Improve Production Performance with Adaptive Process Control Technology

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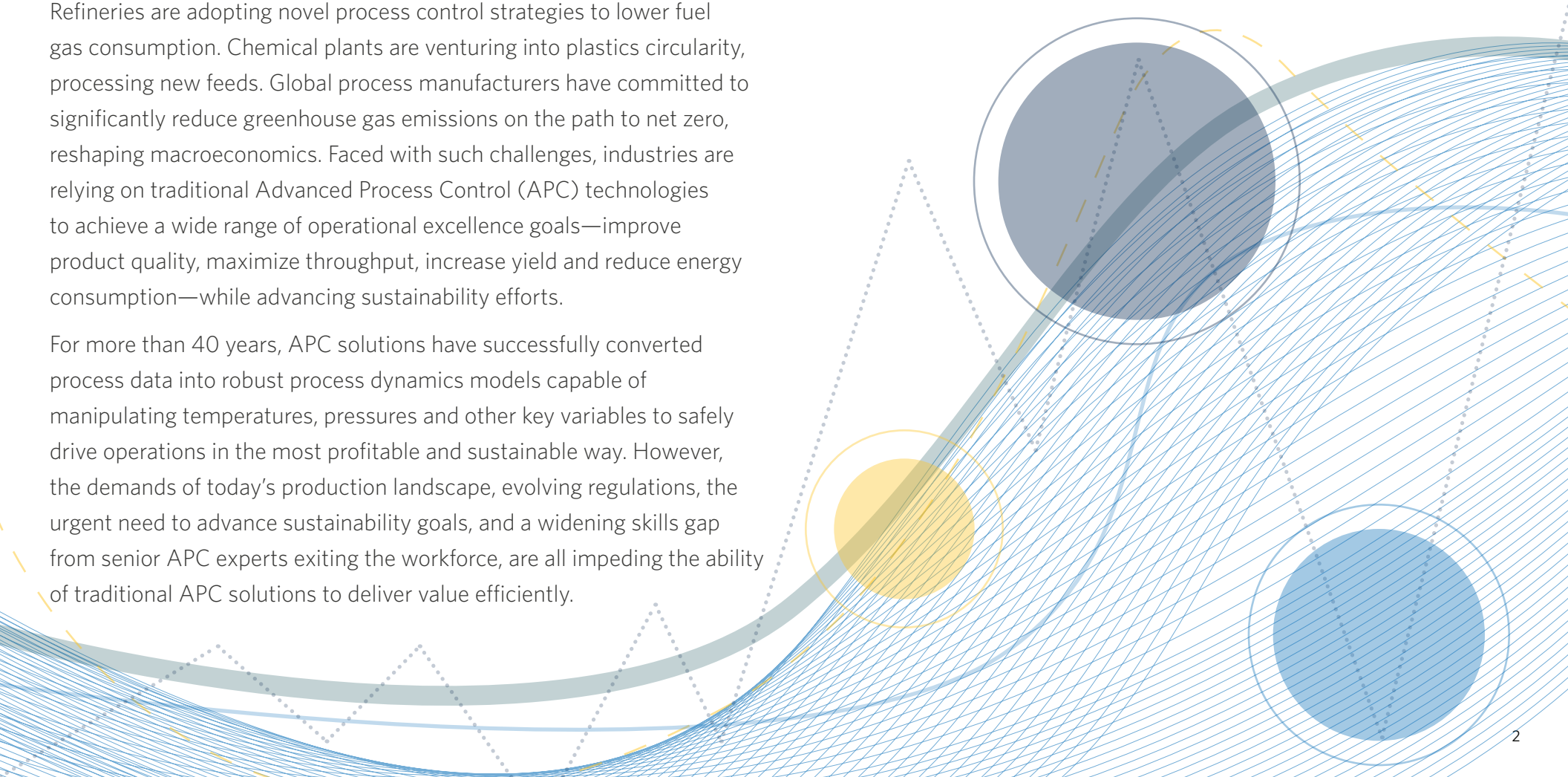
Introduction: Navigating Today's Economic and Environmental Pressures

For oil & gas, and other asset-intensive industries, optimizing process operations and maximizing profitability of assets (equipment) is critical to remaining competitive, especially in today's rapidly changing market. A global landscape marked by economic uncertainty, tightening regulations and increased pressure to integrate decarbonization and sustainability initiatives quickly and affordably have placed unprecedented demands and changes on industrial organizations.

