



Correlating Photovoltaic Power with Irradiance using Operational Machine Learning

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Conference Theme & Keywords



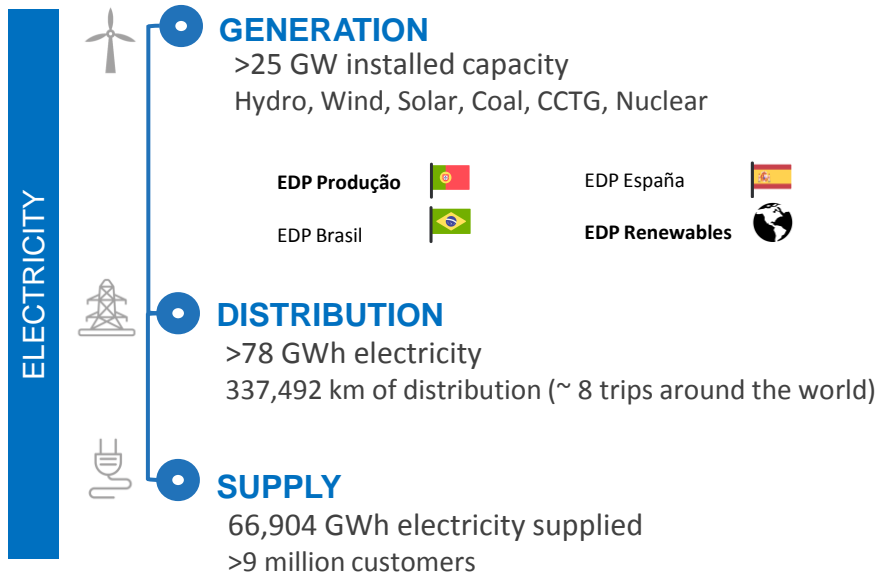
Overview

- About EDP Group & EDP Inovação
- EDP SunLab Project & Proof of Concept
- Application of Operational Machine Learning
- Solution Architecture
- Results Obtained and Business Impact
- Training Lab and Booth Demo at PI World
- Conclusion

