HUB TECH IA

Deliverable report 20

Generative Artificial Intelligence

Design and Planning of Projects and Operations in the Gas Industry, Oil and Water in Vaca Muerta, Neuquén

I. Introduction

1. Presentation of the Sector and Specific Activity

Vaca Muerta, in the province of Neuquén, Argentina, is one of the main shale oil and shale gas formations in the world, representing a key source for the energy development of the country and the region. The exploration and exploitation of these resources require meticulous planning, efficient project design and operations adapted to the geological and environmental characteristics of the area.

The activity in question focuses on the use of Generative Artificial Intelligence (IAGEN) for the design and planning of projects and operations, with special emphasis on infrastructure optimization, operational scenario modeling and analysis predictive in the gas, oil and water industries.

II. Problem, Challenge or Opportunity

The industry could present multiple challenges in planning and executing operations in Vaca Muerta:

- High complexity in project design due to geological variability, strict regulations and high investment costs.

- Lack of precision in planning due to reliance on conventional models that They do not always reflect realistic operating scenarios.
- Delays in project generation due to the need for iterations constants to adjust designs.
- Operational and safety risks arising from extreme geological conditions and environmental factors.

IAGEN allows to overcome these challenges by generating optimized models of infrastructure, operations and project planning in an automated manner, precise and contextualized.

III. Application of IAGEN in the Specific Activity

Generative Artificial Intelligence (GENI) is a branch of artificial intelligence that focuses on the creation of 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 and original that is often indistinguishable from that created by humans. It has the characteristic multipurpose, so it can be applied in virtually all areas of human development and knowledge.

1. How IAGEN is Applied in Project Design and Planning

IAGEN is applied at various key stages of project design and planning in the gas, oil and water industry:

a. Automatic generation of infrastructure and operations models

- Using generative models to create optimized well designs, pipelines, treatment plants and pumping stations based on data geological, costs and regulations.
- Simulation of extraction and distribution scenarios to evaluate efficiency operational before implementation.

- Boost creativity and innovation: IAGEN can help in the process of brainstorming, exploring unconventional solutions and enhancing the creativity in project design.

b. Optimization of contextualized operations design

- Use IAGEN to adjust operational designs based on changes in conditions geological, climatic and regulatory.
- Risk assessment and dynamic adaptation of strategies using models predictive generative.

c. Automation in project planning and generation

- Creation of multiple project variants in record time, with analysis comparative based on costs, safety and viability.
- Reduction of planning time through generative models that learn from previous projects.
- Streamline workflows: IAGEN can optimize resource allocation and manage time by tracking project needs, streamlining workflows.
- Facilitate collaboration: IAGEN can automate routine tasks such as schedule meetings, send reminders, summarize documents for meetings and create meeting minutes, facilitating communication and collaboration in the work teams.

2. Specific Technologies and Models Used

- Generative Adversarial Network (GAN) models for scenario creation geological and operational in 3D.
- Transformers and Large Language Models (LLMs) for the automated generation of technical reports, planning documents, and operational strategies.
- Generative Physical Simulation Models to predict the behavior of infrastructures under different operating conditions.

- Digital Twins powered by IAGEN to test operational models in virtual environments before actual implementation.

IV. Application of AI agents powered by IAGEN in the activity

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 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 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 its potential impacts is fundamental to its effective and safe adoption in various professional contexts.

2. Agentic Flow Design Proposal for Implementation

a. Step-by-Step Workflow with IAGEN

1. Data Entry: Entry of geological, climatic, operational and

regulatory.

2. Model Generation: Using IAGEN to create optimized designs of infrastructure and operations.
3. Predictive Simulation: Scenario evaluation and dynamic project adjustment.
4. Technical Validation: Validation by human experts before execution.
5. Implementation and Monitoring: Field application and adjustments through Digital Twins.

b. IAGEN Agents Involved and Their Role

- 3D Model Generator: Create prototypes of wells, pipelines, and plants. This agent uses geological data, design specifications and operational constraints to generate three-dimensional models of the infrastructure. You can explore different configurations and optimize the design based on criteria such as efficiency, security and cost.
- Operational Scenario Simulator: Evaluates performance and risks. This agent uses the generated 3D models and operational data to simulate the operation of the infrastructure in different scenarios. It can predict the system behavior, identify potential risks and assess the impact of different variables in the operation.
- Resource Optimizer: Reduces costs and improves efficiency. This agent analyzes simulation data and seeks to optimize the use of resources such as materials, energy, and personnel. You can identify areas for improvement in operational efficiency and propose solutions to reduce costs and minimize the impact environmental.
- Technical Documentation Generator Assistant: Automates reports of planning. This agent uses project data and the information generated by other agents to create technical reports, planning documents, and other materials necessary for project execution. This reduces the time and the effort required for documentation, and ensures consistency and accuracy of information.

These agents interact with each other in a coordinated manner. The 3D Model Generator provides the basis for the Simulation of Operational Scenarios, which in turn feeds to the Resource Optimizer. The Technical Documentation Generator Wizard uses information from all agents to create project documentation.

c. Concrete Example

Case 1: Optimization of the design of a gas pipeline in Vaca Muerta

- Input data: Topographic data, production demand, regulations environmental.
- IAGEN generates alternative designs: Models adjusted according to environmental impact and costs.
- Gas flow simulation: Performance evaluation under different conditions.
- Selection of optimal design and technical validation.

