Global Autonomous Maturity Report

Commissioned in partnership with Censuswide and Development Economics, supported by insights from Independent Energy Market Analyst, Gaurav Sharma, alongside interviews with stakeholders and plant managers across the global energy and chemicals sector.



se.com

Schneider Electric

Foreword

By Gaurav Sharma, Independent Energy Market Analyst

In the fiercely competitive world of energy and chemicals, operational excellence is rigorously benchmarked against throughput gains, process efficiencies, and safety. Additionally, the energy transition era is heaping pressure on operators to lower their carbon footprint.



Gaurav Sharma is a London-based energy market analyst covering global oil and gas markets across Asia, Europe, GCC countries and the Americas for over 20 years. A regular commentator for broadcasters and industry platforms, he specializes in energy futures, physical crude oil, natural gas markets, and the transition to cleaner technologies.

Autonomous technologies are increasingly viewed as enablers of operational gains on multiple fronts, underpinned by electrification and digitalization. Long-established industrial platforms and safety integrated systems are fast becoming truly autonomous — driven by artificial intelligence (AI), machine learning (ML), advanced analytics, predictive maintenance, and digital twins.

Today's autonomous systems can be remotely monitored and reconfigured, and increasingly self-heal, detecting and correcting faults to ensure safer, more resilient operations. They help companies cut costs and emissions at a time when slow adoption only increases operational and regulatory risk.

Schneider Electric's Global Autonomous Maturity Report, which I have had the privilege of providing my insights to, is part of the company's commitment to better understand the scale of progress, and the obstacles that remain, in the sector's inexorable march to an autonomous future.

It's a future in which the energy-AI nexus (i.e., AI being a tool for efficiency within the sector as well as the reason behind a spike in energy demand) will likely loom large. The energy demand from AI and datacenters is expected to double to almost 1,000 terawatt hours (TWh) by 2030, nearly equivalent to the power consumption of Japan, according to the International Energy Agency. The idea of producing "more (energy) with less (burn)" — enabled by autonomous technology — has therefore gained substantial traction.



This report finds the adoption of autonomy in the sector to be more advanced than expected, with open, software-defined automation (SDA) essentially leading the next phase of energy innovation. Many respondents routinely flagged AI, SDA, and machine learning as mission critical tools for optimizing processes, supporting intelligent operations and evolving through continuous learning to achieve, and in many cases exceed, the desired outcomes. But cost and legacy infrastructure also came into sharp focus as potential barriers to adoption.

While the technologies enabling this profound shift are among us and already in play, unsurprisingly, their adoption speed is anything but uniform in various global markets. For example, Gulf Cooperation Council (GCC) countries and Asia currently lead in autonomous operations maturity. However, it is North America that appears to be well positioned for the strongest acceleration by 2030. That's in line with its status as the world's leading producer as well as consumer of energy, and the most significant region for datacenter electricity consumption growth.

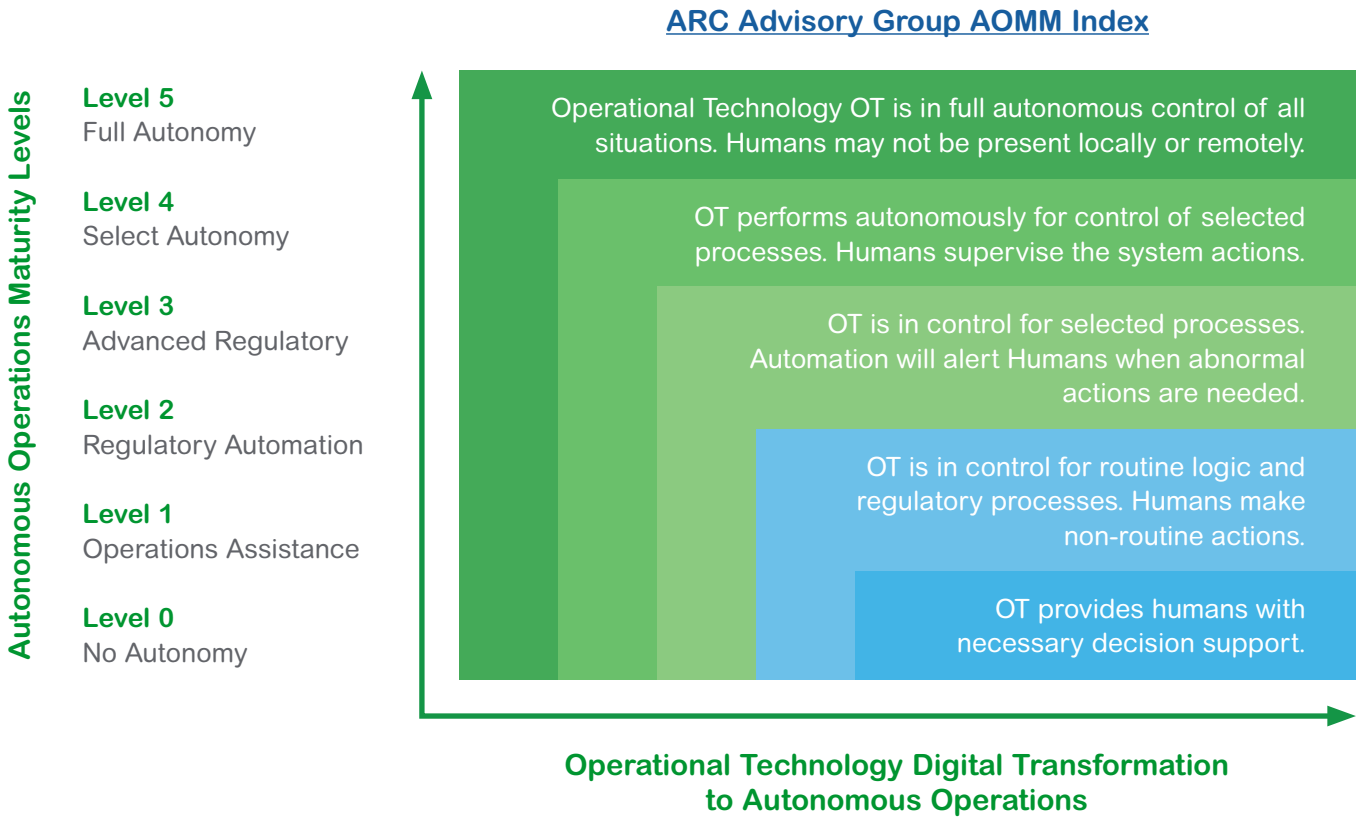
Ultimately, it is all about creating real value using technological levers. This report represents Schneider Electric's definitive assessment of the global landscape — cutting through the complexities, common patterns, and regional divergences to answer the critical question of when and how fast autonomy will scale.

Autonomous Maturity Leaderboard

1	GCC Countries
2	Asia
3	North America
4	Europe

Executive Summary

This study shows that progress toward autonomous operations in the global energy and chemicals sector is stronger than many assumed. Organizations report to operate at an average level of 3.52 out of 5 on ARC's five stage AOMM Index, with ambitions to reach level 4.02 by 2030. However, progress is uneven. Data shows that although GCC countries and Asia currently lead in maturity levels today, North America is targeting the fastest acceleration over the next five years, and Europe is at risk of falling further behind without stronger investment and modernization.





Autonomous operations already play a key role in today's complex energy landscape and are increasingly viewed as a catalyst for business performance. "Productivity gains" and "cost reduction" are the top drivers, each cited by 35% of respondents, followed closely by "competitive advantage." This is balanced against major barriers, notably high upfront costs, legacy infrastructure, and resistance to change. At the same time, organizations that are slow to adopt expect to face rising operational costs, regulatory risk, and worsening skills shortages.

The path forward is clear, and we have the technology needed to enable transformation. Electrification, automation, and digitalization are converging to create an environment where autonomous systems can thrive, and where early movers will shape the next era of the energy sector. What the industry needs now is a clear migration path, a prepared workforce, and collaborative partnerships to scale autonomy responsibly.

Table of contents

Introduction 6

Results and Insights
- Current vs. Desired Maturity Levels 9
- Bold Ambitions 10
- The Drivers Behind the Shift 11
- Top Technology Enablers 13
- The Barriers to Progress 14
- The Cost of Standing Still 15
- Impact on Decarbonization 16

Regional Insights
- North America 18
- Europe 22
- Asia 26
- GCC Countries 30

Conclusion 33

Schneider Electric and AVEVA Offering 35

Case Studies 36

Methodology 39

Introduction

Autonomous systems represent a significant shift in how energy and chemicals companies design, manage, and optimize complex industrial processes, and are essential to our industrial future. These systems use artificial intelligence, machine learning, open software-defined automation, robotics, and advanced analytics to perform tasks with minimal human involvement. The result is safer, more efficient and resilient operations that reduce emissions and enable new business models.

The Current State of Autonomous Maturity

AOMM score



Autonomous technology already delivers substantial commercial benefits across the energy sector. In exploration and drilling, it is transforming geological data collection and analysis, improving discovery success rates, and enabling more precise drilling for deeper and more complex wells, optimizing the potential for resource extraction. In refineries and production facilities, autonomy increases operational resilience, boosts productivity, reduces downtime, and speeds up decision-making.

