
AVEVAWORLD
PARIS

16TH OCTOBER 2024

MINIMIZING EQUIPMENT DOWNTIME AND UNDER PERFORMANCE ISSUES THROUGH DATA MONITORING ON A CENTRALIZED SOLAR POWER PLANT USING AVEVA PI SYSTEM

Gustavo Onofre, Gonçalo Fontenele

enel radix

AVEVA

enel

radix

AVEVA

- About Company and Presenters
- Asset Overview and Distribution
- Overview and Background
- Solution Development
- Conclusion and Results

About Company and Presenters

Gustavo Onofre

Head of Operational Excellence

Enel Green Power Solar Brazil

gustavo.onofre@enel.com

Gonçalo Fontenele

Industrial Data Analyst

Radix

goncalo.junior@radixeng.com

Asset Overview and Distribution

ASSET OVERVIEW AND DISTRIBUTION

7 **Brazil** Solar Power Plants

PI	**São Gonçalo I, II & III**	2021/23 | **867 MWp**
PE	**Fontes Solar**	2016 | **11 MWp**
BA	**Ituverava**	2018 | **254 MWp**
BA	**Horizonte**	2018 | **103 MWp**
MG	**Arinos***	2024 | **611 MWp**

*Under construction (TBC in 2024).

Total Installed Capacity: 1,8 GW

ASSET OVERVIEW AND DISTRIBUTION

7 **Brazil** Solar Power Plants

Cluster São Gonçalo – 1.800 ha – 867,26 MWp

Horizonte – 260 ha – 103,4 MWp

Fontes Solar – 16 ha – 11,01MWp

Ituverava – 546 ha – 254,2 MWp

Arinos* – 1.203 ha – 611MWp

*Under construction (TBC in 2024).

ASSET OVERVIEW AND DISTRIBUTION

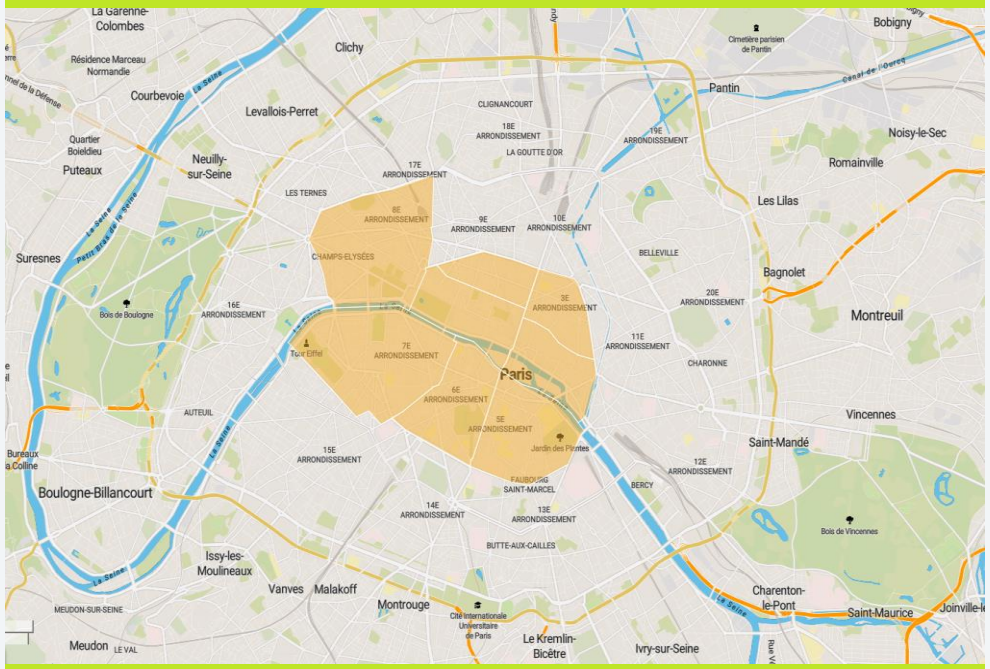
Size Comparison

Cluster São Gonçalo – 867,26 MWp

Solar Cluster total area: ~18km²

=

Paris (1st to 8th Arrondissements)

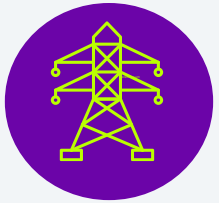


Paris - 1st to 8th Arrondissements area*: ~18,2km²

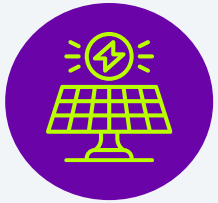
*bibliographic reference: https://opendata.paris.fr/explore/dataset/arrondissements

ASSET OVERVIEW AND DISTRIBUTION

7 **Brazil** Solar Power Plants

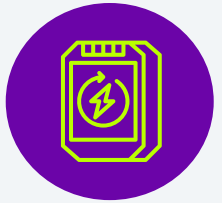


Transmission Line
→46.1 km

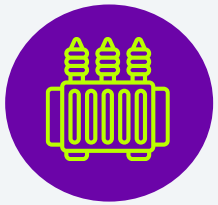


PV Module & Tracker
→ 4.461.694 un
→ 77.930 un

Stringbox
→4.826 un



Inverters
→3.930 un



Transformer LV/MV
→411 un

MV Feeder
→631 km

Transformer MV/HV
→8 un

Overview and Background

BACKGROUND

- **ENEL** Solar Brazil has a PI System installed with an asset hierarchy well defined since the beginning of the project. Although used for multiple activities, even for eventframe generation, plants were not standardized on events and displays;
- **All 7 plants** have their own particularities, needed to be considered on PI System;
- **Also**, was acknowledged an opportunity to improve and accelerate the development of automatic classification on going;
- **Field** team used to verify inverters' alarms on Plant SCADA, acting only in equipment interruption events, but not in inefficiencies;
- **Culture** mindset change from manual and operational work to analytical and strategic for all O&M team (field and back office).

enel Green Power RADIX

OVERVIEW OF THE CHALLENGE AND SOLUTION

Challenge

Standardizing the identification of failures and underperformance in inverters, currently relying on a time-consuming manual process that results in substantial losses and highlights the need for an automated system to monitor key performance indicators and enhance operational efficiency.

