Big Oil, Bigger Data: How AI Is Fueling a $6 Trillion Industry's Transformation

Valued at $6 trillion, the global oil and gas industry powers economies and fuels progress worldwide. The industry is defined by intricate supply chains, geopolitical influences, and a need to balance energy security with sustainability. Key challenges include volatile prices, geopolitical tensions, and the transition to Net Zero, demanding innovative solutions to ensure resilience. The oil and gas industry, often viewed as a traditional sector that is slow to adopt digital transformation, is undergoing a significant evolution with the integration of Artificial Intelligence (AI). From crude oil exploration and production to refining and distribution of refined products, AI is becoming a game changer of industry. Advanced technologies such as machine learning, predictive analytics, and automation are helping oil and gas companies streamline operations, derisk investments, reduce emissions and propel the industry towards sustainable growth.


EXHIBIT 1: AI Market Forecast in Oil and Gas (2024-2029)

In Bn $

7.65 (2029)
3.14 (2024)
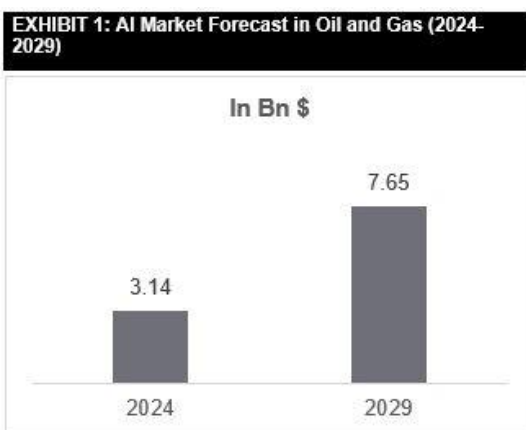
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According to a recent report by leading market research firm AI market size in Oil and Gas is estimated to be $3.14 billion in 2024 and is expected to reach $5.7 billion by 2029 with a CAGR of 12.61%. With North America leading the charge and Asia Pacific emerging as a fast-growing market, AI is not just an option but a necessity for companies to stay competitive.

Unlocking Benefits through AI

A greater need for **operational efficiencies, safety, cost reduction** and growing emphasis on **sustainable growth,** have catalyzed a profound transformation in the oil and gas industry with Artificial Intelligence (AI) being a key enabler. In 2021, C3 AI partnered with Shell, Baker Hughes, and Microsoft to launch the Open AI Energy Initiative, an open ecosystem of AI-driven solutions for the energy and process industries. AI offers practical applications across the entire oil and gas value chain, from upstream exploration to downstream distribution. By integrating AI, companies are optimizing workflows, reducing turnaround times and costs, and revisioning decision-making process from subjective judgments to data-driven insights, particularly in the upstream sector.
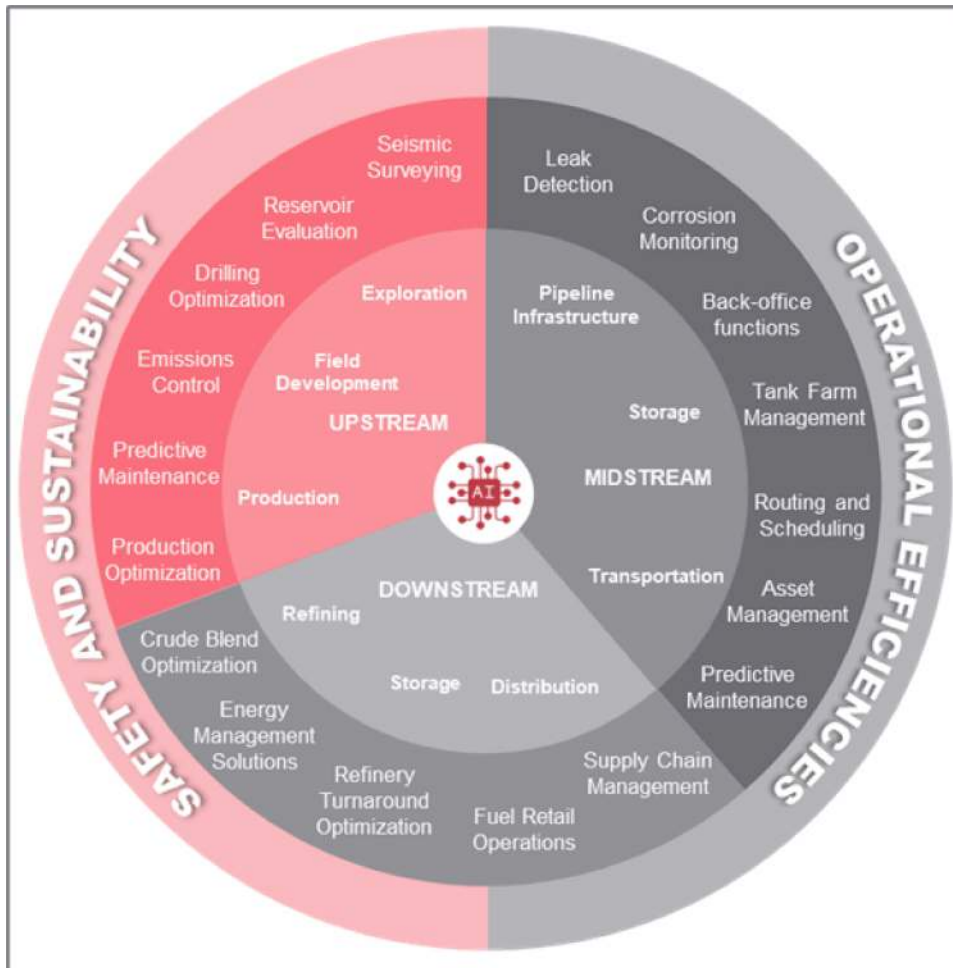
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Upstream Operations: Exploration, Reservoir Development and Production