Refineries are adopting novel process control strategies to lower fuel gas consumption. Chemical plants are venturing into plastics circularity, processing new feeds. Global process manufacturers have committed to significantly reduce greenhouse gas emissions on the path to net zero, reshaping macroeconomics. Faced with such challenges, industries are relying on traditional Advanced Process Control (APC) technologies to achieve a wide range of operational excellence goals—improve product quality, maximize throughput, increase yield and reduce energy consumption—while advancing sustainability efforts.

For more than 40 years, APC solutions have successfully converted process data into robust process dynamics models capable of manipulating temperatures, pressures and other key variables to safely drive operations in the most profitable and sustainable way. However, the demands of today's production landscape, evolving regulations, the urgent need to advance sustainability goals, and a widening skills gap from senior APC experts exiting the workforce, are all impeding the ability of traditional APC solutions to deliver value efficiently.

Despite the prevailing trust in traditional APC systems, many industrial sites are now contemplating the benefits of adaptive APC and its recent innovations. **In the last decade, adaptive APC solutions and implementation service partners have introduced innovative features, workflows and strategies to deliver sustained APC benefits and propel operations toward excellence.** More organizations are looking at adaptive capabilities to address the need for faster time to value, less energy use, and greater resiliency in plants and value chains, displacing traditional APC. These prior-generation systems typically lack the innovative features needed to quickly adapt to market changes or provide a high-fidelity, profit-hungry controller capable of sustaining operations.



Exploring Performance Limits of Traditional APC Platforms

APC technology has evolved over the years, enabling the process industries to improve their operations, resulting in continuous management, control and optimization of complex process interactions. Non-adaptive advanced process control, or traditional APC, grapples with a number of limitations, ranging from outdated algorithms and hardware constraints to integration challenges and limited market adaptability. These deficiencies can hinder its ability to keep pace with a dynamic industrial landscape.

For example, model identification and conditioning features struggle to produce accurate models, delivering low-fidelity representations of process dynamics and controllers with inadequate resistance to disturbances and a lack of process stability. This lack of detail compels operators to restrict variables below optimal targets, resulting in a loss of process throughput and missed opportunities for energy savings.

Optimizer objective functions do not consider multiple economic drivers simultaneously, preventing the attainment of global optimum moves. They rely on static LP parameters that are tuned to a specific optimization direction. Once desired production objectives or operational envelopes change, they fail to reach a global economic optimum. Traditional optimizer tuning is an iterative step that can potentially slow controller application response to shifting market demands and other economic drivers changes, reducing margins.

As industrial processes evolve and become more integrated to save energy and minimize waste, APC controllers must scale up and include process units, secondary units and utilities headers. This results in an increase in process variables (model size) and data processing capability for controllers. In instances where limits are tested and controller scope is expanded, traditional APC performance suffers and control engineers must then decide to split the scope into multiple controllers, increasing maintenance efforts. Multiple controllers can cycle between them, making it difficult to collectively stride for a true global optimum, negatively impacting energy efficiency and margins.

APC benefits are influenced by the evolving plant performance over time, attributed to fouling, catalyst deactivation, revamps and other events. Sustaining APC benefits in

traditional solutions has become increasingly difficult, as model updates require plant tests that disrupt normal operations and lack controller performance monitoring tools.

Maintaining traditional APC applications can have its challenges, especially given the lack of experts capable of supporting maintenance activities through traditional workflows. A poorly maintained controller will impact operations performance and can lose operator trust, leading to the costly decision to turn off the application and run the process manually.

In addition to scarce support resources, traditional solutions also have restricted integration with modern IT infrastructure and use older communication protocols that can compromise enterprise cybersecurity integrity as well. Adaptive process control addresses any longstanding barriers to easily maintaining APC applications by capturing and applying expert knowledge within the software.

Despite performance limits, traditional APC platforms persist in industries characterized by high regulation, risk aversion and safety priorities. APC technology is sometimes described as “sticky” as sites tend to see revamping existing APC applications as less risky than exploring adaptive APC or other modern alternatives. Choosing to revamp rather than adopt new solutions can result in increased operational costs, higher product quality variability, missed production targets, cybersecurity vulnerability and increased energy consumption. The advanced algorithms, real-time data analytics and comprehensive range of services leveraged in adaptive APC technology address the concerns of users who may have been less than satisfied with traditional control systems.

