AVEVA PI WORLD

Gas Turbine Modeling for Efficiency and Using Regressions to Predict Performance

Presented By: José Cardozo, Leonardo Yanzón and Ramiro Abán

- INCLUDE INSTITUTIONAL VIDEO HERE

About Us

Pampa energía

The **largest independent integrated energy** co. in Argentina.

Sales LTM	**US$ 1,662 million**
Employees	**4,956**
Generates	**5,250 MW** **(15% of market share)**
	97% Availability
Operates	**21,104 km** **high voltage transmission lines.**
Produces	**45.5 kboepd2**
	247 mcfpd natural gas
Transports	**60% consumed gas** **(Argentina)**

Last twelve months (LTM) as of June 30, 2021
https://ri.pampaenergia.com/wp-content/uploads/sites/18/2021/09/PAMPA-2021-09-IR-Presentation-Web.pdf

AVEVA

PI System @ Pampa Energía

Pampa Energía acquires Genelba thermal plant

2016

Discovered the benefits of the real time infrastructure

Pampa explores PI expansion to additional sites

2019

2020

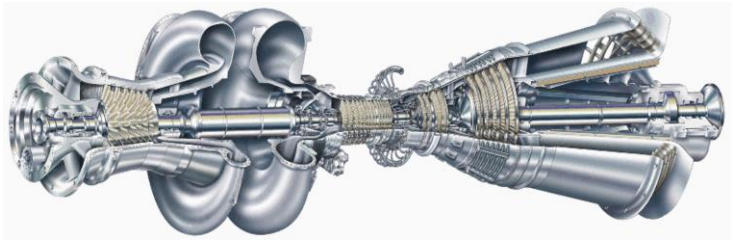
Pampa Energía signs a 5 year Enterprise Agreement

- Corporate visibility
- Break information silos
- Quick response
- Scalable
- Digital Transformation
- Business Initiatives

Pampa Energía Digitalization Program

- During 2020, different meetings and workshops were held to **gather a set of business value initiatives**.
- Different areas from all processes were included in this effort.
- The result was a set of **15 initiatives**, that leveraged the use of PI System.
- From all these initiatives, the **Gas Turbine Modeling** was one of the main ones and is the one that will be presented on the following slides.

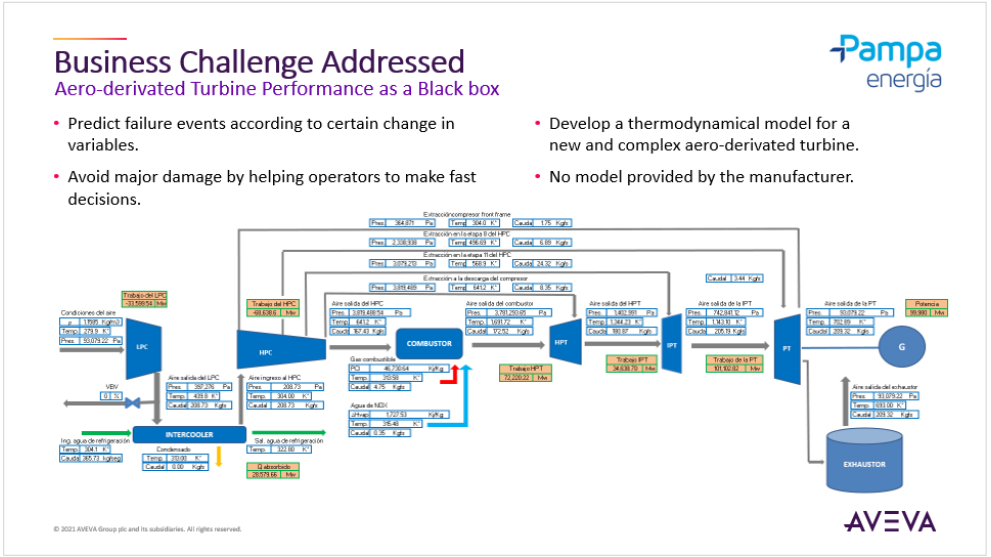
LMS-100



Gas turbine modeling

Challenge

Analyze and detect gas turbines failures in an early manner to enable making fast decision avoiding major damage.

