This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 953016

D8.14 Public report summarizing lessons learnt

T8.5 Performance assessment and quantification of reliability, profitability, and integrability related impacts

Grant Agreement nº:	**953016**
Call:	H2020-LC-SC3-2020-RES-IA-CSA / LC-SC3-RES-33-2020
Project title:	**Smooth, REliable aNd Dispatchable Integration of PV in EU Grids**
Project acronym:	SERENDI-PV
Type of Action:	Innovation Action
Granted by:	European Climate, Infrastructure and Environment Executive Agency (CINEA)
Project coordinator:	Fundación TECNALIA Research & Innovation
Project website address:	*www.serendi-pv.eu; www.serendipv.eu*
Start date of the project:	October 2020
Duration:	48 months
Document Ref.:	SERENDI-PV_D8.14.docx
Lead Beneficiary:	BI – Becquerel Institute
Doc. Dissemination Level:	**PU –** Public
Due Date for Deliverable:	30/09/2024 (M48)
Actual Submission date:	31/10/2024 (M49)
Version	V1

Summary

This report was developed in the frame of T8.5 on Performance assessment and quantification of reliability, profitability, and integrability related impacts. In this report, the project technologies and approaches are outlines, the implemented actions are described and the results and lessons learnt are presented and discussed.

Document Information

Title	Public report summarizing lessons learnt
Lead Beneficiary	Becquerel Institute
Contributors	All partners
Distribution	PU – Public
Report Name	SERENDI-PV_D8.14_ Public report summarizing lessons learnt.

Document History

Date	Version	Prepared by	Organisation	Approved by	Notes
30/10/2024	V1	Elina Bosch Philippe Macé Gaëtan Masson Adrien Van Rechem André Penas	Becquerel Institute	Javier del Pozo (TEC)	

Acknowledgements

The work described in this publication has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 953016.

Disclaimer

This document reflects only the authors' view and not those of the European Commission. This work may rely on data from sources external to the members of the SERENDI-PV project Consortium. Members of the Consortium do not accept liability for loss or damage suffered by any third party as a result of errors or inaccuracies in such data. The information in this document is provided "as is" and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at its sole risk and neither the European Commission nor any member of the SERENDI-PV Consortium is liable for any use that may be made of the information.

Contents

Tables

1 EXECUTIVE SUMMARY

1.1 Description of the deliverable content and purpose

This report was developed in the frame of T8.5 on Performance assessment and quantification of reliability, profitability, and integrability related impacts. In this report, the project technologies and approaches are outlines, the implemented actions are described and the results and lessons learnt are presented and discussed.

1.2 Reference material

Not applicable

1.3 Relation with other activities in the project

Table 1.1 depicts the main links of this deliverable to other activities (work packages, tasks, deliverables, etc.) within SERENDI-PV project. The table should be considered along with the current document for further understanding of the deliverable contents and purpose.

Table 1.1: Relation between current deliverable and other activities in the project

Project activity	Relation with current deliverable
D8.3	This deliverable reports on the Results of field testing and quality control procedures. Lesson learnt and related guidelines which are part of the global demonstration activities covered and assessed in the present deliverable
D8.4	This deliverable reports on the Results of Implementation of diagnostics software packages over large PV power plant portfolios which are part of the global demonstration activities covered and assessed in the present deliverable
D8.5	This deliverable reports on the results and related performance assessment of modelling for large PV plants which are part of the global demonstration activities covered and assessed in the present deliverable
D8.8	This deliverable reports on the results and related performance assessment of digital twins which are part of the global demonstration activities covered and assessed in the present deliverable
D8.9	This deliverable reports on the Results of Implementation of diagnostics software packages over medium/commercial and residential portfolios which are part of the global demonstration activities covered and assessed in the present deliverable
D8.10	This deliverable reports on the results and related performance assessment of modelling for medium-commercial and residential PV plants which are part of the global demonstration activities covered and assessed in the present deliverable

D8.11	This deliverable reports on the results and related performance assessment of advanced forecasting techniques and predictive control for ancillary services by large PV plants which are part of the global demonstration activities covered and assessed in the present deliverable
D8.12	This deliverable reports on the Evaluation of KPIs of OB5 (Increase utility-friendly integration of PV generation at high penetration levels) based on the results of field test of DSO DEMO SITES (Ulm-Hittistetten and Güssing) which are part of the global demonstration activities covered and assessed in the present deliverable
D8.13	This deliverable reports on the key takeaways from demonstration activities for each portfolio and each ER (Exploitation Result).

