

Application of Process Simulation in Gas Pipeline Management for Inventory Evaluation



Jorge Parés⁽¹⁾, Mário Hermes⁽²⁾, Mateus Monteiro^(2,3), Herbert Senzano⁽²⁾ and José María Nougués^{(1)*}

⁽¹⁾ Inprocess Technology and Consulting Group

⁽²⁾ 3R Petroleum

⁽³⁾ Departamento de Engenharia Química, Universidade Federal do Rio Grande do Norte (UFRN)



- **Introduction**
- **Gas Pipeline LifeCycle**
- **Gas Inventory**
- **3R Case**
- **Gas Pipe Track Application**
- **Suggestions for Future Developments**

Since 2006 helping the processing industries in solving design and operational issues

inprocess

independent from any provider
(process simulator or ICSS)

our core business is Process
Simulation

keen to share its knowledge with
clients

Inprocess
Solutions
& Services



Lifecycle Modelling
and Operator
Training Simulators



Process
Simulation
Studies



Professional
Development
& Training



Applications
and Software
Products

2006
est. in Barcelona
by domain experts

55 countries
worldwide
presence

60+
simulation
engineers

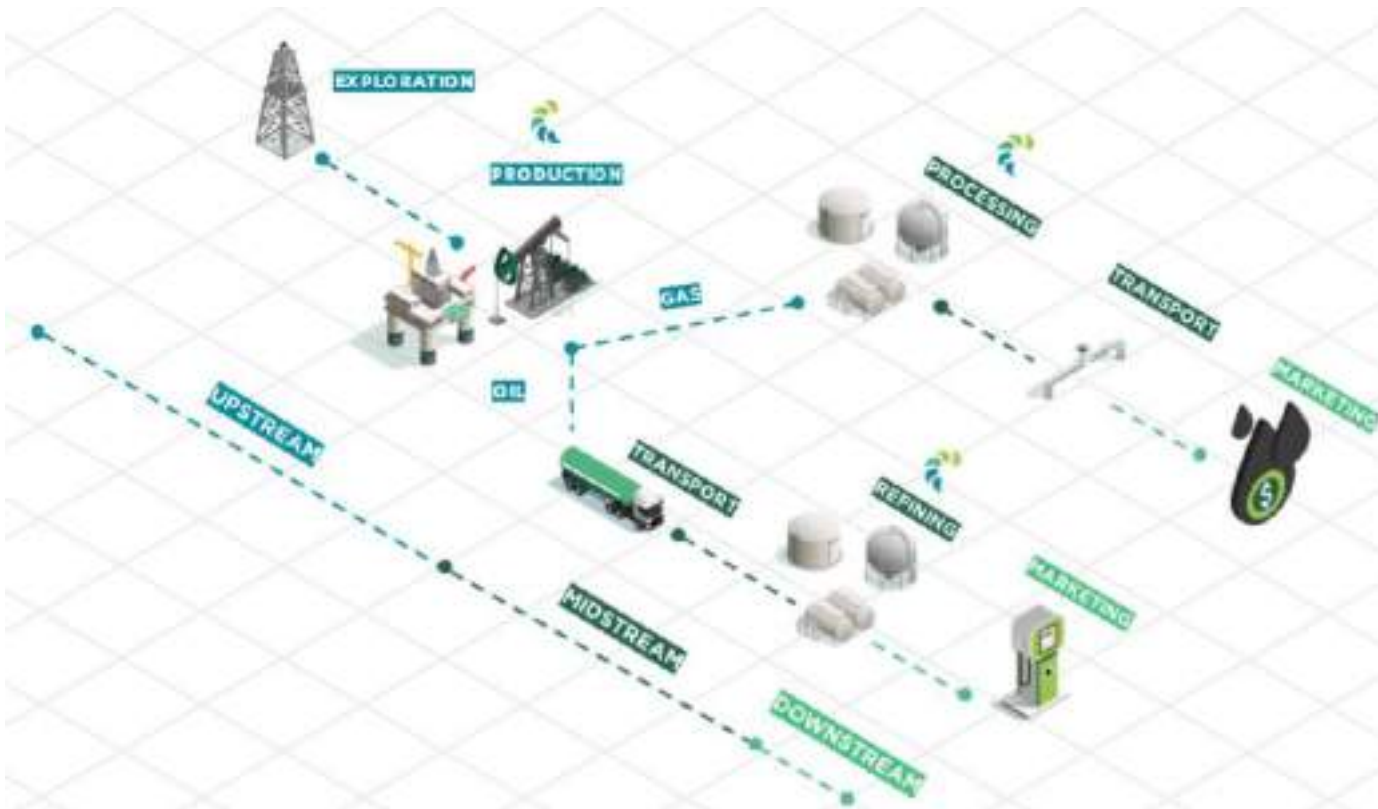
380+
years experience

400+
executed
projects

330+
training courses

Mission

Help our clients to achieve **safer, greener, more reliable** and
more **profitable** industrial operations



3R PETROLEUM

Our *mission* is to develop and produce hydrocarbon reserves with a focus on redevelopment of mature onshore and offshore assets, operating to the best industry standards, ensuring high return on investment for shareholders and acting in an ethical and safe manner.

