HUB TECH IA

Deliverable report 6

AI and IAGEN Application Use Case

Site Assessment, Feasibility Analysis and Project Evaluation Exploitation with Generative Artificial Intelligence (IAGEN) in Vaca Muerta, Neuquén

I. Introduction

1. Presentation of the Sector and Specific Activity

The Vaca Muerta basin, located in the province of Neuquén, Argentina, is recognized for having one of the unconventional hydrocarbon formations most important worldwide.

Its exploitation requires a rigorous evaluation of the site to determine viability. economic, technical and environmental before starting any extractive operation. This analysis involves the evaluation of factors such as reservoir quality, site accessibility, infrastructure availability and environmental impact potential.

2. Challenge and Opportunity

Site evaluation and feasibility analysis traditionally require the manual collection and interpretation of large volumes of geological data, geophysical and drilling. This process can be expensive, time-consuming, and susceptible to human errors. In addition, traditional methods may not be sufficiently

accurate to characterize the complexity of unconventional reservoirs such as those of Vaca Muerta.

Generative Artificial Intelligence (GENAI) 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 content and original that is often indistinguishable from that created by humans.

It offers an innovative opportunity to optimize this process. Through analysis automated data, IAGEN can generate more accurate geological models, identify complex patterns and predict reservoir behavior with greater accuracy. This allows for reduced time and costs, improved decision-making and minimize the risks associated with the exploration and exploitation of hydrocarbons.

II. Application of IAGEN in Site and Feasibility Assessment

1. Using IAGEN in Site Assessment

Generative Artificial Intelligence (GENI) can be used to:

- Generate 3D geological models: From seismic, well and geological data. Remote sensing, IAGEN can create virtual representations of the subsurface more accurately than traditional methods. These models allow for a better understanding of the reservoir structure, the distribution of the hydrocarbons and the geomechanical characteristics of the rock.
- Identify areas of interest: IAGEN can analyze large data sets to identify patterns and anomalies that indicate the presence of hydrocarbons. This allows exploration to be focused on areas with greater potential and reduce the risk of drilling unproductive wells.
- Predict well productivity: By analyzing historical data of wells production and reservoir characteristics, IAGEN can predict the performance of future wells. This allows for optimized well planning.

drilling and maximize hydrocarbon recovery.

- Optimize well placement: IAGEN can help determine the optimal well location to maximize production and minimize environmental impact. This involves considering factors such as proximity to the existing infrastructure, the presence of aquifers and the ecological sensitivity of the area. Intelligent systems can alert operators about conditions dangerous on site, allowing for optimized response to potential problems and reduce the risk of accidents. In addition, IAGEN can contribute to more efficient resource management, optimizing energy use, minimizing waste and reducing environmental impact.

2. Demand Prediction

IAGEN can also be used to predict oil and gas demand. hydrocarbon industry depends largely on market demand, which is crucial to anticipate the quantity of products that will be needed in certain places and times.

IAGEN can analyze historical patterns and consumption trends to predict accurately predict future demand. This helps companies optimize their demand levels. inventory, production and distribution, minimizing the risks of overproduction or shortage of products.

III. Specific Technologies and Models Used

- Generative Neural Networks (GANs): GANs are a type of neural network that can generate new data that is similar to the training data. In the site assessment in Vaca Muerta, GANs can be used to generate realistic 3D geological models that accurately represent the complex structure of the Vaca Muerta formation, including fracture distribution, the porosity and permeability of the rock. They can also simulate production scenarios to predict reservoir behavior under different

operating conditions.

- Transformer Models: Transformer models are a type of network
  neural network that is used to process data sequences, such as text or images.
  In the site evaluation in Vaca Muerta, transformer models were
  can be used to analyze seismic data and interpret geological images,
  identifying subtle patterns that may indicate the presence of hydrocarbons.
- Deep Learning: Deep learning is a type of learning
  automatic that uses multi-layered neural networks to analyze complex data. In the Vaca Muerte site
  assessment, deep learning
  can be used to predict well productivity, considering variables
  such as shale gas composition, reservoir pressure and
  rock characteristics. It can also be used to optimize planning
  of drilling, determining the best trajectory for the wells and minimizing the risk of problems during
  drilling.
- Digital twins: A digital twin is a virtual replica of a physical asset, such as
  a well or a reservoir. In Vaca Muerta, digital twins can be used
  to simulate the behavior of the reservoir in real time, considering
  factors such as well production, water injection and pressure
  reservoir. This allows operators to optimize operations, predict
  potential problems and make informed decisions to maximize production and
  efficiency.