EDP GROUP: What We Do



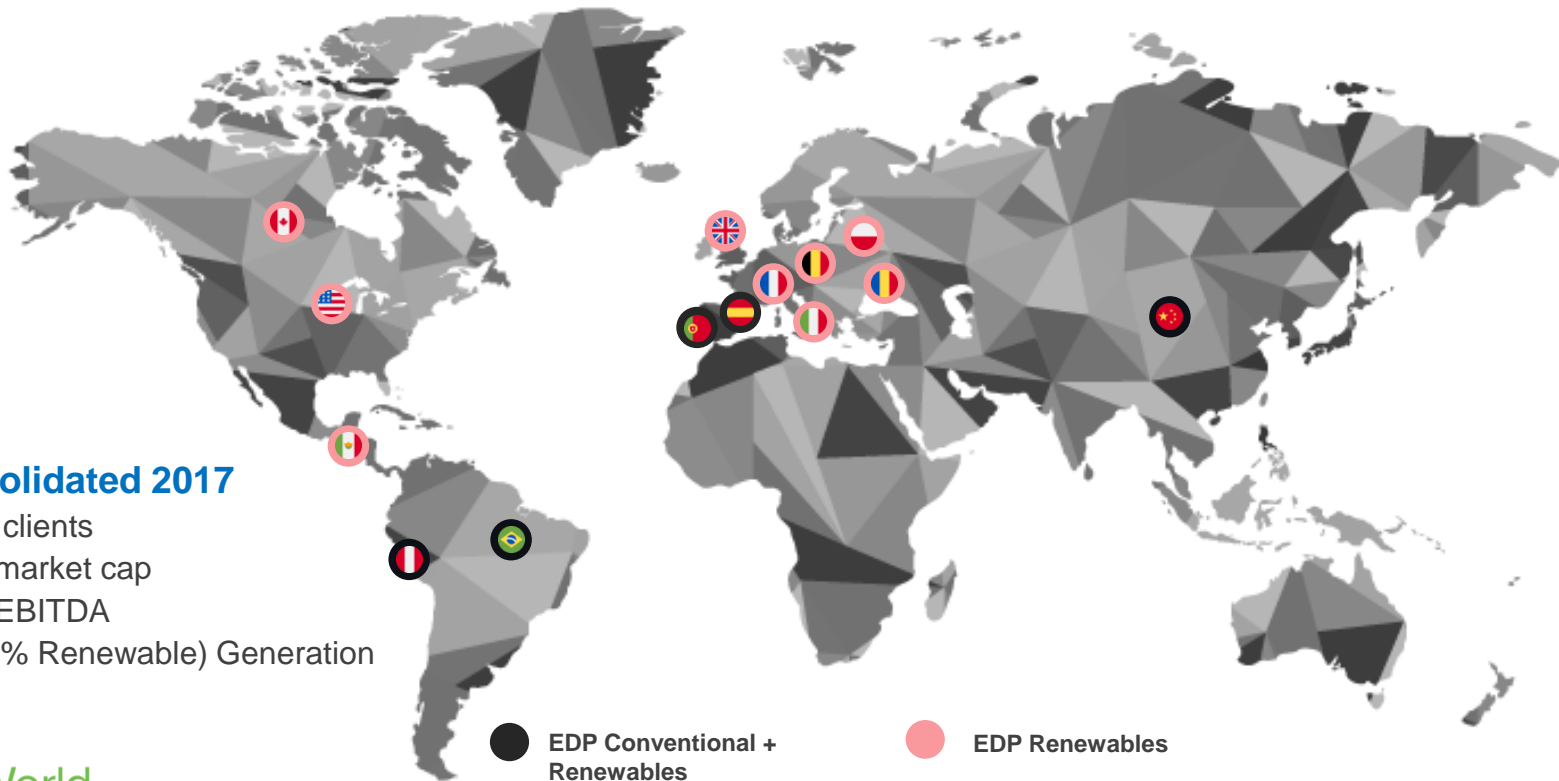
We are a Group that produces, distributes and supplies energy. Our energy reaches the four corners of the world.
We provide electricity to almost 10 million customers and 1.2 million gas connection points.
We have 12 thousand employees around the world.



EDP GROUP: Where We Are



We are present in 14 countries and 4 continents. 70% of our energy is generated by renewable sources.



EDP Consolidated 2017

12 million clients

€ 10 billion market cap

€ 4 billion EBITDA

26.8 GW (73% Renewable) Generation

How We Use The PI System Across EDP



EDP Produção, EDP España & EDP Brazil use **PI Data Archive** and **PI Asset Framework** to

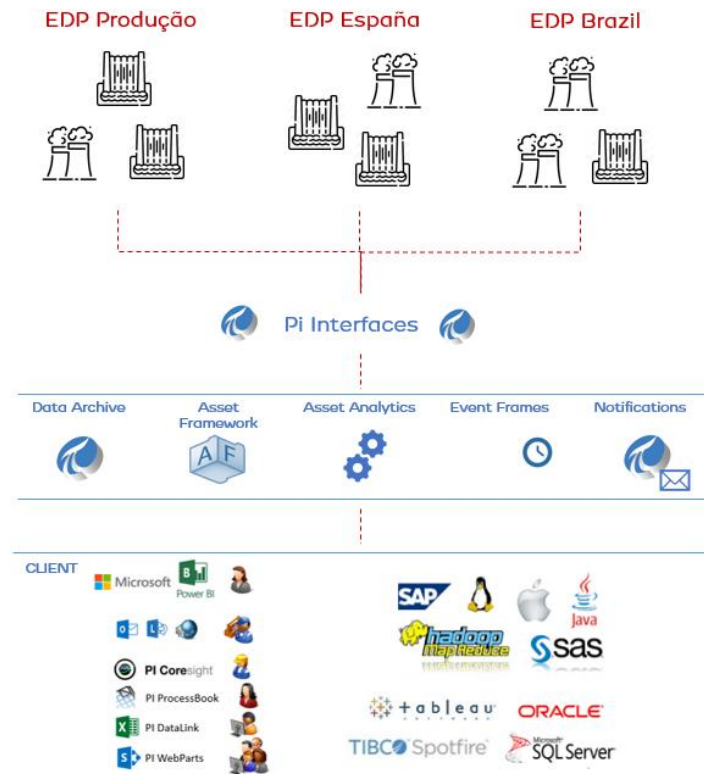
- communicate with each asset (thermal cogeneration and hydro plants)
- acquire real-time data and organize tags in specific frameworks