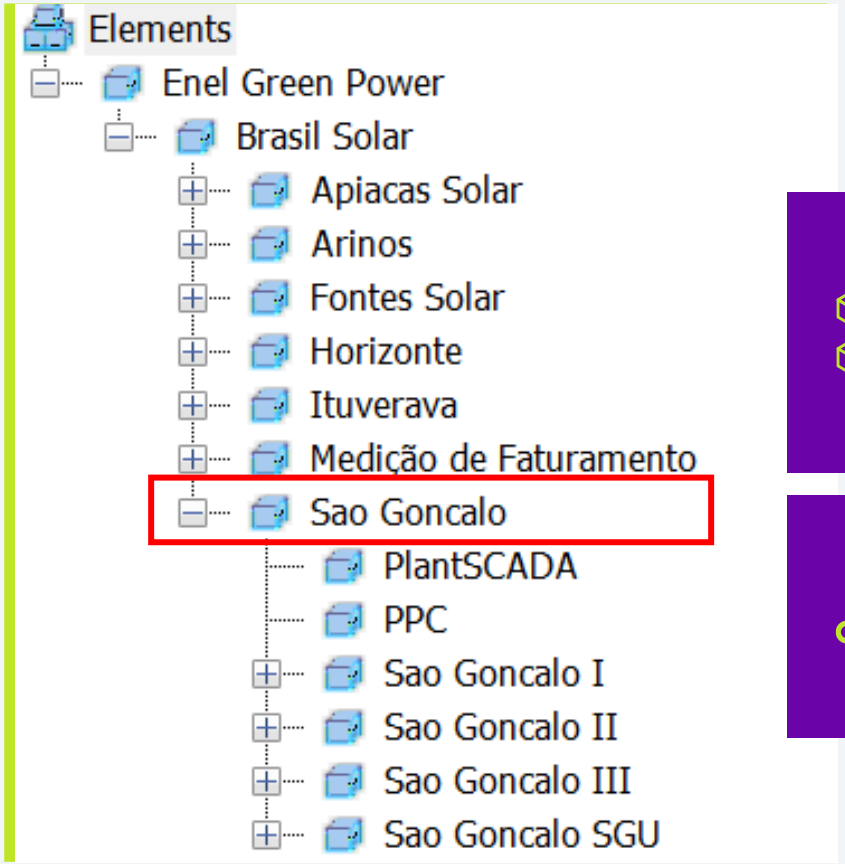
Solution

Deployed the latest AVEVA PI System technology including PI AF and PI Vision as an advanced foundation for Process Monitoring, Failure Identification and Bad Performance Issues Reduction.

Benefits

Increased production and operational efficiency, reduced costs, reduced time-consuming inspections, faster data visualization of all plants and inefficiency events identification, post-operational automatic classification of inefficiencies.

OVERVIEW OF THE CHALLENGE AND SOLUTION

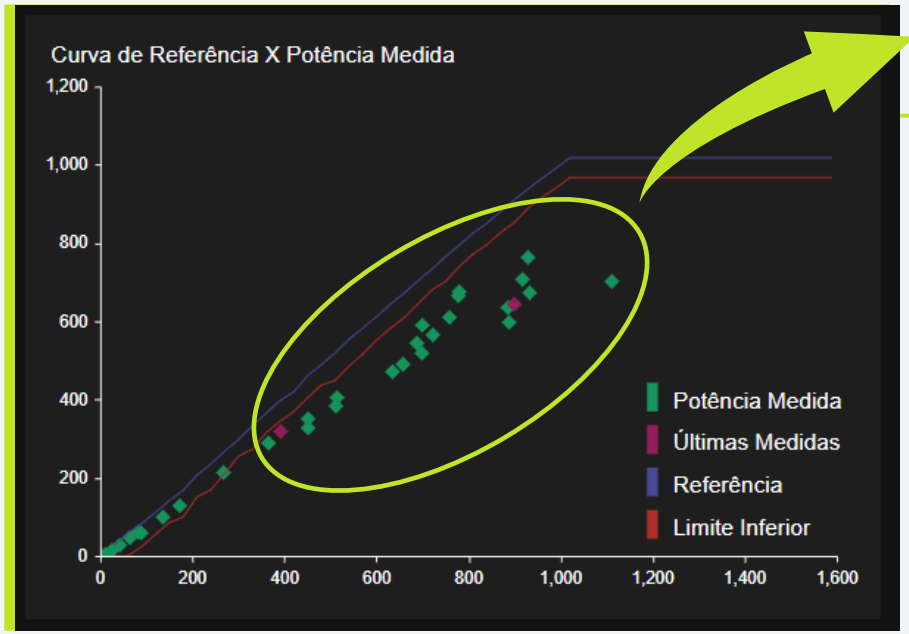


Asset Hierarchy on PI Asset Framework

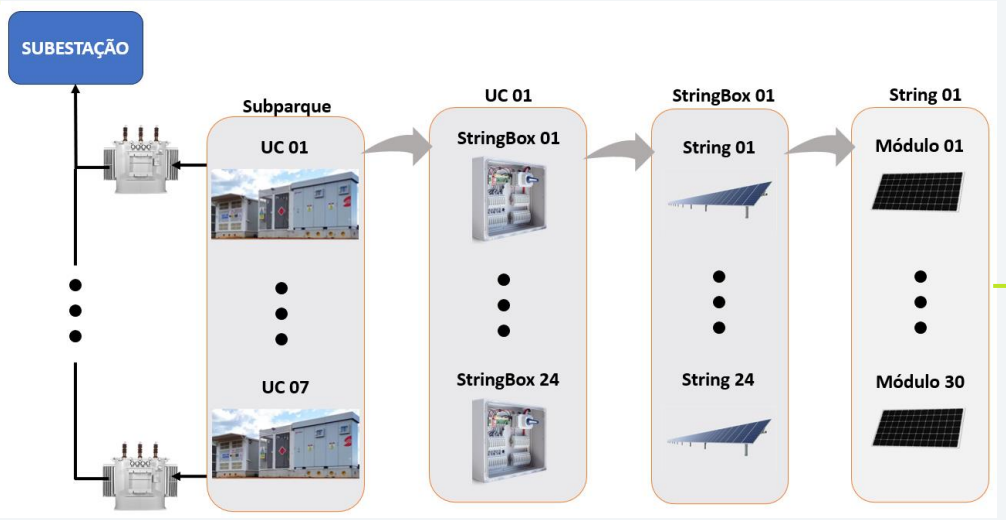
All plants have the same structure of eventframe generation and analysis, when possible. Also, the same PI Vision displays are available, considering each power plant particularity;

We will showcase mostly São Gonçalo Solar Complex (867,26 MWp)

OVERVIEW OF THE CHALLENGE AND SOLUTION



Loss Production events, associated with the failure or inneficiency of one or a combination of elements that participate in the generation system:



São Gonçalo example**:**

- **19** Sub-plants;
- **1392** Inverters;
- **20736** Stringboxes;
- **38880** Trackers;
- **74064** Strings;
- **2.220.480** Modules