2 PROJECT TECHNOLOGIES

2.1 Simulation and modelling of PV systems and components (WP2)

The main objectives of WP2 were:

1- to improve the accuracy of yield prediction
2- to reduce the uncertainty in PV projects (and hence the cost of capital).

The focus was put on the modelling of PV systems under **specific environmental and outdoor conditions** such as **soiling, snow and other sources of degradation** as well as on **innovative PV market segments** such as **floating PV, bifacial PV and BIPV**.

In parallel, **solar resource variability** (long-term variabilities and short-term (sub-hourly) variabilities) and **performance losses uncertainty** at PV system level were analysed. The **influence of these technical uncertainties on financial models** for PV systems and portfolios was then assessed.

Eventually, the outcomes of WP2 are **nine Exploitable Results** presented in Table 2.1 and the developments were **integrated into commercial solutions or research tools**.

- Archelios (CYT)
- Lusim (LUC)
- Solargis Platform (SGIS)
- Trifactors and others (CEA)
- Zenit and others (FHG)

Table 2.1. WP2 Exploitable Results

ER categories	ER id	Title	Owner
ER2_1: Algorithms for improved yield modelling of standard and innovative PV systems (bifacial PV, floating PV, BIPV systems), soiling, snow and ageing (degradation)	ER2_1.1	*Improved yield estimation algorithms*	CEA
	ER2_1.2	*Improved yield estimation algorithms*	CYT
	ER2_1.3	*Improved yield estimation algorithms*	FHG
	ER2_1.4	*Improved yield estimation algorithms*	LUC
	ER2_1.5	*Improved yield estimation algorithms*	SGIS
ER2_2: Load profiles generation for self-consumption evaluation	ER2_2	*Load profiles generation for self-consumption evaluation*	CYT
ER2_3: Uncertainty modelling and propagation in financial models	ER2_3.1	*Modelling of uncertainty and variability and implementation into financial models*	SGIS
	ER2_3.2	*Analytically tracking uncertainty propagation in financial models with probability density functions*	FHG
ER2_4: A novel approach to better model and take into account the long-term evolution of the solar resource in its long-term solar resource assessments	ER2_4	*A novel approach to better model and take into account the long-term evolution of the solar resource in its long-term solar resource assessments*	LUC

2.2 Monitoring and data analytics for fault diagnosis and O&M (WP3)

The main objectives of WP3 were

1- to improve the reliability and performances of PV projects
2- to reduce the O&M costs in PV projects.

The focus was put on the developing specific data analytics for fault diagnosis and O&M for PV systems under **specific environmental and outdoor conditions** such as **soiling, snow and other sources of degradation** as well as on **innovative PV market segments** such as **floating PV, bifacial PV and BIPV**.

In parallel **advanced digital twins for predictive maintenance** of the components with the highest complexity, uncertainty and impact on system reliability in current PV plants (inverter and batteries) were developed.

Eventually, the outcomes of WP3 are **eleven Exploitable Results** presented in Table 2.2 and the developments were **integrated into commercial solutions, services or research tools**.

- ARCHELIOS O&M (from CYT)
- Trifactors and others (CEA)
- PVET® software solution (QPV)
- Lunalytics (LUC)
- Solargis Analyst application and integration into Solargis services (SGIS)
- Failure Detection and Diagnosis (FDD) tool (TEC)
- Integration into “MyLight Energy business unit” and “MyLight system support team” services (MLS)

