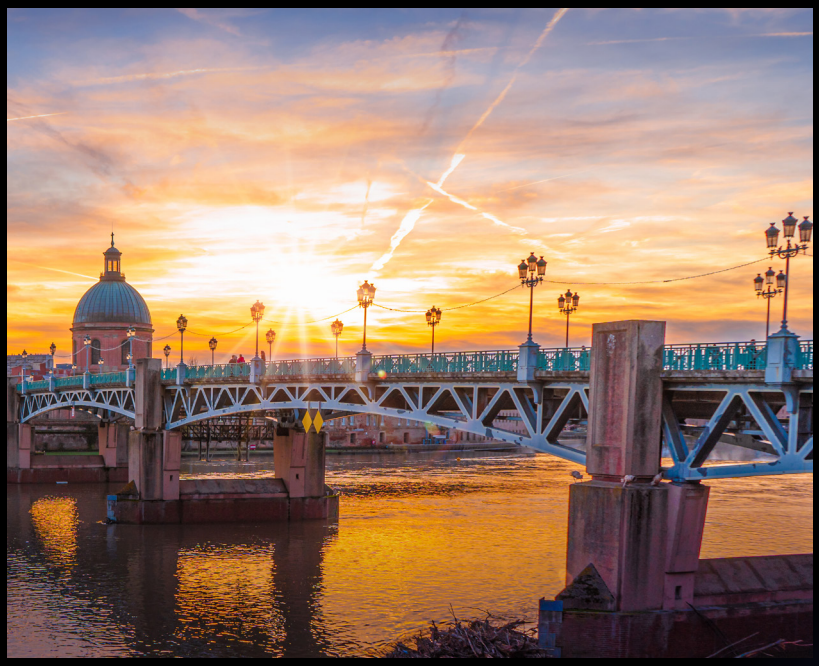
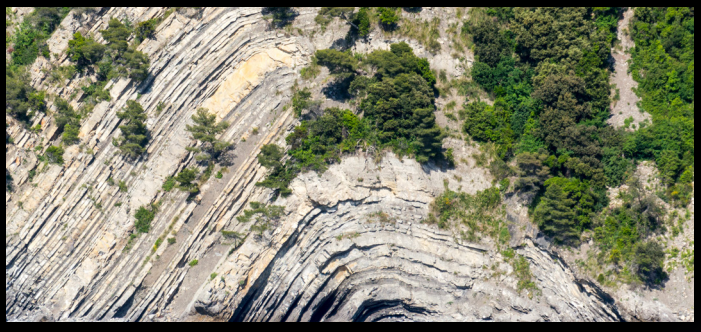
Executive Brief

The E&P Industry of the Future





S&P Global
Commodity Insights

2025 EAGE ANNUAL
86TH CONFERENCE & EXHIBITION
TOULOUSE | FRANCE

Foreword

The global energy landscape is undergoing profound transformation, shaped by shifting market dynamics, technological advancements, and the accelerating need for sustainable energy solutions. The Exploration & Production (E&P) sector stands at the forefront of this evolution, navigating the complex interplay between operational efficiency, resource optimization, and the broader energy transition.

Produced by S&P Global Commodity Insights in collaboration with the European Association of Geoscientists and Engineers (EAGE), this brief is part of a knowledge partnership aimed at bringing together insights from the geoscience community to explore both the immediate opportunities in 2025 and the long-term transformations that will define the industry over the next five and even ten years. With an emphasis on innovation, digitalization, and the evolving role of geoscience in oil and gas, energy security, and sustainability, we examine the key trends, challenges, and strategic imperatives that will shape the future of energy.

This brief is not merely an exploration of industry trends but a roadmap for professionals navigating an era of uncertainty and opportunity. Through this collaboration with EAGE, we aim to foster dialogue, encourage innovation, and provide a forward-looking perspective on how geoscience will continue to drive the evolution of E&P in a changing world.

Rachael Moreland

VP Global Energy Software & Innovation Lead
S&P Global Commodity Insights

An Industry in Transition or Transformation?

The upstream exploration and production (E&P) sector have been through a challenging time in the last decade. A downturn, the onset of the energy transition and the demand destruction that was COVID. It is a resilient industry though and never shies away from a challenge but knowing the core of the challenge or the size of the opportunity is essential and that seems to be what we are all trying to work out.