**Solar Plant example*

7 **Brazil** Solar Power Plants

120K Monthly average of failure / inefficiency events

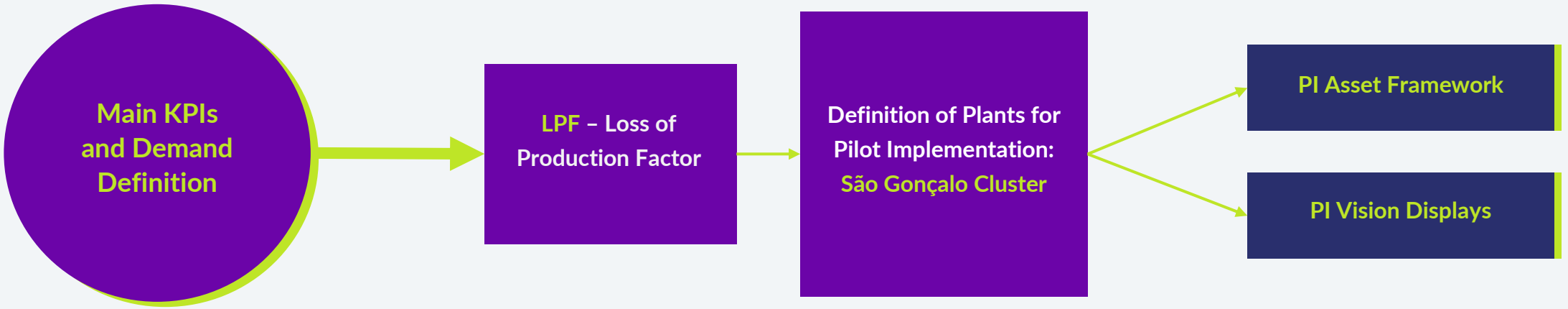
10K Number of core tags

500K Daily number of measures processed

Solution Development

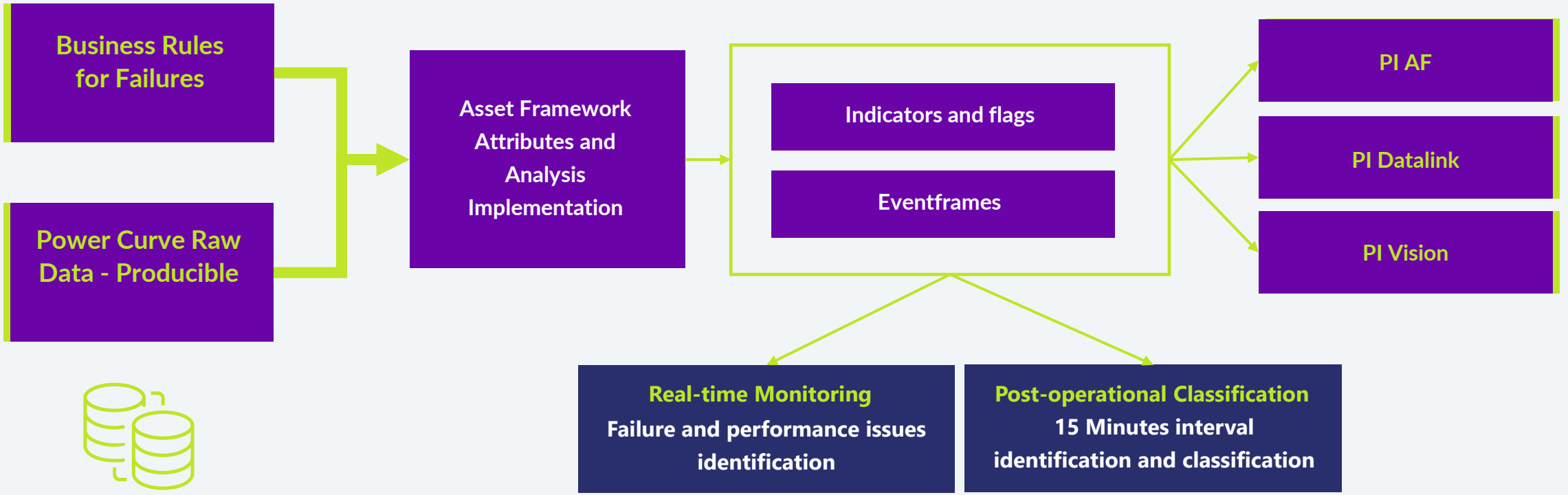
SOLUTION DEVELOPMENT

Project Workflow



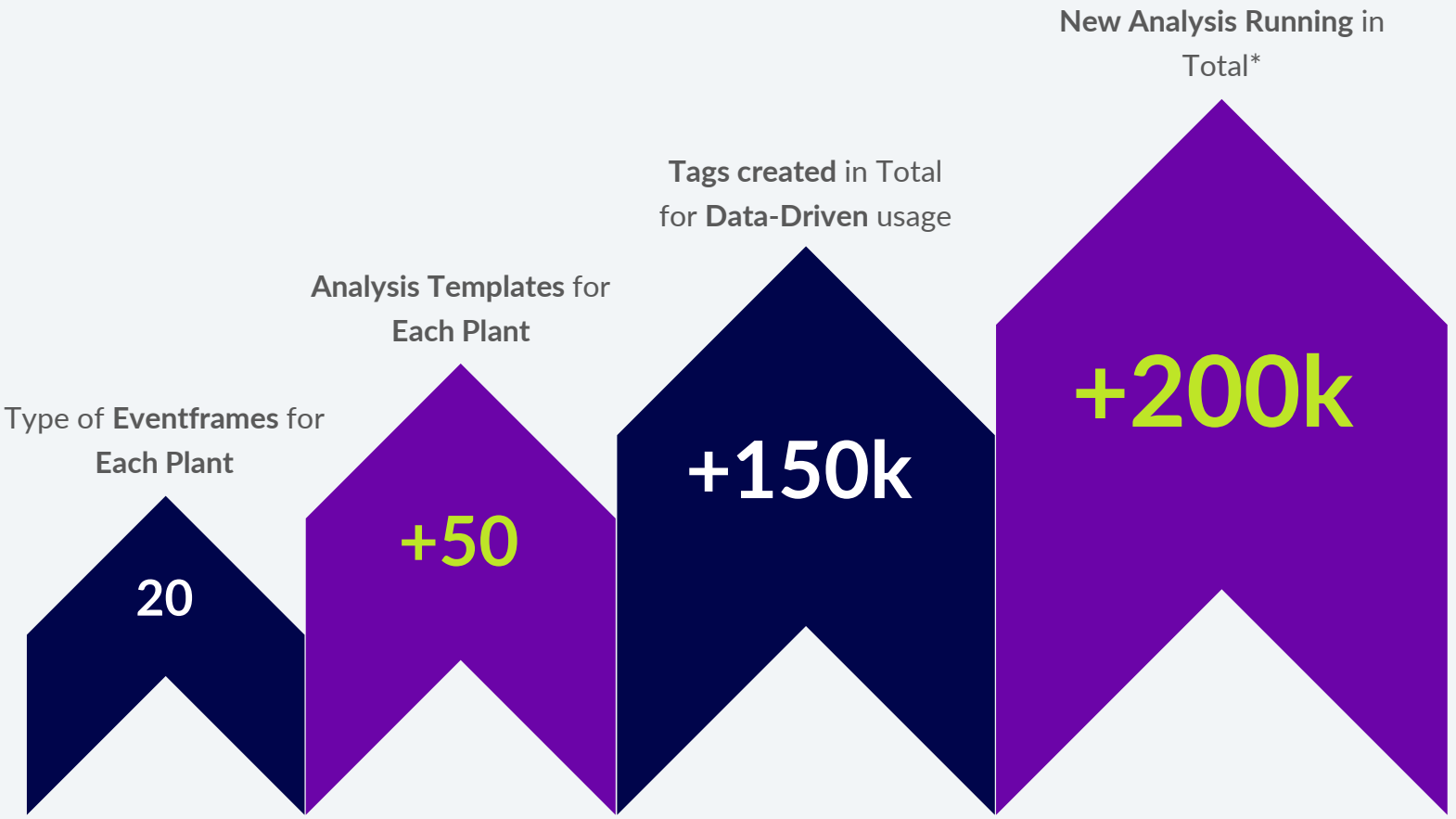
SOLUTION DEVELOPMENT

Using consolidated business rules and merging it with expected power of inverters, so that inefficiencies and failures could be identified and classified



SOLUTION DEVELOPMENT

Asset Framework Insertions and New Items implemented during the Journey



* Considering rollup, EF Generation and expression analysis

SOLUTION DEVELOPMENT

- **Eventframe** Generation;
- 15-20 Eventframe types, mostly on inverter level, with failure or bad performance indication;
- **Flags** created for data-driven verifications on post-operational analysis, including automatic classification of inefficiencies, using enumeration set for reason and root cause identification.