Table 2.2. WP3 Exploitable Results

ER categories	ER id	Title	Owner
ER3_1: Algorithms for specific data analytics for monitoring and diagnostics of PV systems (Bifacial PV, floating PV, BIPV), soiling, snow and ageing (degradation)	ER3_1.1	*Monitoring-Based Diagnostic Algorithm: 1) Bifacial 2) Floating*	CEA
	ER3_1.3	*Specific Data Analytics for PV systems 1) Degradation Analysis in bifacial 2) Degradation Analysis in floating 3) Data Analytics on residential: orientation of the PV systems*	LUC
	ER3_1.4	*Specific Data Analytics for PV systems*	MLS
	ER3_1.5	*Specific Data Analytics for PV systems 1) Shadow Analysis: snow 2) Shadow Analysis: vegetation 3) Open string detection from stringbox or inverter data 4) Predictive diagnosis of inverter temperature anomalies 5) Analysis of anomalous degradation evolution 6) Specific Data Analytics and Failures for bifacial PV systems 7) Specific Data Analytics and Failures for floating PV systems 8) Cross validation meths for IR and SCADA data analysis*	QPV
	ER3_1.6	*Specific Data Analytics for PV systems: 1) Bifacial 2) Floating 3) Soiling & Snow*	SGIS
	ER3_1.7	*Data analytics for Failure Detection and Diagnostics (FDD)*	TEC
ER3_2: IR imaging-based analytics - ASPIRE	ER3_2	*IR imaging-based analytics - ASPIRE*	CEA
ER3_3 – ER3_5: Digital twin	ER3_3	*BIPV digital twin*	TEC
	ER3_4	*PV Inverter digital twin*	TEC(ING)
	ER3_5	*Battery digital twin*	TEC(CEG)
ER3_6: Estimation of Junction Temperature of semiconductors using a detailed Thermal Physical Model	ER3_6	*Estimation of Junction Temperature of semiconductors (TJ) using a detailed Thermal Physical Model*	ING

2.3 On-site testing equipment and procedures for quality control (WP4)

The main objectives of WP4 were

1- to improve the quality and performances of PV projects
2- to reduce the O&M costs in PV projects.

The focus was put on the developing field and lab testing equipment and procedure under **specific environmental and outdoor conditions** such as **soiling, snow and other sources of degradation**, on **innovative PV market segments** such as **floating PV, bifacial PV and BIPV** as well as on critical hardware of a PV system such as **inverter or energy storage systems**.

Eventually, the outcomes of WP4 are **ten Exploitable Results** presented in Table 2.3 and the developments were **integrated into commercial solutions, services or equipment.**

- Commercial available equipment (e.g., E-1500 (capacitive I-V tracer), E-dust (soiling measurement kit))
- Integration into Quality Control Laboratory portfolio (QPV)

Table 2.3. WP4 Exploitable Results

ER categories	ER id	Title	Owner
ER4_1: Procedures for quality control	ER4_1.1	*Quality control system for identification of incorrect data from PV power plants*	SGIS
	ER4_1.2	*Quality control procedures for PV plants with new technologies (bifacial, floating, etc)* *1) Procedure for calibrating bifacial reference modules in the field* *2) Procedure for measuring the I-V curve of bifacial PV modules in the field* *3) (NEW) Procedure for Albedo assessment* *4) (NEW) Procedure for measuring ageing rates in PV modules in the field*	QPV
	ER4_1.3	*Quality control procedures for PV inverters field testing* *1) Procedure for measuring the efficiency of string inverters in the field* *2) Procedure for measuring MPPT efficiency in the field* *3) Procedures for PV inverter MPPT testing*	QPV (ING)
	ER4_1.4	*Procedures for field testing of batteries*	QPV (CEG)
ER4_2: Lab testing equipment & procedures	ER4_2.1	*Lab-testing for soiling analysis and cleaning assessment*	CEA
	ER4_2.2	*Lab-testing facility and methodology for predictive degradation/ageing of modules*	CEA
	ER4_2.3	*Hardware in the Loop (HIL) Platform for testing large inverters in laboratory (Lab-testing)*	ING
ER4_3: On-site testing equipment	ER4_3.1	*Capacitive I-V tracer at 1,500V*	QPV
	ER4_3.2	*Soiling measurement kit: 1) E-Dust 2) CEA's soiling measurement kit "SoilRatio"*	QPV CEA
	ER4_3.3	*Operating conditions measuring kit (E-Ref 01 and E-Ref 03)*	QPV

2.4 Power forecasting (WP5)

The main objective of WP5 was

1- to improve the profitability of PV (though improved accuracy of PV performance forecasts for optimized valuation strategy for produced PV electricity)

The focus was put on the developing improved forecasting algorithms under **specific environmental and outdoor conditions** such as **soiling, snow, dust or fog**, and on **innovative PV market segments** such as **floating PV, bifacial PV and BIPV**.

