1C4PV
One intelligent cloud for PV Assets Diagnosis and Maintenance

Project duration: from 02.2020 to 11.2022
Report submitted: 11.2022

Publishable Summary

1C4PV is an **industry-driven demonstration project** that will contribute to achieve the reduction of the total costs of photovoltaic (PV) generation and the Levelized Cost of Electricity (LCoE), providing advanced and automated functions for data analysis for the early fault diagnosis (detection and classification) and maintenance planning for PV assets. Those functions will be part of a cloud platform that collects data from the Supervisory Control and Data Acquisition (SCADA), Internet of Things (IoT), sensors and information systems, such as maintenance management or inspections, **and facilitates the decision making for optimum Operations and Maintenance (O&M)**. Machine learning algorithms and other artificial intelligence techniques are the back-bone of early and reliable fault diagnosis.

1C4PV faces the main challenges of the PV industry (LCoE reduction) through the optimization of O&M processes in PV plants while maximizing production using the available resources. To achieve the project's objectives, the partners brought on board their extensive experience and expertise, starting the project from a leading position. Specifically, the project consortium is a well-balanced team with three actors covering the whole value chain: a specialist in information systems for monitoring and control of renewables (Isotrol, Spain), an O&M company for solar plants (Tegnatia, Turkey) and a Research Centre for PV generation optimization (FOSS - UCY, Cyprus).

The execution of the project has followed a clear plan based on the study of technologies and their application, modelling PV plants and data characterization for multiple topologies, algorithms development for problem diagnosis and maintenance decision support systems.

As a result of the project, a final integrated platform has been developed, which successfully met all the requirements and objectives that were initially defined. This integrated platform is a cloud-based environment, which, using raw data from PV utility-scale plants, is capable of providing recommendations for operation and maintenance in the context of the exploitation of photovoltaic plants, as well as visualization tools for the analysis in detail of the status of the operation. The tool can be used to identify deviations from normal PV operation, as well as problems and underperformances, which could affect the energy production. The developments were validated using, firstly, controlled datasets and a laboratory environment and, finally, in a real PV plant, connecting its SCADA data with the analytic platform using data extraction, load, transformation and sharing tools.

The algorithms for the detection of anomalies and deviation are a combination of processes and mechanisms, based on machine learning and other analytical methodologies, which are coordinated in order to provide a set of results manageable and relevant for operators involved in operation and maintenance, which helps to reduce the time investment in the detection of

problems, as well as to prioritize and coordinate the maintenance and operation of PV plants in the most profitable way from the energy-production standpoint.

The developments have allowed to increase the performance ratio (PR) values near 88%, a reconstruction of data which resulted in less than 3% inconsistencies, and an accurate failure detection with negligible wrong detection of problems. All of this has been validated in real environments, reaching a TRL of 7, which proves that the results are real and easily transposed to other real environments, ensuring a short road to market.

Project consortium

Coordinator and all contact details:

Full name of organisation	ISOTROL SA
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Participating countries and financing:

Country	**Number of organisations involved**	**Project costs in EUR**	**Public funding in EUR**
Spain	1	237 354	117 371
Turkey	1	52 751	14 240
Cyprus	1	172 507	69 024
Total	3	462 612	200 635

Funding agencies involved and contracts

Funding Agency	**Contract N° and Title**
Centro para el Desarrollo Tecnológico Industrial (CDTI)	Project Number: EXP 00128042/ SERA-20201002 Title: 1C4PV_One Intelligent Cloud For Pv Assets Diagnosis and Maintenance
TUBITAK (The Scientific and Technological Research Council of Turkey)	Project Number: 9190050 Title: Intelligent cloud system for the failure detection and maintanance of PV Investments
Research and Innovation Foundation (RIF) of Cyprus	P2P/SOLAR/0818/0010 Title: One intelligent cloud for PV Assets Diagnosis and Maintenance Acronym: 1C4PV