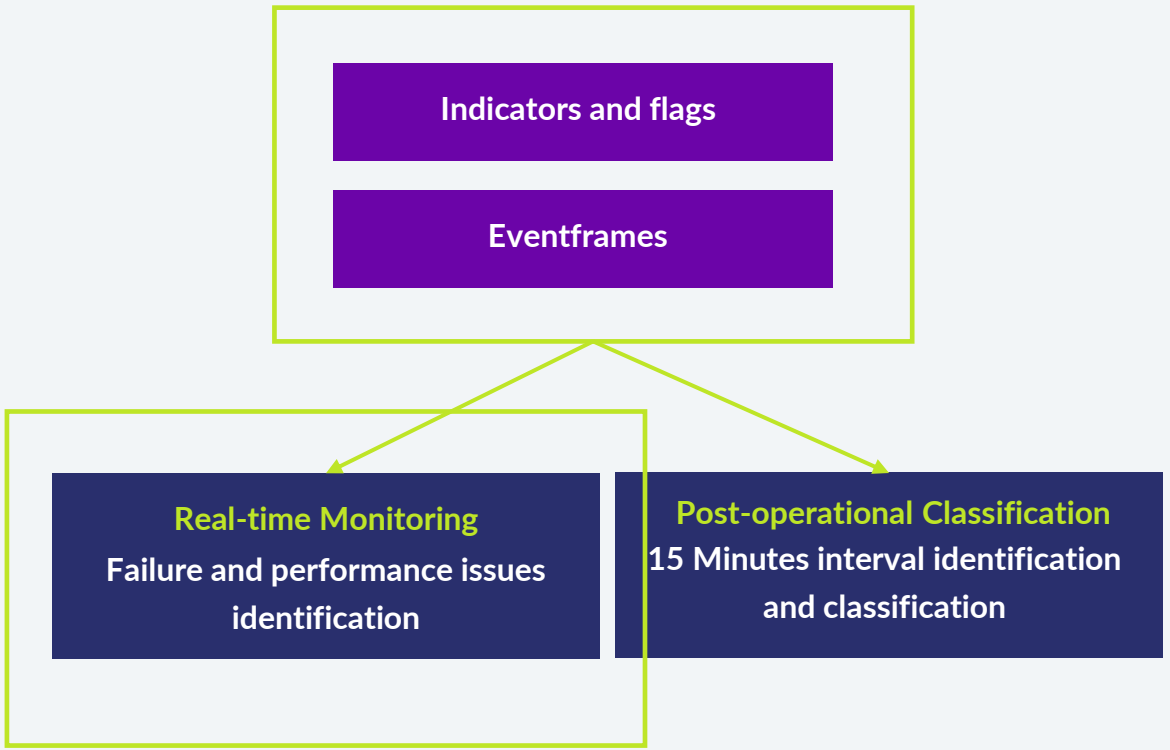
+3.5k
Inverters
Most Critical Equipment

85k
Elements
Directly Covered

enel Green Power radix

SOLUTION DEVELOPMENT

Using consolidated business rules and merging it with expected power of inverters, so that inefficiencies and failures could be identified and classified



SOLUTION DEVELOPMENT

FASTER DATA VISUALIZATION

Uses **data** that already exists on PI AF on **displays**, mostly **inverter** data.

EVENTFRAME VISUALIZATION

Strategic view of **events table**, with different severities, showing all the events that causes loss of production.

MAIN EQUIPAMENT STATUS

Show equipment **failure** and its **unavailability** according to business rule.

COMMUNICATION ERRORS

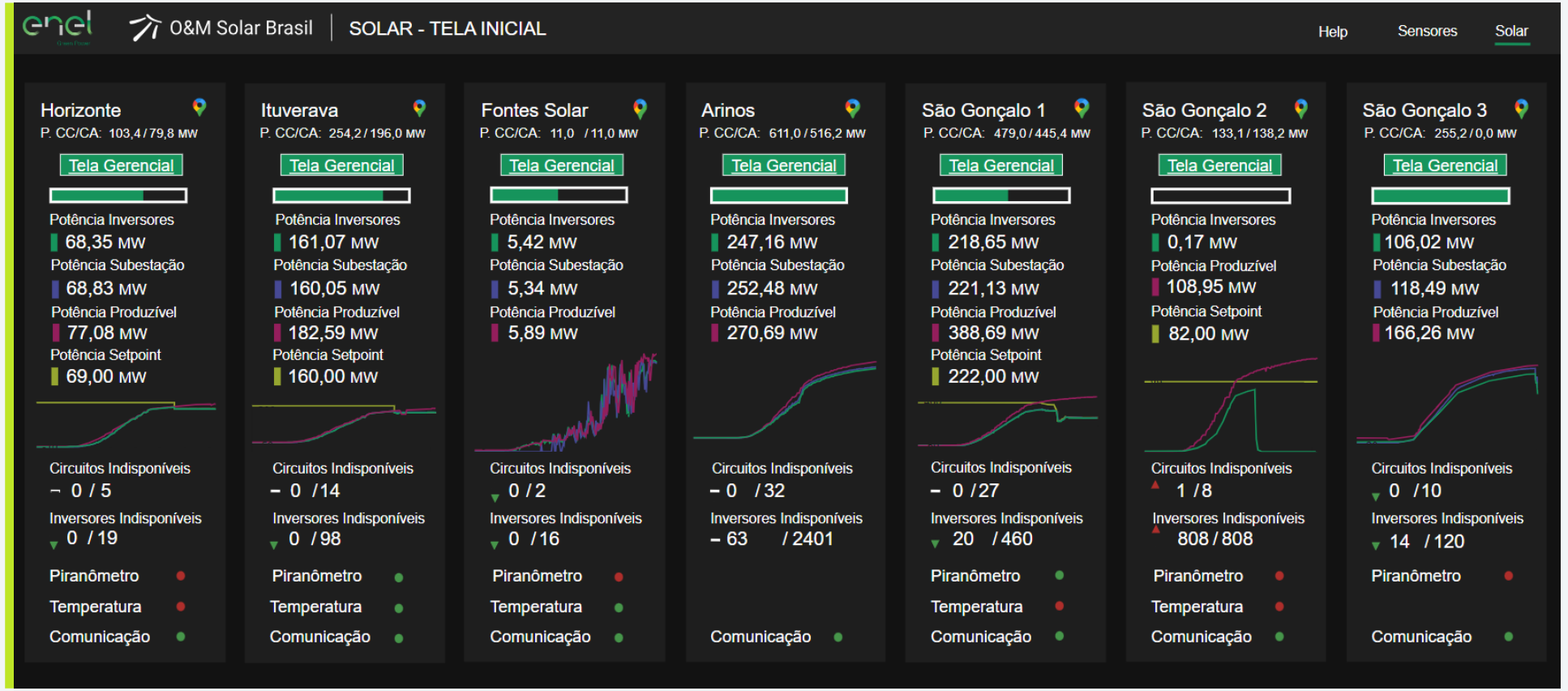
Show communication error in all plant levels (feeder, inverter, stringbox...).