EDP's Business units use **PI Asset Analytics, Event Frames** and **Notifications** to

- monitor if performance specifications are accomplished
- identify room for improvement or underperformance

EDP Renewables uses **PI**

- to manage assets across the world.
- for KPI's, reporting, user data requirements, Queries, PRGMS (Power Regulation Management System)



EDP Inovação: What We Do



The energy with which we project our leadership into the future. To innovate is to apply creativity in the search for new opportunities, improving processes, exploring collaborative practices in the design, production and delivery of services and promote research, technological development and knowledge management.



Business expertise



Interim management



Pilot projects



Incubation and acceleration programs



Corporate venture capital



SMARTER GRIDS

Smart Grids Infrastructure
Energy Distribution Management



CLEANER ENERGY

Renewable Energy
Thermal & Big Hydro Generation



CLIENT-FOCUSED SOLUTIONS

Smart Pricing And Bundling
Energy Efficiency
Increase Electrification



DATA LEAP

Cloud Computing
Big Data
Web 3.0
IoT
Advanced Analytics



ENERGY STORAGE

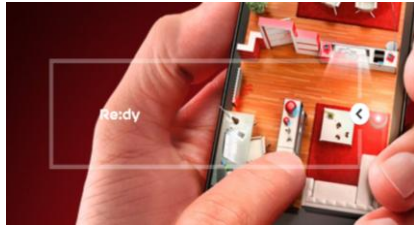
Battery Technologies
Storage Management And Control

Our Projects



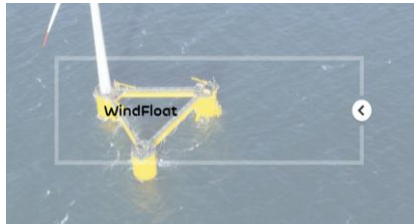
Sinapse

Imagine you are at home and suddenly there is a power failure. One objective of the project is to replenish the supply of electricity more quickly, and is designed to make the network more 'intelligent' and functional.



Re:dy

Edp re:dy - Remote Energy Dynamics is a groundbreaking service offered by EDP Commercial in Portugal. It allows residential consumers to manage their energy consumption in real time, wherever they are, from their computer, tablet or smartphone, in order to reduce costs.



WindFloat

An innovative technology that will allow the exploitation of wind potential at sea, at depths of more than 40 meters.

The innovation focus is a floating foundation, based on the experience from oil and gas industry, which will support multi-MW wind turbines in offshore applications.



SMARTER GRIDS

Smart Grids Infrastructure
Energy Distribution Management



CLEANER ENERGY

Renewable Energy
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CLIENT-FOCUSED SOLUTIONS

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DATA LEAP

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ENERGY STORAGE

Battery Technologies
Storage Management And Control

EDP SunLab Project: Falkonry Proof of Concept



OBJECTIVE

- Identify unexpected correlations between irradiance and photovoltaic power production
- Validate the accuracy of the Falkonry machine learning generated model vs in-house developed model