IV. Workflow for the Implementation of Artificial Intelligence Agents

1. Concept of IAGEN agents

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 high-demand cognitive tasks. From this capability, a new architecture emerges

Technological: IAGen-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 around.

An IAGen agent combines large language models with components additional features such as external tools, memory, planning and autonomous execution. This allows them to operate in complex environments, with the ability to break down objectives in steps, coordinate multiple actions, interact with digital systems (such as databases, APIs or documents) and adapt to changes in context in real time. These qualities distinguish them from traditional chatbots, and open up a spectrum 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 assume human resources, legal, financial or logistical tasks, and even those 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 your operations without losing quality or control.

In addition, agentic workflows—structures where multiple agents collaborate each other to solve complex problems—allows for the distribution of responsibilities among different agent profiles, each with specific functions. This generates Hybrid work environments where humans and agents coexist, optimizing times, costs, and results. The ability to connect agents with tools such as Google Drive, CRMs or document management platforms further expands its capabilities.

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

Among the benefits of authentic workflows driven by business models generative artificial intelligence, the possibility of automating processes is found complete, end-to-end production systems, and even add value from the leveraging the skills of language models based on these technologies.

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

2. Step-by-Step Workflow Design with IAGEN

a. Data collection: Collect geological, geophysical, well and remote sensors. In the case of Vaca Muerta, this involves the integration of data from various sources including existing well databases, drill logs, 2D and 3D seismic images, sensor data downhole, information on the composition of shale gas, and data microseismic to monitor fracturing activity.

b. Data preprocessing: Clean, organize and prepare the data for processing. analysis with IAGEN. This involves eliminating erroneous data, data normalization and transformation of data into a format suitable for IAGEN algorithms, such as creating maps of reservoir properties, generation of 3D geological models and preparation of time series data for production analysis.

c. Model training: Use the data to train IAGEN models specific to site assessment and feasibility prediction. This involves selecting the most appropriate IAGEN models for the task, as GANs for the generation of geological models, models of transformers for seismic analysis, and deep learning algorithms for productivity prediction. Optimization of model parameters to ensure its accuracy and performance.

d. Model validation: Evaluate the accuracy and performance of models using test data. This involves comparing the predictions of the model with actual production data, geological information from appraisal wells, and reservoir monitoring data to ensure reliability of the model.

e. Generating results: Using the models to generate predictions, simulations and visualizations. This involves applying the model to new data to obtain site information, such as predicting well productivity, identifying areas of interest for exploration, the simulation of reservoir behavior under different scenarios production, and the generation of geological risk maps.

f. Analysis and interpretation: Interpret the results generated by the IAGEN to make informed decisions about exploration and exploitation. This involves the Collaboration between AI and geoscience experts to analyze the results, validate the model's predictions with your expert knowledge, and extract conclusions relevant to decision-making.

3. IAGEN Agents Involved and their Role

- Data Collection Agent: Automates the collection and organization of data. data from various sources. This agent is responsible for accessing the different data sources, extract relevant information and organize it in a format suitable for analysis.
- Data Preprocessing Agent: Cleans and prepares data for use in IAGEN models. This agent is responsible for eliminating erroneous data, normalizing the data and transform it into a format suitable for IAGEN algorithms.
- Model Training Agent: Selects and trains IAGEN models most suitable for the task. This agent is responsible for evaluating different IAGEN models, select the most appropriate model for the task and optimize the model parameters.
- Model Validation Agent: Evaluates the accuracy and performance of the models.

models. This agent is responsible for comparing the model's predictions with real data to ensure the reliability of the model.