However, autonomy is not only a technological progression, and adoption is not without its challenges. Leaders emphasize the need for transformation programs that include governance, workforce reskilling, strong change management, and a leadership culture grounded in data. McKinsey has highlighted that many energy companies under-realize the value of their automation investments, noting that roughly 70% of digital transformation initiatives fall short of their expected outcomes, often because of organizational behaviors and capability gaps.

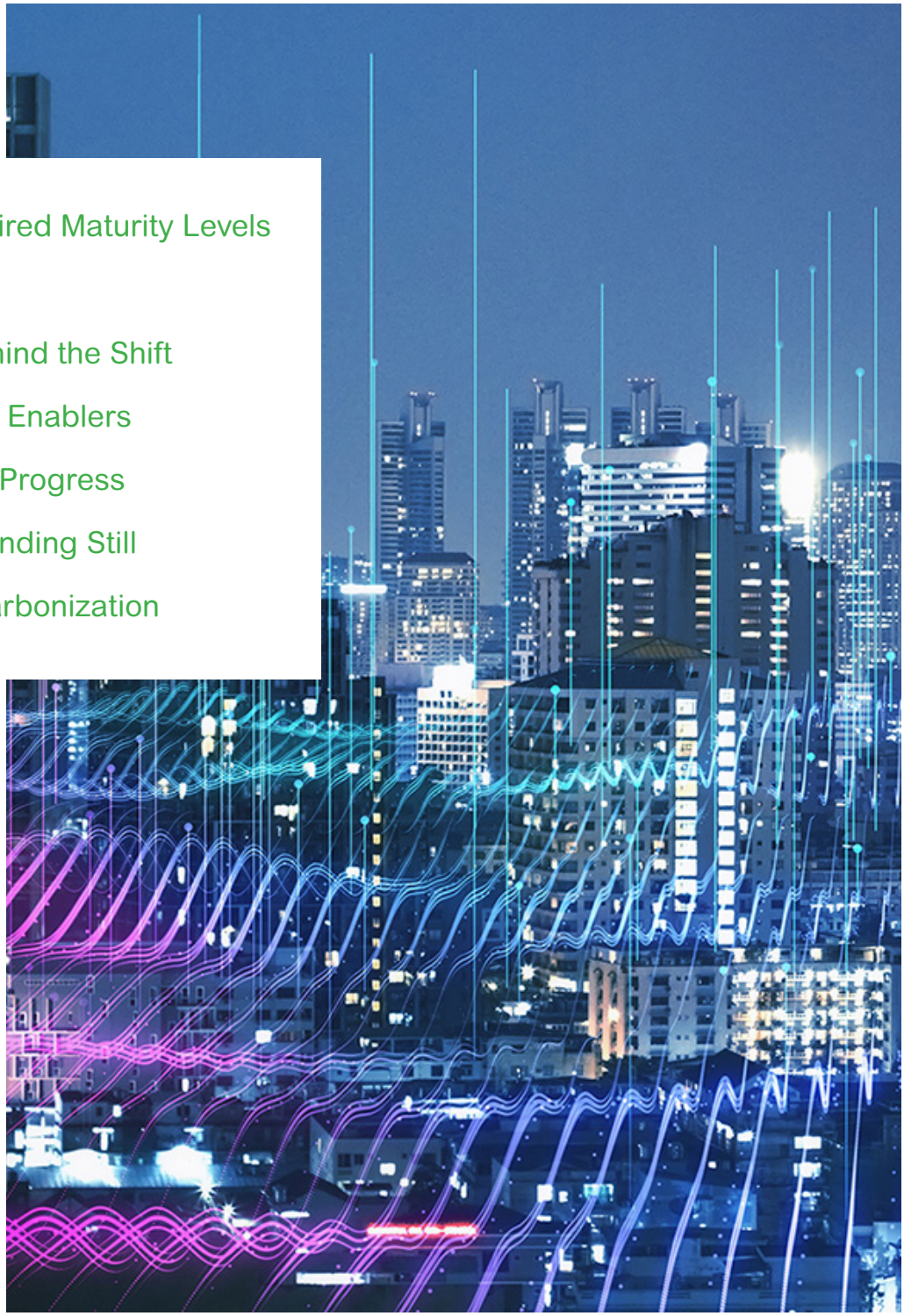
To better understand the scale of progress and the obstacles that stall progress, Schneider Electric commissioned research that identifies current maturity levels, regional differences, enabling technologies, barriers to adoption, and the consequences of delaying investment.

This report captures insights from 400 senior energy executives across twelve countries in four key regions — North America, Europe, Asia, and GCC countries — supported by desk research and conversations with industry stakeholders and commentators.



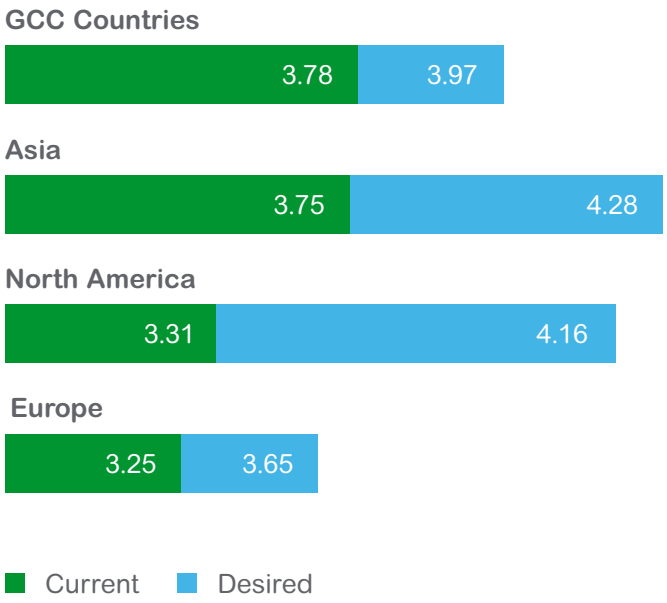
Results & Insights

- Current vs. Desired Maturity Levels
- Bold Ambitions
- The Drivers Behind the Shift
- Top Technology Enablers
- The Barriers to Progress
- The Cost of Standing Still
- Impact on Decarbonization



Current vs. Desired Maturity Levels

> Advancing autonomous operations isn't just a technology challenge — it's an organizational one. It requires people who are prepared, supported, and working toward a shared purpose. Many teams struggle with defining a clear vision, mapping out a realistic migration path, and understanding how each stage of the journey fits together. Change management is critical to overcoming cultural and structural barriers, ensuring that new ways of working can take root.
>
> Across the energy and chemicals sector, we see that the sites making the strongest progress are those that invest early in developing workforce capabilities, rethinking operational practices, and building a culture grounded in data-driven decision-making. These foundations are what enable autonomous operations to scale effectively, sustainably, and safely."
>
> **Cecile Vercellino**
> SVP IA Services and Advisory, Schneider Electric



The findings reveal the current level of adoption of autonomy is perceived to be more advanced than expected, with a global average score of 3.52 on the five-stage AOMM index, although stakeholder insights suggest this may be influenced by natural bias among organizations assessing their own progress.

The momentum is clear, though readiness for an autonomous future varies significantly by region. The greatest progress was found in GCC countries, with an average score of 3.78, closely followed by Asia (3.75). GCC countries are expected to continue to lead by 2030, North America, currently at 3.31, is poised for strong growth toward 4.16. Europe faces the slowest trajectory, rising only modestly from 3.25 to 3.65. These findings were in line with insights from stakeholder interviews, with the GCC countries highlighted as the region in the vanguard of autonomy adoption in the energy sector. The interviews also highlighted that adoption of autonomous technology was likely to be more advanced in the locations where the largest companies (i.e., those with a global reach) were more active.

However, to some extent, the regional average scores mask significant variations in responses from individual countries. The country-level results reveal various hot and cold spots with respect to current autonomous technology deployment, with the hottest locations being China, India, Saudi Arabia, and France.

It also confirmed a clear ambition among energy companies to significantly raise their autonomy maturity within the next five years, targeting a global average of level 4.02. Asia leads with the highest desired maturity level (4.28), followed closely by North America (4.16).

The research revealed that the extent of advancement in GCC countries over the next half decade is likely to be much slower, with a desired average level of 3.97 in five years, largely due to its current position as front-runner. It also showed that Europe (3.65), already lagging the global average, is at risk of falling even further behind competing regions.

Bold Ambitions

It's clear, and encouraging, that global ambition for autonomy is rising. When asked about the extent to which advancing autonomous operations was a strategic priority, 32% of global energy executives overall acknowledged that autonomy is a "critical" priority for their organization over the next five years. Companies plan significant maturity gains within the next five years, especially in Asia and North America. GCC countries' advancement will be steadier because they already have a high starting point.

Further highlighting autonomy's central role in achieving business goals, 20% of North American companies surveyed say autonomous operations will be "critical" for them in 5 years. That number rises to 62% when looking out 10 years. Similarly, 22% of Asian companies surveyed reported autonomous operations as "critical" for them in 5 years, rising to 46% in 10 years.

These findings were in line with the stakeholder interviews, where particular emphasis was placed on accelerated investment in offshore energy assets (where operations tend to be more complex, space-constrained, expensive, and hazardous for human operators).

Of course, the regional averages mask marked variations from the respective regional averages, with executives in certain countries even further ahead of the curve when it comes to recognition of the importance of autonomy. Most prominent of these vanguard countries for autonomy is the United States, with criticality projected to increase from 20% over five years to 68% over 10 years.