Rethink

Redevelop

Revitalize

People, Safety and the Environment are at the center of our 3R's. We rethink processes. We redevelop production. We revitalize operations, communities and the environment.

Production

Transmission

Distribution



Gas Field

Gas-Oil Separation
Subsea pipelines
Compressor
Gas conditioning



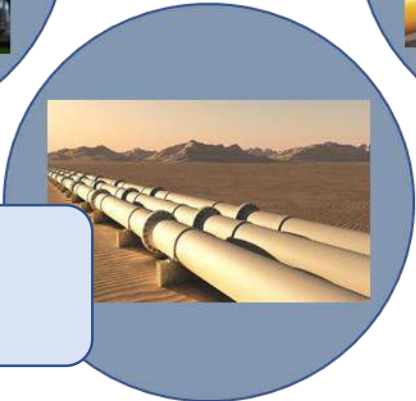
Gas Pipeline

Rich Gas feed
transportation



Processing

Gas treatment
NGL separation
Gas liquefaction
Regassification



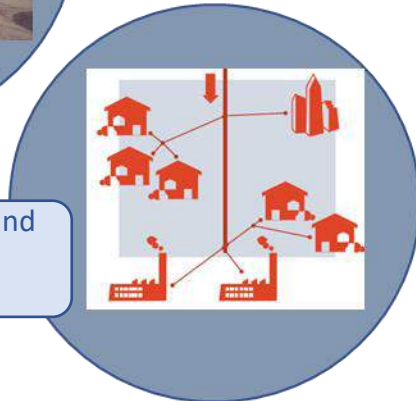
Gas Transmission

Processed Gas
transportation
Compression



Gateway

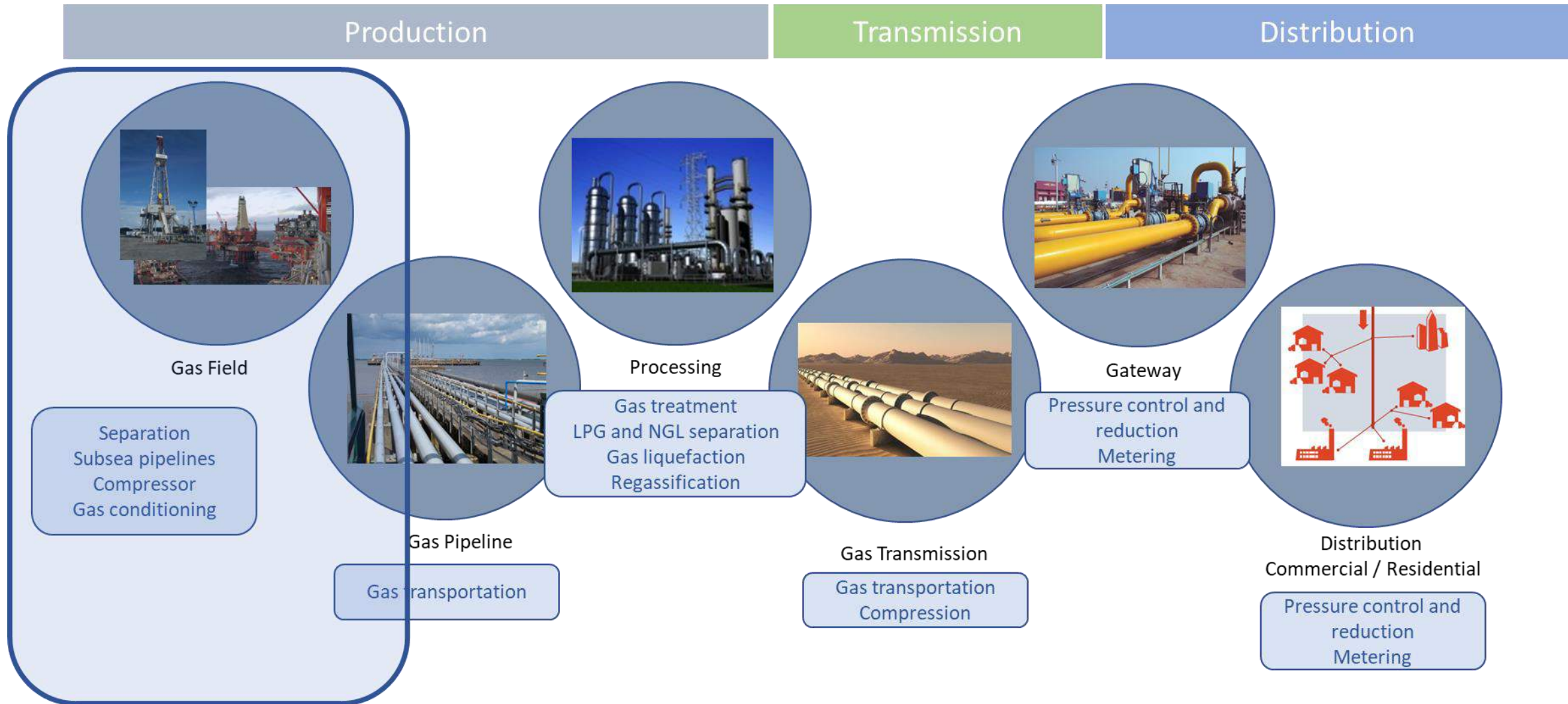
Pressure control and
reduction
Metering



Distribution
Commercial / Residential

Pressure control and
reduction
Metering

Where simulation can Help?



Production

Transmission

Distribution



Gas Field

Separation
Subsea pipelines
Compressor
Gas conditioning



Processing

Gas treatment
LPG and NGL separation
Gas liquefaction
Regassification



Gas Pipeline

Gas transportation



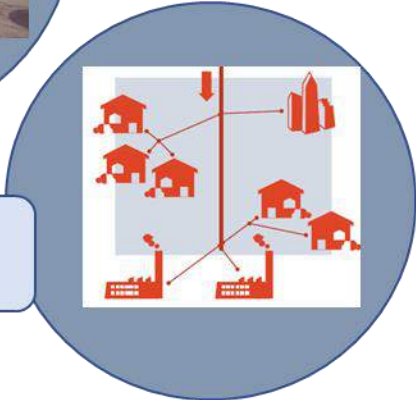
Gas Transmission

Gas transportation
Compression



Gateway

Pressure control and reduction
Metering



Distribution

Commercial / Residential

Pressure control and reduction
Metering

Production

Transmission

Distribution



Gas Field

Separation
Subsea pipelines
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Gas conditioning



Gas Pipeline

Gas transportation



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Gas treatment
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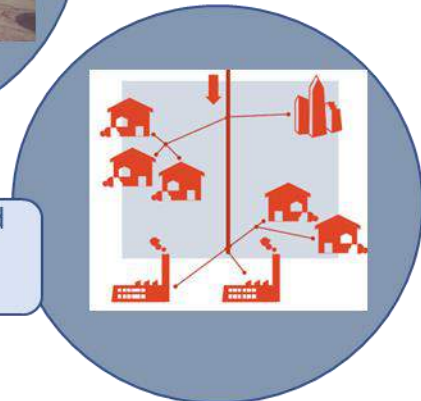
Gas Transmission

Gas transportation
Compression



Gateway