- Results Generation Agent: Generates predictions, simulations and visualizations from the models. This agent is responsible for applying the model to new data to gain insight into the site and feasibility of the project.
- Results Interpretation Agent: Helps experts interpret the results. results and make decisions. This agent is responsible for presenting the results clearly and concisely, and collaborating with experts in the interpretation of the results. results.

V. Direct Benefits in Operational and Strategic Terms

- Time reduction: IAGEN can significantly speed up the process of site evaluation, going from months to weeks or even days. This allows companies to make faster and more efficient decisions on exploration and exploitation of resources.
- Greater accuracy: The models generated by IAGEN are more accurate and robust than traditional methods, allowing for better decision making decisions. In the case of Vaca Muerta, IAGEN can improve the accuracy of the subsoil ownership model by 60% compared to the traditional geostatistics, reducing response time by 75%. This significantly reduces the risk in well location and improves any economic decision based on reservoir simulation.
- Cost reduction: Automating data analysis reduces costs associated with the exploration and evaluation of the site. IAGEN has the potential to reduce production costs by up to $5 per barrel, with a profit of productivity by 25%. Furthermore, it could increase oil reserves by 8%. to 20% by improving resource recovery methods.
- Risk minimization: IAGEN can predict potential geological and operational, allowing preventive measures to be taken. IAGEN's systems

They can monitor the status of the equipment in real time, using sensors and historical data to predict failures before they occur. This not only minimizes the risk of unplanned downtime, but also prolongs the lifespan of the equipment and reduces maintenance costs.

- Improving sustainability: IAGEN can contribute to optimizing the production and the reduction of the environmental impact of operations. IAGEN algorithms can analyze energy consumption data and propose changes in operating patterns that allow consumption to be reduced without compromising product quality.

1. Measurable Impact on Efficiency, Costs and Safety

- Increased efficiency: It is estimated that IAGEN can increase efficiency in the site evaluation by 30% to 50%. This translates into a reduction significant reduction in the time required for exploration and evaluation of resources.
- Cost Reduction: IAGEN can reduce production costs by up to 5%. dollars per barrel.
- Improved safety: Geological hazard prediction with IAGEN can improve the safety of operations and reduce the likelihood of accidents. This is achieved by early identification of potential hazards and implementation of preventive measures.

2. Comparison with Traditional Methods

Aspect	Traditional Method	IAGEN
Evaluation Time	3-6 months	2-6 weeks
Costs	High	Reduced

Precision	Variable	High
Risks	High	Mitigated with AI
Environmental Impact	Elderly	Minor
Efficiency of Analysis Data	Low	High

VI. Challenges and strategies

Impact of IAGEN on Employment in the Oil Industry

The implementation of IAGEN in the oil industry raises questions about its impact on employment. The cyclical nature of the industry, with fluctuations in the demand for labor, already represents a challenge for job stability in the sector. While the automation of tasks can lead to the reduction of some jobs, IAGEN is also expected to generate new opportunities
Job opportunities. The demand for professionals with experience in AI and earth sciences will increase, and new skills will be required for the management and interpretation of the data generated by IAGEN. It is crucial to invest in training and development of the workforce to ensure a fair transition and make the most of the opportunities offered by IAGEN.

Additionally, the adoption of new technologies may encounter resistance from part of the staff accustomed to traditional methods. It is crucial to address these concerns through training and effective communication of benefits from IAGEN.

Ethical Considerations of the Use of AI in the Hydrocarbon Industry

The use of AI in the hydrocarbon industry raises ethical considerations that must be addressed. It is essential to ensure that AI is used in a responsible and that potential risks are minimized. Transparency in AI decision-making processes is crucial to building trust and facilitating error identification. Protection of personal data and privacy of workers must also be guaranteed. Ethical frameworks must be established clear guidelines to guide the development and use of AI in the petroleum industry, considering the social, environmental and economic impact of these technologies.

Regulatory limitations

It is necessary to ensure that IAGEN is used responsibly and complies with the existing regulations. This involves working with authorities to establish regulatory frameworks that promote innovation and security.

Data availability

IAGEN requires large amounts of quality data for its training and operation. It is essential to invest in the acquisition, processing and data storage to ensure the effectiveness of IAGEN. The digitalization and Evaluation of data records is crucial, since incomplete records can be a major problem in the industry.