Slightly behind the US — but still noteworthy nonetheless — is France where "criticality" for autonomy is set to rise from 28% to 52% and India (from 33% to 55%).

> "Software-enabled automation represents the next phase of energy innovation, and leaders from Equinor to Shell are already deploying it at scale. At a systems level, autonomous tools help to solve the biggest challenges that operators face, from capturing knowledge from retiring workers, to managing ever-more complex networks, or bringing carbon capture and hydrogen into the mix. For individuals, AI-enhanced decision support makes it easier to focus on mission-critical tasks. Combined, these technologies are driving an intelligence "big bang" in energy, where success is increasingly defined by how efficiently you can adopt automation to drive competitive advantage."
>
> **Rob McGreevy**
> Chief Product Officer, AVEVA

The Drivers Behind the Shift

Energy executives typically identified value creation as the main benefit sought from embracing autonomous technology, demonstrating that autonomy is viewed as a business performance enhancer. The main benefits from autonomy identified globally were:

- Enhanced productivity (35%).
- Reduction of costs and/or improved profitability (35%).
- Gaining competitive advantage (34%).
- Improve operational resilience/asset reliability (29%).
- Improve environmental performance (28%).
- Optimize decision-making (28%).

3 Main Benefits



Enhanced productivity



Reduction of costs and/or improved profitability



Gaining competitive advantage

There was also a secondary cluster of benefits identified, where the themes included operational resilience (29%), optimizing decision-making (28%), environmental performance (28%), and workforce safety (27%).

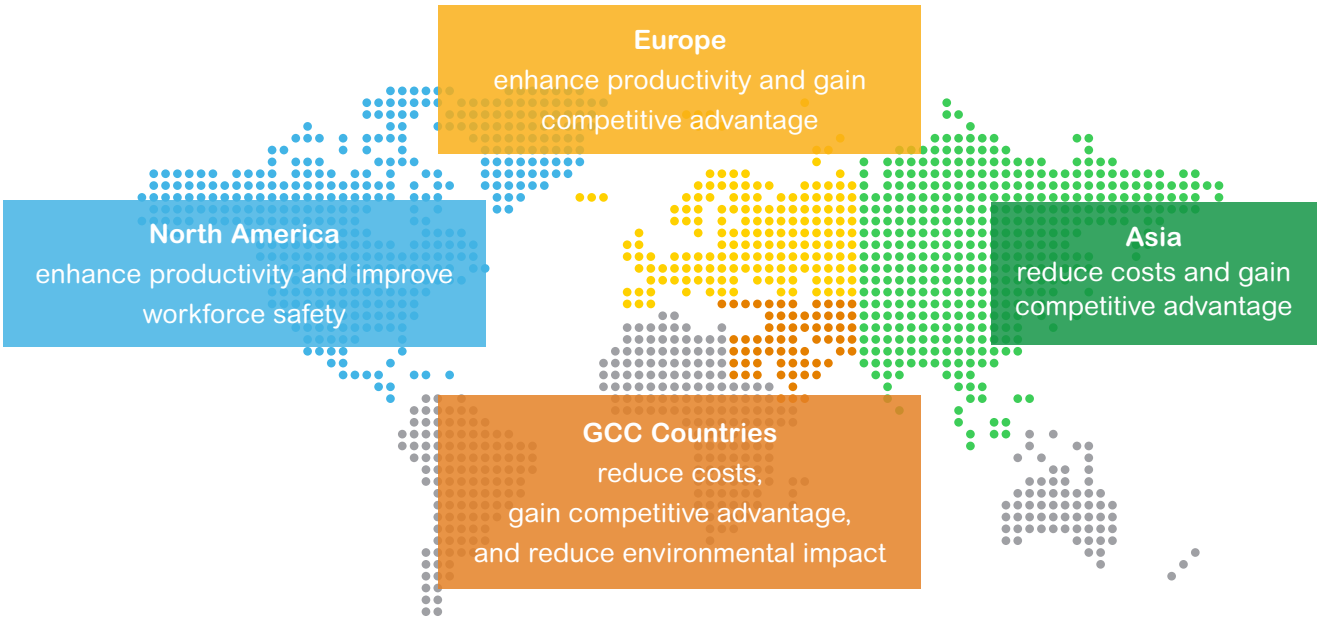
However, across the regions there were striking departures from these global averages, especially in North America where there was far greater prioritization of productivity (59%) and workforce safety (42%). This survey finding aligns with feedback from stakeholders.

It is also evident from the findings that executives in Asia place much greater emphasis on cost reduction/improved profitability (39%), while in GCC countries there was more attention given to environmental performance (31%).

At the level of country-specific responses there were even starker contrasts, especially in Asia and the GCC countries:

- Reduction of costs and/or improved productivity is strongly favored in Japan (55%), Qatar (50%), and the UK (48%).
- Competitive advantage had greater emphasis from executives in China (41%), UAE (40%), and Sweden (also 40%).
- Operational resilience and asset reliability was the standout benefit sought in India (55%).
- Improved environmental performance was particularly important for executives based in the Japan (45%), UAE (40%) and Canada (36%).

Regional Drivers for Autonomy



Top Technology Enablers

The data clearly identified AI and machine learning as the most critical technologies for enabling autonomy over the next five to ten years, selected by nearly half of respondents. Some countries viewed it as even more critical, including Canada, Japan, and the United States. GCC countries were the main exception, with far fewer executives selecting AI as their leading technology.

Interviews with stakeholders reinforced that AI is widely seen as the primary driver of autonomy. At the same time, digital twins and advanced process control were highlighted as important enablers, receiving more emphasis in conversations than in the formal survey results. These technologies were recognized for their role in strengthening insight, prediction, and operational decision making.

Cybersecurity and safety frameworks ranked second globally as the most important enabler. Support varied across regions, with North America placing the most weight on these safeguards and GCC countries placing the least. This variability reflects the distinct regulatory, operational, and geopolitical realities across regions.

> “The global energy sector has never been more technologically ready - and industrial AI is the catalyst that will turn that readiness into real transformation. We’re sitting on an abundance of tools to drive efficiency, resilience, and decarbonization. The only risk now is failing to use them.”
>
> **Hany Fouda**
> Senior Vice President, Process Automation, Schneider Electric

Cloud and edge computing ranked third, with strong enthusiasm in North America compared to lower levels in Europe. Advanced process control ranked fourth, though it was the top choice among energy leaders in in GCC countries and a strong priority in Asia. Robotics completed the top five globally and was especially important among Asian executives, who rated it second only to AI.

1. **AI & Machine Learning** 49%
2. **Cybersecurity & Safety Frameworks** 40%
3. **Cloud/Edge Computing** 36%
4. **Advanced Process Control (APC)** 35%
5. **Robotics** 34%

The Five Most Critical Automation Technologies

The survey asked energy executives which five technologies are most important for enabling autonomy over the next 5-10 years. Here is how they responded.

The Barriers to Progress

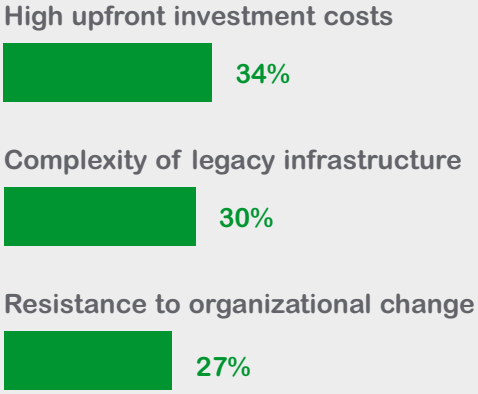
The research identified the top barriers to faster deployment, with the most frequently cited reason being high upfront investment costs (34%), followed by complexity of legacy infrastructure (30%), and resistance to change within the organization (27%). The cost barrier was reiterated in interviews with stakeholders who identified the need for a compelling business case, likely to be a particular constraint for smaller and state-owned energy companies.

Another major set of barriers related more to business culture and regulatory concerns, with a lack of forward thinking within the organization, shortage of skilled workforce, and uncertainty about regulatory matters each acknowledged by around a quarter of executives.

However, at a regional level there were distinct contrasts with the average global pattern, most notably in North America, where executives placed far greater emphasis on upfront investment costs (51%) as a hindrance to progress. GCC country executives placed greater stress on the complexity of legacy infrastructure (35%), whereas Asian-based executives highlighted resistance to change within the organization as the chief impediment holding back autonomous technology (34%). On the other hand, concern regarding cybersecurity is the challenge most frequently cited by European executives (31%).



Top Barriers to Deployment



Even greater variations appear at the country-level responses, the most striking being:

- Upfront investment costs dominated responses from executives in the United States (59%).
- The complexity of legacy infrastructure is an especially challenging issue for companies operating in the UAE (48%) and Qatar (40%).
- Internal resistance to change is most problematic in Japan (42%) and the UK (40%).
- Cybersecurity concerns are especially acute in Canada (44%) and Sweden (40%).
- Regulatory uncertainty is particularly problematic in Germany (36%).

The Cost of Standing Still

Delayed adoption carries adverse consequences. Among these, increased operating costs are the top concern globally, cited by 59%, followed by worsening skills shortages (52%) and reduced industrial competitiveness (48%). Increased safety risks (46%) and higher carbon emissions (45%) were other risks frequently cited.

