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HUB TECH IA

Deliverable report 2

AI and IAGEN Application Use Case
Site Assessment, Planning and Site Feasibility Reporting in Vaca Muerta, Neuquén

I. Introduction

Vaca Muerta, located in the province of Neuquén, Argentina, is one of the formations of the world's largest shale oil and shale gas reserves. Exploration and exploitation of hydrocarbons in this region presents unique challenges due to the complexity geological, environmental considerations and the need for infrastructure robust.

Generative Artificial Intelligence (GENI) offers an unprecedented opportunity to optimize the assessment of site feasibility, generating detailed reports and accurate from multidisciplinary data.

II. Presentation of the opportunity

Traditional evaluation of sites for hydrocarbon exploration and exploitation is based on manual processes or semi-automated approaches with capabilities limited, which can be slow, expensive, and error-prone. Uncertainty Geological variability, environmental variability, and strict regulatory requirements add complexity to the process. IAGEN offers an innovative solution to automate the analysis, reporting and decision making, with greater precision, speed and efficiency. There are already success stories in the industry. For example, companies

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as Shell, BP and Exxon Mobil are using IAGEN for exploration
reservoirs, production optimization and risk management 5.

III. Application of AI, AI agents and IAGEN in Site Assessment

1. Implementation of IAGEN in Feasibility Analysis

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.

IAGEN can be used to process and analyze large volumes of data geological, geophysical, geochemical, environmental, infrastructure and production. These data are integrated to generate predictive models and simulations that allow assess the viability of a site more accurately.

In addition, IAGEN allows the creation of predictive maps of the properties geological information of the subsurface from laboratory data and field measurements. These maps, generated by neural networks, offer an accurate representation of the distribution of geological formations, including porosity, permeability and the presence of fractures, which facilitates the identification of areas with greater potential for the exploration and exploitation of hydrocarbons.

Specific application examples:

- Productivity Prediction: IAGEN analyzes historical production data, geological information, drilling parameters and nearby well data for predict future production from a well more accurately than traditional methods traditional.
- Well Location Optimization: IAGEN identifies optimal locations for drilling new wells, considering factors such as geology,

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existing infrastructure, environmental impact and proximity to other wells productive.

- Environmental Risk Assessment: IAGEN simulates the environmental impact of different development scenarios, including waste generation, emissions greenhouse gases and the impact on biodiversity, helping to identify and mitigate potential risks.
- Development Strategy Design: IAGEN generates different development scenarios. development, considering economic, environmental and social factors, to help companies make informed decisions about how best to exploit the resources of Vaca Muerta.

2. Technologies, techniques and models used

- Deep Neural Networks (DNN): For the analysis of geological data, geophysical and production, including well productivity prediction, the optimization of well location and the generation of predictive maps geological properties. Artificial Neural Networks (ANN) are also used in 3D modeling of geological attributes and in grade estimation minerals, improving the accuracy of geological models and the evaluation of resources.
- Natural Language Processing (NLP): For the generation of automatic reports from the analyzed data, the extraction of information relevant technical documents, contracts and regulations, and efficient communication between the different actors involved in the project.
- Artificial Vision: For the analysis of satellite images, aerial photos and data from drones, allowing the identification of geological features, the detection of anomalies and environmental impact monitoring. Computer vision is also It is applied in other energy sectors, such as the nuclear industry, where it is used for fuel pellet inspection and defect detection fuel rods, ensuring the quality and safety of the components. • Generative Adversarial Models (GAN): For the simulation of reservoir development scenarios, the generation of synthetic data that complements the

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real data and the creation of more accurate geological models. GANs can generate synthetic data that mimics the characteristics of real data, which It is especially useful when the availability of real data is limited.
Within the GAN models, there are variants such as the Wasserstein GAN (WGAN), which has been applied in high energy physics to improve the accuracy of simulations.

- Optimization Algorithms: For drilling planning, management of resources, production optimization and impact minimization environmental.
- Big Data and IoT Platforms: For the collection, storage and management of large volumes of real-time data from various sources, including sensors in wells, weather stations and satellite images.

IV. Phases for the Implementation of Generative AI

1. Definition of objectives and scope: Clearly define the objectives you are seeking to be achieved with the implementation of IAGEN, the scope of the project and the areas specific where the technology will be applied.
2. Data collection: Integrate data from various sources, including images satellite, seismic data, real-time sensors, historical records, geological information, environmental data, prediction models, information production and economic information.
3. Data processing and analysis: Use IAGEN to process, clean and analyze the data, identifying patterns, trends and anomalies.
4. Modeling and simulation: Develop predictive models using the techniques of IAGEN best suited to the problem, such as neural networks, models generative or optimization algorithms, and perform simulations to evaluate different development scenarios.
5. Reporting: Generate automated reports that present the analysis results in a clear, concise and visually appealing manner, including

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maps, graphs and tables.