In the upstream sector, AI enhances operations by leveraging data and advanced analytics to boost efficiency and deliver actionable insights across key activities. Applications include:

Seismic Surveying and Reservoir Modelling

Revolutionizing seismic surveying and reservoir modeling, deep learning transforms processes that once took weeks into real-time insights, setting a new standard in efficiency for the upstream sector. Companies like **SubsurfaceAI and GeoplatAI** have partnered with major energy companies for their geomodelling, reservoir characterization and seismic data interpretation services. These AI products have significantly reduced exploration timelines while improving accuracy and minimizing the risk of dry wells.

Drilling Optimization

Real-time AI models are transforming drilling operations by predicting optimal paths and reducing non-productive time (NPT). The rate of penetration (ROP) is a critical parameter that has a direct impact on the overall cost and companies seek to optimize it. For instance, AIQ, the Abu Dhabi based AI company has partnered with ADNOC, Baker Hughes and CORVA (a leading drilling optimization solution provider) and have announced the launch of AI Rate of Penetration (ROP) optimization initiative, which aims to optimize drilling operations across ADNOC oil field through their state-of-the-art AI solutions. In the Delaware Basin, CORVA and NABORS deployed an AI-based ROP optimization solution, achieving a 36% improvement in lateral ROP and a 9.7% reduction in vibration.

Predictive Maintenance

Upstream operations face frequent challenges such as unplanned downtimes and equipment failures leading to increased costs. AI based predictive maintenance solutions can prevent equipment failures by analyzing equipment data captured through various IoT devices and using machine learning algorithms. C3 AI has partnered with Shell to provide predictive maintenance solutions for monitoring more than 10,000 critical pieces of equipment across their upstream, and integrated gas assets globally. Since each piece of equipment is unique and encounters its own set of challenges, there are about more than two million models.

Midstream Operations: Transportation, Storage and Infrastructure

The midstream sector leverages AI to optimize logistics, enhance infrastructure reliability, and prevent leakages, ensuring efficient flow with minimal disruptions. Key applications include:

Pipeline Infrastructure Monitoring

Oil and gas pipelines, carrying high-pressure fuels underground, face risks from small cracks and corrosion that can lead to costly leaks and environmental harm. AI-powered systems redefine pipeline monitoring by detecting leaks and corrosion in real time, reducing environmental risks, minimizing repair costs, and preventing unplanned downtime. Cyient's GeoAI uses earth observation data to monitor pipelines using machine learning algorithms. It can detect and pin-point leaks and monitor corrosions along the oil and gas pipelines using remote sensing technologies such as satellite imagery, LiDAR and drones.

