ROM-PV
Reducing the photovoltaic operation and maintenance (O&M) costs through an advanced online platform

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Publishable Summary

A challenge in the scope of facilitating further the uptake of photovoltaic (PV) technology is the reduction of levelised cost of energy (LCOE) by increasing the lifetime output, quality and sustainability as targeted by the SET-Plan. This can be achieved by improving the lifetime energy yield and operation and maintenance (O&M) costs through online data-driven and statistical algorithms that will enable the analysis of measurements collected from constant monitoring of PV plants. In this sense, a main challenge for ensuring quality of PV power plant operation is to safeguard reliability and optimum performance by detecting, classifying and accurately quantifying performance losses and failures.

The ROM-PV project was initiated to overcome these challenges by developing and commercialising a product that enables preventive and predictive maintenance and ensures optimal PV plant performance while also reducing the associated O&M costs. This was achieved through the development of a cloud-based solution that hosts innovative algorithms able to a) ensure data quality and b) allow failure and performance loss diagnosis (open- and short-circuit failures, inverter and bypass diode faults, shading, degradation, soiling, etc.) without disrupting the normal operation of the PV plant. The methodology was primarily based on real-time analysis of measurement data, machine learning and statistical analysis and was verified experimentally against field measurements from existing PV systems installed worldwide.

A complete methodology for ensuring data quality was developed (WP3). The optimum methodology ensures data sanity by treating missing and erroneous data, performing data aggregation, imputation and filtering. The data quality and management methodology was developed as an algorithm (routine) and it was validated against historical field measurement data obtained from PV systems installed in Cyprus, Greece and Spain. The proposed algorithm ensures high-quality data for the proposed monitoring solution. Research work was also conducted in the field of failure and losses diagnosis (WP4). More specifically, algorithms for detection and classification of commonly occurred failures in grid-connected PV systems were developed (software scripts). The developed algorithms were benchmarked using historical field data from small- and large-scale PV installations and proved the effectiveness of fault diagnostic algorithms for diagnosing underperformance incidents in operating PV systems. Similarly, software algorithms for the quantification of soiling losses were also devised along with a cleaning optimization technique (WP5). The developed algorithms can extract the soiling losses in real time from PV performance time series and profiles, without the need of soiling stations or additional labor cost and maintenance. The proposed algorithms were validated under controlled laboratory and real operating conditions in different locations. The developed algorithms can identify the optimum cleaning schedule for any PV plant, thus maximizing its performance and limiting the O&M costs. Finally, the data quality methodology, the fault diagnostic algorithms and the soiling algorithms

were finally incorporated into the cloud-based monitoring solution for ensuring optimal PV performance, while also reducing the O&M costs (WP6). The PV O&M commercial product was validated against real data from operating PV plants and Key Performance Indicators (KPI). The results provided evidence for the enhanced capabilities of the new product for monitoring the PV asset's health-state and enabling optimum O&M including predictive and preventive maintenance.
The undertaken research work has a significant impact on reducing the LCOE, by increasing the lifetime output (performance and energy yield), quality and sustainability of the technology as targeted by the SET-Plan. This was achieved by predicting and accurately detecting faults and losses (i.e., soiling, shading, faulty inverter, etc.), performing preventive maintenance and cleaning maintenance strategies. Therefore, combining the preventive and predictive maintenance aspects of this project can impact positively the way O&M providers perform their services, making them more efficient and cost effective, but it will also have a positive impact on plant lifetime performance.
Finally, this is an industry driven project which combines the research expertise of two well reputed research groups, the PV Technology Laboratory of the University of Cyprus (UCY) and the Centre for Advanced Studies in Energy and Environment (CEAEMA) of the University of Jaén (UJA) with the market experience of a global organization (Alectris Hellas IKE – industrial partner) that delivers assets care innovation for the global solar industry since 2012.

Project consortium

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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Cyprus	1	155 558	155 558
Spain	1	113 400	113 191
Greece	1	168 869	108 076
Total	***3***	***437 827***	***376 825***

Funding agencies involved and contracts

Funding Agency	Contract N° and Title
Cyprus Research and Innovation Foundation (RIF)	P2P/SOLAR/0818/0009 – ROM-PV
Ministry of Economy, Industry and Competitiveness – State Research Agency (MINECO-AEI)	PCI2019-111852-2/ IOM-PV
General Secretariat for Research and Technology (GSRT)	T11EPA4-00023 GSRT System Contract Code: 5087186