Eventually, the outcomes of WP5 are **sixteen Exploitable Results** presented in Table 2.4 and the developments were **integrated into commercial solutions and services.**

Table 2.4. WP5 Exploitable Results

ER categories	ER id	Title	Owner
ER5_1: Improved forecast accuracy	ER5_1.1	*Improved forecast accuracy ("intra-day")*	LUC
	ER5_1.2	*Improved forecast accuracy ("day-ahead")*	SGIS
	ER5_1.3	*Improved nowcast accuracy ("intra-hour")*	FHG
ER5_2: Forecast model accounting for soiling / dust, snow and fog	ER5_2.1.1	*Forecast model accounting for soiling / dust*	SGIS
	ER5_2.2.1	*Forecast model accounting for snow*	SGIS
	ER5_2.3	*Forecast model accounting for fog*	SGIS
ER5_3: Forecast model for bifacial and floating PV	ER5_3.1.1	*Forecast model for bifacial PV*	CEA
	ER5_3.1.2	*Forecast model for bifacial PV*	SGIS
	ER5_3.1.3	*Forecast model for bifacial PV*	LUC
	ER5_3.2	*Forecast model for floating PV*	CEA
ER5_4: Forecast for residential PV - estimation for PV configuration	ER5_4.1	*Forecast for residential PV - estimation for PV configuration*	SGIS
	ER5_4.2	*Forecast for residential PV – improved forecasting for shading*	FHG
	ER5_4.3	*Forecast for residential PV - estimation for PV configuration*	LUC
ER5_5: Forecast uncertainty evaluation for different geographical scales (spatial PV power averaging)	ER5_5	*Forecast uncertainty evaluation for different geographical scales (spatial PV power averaging)*	FHG
ER5_6: Definition of portfolio forecast (concept of virtual PV power plants)	ER5_6	*Definition of portfolio forecast (concept of virtual PV power plants)*	SGIS
ER5_7: Parameters free PV production forecast for residential building	ER5_7	*Parameters free PV production forecast for residential building*	MLS

2.5 High PV integration into utility grids and markets (WP6)

The main objectives of WP6 were

1. To facilitate higher PV penetration in electricity grids (e.g., improved transparency and control of PV systems for the distribution networks, PV data integration in DSOs smart grid IT infrastructure, hybrid PV and storage systems..)
2. To facilitate higher PV penetration in electricity markets (e.g., capability of PV plants to provide ancillary services and grid stability)

Eventually, the outcomes of WP5 are **sixteen Exploitable Results** presented in Table 2.5.

Table 2.5. WP6 Exploitable Results

ER categories	ER id	Title	Owner
ER6: High PV grid penetration and energy management	ER6_1	*Real-time Control and Marketing System enabling the participation in ancillary services by a pool of PV plants*	NKW
	ER6_2	*Automated data model integration framework for PV integration and communication in DSO data systems*	THU
	ER6_3	*Digital twin of the grid with high PV contribution*	THU
	ER6_4	*Further integration of G2V into self-consumption optimisation software*	MLS
	ER6_5	*Implementation of IEC61850 for data communication on MV/LV grid*	FIB
	ER6_6	*Predictive EMS for PV storage self-consumption*	TEC
	ER6_7	*Real time commitment dispatch and IT system for down FCR participation of PV plants (without storage): Demonstration in the Grid Control Lab at INES Chambéry*	CEA
	ER6_8	*Service system for aggregating anonymous data for the monitoring and management of distributed generation systems (residential, commercial and small industry).*	ING
	ER6_9	*Operation of PV ensuring active power reserve available to provide ancillary services - grid connected*	ING

2.6 Collaborative modelling & monitoring platform (WP7)

The main objectives of WP7 were

1. To create a collaborative platform (with web-based interface) for all relevant stakeholders of the PV community in the world with focus in Europe.
2. To foster information exchange between the different actors involved in PV quality control, modelling and monitoring

Eventually, the outcomes of WP7 are **two Exploitable Results** presented in Table 2.6.

The collaborative platform is accessible through this link: https://coplasimon.eu/.

Table 2.6. WP7 Exploitable Results

ER categories	ER id	Title	Owner
ER7: Collaborative database, modelling & monitoring platform	ER7_1	*Collaborative platform for the management of technical specifications of PV components*	SGIS
	ER7_2	*Public database of solar resource and weather data*	SGIS

3 APPROACHES AND IMPLEMENTED ACTIONS

3.1 Collaboration calls

Several open calls have been launched to invite external stakeholders to share their data with the SERENDI-PV partners with the aim to demonstrate the innovations developed in other WPs in additional datasets or to test their own innovations on SERENDI-PV datasets. Collaboration calls were launched on various topics such as bifacial PV, floating PV, soiling, residential PV and BIPV, PV Degradation, financial Tools for PV and PV forecasting.