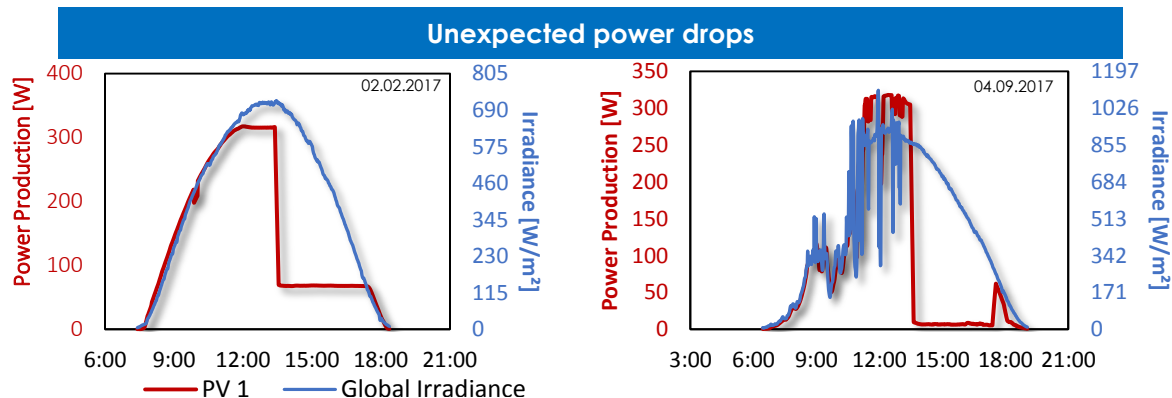
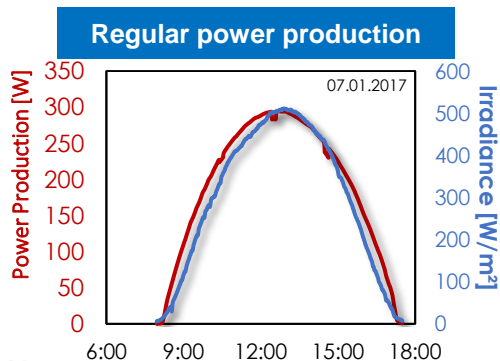


USE CASE

- Location: EDP SunLab Project, Santarém, Portugal
- Technology: 1 PV module installed at 30° and South oriented
- Time Frame: Jul'16 – Sep'17



WHAT ARE WE LOOKING FOR?



