HUB TECH IA

Deliverable report 38

AI and IAGEN Application Use Case

Predictive Performance Analysis for Well Performance Prediction

I. Introduction

Growing global energy demand is driving the exploration and development of energy resources in various forms, including unconventional hydrocarbons. Among these, the Vaca Muerta shale formation, located in Neuquén Province, Argentina, stands out for its vast potential as one of the largest shale oil and gas reserves in the world.

However, optimizing production and well performance in unconventional reservoirs presents unique challenges due to geological complexity, variability in reservoir properties, and the dynamic nature of production processes.

In this context, predictive analytics has become an essential discipline for the oil and gas industry, offering the ability to anticipate well behavior, optimize operations, and make informed decisions to maximize hydrocarbon recovery and economic efficiency.

This report focuses on the application of predictive analytics for energy optimization in Vaca Muerta, exploring its potential to improve operational efficiency, reduce costs, improve response times, and enhance safety in this important hydrocarbon-producing region.

II. Advanced Predictive Modeling for Well Performance

1. Recurrent Neural Networks (RNNs)

Recurrent Neural Networks (RNNs) are deep learning architectures specifically designed to process sequential data, making them ideal for time series analysis such as oil well performance prediction.

Their ability to maintain a memory state allows them to learn from past data and predict future points in a sequence. Variants such as LSTM (Long Short-Term Memory) and GRU (Gated Recurrent Unit) networks incorporate mechanisms for long-term information recall, which improves their performance in modeling complex time series data.

Advantages and Limitations:

RNNs, especially LSTM and GRU architectures, are highly effective at modeling time-series data and capturing complex sequential patterns in well performance. However, they require a significant amount of historical data for effective training and can be computationally intensive. Although LSTMs and GRUs mitigate the gradient vanishing problem present in traditional RNNs, the selection and optimization of the model architecture and hyperparameters remain crucial for obtaining accurate results.

2. **Support Vector Machines (SVMs)**

Support Vector Machines (SVMs) are supervised learning algorithms used for both classification and regression tasks. They are based on the principle of finding the hyperplane that best separates different classes of data (in classification) or finding a function that best fits the data within a certain error margin (in regression). SVMs are particularly effective in problems with small samples, high dimensionality, and nonlinearity.

Strengths and Weaknesses:

SVMs offer several advantages, such as their ability to handle high-dimensional data, their robustness against overfitting, and their effectiveness even with limited data. However, their performance can be highly dependent on the appropriate kernel selection, and they can be computationally expensive for very large data sets. The interpretability of SVM models can also be a challenge compared to other algorithms.

3. **Decision Trees**

Decision trees are machine learning models that use a tree structure to represent decisions and their potential consequences. They are used for both classification and regression tasks. Ensemble methods, such as Random Forests and Gradient Boosting Decision Trees (GBDT), combine multiple decision trees to improve model accuracy and robustness.

Interpretability and Limitations:

One of the main advantages of decision trees is their high interpretability, as the tree structure makes it easy to understand the factors influencing predictions. However, individual decision trees can be prone to overfitting, especially if they are very deep. Ensemble methods, such as random forests and gradient boosting, mitigate this problem by combining predictions from multiple trees, often leading to improved predictive performance and greater stability.

4. **Advanced Regression Models**

Advanced regression models encompass a variety of statistical and machine learning techniques that go beyond simple linear regression to model complex relationships between variables. These include polynomial regression, support vector regression (already mentioned as a regression technique), Gaussian process regression, and ensemble methods such as random forests, gradient boosting (including XGBoost and LightGBM), and neural networks (when used primarily for regression).

Comparative Analysis:

The choice of the most appropriate forward regression model depends on the specific characteristics of the dataset and the prediction problem. Deep learning models, such as recurrent and convolutional neural networks, can capture complex nonlinear relationships but often require large amounts of data for effective training.

Ensemble methods, such as random forests and gradient boosting, typically offer a good balance between accuracy and interpretability and are robust against overfitting. Support vector regression can be effective on high-dimensional datasets and can perform well even with limited data.

III. Application of AI and IAGen in Predictive Performance Analysis for Well Performance Prediction

1. General Objective

Predict future well performance (oil and gas production, pressure, flow rate, etc.) by analyzing historical, geological, operational, and environmental data, optimizing decision-making in exploration and exploitation.