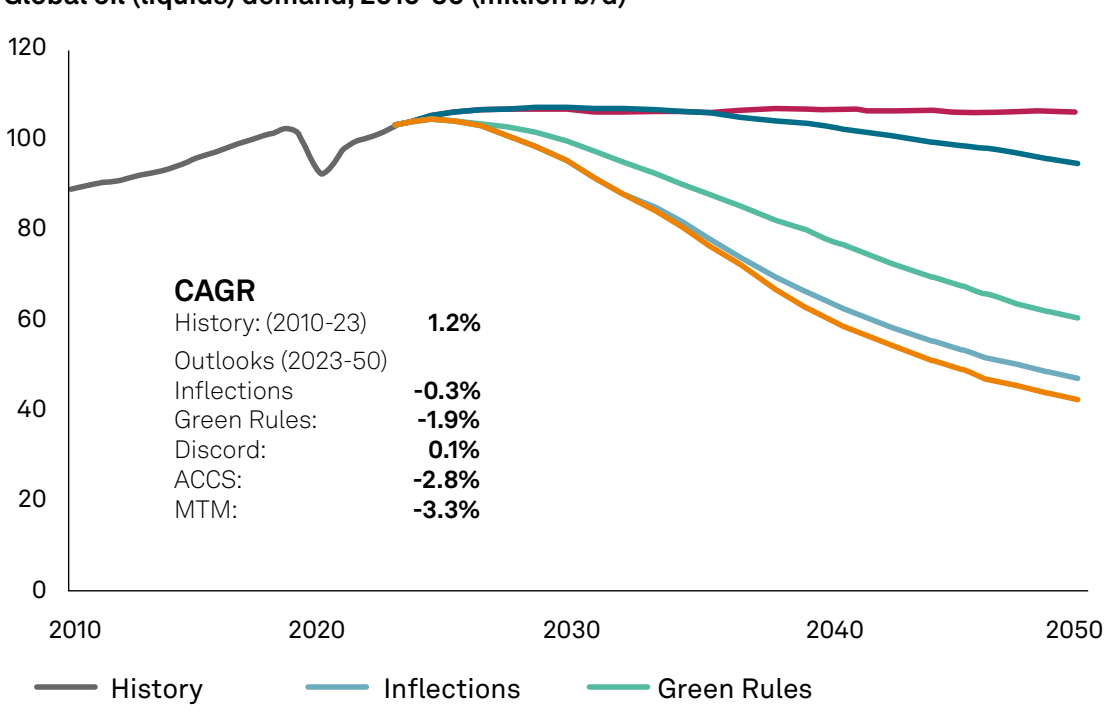
The most common question is "where will we (the E&P industry) be 10 years from now?" Some interpret this as an existential question, but others see the real question is more "what type of industry will we be and how will we continue to deliver energy to a decarbonizing planet?" This opens a series of conversations:

- {SURVIVAL OR REVIVAL?} How long will we be delivering oil and gas, and what do we need to do to be resilient and transformative at the same time?
- What capabilities will we need in our workforce by 2035? Can we attract the right people and hold onto them? Where will our stars of tomorrow come from?
- What technology can help upstream achieve and can we realize returns on our technology investments at a scale that our companies want us to?

Figure 1 below shows a plot of the S&P Global Energy Scenarios liquids demand up to 2050. There are five different scenarios but let us focus on "Inflections" which is the base case. Far from a steep decline it shows peak demand around 2029 followed by a very gentle decline. If this scenario unfolds as modelled, some E&P companies could face a dilemma in the 2040s, as their current portfolios may lead to lost revenue opportunities. The world faces a potential reduction of diversity in supply during the same period, which many countries are not comfortable with due to energy security considerations. The arguments for continued investment in oil and gas exploration, including improving returns by increasing risks, are being discussed today. At the same time, the upstream industry knows it cannot expect a super cycle bounce-back. It must earn the right to operate, and this includes decarbonization while trying to reduce cycle time, increase efficiencies, and decrease costs.

The solutions lie in several areas and will be discussed at the EAGE Annual conference in Toulouse in June 2025. This will include how Geoscience will evolve as a discipline in the next decade. What technology will achieve both in taking over processes and supplementing expertise on core activities.

Figure 1. Plot Source, S&P Global Commodity Insights Scenarios © 2024



Global Geoscience Outlook for 2025: Setting the Stage for Years to Come

The Energy industry is undergoing a fundamental shift in how we work, manage data, and make operational decisions. As we enter 2025 the uncertainty faced in the Geopolitical landscape of energy could drive change across the industry that shapes the future for years to come. This will be a year where we have the potential to see the introduction of sanctions and tariff changes that have the potential to impact commodities production, supply, and prices. The global conflict landscape with key impact zones of Ukraine and the Middle East also continues to threaten energy infrastructure and supply routes. One certainty that remains consistent is the growing global demand for Energy.

The complexity of Energy lies in how to meet increasing demand while developing infrastructure that diversifies resources and meets policy-driven climate goals at regional levels. Key themes for 2025 will include emerging technologies, sustainability and decarbonization, evolving workforce skillsets, and global challenges in transforming the geopolitical landscape.

Opportunities will center around new and emerging job roles in Carbon Capture and Storage, Geothermal, and Digital Transformation within the E&P sector, driving greater diversification in geology careers across the industry and adjacent markets. We also see companies shifting their exploration focus to high potential regions such as Africa, South America, and Southeast Asia.