Pressure control and reduction
Metering



Distribution
Commercial / Residential

Pressure control and reduction
Metering

Production

Transmission

Distribution



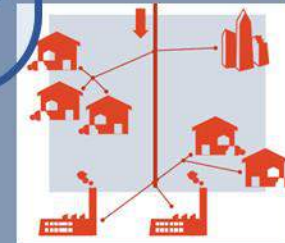
Gas Field



Processing



Gateway



Distribution

Commercial / Residential

Separation
Subsea pipelines
Compressor
Gas conditioning

Gas treatment
LPG and NGL separation
Gas liquefaction
Regassification

Pressure control and
reduction
Metering



Gas Pipeline

Gas transportation



Gas Transmission

Gas transportation
Compression

Pressure control and
reduction
Metering

Production

Transmission

Distribution



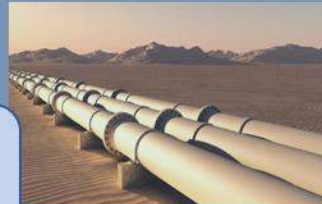
Gas Field



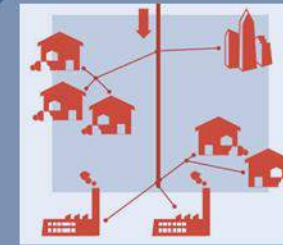
Processing



Gateway



Gas Transmission



Distribution
Commercial / Residential

Separation
Subsea pipelines
Compressor
Gas conditioning

Gas treatment
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Metering

Gas Pipeline

Gas transportation

Gas transportation
Compression

Pressure control and
reduction
Metering

Step 1

Pipeline Conceptualization,
Design and Construction

Step 2

Operation and Maintenance

Step 3

Safety and Emergency Response

Step 4

Gas Quality Management

Step 5

Capacity Management

Step 6

Supply and Demand Planning

- Efficient and effective management of natural gas transportation and distribution systems.
- Determine the amount of gas present within the pipeline at any given time

- **Operational**
- **Economic**
- **Safety reasons**

3R require a tool to manage

- Contractual need for the Gas Market operation.
- Inventory control for gas mixture allocation.
- Phenomenological simulation for robustness and reliability.