“Ready-to-Use” Operational Machine Learning



Falkonry LRS finds opportunity in underutilized operations data

Discovers hidden
patterns



Predicts early
warnings



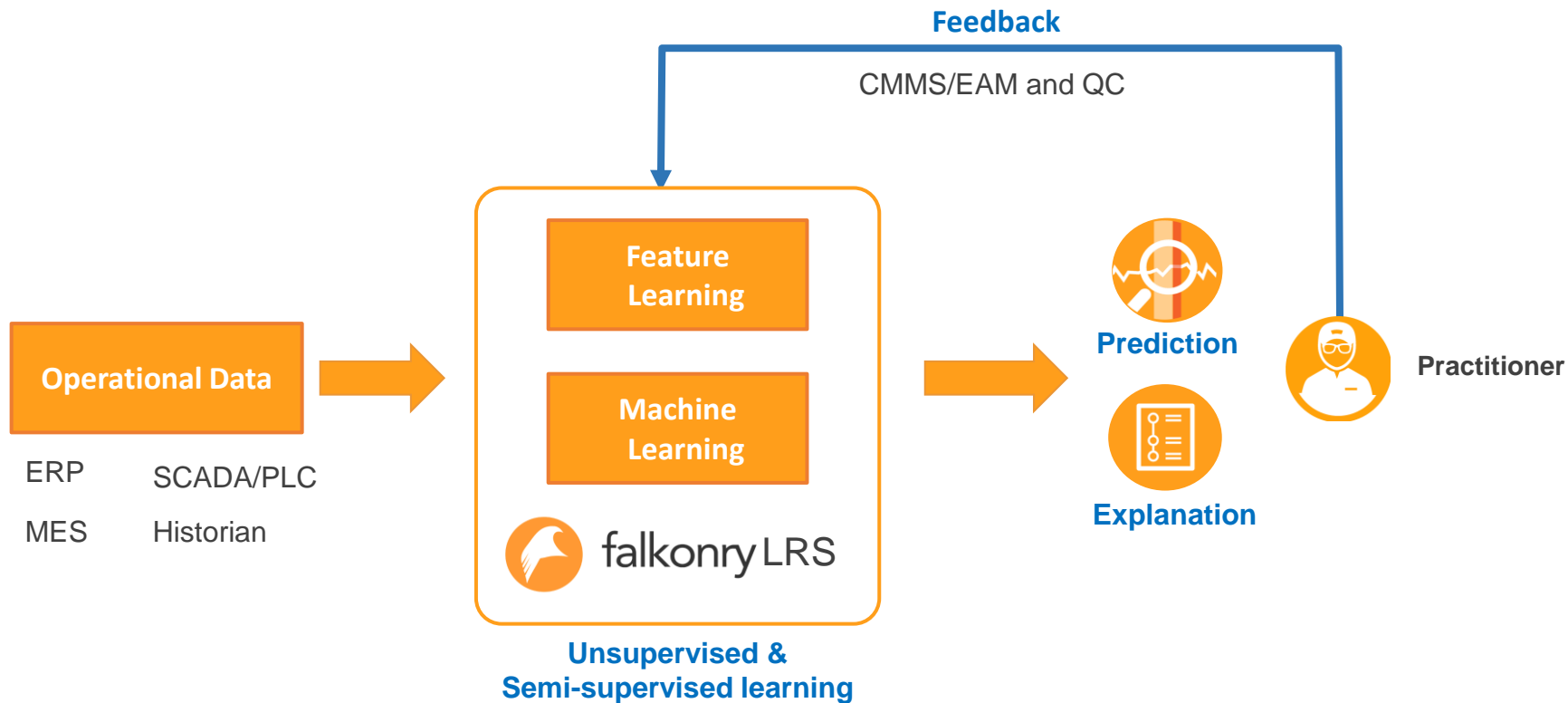
Provides explanation
of its work



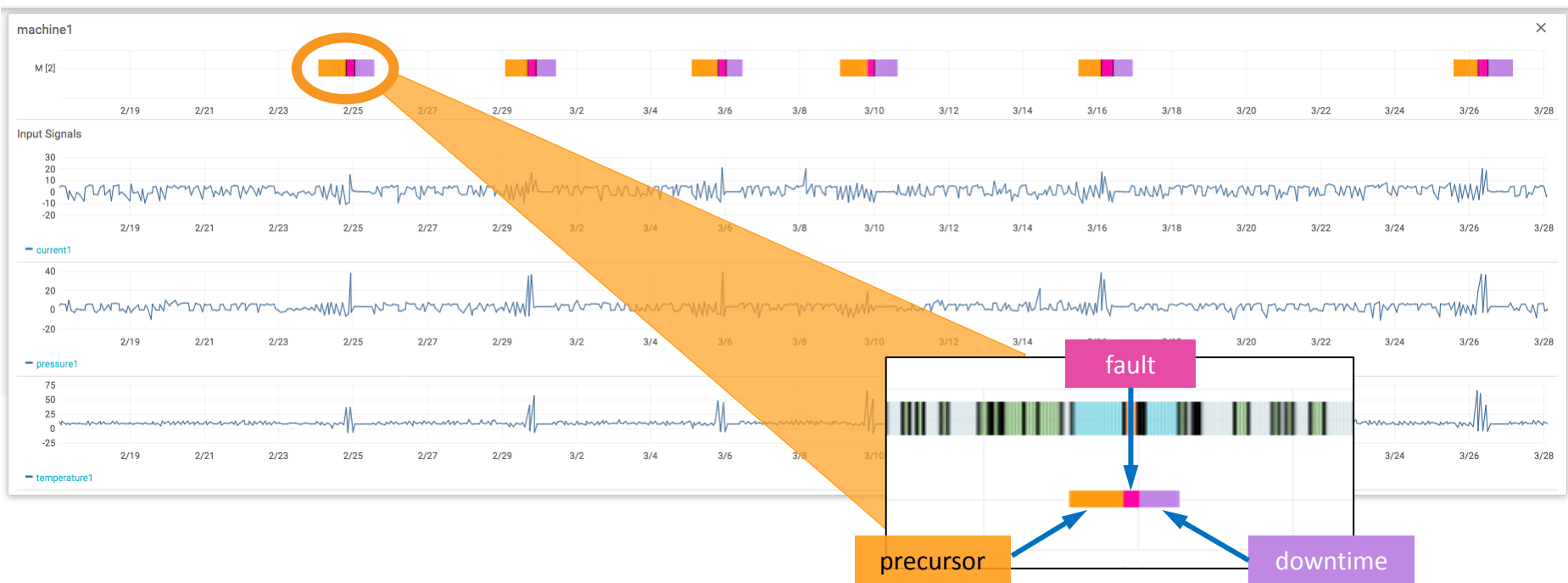
Empowers industrial
practitioners



Falconry LRS: “Data Scientist in a Box”