2. Artificial Intelligence (AI)

Traditional AI techniques are used such as:

- **Supervised Machine Learning** : Models such as Random Forest, Gradient Boosting, or neural networks to predict daily/weekly/monthly production based on:
  - Rock type, porosity, permeability
  - Completion and fracture data
  - Operating parameters (bottomhole pressure, flow rate, GOR, etc.)
  - Seismic data, well logs, core images
- **Advanced Time Series** : Using models such as LSTM (Long Short-Term Memory)

or Prophet to anticipate performance drops or anomalous behavior.

- **Multivariate Optimization** : to recommend optimal operating settings (pressure, injection volume, pumping frequency, etc.) that maximize production.

3. **Generative Artificial Intelligence (GAI)**

Generative Artificial Intelligence (GENI) is a branch of artificial intelligence that focuses on creating new content, such as models, images, code, or text, from existing data. This technology uses advanced algorithms to analyze large amounts of information, identify patterns, and generate new, original content that is often indistinguishable from human-created content.

The IAGen adds a unique layer of value:

- **Automated Predictive Reporting** : After processing well data, an LLM (such as GPT-4) can automatically write comparative analyses between wells, explaining why one will perform better than another and suggesting improvement scenarios.

- **Geological + Operational Model Synthesis** : By combining large volumes of technical documents, field reports, plans, and seismic data, you can generate new scenarios or simulations (even visual or in natural text).

- **Self-explanatory results** : generative models explain why a well has a certain production or decline curve in natural language, accessible to different profiles (engineers, managers, regulators).

IV. Use of IAGEN-powered Agents in the activity

1. **IAGEN Agents Concept**

In recent years, generative artificial intelligence (GAI) has revolutionized the way we interact with technology, enabling the development of systems capable of generating content, answering complex questions, and assisting with highly demanding cognitive tasks. From this capability, a new technological architecture has emerged: GAI-powered agents. These agents are not simple conversational interfaces, but autonomous systems that can interpret instructions, make decisions, execute tasks, and learn from their interactions with the environment.

An IAGen agent combines large language models with additional components such as external tools, memory, planning, and autonomous execution. This allows them to operate in complex environments, with the ability to break down objectives into steps, coordinate multiple actions, interact with digital systems (such as databases, APIs, or documents), and adapt to context changes in real time. These qualities distinguish them from traditional chatbots and open up a range of more sophisticated and customizable applications.

At the organizational level, these agents are being used to automate processes, generate data analysis, assist in decision-making, and improve the user experience, both internally and externally. For example, they can take on human resources, legal, financial, or logistics tasks, and even tasks linked to the technical areas of production processes, acting as intelligent assistants that collaborate with human teams. This ability to integrate knowledge and execute tasks autonomously transforms the way organizations can scale their operations without losing quality or control.

Furthermore, agentic workflows—structures where multiple agents collaborate to solve complex problems—allow responsibilities to be distributed among different agent profiles, each with specific functions. This creates hybrid work environments where humans and agents coexist, optimizing time, costs, and results. The ability to connect agents with tools such as Google Drive, CRMs, or document management platforms further expands their capabilities.

The development of IAGen-powered agents represents a crucial step toward a new era of intelligent automation.

Among the benefits of authentic workflows powered by generative AI models is the ability to automate entire production processes, end-to-end, and even add value by leveraging the capabilities of language models based on these technologies.

However, its implementation also poses technical, ethical, and legal challenges, ranging from responsible design to human oversight. Therefore, understanding its architecture, operational logic, and potential impacts is critical for its effective and safe adoption in diverse professional contexts.

2. Proposed Applications of AI Agents in Well Performance Prediction

a. Data Explorer Agent

- Automatically collect data from SCADA sensors, geological databases, PDF files, or production systems.
- Cleans, normalizes and organizes information for analysis.

b. Predictive Modeling Agent

- Applies traditional AI models to predict production.
- Tune hyperparameters and evaluate the accuracy of each model.

c. Knowledge Generating Agent

- Use IAGen to write reports, hypotheses, and operational recommendations.
- Compare the current well with similar historical wells and suggest

improvement plans.

d. **Critical/Validating Agent**

  - Review predictions and suggestions generated by other agents, identify errors or risks.
  - You can propose mitigation measures.

e. **Integrating Agent with Decision Platform**

  - It interacts with planning systems (SAP, Power BI, ERPs) and presents integrated dashboards and visualizations for decision-making.