Operational Control

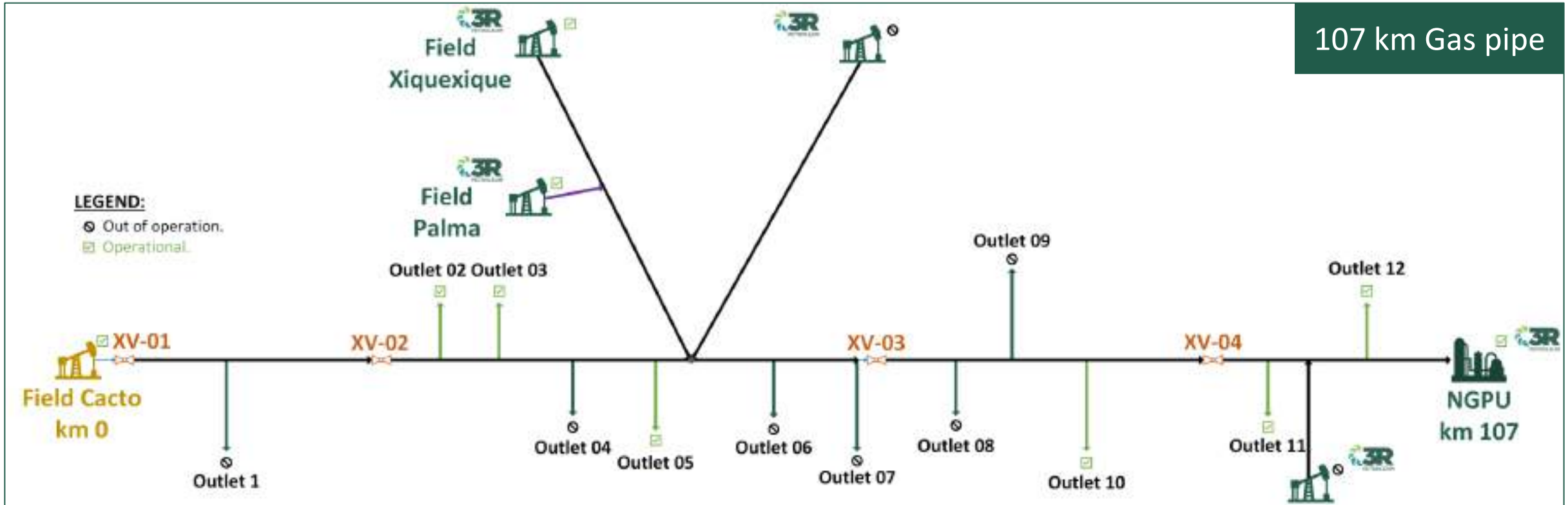
System Balancing

Nomination and Scheduling

Billing and Financial
Transactions

Emergency Response and
Safety

Capacity Planning and
Expansion



The gas inventory calculation is an essential part for the management of the Natural Gas Market, which has a monthly turnover of around 2,0 M USD.

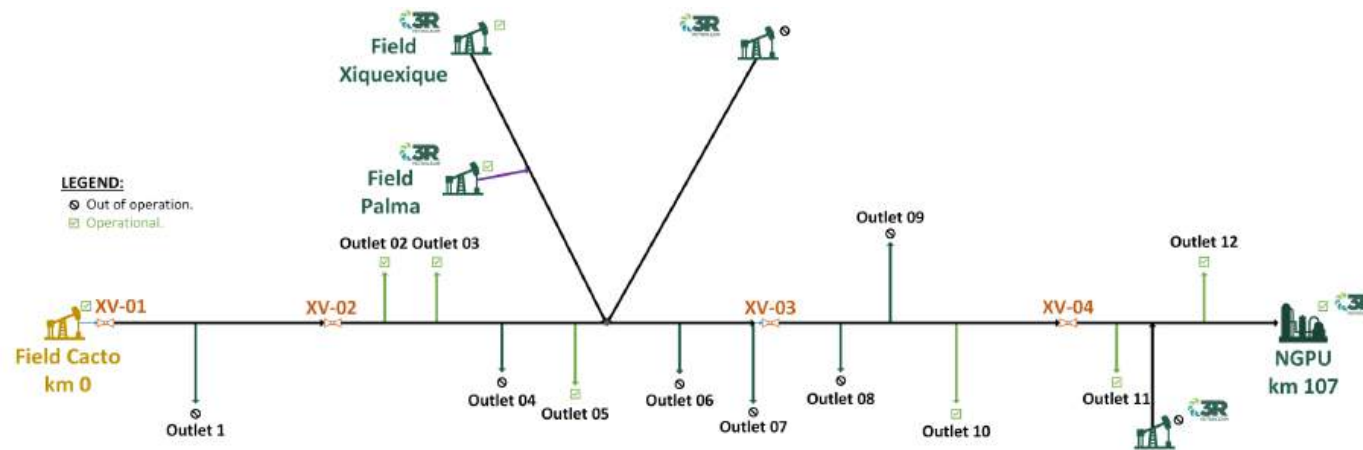
The image displays a software interface for process simulation. On the left, a legend defines symbols for 'Outlet' and 'Oper'. Below the legend, a wellhead icon is labeled 'Field Cacto km 0' with an arrow pointing to 'Outlet 1'. The main area shows a complex piping network with several storage tanks. A large green-bordered window provides a zoomed-in view of a specific section of the piping. A smaller window in the foreground shows a 'Properties' dialog box with tabs for 'Description', 'Safety Analysis', and 'Energy Analysis'. The 'Description' tab is currently selected.