Challenges throughout the industry persist, including navigating reduced exploration budgets within some organizations, industry consolidation due to a series of energized M&A scenarios, regulatory hurdles, and a rapidly evolving energy landscape.

As the E&P industry navigates a year marked by both opportunity and uncertainty, 2025 stands out as a critical inflection point for global geoscience. Continued innovation in seismic and subsurface technologies is enhancing the precision and efficiency of resource discovery, unlocking new value in both mature and frontier basins. The industry's focus is shifting toward maximizing asset performance through advanced reservoir optimization techniques, increasingly enabled by data-driven decision-making tools that integrate machine learning, real-time analytics, and predictive modeling.

This digital evolution is reshaping the skillsets required across geoscience disciplines, prompting a surge in career development initiatives aimed at upskilling professionals for a new era shaped by AI and automation. Concurrently, the global policy landscape is evolving, with the outcomes of several pivotal elections—including the return of Donald Trump to the U.S. presidency—potentially driving significant shifts in regulatory frameworks, energy policy, and investment climates. These developments will influence exploration strategies, capital flows, and climate commitments, requiring geoscientists to remain agile, globally informed, and technologically adept as the industry redefines its role in a fast-changing energy world.

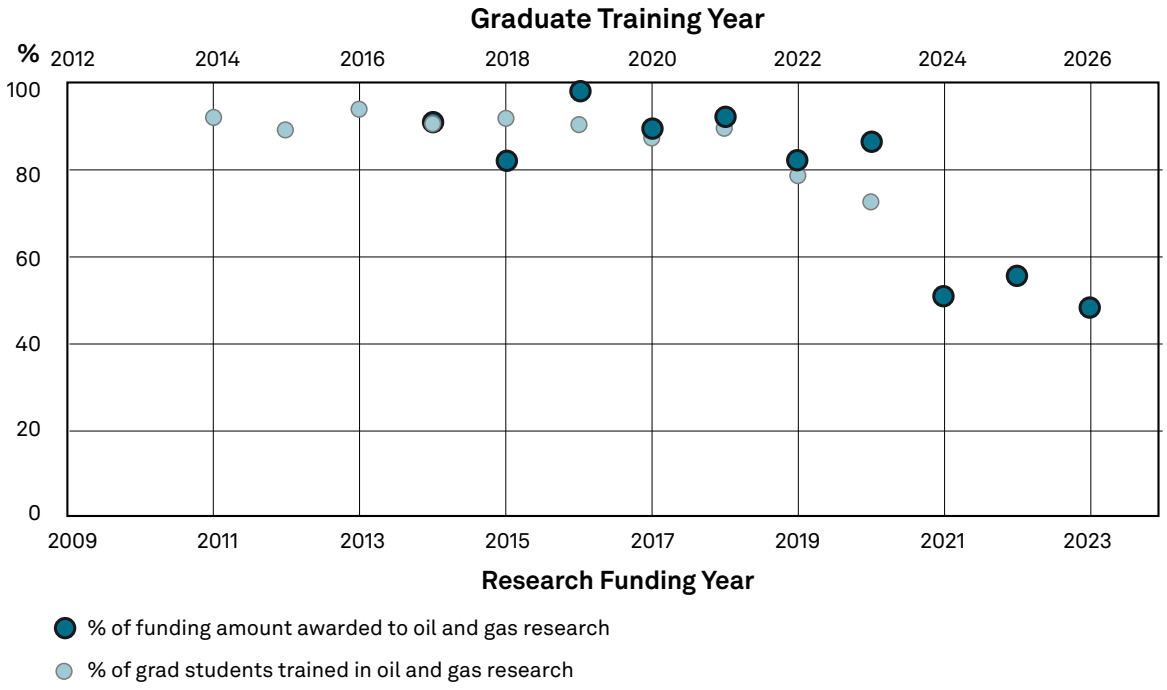
E&P Workforce of the Future: The Dilemma

Given that demand for hydrocarbons will continue for many years, there will inevitably be a demand for people with the skills to find and produce it. This is not just about squeezing the last drops out of existing fields, but also identifying new resources which will be more 'advantaged;' that is lower cost, lower emissions, higher margin, and faster pay-back. These will be the resources of the future and ultimately will allow cessation of production from high cost, high emission older fields.

But who will do this work? Industry has been talking about the 'Great Crew Change' for 20 plus years, as the Boomer Generation edge their way to retirement and broadly speaking, have not been replaced. At the same time, the number of E&P companies has reduced markedly, meaning there is less activity in the industry and fewer job opportunities within it. Not surprisingly, this has led to a decline in demand for industry training and the universities have responded by closing or curtailing their teaching provision. This has cut the supply of youngsters, who were already swimming against the tide of increasing societal pressure to not work in a 'dirty' industry.