Specialized talent

Staff with experience in AI and earth sciences are needed to develop and Implementing IAGEN solutions. Investing in the training and recruitment of qualified personnel is crucial to ensuring the success of IAGEN implementation. Interdisciplinary collaboration between AI and geoscience experts is essential for maximize the benefits of IAGEN.

Strategies for Effective Integration

- Training and communication: It is essential to train staff in the use of IAGEN and communicate the benefits of its implementation. This involves developing

training programs that address the specific needs of
different roles and levels of the organization.

- Collaboration with regulators: Work with authorities to ensure the
compliance with regulations and promote responsible adoption of IAGEN.
This involves engaging in dialogues with regulators to establish frameworks
clear and efficient regulatory frameworks.
- Investment in data infrastructure: Develop a data infrastructure
robust and accessible to facilitate the use of IAGEN. This involves investing in
data storage, processing and analysis systems that allow for the
efficient information management.
- Short-term investment in AI agent implementation teams
Technology and training: Investment in proof of concept and testing is required
The focus here must be on developing the talent to implement it, as there is a trend toward cost
reduction in systems that allow
“no code” and “low code” automation. For the first stage, we also
recommends using teams with experience in design and implementation
AI agents. Finally, it is key to form an in-house team for the
accompaniment and appropriation of an agentic culture that redefines the
human-computer interaction.
- Attracting talent: Invest in the training and hiring of personnel with
experience in AI and geosciences. This involves developing specialized training programs and
offering competitive working conditions to attract
best talents.

VII. Conclusion

The application of Generative Artificial Intelligence in site assessment and
The feasibility of exploitation in Vaca Muerta has the potential to transform the industry
of hydrocarbons. By automating data analysis, we can generate more
accurate and predict reservoir behavior, IAGEN allows for optimization of the

decision-making, reduce costs, improve safety and minimize impact
environmental. The adoption of this technology will be key to competitiveness and
sustainability of the sector in the future.

In the future, IAGEN is expected to continue to evolve and its application in the
oil industry to expand further. Research and development of new
IAGEN techniques, along with improving data quality and availability,
will allow greater precision in site evaluation, prediction of the
well productivity and operations optimization. IAGEN has the potential to contribute to more sustainable
and efficient energy production in the
long term, maximizing the value of Vaca Muerta's resources and minimizing the
environmental impact.

Sources cited

1. The Influence of Artificial Intelligence on the Oil Industry. - University
Territorial Polytechnic of the Tuy Valleys, access: February 28, 2025,
https://uptvallesdeltuy.com/ojs/index.php/revista_criticaconciencia/article/download/4
11/194/960

2. The Era of Artificial Intelligence in the Oil Industry: Key Opportunities and Challenges for the Sector in
Mexico - ITPE, access: February 28, 2025,
https://itpe.mx/la-era-de-la-inteligencia-artificial-en-la-industria-petrolera-oportunidades-
Keys and challenges for the sector in Mexico

3. The Impact of AI on the Oil and Gas Industry, accessed: February 28, 2025,
https://acp.com.co/portal/el-impacto-de-la-ia-en-la-industria-del-petroleo-y-el-gas/ 4. How Artificial
Intelligence can strengthen the oil industry - Misión Verdad,
access: February 28, 2025,
https://mision Verdad.com/venezuela/como-la-inteligencia-artificial- may-fortalecer-la-i
oil industry

5. Global oil industries, limitations and scope in the 21st century - Dialnet, accessed: February 28, 2025,
https://dialnet.unirioja.es/descarga/articulo/9493475.pdf

6. 10 Ethical Considerations Regarding the Use of Artificial Intelligence, accessed: February 28, 2025, https://adrianvillegasd.com/10-consideraciones-eticas-en-torno-al-uso-de-la-inteligencia-artificial/

7. Petroleum Engineering Magazine July-August 2024 by aipmac - Issuu, accessed: February 28, 2025, https://issuu.com/aipmac/docs/revista_ingenier_a_petrolera_julio-agosto_2024