3.2 Demonstration activities

Demonstration activities were conducted across technical work packages to validate the project innovations. The demonstration activities were conducted by leveraging the PV plant and PV data available among project consortium members. Indeed, the portfolio of project consortium members showcased a great variety of technical configurations (BIPV, floating PV, bifacial PV, …) and environmental configurations (areas prone to soiling, to dust, to snow, …). The demonstration PV plants or portfolios are presented hereafter.

3.2.1 Large PV plant demo sites

			
O'mega 1	**Ouaco**	**Saint Charles**	**Kita**
O'MEGA 1 project is a 17 MWp **floating PV** plant located in Piolenc, France. It was commissioned in October 2019 and was the biggest floating PV plant in Europe when it was built.	**Ouaco** PV plant is a 5 MWp PV plant located in the Northern Province of New Caledonia. It was commissioned at the end of 2020 and comprised of two parts: 5.4 MWp of ground mounted PV plant (with monofacial PV modules) and 600 kWp of greenhouses (with **bifacial PV** modules).	**Saint Charles PV** plant is located in Perpignan, France. It is a 9 MWp **BIPV** project built with Sunstyle® and was commissioned in 2011.	**Kita** is a ground-mounted PV plant of 50 MWp located around 180 km west of Bamako, in the Kayes region, Mali. The multi MW site is prone to **soiling**.

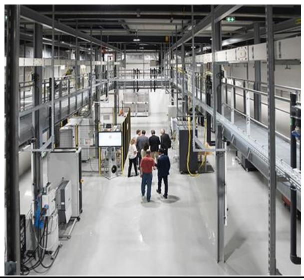
		
Sablons	**La Madone**	**Trescléoux**
The “Sablons” photovoltaic power plant is a **bifacial** PV plant of 104 kWp. The PV plant is made up of a set of modules, each connected by an independent micro-inverter. The modules are bifacial, oriented to the east and west. They are organized on a line 144 modules long and 2 high. This plant is also significantly affected by shading from adjacent rows of trees.	The “La Madone” photovoltaic power plant is a **floating** PV plant of 200 kWp. The PV plant was CNR's first floating photovoltaic park. The 2,500 m² site was built on the Madone irrigation basin (Rhône), an irrigation and fishing pond. Inaugurated in 2019, the installation consists of 630 PV panels fixed to a framework of floats anchored to the bottom of the lake.	The “Trescléoux” photovoltaic power plant is a **ground-mounted** PV plant of 1,8 MWp using monofacial monocrystalline PV modules. The PV plant is located on a 3-hectare site in a former clay quarry, in the Hautes Alpes region in France. There is a presence of dirt, rocks and natural grass in the area making it prone to **soiling**

		
Pitarco	**Alcoutim**	**Large PV plant portfolio**
Pitarco is a photovoltaic project of 62 MW of peak power, in the municipality of Muel in the province of Aragon. This PV complex is fully equipped by **bifacial** PV modules.	**Alcoutim** is a 144 MW photovoltaic project located in Alcoutim, Portugal.	The capacity of the **portfolio** adds up to about 800 MW and consists in PV plants spread over seven countries and three continents. Most PV systems are ground-mounted. Around half are equipped with 1-axis tracking. The majority uses monofacial modules

3.2.2 Small and medium scale demo sites

			
MyLight Systems portfolio (FR, BE, UK)	**Cythelia (carport) (FR)**	**Cythelia (roof-mounted) (FR)**	**Agricultural College in Güssing (AT)**
PV Systems' database of MyLight Systems contains over 40,000 residential PV systems in 2024. Demonstration was conducted using around 500 PV systems in France and around 2000 PV systems mostly in Belgium, UK and France.	The PV plant is located at the Cythelia premises in La Motte-Servolex, Savoie-Technolac, France. It is a Carport integrated PV plant with 42,9 kWp installed capacity.	The PV plant is located at the Cythelia premises in La Motte-Servolex, Savoie-Technolac, France. It is a A 27,72 kWp bifacial, roof-mounted PV system with single axis trackers.	The demonstration site is the Agricultural College in Güssing (Austria). It consists in a rooftop PV generator of 30 kWp as well as a battery system with a storage capacity of 100 kWh and a nominal power of 50 kW.