In North America and Europe, several institutions have reported declining enrollments in conventional petroleum engineering programs (see Figure 2 below). In response to declining interest, some universities are revamping their curricula to encompass a broader range of energy topics, including renewable energy and sustainability. This approach aims to align educational offerings with the evolving energy landscape and attract students interested in diverse energy sources. Contrastingly, some institutions, particularly in regions with robust oil and gas industries, have maintained or even increased enrollment in petroleum engineering programs.

Figure 2. Plot Source, JPT November 1, 2024, article titled Petroleum Engineering Research Shifts Focus From Oil and Gas to New Horizons.



Universities Decreasing or Eliminating E&P Programs

- **University of Calgary (Canada)** – Phasing out parts of petroleum engineering.
- **University of Oklahoma (USA)** – Merging petroleum engineering with energy transition research.
- **Heriot-Watt University (UK)** – Transitioning focus to decarbonization and geothermal energy.
- **Aarhus University (Denmark)** – Phasing out petroleum-related geoscience programs.
- **TU Delft (Netherlands)** – Shifted petroleum geoscience focus to broader subsurface energy applications.

Universities Expanding or Retaining E&P Programs

- **Texas A&M University (USA)** – Still has a strong petroleum engineering focus but integrates energy transition topics.
- **Colorado School of Mines (USA)** – Expanding geothermal, CCS, and hydrogen courses alongside petroleum engineering.
- **China University of Petroleum (China)** – Maintaining petroleum programs due to domestic energy security priorities.
- **Ufa State Petroleum Technological University (Russia)** – Petroleum programs remain strong due to national energy strategy.

Against this gloomy scenario, what can the industry do? Retaining existing staff is an obvious first step; particularly those who are younger and will be around for longer. Secondly, ensuring they are up to speed with the newest technology. AI and manipulation of large datasets, to incorporate machine learning are likely to become key skills for all. Further, ensuring data feeds are in compatible formats, so that they can be imported/exported between applications will require a growing army of data technicians, so that the 'experts' can focus on their own chosen discipline. But above all, the industry needs to find a way to attract bright new staff, by showing them that there is a long-term and strategically vital career to be had in the world of E&P.

E&P Technology Innovation

Technological innovations have made a major impact on the E&P industry and the geoscience domain in recent years. These innovations primarily focus on enhancing efficiency and developing new capabilities, driven by a need for reliable, high-resolution understanding of the subsurface. This need is prompted by:

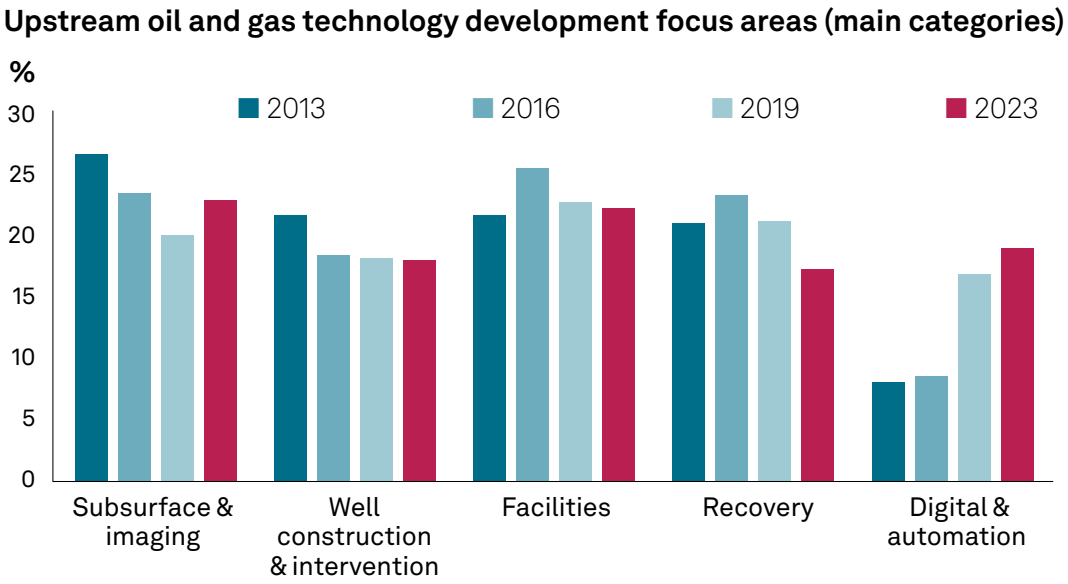
– A renewed interest in exploration as the industry continues to search for lower cost, lower carbon-intensive resources.

– Increasing the success rate of, often costly, EOR projects.

– The emergence of CCS as a potential business opportunity for the E&P sector.