Meeting Market Demands with Adaptive APC Innovations

Industrial sites require a modern APC solution capable of maximizing asset performance amidst process changes, providing operational agility to market demands, enhancing energy efficiency and empowering users to deliver value efficiently. The development of adaptive APC innovations aims to tackle these challenges.

With the traditional approach, designing and revamping controllers is a time-consuming task requiring costly and disruptive step tests that are often difficult to schedule and can only be performed by experienced engineers. An innovative adaptive process control approach eliminates these challenges by adapting and optimizing to changing plant conditions. Because this breakthrough technology makes controller maintenance a built-in function, it enables users to reap the benefits of control and optimization while simultaneously performing critical maintenance.

Adaptive APC solutions, like those provided by AspenTech, enable users to achieve maximum APC potential to generate large scope fidelity models, optimizing profitability while ensuring optimal process conditions. Advancements in model subspace identification, conditioning and tuning tools excel in producing accurate models, mitigating issues such as controller cycling resulting from fuzzy dynamics or collinear dependencies between process variables. Experts can incorporate domain expertise with models, and apply mass and energy conservation constraints that improve performance, operations trust and profitability.

Adaptive process control also streamlines the application lifecycle, ensuring the sustainment of APC benefits through advanced technology and efficient workflows. Adaptive APC workflows can reduce deployment times by as much as 75% compared to traditional solutions, delivering fast ROI. This increased efficiency is due in large part to the patented auto stepper technology, which enables plant testing while optimizing operations profitability with no disruptions.

Adaptive APC combines AI technology with domain expertise to increase APC automation and advance user productivity. Model-building complexity and time are

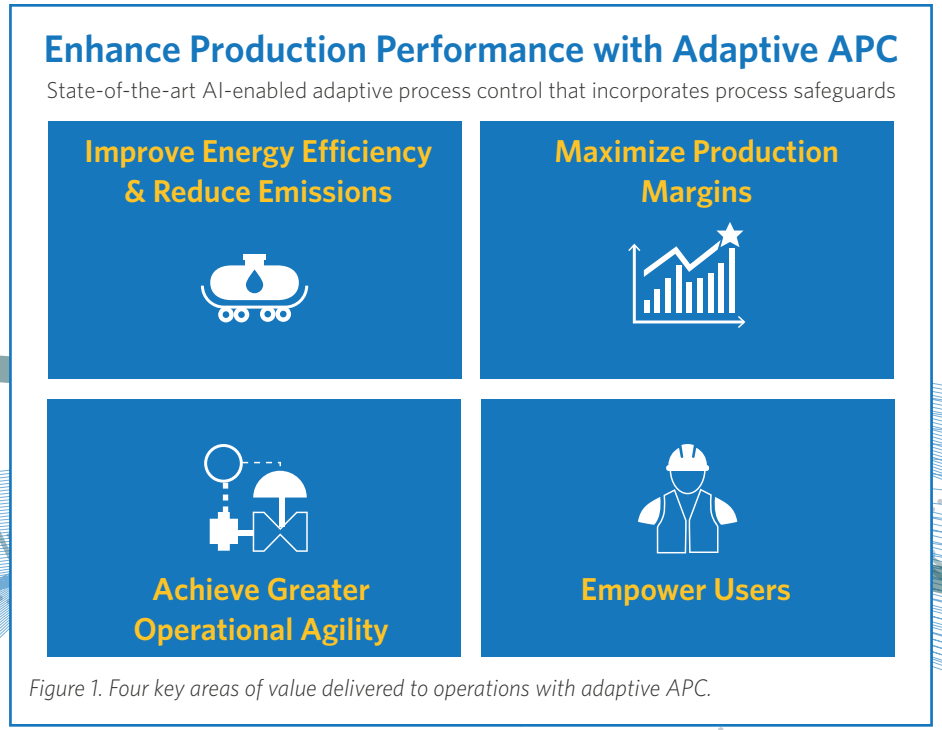


Figure 1. Four key areas of value delivered to operations with adaptive APC.

further reduced through controller seed models created with embedded Industrial AI, which utilizes powerful machine learning algorithms that mine the wealth of historical process data. By updating applications more efficiently, sites can minimize plant-model mismatches and operate with robust controllers capable of maximizing production margins.

Adaptive APC workflows can reduce deployment times by up to 75% to deliver fast ROI.