REAL AND PRODUCIBLE COMPARISON

Direct comparison between irradiance, as producible in **MW**, with **actual active power** in **MW**.

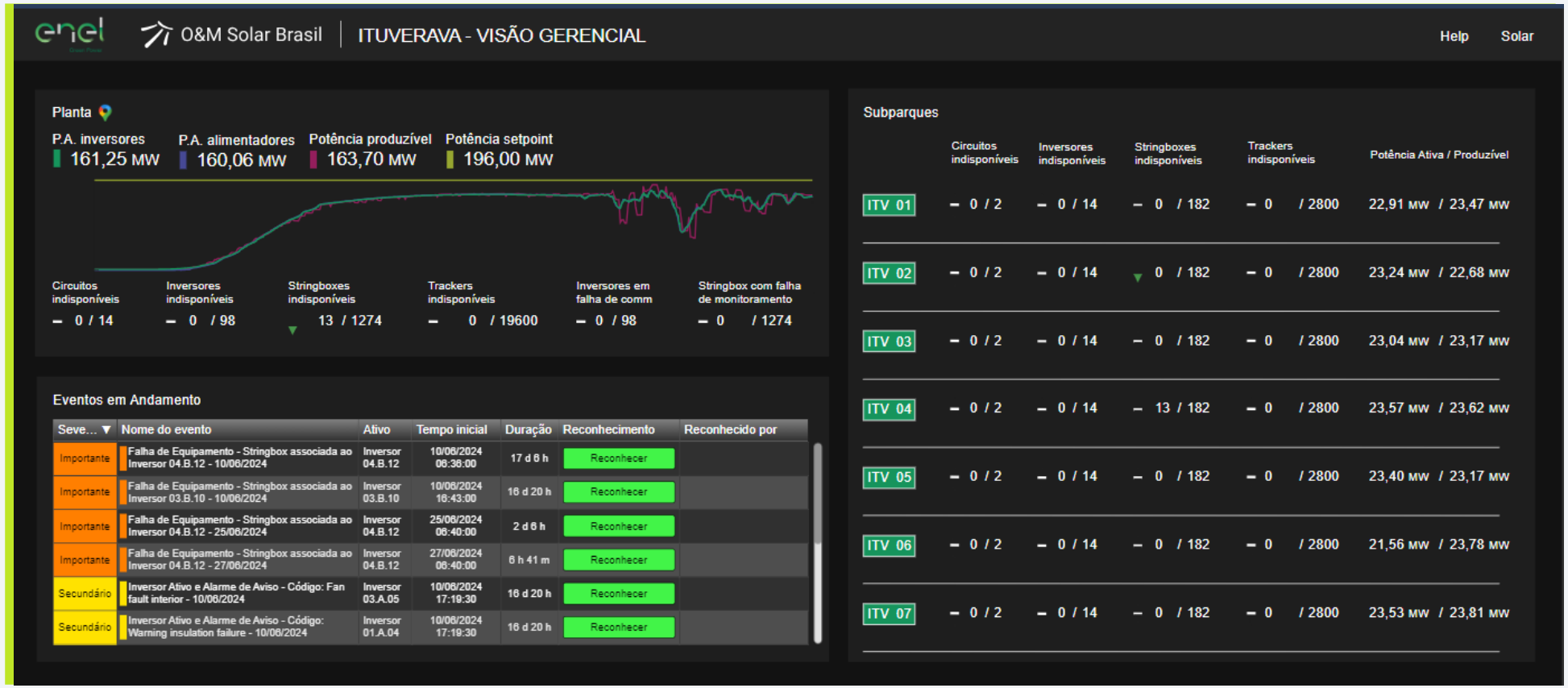
PI VISION DISPLAYS

Top Management Display



PI VISION DISPLAYS

Executive Plant Display



PI VISION DISPLAYS

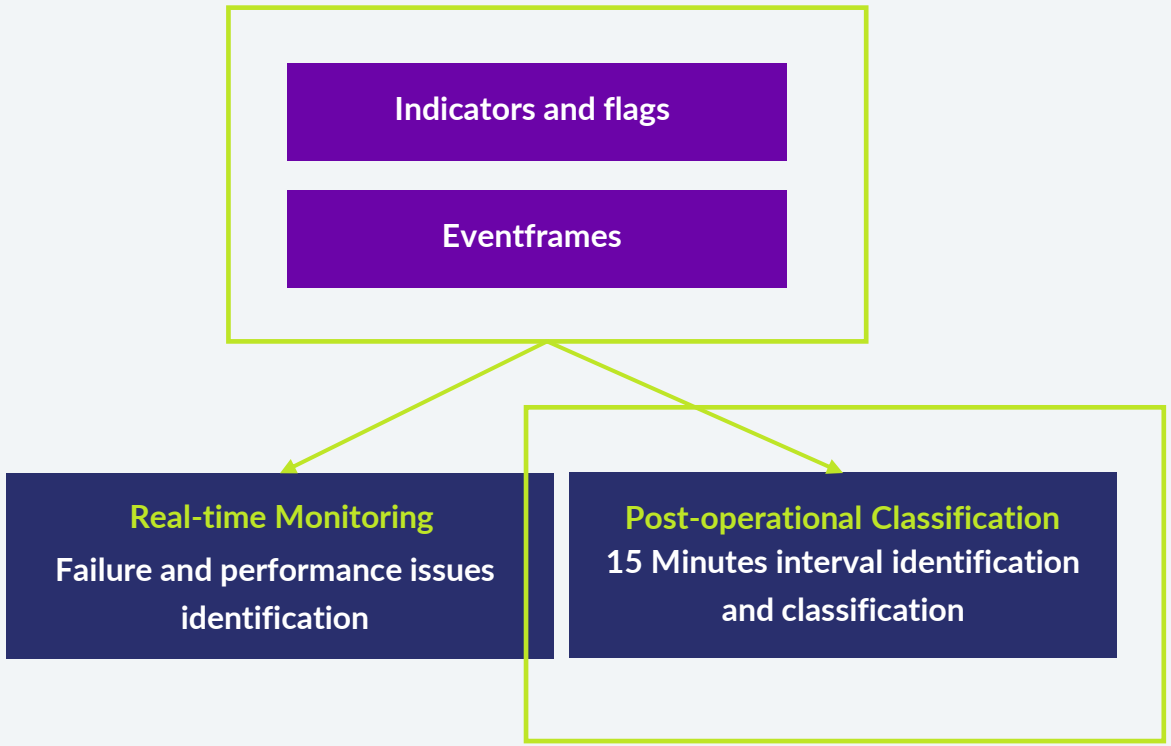
Subpark Level Display

PI VISION DISPLAYS

Inverter Level Display

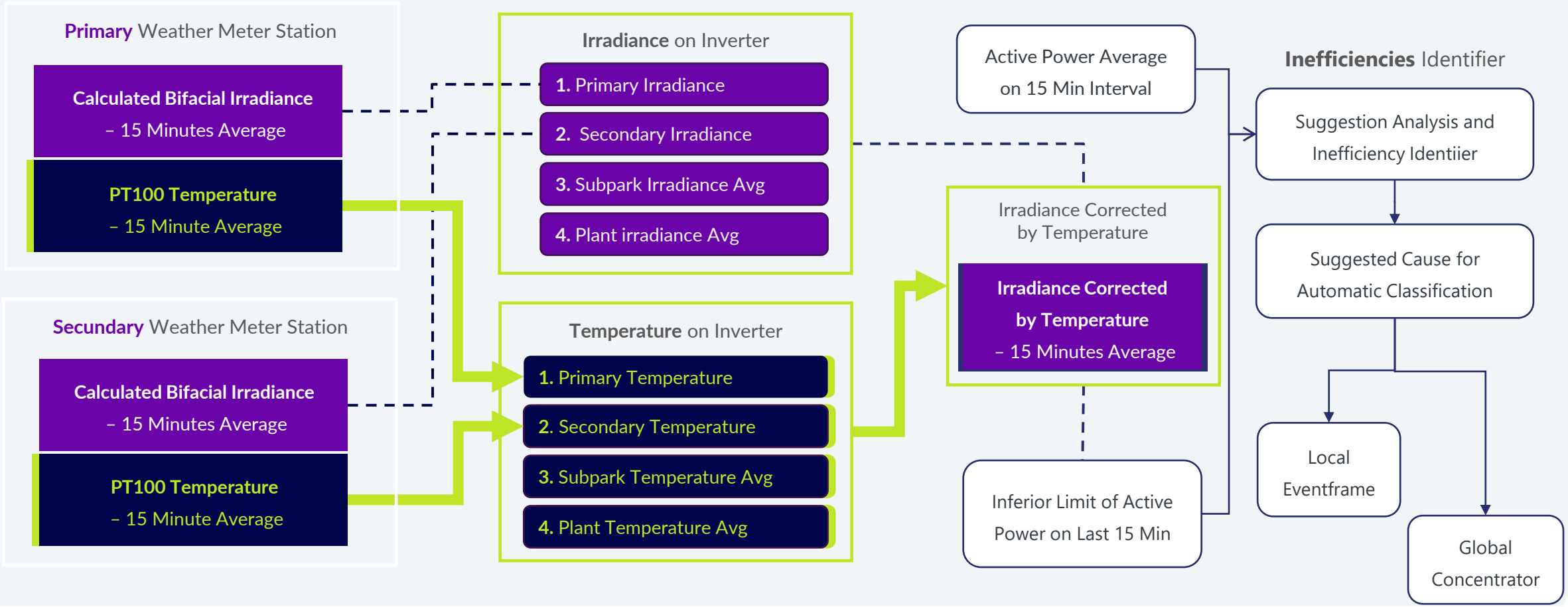
SOLUTION DEVELOPMENT

Using consolidated business rules and merging it with expected power of inverters, so that inefficiencies and failures could be identified and classified



POST-OPERATIONAL CLASSIFICATION

Data Flow in PI System



POST-OPERATIONAL CLASSIFICATION

Global System Integration

Data from Power Plants – Tag with Suggested Reasons for Inefficiencies

Global PI System

PI Interface node