Tank Farm Analytics

Given the volatile nature of oil prices and ongoing geopolitical tensions, optimizing tank utilization is critical to preventing supply disruptions. Currently, tanks are scheduled for maintenance and inspection (M&I) every 10-15 years after commissioning, regardless of actual need.. When multiple tanks are commissioned simultaneously, decommissioning them together for M&I can heighten the risk of supply interruptions. This highlights the need for a strategic, data-driven approach to prioritize maintenance activities and ensure uninterrupted operations. Bahwan CyberTek Group's Rentina360 AI, tank farm analytics solution enables intelligent prioritization of tank maintenance using a comprehensive health scorecard. The system evaluates key factors such as bottom plate corrosion, estimated sludge deposition, and crude oil properties to accurately assess tank health and optimize maintenance planning.

Downstream Operations: Refining, Storage and Distribution

Downstream operations are the powerhouse of the oil and gas value chain, driving the highest value creation. With AI integration, companies can achieve unprecedented levels of efficiencies in the refinery processes translating into millions of dollars in overall impact. Key applications include:

Crude Blend Optimization

Crude oil blending is done by refineries to optimize product quality, meet market demand, reduce energy consumption and adhere to environmental regulations. Factors such as API gravity, sulfur content and distillation curve play a significant role in determining the blend's final properties. AI models can analyze the properties of the crude oils available, to recommend optimal blends as per requirements. AISPAK's CrudeAI Blendix, takes into consideration different parameters such as oil quality, market demand and operational constraints to recommend the optimal blending strategy that maximizes profitability while ensuring product quality and regulatory compliance.

Refinery Turnaround Optimization

Refinery turnarounds are planned shutdowns designed to ensure the safe, efficient, and compliant operations of refinery facilities. These periods are critical for maintenance, inspections, and upgrades, enabling refineries to operate at peak performance while adhering to safety, design and regulatory standards. AI based refinery turnaround solutions support the PMO in ensuring that the milestones are being met within the budgeted cost and timeframes. Key features include prediction of delays, scenario analysis, optimized schedules in real time and monitor project execution. C3 AI's Turnaround optimization solutions can improve efficiencies and effectiveness of refinery turnarounds planning. These solutions take into consideration the historical maintenance and inspection data, resource availability, past equipment performance data and other equipment sensors data to not only identify the risks but also recommended data-backed solutions to minimize losses.

Energy Management Solutions

As the industry is transitioning towards Net Zero, Energy Management solutions (EMS) play a crucial role due to their ability to optimize energy usage and reduce greenhouse gas (GHG) emissions. These solutions enable seamless integration of renewable energy into oil and gas operations by leveraging data analytics and machine learning to predict energy demand and optimize production. Enel X's energy management solutions provide a bird's eye view of a company's energy consumption, costs and identifies opportunities for energy savings. The solutions aggregate data from equipment line sensors, utility bills, historical consumption trends, and ERP systems to pinpoint energy-saving opportunities and optimize GHG emissions control. With these AI-based continuous monitoring solutions across the operations, companies can optimize their energy use, reduce utility bills, lower GHG emissions and accelerate the transition towards Net Zero emissions.

Supply Chain Management

Supply Chain Management (SCM) allows businesses optimize and build resilient supply chain operations – from procurement of raw materials to the delivery of finished goods. AI plays a critical role in supply chain management by enhancing visibility across multiple stakeholders in real time to ensure smooth operations. These solutions support in buying the raw materials at the right price and at the right time, inventory management, demand forecasting and aligning production schedules, and route optimization and logistics. Enhanced supply chain integration ensures real-time coordination between refineries, distributors, and retailers, minimizing disruptions and maximizing profitability. Didero is re-defining the future of procurement with their AI agents automating the entire procurement process. C3 AI inventory optimization solutions reduce inventory requirements at an SKU level while improving service levels. Companies usually use material requirements planning (MRP) software to plan their inventory, however, this traditional software rely on historic demand-based forecast, available inventory, historic lead time and target safety stock to calculate material requirements. These systems lack the ability to consider the near-real time uncertainties such as delay in supplier lead times, inaccurate demand forecast etc. leading to lower service levels. C3 AI Inventory optimization solution addresses these challenges by aggregating data from multiple data sources such as bill of materials (BOM), supplier inventory movements, demand forecasts and internal stock transfers data to model uncertainties in demand, supplier delivery times and inventory positions to optimize reorder parameters thereby minimizing inventory holding and shipping costs at an SKU level. NextBillion.ai's route optimization solution leverages artificial intelligence to determine the most efficient paths for transportation. Traditional route optimization algorithms rely on static maps and pre-determined routes which are inefficient and not flexible. AI algorithms can identify optimal routes by analyzing data such as traffic patterns, weather forecasts, road closures and delivery constraints to minimize travel time and logistic costs.

