« Exchange of Experiences » - Webinar

Insights, outcomes and results – 28 September 2023

«PV-ANALYTIC»

Advanced photovoltaic system monitoring and analytics solution enhanced with intelligent interoperable data-driven features for efficient big data real-time analysis, failure diagnosis, automated management and integrated micro-grid control

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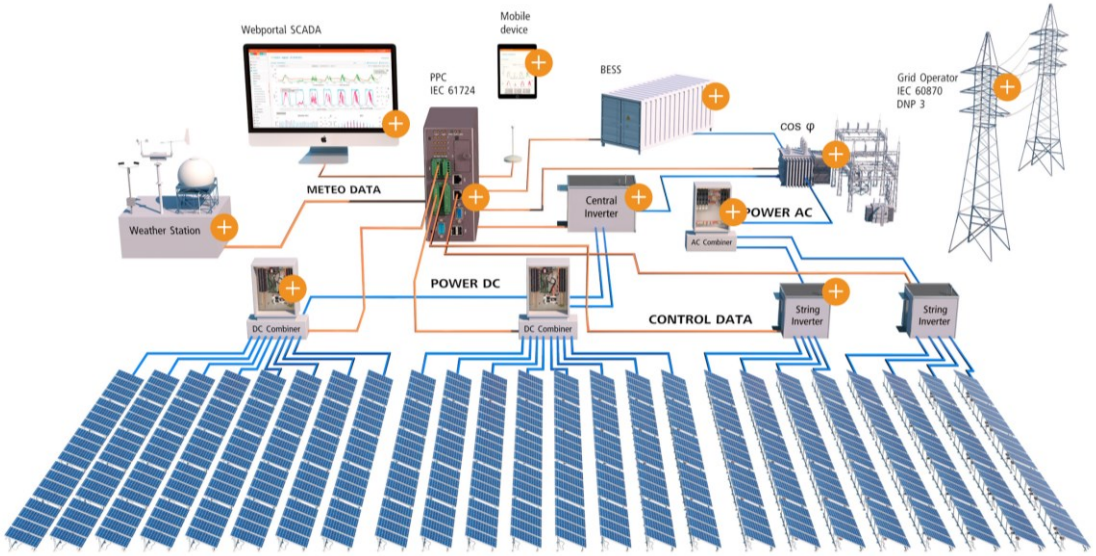
Contents

Overview

SCOPE

Increase the value and competence of PV systems by developing a next-generation multi-service monitoring and control system.



FUNDING

SOLAR-ERA.NET Regional Funds

€460,080

CONSORTIUM

Gantner Instruments GmbH Austria and
University of Cyprus, Cyprus

TIMELINE

36 Months (1/11/2019 – 31/10/2022)

APPLICATION

AI-driven supervision and control of PV power plants for smart grids

TOPICS

Smart Grid, PV systems

SHORT DESCRIPTION

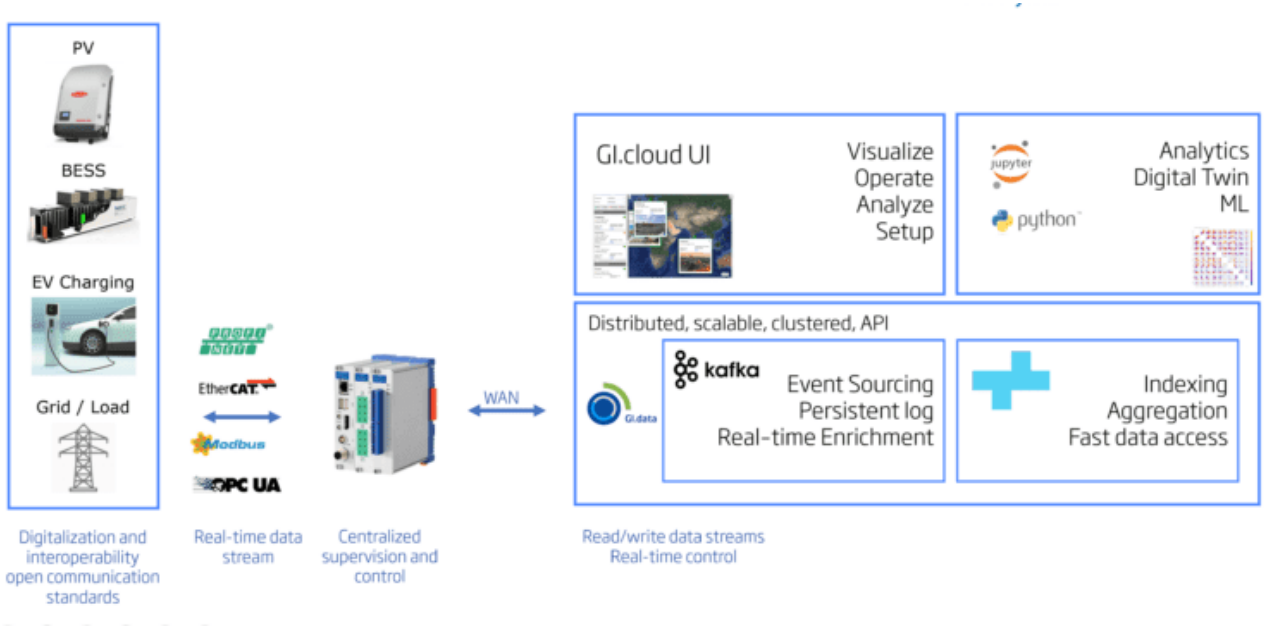
Advanced system monitoring and analytics solution for efficient big data real-time analysis and integrated smart grid control of PV power plants.