Automatic Classification on Loss of Production

Suggested Classification on Loss of Production

Conclusion and Results

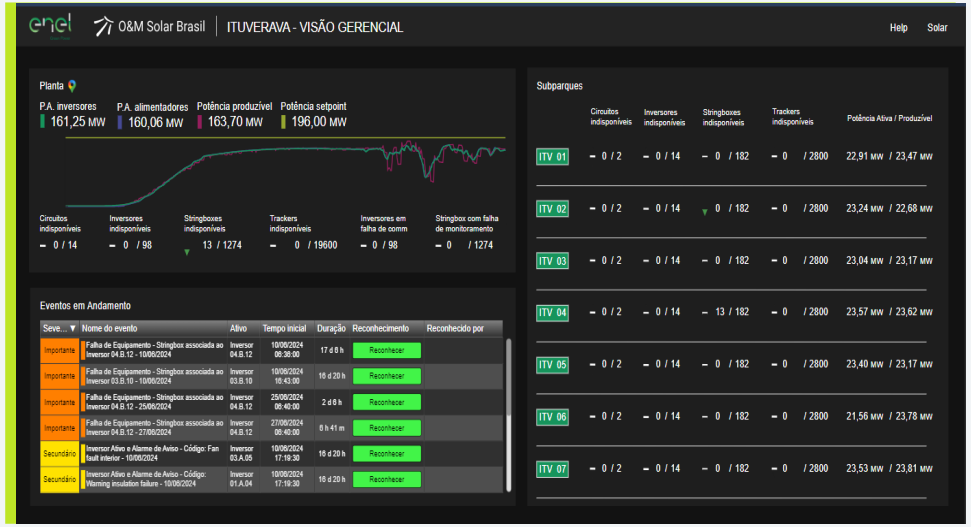
CONCLUSION AND RESULTS

Project Drivers

- **Real Time** Monitoring, Analysis and Intelligent Alarms
- **Failure** Identification and Inefficiency Classification
- **Faster** Data Visualization and Event Acknowledgement
- **Data-Driven** Field Operations and Maintenance
- **Reduction** of Manual Load focusing on strategic activities

enel Green Power radix

CONCLUSION AND RESULTS



✓ Real Time Monitoring, Analysis and Intelligent Alarms

- Executive and operational displays showing real time plant condition and alarms.

✓ Faster Data Visualization and Event Acknowledgement

- Events displayed colored by priority category and enabling acknowledgement by field operator.