Fuel Retail Operations

AI is revolutionizing the fuel retail sector by streamlining the operations, enhancing customer experience and strengthening security measures. Internet of Things (IoT) has been the key enabler for developing AI based solutions driving a new and improved customer experience. Inventory optimization solutions from the pump level IoT monitors, designing rewards and loyalty programs and marketing campaigns-based customer buying behavior which can be analyzed through POS data and video-based analytics to monitor and alert in case security violations. For example, Microsoft's Azure IoT Edge AI solution and Shell have partnered to deploy AI-based video analytics solutions at gas stations in Singapore and Thailand. These solutions process data in real-time to detect potential hazards such as smoking near fuel pumps, while questionable incidents are uploaded to cloud for advanced analysis. Alerts are raised instantly, enabling swift action to prevent potential disasters.

Challenges in adoption of AI

While AI holds transformative potential for the oil and gas industry, its implementation and widespread adoption faces several challenges which are critical in unlocking AI's full potential
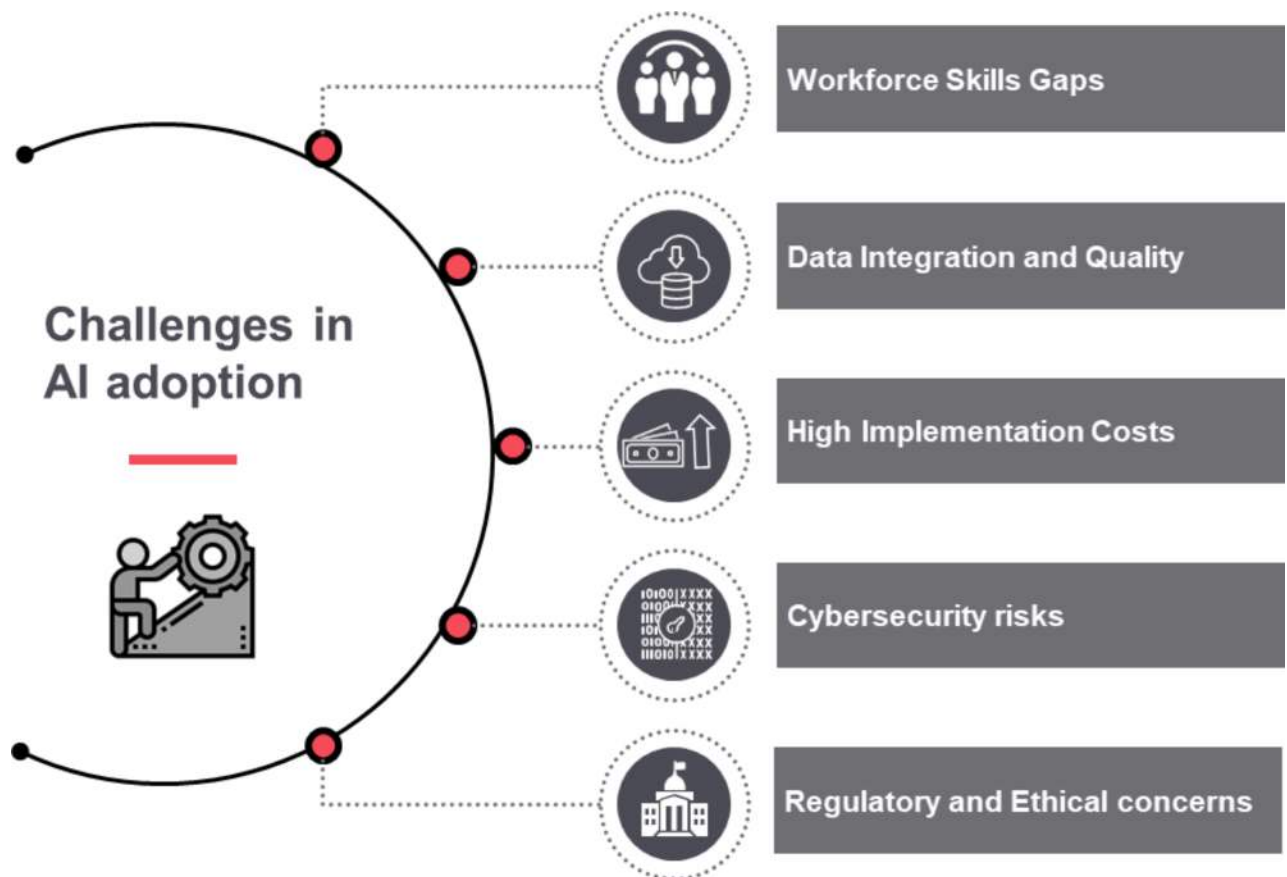
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Workforce skill gaps