6. Validation and adjustment: Validate the models with industry experts and adjust them.
   parameters to improve the accuracy and reliability of the results.
7. Communication and Collaboration: Use NLP tools to facilitate communication
   communication and collaboration between the different actors involved in the
   project, including geologists, engineers, managers, and regulators. This allows
   better understanding of results, more informed decision-making
   and more efficient project management.
8. Decision making: Use the reports generated by IAGEN to make decisions.
   informed decisions on site viability, development planning,
   risk management and production optimization.
9. Monitoring and Evaluation: Monitor the performance of IAGEN models throughout the
   over time, assess their impact on efficiency, costs and decision-making
   decisions, and make adjustments or improvements as needed.

V. AI agents applied to Vaca Muerta: site assessment and planning

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 tasks
high-demand cognitive skills. From this capacity, 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 additional components such as external
tools, memory, scheduling, and autonomous execution.
This allows them to operate in complex environments, with the ability to break down

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Step-by-step objectives, 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 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 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 with each other to solve complex problems—allow responsibilities to be distributed between 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,

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from responsible design to human oversight. Therefore, understanding your architecture, its operational logic and its potential impacts is fundamental to its effective and safe adoption in various professional contexts.

2. Agent design proposal applicable to the activity

a. AI agent for data extraction and systematization

• What it does: Automates data collection from sensors, internal databases, satellite images and open sources.

• How it helps: Accelerates and systematizes the acquisition of critical data from the field and wells, key to assessing the site's potential.

b. AI agent to process data

• What it does: Cleans, corrects, and transforms data for analysis by another Agent of AI

• How it helps: Ensures that the information used to evaluate the site is accurate, reliable and in usable format.

c. Geological Analysis Agent

• What it does: Detects patterns, structures and hydrocarbon-rich zones from geological data.

• How it helps: It allows you to quickly identify which areas of the site have the most production potential.

d. AI agent for modeling environmental impact

• What it does: simulates environmental impacts under different scenarios (water, air, waste, biodiversity).

• How it helps: It assesses the environmental viability of the project before intervening in the

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land, avoiding legal and ecological risks.

e. AI agent that systematizes results and generates reports

• What it does: Creates reports with graphs, analysis, and automatic recommendations.

• How it helps: Facilitates communication of technical results to teams executives and regulatory authorities.

f. Resource Optimization AI Agent

• What it does: Recommends how to use water, energy and materials more efficiently efficient.

• How it helps: Reduces costs and improves the sustainability of site development.

g. Scenario simulation agent

• What it does: Simulates different operating configurations and their impacts (productivity, costs, safety).

• How it helps: It enables informed strategic decisions about how to develop the site.

3. Summary of agentic workflow for the Vaca Muerta use case

Orchestration of AI agents for:

• Analyze the geological and productive potential of the site.

• Evaluate environmental and operational risks.

• Simulate and plan more viable and efficient development strategies.

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• Deliver clear, automated reports for quick decision making and
data-driven.

AI Agents	Role/task
Data Collection Agent	Automates data collection various sources, including databases internal data, sensors, images satellite and public sources.
Data Processing Agent	Clean, structure and prepare data for analysis, performing tasks such as data deletion duplicates, error correction and the transformation of data into formats compatible with IAGEN.
Geological Analysis Agent	Analyzes geological and geophysical data to identify patterns, structures, faults and areas of interest for the exploration and exploitation of hydrocarbons.
Environmental Modeling Agent	Simulates the environmental impact of different development scenarios,

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	including water pollution, the air and the soil, the generation of waste and the impact on the biodiversity.
Reporting Agent	Generate automated reports with visualizations, analysis and recommendations, presenting the information in a clear and concise manner for decision-making.
Resource Optimization Agent	Optimizes resource allocation, such as water, energy and materials, to maximize efficiency and minimize production costs.
Scenario Simulation Agent	Generates simulations of different operational scenarios to evaluate your impact on production, costs, environment and safety.

VI. Concrete opportunities and benefits

1. Impact on Efficiency and Costs

- Reduction in Analysis Time: IAGEN significantly reduces the time necessary for site evaluation, allowing for more informed decision-making fast and accelerating the development process.
- Resource Optimization: IAGEN helps optimize the use of resources, such as

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water, energy and materials, reducing exploration and development costs and minimizing environmental impact.