3. Practical Example Statement

- **Input** : Operating data of well X, production history, log images.
- **Agent 1** : Extracts data and converts it into a structured table.
- **Agent 2** : `Runs ML models → predicts 15% drop in flow in 3 months.`
- **Agent 3** : Writes report: *"Given the behavior of similar wells with type A hydraulic fracture, we recommend implementing pressure variation..."*
- **Agent 4** : Audits suggestions and warns: *"But the well is located in an area with limit fracture pressure, risk of reservoir damage."*
- **Agent 5** : Integrates visualizations for presentation in planning meeting.

V. Quantifying the Value of Predictive Analytics in the Oil and Gas Industry

1. Improvements in Operational Efficiency

Predictive analytics enables oil and gas companies to anticipate equipment failures before they occur, schedule repairs, optimize resource allocation, and forecast market fluctuations.

By providing real-time insights into the performance and health of critical assets such as pipelines, drilling rigs, and refineries, predictive analytics facilitates proactive maintenance, ensuring smooth operations and improving asset reliability.

In production operations, predictive analytics optimizes extraction by analyzing real-time drilling data, reservoir conditions, and historical production patterns, maximizing output.

IoT sensors and smart gateways can monitor equipment performance in real time, enabling predictive maintenance and minimizing downtime, leading to increased productivity.

Predictive maintenance can improve asset performance by simulating future behavior under various operating conditions. A gas extraction company that used AI-powered predictive analytics to maintain its drilling rigs achieved a 30% reduction in downtime. Predictive maintenance can reduce unplanned downtime by 30% to 50%.

2. Cost Reduction Strategies

Predictive analytics helps prevent costly damage and production downtime by detecting early signs of equipment problems. Predictive maintenance minimizes unexpected downtime, improves safety, and reduces repair costs. By predicting equipment failure or market demand, companies can allocate resources more effectively, minimizing operating costs. Predictive maintenance can significantly reduce project management costs in the oil and gas industry by minimizing unexpected and costly repairs.

IoT solutions can increase production by 25% and reduce maintenance costs by 30%, while also decreasing equipment downtime by 45%. Artificial intelligence enables companies to address problems when they are small and less costly to fix, avoiding expensive repairs or replacements .

3. **Improvements in Response Times**

Real-time information provided by predictive analytics enables faster decision-making and interventions. Real-time data analysis offers an instant and complete view of operations, essential for making fast and accurate decisions. Predictive maintenance enables timely intervention that is neither too early nor too late. The real-time communication facilitated by data analytics improves collaboration, allowing teams to make decisions quickly and resolve issues in real time.

4. **Safety and Environmental Benefits**

Predictive analytics can help prevent accidents and other disruptions by anticipating equipment failures and dangerous operating conditions . By analyzing historical incident data, weather patterns, and equipment performance, predictive analytics identifies potential hazards before they occur, enabling proactive safety measures . AI-driven analysis helps design better safety protocols, reducing the risk of accidents . Predictive maintenance contributes to safer working environments by preventing asset failures that could lead to dangerous situations .

Predictive analytics can forecast greenhouse gas emissions, allowing companies to take proactive steps to reduce them. IoT devices and technologies can detect and alert operators to potential hazards, such as gas leaks, equipment malfunctions, or unsafe working conditions, enabling rapid response.

Predictive models can analyze historical accident data and environmental conditions to estimate the likelihood of incidents such as oil spills or gas leaks, helping companies allocate resources for prevention and mitigation.

5. Table of Quantified Benefits of Predictive Analytics in Oil and Gas

Benefit Category	Metric/Quantifier
Reducing Downtime	30-50%
Reducing Downtime	30% (in a case study)
Reduction of Maintenance Costs	30% (with IoT solutions)
Reduction of Security Incidents	40% (with VR training)
Increased Production	25% (with IoT solutions)

VI. Analysis of the Impact of the Regulatory Framework on the Adoption of AI in the Energy Sector

The lack of a comprehensive and forward-looking regulatory framework can be an obstacle to the advancement of AI. Some argue that a lack of regulation could harm investment prospects, as companies may prefer greater clarity. Argentina's energy sector is currently undergoing deregulation to promote private investment . The RIGI offers tax stability and other incentives for large energy investments, which could indirectly facilitate AI adoption in the sector.

Potential Barriers and Facilitators to Implementation

Barriers:

- Absence of a specific legal framework for AI.
- Potential investor concerns due to lack of regulatory clarity.

●Need for significant energy supply to power AI infrastructure.

●Possible lack of a qualified AI workforce.

●High cost of technology.

●Cybersecurity concerns.

Facilitators:

●Declared government interest in becoming an AI hub and promoting technological development.

