HUB TECH IA

Report and deliverable 25

Use case

"Implementation of Generative Artificial Intelligence (IAGEN) for Automated Monitoring at Power Plants in Neuquén, Vaca Muerta

I. Introduction

The energy industry is in a constant search for optimization of processes and improved production efficiency.

In this scenario, Generative Artificial Intelligence (IAGEN) is presented as a tool with disruptive potential to revolutionize the monitoring and management of power plants.

This report analyzes the implementation of IAGEN for automated monitoring in power plants in Vaca Muerta, Neuquén, Argentina, considering the current state monitoring, available technologies, benefits, challenges, ethical aspects and the security of your application.

II. Current Status of Monitoring at Power Plants in Vaca Muerta

Vaca Muerta has established itself as the main non-metallic hydrocarbon deposit Argentina's conventional oil, representing 52% of oil production and 46% of the country's gas production. Despite its importance, monitoring in the power plants in the region still present challenges. Most companies are based on traditional methods that require the presence of personnel on site and the

manual review of data, which may result in delays in detecting anomalies and an increase in operating costs.

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.

The adoption of IAGEN technologies has not yet become widespread in the industry, however However, it has great potential to increase efficiency in the sector.

III. IAGEN Technologies Available for Power Plant Monitoring

IAGEN encompasses a set of technologies that enable machines to learn from data and generate solutions to complex problems. In the context of data monitoring power plants, some of the most relevant technologies are:

- Machine Learning (ML): Allows systems to learn from historical data and predict future events, such as equipment failures or changes in demand. energetic.
- Deep Learning (DL): A branch of ML that uses artificial neural networks to analyze large volumes of data and detect complex patterns.
- Artificial Vision: Allows machines to "see" and analyze images, which can be useful for visual inspection of equipment and real-time anomaly detection real.
- Natural Language Processing (NLP): Allows machines to understand and process human language, which can be useful for analyzing business reports. maintenance or extract relevant information from technical documents.
- Internet of Things (IoT): Facilitates the connection of devices and sensors to Internet, allowing real-time data collection and remote control of

the teams.

These technologies work together to create a monitoring system
automated.

IoT sensors collect real-time data from the plant, which is then analyzed.
by ML and DL algorithms to detect anomalies and predict failures.

Machine vision can be used to visually inspect equipment, while
that NLP can help analyze reports and extract relevant information.

Remote monitoring platforms, such as the one offered by IAC, integrate these technologies.
and allow the visualization and analysis of data in real time.

VI. Application of agents driven 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 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 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 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, 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. Work phases

Phase	Activities
Phase 1: Assessment and Planning	* Infrastructure assessment existing ID of applications * Selection of technologies * Training plan
Phase 2: Implementation	* Acquisition of hardware and software * Facility and configuration * Testing and validation
Phase 3: Monitoring and Optimization	* Performance Monitoring * Optimization of algorithms * Technology update

b. Generative Artificial Intelligence Agent for Monitoring Plants Energy (PowerMonitorAI)

a. General Agent Architecture

- **Agent Name:** PowerMonitorAI

- **Main Objective:** Optimize the operation, maintenance and safety of power plants through intelligent real-time monitoring,

failure prediction and automated report generation.

b. Flow

i. Tickets:

- Sensor data (IoT): temperature, pressure, vibration, consumption.
- Images or videos from inspection cameras.
- Technical documentation and maintenance reports (PDF, text).
- Failure and maintenance history database.

ii. **Exits:**

- Predictive failure alerts.
- Preventive maintenance recommendations.
- Automatic reports for operators and technicians.
- Anomaly and trend display panel.

c. Agent Technological Modules

Module	**Technology**	**Functionality**
1. SensorCollector	IoT	Collects real-time data from sensors connected to critical machinery.
2. PredictiveCore	Machine Learning (ML)	Predicts failures mechanics, overheating or loss of efficiency based on historical data.
3. AnomalyVision	Computer Vision + Deep Learning (DL)	Automated visual inspection of turbines, valves, generators, detecting cracks, leaks or wear.

4. ReportNLP	Prosecution of Language Natural (PLN)	Analyze technical texts and reports to extract maintenance patterns and generate automatic summaries.
5. DecisionMaker	LLM (as GPT-4)	Integrates all the information, summarizes status general and generates strategic recommendations (e.g. "Replace valve X in 10 days").

d. Agent Benefits

a. **Proactive Failure Prediction** ÿ avoids unplanned downtime.

b. **Visual Analysis Automation** ÿ reduces the need for inspection manual.

c. **Intelligent Document Analysis** ÿ continuous pattern learning operatives.

d. **Automated Reports** ÿ improves operational decision making and managerial.

e. **Adaptability and Scalability** ÿ adapts to different types of plants: thermal, hydraulic, solar or wind.