The gas inventory calculation is an essential part of the design which has a monthly

Based on previous day's measurement data, the current inventory is calculated.

Data used:

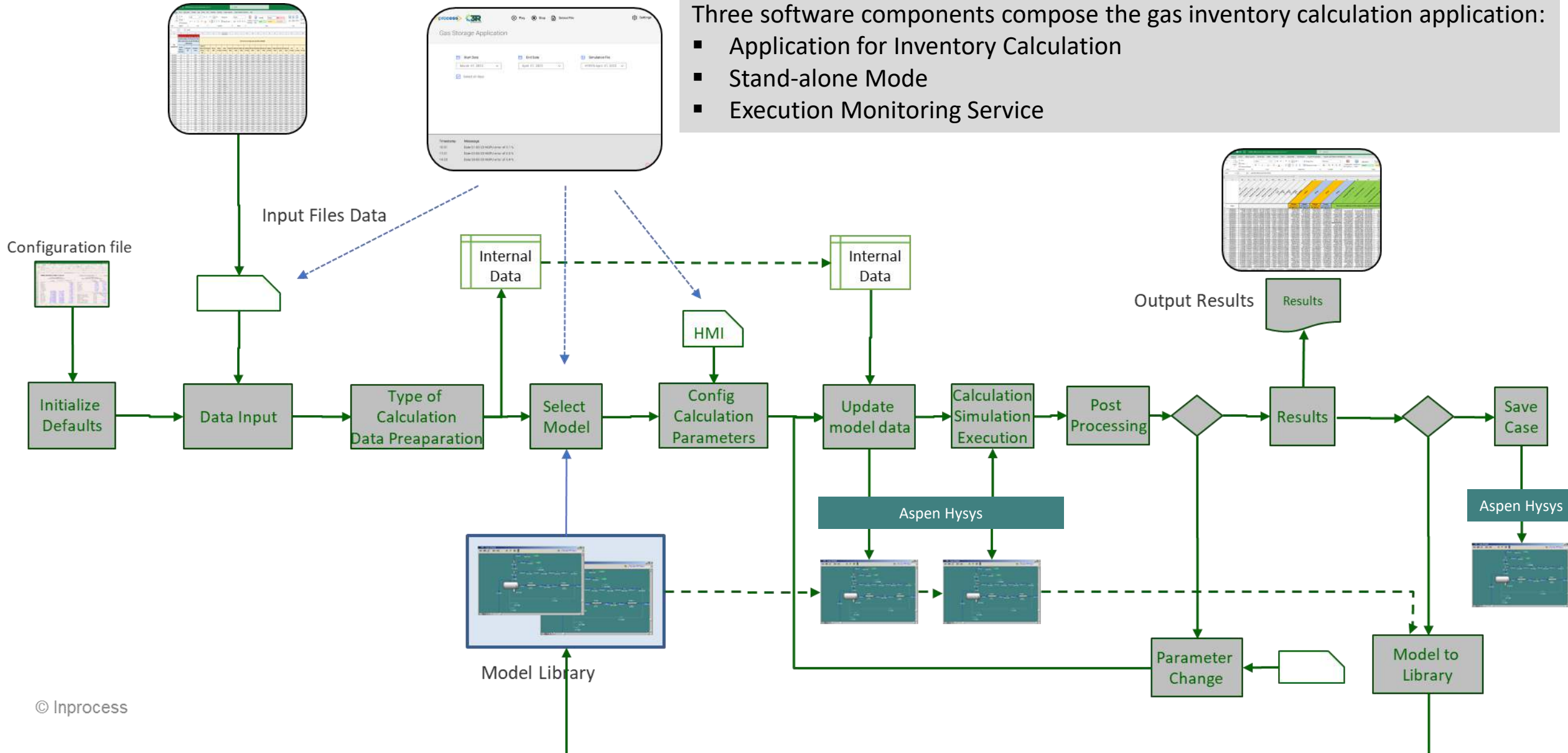
- Gas flows producers
- Gas flows consumers
- P, T and composition measurements (if any)