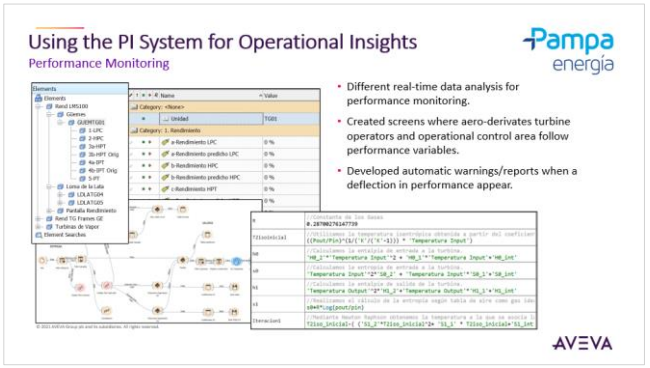


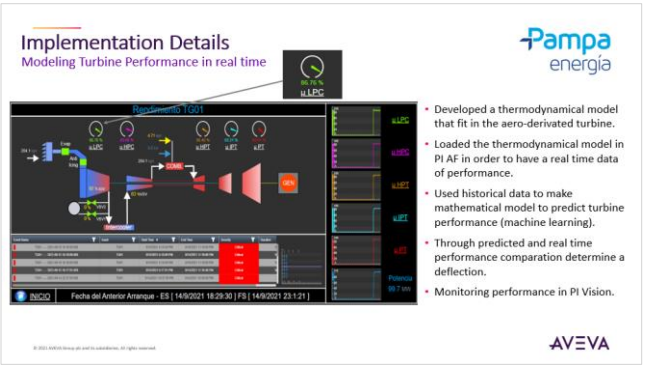
Gas turbine modeling

Solution

Developed different gas turbine models to deploy them in AVEVA PI System technology

Developed live monitoring displays to predict the suitable performance and anticipate failure.

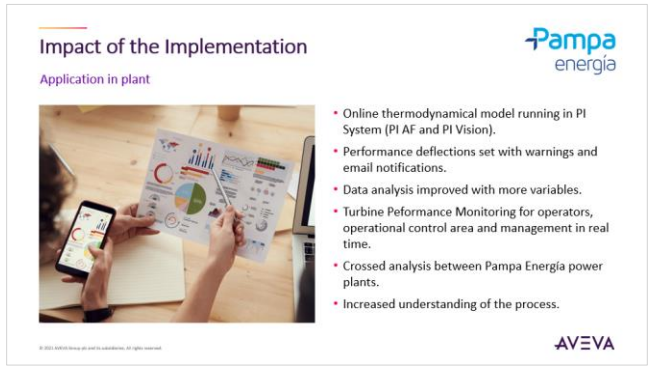




Gas turbine modeling

Benefits

Improved knowledge about gas turbines leading to recognize different failure mechanisms in turbine and balance of plant (BOP), prevented efficiency decreases by the fast detection and correction to normal parameters meaning a production and income increase.



Gas turbine modeling

Challenge

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Benefits

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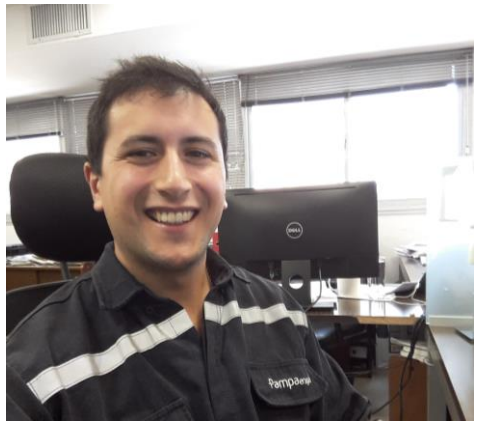
Real-time performance monitoring in aero-derivated turbines as a failure preventive tool.