V. Benefits of Implementing IAGEN for Automated Monitoring

The implementation of IAGEN for automated monitoring in power plants in Vaca Muerta offers a number of significant benefits:

- Greater operational efficiency: Automation of monitoring tasks reduces the need for human intervention, freeing up staff to focus on more strategic activities.
- Failure prediction: ML and DL algorithms can analyze historical data and

in real time to predict equipment failures, allowing for maintenance preventative and reducing unplanned downtime.

- Production optimization: IAGEN can analyze production data and adjust operating parameters to maximize efficiency and reduce costs. This includes the optimization of oil and gas separation, as mentioned in .
- Improved safety: Early detection of anomalies and prediction of failures contribute to a safer work environment, with the potential to predict and prevent accidents.
- Cost reduction: Greater operational efficiency, reduced production time, downtime and production optimization result in a decrease in operating costs.
- More informed decision making: IAGEN provides detailed information and real-time analysis, enabling faster decision-making and precise.
- Optimization of resource use: IAGEN can optimize the use of resources such as water and energy, contributing to the sustainable development goals and reducing the environmental impact.
- Emissions reduction: IAGEN can help reduce greenhouse gas emissions. greenhouse effect by optimizing energy production and consumption.
- Better well planning: IAGEN can help optimize the location of wells. wells, considering factors such as geology, pressure and proximity to other wells, to avoid problems and maximize production.
- Better understanding of the deposit: IAGEN can improve the understanding of the Stimulated Rock Volume (SRV) and Drained Rock Volume (DRV), which which allows for better well design and production optimization.
- Production Prediction: IAGEN can be used to predict production of the wells and optimize their spacing and stacking.
- Optimizing fluid management: IAGEN can help reduce the time

drilling and improve efficiency by optimizing mud weight, speed
flow and other parameters in fluid management.

VI. Ethical and Safety Aspects of IAGEN

The implementation of IAGEN in power plants raises ethical and legal questions.
security that must be considered:

- 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 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.
- Data privacy: It is essential to guarantee the privacy and security of data.
  data collected by IAGEN systems, especially if it is
  sensitive information. Data security and confidentiality are crucial
  to avoid any type of affectation.
- Biases in algorithms: IAGEN algorithms may be affected by
  biases in the training data, which can result in decisions
  discriminatory or unfair.
- Responsibility in decision-making: It is important to clearly define the
  responsibility in decision-making when using IAGEN systems,
  especially in critical situations that may affect safety.
- Impact on employment: The automation of tasks can have an impact on the
  employment, so it is important to consider relocation strategies or
  training for affected workers. Labor productivity in
  Argentina could be affected, which forces us to consider reintegration policies.

labor .

VII. Conclusions

The implementation of IAGEN for automated monitoring in power plants in Vaca Muerta offers a unique opportunity to improve efficiency, safety and profitability of energy production in Argentina. Although there are challenges in its implementation, such as initial investment, integration with existing systems and availability of data, the potential benefits are significant.

A well-defined implementation plan, which considers the evaluation of the infrastructure, technology selection, staff training and management ethical risks, is essential for the success of the project. The experiences of other Industries demonstrate that IAGEN can generate a positive impact on efficiency operational and decision-making.

The IAGEN has the potential to transform the energy industry in Vaca Muerta, moving from reactive to proactive monitoring. This will not only optimize the gas and oil production, but it will also help Vaca Muerta compete with other shale-producing regions, such as the Permian Basin in the United States, reduce costs and increase efficiency. In addition, IAGEN can help ensure the long-term viability of Vaca Muerta in the context of the energy transition global.

It is important to highlight the strategic role of IAGEN for energy independence and Argentina's economic growth. Optimizing production in Vaca Dead, along with the possibility of using IAGEN in renewable energy generation , will allow the country to secure its energy supply and generate new development opportunities.

Finally, the adoption of IAGEN in Vaca Muerta will not only contribute to the optimization of energy production, but will also position Argentina as a leader in the application of innovative technologies in the energy sector.

requires a joint effort from all actors involved, including companies, government and academic institutions, to promote the implementation of IAGEN and ensuring a sustainable energy future for Argentina.