3.2.3 Grid integration demo sites

			
ISARE (SP)	**Hittistetten village (DE)**	**Güssing (AT)**	**Grid testing/simulation (FR)**
The demonstration site is the ISARE Smart Grid in San Sebastian (SPAIN). It consists in a 40 kW PV system, a 12,2 kW wind energy system, a 22 kWh OPZV battery, a 148 kWh Li-ion battery and other small storage technologies (e.g., flue cell, flywheel).	The demonstration site is a small village situated in the province of Bavaria. There are 82 small residential to medium size commercial PV systems. The total yearly yield is higher than the total electricity demand due to the high number of PV systems.	The demonstration site is the small town of Tobaj with an already high amount of rooftop PV and a predictable trend towards additional PV installation.	The demonstration site is a grid testing/simulation environment. The demonstrator comprises the following hardware components: a connection to the public power grid, three PV plant simulators, a communication infrastructure, a power meter.

	
Varied portfolio (DE)	**Varied portfolio (ES)**
The portfolio used in demonstration activities is composed of various PV systems ranging from residential rooftop installations, commercial and industrial rooftop PV installations up to multi hundreds of MW ground mounted PV installations.	The portfolio is composed of (i) two residential PV systems with storage ; (ii) two industrial and commercial PV installations, none of which included storage (iii) a 400 MW ground-mounted photovoltaic installation and (iv) a 40 MW ground-mounted photovoltaic installation.

4 RESULTS/LESSONS LEARNT/TAKE AWAYS

- The demonstration activities have allowed to shows in most cases the improvement in terms of PV plants reliability, performance and profitability, and the improvements on high-level PV grid integration, brought by the SERENDI-PV project development.

- This was made possible also thanks to the variety of the demonstration sites arising from the partners' portfolios covering specific technologies such as bifacial PV, floating PV as well as different environmental conditions (snow, soiling, dust, …).

- The final assessment of the improvements on PV plants reliability, performance and profitability, and the improvements on high-level PV grid integration, brought by the SERENDI-PV project development is conducted and presented in D1.6 "Final follow-up on KPI progress" which is a public deliverable.

- Beyond the purpose of demonstrating the impacts of the developed innovations in SERENDI-PV, demonstration activities were also beneficial to demonstration PV plant owners allowing them to identify potential improvement perspectives for their PV plant development, PV plant construction and PV plant operation and maintenance activities. A few examples are mentioned below

    - Data Management Improvement: Collaborating closely with researchers has showed how to more effectively collect and filter data. PV plant owners gained insights into their internal databases, identifying which ones had data issues that led to outliers, enabling to enhance data quality and reliability.
    - Failure Identification: The project has been instrumental in helping recognize potential failures and operational challenges within the PV portfolio owners' power plants, allowing for proactive measures and better maintenance strategies.
    - Sensor Calibration and Maintenance: PV plant owners learned the importance of precise calibration for sensors measuring soiling, rainfall, relative humidity, and wind. To ensure high-quality data for future analyses, these sensors must require minimal maintenance and be monitored consistently.
    - Technological Insights: The demonstrations facilitated the understanding of modeling related to innovative technologies, such as bifacial and floating systems. Typically, insufficient time is dedicated to thoroughly analyze these advancements, and the PV plant owners' current commercial solutions often lack precision in quantifying their benefits and impacts. On the other hand, demonstration activities' results have shown that data analytics can greatly contribute to improve PV plant's performances, reliability and profitability.
    - Enhanced Production and OPEX Estimation: The findings from the project could help better estimate production and opex, particularly concerning cleaning requirements. This knowledge could reduce uncertainty in business plan with the potential to lead to more favourable financing conditions.
    - Commercial Viability of Innovations: The commercial solutions developed by the project partners are being seriously investigated and evaluate in terms of applicability and profitability by the PV plant owners to determine if they could be used in their company.

- In many cases, PV plant owners which made their assets and data available for demonstration activities are already seeing the potential added value for their current and future PV portfolio thanks to the demonstration results and are engaging in post-project (commercial) collaborations.