●RIGI Investment Incentives for AI.

●Existing robust technology ecosystem and skilled workers in the IT sector.

●Low energy prices in some regions.

●Increase in renewable energy capacity.

Change Management Strategies and Training Programs Implemented in Energy Companies to Promote the Adoption of New Technologies such as Artificial Intelligence

VII. Strategies for Managing Organizational Change in Energy Companies Adopting AI

Successful AI implementation relies heavily on effective change management strategies. Key strategies include leveraging sponsorship and building a network of change champions among stakeholders within the organization.

- Short-term investment in AI agent implementation teams in technology and training: Investment is required in proofs of concept and pilot testing. The focus here must be on developing the talent needed to implement these solutions, as there is a trend toward cost reduction in systems that enable "no-code" and "low-code" automation. For the first stage, it is also recommended to recruit teams with experience in AI agent design and implementation. Finally, it is key to form an in-house team to support and foster an agentic culture that redefines human-machine interaction.
- Prioritizing clear and transparent communication with stakeholders is essential

to address concerns and mitigate resistance.

- Investing in employee training and skills enhancement is crucial to ensure they can effectively use AI tools and maximize their benefits.
- Starting with small AI programs can help build confidence and experience gradually.
- Involving stakeholders early in AI initiatives fosters a sense of ownership.
- Creating a clear business case for AI adoption helps communicate goals and potential benefits.
- Assessing the organization's readiness for AI implementation is important to tailor the implementation strategy.
- Identifying AI champions within your organization can help drive change and inspire your colleagues.
- Establishing strong governance and clear policies around the ethical use of AI, data security, and risk management is essential.
- Fostering a culture of experimentation and calculated risk-taking is important for sustained AI adoption.

VIII. Considerations for Selecting Appropriate Software Solutions

When selecting software solutions for predictive well performance analysis, several factors must be considered. These include specific prediction needs (e.g., production rate, equipment failure, reservoir properties), the volume and type of data available, the required level of accuracy and interpretability, ease of integration with existing systems, software cost, and the level of technical expertise within the organization.

Future Trends in the Application of Artificial Intelligence and Machine Learning in the Optimization of Hydrocarbon Production in Unconventional Reservoirs such as Vaca Muerta

Emerging Trends in Machine Learning and Artificial Intelligence for Oil and Gas Production

AI is becoming an essential tool for navigating market uncertainties and meeting the demands of the evolving energy landscape, helping to reduce waste, lower emissions, and maximize resource utilization.

Future research directions include establishing standardized data exchange and labeling systems, integrating domain knowledge with engineering mechanisms, and advancing interpretable modeling and transfer learning techniques.

Robotics and AI are transforming exploration, production, and maintenance in unconventional fields, improving efficiency and recovery rates.

AI will revolutionize the industry by improving drilling accuracy, hydraulic fracturing optimization, reservoir characterization, emissions reduction, and water use.

The GPT model has demonstrated its ability to provide accurate production estimates with minimal historical data, outperforming traditional methods [83] . Trends include autonomous operations, human-machine collaboration, remote operations and drilling automation, all with the aim of improving the sustainability of the industry .

IX. Possible Innovations and Their Impact on the Development of Unconventional Resources in Vaca Muerta

The development and adoption of autonomous drilling technologies will continue to advance. Enhanced AI-driven optimization of hydraulic fracturing techniques is expected to maximize production and minimize environmental impact (e.g., water use, emissions).

The use of AI for real-time reservoir characterization and dynamic production adjustments will expand. Integration of AI with digital twins for integrated asset management and predictive maintenance will become more common. More robust and interpretable AI models will be developed to build trust and facilitate adoption. The use of AI for environmental monitoring and regulatory compliance in the Vaca Muerta region will increase.

These innovations have the potential to significantly improve the efficiency, productivity, and sustainability of unconventional resource development in Vaca Muerta, making it a more economically viable and environmentally responsible energy source.

X. Conclusion and Recommendations

Predictive analytics plays a pivotal role in optimizing energy production in Vaca Muerta. The significant production growth, considerable economic benefits, and technological advancements presented in this report underscore the transformative potential of these techniques. However, to fully realize this potential, a strategic and well-planned approach to AI adoption, including change management and workforce training, is crucial.