Sources cited

1. Vaca Muerta: already generates 50% of Argentina's energy and is on its way to becoming the next soybean - Clarin.com, access date: March 7, 2025, https://www.clarin.com/economia/vaca-muerta-genera-50-energia-argentina-va-camino-proxima-soja_0_Lv6RhUbtW2.html

2. YPF: digitalization and artificial intelligence at the Vaca operations center Dead, date of access: March 7, 2025, https://argenports.com/nota/ypf-digitalizacion-e-inteligencia-artificial-en-el-centro-de-o dead-cow-operations/

3. Artificial intelligence, YPF's bet to expand the limits of Vaca Muerta, date of access: March 7, 2025, https://econojournal.com.ar/2019/09/inteligencia-artificial-la-apuesta-de-ypf-para-expa ndir-the-limits-of-vaca-muerta/

4. Image recognition and AI in agricultural production (2024) (computer vision), date of access: March 7, 2025, https://visionplatform.ai/es/recología-de-imagenes-y-ia-en-la-produccion-agricola-2024-computer-vision/

5. Innovations and Technology – Tec Eos, access date: March 7, 2025, https://tec-eos.com/innovaciones-y-tecnologia/

6. IAC Smart Plant Remote Monitoring System, access date: March 7, 2025, https://iac-intl.com/es/sistema-de-monitoreo-remoto-de-planta-inteligente-iac/

7. Vaca Muerta: Challenges and Contradictions of Gas Use in Argentina - Climate Tracker, date of access: March 7, 2025, https://climatetrackerlatam.org/historias/vaca-muerta-desafios-y-contradicciones-del-u gas-supply-in-argentina/

8. REVOLUTIONIZE(AI) | Sustainable Development - Dailymotion video, access date: March 7, 2025, https://www.dailymotion.com/video/x9f9qlk

9. Challenges of Vaca Muerta in the era of energy transition - Fundar, date of access: March 7, 2025, https://fund.ar/publicacion/desafios-de-vaca-muerta-en-la-era-de-la-transicion-energetic to/

10. Seminar: "Vaca Muerta: new technologies in directional drilling and geosteering", date of access: March 7, 2025, https://www.youtube.com/watch?v=llr34h1kFmI

11. Vaca Muerta - IAPG, access date: March 7, 2025, https://www.iapg.org.ar/conexplo/vaca-muerta.html

12. Artificial intelligence in Vaca Muerta: YPF looks for the best well to beat shale US gas - Clarín, access date: March 7, 2025, https://www.clarin.com/economia/inteligencia-artificial-vaca-muerta-ypf-busca-mejor-p ozo-beat-shale-gas-usa_0_sqUQt9jtH3.html

13. YPF inaugurated the Real Time Intelligence Center to manage the Drilling and fracturing wells in Vaca Muerta • econojournal.com.ar, access date: March 7, 2025, https://econojournal.com.ar/2024/12/ypf-inauguro-el-real-time-intelligence-center-para- control and intervene in the drilling and fracturing of its wells in Vaca Muerta in a manner emote/

14. Artificial intelligence joins YPF to remotely control operations Vaca Muerta | Channel 26, access date: March 7, 2025, https://www.canal26.com/economia/la-inteligencia-artificial-se-suma-a-ypf-para-control remotely ar-the-vaca-muerta-operations--406699

15. Ethical aspects in the use of different energies* - Pontifical University Quotation marks, date of access: March 12, 2025, https://pascua.iit.comillas.edu/pedrol/documents/etica_y_energia.pdf

16. “Opportunities and Challenges of Vaca Muerta” - International Finance Conference

Public - National University of Córdoba, access date: March 12, 2025, https://jifp.eco.unc.edu.ar/images/JIFP_Ariel_Masut_Sep_19_vf_compressed.pdf

17. Ethical principles for an anthropocentric artificial intelligence: current consensus from a global and regional perspective. | Montreal AI Ethics Institute, access date: March 12, 2025, https://montrealethics.ai/principios-eticos-para-una-inteligencia-artificial-anthropocentric a-current-consensuses-from-a-global-and-regional-perspective/

18. Artificial Intelligence: Business Success Stories - ADEN International Business School, date of access: March 12, 2025, https://www.aden.org/business-magazine/inteligencia-artificial-casos-de-exito-empresa rial/

19. 10 successful examples of Artificial Intelligence in companies - Rock Content, date of access: March 12, 2025, https://rockcontent.com/es/blog/artificial-inteligencia-en-las-empresas/

20. 50 Stunning Examples of Generative AI That Are Transforming the World industries, date of access: March 12, 2025, https://clickup.com/es-ES/blog/238921/ejemplos-de-ia-generativa

21. Real Time Intelligence analyzes key indicators of Vaca Muerta - YouTube, Access date: March 7, 2025, https://www.youtube.com/watch?v=hQ9tZPX0Qto

22. Vaca Muerta and the energy transition need planning - CIPPEC, date of access: March 12, 2025, https://www.cippec.org/textual/vaca-muerta-y-la-transicion-energetica-necesitan-planifi cation/