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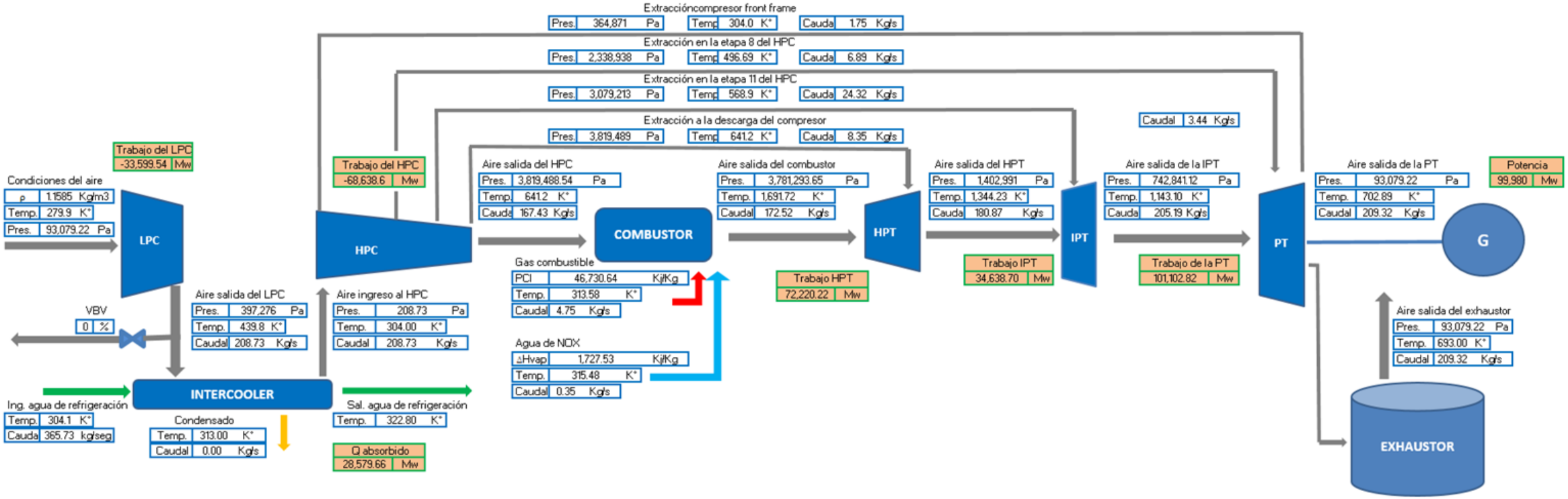
Business Challenge Addressed

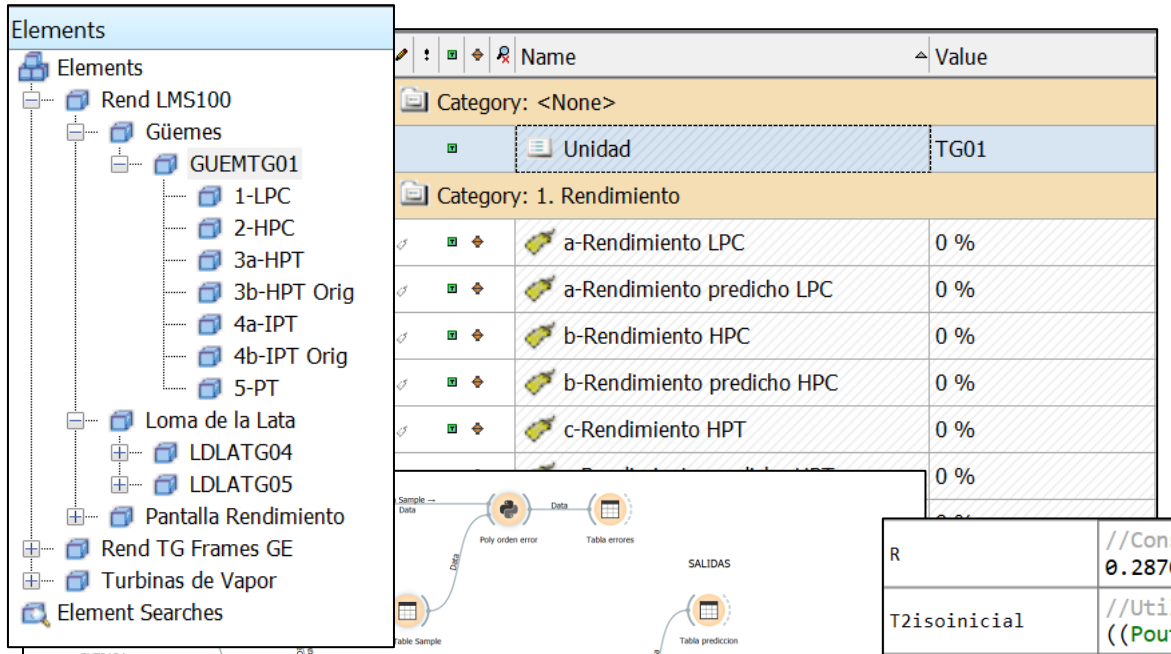
Aero-derivated Turbine Performance as a Black box