The following recommendations are offered to stakeholders:

- For oil and gas companies: Invest in building a robust data infrastructure, explore and implement relevant AI software solutions, prioritize workforce training and upskilling, and foster a culture of innovation and experimentation.
- For government agencies: Develop a clear and supportive regulatory framework for AI in the energy sector, promote investment in AI research and development, and facilitate collaboration between industry and academia.
- For technology providers: Continue developing and refining AI solutions tailored to the specific challenges of unconventional hydrocarbon production, focusing on ease of use and model interpretability.

In conclusion, predictive analytics has the potential to transform the oil and gas industry, ensuring a more sustainable energy future. Vaca Muerta, with its vast resources and growing focus on AI-powered optimization, is well positioned to play a crucial role in this future.

Works Cited

1. Argentina's Vaca Muerta Fuels Oil Production Surge - Brazil Energy Insight,

accessed March 21, 2025, https://brazilenergyinsight.com/2025/03/13/argentinas-vaca-muerta-fuels-oil-production-surge/
2. Predictive Analytics in Oil and Gas: Applications & Advantages - Appinventiv, accessed March 21, 2025, https://appinventiv.com/blog/predictive-analytics-in-oil-and-gas/
3. Vaca Muerta: The oil landscape for 2025 - BNamericas, accessed March 21, 2025, https://www.bnamericas.com/en/features/vaca-muerta-the-oil-landscape-for-2025
4. Argentina | Energy Outlook 2025: Oil and Gas - BBVA Research, accessed March 21, 2025, https://www.bbvaresearch.com/en/publicaciones/argentina-energy-outlook-2025-oil-and-gas/
5. Argentina's oil and gas sector: Vaca Muerta shale can drive near-term growth and fuel medium-term opportunities - Deloitte, accessed March 21, 2025, https://www2.deloitte.com/us/en/insights/economy/americas/vaca-muerta-argentina-energy-sector-boom.html
6. LatAm Insights: Soaring Vaca Muerta output drives Argentina oil export revenues, accessed March 21, 2025, https://www.rystadenergy.com/insights/soaring-vaca-muerta-output-drives-argentina-oil-export-revenues
7. of Argentina Vaca Muerta: the future, access date: March 21, 2025, https://www.pwc.com.ar/es/assets/document/invest-in-vaca-muerta.pdf
8. Credit FAQ: Renewed Interest in Argentina's Vaca Muerta Shale | S&P Global Ratings, accessed March 21, 2025, https://www.spglobal.com/ratings/en/research/articles/250117-credit-faq-renewed-interest-in-argentina-s-vaca-muerta-shale-13381062
9. Vaca Muerta Sur Oil Pipeline Gets US$3 Billion Green Light - Buenos Aires Herald, accessed March 21, 2025,

https://buenosairesherald.com/business/energy/vaca-muerta-sur-oil-pipeline-shareholders-greenlight-us3-billion-rigi-project
10. Vaca Muerta smashes raw output record in 3Q; on track to meet 1 million bpd in 2030, access date: March 21, 2025, https://www.rystadenergy.com/news/vaca-muerta-smashes-crude-output-record-in-3q
11. Vaca Muerta: Argentina on the global energy stage - Tecpetrol, access date: March 21, 2025, https://www.tecpetrol.com/en/news/2025/techint-group-at-ceraweek
12. Argentina's crude oil and natural gas production near record highs - US Energy Information Administration (EIA), access date: March 21, 2025, https://www.eia.gov/todayinenergy/detail.php?id=63924
13. Enhancing Oil Reserve Prediction with Recurrent Neural Networks: A Data-Driven Approach, access date: March 21, 2025, https://www.researchgate.net/publication/383209180_Enhancing_Oil_Reserve_Prediction_with_Recurrent_Neural_Networks_A_Data-Driven_Approach
14. Production prediction at ultra-high water cut stage via Recurrent Neural Network, access date: March 21, 2025, https://ped.cpedm.com/EN/10.1016/S1876-3804(20)60119-7
15. Forecasting of oil production driven by reservoir spatial–temporal data based on normalized mutual information and Seq2Seq-LSTM - Sage Journals, access date: March 21, 2025, https://journals.sagepub.com/doi/full/10.1177/01445987231188161
16. Time-Series Well Performance Prediction Based on Convolutional and Long Short-Term Memory Neural Network Model - MDPI, access date: March 24, 2025, https://www.mdpi.com/1996-1073/16/1/499
17. Predicting Oil Production in Single Well using Recurrent Neural Network - ResearchGate, access date: March 24, 2025, https://www.researchgate.net/publication/344982805_Predicting_Oil_Production_in_Single_Well_using_Recurrent_Neural_Network