Regional patterns differ. North America shows the highest concern over increased operating costs, with 69% highlighting this issue. On the other hand, only 37% highlighted carbon emissions, compared to the global average (45%).

By contrast, in GCC countries, executives displayed the opposite pattern, with a low proportion — compared to global averages — highlighting operating cost risks (49%) and a relatively high proportion citing carbon emissions risks (48%).

Asian executives were nearly as concerned as their American counterparts about the potential adverse impact on operating costs (65%), but they also had the greatest concern about the potential effect on carbon emissions (55%).

Biggest concerns about delaying adoption of autonomous technologies:



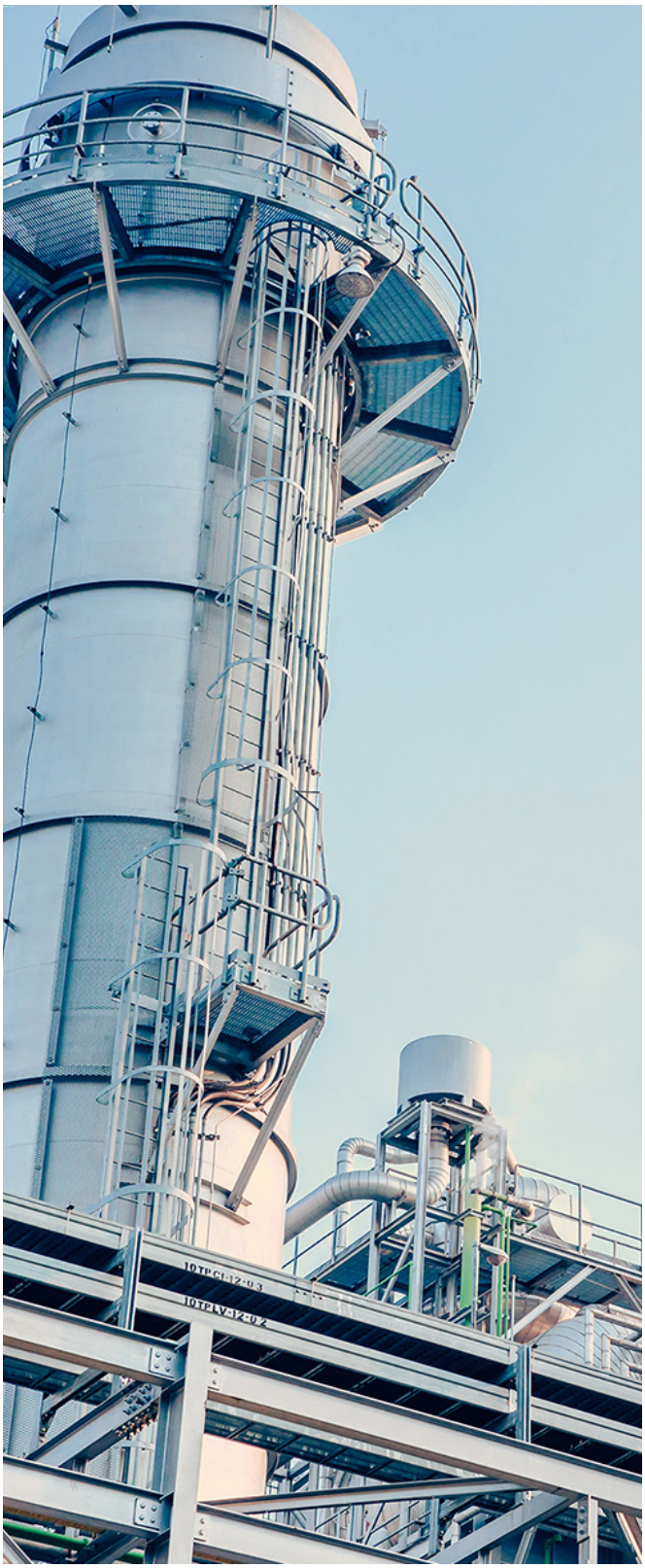
In Europe, the most significant departure from the global average was the perceived risk of undermining industrial competitiveness, with only 37% acknowledging this potential impact, compared to the global average of 48%. This survey suggests many European energy companies may not fully recognize how slower investment in autonomous technology could harm their competitiveness in the medium to long term.

Country-level results add further nuance:

- Risks of higher operating costs were particularly acute for executives based in the US (72%), Germany (68%), Japan (67%), and India (also 67%).
- Exacerbated skills shortages were more frequently identified by executives in Sweden (68%) and the US (64%).
- The risk of lower industrial competitiveness was a major concern for those located in Qatar (65%) and China (62%).
- Workforce safety risks were emphasized by executives located in India (70%).
- Executives in India (64%) and the UAE (63%) were most concerned about the potential impact on targets for carbon emissions reductions.

These perceptions reflect a clear reality: organizations that wait face compounding pressure on talent, cost structure, and regulatory compliance.

Impact on Decarbonization



Despite regional variations, autonomy is broadly viewed as inseparable from decarbonization. Nearly six in ten energy executives say autonomous operations are critical to achieving net zero — with 23% believing it's not possible without it and a further 35% believing it's possible, but with major difficulty.

These views are strongest in Europe, where 69% consider autonomy to be essential to net zero progress, or at the very least, an uphill struggle without it. By contrast, 45% of executives in Asia hold these views, and 52% in GCC countries.

The survey responses from the GCC countries and Asia might reflect the already advanced deployment of autonomous technology across the energy sector in these two regions (whereas, in Europe, adoption of autonomous technology is already lagging other regions in deployment, and the indication from our survey is that Europe is in danger of falling even further behind).

It is worth highlighting that in some individual countries the proportion of energy industry executives who consider that autonomous technology is either essential to, or a powerful accelerant for, realization of net zero targets is much higher than global or regional averages. In Sweden, 96% of executives surveyed said it is not possible without autonomy, compared to 96% in Japan, and 72% in the Canada.

Regional Insights

- North America
- Europe
- Asia
- GCC Countries



North America



Regional Landscape

North America is a global hub for industrial innovation, supported by a highly developed digital technology ecosystem and strong AI and automation capabilities. The United States and Canada were recently named by Boston Consulting Group among the world's five "global pioneers" in AI, and the 2025 Global Innovation Index ranks the US third globally for industrial innovation. The United States also remains a leader in market and business sophistication and ranks near the top for gross R&D spending and business-financed research, highlighting the private sector's central role in driving technological advancement.

This innovation strength is amplified by the scale and strategic importance of the region's energy sector. It is one of the world's largest producers of oil and natural gas, with significant shale development, extensive refining and petrochemical capacity, and a rapidly expanding LNG export industry that now shapes global energy flows. The Gulf Coast hosts some of the world's most complex and capital-intensive industrial assets, creating an environment where autonomy offers outsized returns. High-output, high-complexity, and highly profitable operations stand to benefit materially from efficiency, reliability, and safety gains delivered by autonomous systems.

North America's diverse energy mix, including oil, natural gas, nuclear, and renewables further accelerates the case for autonomy. The complexity and interdependence of this system, from upstream production to refining, petrochemicals, power generation, and grid operations, create ideal conditions for advanced autonomous deployment. Structural headwinds such as rising operating costs, aging infrastructure, and workforce shortages only heighten the need to automate mission-critical functions and minimize exposure in hazardous or remote environments.

According to Schneider Electric's Sustainability Research Institute, grid instability costs US businesses billions annually. The nation must add 1,000–2,000 (TWh) of electricity per decade to meet demand from AI computing, manufacturing, and electrification. Achieving this requires deploying software and AI to unlock capacity, reliability, and efficiency from existing systems; and modernizing grid operations so energy can be orchestrated at scale. Delays risk grid congestion, affordability challenges, and lost industrial competitiveness. In this context, autonomy, digital optimization, and flexible infrastructure are not optional — they are commercially imperative.

Policy and Partnership Environment

The policy environment in North America emphasizes energy security, operational efficiency, and investment in critical infrastructure. Regulatory frameworks continue to evolve with a focus on streamlining project delivery, supporting domestic energy production, and ensuring system reliability, while balancing safety considerations. These conditions create a broadly supportive backdrop for investment in automation and autonomous operations, particularly for capital-intensive assets with long operating lifetimes.

As energy systems become more complex and interconnected, regulatory attention is increasingly focused on reliability, safety, and cybersecurity, further strengthening the business case for advanced automation and AI-enabled monitoring. Given the resurgence in localizing supply chains and policies to incentivize domestic manufacturing (particularly in the US), there is a growing opportunity to deploy and integrate next-generation energy technologies (AI, digital twins, and software-defined automation) within new or modernized company operations.

Ample opportunities exist across the private sector to adopt innovative industrial automation technologies. However, there are obstacles that federal and state governments in the US can help address, from reducing cross-jurisdictional regulatory hurdles that slow infrastructure modernization to offering grants or tax rebates that help small and medium-sized businesses close the digital maturity gap.

Ultimately, the scale and complexity of North American energy assets and partnerships between industry, technology providers, and government, remain critical. These regulatory priorities align well with North America's broader strengths in research, innovation, and technological leadership.

