SHAPING EUROPEAN COLLABORATION ON PHOTOVOLTAICS: A COLLABORATIVE PLATFORM FOR SIMULATION AND MONITORING (COPLASIMON)

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ABSTRACT: The Collaborative Platform for Simulation and Monitoring (COPLASIMON) has been developed within the SERENDI-PV project, funded by the EC Horizon Europe H2020 Programme, to foster collaboration and knowledge sharing within the photovoltaic (PV) community. COPLASIMON aims to serve the entire PV community by providing resources and opportunities for collaboration on diverse solar energy topics. In addition, the platform includes valuable research outputs from the SERENDI-PV project, such as insights on bifacial PV, building-integrated PV (BIPV), and floating PV technologies, which are available to users seeking information on these emerging areas. The platform features a range of functionalities, including demo versions of software tools, multiple calls for collaboration on topics such as bifacial PV, floating PV, BIPV, residential PV, solar resource, quality control, soiling, and grid integration and flexibility, as well as comprehensive data analytics to support the development and optimisation of PV systems. To further enhance stakeholder engagement, COPLASIMON offers interactive features, such as a matchmaking page for PV stakeholders, online workshops for community feedback, and a forum for ongoing dialogue, aiming to support the wider PV community beyond the specific scope of the SERENDI-PV project.
Keywords: Collaboration, Platform, PV, Demo, Matchmaking, COPLASIMON

1 INTRODUCTION

The Collaborative Platform for Simulation and Monitoring (COPLASIMON) serves as a central hub for photovoltaic (PV) research, collaboration, and innovation. Developed as part of the SERENDI-PV project (https://serendipv.eu/coplasimon/), it has been continuously enhanced with new tools, content, and materials to support a wide range of PV stakeholders. COPLASIMON provides a comprehensive online environment designed to facilitate knowledge exchange and collaboration within the PV community. Key features include an interactive forum based on the Discourse framework, which acts as a matchmaking tool for connecting researchers and industry professionals, a GitHub repository for sharing source code and software, and a CKAN-based database for structured data management. These resources enable a dynamic exchange of insights and foster cooperation on topics critical to advancing solar energy technology.

The platform's website is accessible at https://coplasimon.eu/. Throughout the SERENDI-PV project, multiple partners have contributed research outputs, datasets, and simulation tools, many of which are highlighted in this scientific contribution. COPLASIMON also hosts collaboration calls to promote research on a variety of emerging PV topics, including Building Integrated Photovoltaics (BIPV), floating PV, soiling, bifacial technologies, and grid integration. The platform aims to go beyond showcasing the results of SERENDI-PV by actively supporting engagement and collaboration across the broader PV community. Through mapping ongoing research and sharing key findings, COPLASIMON provides a unique space for stakeholders to access and contribute to cutting-edge developments in the solar energy field.

2 THE COPLASIMON PLATFORM

The SERENDI-PV project aimed to address critical challenges to increase the penetration of photovoltaic (PV) power in the European energy market by focusing on advanced modelling, diagnostics, quality control, and grid integration. The project achieved its objectives by enhancing the accuracy of modelling for new PV technologies—such as bifacial PV, floating PV, and building-integrated PV (BIPV)—innovating in fault diagnosis, and improving quality control both in the field and in the lab. This comprehensive approach helped reduce performance uncertainties, improve the bankability of new technologies, and explore solutions for managing higher PV penetration in the grid through enhanced forecasting and distributed energy resource management.
The Collaborative Platform for Simulation and Monitoring (COPLASIMON) was created to support these efforts by providing an accessible space for sharing SERENDI-PV's content and developments, focusing on modelling, data analytics, and scenarios for grid-PV interaction. While the platform showcases SERENDI-PV's results, its primary purpose is to serve the broader PV community, enabling knowledge exchange and fostering collaboration both among project partners and external stakeholders.

Key contributors such as CEA-INES, LuciSun, MyLight150, THU, and QPV have significantly expanded the platform's capabilities by adding content and engaging external stakeholders. This collaborative effort aims to address common barriers in the PV sector, including the lack of data management tools and standards, limited communication channels for PV experts, and the absence of a centralised repository to track global PV research and collaborations.