- Early Risk Detection: IAGEN identifies potential risks in the early stages of the project, such as the presence of geological faults, the possibility of contamination of aquifers or instability of the ground, which allows taking preventive measures and avoid costly mistakes.
- Increased Accuracy: IAGEN improves the accuracy of predictions and simulations, which reduces uncertainty in decision-making and increases the probability of project success.
- Safety Improvement: IAGEN can contribute to the safety of operations in Vaca Muerta by identifying potential risks, predicting equipment failures and the implementation of proactive security measures. By For example, machine vision can be used to monitor facilities in real time, detecting anomalies and preventing accidents.

2. Contribution to Sustainable Development

The application of IAGEN in Vaca Muerta not only offers economic benefits, but It also has the potential to contribute to the sustainable development of the region. optimize the use of resources, minimize environmental impact and support decision-making informed decisions, IAGEN can help ensure the responsible exploitation of Vaca Muerta resources, protecting the environment and communities locals.

3. Comparison with Traditional Methods

Feature	Traditional Methods	IAGEN

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Analysis time	Slow (weeks or months)	Fast (days or hours)
Precision	Limited by the human experience and the amount of data that can be processed manually	Greater precision thanks to to the analysis of large volumes of data and the ability to identify complex patterns
Cost	High (requires a lot of hand of construction site specialized and long of processing times)	Minor cost (automation of tasks, reduction of staff and optimization of resources)
Ability of simulation	Limited to scenarios simple and with a high degree of uncertainty	High capacity of simulation of complex scenarios with greater precision and detail
Adaptability	Low adaptability to new conditions or unexpected data	High adaptability to new conditions and the ability to integrate data from various sources
Subjectivity	Greater subjectivity in the	Minor subjectivity

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	interpretation of the data	thank you to the analysis automated and the ID of objective patterns

VII. Challenges and strategies for implementing AI agents in use cases

Barriers to Implementation

- Resistance to change: The energy industry may be reluctant to adopt new technologies due to the initial investment, the need to train staff and the uncertainty about the results.
- Need for protocols and mitigation measures: protocols and measures are needed Risk mitigation measures on the use of IAGEN in the assessment environmental, operational safety and data protection.
- Reliability and explainability: It is essential to ensure reliability and mitigate the “black box” scenarios of the IAGEN models, so that the results are understandable and reliable for decision-makers.
- Integration with existing systems: IAGEN must integrate with the company's existing planning, project management, and database systems.

Recommendations and necessary investment

It is recommended to explore the “on-premise” or local AI Agent models.

- Short-term investment in AI agent implementation equipment: It requires investment in proof of concept and pilot testing. The focus here has to be on training the talent to implement it, as there is a trend of cost reduction in systems that allow “no code” and “low code”. For the first stage, it is also recommended to use teams with experience in designing and implementing AI agents. Finally, it is key form an in-house team to support and embrace an agentic culture that redefines human-machine interaction.

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- Training and communication: It is essential to train staff in the use of IAGEN and communicate the benefits clearly and transparently, to generate trust and facilitate the adoption of technology.
- Collaboration with regulators: Work with regulatory bodies to develop regulatory frameworks that enable the safe and responsible adoption of IAGEN in the energy industry.
- Data availability: The quality and quantity of available data are crucial for the success of IAGEN. It is necessary to evaluate, when designing pilot tests, various strategies to determine how to address the challenge.
  extraction, reuse and systematization of data that will be key to the development of agentic AI. In particular, accurate, complete and representative of the conditions of the deposit.
- Data privacy and security: It is important to ensure the privacy and security of data. security of the data used by IAGEN, especially when it comes to sensitive or confidential information.

2. Specific solutions and strategies

Next, we develop concrete examples and sequential approximations, which allow us to understand the logic of interaction between humans and AI agents.

Development of explainable models: an important challenge is linked to understanding the way in which agents “explain” the decisions and results they arrive at.
“Explainable and interpretable AI” techniques are key.
Feature importance heat maps. A GEN AI agent predicts the productivity of a well at a specific location. A map of the well is then generated. heat map showing which features (geological, seismic, production data from nearby wells, etc.) were most influential in the prediction. The map might show that rock porosity was the most important factor, followed by proximity to a geological fault.

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Stage of human intervention: geologists can validate whether the importance assigned to the features make sense based on your expert knowledge, increasing the confidence in the prediction.

Rule-based or weighted rule explanations: an IAGEN model suggests an optimal location for a new well. The model generates a series of rules that They reduce our uncertainty about the variables and factors that were taken into account at the time to probabilistically weight the data. For example: "If the porosity is high, the permeability is high and the depth is less than X meters, then this location might be more favorable based on criteria defined by a human expert."