Adaptive APC applications utilize Sequential Multi-Objective Optimization (SMO) patented technology, fundamentally changing how APC controllers are tuned and configured by enabling users to explicitly specify the economic objectives directly into the controller. If controller economic objectives change, users simply change the optimizer priorities, without needing to revisit any LP cost tuning, improving their operational agility to respond to market conditions.

Most APC implementations will start with high priority process units, as sites mature and see the value of APC, interest to scale and capture more process units grows. The scope in adaptive APC controllers is easily scalable when compared to traditional applications. Adaptive controllers are capable of handling substantial amount volumes of real-time data and process variables in highly integrated industrial processes. From process units to secondary units and utility distribution, adaptive APC controller implementation can extend seamlessly, increasing throughput, improving energy efficiency and reducing emissions.

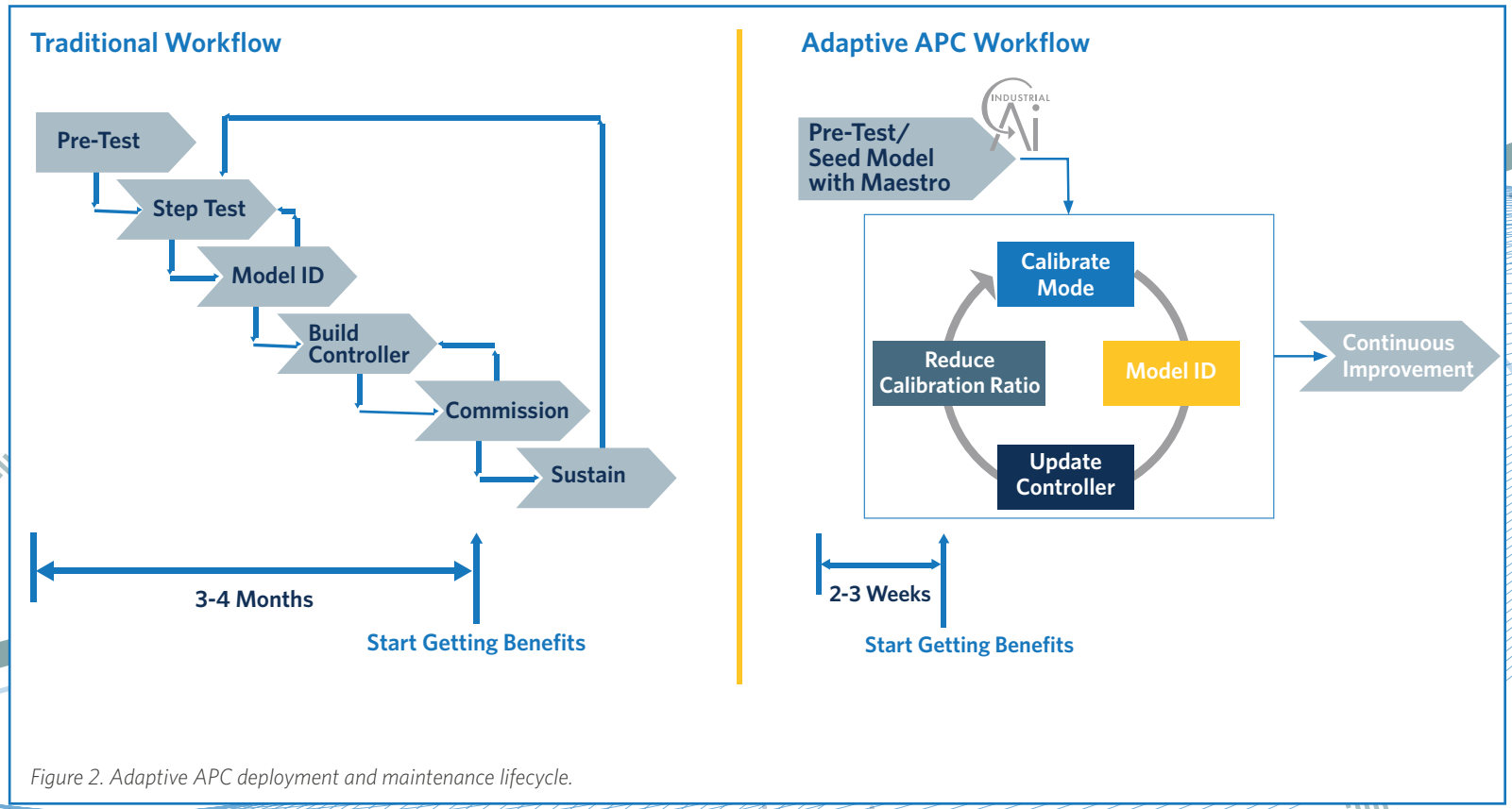


Figure 2. Adaptive APC deployment and maintenance lifecycle.