In fact, S&P Global is observing, following a decade of decline, an uptick in subsurface-focused technology developments (e.g., seismic, static subsurface modelling).

Figure 3. Plot Source, S&P Global Commodity Insights Scenarios © 2025.



Source: S&P Global (Division)
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Technology has always been vital to the E&P sector for addressing evolving resource challenges, such as deeper and more complex reservoirs, and rising capital constraints. Technical innovations have been a crucial response to these challenges. Recent improvements and new technologies on the hardware side include:

– Seismic acquisition technologies (e.g., OBN, wireless MEMS-based geophones).

– Wellbore technologies (e.g., LWD sensors, downhole measuring tools, DAS technologies).

– Reservoir technologies (e.g., tracers, AICDs).

However, the innovations on the "software" side – the digital transformation – have been stunning and have manifested in a range of areas:

– Exploration and production workflows, making handovers between disciplines and integration of research results much more efficient.

– Retrieval and processing of vast quantities of data.

– Increased capabilities such as automatic horizon tracking and fault detection.

– Increased innovation cycles bringing new technologies faster to the work floor.

Looking ahead, the E&P industry is poised for transformative growth, driven by technological innovations in the geoscience domain. The integration of advanced hardware and digital solutions will continue to enhance efficiency and accuracy. As the industry increasingly focuses on lower-cost, lower-carbon resources, and explores new opportunities, the demand for high-resolution subsurface understanding will intensify. Embracing data-driven approaches and leveraging advanced analytics will be crucial for companies seeking to optimize geoscience workflows rates and unlock new capabilities. The ongoing digital transformation promises to accelerate the adoption of new technologies, paving the way for a more sustainable and innovative future in the E&P sector.

The Impact of AI and Technology on the E&P Industry of the Future

The E&P industry is undergoing a profound transformation, driven by advancements in artificial intelligence (AI), automation, and digitalization. As operators and service companies strive to enhance efficiency, optimize reservoir management, and reduce operational costs, AI is increasingly becoming a core enabler of technological evolution in this space.

Today's Landscape

Currently, AI is being leveraged in the E&P sector primarily for predictive analytics, seismic interpretation, reservoir modeling, and production optimization. Machine learning algorithms are improving geophysical imaging, enhancing drilling accuracy, and enabling faster, more informed decision-making. Cloud computing and high-performance computing (HPC) platforms have facilitated the deployment of AI-driven analytics, enabling real-time monitoring and predictive maintenance of assets.

Autonomous operations and robotics are also gaining traction, particularly in offshore environments where unmanned systems improve safety and reduce costs. Meanwhile, digital twins—virtual replicas of physical assets—are becoming widely used for scenario testing and predictive modeling, allowing for more efficient resource management.

The Next Five Years

Over the next five years, AI-driven geoscience models will improve subsurface imaging, reducing exploration risks and enhancing the identification of untapped resources. AI-augmented seismic processing will shorten cycle times for interpretation, increasing exploration efficiency. These advancements will allow for more accurate predictions and a more streamlined exploration process.

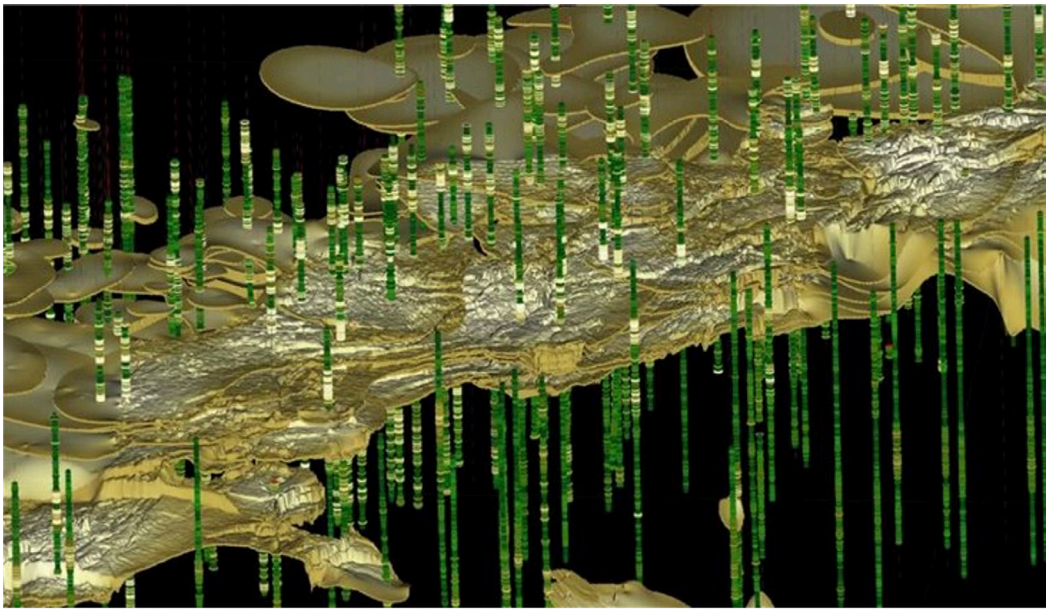

Image Source. Kingdom™ geoscience subsurface interpretation software, S&P Global Commodity Insights.