Human intervention: Engineers can design the prompts to be injected into the AI agents that determine the rules to be considered and reviewed.

Visualizing training data:

Hypothetical scenario: An IAGEN model agent assesses the environmental risk of a project based on several variables to be correlated. The agent is designed to show examples of training data that led the model to predict a high risk. For example, satellite images showing previous deforestation in areas similar or historical data on water pollution.

Human intervention: Environmental experts can assess whether data from training are relevant and representative, and if the risk assessment of the model It is reasonable.

Sensitivity analysis. Hypothetical scenario: an IAGEN model simulates different reservoir development scenarios. The AI agent shows how the model's prediction changes when input values (e.g., reservoir pressure or water injection rate) are slightly modified.

Human intervention: Engineers can identify which parameters have the greatest impact on predictions and better understand the uncertainty associated with results.

Using simpler models for explanations:

Hypothetical scenario: An AI agent predicts the viability of a site. To improve the explainability, a simpler model (such as a decision tree) is trained that

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approximates the behavior of the complex model. The simple model is easier to interpret and can provide a general explanation of the model's decision complex.
Human intervention: the developers of the simplest model design the rules that will be critical in the decision tree.

- Integration with existing systems: Develop IAGEN solutions that integrate with the company's existing systems, facilitating adoption and use of technology.
- Data acquisition and management strategies: Implement strategies for the data acquisition, cleaning, validation and management, ensuring quality and availability of the information necessary for IAGEN.
- Security and privacy protocols: Implement security and privacy protocols. privacy to protect the data used by IAGEN, complying with the regulations and ensuring the confidentiality of information.
- Skills and Experience for IAGEN Implementation

The successful implementation of generative AI and AI agents in the energy industry requires professionals with skills and experience in different areas, including geology, engineering, prompting, AI agent design, traditional software and statistics. It is essential that geologists working with integrated with IAGEN and agentic flows, in order to understand and apply IAGEN techniques in a effective.

VIII. Conclusion and Recommendations

Generative Artificial Intelligence (IAGEN) is presented as a tool with enormous potential to transform the energy industry, optimizing the evaluation of sites, improving efficiency, reducing costs and mitigating risks in Vaca Muerta.
Its application in the evaluation of sites in this formation can generate benefits significant, such as the reduction of exploration times and costs, optimization

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of well location, improved productivity prediction, evaluation
environmental risk and the design of more efficient development strategies and
sustainable.

Agentic AI and generative AI drive efficiency and profitability in the
exploitation of hydrocarbons, but also plays a crucial role in promoting the
sustainable development in Vaca Muerta. By allowing a better understanding of the subsoil,
By optimizing the use of resources and minimizing environmental impact, IAGEN contributes to the
responsible exploitation of the region's energy resources, ensuring their
long-term viability.

Short-term recommendations:

- Implement pilot projects: start with pilot projects to validate the
  effectiveness of IAGEN under real-life conditions and evaluate its impact on efficiency,
  costs and decision-making. The planned pilots must consider the specific context of
  Vaca Muerta, geological complexity, and the protection of the
  environment, water availability and infrastructure. It is also key
  consider when designing them, how they influence cost reduction and
  the overall efficiency of the tasks or subtasks involved in the agentic flow or
  in the IAGEN intervention.
- Promote collaboration: promote collaboration between companies, institutions
  academics, regulatory bodies and technology providers for the
  development and implementation of IAGEN solutions in the energy industry.
- Develop standards and protocols in pilots or proofs of concept: work
  in the development of standards and best practices in the elaboration and application
  of the pilot.
- Invest in research and development: interact with academia and research areas
  (laboratories and centers) to absorb trends and exponential changes in the AI industry,
  allowing for adaptation to more
  innovative and efficient, which at the same time reduce implementation costs.

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- Consider ethical implications: address the ethical and responsible for the use of AI Agents and IAGEN, depending on the tasks and the use case to be addressed.

Additional information

- Specific benefits for Vaca Muerta: AI agents and the different IAGEN models can help address the specific challenges of exploration and exploitation in Vaca Muerta, such as the geological complexity, the environmental protection and production optimization. For example, the Computer vision can be used to analyze satellite images and identify areas most likely to contain hydrocarbons, while Generative models can simulate reservoir behavior under different operating conditions, optimizing production and minimizing environmental impact.
- Safety Considerations: It is important to address safety considerations. security related to the use of IAGEN, such as data protection, cybersecurity and error prevention in models. They must be implemented security measures to protect sensitive data, ensure the integrity of systems and validate the results of IAGEN models.

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