Survey Insights

North America aims to make the most dramatic shift toward autonomous operations globally over the next five years, with organizations planning a maturity uplift of +0.85, nearly double Europe's pace and well above the +0.50 global average. 86% of energy and chemicals leaders rank automating operations as a "high priority" for the next 5 years. This urgency triples by 2035, with its importance upgraded to a "critical priority" (20% "critical priority" in 5 years to 62% in 10 years). While the region currently ranks third behind GCC countries and Asia in autonomous maturity, its ambition is clear. Nearly half (46%) of North American energy executives say the pace of autonomous adoption in their organization is "rapid and accelerating."

AI and machine learning stand out as the top technologies enabling this shift, far ahead of other regions (75% in North America vs. 49% global). Productivity is the main reason companies are investing, followed by improved workforce safety 42% (vs. 27% global) given that higher autonomy reduces human exposure to hazardous tasks.

High up-front investment costs were identified as the primary barrier to adoption, cited by 51% compared with the global average of 34%. This was followed by the complexity of legacy infrastructure (34% vs. 30% globally) and cybersecurity concerns (31% vs. 26% globally).

According to the responses, delayed adoption of autonomous technology may impact long-term competitiveness in two significant ways: increases in operating costs (69% vs. a global average of 59%) and worsening shortages of talent and skills (55%). With many high-risk, hard-to-fill roles going unstaffed, greater autonomy helps close the talent gap by shifting dangerous, manual tasks to intelligent systems.

North America: Key Stats

North America is #3 in maturity today but shows the **boldest 5-year ambition** to adopt autonomous technologies.

Productivity leads as the #1 driver

Worker safety lands as the #2 motivator

High upfront cost is key barrier: 51% (vs. 34% globally)

69% **fear rising operating costs** without autonomy (vs. 59% globally)

55% expect **worsening talent shortages** without adoption

46% say they see **rapid and accelerating pace of adoption**

Implications

Overall, the North American responses were more pronounced than global averages, underscoring a sharper regional perception of both financial and operational risks associated with delayed deployment of autonomous technologies.

Autonomous technologies can significantly improve resource extraction, increase operational flexibility and productivity, and enhance safety. Automation in oil and gas exploration and drilling is enabling companies to analyze geological data more effectively and drill deeper, more complex wells to optimize output. For example, a leading energy company recently reported that its rollout of autonomous hydraulic fracturing technology in the Permian Basin of West Texas has led to a 17% increase in stage efficiency in fracture execution following initial deployment.

High upfront investment costs continue to present a barrier for some organizations, suggesting that incentive mechanisms, innovative financing models, and collaborative approaches can play an important role in accelerating adoption and reducing deployment risk.

The region's depth in industrial robotics, digital innovation, and AI-enabled software reinforces its ability to scale autonomy across complex, asset-intensive operations. Against a backdrop of macroeconomic uncertainty and shifting policy priorities, autonomous technologies provide energy companies with a powerful lever to enhance productivity, improve safety, and maintain cost competitiveness.

Together, the region's innovation leadership, its world-class energy sector, and the urgency of the "time-to-power" challenge create a uniquely strong foundation for accelerating autonomy across the entire value chain from resource extraction and processing to power generation, grid management, and infrastructure resilience. The companies that act now will shape North America's competitiveness.



Case Study

Shell's Scotford refinery in Canada modernized its automation by integrating EcoStruxure Automation Expert with its existing Foxboro DCS and Triconex systems. The hybrid setup cut engineering complexity, reduced vendor lock-in, and increased procedural automation — supporting Shell's "design once, build many" approach and paving the way for more autonomous industrial operations.

Europe



Regional Landscape

Europe's energy and industrial sectors continue to navigate persistent structural challenges — including slower economic growth, elevated production and energy costs, and ongoing inflationary pressure. Despite this backdrop, the region remains well positioned to strengthen its competitiveness in the next wave of industrial transformation. Resilient private consumption is underpinning a projected Eurozone rebound toward 1.5%–1.6% GDP growth in 2026, with Germany expected to regain momentum, and Southern and Eastern Europe continuing to drive regional dynamism. By contrast, the UK outlook remains comparatively softer.

The region benefits from an advanced industrial base. Although higher interest rates have weakened demand in construction and manufacturing, Europe retains strong foundations for accelerating automation, digitalization, and electrification.

Europe also remains a leader in industrial automation. Germany and Sweden rank among the top six countries globally for robot density, reflecting deep adoption of advanced manufacturing technologies. The region is likewise a hub for innovation and digital advancement: Sweden ranks second globally in the Global Innovation Index, while the UK, Germany, and France consistently place among the world's most innovative economies. Recent analyses position the UK as a global AI pioneer, with Germany, France, and Sweden recognized as emerging leaders as AI adoption accelerates across industry in 2026.

At the same time, Europe faces a significant workforce challenge, with more than 500,000 STEM vacancies. This shortage is driving increased focus on digital skills, reskilling programs, and workforce transformation, turning talent development into a strategic lever for competitiveness. These efforts create an opportunity to convert current market pressures into a catalyst for broader adoption of autonomous systems, advanced analytics, and AI-enabled productivity gains.

Clean energy momentum continues to build across the region. Double-digit growth in solar and wind is expected as permitting reforms from 2023–2024 translate into operational capacity. Storage is projected to grow by 30% annually, and 2026 will bring the first wave of large-scale industrial electrolyzers, marking meaningful progress in hydrogen deployment. Meanwhile, the end of the Carbon Border Adjustment Mechanism (CBAM) transitional phase will shift imports of carbon-intensive materials such as steel, cement, aluminum, fertilizers, hydrogen, and electricity from reporting-only requirements to full compliance, requiring importers to purchase CBAM certificates, starting in February 2027. Energy supply mixes remain diverse.

- France continues to rely heavily on nuclear energy and plans long-term reinvestment.
- Germany has exited nuclear entirely, shifting toward gas, renewables, hydrogen infrastructure, and storage.
- Sweden remains anchored in hydro and wind as it advances toward 100% renewable energy by 2040.
- The UK is expanding offshore wind while planning to replace its aging nuclear fleet with a mix of European Pressurized Reactors (EPRs) and potential Small Modular Reactors (SMRs) under its new national nuclear strategy.

Amid this transformation, Europe must address several structural risks — including rising raw material prices, systemic cybersecurity threats, and supply-chain re-regionalization driven by geopolitical uncertainty. A study by BusinessEurope found that the permitting process is slow and burdensome, leading to long delays, stating “The EU has taken steps in the right direction but more needs to be done.” However, with the right combination of regulatory alignment, investment, and talent development, Europe remains well positioned to strengthen its industrial resilience and long-term competitiveness.

Policy and Partnership Environment

The policy environment in Europe is undergoing significant acceleration as energy security, industrial strategy, and competitiveness become increasingly interconnected. The EU’s plan to end reliance on Russian fossil fuels by 2027, combined with rollout of the Net Zero Industry Act (NZIA) the region’s flagship framework for scaling cleantech manufacturing marks a major shift in strategic direction. The region is expecting more legislative proposals, including the Industrial Accelerator Act, designed to boost industrial competitiveness, by introducing clean, resilient, circular, cybersecure criteria to strengthen demand for EU-made clean products and deliver clean European supply for energy-intensive sectors. These initiatives underscore how rapidly Europe is aligning environmental, industrial, and economic priorities.

A series of complementary measures around digitalization, electrification, and energy efficiency is reinforcing this convergence. The Renewable Energy Direction (RED III) sets an ambition to increase the renewable energy share from 23% in 2022 to 42.5% by 2030, while the UK’s Clean Power 2030 strategy aims for 95% low-carbon electricity including expanded wind, solar, and nuclear capacity — restricting unabated gas to no more than 5%.

Yet, Europe still has vulnerabilities. The April 2025 Blackout, a sudden and widespread power outage, affected millions of people across Spain, Portugal, and Southern France. Transportation, communication, airports, and essential services were all impacted. This incident underscored that while the energy transition is advancing, grid infrastructure is under increasing strain, and investment in resilience, cross-border planning, and system digitalization remains a critical priority.

Against this backdrop, partnerships between industry, government, and technology providers are becoming essential. Investments in smart grids, energy storage, hydrogen, AI, and automation will depend heavily on coordinated policy frameworks, regulatory clarity, and public-private collaboration. These partnerships will ultimately determine Europe's ability to scale clean technologies, strengthen industrial resilience, and ensure supply-chain security in an increasingly competitive global landscape.

Survey Insights

The survey findings show a mixed picture of progress. Consistent with the global average, 6% of European companies reported no autonomous deployment, though this figure is heavily influenced by Sweden where nearly one quarter of respondents had not yet adopted autonomous technologies. Companies in Germany, France, and the UK all reported having begun deployment.

Among adopters, progress is strong: 59% of European firms described adoption as "rapid and accelerating" (vs. 45% globally), led by France at 76%. Ambition is lower than elsewhere, with 38% of European executives targeting full autonomy within five years (vs. 47% globally), ranging from 88% in France to no ambitions for full autonomy in Sweden — however this may be influenced by differing energy supply mixes across the countries.

European executives identified AI and machine learning (41%), open, software-defined automation (38%), and cybersecurity networks (37%) as the top enabling technologies, mirroring global trends. Their main drivers were productivity gains (30%), competitive advantage (30%), and cost reduction (29%), all slightly lower than global averages.

Cybersecurity was the leading barrier in Europe (31% vs. 26% globally), though challenges varied by country: Germany highlighted regulatory uncertainty (36%) while France pointed to the complexity of legacy infrastructure (36%); the UK showed unusually low concern about skills shortages in the external job market (8%); and Sweden reported the highest cybersecurity concern (40%) and strong skills issues in both the internal workforce (36%) and external job market (32%).