- Predict failure events according to certain change in variables.
- Avoid major damage by helping operators to make fast decisions.
- Develop a thermodynamical model for a new and complex aero-derivated turbine.
- No model provided by the manufacturer.



Using the PI System for Operational Insights

Performance Monitoring

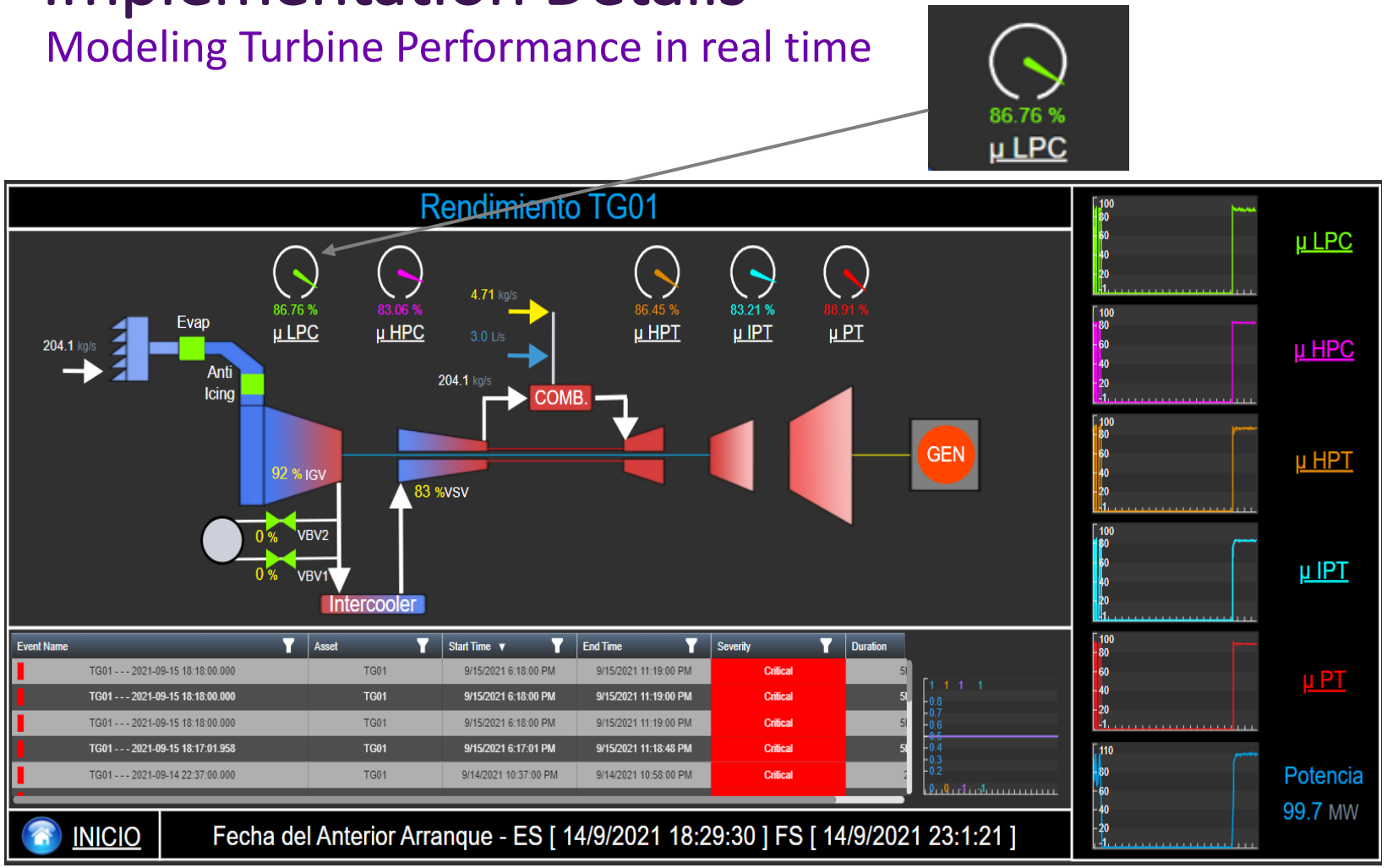


- Different real-time data analysis for performance monitoring.
- Created screens where aero-derivates turbine operators and operational control area follow performance variables.
- Developed automatic warnings/reports when a deflection in performance appear.

R	//Constante de los Gases 0.28700276147739
T2isoinicial	//Utilizamos la temperatura isentrópica obtenida a partir del coeficien ((Pout/Pin)^(1/('K'/('K'-1))) * 'Temperatura Input')
h0	//Calculamos la entalpía de entrada a la turbina. 'H0_2'*'Temperatura Input'^2 + 'H0_1'*'Temperatura Input'+'H0_int'