The user-friendly tools provided by adaptive process control effectively reduce the expertise barriers for developing and managing APC applications. Embedded Industrial AI in Adaptive APC enables users to perform at a higher level. One example is the newly added virtual advisors that offer practical guidance and recommendations using domain expertise, empowering operators and engineers to make well-informed control decisions. The integration of intuitive workflows and tools for seamlessly incorporating domain expertise empowers users to enhance efficiency and concentrate on high-value activities.

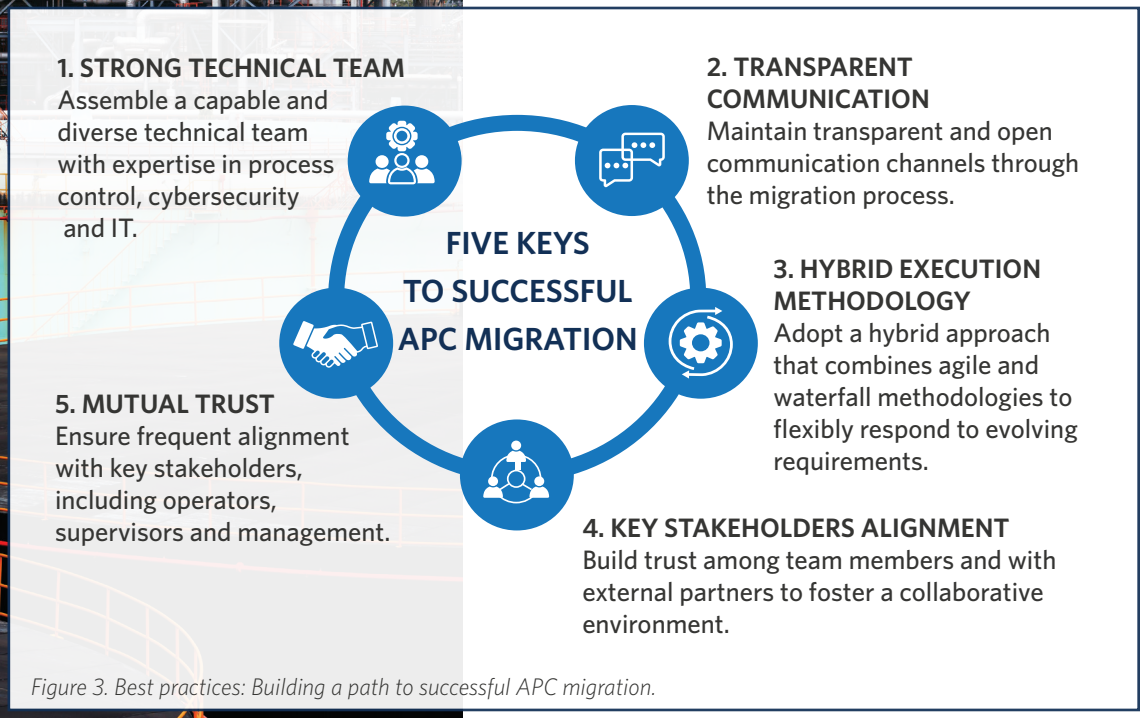


Figure 3. Best practices: Building a path to successful APC migration.

It is imperative that APC solutions be secure and safely exchange process information with DCS, PLCs and other modern IT infrastructure. Adaptive APC systems adhere to the latest cybersecurity standards and utilize OPC communication protocols that are years away from deprecation. This commitment to security and technological currency adds an extra layer of reliability to the overall adaptive APC framework.

Supported by a vast global network of implementation service providers, adaptive APC emerges as a comprehensive solution for industrial APC, seamlessly combining innovation, reliability and ease of implementation.

Charting the Path to Greater APC Benefits

The seamless and efficient implementation of successful APC solutions is often best achievable with strong collaboration between technology providers and services companies. A close partnership can provide valuable insights and best practices that contribute to building a robust technical team, ensuring transparent communication, adopting a flexible execution methodology and fostering trust among stakeholders. These partnerships can

then guide sites that are adopting APC for the first time or migrating from traditional APC platforms. Figure 3 on page 7 summarizes five best practices that partnerships can deliver when migrating from traditional APC.