AI-powered automation will further optimize drilling parameters in real-time, reducing non-productive time (NPT) and enhancing wellbore stability. Fully autonomous rigs may become a reality, improving safety, and reducing human error. Some companies in North America are piloting autonomous operations today in drilling. This shift will lead to increased efficiency and a reduction in operational costs for drilling activities.

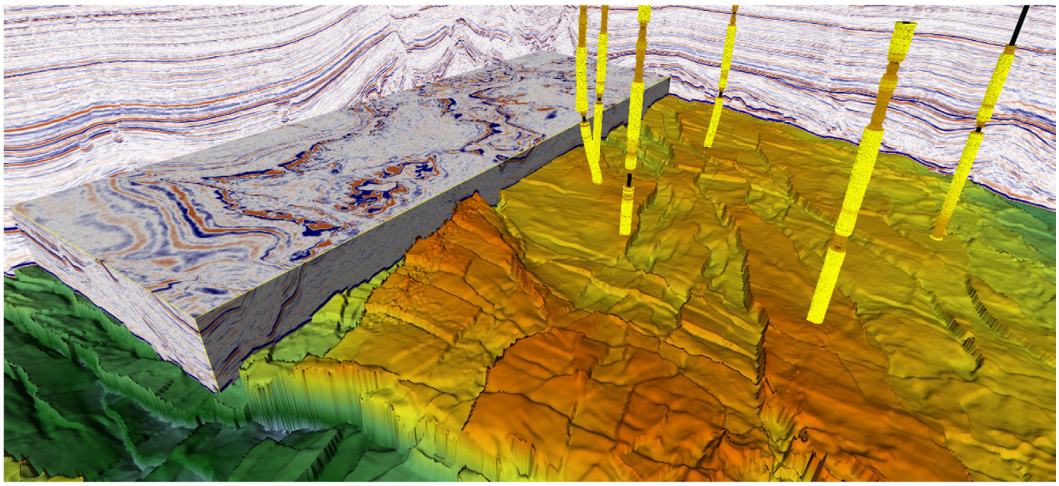

Image Source. Kingdom™ geoscience subsurface interpretation software, S&P Global Commodity Insights.

New technological enhancements will enable dynamic reservoir models that self-update based on real-time production data, improving forecasting accuracy and field development planning. These enhanced models will allow for better reservoir management and more precise production strategies, maximizing resource recovery.

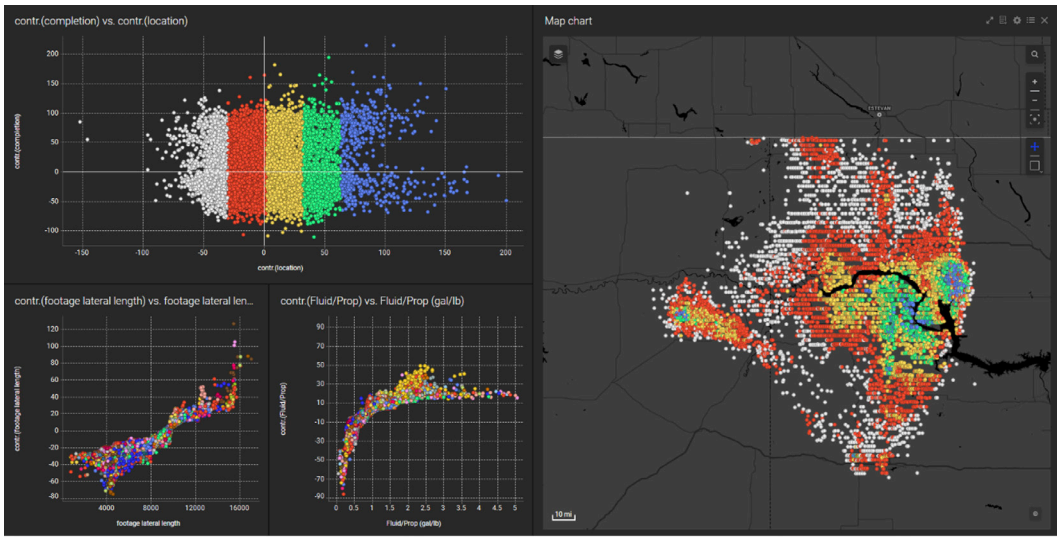

Image Source. Analytics Explorer, analytics and AI software, S&P Global Commodity Insights.