18. Prediction of Oil and Gas Reservoir Properties using Support Vector Machines | Request PDF - ResearchGate, access date: March 24, 2025, https://www.researchgate.net/publication/215662105_Prediction_of_Oil_and_Gas_Reservoir_Properties_using_Support_Vector_Machines
19. (PDF) Applications of Support Vector Machines in the Exploratory Phase of Petroleum and Natural Gas: a Survey - ResearchGate, access date: March 24, 2025, https://www.researchgate.net/publication/243190076_Applications_of_Support_Vector_Machines_in_the_Exploratory_Phase_of_Petroleum_and_Natural_Gas_a_Survey
20. Application of Machine Learning in Well Performance Prediction, Design Optimization and History Matching - OAKTrust, access date: March 24, 2025, https://oaktrust.library.tamu.edu/items/8fdb101d-e134-4b3b-b865-2722e900b762
21. A novel method for petroleum and natural gas resource potential evaluation and prediction by support vector machines (SVM), access date: March 24, 2025, https://www.cup.edu.cn/pub/geosci/docs/2023-10/1942e9be5ef54ac88092b866a3ffcc72.pdf
22. Decision Tree - Regulatory Compliance - Simply Explained | Home Page, access date: March 24, 2025, https://www.tidjma.tn/glossary/pm-decision-tree-2261/
23. A Data-Driven Oil Production Prediction Method Based on the Gradient Boosting Decision Tree Regression - Tech Science Press, access date: March 24, 2025, https://www.techscience.com/CMES/v134n3/49751/html
24. Oil and Gas Production Forecasting Using Decision Trees, Random Forst, and
25. Gas Production Forecasting Using Decision Trees, Random Forst, and
26. A Two-Stage Prediction Framework for Oil and Gas Well Production Based on Classification and Regression Models | Energy & Fuels - ACS Publications, access date: March 24, 2025, https://pubs.acs.org/doi/10.1021/acs.energyfuels.4c04762

27. Optimization of Oil Well Production Prediction Model Based on Inter-Attention and BiLSTM, access date: March 24, 2025, https://www.mdpi.com/2079-9292/14/5/1004
28. Advanced Deep Regression Models for Oil Production Forecast - PubPub, access date: March 24, 2025, https://assets.pubpub.org/uou6wlls/Hosseini-51716777093088.pdf
29. Advanced Deep Regression Models for Oil Production Forecast - Canadian AI Proceedings, access date: March 24, 2025, https://caiac.pubpub.org/pub/fkbusk2m
30. Advanced Deep Regression Models for Forecasting Time Series Oil Production - arXiv, access date: March 24, 2025, https://arxiv.org/abs/2308.16105
31. Prediction of Single-Well Production Rate after Hydraulic Fracturing in Unconventional Gas Reservoirs Based on Ensemble Learning Model - MDPI, access date: March 26, 2025, https://www.mdpi.com/2227-9717/12/6/1194
32. Top 5 Use Cases and Advantages of Predictive Analytics in Oil & Gas Sector - 10xDS, access date: March 26, 2025, https://10xds.com/blog/top-5-use-cases-and-advantages-of-predictive-analytics-in-oil-gas-sector/
33. IoT in Oil and Gas Industry, Technologies, Device List and Implementation Guide - DusunIoT, access date: March 26, 2025, https://www.dusuniot.com/blog/iot-in-oil-and-gas-industry/
34. Why is predictive maintenance so important for oil and gas operations? - Akselos, accessed March 26, 2025, https://akselos.com/predictive-maintenance-for-oil-and-gas-operations/
35. Predictive Data Analytics in Oil And Gas with AI - Talonic, access date: March 26, 2025, https://www.talonic.com/blog/predictive-data-analytics-in-oil-and-gas-with-ai
36. Data-Driven Decision-Making in Oil and Gas: The Power of Real-Time Analytics - TrackLynk, access date: March 26, 2025, https://www.tracklynk.com/data-driven-decision-making-in-oil-and-gas-the-power-

of-real-time-analytics/

37. Predictive Maintenance in Oil and Gas Project Management - Prismecs, accessed March 26, 2025, https://prismecs.com/blog/predictive-maintenance-in-oil-and-gas-project-management

38. The benefits of predictive maintenance | Business, accessed March 26, 2025, https://www.shell.us/business/fuels-and-lubricants/lubricants-for-business/lubricants-services/industry-articles/the-benefits-of-predictive-maintenance.html