✓ Data-Driven Field Operations and Maintenance

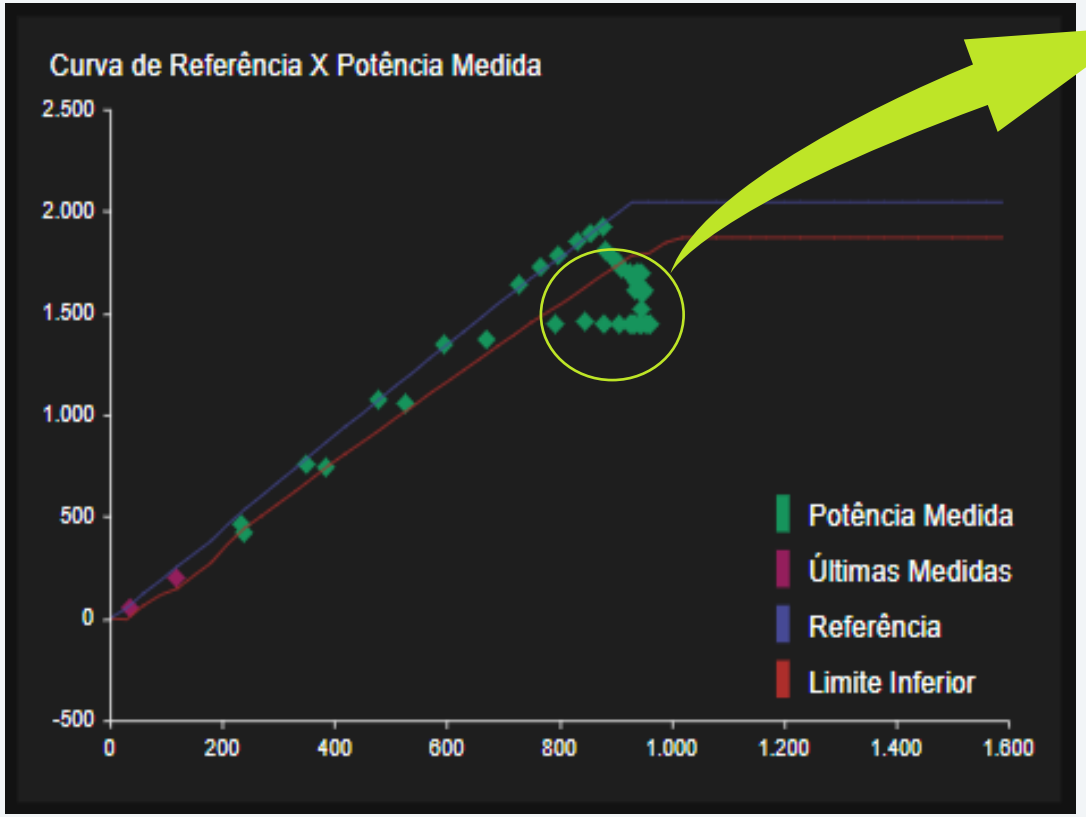
- First steps of data driven analysis enabling future improvements to anticipate failures and avoid losses.

✓ Reduction of Manual Load focusing on strategic activities

- No need for manual input from field or back office team. mindset change for analytical and strategic work.

CONCLUSION AND RESULTS

Inefficiency Detection and Suggested Root Cause



Ineficiências Constatadas

Nome do evento	Tempo inicial	Tempo final	Duração	Motivo
Ineficiência Constatada - Inversor 01.A.03 - 09/09/24 - 11:00 - 14:15	09/09/2024 11:00:00	09/09/2024 14:15:00	3 h 15 m	Curtailment
Ineficiência Constatada - Inversor 01.A.03 - 09/09/24 - 07:45 - 11:00	09/09/2024 07:45:00	09/09/2024 11:00:00	3 h 15 m	Grid Limitation - Ancillary Services
Ineficiência Constatada - Inversor 01.A.03 - 09/09/24 - 07:00 - 07:15	09/09/2024 07:00:00	09/09/2024 07:15:00	15 m	Current Inefficiency - Zone Monitoring
Ineficiência Constatada - Inversor 01.A.03 - 09/09/24 - 06:45 - 07:00	09/09/2024 06:45:00	09/09/2024 07:00:00	15 m	Tracker Failure

✓ Failure Identification and Inefficiency Classification

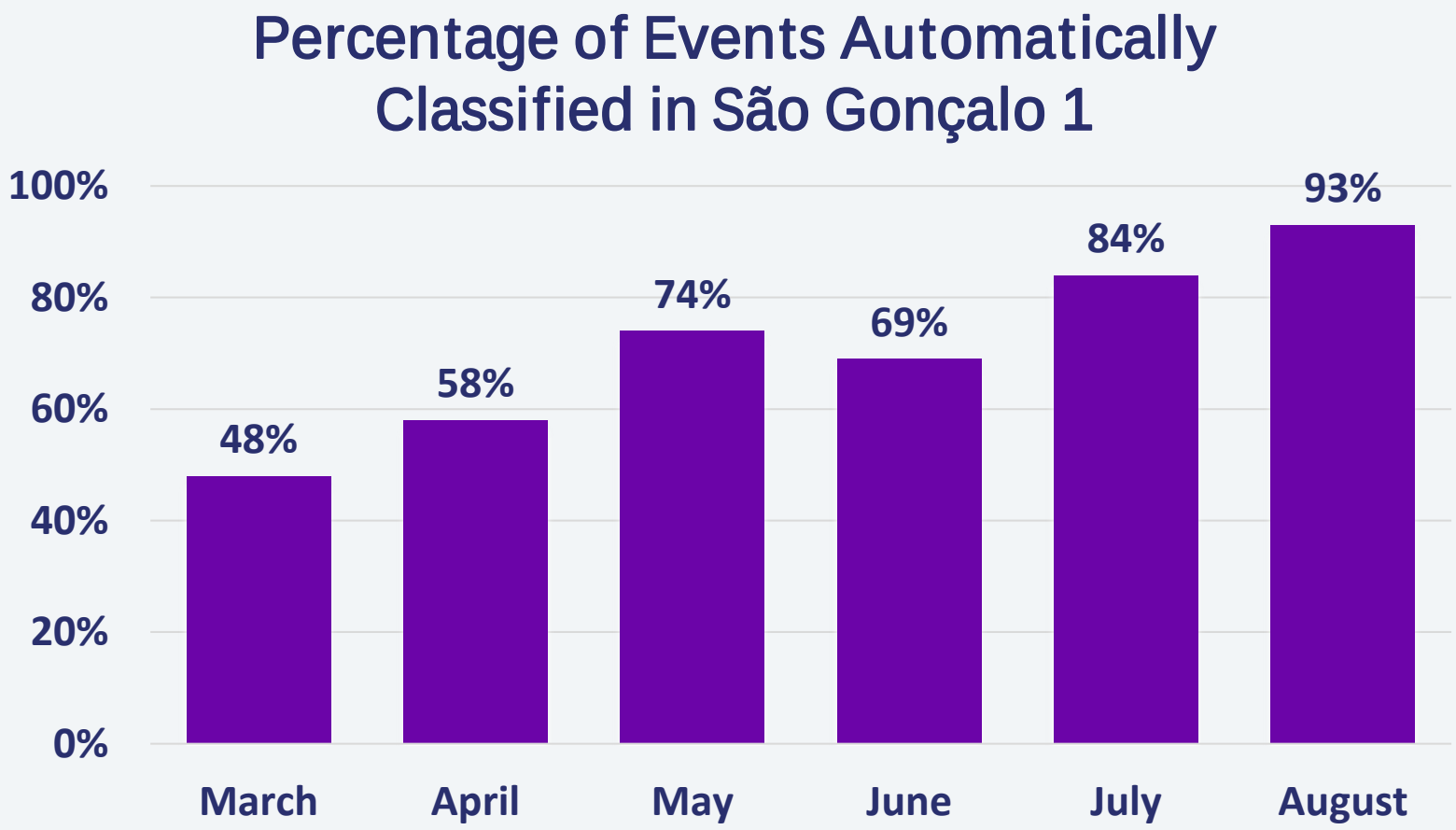
- Automatic events with suggested failures and inefficiency root cause acquired by algorithms created with O&M know-how.
- Automatic classification in post-operational reports without the need for human intervention.