s0	//Calculamos la entropía de entrada a la turbina. 'Temperatura Input'^2*'S0_2' + 'Temperatura Input'*'S0_1'+'S0_int'
h1	//Calculamos la entalpía de salida de la turbina. 'Temperatura Output'^2*'H1_2'+'Temperatura Output'*'H1_1'+'H1_int'
s1	//Realizamos el cálculo de la entropía según tabla de aire como gas ide s0+R*Log(pout/pin)
Iteracion1	//Mediante Newton Raphson obtenemos la temperatura a la que se asocia l T2iso_inicial-(('S1_2'*T2iso_inicial^2+ 'S1_1' * T2iso_inicial+'S1_int'

Implementation Details

Modeling Turbine Performance in real time



- Developed a thermodynamical model that fit in the aero-derivated turbine.
- Loaded the thermodynamical model in PI AF in order to have a real time data of performance.
- Used historical data to make mathematical model to predict turbine performance (machine learning).
- Through predicted and real time performance comparation determine a deflection.
- Monitoring performance in PI Vision.

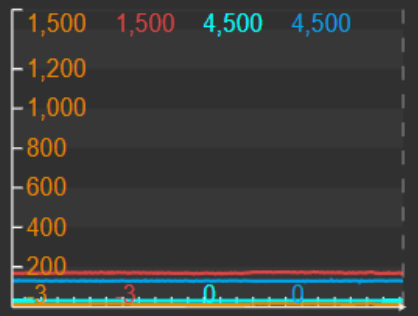
TG05 - Rendimiento Compresor de Baja Presión