Case 2: Optimization of water production for hydraulic fracturing

- Input data: Hydrogeological data, well location, water demand, environmental regulations.
- IAGEN generates production models: Simulates different extraction scenarios of water, considering the availability of the resource, the quality of water and the environmental impact.
- Pumping system optimization: IAGEN adjusts the design and operation of the pumping system to minimize energy consumption and ensure a efficient water supply.
- Risk prediction: IAGEN identifies potential risks such as contamination of aquifers or the decrease in water flow, and proposes preventive measures.
- Real-time monitoring: Sensors and control systems are implemented to monitor water production and adjust operations accordingly changing conditions.

V. Concrete Opportunities and Benefits

1. Measurable Impact on Efficiency, Costs, Time and Safety

- Reduction of project planning time by 40%-60%, thanks to the automatic model generation.
- Savings of up to 30% in design and engineering costs by avoiding iterations unnecessary.
- 25% improvements in operational efficiency, through optimized simulations of extraction and distribution processes.
- 50% reduction in operational risks, thanks to generated predictive models with IAGEN that simulates possible failures before they occur.
- Resource allocation optimization: IAGEN merges historical and current data real-time in a unified dashboard to optimize the allocation of resources, discover patterns and potential bottlenecks, offering insight clearer understanding of workload distribution and budget use.
- Improved employee performance: LLM agents can be especially transformative for less experienced employees, improving their performance and facilitating knowledge transfer within the teams.

2. Comparison with Traditional Methods

Feature	Traditional Methods	IAGEN
Planning	Rigid, sequential, with little flexibility changes.	Adaptive, iterative, allows adjustments during the process.

Design	Model-based with predefined, limitations in the exploration of alternatives.	Generation of multiples optimized designs, exploring a greater solution space.
Decision making	Based on experience and limited data, with higher risk of bias.	Based on analysis of large volumes of data, with models predictive that reduce uncertainty.
Efficiency	Manual processes that They consume time and resources.	Automation of tasks, optimization of resources and reduction of time.
Communication	Limited to channels traditional, with greater risk of errors and lack of coordination.	Facilitated by AI tools that allow a fluid communication and transparent between the teams.
Risk Management	Reactive, with risk identification in late stages.	Proactive, with models predictive that anticipate possible issues.

Costs	Seniors costs associated with iterations, errors and delays.	Cost reduction thank you to the optimization of resources and efficiency in planning.

VI. Challenges and Strategies to Overcome Them

• Barriers to Implementation

- Resistance to change in engineering and planning teams.
- Lack of structured data to feed generative models.
- Regulations and standards that do not yet contemplate the use of IAGEN.
- High initial implementation costs.
- Data availability: The quality and quantity of data available in Vaca Muerta may be limited, especially historical and contextualized data that are relevant to training IAGEN models. It is crucial to invest in collecting, data cleansing and structuring to ensure the effectiveness of IAGEN.
- Connectivity in the area: Communications infrastructure in remote areas Vaca Muerta may present limitations in terms of bandwidth and reliability. This can make it difficult to implement IAGEN solutions that require cloud access or real-time data processing. They must be consider solutions that allow local data processing or optimization of the use of available connectivity.
- Need for collaboration between different actors: The successful implementation of The IAGEN in Vaca Muerta requires collaboration between operating companies, technology companies, academic institutions and government agencies. It is essential to establish cooperation mechanisms to share data,

knowledge and resources, as well as to define regulatory frameworks that promote innovation.

- **Possible Negative Consequences or Risks**

While IAGEN offers great opportunities, it is crucial to consider the potential risks associated with its implementation:

- Technological dependence: Excessive dependence on IAGEN can reduce the capacity for critical analysis and independent decision-making on the part of of professionals. It is essential to maintain a balance between the automation and human intervention.
- Data biases: IAGEN models are trained on historical data, that may contain biases that are perpetuated in the decisions made by the AI. It is important to ensure the quality and representativeness of the data used to avoid discriminatory or unfair results. • Information security: IAGEN requires access to large volumes of data, which increases the risk of cyberattacks and the vulnerability of the sensitive information. It is crucial to implement robust security measures to protect data and technological infrastructure.
- Lack of transparency: Some IAGEN models can be complex and difficult to interpret, making it difficult to understand the decisions made by AI. It is important to develop mechanisms that allow transparency and the explainability of IAGEN models.

- **Strategies for Effective Integration**

- Specialized IAGEN training for technical and planning teams.
- Progressive use of IAGEN in specific areas before full adoption.
- Collaboration with regulatory bodies to update standards to new technologies.

- Implementation of hybrid systems that combine human expertise with generative models.
- Short-term investment in AI agent implementation teams
  Technology and training: Investment in proof of concept and testing is required pilot. The focus here has to be on training the talent to implement, since There is a trend towards cost reduction in systems that allow "no code" and "low code" automation. For the first stage, we also recommends using teams with experience in the design and implementation of 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.

VII. Conclusion

Generative Artificial Intelligence represents a radical transformation in project planning and design in the gas, oil, and water industry in Vaca
Dead. Its application allows for accelerating infrastructure design, reducing costs, improve operational efficiency and optimize strategic decision-making.
Adoption of this technology not only improves the competitiveness of companies in the sector, but also sets a new standard in resource management
energetic.

IAGEN is not limited to being an efficiency tool, but acts as a
A catalyst for innovation and sustainable development in Vaca Muerta. By optimizing infrastructure design, improving water management, and predicting risks, IAGEN contributes to a more responsible exploitation of resources, promoting the economic growth and sustainability in the region, in line with the objectives of the Vaca Muerta AI Pole.

Glossary of Technical Terms

- IAGEN: Generative Artificial Intelligence.
- GANs: Generative Adversarial Networks.
- LLMs: Large Language Models.
- Digital Twins: Digital representations of physical assets.
- Shale oil and shale gas: Shale oil and gas.
- Hydraulic fracturing: Technique used for the extraction of gas and oil from shale formations.

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