AI will also play a crucial role in emissions monitoring, energy efficiency optimization, and carbon capture utilization and storage (CCUS) initiatives. AI-driven models will help optimize injection strategies and enhance carbon sequestration efficiency, contributing to the industry's sustainability goals.

The integration of quantum computing with traditional High-Powered Compute (HPC) will enable unprecedented simulations of complex reservoirs, reducing uncertainty in exploration and enhancing reservoir simulation capabilities. These advancements will push the boundaries of computational modeling, leading to more precise and effective decision-making in exploration and production.

The reality

It is critical to note that Energy is not AI. AI and emerging technologies will continue to drive efficiency and innovation in the E&P industry, enabling data-driven decision-making, reducing operational costs, and improving sustainability efforts. As exploration technology evolves, the next five years will likely see a fundamental shift towards fully integrated digital ecosystems, where AI, automation, and new computing paradigms redefine traditional workflows and open new frontiers for exploration and production.

Throughout this shift in the E&P industry, human expertise remains essential as nuanced judgment, ethical considerations, strategic thinking, geopolitical navigation, and complex decision-making are required. While automation is transforming day-to-day operations, humans will play critical roles in overseeing, guiding, and enhancing these autonomous systems.

Energy Diversification for a Profitable Energy Transition

With the potential for oil and gas demand projected to grow through 2030, then facing a decline in following years, Energy companies are at a pivotal point in time to examine portfolio diversification. With Oil & Gas remaining at the forefront of many companies' portfolios, some of the larger Exploration & Production companies are diversifying their energy portfolio beyond traditional oil and gas as part of broader energy transition strategies. This shift is driven by factors such as climate change concerns, government regulations, investor pressure, and the need to secure long-term business sustainability.

CCUS/CCS

The outlook for carbon sequestration projects is increasingly optimistic globally, as governments, industries, and investors recognize carbon capture, utilization, and storage (CCUS) as technology for reducing greenhouse gas emissions.

From a sustainability perspective, E&P companies are investing heavily in CCUS technology to reduce emissions from industrial operations to power plants. There is also a rise in the development of carbon sequestration projects to capture CO_2 and store it underground.

The U.S. is a global leader in CCUS deployment due to strong policy frameworks like the 45Q tax credit, which incentivizes carbon capture projects with up to $85 per metric ton for geological storage. Many of the upcoming projects are tied to hard-to-abate industries such as cement, steel, and chemicals.

Significant growth is expected in the regional hubs of the Gulf Coast, Permian Basin, and Midwest due to favorable geology and proximity to industrial emissions sources. Notable projects include the following:

- ExxonMobil's Houston CCS Hub: Targeting emissions from local industries and potentially sequestering up to 100 million tons of CO_2 annually by 2040.
- Summit Carbon Solutions: A project in the Midwest United States developing one of the largest CO_2 pipelines to capture emissions from ethanol plants.

In Europe we see strong government backing with the European Union's Green Deal and funding mechanisms like the Innovation Fund are driving CCUS projects. The EU aims to store 50 million tons of CO_2 annually by 2030. Notable projects include:

North Sea Projects from countries like Norway, the UK, and the Netherlands, often backed by taxpayers but chasing bankability, are leveraging the North Sea's extensive storage potential. Key projects include:

- Northern Lights (Norway): A flagship project for CO_2 transport and storage, supported by the Norwegian government.
- Net Zero Teesside (UK): A major hub integrating CCUS with hydrogen production.
- Industrial Integration: Europe is focusing on decarbonizing industrial clusters in Rotterdam, Antwerp, and Hamburg.

Renewable Energy Investments

The global outlook for renewable energy investments remains robust, with North America, Europe, and Asia-Pacific leading the transition to a low-carbon energy system. In North America, the United States is experiencing record-breaking investment in renewables, driven by policy support from the Inflation Reduction Act (IRA), which provides long-term tax incentives for solar, wind, battery storage, and emerging technologies like green hydrogen. It is important to note that the IRA may become challenged under the new administration in the USA with Donald Trump taking office. He issued an executive order in January titled “Unleashing American Energy,” which directed federal agencies to pause the disbursement of funds appropriated under the IRA and the Infrastructure Investment and Jobs Act (IIJA) for a 90-day review period. This pause is intended to assess whether these funds align with the new administration's energy policies.

Europe remains a global leader in renewable investments, with the European Union's Green Deal and REPowerEU plan targeting accelerated deployment to reduce reliance on fossil fuels. The North Sea continues to be a major hub for offshore wind, with multi-gigawatt projects in the UK, Denmark, and the Netherlands, while France, Spain, and Germany are scaling up solar and wind capacity to meet ambitious 2030 targets. The continent is also at the forefront of green hydrogen production, with major projects in Germany and the Iberian Peninsula aiming to support industrial decarbonization. However, permitting bottlenecks and grid constraints remain challenges that policymakers are actively addressing through regulatory reforms.