Discover Time Series Patterns with Machine Learning



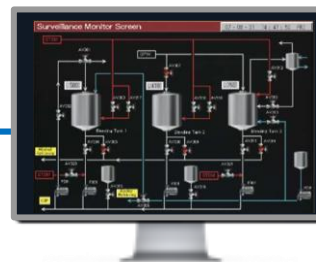
Solution Architecture



Operations
Management
Solution



Data Collection



Control Ops



Automation / Operators

Signals

Assessments



Domain Experts
Operations engineers
Process engineers

All data and assessment results are stored in PI



Falconry LRS: Sliding Window Model



METHODOLOGY

1

Definition of entities correspondent to each PV module
Input signals: PV Power Production and Irradiance

2

Entity to train: 1
Add facts in period of train (01/07/2016 – 22/09/2016) – 29 facts

3

Apply the model to the whole period of analysis and entities

4

Validate the output



RESULTS



Accuracy: 97% of the periods well identified (84/87)

Power drop ~ 0 W



Accuracy: 95% of the periods well identified (94/97)

Power drop ~ 60 W



Falconry LRS: Batched Window Model

METHODOLOGY

1

Definition of entities correspondent to each PV module
Input signals: PV Power Production and Irradiance

2

Window defined based on a daily basis
Add facts in the whole period of analysis (01/07/2016 – 30/09/2017) for entity 1

3

Apply the model to the remain entities

4

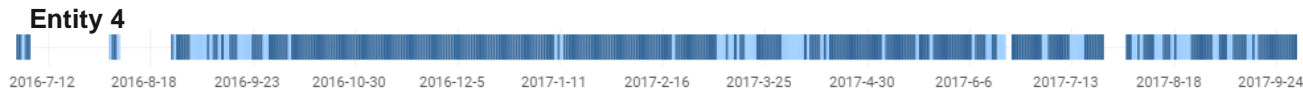
Validate the output

RESULTS



Accuracy: 99% of the periods well identified (77/78)

Irregular



Accuracy: 91% of the days well identified (81/89)

Normal



EDP SunLab: Falkonry Proof of Concept

✓ CONCLUSIONS

- ✓ Very user-friendly allowing for a quick and intuitive model development
- ✓ Easy to adapt to several generation technologies
- ✓ High accuracy of the results

POTENTIAL BUSINESS IMPACT

- ✓ Potential to improve renewable operations by remotely
 - identifying failures in PV output;
 - Identifying underperformance of solar assets;

Prediction with Falconry LRS



COMPANY AND GOAL

EDP generates **73%** of electric power from renewable sources for **10 million** customers in Europe.

Falconry has showed to be a tool with high potential to **accurately identify underperformance and failures** of EDP's renewable assets



CHALLENGE

Underperformance and failures of solar panels

- Unexpected relation between power output and solar irradiation patterns

SOLUTION

Use Falconry LRS to discover patterns and conditions in multivariate time series data

- Automated machine learning and predictive analytics from Falconry
- No data scientists. Can be run by Business Unit staff

RESULTS

Accurate PV output prediction in < 3 weeks

- Easy to implement
- User friendly
- High accuracy of the results

Contact Information



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SVP, Customer Success
Falconry

Call to Action

- Visit Booth #6 in Golden Gate room for a demo of operational machine learning
- Sign up for Falconry Training Lab on April 26 at Hotel Nikko

Questions

Please wait for the **microphone** before asking your questions

State your **name & company**



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Merci

谢谢

Спасибо

Danke

Gracias

Thank You

감사합니다

ありがとう

Grazie

Obrigado