To overcome these challenges, COPLASIMON offers several key features:

- CKAN data exchange database: The platform includes a CKAN-based data exchange database (https://ckan.coplasimon.eu/) to facilitate structured data sharing. Users can upload datasets either publicly or for private data exchange. A survey was also conducted to gather information on data standards and practices within the energy sector to enhance interoperability.
- Discourse forum: The Discourse-based forum (https://forum.coplasimon.eu/) has been structured to promote collaboration and

knowledge exchange. Specific tutorials are available to guide users on how to initiate and manage permanent collaboration calls. Several calls are already open, focusing on topics such as bifacial PV, BIPV, soiling, and floating PV. The platform also includes a dedicated matchmaking tool to connect stakeholders and facilitate partnerships.

- Mapping of PV collaborations: COPLASIMON provides a structured mapping of existing PV collaborations in Europe. Researchers and stakeholders are encouraged to promote their projects, propose new collaborations, and showcase ongoing research initiatives through the platform (https://coplasimon.eu/).

Another major challenge in the PV community is the limited availability of open-access content and demo software tools. To address this, COPLASIMON features a dedicated section for demo software tools, which includes resources for testing, information on tools with free demo versions, and links to open-source software hosted on GitLab or GitHub repositories.

In Section 3, we provide detailed examples of materials and tools contributed by our partners to highlight the benefits gained from participating in COPLASIMON and to demonstrate how the platform supports collaboration and innovation across the PV community.

3 DEMO TOOLS

Several initiatives have been launched within COPLASIMON through the collaboration between SERENDI-PV partners and external stakeholders. These contributions include simulation tools, data sets, and analytical resources to support diverse PV research and development activities. Specifically:

- LuciSun, which led the development of the platform, has provided demo versions of tools focused on PV modelling (LuSim) and the financial planning of residential PV systems within energy communities (Consolectiv).
- CEA-INES has contributed tools such as Trifactors for simulating bifacial PV systems, SQSL for quantifying the impact of soiling, and ASPIRE for fault detection in PV modules using drone imagery.
- MyLight150 has made available a detailed dataset on PV system performance, supporting extensive research and analysis activities.
- THU is involved in simulating PV feed-in and grid interactions at the demo site in Hittistetten, Germany, focusing on voltage and loading impacts. THU has also collaborated with LuciSun to develop an interactive platform for exploring flexibility options in grid management.
- QPV offers a soiling analysis tool and a performance analysis tool that helps optimize PV plant operations by comparing expected and actual production data.

3.1 LuSim (LuciSun)

LuSim is a PV simulation software tool that is particularly suitable for PV systems with complex 3D scenes, complex shading, irregular terrain, bifacial PV, agrivoltaics, or building-integrated photovoltaics (BIPV) [1], [2], [3].

As part of their contributions, LuciSun has made a demo version of the LuSim software tool available online (https://coplasimon.eu/index.php/lusim-demo-teaser/).

This demo version is designed to provide insights into the different irradiance components at the module cell level for photovoltaic (PV) systems, allowing users to visualize these components in a 3D scenario for a specific timestamp or retrieve a time series for a selected cell. The tool enables users to generate graphs and download the results for further analysis.

The current version of LuSim offers two predefined scenarios where users can modify parameters such as tilt and pitch. However, certain elements, including module type, location, and the number of PV modules or sheds, remain predefined (**Error! Reference source not found.**).

Figure 1: Example of PV plant modelling in the LuSim demo.

3.2 Consolectiv (LuciSun)

LuciSun has published a free online tool, named Consolectiv Europe (for CONsumption, SOLar, and collECTIVe) that can be used through a public website (https://consolectiv.eu/) (**Error! Reference source not found.**).