If autonomous technologies are not adopted, European companies fear rising operating costs (52%) and worsening skills shortages (49%), though both concerns are slightly lower than global averages. National patterns again diverged: 68% of German firms worried about cost increases, 68% of Swedish firms highlighted worsening talent shortages, 52% of French executives were equally concerned about increased carbon emissions and rising operating costs, and only 32% of UK respondents expressed concern about reduced competitiveness, well below the global figure of 48%.

Implications

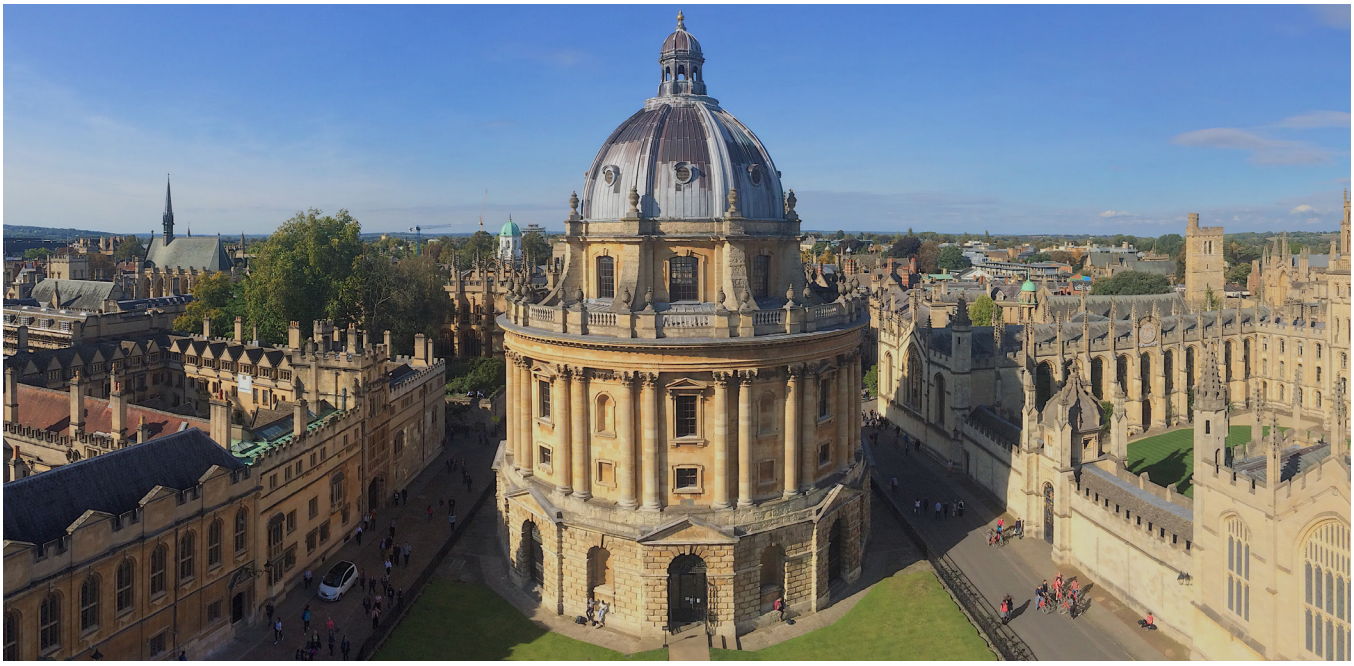
Europe's innovation ecosystem, with its rich history of academic research, is neither lacking enthusiasm nor technology, but requires collaboration, policy support, and a concerted call to action.

The findings show that while Europe's energy sector is adopting autonomous operations, progress is slower than in other regions, with lower corporate ambition for future investment compared to Asia and North America.

There is, however, an opportunity wherein Europe's productivity challenges, skills shortages, and aging workforce can be tackled. The sector's ability to invest may be constrained by high upfront technology costs, regulatory uncertainty, legacy infrastructure, and a traditionally conservative decision-making culture, but addressing these barriers requires stronger partnerships between industry and government to reduce regulatory uncertainty and close skills gaps.

Case Study

European Energy built a clean fuel ecosystem — combining an e-methanol plant, a green hydrogen facility, and a solar park — on a unified EcoStruxure and AVEVA platform. Close collaboration with system integrator Soft & Teknik A/S streamlined decisions and execution. The result: safer, more reliable, remotely managed operations and 2,079 GWh of renewable power in 2024, enough for over half a million homes.



Asia

Regional Landscape

Energy demand across Asia — particularly in China and India — is accelerating rapidly, driving substantial investment in new energy production and distribution infrastructure. Over the past five years, both countries have recorded some of the largest increases in global power generation capacity, with China ranking first and India third, according to IEA data. Japan, while experiencing slower demand growth, continues to modernize its energy system through efficiency improvements and advanced digital technologies. This creates a region marked by diverse energy dynamics, from fast-growing markets expanding capacity at scale to mature systems focusing on modernization and optimization.

The energy sector across the region is equally varied in its adoption of autonomy. China is progressing quickly, deploying automation across renewable generation, grid operations, and industrial energy use. India is expanding deployment from a lower base, driven by the need to manage rapid grid expansion and improve operational reliability. Japan, meanwhile, remains an advanced adopter in precision manufacturing, robotics, and digitally enabled infrastructure, creating a strong foundation for more sophisticated autonomous energy applications. This mix of maturity levels is producing a landscape where frontier innovation coexists with emerging deployment.

Technologically, the region is exceptionally strong. China and Japan are globally recognized hubs for industrial research and innovation, supported by extensive digital technology ecosystems and leading capabilities in AI, automation, and advanced robotics. India is also strengthening its digital and AI capabilities, supported by a rapidly expanding tech ecosystem and increasing government focus on digital infrastructure.



Policy and Partnership Environment

Case Study

Baosteel, one of China's largest modern steel producers, launched a "Made in China 2025" pilot to modernize its labor-intensive, safety critical crane operations. Partnering with Schneider Electric, the company deployed an EcoStruxure Plant solution with unmanned crane control, optimized logistics algorithms, and real-time monitoring. The initiative delivered 98% autonomous operation, a 15–30% output increase, stronger safety, and a more data driven supply chain.

Energy policy across Asia is being reshaped by divergent economic growth trajectories. India and China are expected to deliver some of the strongest short-to-medium term growth among major economies, outpacing the G20 average. This positions both countries for continued expansion in energy demand and investment in modern, resilient, and increasingly low carbon infrastructure.

China is accelerating its clean energy agenda at scale. Policy direction remains firmly focused on expanding renewable generation, storage, and grid capacity. In the first half of 2025, wind and solar output rose 27% year, enough to reduce fossil fuel generation by 2%. These developments are aligned with national initiatives that prioritize digitalization, grid modernization, and deeper integration of AI-enabled and autonomous systems.

Japan is sharpening its long-term commitment to energy transition. The government's 7th Strategic Energy Plan, approved in February 2025, targets renewables accounting for up to 50% of power generation by 2040, more than double the current share. This direction builds on Japan's established strengths in advanced manufacturing, robotics, and digital infrastructure, potentially supporting the adoption of more sophisticated autonomous technologies across energy operations.

India's fast-growing economy continues to drive significant increases in energy demand. Clean power remains the focal point of new investment, with an estimated 83% of 2024 power sector capital going into renewable technologies. While some investment in fossil fuel capacity persists to meet reliability needs, policy momentum is shifting toward modernizing the grid, improving system efficiency, and adopting digital and autonomous solutions to manage scale and reduce losses.

Survey Insights

The pace of advancing autonomy in Asia is strong, with 77% reporting progress as either “complete” or “rapid and accelerating,” slightly above the 74% global average. Adoption, however, varies sharply by market: India (91%) and China (89%) show significantly faster progress than Japan (51%).

Ambitions are similarly split. While 64% of Asian executives aim for “full autonomy” within 5 years, the figures range from 73% in India, 76% in China, and 42% in Japan.

AI and machine learning are seen as the most important enabling technologies across Asia (55% vs. 49% globally), with particularly strong emphasis in Japan (73%). Leading drivers for autonomous technology adoption include reducing costs and boosting profits (39% vs. 35% globally, rising to 55% in Japan) and gaining competitive advantage (38%).

Barriers to adoption also differ significantly across the region. In India, high up front investment costs were the dominant concern (45% vs. 34% globally), while in China the main issue was the lack of skills in the existing workforce to run the technologies (38% vs. 21% globally). In Japan, internal resistance to change was the most frequently cited impediment (42%).

Despite these variations, Asian executives broadly agree on the risks of slow adoption: 65% expect significant increases in operating costs, and 55% cited rising carbon emissions as a threat — though this concern was highest in India (64%) — which may be a reflection of the government’s clean energy push. In China, concerns about lost competitiveness (62%) were as prominent as worries about operating costs (62%).