39. AI for Oil and Gas - AspenTech, accessed March 26, 2025, https://www.aspentech.com/en/cp/ai-for-oil-and-gas

40. How Predictive Analytics is Revolutionizing Oil and Gas Operations - Cloud4C, access date: March 26, 2025, https://www.cloud4c.com/blogs/how-predictive-analytics-is-transforming-oil-and-gas-operations

41. Data Science in Oil and Gas: Improving Safety and Risk Management, access date: March 26, 2025, https://bigdata.growth.pro/blog/data-science-in-oil-and-gas/

42. Next-Generation Training Solutions for Oil & Gas - Tesseract Learning, access date: March 26, 2025, https://tesseractlearning.com/oil-and-gas/

43. Sensors in Oil and Gas Market to Grow by USD 1.59 Billion from 2025-2029, Driven by Rising LNG Trade and AI-Powered Market Evolution - Technavio - PR Newswire, access date: March 26, 2025, https://www.prnewswire.com/news-releases/sensors-in-oil-and-gas-market-to-grow-by-usd-1-59-billion-from-2025-2029--driven-by-rising-lng-trade-and-ai-powered-market-evolution---technavio-302347906.html

44. IoT in Oil and Gas | Benefits, Capabilities & Use Cases - A3Logics, access date: March 26, 2025, https://www.a3logics.com/blog/iot-in-oil-and-gas/

45. Sensors for the Oil & Gas Industry - TE Connectivity, access date: March 26, 2025,

https://www.te.com/en/industries/oil-gas-marine/applications/sensors-for-oil-and-gas.html
46. Real-Time Pipeline Monitoring and Threat Detection - OptaSense, accessed March 26, 2025, https://www.optasense.com/real-time-pipeline-monitoring/
47. IoT Solutions Impacting Oil and Gas Industry - Intrinsically Safe Store, access date: March 26, 2025, https://intrinsicallysafestore.com/blog/iot-solutions-for-oil-and-gas-industry/
48. Best Communication Solutions for the Oil and Gas Industry | Tridon, access date: March 26, 2025, https://www.tridon.com/best-communication-solutions-for-the-oil-and-gas-industry/
49. Oil and gas communications | HiSky - Hiskysat, accessed March 26, 2025, https://hiskysat.com/industry-use-cases/oil-and-gas/
50. How Does SCADA Work in Oil and Gas Applications? - Kimray, access date: March 26, 2025, https://kimray.com/training/how-does-scada-work-oil-and-gas-applications
51. Communications for Oil & Gas - Siemens Global, access date: March 26, 2025, https://www.siemens.com/global/en/products/automation/industrial-communication/communications-oil-gas.html
52. Argentina's plans to become a regional AI hub - BNamericas, accessed March 26, 2025, https://www.bnamericas.com/en/features/argentinas-plans-to-become-a-regional-ai-hub
53. Predictive Analytics Oil and Gas Industry - Teradata, access date: March 26, 2025, https://www.teradata.com/industries/energy-and-natural-resources/oil-and-gas
54. Oil & Gas Analytics - SAS Institute, access date: March 26, 2025, https://www.sas.com/en_us/industry/oil-gas.html
55. Well Data Analytics | Oil & Gas Analytics Software By TGS, accessed March

26, 2025, https://www.tgs.com/well-data-products/well-data-analytics
56. Oil and Gas Analytics Software - dataPARC, access date: March 26, 2025, https://www.dataparc.com/oil-gas/
57. Oil and Gas Analytics - Alteryx, access date: March 26, 2025, https://www.alteryx.com/solutions/industry/oil-and-gas
58. Big Data in the Oil and Gas Industry: Impact, Adoption, and Benefits - Computools, access date: March 26, 2025, https://computools.com/big-data-in-oil-and-gas-industry/
59. (PDF) Argentina's Potential in Artificial Intelligence - ResearchGate, access date: March 26, 2025, https://www.researchgate.net/publication/387172794_Argentina's_Potential_in_Artificial_Intelligence
60. Regulating Artificial Intelligence in Argentina - WSC Legal, accessed March 26, 2025, https://wsclegal.com/regulating-artificial-intelligence-in-argentina/
61. Energy Laws and Regulations 2025 | Argentina - Global Legal Insights, accessed March 26, 2025, https://www.globallegalinsights.com/practice-areas/energy-laws-and-regulations/argentina/
62. Could Argentina become the world's next AI hub? - Buenos Aires Herald, accessed March 26, 2025, https://buenosairesherald.com/business/tech/is-argentina-going-to-be-the-worlds-next-ai-hub
63. Foster innovation or mitigate risk? AI regulation in Latin America | White & Case LLP, access date: March 26, 2025, https://www.whitecase.com/insight-our-thinking/latin-america-focus-2024-ai-regulation
64. Argentina's approach to AI: 'Let's not overregulate ourselves' - BNamericas, accessed March 26, 2025, https://www.bnamericas.com/en/interviews/argentinas-approach-to-ai-lets-not-regulate-ourselves