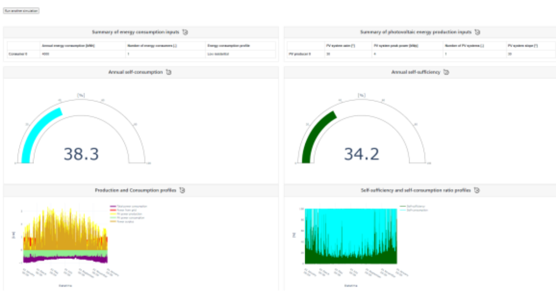

Figure 2: Example of results available from Consolectiv.

The tool includes an interface for calculating the self-consumption ratio, self-sufficiency ratio, and other metrics related to the energy self-consumption of photovoltaic installations within energy communities (ECs) and for prosumers. It is designed to be used by the general public, policymakers, and PV installation professionals. Initially developed with a focus on the Brussels Region in Belgium [4], the tool has since been expanded to cover a broader range of European countries, as shown in **Error! Reference source not found.**.

Figure 3: Available countries in Consolectiv Europe.

The tool calculates self-consumption and self-sufficiency ratios for all of Europe at a 10-minute resolution, with subsequent aggregation over intervals of 1 hour, 1 day, 1 month, and 1 year, based on the location and other user-defined parameters. For the consumption data, synthetic profiles in TMY format have been used, corresponding to 17 different types of buildings and their associated consumption patterns. These profiles are generated using a synthetic method developed by the National Renewable Energy Laboratory (NREL) in the USA ([5], [6]) and consider local climate conditions and consumer preferences.

Two main functionalities have been developed:

- The first is aimed at individual prosumers, providing a tool to help them identify the optimal design conditions for their photovoltaic installations, taking into account self-consumption and calculating the corresponding return on investment (ROI).
- The second functionality is designed for energy communities, allowing users to combine different building consumption profiles with various photovoltaic production setups to assess the overall impact on self-consumption and self-sufficiency for an entire neighbourhood of prosumers.

3.3 Trifactors (CEA-INES)

CEA-INES has developed a simulation tool for bifacial PV systems called Trifactors, which uses a 3D view factors approach to calculate the reflected irradiance on the backside of the modules. This method determines the proportion of radiation (in this case, luminous) that leaves a given surface and directly reaches another, accurately accounting for side effects. The resulting irradiance is then fed into electrical and thermal modelling algorithms to calculate the system's electrical output, taking into account the uneven distribution of irradiance on both sides of the modules [7] [8]. Recent updates now enable the tool to consider the impact of nearby obstacles, such as the module support structure.

3.4 ASPIRE (CEA-INES)

CEA-INES has developed the ASPIRE tool to detect PV module faults using aerial images captured by drones. It consists of three functional blocks:

- PV module detection: Uses a combination of RGB and infrared images to identify PV modules through segmentation, based on the detection of module edges.
- Anomaly detection: Identifies issues such as hot spots, faulty bypass diodes, junction boxes, potential-induced degradation (PID), and disconnected modules by detecting electrical faults or soiling at the module level, and assesses the impact at the PV plant level by considering the plant's electrical architecture.
- Estimation of power losses: Calculates power losses at the module, string, and overall PV plant level.

Figure 4 shows an example of the ASPIRE tool.

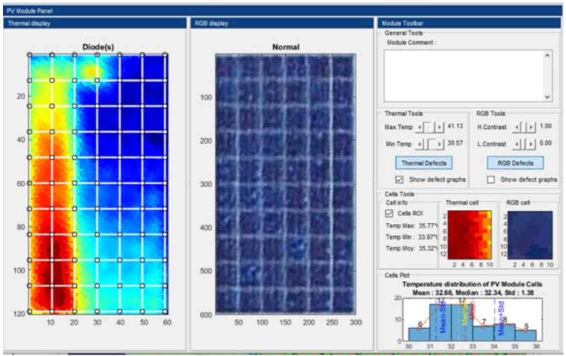

Figure 4: ASPIRE interface showing the detection of a bypass diode fault on a PV module and its analysis.

As ASPIRE manages the electrical architecture of the entire PV plant, it determines the impact of module failures on the affected PV strings. The tool estimates power losses for each module, each PV string, and the entire plant.