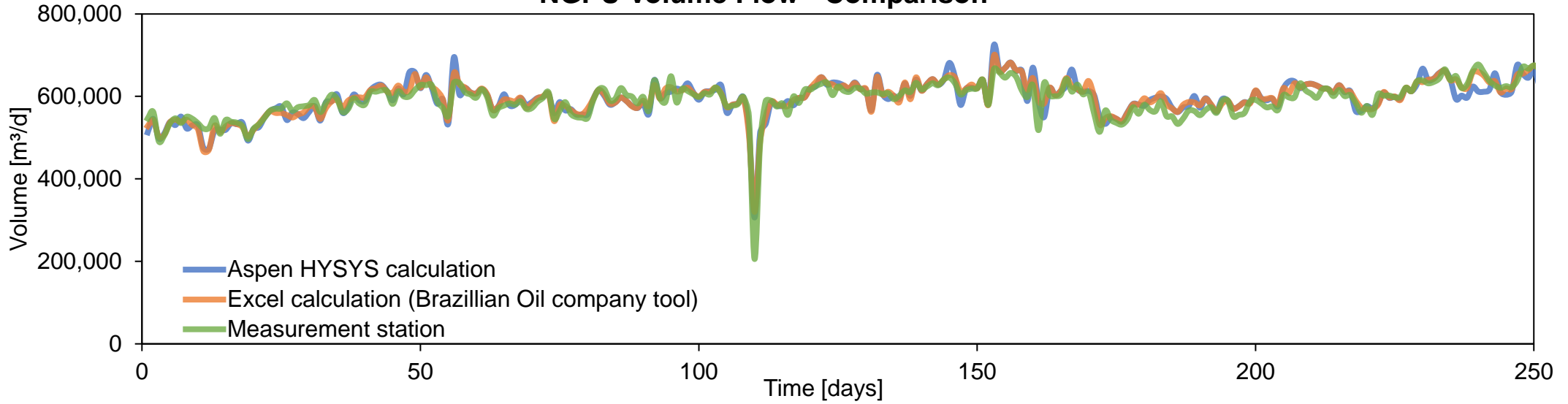
- The gas inventory calculation is executed within defined system boundaries.
- The application calculates gas inventory in each pipeline segment through an Aspen HYSYS simulation.
- The model incorporates the calculated gas density at flow conditions, computed using the measured pressure and temperature values obtained from the pipeline data historian system.

Three software components compose the gas inventory calculation application:

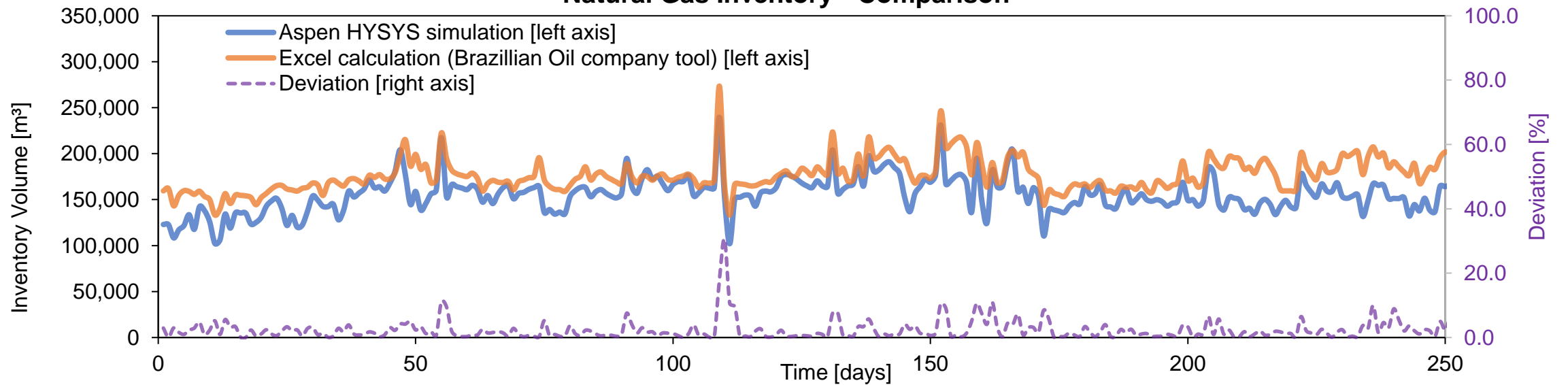
- Application for Inventory Calculation
- Stand-alone Mode
- Execution Monitoring Service