In the Asia-Pacific region, China dominates renewable energy investments, accounting for over half of global solar and wind installations. The country is expanding its ultra-high-voltage transmission networks to integrate renewables while ramping up investment in battery storage and green hydrogen. India is also emerging as a key player, with aggressive targets for solar and wind capacity expansion backed by government auctions and international financing. Japan and South Korea are focusing on offshore wind and hydrogen, while Australia is witnessing a surge in solar and battery storage projects, supported by state policies and private investment.

The Middle East and Africa are also seeing growing investment in renewables, particularly in solar energy. The UAE and Saudi Arabia are leading the way with gigawatt-scale solar projects and green hydrogen initiatives as part of their economic diversification strategies. Africa, with its vast solar and wind potential, is attracting increasing foreign investment, but infrastructure challenges and political risks continue to limit large-scale deployment. Latin America remains a key growth region, with Brazil, Chile, and Mexico expanding wind and solar portfolios, often driven by competitive auctions, and rising corporate demand for clean energy.

Global renewable energy investments are expected to exceed $1.7 trillion annually by 2030, as countries and corporations strive to meet net-zero commitments. While financing, supply chain constraints, and grid infrastructure remain hurdles, technological advancements and policy support are positioning renewables as a dominant force in the future energy mix. Even with the scaling investment in the renewable energy space global CAPEX trends still highlight the Upstream oil and gas space experiencing the largest nominal increases. According to a recent report by the International Energy Forum (IEF) and S&P Global Commodity Insights, annual upstream oil and gas CAPEX will need to rise by 22% by 2030 to ensure adequate supplies, driven by growing demand and cost inflation. This translates to a cumulative $4.3 trillion in new investments required between 2025 and 2030.

Final Thoughts

The evolving global E&P landscape presents a dynamic and opportunity-rich environment for geoscientists, as the industry adapts to shifting energy demands, advancing technologies, and geopolitical uncertainty. Near-term innovations in seismic imaging, subsurface modeling, and reservoir optimization are already transforming operational efficiency and unlocking new reserves, while data-driven decision-making is reshaping exploration strategies. As artificial intelligence becomes more deeply embedded in workflows, geoscientists are stepping into more integrated, high-impact roles, requiring both technical depth and digital fluency. At the same time, rising global energy demand, driven in part by the exponential growth of data centers powering AI and digital infrastructure, underscores the need for reliable, well-managed hydrocarbon supply during the transition to a lower carbon future.

Looking towards 2035, the convergence of talent development, policy evolution, and cross-disciplinary innovation will empower geoscientists to drive value across a broader energy mix, balancing carbon reduction goals with energy security. The global leadership changes in 2025 may bring regulatory uncertainty, but also opens pathways for bold, market-responsive strategies. For geoscientists, the decade ahead offers a clear call to lead: to innovate responsibly, manage risk proactively, and shape a resilient, forward-looking future for the E&P industry.

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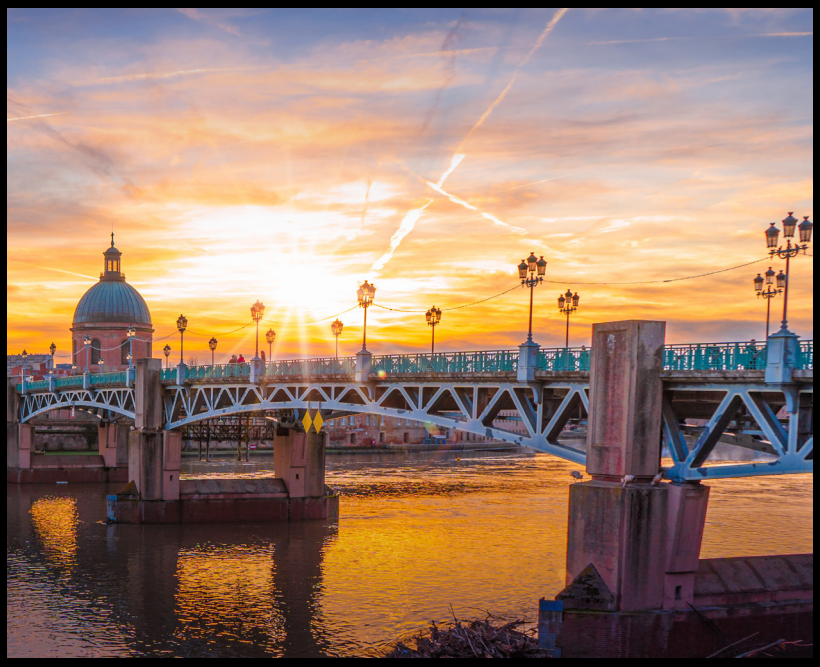

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