Asia: Key Stats

77% report autonomy as “complete” or “rapid and accelerating”

Adoption varies sharply across the region:

- **India** - 91%
- **China** - 89%
- **Japan** - 51%

64% aim for full autonomy within 5 years
(73% in India, 76% in China, 42% in Japan)

#1 Barriers to adoption:

- **India:** High upfront costs 45%
- **China:** Skills shortages 38%
- **Japan:** Internal resistance to change 42%

AI & ML tops the list of enabling tech across Asia (55%), *with only India placing “cloud /edge computing” higher (64%).*

Implications

Evidence from the survey indicates a two-tier approach, with progress and ambition for autonomous technology at a high level in China and India. Around three quarters of companies in those countries desire full autonomy in their operations over the next 5 years, indicating that autonomy is already a near universal priority in those countries.

The survey indicates that Japan currently shows lower ambition and slower momentum toward autonomous technologies. However, the country's energy policy is now shifting significantly, with more aggressive investment plans for clean energy and a renewed commitment to expanding nuclear power. This policy reset is expected to create a far more supportive environment for autonomous technology adoption across Japan's energy sector over the next 5–10 years.

The region's convergence of rising energy demand, technological capability, and policy support is accelerating the development of pioneering autonomous solutions. China alone accounts for an estimated three quarters of global clean energy technology patents and continues to expand its innovation capacity through national strategies that emphasize digitalization, modernization, and the integration of AI-driven autonomous systems across power, industrial, and grid operations. Combined with Japan's leadership in robotics and India's rapidly growing digital economy, the region may emerge as a major force in the global evolution of autonomous energy technologies.



GCC Countries

Regional Landscape

The strategic location of the GCC countries between Asia, Europe, and Africa — combined with their substantial oil and gas reserves and expanding investments in renewables — has established the region as a global center for energy production, processing, and export. National oil companies (NOCs) and utilities are now modernizing large, complex energy systems that span upstream oil and gas, LNG value chains, power and water production, grid transmission, and industrial energy hubs. As regional economies diversify, countries such as the UAE, Saudi Arabia, and Qatar are increasingly pairing traditional hydrocarbon strengths with major investments in clean energy, hydrogen, and grid digitalization.

Within this evolving landscape, autonomous technologies are playing a growing role across operational domains. Advanced process controls, robotics, predictive maintenance, AI, machine learning, digital twins, and autonomous plant mobility are being integrated into refinery complexes, petrochemical clusters, and gas-processing facilities. Early deployment is visible among leading operators in refining and petrochemicals, where high-volume, asset-intensive operations benefit significantly from automation and real-time optimization. These technologies are enabling improvements in throughput, operational efficiency, asset reliability, and margin performance, though progress varies by country.

AI in particular is becoming a key driver of the region's energy-sector transformation. Energy operators are increasingly using AI for subsurface optimization, emissions monitoring, and grid stability management. Investment in the region is accelerating in parallel: PwC projects substantial economic gains from AI across GCC countries' economies by 2030, with the UAE, Saudi Arabia, and Qatar among the largest contributors.



Policy and Partnership Environment

Government leadership is a defining factor behind the region's rapid shift toward autonomous energy operations. The UAE, Saudi Arabia, and Qatar have articulated national strategies that place digital transformation, advanced energy infrastructure, and industrial autonomy at the center of long-term economic plans, supported by expanding public-private partnership initiatives.

Digital twins are increasingly being used across brownfield upgrades, greenfield megaprojects, and integrated asset planning. Regional NOCs, utilities, and independent power producers are adopting these technologies to test operating scenarios, improve reliability, and reduce risk across large energy systems. This policy alignment is setting the stage for GCC countries to become a global leader in autonomous energy operations.

GCC Countries: Key Stats

78% report high levels of autonomy in current operations with 39% at Select Autonomy (Level 4) and 39% at Full Autonomy (Level 5)

Just under half (44%) said they desire to be fully autonomous in five years.

94% rank autonomy as a top strategic priority (vs. 85% globally)

Top 3 Enabling Technologies:

- Advanced process control & optimization - 33%
- Robotics, drones & field automation - 33%
- Digital twins - 32%

Top 3 Barriers:

- Legacy infrastructure (35%)
- Lack of forward thinking (33%)
- High upfront costs (32%)

Survey Insights

The research results reveal a highly mixed landscape for autonomous energy technology adoption GCC countries. Overall, 68% of energy executives report that they have high levels of autonomous technology already embedded in operations, yet the region also shows a wide spread of maturity. While 9% of companies have yet to deploy any autonomy — double the 4% global average and especially high in Qatar (15%) — the region also includes some of the world's leading adopters: 39% report full deployment, well above the 31% global benchmark, with the UAE highest at 47%.

The pace of adoption appears to be leveling as many operators consolidate gains: 50% of GCC executives surveyed say their investment pace is now focused on maintaining full autonomy — far above the 29% global average. Only 28% report rapid or accelerating investment, versus 45% globally.

Future ambition remains strong, especially in the UAE, where 58% of leaders aim to reach full autonomy within five years, compared to 38% in Saudi Arabia and 30% in Qatar. Overall, 94% of the GCC executives view autonomy as a top strategic priority, ahead of the 85% global average.

The top enabling technologies are advanced process control (33%), robotics (33%), and digital twins (32%) — a different mix from global peers prioritizing AI/ML and cybersecurity. Key adoption drivers include cost reduction (32%), competitive advantage (31%), and decarbonization (31%), though emphasis varies by country.

The biggest regional barrier remains legacy infrastructure complexity (35%), especially acute in the UAE (48%) and Qatar (40%), while organizations also cite lack of forward planning and high upfront costs. Failure to advance autonomy is seen as a threat to competitiveness and talent availability, with concerns diverging by market — competitiveness in Qatar, carbon emissions in the UAE, and safety in Saudi Arabia.

Case Study

Schneider Electric and ADNOC Refining completed a proof-of-concept that showcased AI-driven autonomous operations at the Unit 14 Hydrotreater. Using EcoStruxure™ and NVIDIA's Raptor DRL engine, the system optimized hydrogen use, energy efficiency, and condition monitoring. The project delivered projected gains including reduced energy consumption, lower CO_2 emissions, and significant cost savings, validating a secure, semi-autonomous to fully autonomous operations model over seven months.

Implications

Autonomy represents a strategic response to some of the Gulf region's most serious operational challenges — remote assets, hazardous environments, and constrained labor pools. Each have the potential to be helped by technological solutions that reduce reliance on the presence of humans.

For example, autonomous robots are now routinely deployed to monitor pipelines replacing manual inspection, eliminating the need for helicopter supported human interventions. They can be deployed in production environments with very high temperatures and/or strong electromagnetic fields, allowing inspections to occur without shutdowns, improving facility uptime, and reducing operational risk.

As the region advances its smart-energy transition, the findings indicate a sector undergoing significant change, with increasing adoption of more intelligent and autonomous systems. Sustaining this momentum will be important to support continued progress.

Conclusion

This research confirms that while not all energy companies have fully committed to autonomous technology, today the global average already sits between Advanced Regulatory (Level 3) and Select Autonomy (Level 4). This is more advanced than expected (based on insights from a review of recent industry commentary).

This position is encouraging. Stakeholders consistently noted that operations need to reach at least Level 3 to take advantage of existing technology and achieve strong performance across production efficiency, sustainability, and other key metrics.

Motivations for investment differ by company and region, but value creation remains the primary driver. Growing recognition of the potential for autonomous technology to support broader objectives, including workforce safety and regulatory compliance, is expected to reinforce the pace of adoption.

Comparing today's autonomy levels with expectations for the next five years reveals where deployment is set to accelerate most. North America and Asia show the strongest intentions to expand investment. If these plans materialize, the United States, Canada, and Japan are positioned for the most significant gains.

In the United States, national efforts to strengthen energy independence and stimulate domestic production are expected to support greater investment in autonomy. By contrast, GCC countries may face a slowdown. Legacy infrastructure, especially in the UAE and Qatar, along with conservative organizational cultures, high upfront costs, and competing capital priorities, pose barriers. If these challenges persist, the region risks losing its early leadership in autonomous deployment.

> "In today's volatile landscape, especially across heavy industries, resilience has become the currency of competitiveness.
>
> Our research shows that industrial AI is the most powerful lever we have to drive productivity, safety, and sustainability simultaneously. And while it is encouraging to see autonomy accelerating in the energy sector, progress remains uneven and hesitation carries a cost.
>
> The opportunity is huge: With bold ambition, smart investment, and strong partnerships, autonomous operations can deliver the performance and energy security our future depends on."
>
> **Devan Pillay,**
> Heavy Industries President,
> Schneider Electric

Europe faces even greater pressure. Already the slowest adopter, it may fall further behind due to slower economic growth, higher production costs, supply volatility linked to geopolitical events, and a more stringent regulatory environment. A global survey published by Roland Berger in May 2025 also predicted Europe to be the lowest growth region for automation growth in the petrochemicals sector over the period 2024-2030.

Smaller energy companies, in particular, face barriers especially when high upfront investment costs limit autonomy adoption. In markets with a strong presence of smaller operators, there may be a case for targeted incentives or government support to unlock capital for technology that is increasingly important for sustainability progress.

Despite these challenges, the overall trajectory is optimistic. Executives across regions recognize the strategic value of autonomy, and many markets are preparing for significant expansion. As companies translate ambition into action, the industry is well positioned to accelerate performance, strengthen resilience, and make meaningful progress toward long-term sustainability goals.



Schneider Electric and AVEVA Offering

The integration of Schneider Electric's energy management and automation technology with AVEVA's industrial intelligence and software provides operators with an integrated stack that helps systems predict, adapt, and optimize automatically, while maintaining clear human governance.