Delivering Value through Partnership: Overview

AspenTech, a global software leader, formed a strategic alliance with Accenture, a leading global consulting and technology services firm, to facilitate a seamless migration from traditional APC to AspenTech's modern adaptive APC technology for a large refinery site. A successful transition was achieved as a result of the strong collaboration and successful partnership between the two companies. The migration enabled the energy company to achieve significant improvements in process, productivity and cost savings. Results indicated a doubling of expected outcomes compared to the old controllers, with a **3% increase in petroleum processing and diesel oil production within the first year**.

AspenTech collaborated with Accenture to lead a successful migration from traditional APC to adaptive APC technology, resulting in significant improvements in process, productivity and cost savings for the energy company.

APC Migration Results and Outcomes

Multiple APC controllers and inferentials were converted from a traditional APC to an adaptive APC platform, covering functions related to atmospheric and vacuum distillation, dewaxing, HDS Cracked Naphtha and cracking units. Below are executed key steps that led to a successful implementation:

- **Precisely delineate essential controllers for migration,** giving precedence to those with the most significant operational influence.
- **Ensure well-staffed technical teams**, with roles and responsibilities clearly defined for both the existing and new APC platforms. The company established a dedicated advanced solutions team of control and process engineers with domain expertise and in-depth familiarity with the technical intricacies of APC platforms.
- **Leverage partnerships with ecosystem providers who can offer specialized expertise or support during migration.** Both partners contributed substantial value by introducing an effective migration methodology, augmenting the technical workforce and furnishing APC support.
- **Establish robust governance structures** and craft a comprehensive migration plan that encompasses clear timelines, critical milestones and contingency strategies. The project benefitted from strong support and sponsorship from firm leadership in both the Information Technology (IT) and Operational Technology (OT) domains.

The project team meticulously developed a foundational migration plan that unfolded in two distinct phases. In the initial phase, a preliminary migration took place within a cloud-based development environment, commencing with the most intricate controller and subsequently extending to the remaining scope. The migration for each controller was executed following a structured approach (Figure 4, next page).

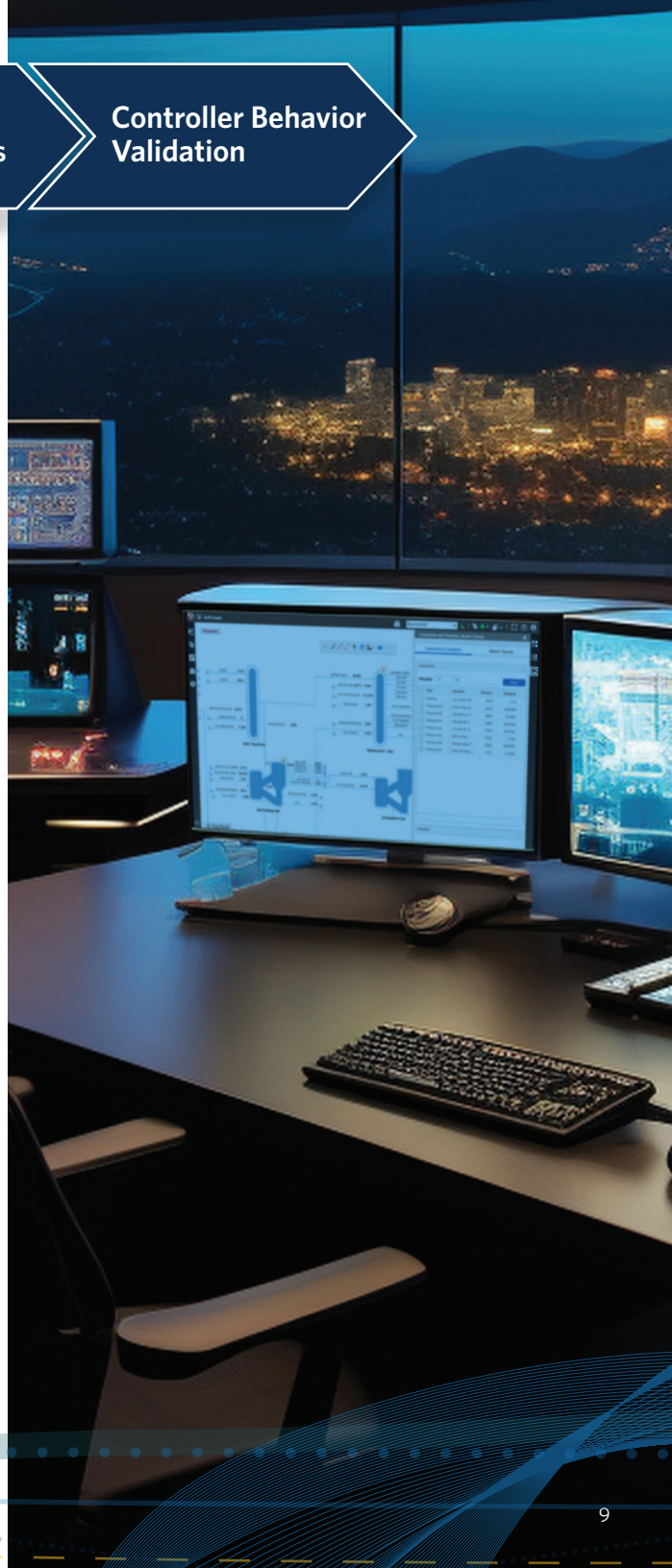
Figure 4. Steps implemented to convert traditional APC applications.