Challenges addressed

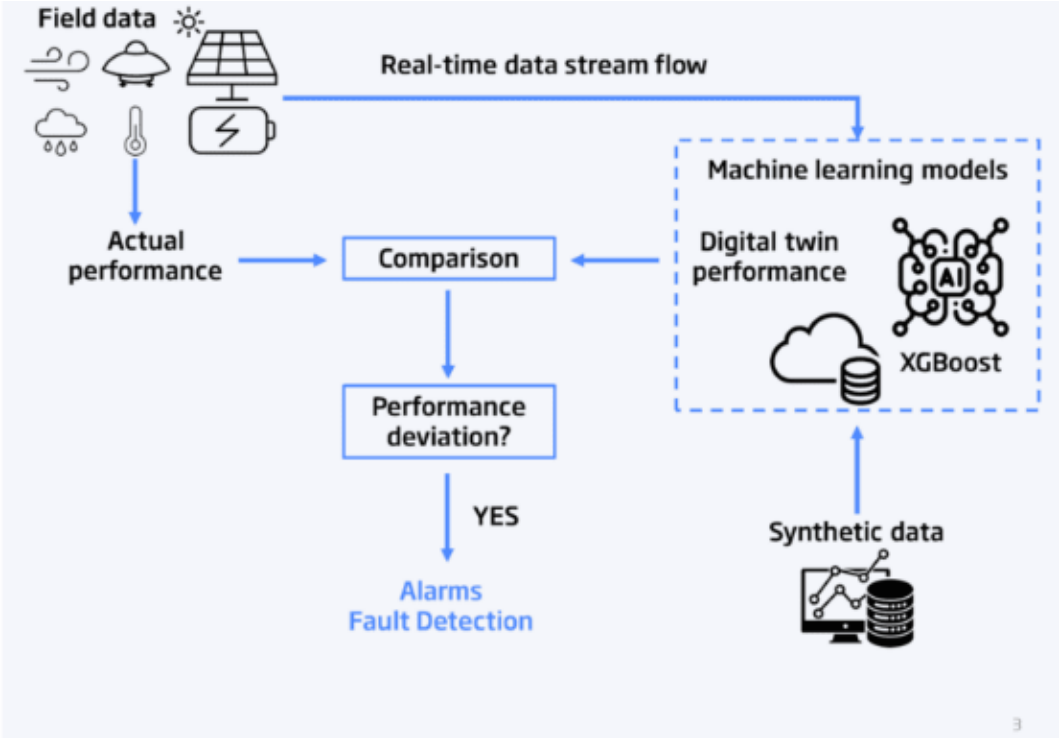
- Scientific
  - Lack of optimized and automated functions for reactive and proactive O&M.
  - Lack of data analytic energy loss predictive and diagnostic algorithms.
- Technical
  - Lack of Digital Twin condition monitoring and failure diagnosis models for utility-scale PV power plants.
- Commercial
  - Lack of commercially available AI-driven power plant controller and cloud-based control system.