Implementing AI solutions necessitates the requirement of new job profiles for workforce who can develop, maintain and interpret AI-driven systems. Most of the AI solutions out there are generic and are required to be customized as per the business context and the data available, hence, to develop, use and maintain AI in processes, companies must grow in-house data and AI scientists. BP recognized this challenge early and launched its "Digital Academy" that provides training programs to upskill its workforce in AI and digital technologies.

Data Integration and Quality

AI tools need good quality and quantum of data to unlock its true potential because if the input data is corrupted, no matter how smart the algorithms are, the output will not be useful. Thus, access to proper, labelled and quality data is a crucial enabler for the AI application's successful development and deployment. Oil and gas operations generate vast amounts of raw data, but issues with quality and accuracy often result in significant manhours being spent on data cleaning and enhancement. To improve the data quality, companies must keep redesigning their organizational structure and processes to a more agile way and maintain a centralized data storage to allow people and AI solutions easy access and usage. Shell is making significant investments in developing integrated digital ecosystems that leverage advanced technologies like Digital Twins and ATEX-certified robots to collect data directly from the field. By capturing high-quality, real-time data from a variety of sources and storing this information in centralized data warehouses, Shell is ensuring seamless and rapid access across their global operations. This strategic approach enables the company to optimize its operations, enhance decision-making, and drive innovation through data-driven insights.

High implementation costs

The initial investment in AI technologies, encompassing hardware, software, and training, can be substantial, and the returns may not be immediately apparent. To manage costs and mitigate risks, companies can prioritize specific focus areas or target low-hanging fruits for AI implementation. A phased approach allows businesses to gradually realize benefits, all while improving their learning curve and gaining valuable insights from early successes. This strategy not only helps in controlling expenses but also paves the way for scalable growth and long-term value from AI adoption.

Cybersecurity risks

Increased reliance on AI and digital systems exposes operations to potential cybersecurity threats which leads to both financial and reputational loss. While it is impossible to eliminate the possibility of cyberattacks, businesses can take proactive steps to protect their digital assets. Implementing robust governance and cybersecurity frameworks—such as employee training, multi-factor authentication, risk management plans, firewalls, antivirus, regular security audits, and restricted access to sensitive data—can safeguard operations from attacks and ensure a resilient digital infrastructure.

Regulatory and Ethical concerns

The ever-evolving regulatory landscape and the need to address ethical concerns related to AI decision-making can slow the adoption of these technologies. However, it is crucial for companies to ensure their AI systems comply with local regulations while upholding ethical principles that promote trust and transparency. By engaging with regulators in policy-making discussions, adopting transparent and well-documented AI models, and making this information accessible to the regulatory bodies, companies can build credibility. Implementing ethical AI governance frameworks and fostering industry collaboration to define standards for responsible AI use will help oil and gas businesses navigate regulatory complexities, build stakeholder trust, and set a precedent for ethical AI adoption.

Way Forward

AI is revolutionizing the oil and gas industry, redefining traditional operations and unlocking new efficiencies across the value chain. From improving exploration accuracy to optimizing supply chains, AI is driving innovation and operational excellence. However, the industry's future hinges on integrating these advancements with sustainable practices to address environmental, social, and regulatory challenges.

In the coming years, AI solutions will play a crucial role in achieving sustainability by optimizing energy use, reducing emissions, and improving safety and efficiency. Beyond operations, AI will automate tasks like financial reporting, compliance tracking, and approvals, freeing up human resources for strategic activities and fostering a culture of innovation.

Collaboration among companies will be vital to scaling AI solutions and addressing shared challenges. By investing in ethical and sustainable AI today, the industry can build trust, drive unprecedented value, and position itself as a leader in the energy transition. FutureBridge believes that by aligning AI-driven innovation with sustainability, the sector can meet global energy demands while shaping a resilient, low-carbon future.

Reference

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