The Stochastic Quantifying Soiling Loss (SQSL) method, also developed by CEA-INES, provides a way to measure soiling using standard monitoring data from a PV plant. Unlike other methods, SQSL does not require environmental data or information about artificial cleaning operations. Instead, it calculates the soiling impact directly from the electrical data measured in solar power plants. Unlike conventional approaches that look for change points or rely on identifying clean-only days, SQSL classifies performance metrics into three distinct categories: cleaning days, stable periods, and soiling periods.

The method uses a performance metric (PM), defined as the ratio of relative current (DC current/STC DC current) to relative irradiance (G/STC G). A typical PM profile consists of different periods divided into three types: cleaning days, stable periods, and soiling periods. Once these periods are characterized, the Monte Carlo method is applied to generate multiple random PM profiles using the probability distributions of various parameters such as frequency, duration, and soiling rates. A statistical analysis of these generated profiles allows for the estimation of the most likely average soiling ratio, along with an uncertainty interval.

3.5 MyProSizer (MyLight150)

Within the project, MyLight150 enhanced its residential PV simulation tool, MyProSizer (Figure 5), which enables PV system installers to simulate performance under different renovation scenarios, estimate savings for potential customers, run financial analyses, and generate customizable reports for clients. The MyProSizer simulator integrates real consumption data and appliance usage profiles to accurately model energy projects.

MyLight150 also offers to share a subset of its PV production data in exchange for detailed analysis. The dataset includes 2,037 photovoltaic (PV) systems from 2015 to 2021, primarily located in Belgium and France. The systems, mostly under 12 kWp, have their energy production monitored at 10-minute intervals. The shared PV systems were selected to create a dataset with minimal missing data.

The collaboration calls provided MyLight150 with increased visibility among stakeholders who could benefit from this data. The COPLASIMON platform served as a unified space for connecting multiple actors and businesses, fostering a collaborative environment.

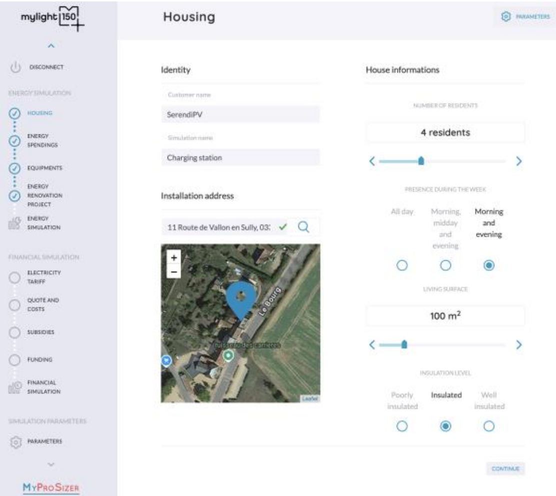

Figure 5: MyProSizer Residential PV simulation tool.

3.6 Flexibility Platform (THU)

Within the project, THU has been involved in simulating PV feed-in from selected households combined with grid simulations, focusing on voltage levels and loading of grid components at the demo site in Hittistetten, Germany. This village, located near the city of Senden in Bavaria, is characterized by a high penetration of PV systems. In Hittistetten, approximately 1.66 MWp of PV capacity is installed, corresponding to an average of around 14 kWp per residential building.

The simulation data is generated using the grid simulation software PowerFactory (https://www.digsilent.de/en/powerfactory.html) and is based on a detailed grid model built from real data provided by the Geographic Information System of the local grid operator, Stadtwerke Ulm/Neu-Ulm Netze GmbH (SWU) (https://www.ulm-netze.de/). The study also explored the available flexibilities of these PV systems, guided by site-specific PV forecasts for the Hittistetten area.

The results of these simulations have been made accessible through the COPLASIMON platform via an interactive PowerBI interface.

The interface is shown in Figure 6. More interactive material can be found in the DSO platform website.