Results – Advanced hardware and cloud monitoring solution

R1 – Advanced monitoring solution

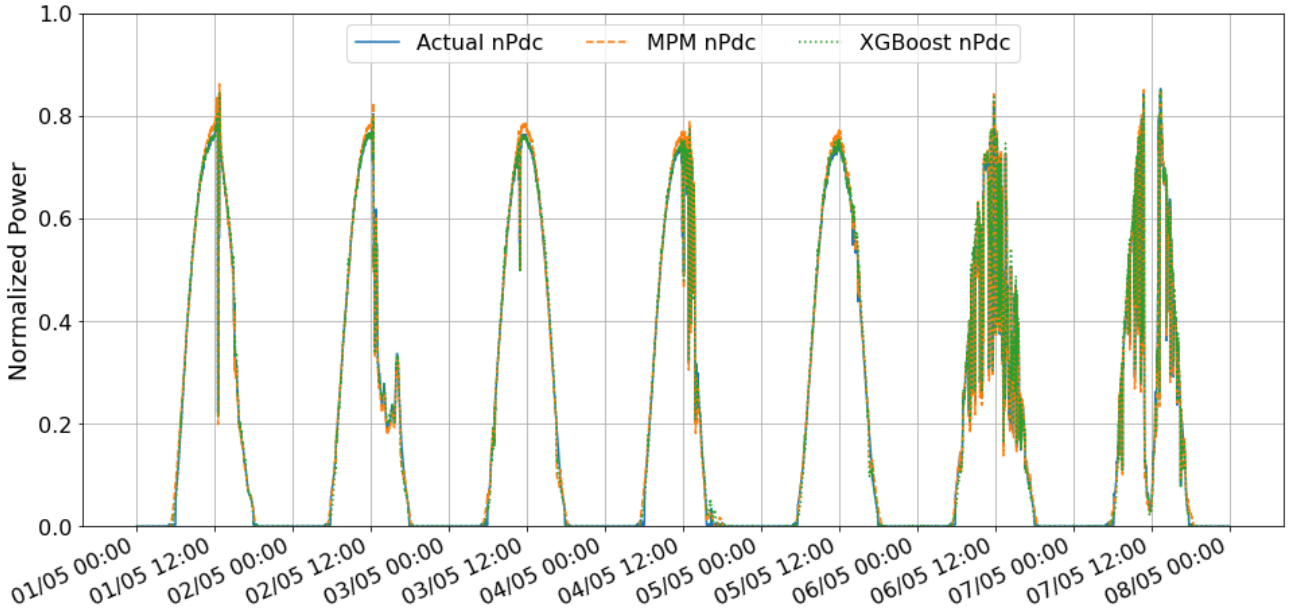


R2 – Digital Twin <2% prediction error



Results – Predictive modelling and ML

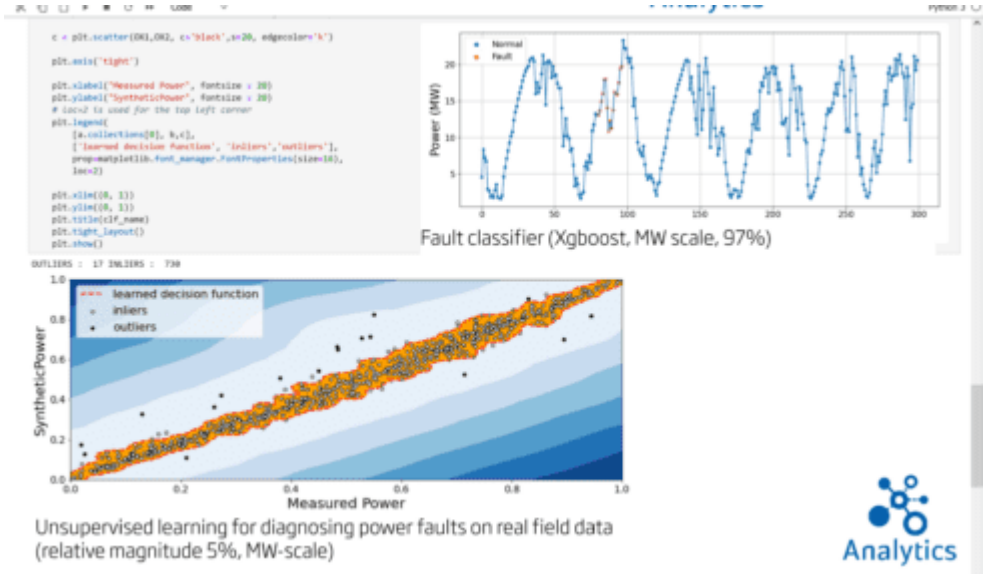
R3 – Mechanistic performance model for PV arrays