CONCLUSION AND RESULTS

Events of Loss Of Production Automatically Classified on São Gonçalo Complex

Up to **93%** of automatic classification on loss of production in Aug/24 on SGL1;

Also, up to **91%** of automatic classification on loss of production in Aug/24 on other plants;



CONCLUSION AND RESULTS

Expected Results:

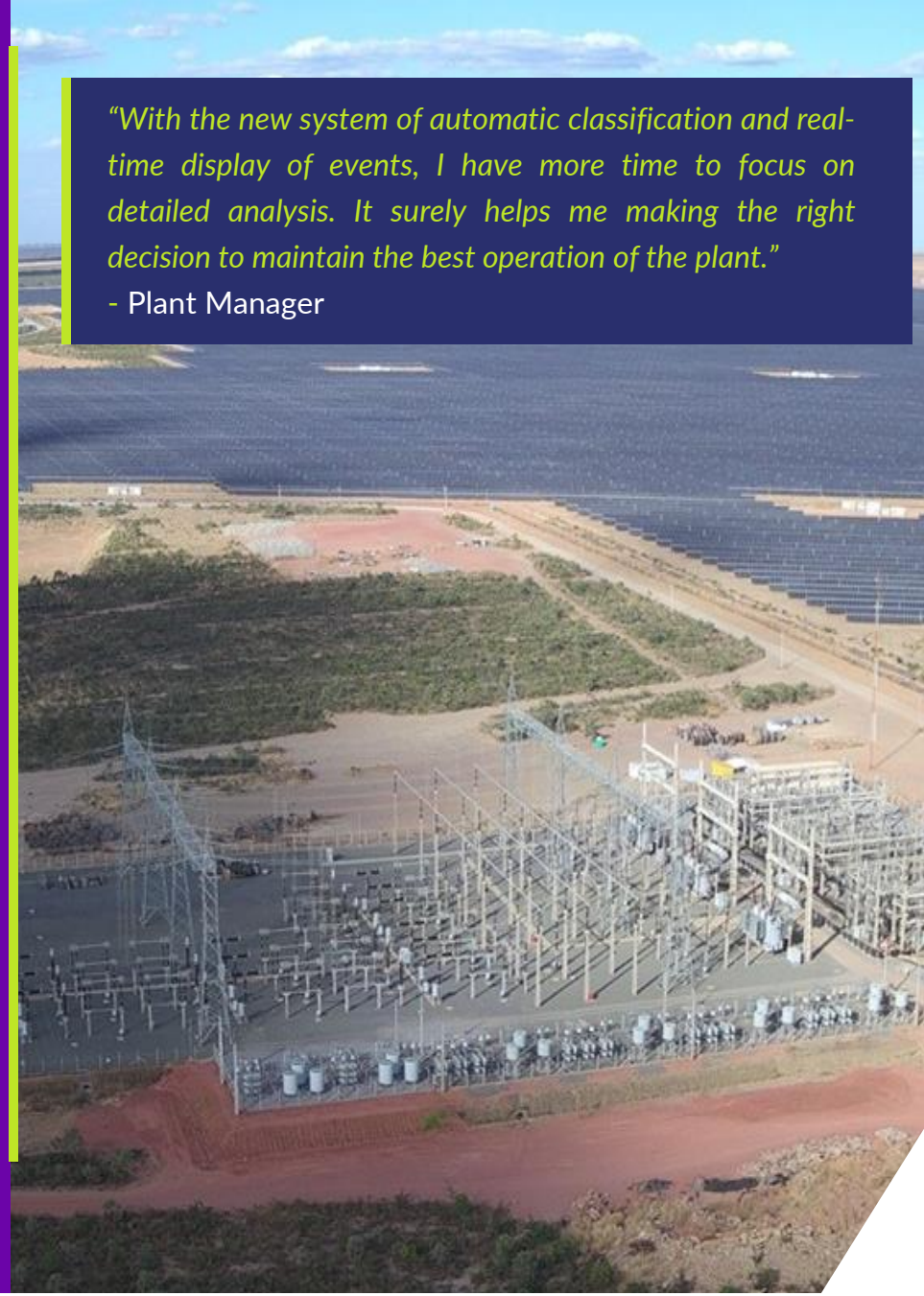
- Reduction of losses due to real time inefficiency alarms identification in PI Vision Displays;
- Reduced man-power costs by providing main cause of failures, optimizing time during field inspections and corrective maintenance;
- All the hours once focused on manual classification of events converted in analysis and “decision-making” work time, grants a much faster and effective response upon new failures and inefficiencies;

Estimated around **5 GWh of yearly losses avoided** in São Gonçalo Cluster due to faster event identification (***i.e. equivalent to 1 day extra of full Generation***);

5 GWh extra production represents avoiding, approximately, 341ton of CO2 emissions (equivalent reduction of 2.0M km traffic by economic combustion engine cars per year or equally the equivalent of reforesting around 61.000 trees during the remainder of the plant's life cycle).

“With the new system of automatic classification and real-time display of events, I have more time to focus on detailed analysis. It surely helps me making the right decision to maintain the best operation of the plant.”

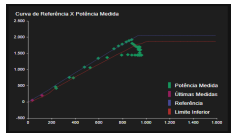
- Plant Manager



Project Roadmap

Current Scenario (2024)

PI Vision Real Time Monitoring and Failure Identification; Post-Operation Automatic Classification.



Past Scenario

Unknown financial losses due to difficulties in managing large volumes of data and technical failures; Absence of a standard Monitoring System; Workforce waste and overload for manual inefficiency classification.

Future Goal

Maximize Solar Operation Efficiency; Data Driven algorithms to achieve predictive maintenance complete solution using AI.

Project Start (2023)

PI System AF Standardizing; PI tags for automatic classification algorithms; PI Vision Monitoring System.

AVEVA

POWER | BRAZIL

Enel Green Power minimizes equipment downtime and improves performance

Challenge

- Standardizing the identification of failures and underperformance in inverters
- Currently relying on a time-consuming manual process that results in substantial losses and highlights the need for an automated system to monitor key performance indicators and enhance operational efficiency.

Solution

- Deployed the latest AVEVA PI System technology including PI AF and PI Vision as an advanced foundation for Process Monitoring, Failure Identification and Bad Performance Issues Reduction.

Results

- Estimated around 5 GWh of yearly losses avoided in São Gonçalo Cluster due to faster event identification
- Increased production and operational efficiency
- Reduced costs, reduced time-consuming inspections
- Faster data visualization of all plants and inefficiency events identification, post-operational automatic classification of inefficiencies.

Thank You!

Gustavo Onofre

Head of Operational Excellence

EGP Brazil

gustavo.onofre@enel.com

Gonçalo Fontenele

Industrial Data Analyst

Radix

goncalo.junior@radixeng.com

This presentation may include predictions, estimates, intentions, beliefs and other statements that are or may be construed as being forward-looking. While these forward-looking statements represent our current judgment on what the future holds, they are subject to risks and uncertainties that could result in actual outcomes differing materially from those projected in these statements. No statement contained herein constitutes a commitment by AVEVA to perform any particular action or to deliver any particular product or product features. Readers are cautioned not to place undue reliance on these forward-looking statements, which reflect our opinions only as of the date of this presentation.

The Company shall not be obliged to disclose any revision to these forward-looking statements to reflect events or circumstances occurring after the date on which they are made or to reflect the occurrence of future events.

linkedin.com/company/aveva

@avevagroup

ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

Learn more at www.aveva.com

AVEVA