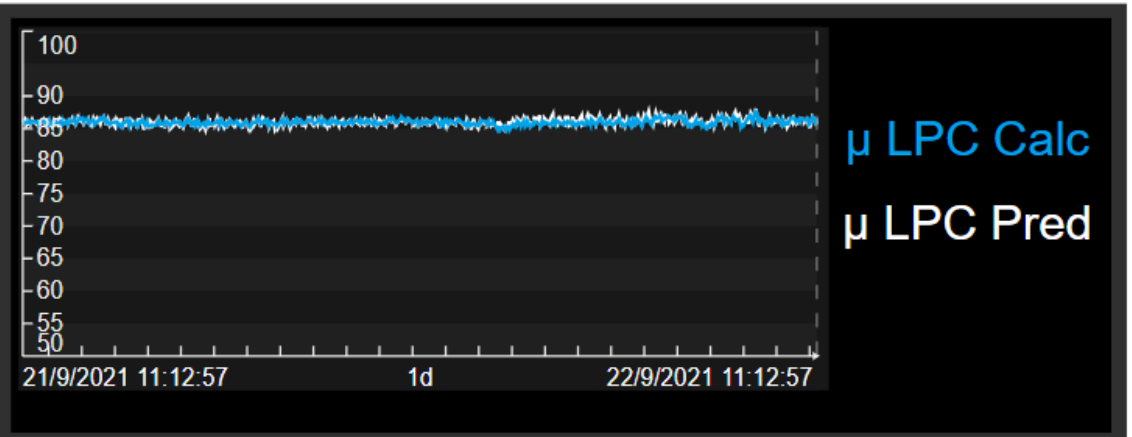
μ Calc 86.3 %

μ Pred 86.0 %

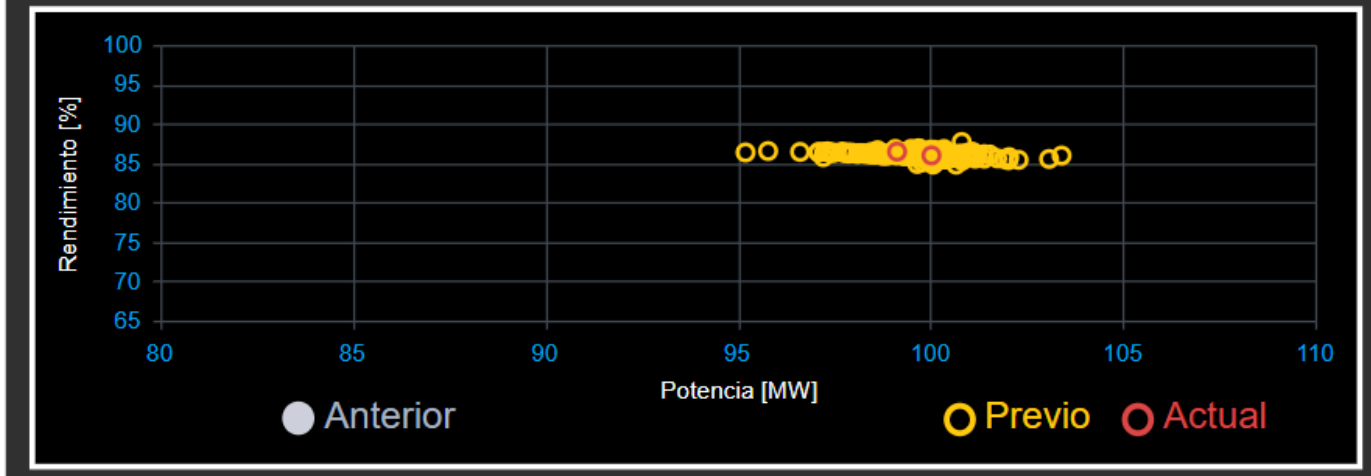
100.3 MW

Name ▲	Value	Units
LPC|Presion Input	95.5	kPa
LPC|Presion Output	397.5	kPa
LPC|Relación de Compresión	4.2	
LPC|Temperatura Input	9.4	°C
LPC|Temperatura Output	167.9	°C