This holistic energy management technology forms the backbone of industrial transformation. At the core is EcoStruxure™ Power & Process, Schneider Electric's integrated approach that unifies electrification, automation, and digitalization. By combining hardware and software — including platforms such as AVEVA Unified Operations Center, AVEVA Process Simulation and ETAP Electrical Simulation — it gives operators a single, real-time operating environment across assets, plants, and entire networks.

Together, this combined technology enables AI-powered digital twins that allow autonomous systems to "see," understand and simulate plant behavior, optimize operations before issues occur, and drive predictive, self-governing workflows.

EcoStruxure Automation Expert provides energy companies more flexible, efficient, and future-ready operations through adaptive, open, software-defined automation.



Case Studies



North America

Shell's Scotford refinery in Alberta, Canada — long known for converting oil-sands bitumen into synthetic crude — underwent a significant shift in how it approached automation. The company had been facing rising project and support costs, a shortage of specialized expertise, and the need to develop smarter, more repeatable systems for its growing carbon-capture initiatives.

To address these challenges, Shell partnered with Schneider Electric and AVEVA to introduce EcoStruxure Automation Expert (EAE) into its existing EcoStruxure Foxboro DCS and Triconex environment. The goal was to modernize operations with an open, software-defined platform that could overcome the constraints of traditional control systems.

Three EAE installations operated alongside the refinery's legacy infrastructure, creating a hybrid environment that simplified engineering work, reduced vendor lock-in, and improved system interoperability. By automating more procedures and reducing manual operator tasks, the refinery established a foundation for Shell's "design once, build many" strategy — an early move toward more autonomous, adaptable energy facilities.

LINK: Scotford | Shell Canada

Europe

Schneider Electric's technology blueprint is paving the way for the future of clean fuel at European Energy's first-of-its-kind Kassø Power-to-X facility: the world's first commercially viable e-methanol plant. Powered by renewable electricity from the adjacent 304 MW Kassø Solar Park, the largest in the Nordics, the facility captures biogenic CO_2 from nearby sources to produce up to 42,000 tonnes of e-methanol annually.

To hit aggressive timelines and keep the tech stack flexible across multiple electrolyzer types, they needed one unified ecosystem.They tapped EcoStruxure for Energies & Chemicals and EcoStruxure for Renewables, pairing them with Schneider Electric automation, power systems, AVEVA's industrial software suite and deep engineering expertise. Working side-by-side with Soft & Teknik A/S — both a Schneider Alliance Partner system integrator and a European Energy subsidiary — the team locked in tight coordination from hardware choice to project delivery.

The result: safer, more reliable operations, hardened remote monitoring through AVEVA Operations Control, and project timelines that held firm. The payoff is already real. In 2024, European Energy generated 2,079 GWh of renewable power — enough clean electricity to keep more than half a million European homes running.

LINK: Schneider Electric's Technology Blueprint Paves Way for e-Methanol Fuel Expansion | Schneider Electric Global



GCC Countries

Schneider Electric and ADNOC Refining launched a pioneering proof of concept (PoC) that demonstrated how artificial intelligence could reshape refinery operations. The project deployed an AI-driven autonomous operations solution at the kerosene/light gas oil hydrotreater (Unit-14) in ADNOC's hydro-skimmer plant. Built on Schneider Electric's EcoStruxure platform and NVIDIA's Raptor DRL engine, the system continuously monitored, controlled, and optimized processes with minimal human intervention.

The PoC focused on high-impact use cases — hydrogen optimization, energy efficiency, condition monitoring, and alarm analytics — and delivered projected benefits including a 3% reduction in energy use, 422 TPA in CO_2 savings, and more than $130,000 in annual hydrogen-related cost reductions. A cybersecure architecture and phased rollout ensured safe integration with ADNOC's existing control systems.

Over seven months, the initiative validated a semi-autonomous to fully autonomous operations model, supported by an AI-driven operator dashboard, marking a significant step toward smarter, more resilient energy operations.

Asia

As China's largest modern steel producer, Baosteel launched a pilot project aligned with the national "Made in China 2025" initiative — an effort championed by the Ministry of Industry and Information Technology to drive advanced manufacturing and digital transformation. Baosteel faced rising labor costs, tighter safety requirements, and the need to modernize crane operations that had long depended on manual processes. These limitations constrained productivity and made it difficult to meet evolving efficiency and safety expectations.

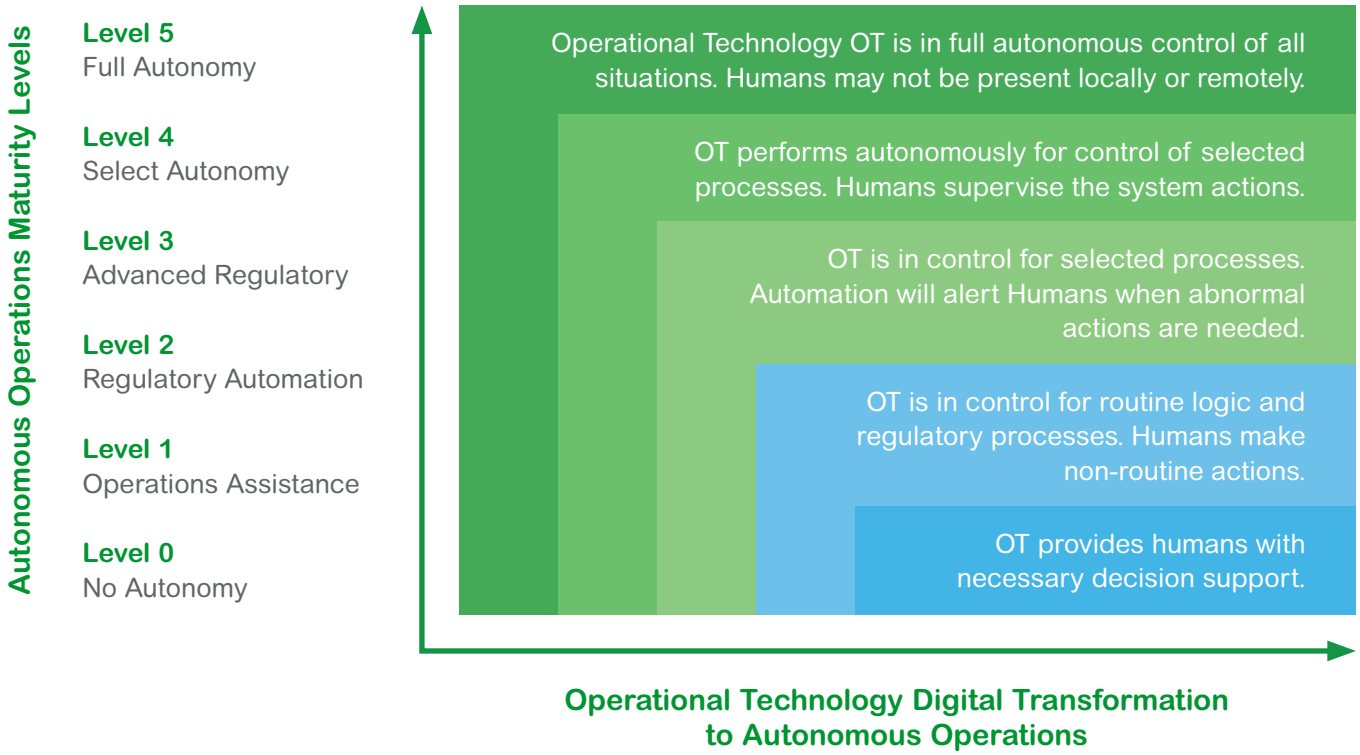
To address this, Baosteel partnered with Schneider Electric to deploy an EcoStruxure Plant solution, in the 1580 hot rolling yard line at the Baoshan base (Shanghai), fully digitalizing and automating its material-handling workflow. The project introduced integrated hardware and software for unmanned crane control, an optimized hoisting and logistics algorithm, and real-time monitoring across critical equipment. Tailored engineering support ensured a smooth transition.

The results were significant: crane operations reached 98% autonomy, productivity increased by 15–30%, workplace safety improved, and the plant gained a more efficient, data-driven supply-chain operation — supporting Baosteel's role as a national manufacturing innovator.

Methodology

This report focuses on findings from interviews undertaken with 400 senior decision makers in the energy industry located in twelve countries, with survey fieldwork taking place in September and October 2025. The thrust of the survey involved questions on the current situation and future ambitions for deployment of autonomous technology within energy companies.

The framework used in the survey is the Autonomous Operations Maturity Model (AOMM) developed by ARC Advisory Group. This model proposes a five-step hierarchy for adoption of autonomous technology, with Level 5 representing full autonomy.



The development of the Global Autonomous Maturity Report involved the following three stages of work:

1. Desk-based review of documentary evidence, investigating the current state of play of the use of autonomous technology in the global energy sector. The literature review placed emphasis on gathering insights from research material published by companies operating in the sector, as well as various independent sources, leading international management consultancies, and specialist energy sector publications and commentators.
2. Bespoke business survey conducted with senior decision-makers in the global energy industry. Censuswide undertook the research fieldwork in September and October 2025, targeting 400 senior energy sector executives in Asia, Europe, GCC countries, and North America.
3. Viewpoints gained from the survey were obtained through a series of semi-structured interviews with industry stakeholders.

