American refiner evaluating CO₂ capture from an existing SMR discovered, through preliminary assessment, that firing PSA tail gas post-capture would significantly disrupt heat balance and air handling, introducing both operability and emissions risk. Early modelling flagged these issues before detailed engineering began, helping the refiner avoid design missteps and frame future studies around realistic integration limits.

And the same principles apply beyond carbon capture. A North American refinery planning to co-process renewable feedstocks identified early gaps in material handling capability and control logic. Addressing these constraints through phased infrastructure upgrades enabled renewable processing with minimal disruption to existing operations. Just as importantly, this approach preserved flexibility for future expansion as feedstock availability and market conditions evolve.

Conclusion

Refining is not going away, but tomorrow's winners will look very different from those of a decade ago. Future competitiveness will depend on how decisively refiners act and how flexibly their operations allow technical constraints to be turned into margin opportunities.

Digital systems and structured evaluation are now essential tools in the new refinery playbook – one where connected execution is explicitly guided by economics. With a disciplined foundation and digitally enabled agility, refiners can thrive even in a decarbonising, margin-constrained world. 