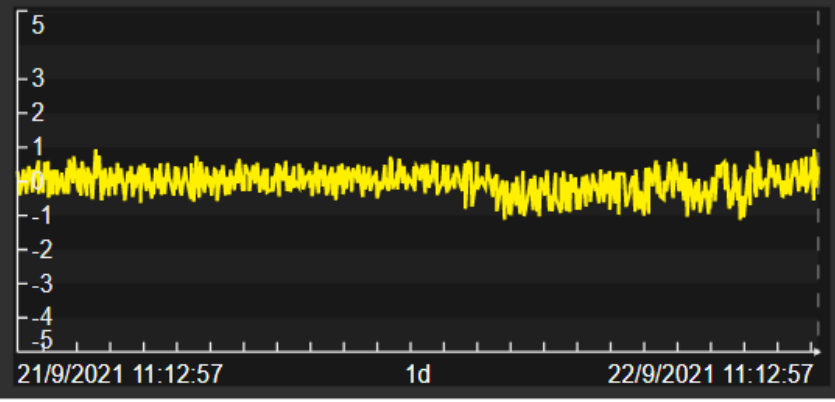




Eficiencia



Delta Redimiento

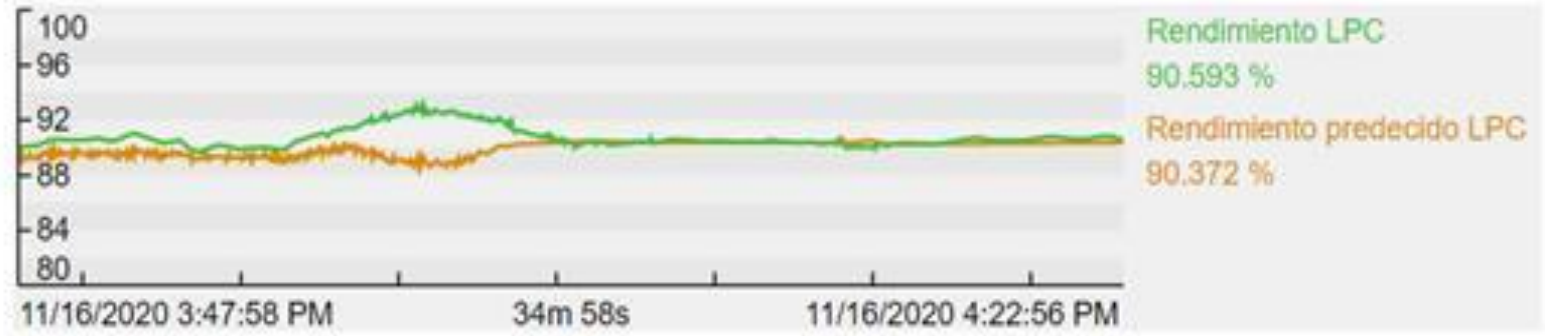


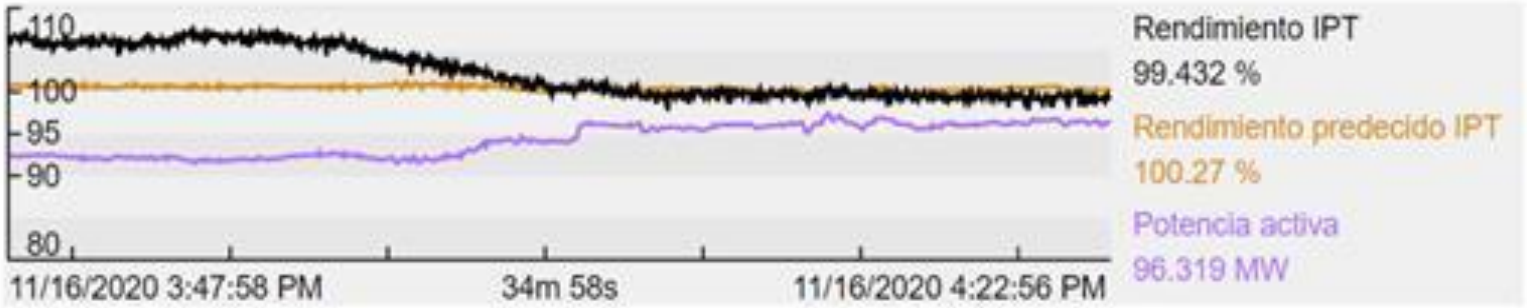
Impact of the Implementation

Application in plant

- Online thermodynamical model running in PI System (PI AF and PI Vision).
- Performance deflections set with warnings and email notifications.
- Data analysis improved with more variables.
- Turbine Peformance Monitoring for operators, operational control area and management in real time.
- Crossed analysis between Pampa Energía power plants.
- Increased understanding of the process.

Benefit Achieved





- A DEFLECTION IN THE PERFORMANCE OF THE LPC AND IPT CAUSED BY AN INTERCOOLER ISSUE.
- OPERATORS FIXED IT **IN LESS THAN 23 HOURS**

Event Name	Asset	Start Time ▲	End Time	Severity	Duration
IPT-TG4 LMS100-2020-11-16 11:20:08	TG4 LMS100	11/16/2020 11:20:08 AM	11/16/2020 4:03:55 PM	Warning	4h 43m

Benefit Achieved

Gap between HPT blades and case

- A POWER DECREASE FOLLOWED BY AN INCREASE IN THE INLET TEMPERATURE OF LPC
- ISSUE IN DISCUSSION WITH MANUFACTURER.