The migration journey commenced by exporting control models from the traditional APC to the adaptive APC solution. The primary focus was on ensuring the accurate transfer of models, preserving key control strategies proven effective in current operations. Input parameters were meticulously mapped, identifying equivalent variables, units and scaling factors to ensure precision in the adaptive APC solution. The subsequent step involved the implementation and validation (through simulation) of inferences, encompassing algorithms, input/output variables and configuration parameters. Next, a thorough validation of these inferences was conducted to guarantee their accurate reflection of plant operations. Any discrepancies were promptly addressed and fine-tuned to optimize performance.

Following the migration of inferences, custom calculations and additional customization were added, incorporating specialized control strategies and specific operational logic tailored to the plant's unique requirements. Finally, the control behavior underwent rigorous validation in a simulated environment closely mirroring real plant conditions. Subjecting the controllers to various scenarios and disturbances allowed the team to verify their expected responses and the achievement of desired control objectives. Any anomalies or deviations from expected behavior were diligently addressed and fine-tuned during this phase.

Once the preliminary migrations of all controllers were finalized, the commissioning phase started. It encompassed migrating the newly developed controllers from the cloud to on-premises infrastructure, the creation of "dummy" controllers within the plant's control system, seamless integration with other essential systems (such as the process historian and laboratory system), operator training initiatives, and the final implementation and go-live of the new controllers.

After the adaptive APC implementation, the site successfully moved away from traditional APC technology, increasing petroleum throughput and diesel production yields.



Conclusion: Partnering for Effective Implementation

The winning partnership between AspenTech and Accenture underscores the significance of collaboration between technology providers and services companies in achieving swift and effective implementation of APC platforms. The success story for the oil & gas industry showcases the tangible benefits of migrating from traditional APC to the adaptive APC solution, resulting in substantial improvements in process efficiency, productivity and cost savings. The outlined key steps in successful implementation, from meticulous delineation of essential controllers to robust governance structures, provide a roadmap for other industrial sites contemplating the transition. The case study detailing the conversion of controllers from a traditional APC to adaptive APC illustrates a structured and rigorous approach, ensuring accuracy, reliability and seamless integration.

As industries continue to navigate an ever-evolving technological landscape, the adoption of innovative adaptive APC solutions is not just a technological upgrade but a strategic move toward operational excellence, improved sustainability and heightened competitiveness in the global market.

Global consulting and technology firm Accenture played a crucial role in this initiative by providing expertise in system integration, customization and deployment. Accenture's knowledge of industry best practices and hands-on experience with various technologies ensured a smooth transition from traditional systems to modern adaptive APC solutions.

About Aspen Technology

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in capital-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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About Accenture

Accenture is a leading global professional services company that helps the world's leading businesses, governments and other organizations build their digital core, optimize their operations, accelerate revenue growth and enhance citizen services—creating tangible value at speed and scale. Accenture is a talent- and innovation-led company with 743,000 people serving clients in more than 120 countries. Technology is at the core of change today, and Accenture is one of the world's leaders in helping drive that change, with strong ecosystem relationships.

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