65. The Role of Artificial Intelligence in Latin America's Energy Transition, access date: March 26, 2025, https://latamt.ieeer9.org/index.php/transactions/article/download/6829/1634/90112
66. Argentina - Digital Economy - International Trade Administration, access date: March 26, 2025, https://www.trade.gov/country-commercial-guides/argentina-digital-economy
67. Introducing AI Into Your Organization: Change Management Considerations for Utility Providers | Energy Central, access date: March 26, 2025, https://energycentral.com/o/greencastle-consulting/accounting-storm-activity-financial-forecasts-0
68. AI Change Management – Tips To Manage Every Level of Change | SS&C Blue Prism, access date: March 26, 2025, https://www.blueprism.com/resources/blog/ai-change-management/
69. Data strategy & AI adoption in Energy - Strategyand.pwc.com, accessed March 26, 2025, https://www.strategyand.pwc.com/it/en/insights/data-strategy-ai-in-energy.html
70. AI Adoption in Energy Should Focus on Agility, Not Algorithms, access date: March 26, 2025, https://www.bcg.com/publications/2024/ai-adoption-in-energy
71. Digital Transformation Training Courses - PetroKnowledge, access date: March 27, 2025, https://petroknowledge.com/training-courses/digital-transformation
72. VR Learning in Oil & Gas: 2024 Guide to Immersive Training - SynergyXR, access date: March 27, 2025, https://synergyxr.com/resources/learn/blogs/vr-learning/
73. Managing Innovation and New Technologies in the Upstream Oil & Gas Industry - Virtual Instructor Led Training (VILT) - EnergyEdge - PetroEdge, access date: March 27, 2025, https://petroedgeasia.net/training/managing-innovation-and-new-technologies-in-the-upstream-oil-gas-industry-training-course/

74. NExT | Energy Courses | Exploration and Production Training Courses, access date: March 27, 2025, https://www.nexttraining.net/
75. AI in Oil and Gas: Future Trends & Use Cases - Moon Technolabs, accessed March 27, 2025, https://www.moontechnolabs.com/blog/ai-in-oil-and-gas/
76. AI-Driven Reservoir Optimization for Oil & Gas Efficiency - Rosenxt, accessed March 27, 2025, https://www.rosen-nxt.com/en/business-fields/performance-optimization/upstream-optimization
77. AI-Based Smart Proxy Models for Accurate Oil Rate Prediction and Efficient Pipeline Monitoring, access date: March 27, 2025, https://www.biolscigroup.us/articles/AMS-8-148.php
78. AI spells opportunity and manageable risk for the oil and gas industry - DNV, access date: March 27, 2025, https://www.dnv.com/article/ai-spells-opportunity-and-manageable-risk-for-the-oil-and-gas-industry/
79. NEUQUÉN VACA MUERTA PRODUCTION DATA ANALYTICS: IMPACT OF GEOLOGY AND WELL COMPLETION DESIGN PARAMETERS ON WELL PRODUCTION, access date: March 27, 2025, https://www.iapg.org.ar/conexplo/PENDRIVE/pdf/simposios/vaca/vacamuerta16.pdf
80. Top AI Trends in the Oil and Gas Industry for 2025 - Medium, access date: March 27, 2025, https://medium.com/@API4AI/top-ai-trends-in-the-oil-and-gas-industry-for-2025-ad29774ae190
81. A Review of AI Applications in Unconventional Oil and Gas Exploration and Development, access date: March 27, 2025, https://www.mdpi.com/1996-1073/18/2/391
82. Robotics and artificial intelligence in unconventional reservoirs: Enhancing efficiency and reducing environmental impact., access date: March 27, 2025, https://wjarr.com/sites/default/files/WJARR-2024-3185.pdf

83. Transforming early-stage oil and gas production forecasting with generative AI - SEG Library, access date: March 27, 2025, https://library.seg.org/doi/10.15530/urtec-2024-4043583