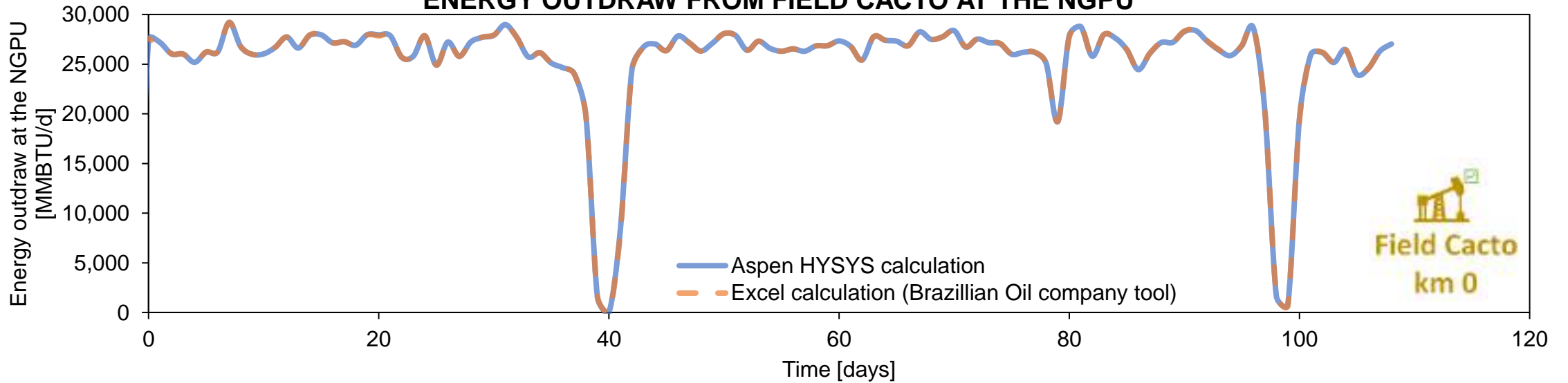
NGPU Volume Flow - Comparison



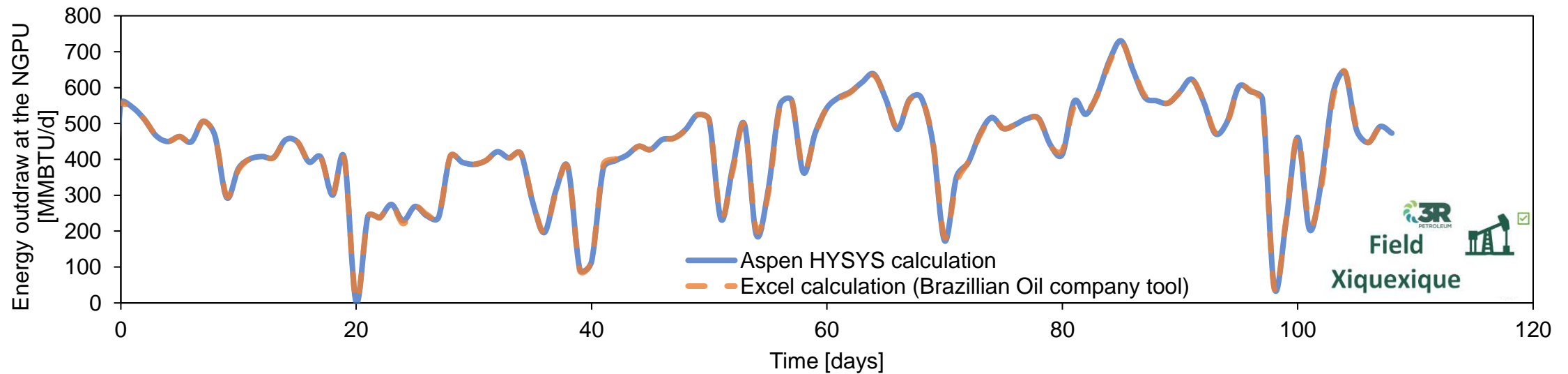
Natural Gas Inventory - Comparison



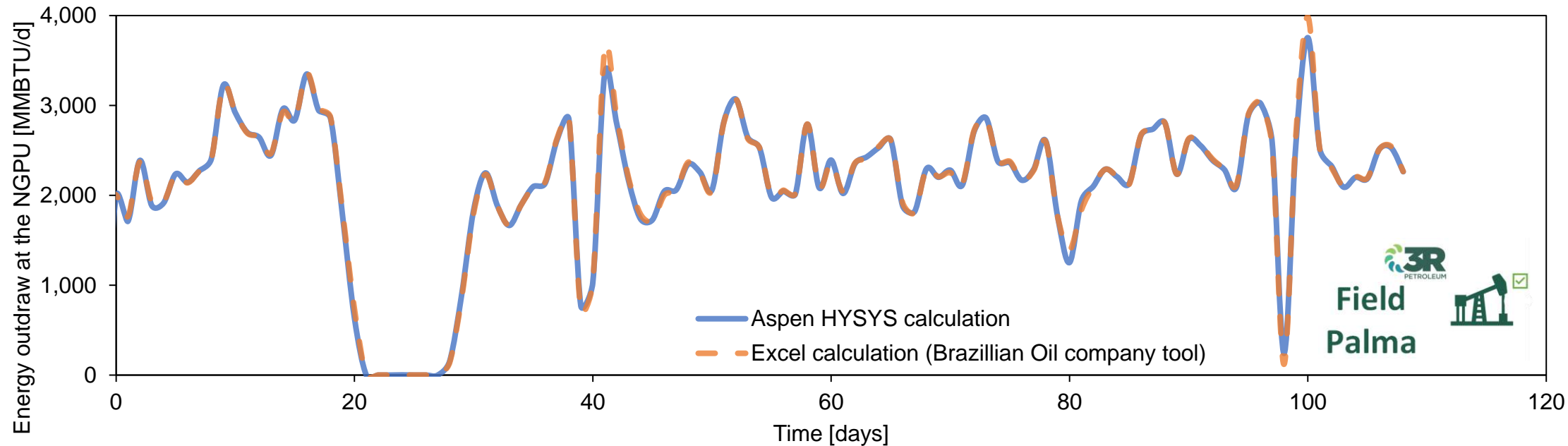
ENERGY OUTDRAW FROM FIELD CACTO AT THE NGPU



ENERGY OUTDRAW FROM FIELD XIQUEXIQUE AT THE NGPU



ENERGY OUTDRAW FROM FIELD PALMA AT THE NGPU



- The gas inventory calculation can operate independently through a graphical user interface or in silent mode;
- Configuration of calculation periods;
- Connections with calculation engines;
- Executing production forecasts for different time periods;
- Performing periodic checks on information retrieval from measured data;
- Data exchange with MS Excel or third-party general information management application;
- The Execution Monitoring Service coordinates data recovery and upload from third party application, triggering gas inventory evaluations.

All these features are essential for the gas flow accounting in the pipeline, once different companies have to distinctly contribute for gas inventory.

- **GasPipeTrack (GPT), developed by InProcess, estimate the gas inventory in gas transportation pipelines** by leveraging process simulation principles. The application utilizes Aspen HYSYS simulation to calculate and monitor gas inventory daily, considering multiple suppliers and consumers along the pipeline network;
- **In the 3R Petroleum case, GPT calculates gas inventory within defined system boundaries**, incorporating flow data from gas producers and consumers, as well as pressure, temperature, and composition measurements;
- **The calculated gas density at flow conditions is integrated into the model**, ensuring accuracy in inventory assessments;