$$MPM_{Param} = C_1 + C_2*(T_{MOD}-25) + C_3*Log_{10}(G_I) + C_4*G_I + C_5*WS$$

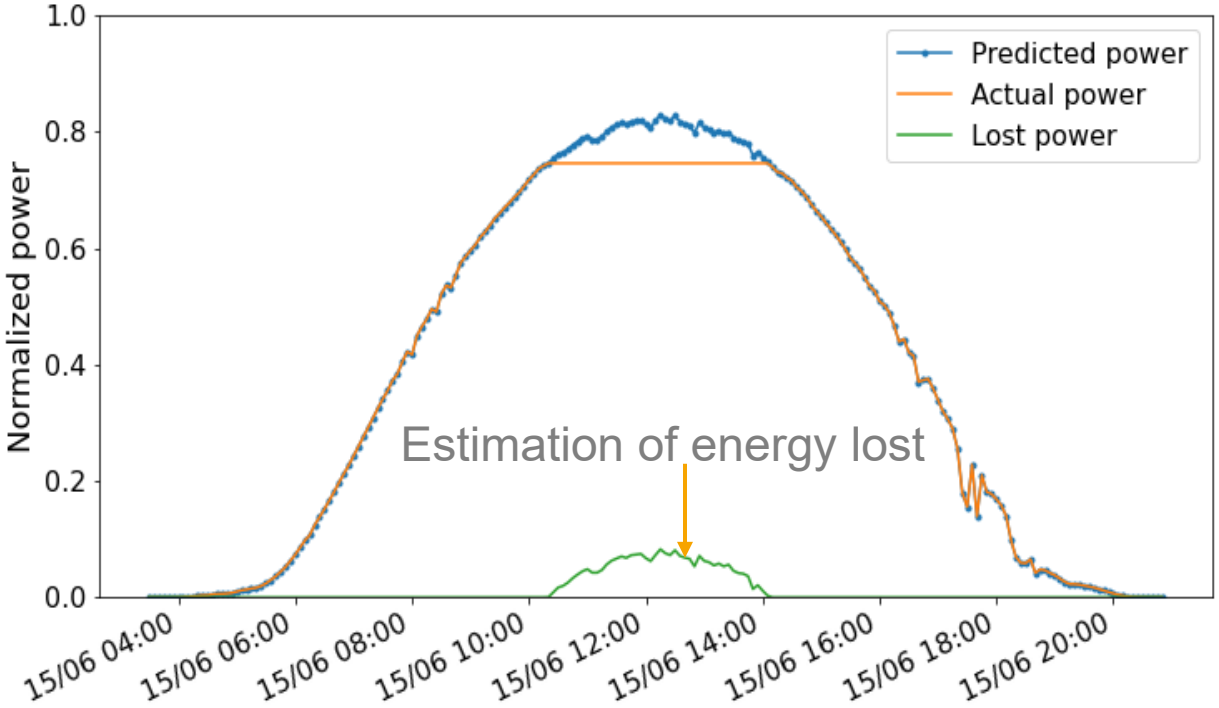
e.g., PR, nVdc, nIdc — Tolerance — Temperature — Voc and Rshunt — R_{SERIES} — Wind

R4 – Unsupervised-Learning for fault classification at MW-scale & Microgrids



Results – Fault diagnosis and demonstration

R5 – Failure detection and classification



R6 – Actual-environment demonstration

Outcomes and benefits

- Innovative monitoring and control guidelines
- Analysis of main PV system failures and trend-based losses
- PV power plant interoperability protocols
- Energy loss predictive and diagnostic algorithms
- Virtual digital twin technologies

Benefits

- PR >5% over 2017
- Yield >5% over 2017
- Risk <5% over 2017
- Monitoring costs <20% over 2017
- O&M costs <1% over 2017
- End-solution with smart functions

Experiences gained in transnational set-up

University of Cyprus

- Access to utility-scale high-resolution datasets
- Usage of latest technology programmable automation devices
- Transfer of industrial know-how on cloud-based monitoring

FOSS
Research Centre for Sustainable Energy

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- Machine learning modeling exposure
- Knowledge gain on future PV power plant services
- Advanced testing of end-solution using high-tech academic tools

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Lessons learned and critical factors

Lessons Learned

- Data enrichment and normalization is a requirement for site-independency and scalability of data-driven models.
- Digital Twin models (ML or mechanistic) can predict performance accurately using only irradiance and temperature measurements.
- Onsite power plant controllers provide the fast response (low-latency) for future smart grid closed loop controls of PV power plants.

[CF1] - High-quality data at utility-scale necessary for data-driven operations.
[CF2] - Unified, high-throughput, low-latency platform necessary for smart grid operations and for handling real-time data feeds.

Thank you for your attention

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