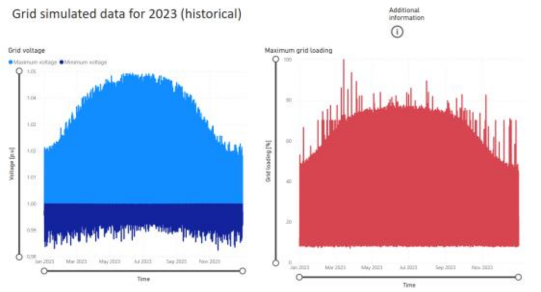

Figure 6: Example of interface of the PowerBI platform.

The simulation results presented on the collaborative platform include key parameters relevant for grid operators, such as the maximum and minimum voltage levels of the grid and the maximum loading of all grid components. These parameters are critical to ensuring that the grid operates within predefined limits under normal conditions, as specified by the European standard DIN EN 50160.

The platform can be accessed at the following link: https://coplasimon.eu/index.php/dso-flexibility-platform/.

3.7 Field lab measurements platform (FHG)

Several innovations related to soiling detection and quantification have been developed by different partners within the project. To gather feedback from relevant industry stakeholders outside the project, several activities were undertaken:

- Online webinar: Key representatives from various sectors, including PV system operators, O&M service providers, and academia, were invited to share their feedback on the soiling-related innovations developed within SERENDI-PV. The general audience also participated, contributing their views on the topic. Highlights from the event have been shared on the COPLASIMON platform.
- Call for PV performance monitoring data to analyze soiling impact: A public call for cooperation was launched on COPLASIMON to gather additional real-world datasets for analysis. Participating companies receive a free analysis of their data and can provide feedback on the proposed solutions and results. Confidentiality has been ensured throughout the process.
- Showcasing soiling innovations: The collected data will be analyzed using various approaches, including those developed within SERENDI-PV and other established methods in the literature. The results will be published on COPLASIMON for the broader community.

3.8 E-Dust (QPV)

The performance and soiling analysis tool enables detailed evaluation of key performance indicators (KPIs), comparison with initial production estimates, and identification of optimization opportunities. By analyzing production and operating data—preferably over periods of one year or more—deviations in the generation and loss chains can be detected and compared to the initial expectations. This allows for targeted recommendations to improve the efficiency of PV systems.

The analysis can also be applied specifically to soiling using a prototype tool called E-Dust, which has been validated through multiple field campaigns. E-Dust has provided extensive insights into real-world soiling patterns, enabling the optimization of cleaning schedules and reducing the cost of cleaning operations based on operating data.

4 DATA SHARING AND COLLABORATION CALLS

The COPLASIMON platform aims to serve as an entry point for continuing to promote connections between stakeholders even after the project's completion. Through the platform, users can access a marketplace to offer or request services and a data-sharing repository where relevant datasets are made available for the community.

Within the SERENDI-PV project, the COPLASIMON platform has been developed to foster data sharing and collaborative research within the photovoltaic (PV) community. Various collaboration calls and data-sharing initiatives have been established to promote participation from external stakeholders and to enhance the usability of the shared data. These calls are aimed at addressing diverse topics such as bifacial PV, floating PV, building-integrated photovoltaics (BIPV), soiling, residential PV, solar resource, quality control, and grid integration. The COPLASIMON platform aims to serve as an entry point for continuing to promote connections between stakeholders even after the project's completion. Through the platform, users can access a marketplace to offer or request services and a data-sharing repository where relevant datasets are made available for the community.

Key data sharing initiatives:

- Public data repositories: The COPLASIMON platform hosts several public data repositories accessible through the CKAN database interface, allowing users to upload and download datasets related to PV performance, solar resource, and grid integration. These repositories are structured to support effective data management and encourage contributions from both SERENDI-PV partners and external stakeholders.
- Confidential data sharing via NDA: For datasets containing sensitive information, sharing is facilitated through non-disclosure agreements (NDAs). For instance, MyLight150, a SERENDI-PV partner, shared operational data from over 2,000 PV systems under specific NDAs, ensuring that data usage and publication are aligned with privacy requirements. These agreements provide a clear framework outlining the use of data, the project context, and approval processes for any published results.
- Public database of solar resource and weather data: A comprehensive database was created to provide high-quality solar resource and meteorological data. It integrates publicly available ground measurements with Solargis satellite model data, allowing users to cross-compare datasets and gain insights into the use and limitations of satellite-based solar resource models. The database interface, built using Google My Maps, is user-friendly and includes links to source data and validation reports. This initiative aims to improve transparency and promote the use of high-quality data in research and industry(SERENDI-PV-D7.4_Public_…).
- Performance monitoring of non-degraded and degraded PV modules: A detailed performance monitoring system was implemented at Tecnalia facilities in Spain to assess both non-degraded and degraded PV modules, monitored from April to September 2024. This dataset, which includes a mix of artificially degraded units and naturally degraded ones obtained from various PV sites, serves as a benchmark for fault detection and diagnosis (FDD) tools at the PV module level. The data includes operating voltages and currents of PV modules, periodic measurements of key parameters such as short-circuit current (Isc), open-circuit voltage (Voc), maximum power point current (Imp), maximum power point voltage (Vmp), fill factor (FF), series resistance (Rs), and shunt resistance (Rp), along with detailed irradiance and module temperature data. This information supports the analysis of various degradation modes and enables the development of robust diagnostic solutions.
- Collaboration calls for external stakeholders: The collaboration calls within COPLASIMON have allowed partners to engage with a wider audience by providing a public space for showcasing research results and inviting contributions from other organizations. For example, calls for data contributions and feedback have been launched on topics such as soiling and performance monitoring, encouraging a dynamic exchange of knowledge and insights.
- Anonymisation and data quality control: In cases where data sensitivity is a concern, anonymisation techniques have been applied. For example, personal information has been removed and location resolution reduced to maintain confidentiality of shared datasets. A systematic quality control process ensures that shared data meets a high standard of reliability, which is essential for building trust among collaborators.
- Metadata from 18,000 PV systems: The BDPV (Base de Données Photovoltaïque) database is a large French platform dedicated to the collection, analysis, and sharing of data related to PV installations. It provides performance monitoring, data sharing, and benchmarking tools for over 18,000 PV systems. Users can voluntarily share their production data to contribute to a larger dataset that helps track the overall performance of PV systems in France. The metadata include information such as system location, size, and technology, supporting transparency and community engagement in the solar sector.
- Marketplace and service offerings: The COPLASIMON platform also serves as a marketplace where services such as data analysis, simulation tools, and research partnerships can be offered or requested by members of the community. This feature allows participants to leverage shared resources and engage in mutually beneficial collaborations.

By providing these structured mechanisms for data sharing and collaboration, the COPLASIMON platform plays a pivotal role in promoting innovation and cooperation in the PV sector, extending beyond the scope of the SERENDI-PV project and supporting a broad range of solar energy research initiatives. These efforts are complemented by a focus on adhering to the FAIR (findable, accessible, interoperable, and reusable) principles to maximize the impact of shared data and ensure that it is used effectively across the PV community.

5 CONCLUSION

The results from the SERENDI-PV project have demonstrated the value of involving a wide range of external stakeholders from the photovoltaic sector, highlighting the crucial role of collaboration in refining and validating the tools developed throughout the project. Engaging with these stakeholders through workshops and data-sharing initiatives has not only enriched the platform's content but also underscored its potential to serve as a hub for future collaborations in the PV community.

The collaborative environment fostered by COPLASIMON has helped align the interests of various actors, enhanced the understanding of shared research challenges, and informed the development of policies supporting the sustainable growth of PV. The lessons learned have contributed to defining a long-term vision for data sharing and stakeholder engagement, addressing one of the key challenges faced by the PV sector today.

Looking ahead, increasing the number of active users and contributors on the platform will be essential for maintaining its relevance and impact. We invite the scientific community and industry professionals to join us by visiting our contact page and contributing their research and expertise. By expanding the network of contributors, COPLASIMON will continue to evolve as a dynamic and effective resource for promoting innovation and knowledge sharing across the photovoltaic sector.

6 ACKNOWLEDGEMENTS

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