- **GPT comprises three key software components**: the Application for Inventory Calculation, Stand-alone Mode, and Execution Monitoring Service;
- **The Stand-alone Mode facilitates independent operation of gas inventory calculation**, while the Execution Monitoring Service coordinates data recovery, triggering inventory evaluations, executing production forecasts, and ensuring periodic checks on data retrieval.

- Furthermore, **GPT's integration with third-party information management applications enhances its functionality**, enabling seamless data import/export and email notifications;
 - **GasPipeTrack provides a robust solution for accurate and near real-time gas inventory evaluation**, playing a relevant role in the management of the Natural Gas Market with significant financial implications. Its integration of process simulation with other software components improve the capabilities in gas flow accounting for pipeline operations;
 - **Integration with an online data management system can make the process near completely automated**, with human action needed only for validation and approval of critical procedures;
 - **Data analysis modules could be constructed to help follow-up studies of the pipeline**, for instance, pressure monitoring around the valves to find stress periods, determine inlet temperature limits, among others.
- **Daily management of around 1 MM m³ (one million cubic meters at 20°C 1 atm) of Rich Natural Gas.**
 - **Allow the accounting of gas volume that will be sent for processing and partially used for oil production increase through steam injection (natural gas-powered steam generators).**



José María Nougués

josemaria.nougues@inprocessgroup.com

+34 691 408 450

Herbert Senzano Lopes

herbert.senzano@3rpetroleum.com.br

+55 84 999 471 293

www.inprocessgroup.com

www.3rpetroleum.com.br

