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

SERENDI PV

D8.2 Report on monitoring implementation and data collection process. Lesson learnt and related guidelines

T8.1 Demonstration of modelling, diagnostics and field testing of large PV plants

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_D8.2 Report on monitoring implementation and data collection process
Lead Beneficiary:	TECNALIA (TEC)
Doc. Dissemination Level:	**Public**
Due Date for Deliverable:	31/05/2022 (M20)
Actual Submission date:	31/03/2023 (M30)
Version	2.0

Summary

The present deliverable details the monitoring implementation and data collection from large PV systems. The deliverable explains **what** data is being monitored, **how** it is **used**, **how** it is being **monitored**, **stored**, **shared**, any **data quality procedures**, and **any lessons learnt** during the implementation of the monitoring guidelines set out in deliverable D8.1.

Monitoring information has been collected in operational conditions from heterogeneous portfolios of large PV plants for the assessment of developed innovations in WP2, WP3 and WP4 for a better modelling, diagnostics and field testing.

Three main portfolios (and one clients´ portfolio) will be used for the validation of the developments (innovations) done:

- PORTFOLIO 1: provided by AKUO and CNR for the development and assessment of the BIPV, floating and bifacial innovations applied to large PV plants
- PORTFOLIO 2a: provided by GALP for the demonstration of the bifacial innovations applied to large PV plants
- PORTFOLIO 2b: provided by QPV (data from its clients´ portfolio) for the development and assessment of the bifacial innovations applied to large PV plants
- PORTFOLIO 3: provided by ING for the development and assessment of PV inverter digital twin.

This deliverable D8.2 is an output of task T8.1.2.

Document Information

Title	Report on monitoring implementation and data collection process. Lesson learnt and related guidelines
Lead Beneficiary	TECNALIA (TEC)
Contributors	CEA, AKUO, CNR, GALP, ING
Distribution	Public
Report Name	Report on monitoring implementation and data collection process. Lesson learnt and related guidelines

Document History

Date	Version	Prepared by	Organisation	Approved by	Notes
14/03/2023	0.1	Javier del Pozo	TEC		
15/06/2023	0.2		AKUO, CNR, GALP, ING		Contributions of partners
15/09/2023	0.3		GALP		Contributions of partners
15/10/2023	0.4	Ioannis Tsanakas	CEA		Review of the content and contributions
21/12/2023	1.0	Ricardo Alonso	TEC	Javier del Pozo (TECNALIA)	

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.

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1 EXECUTIVE SUMMARY

1.1 Description of the deliverable content and purpose

This document contains monitoring information in operational conditions from heterogeneous portfolios of large PV plants for the assessment of developed innovations in WP2, WP3 and WP4 for a better modelling, diagnostics, and field testing.

Three main portfolios (and one clients´ portfolio) will be used for the validation of the developments (innovations) done:

- PORTFOLIO 1: provided by AKUO and CNR for the development and assessment of innovations applied to large PV plants, specific to floating PV, bifacial PV, BIPV and PV losses (soiling, degradation).
- PORTFOLIO 2a: provided by GALP for the demonstration of the innovations applied to large PV plants, specific to bifacial PV and PV losses (soiling).
- PORTFOLIO 2b: provided by QPV (data from its clients´ portfolio) for the development and testing / assessment of the bifacial innovations applied to large PV plants.
- PORTFOLIO 3: provided by ING for the development and assessment of PV inverter digital twin.

The present deliverable details the monitoring implementation and data collection from large PV systems. Therefore, each of the portfolios has their own section on where it is explained:

- what is the **metadata** needed to describe the PV plant used (x.2.1)
- what **data set** is being monitored (x.2.2)
- how the data set is **stored and shared** with the developing partners, (x.2.3)
- **data quality procedures,** analysis of the data acquired and filtered (x.2.4)
- **limitations** for the use of the data and problems found in the installation of the monitoring system (x.2.5)

1.2 Reference material

This deliverable follows on from Deliverable *D8.1: Monitoring guidelines and specific monitoring and validation plan for demonstration of modelling, diagnostics and field testing of large PV plants*. It shows the result of the monitoring implementation.

The deliverable makes multiple references to other tasks of which the data portfolios will be used in the demonstration of. More information on these tasks can be found in the Project Management Plan:

- WP10/D10.8 Project Management Plan – final version

Besides this document refers to the data shared and used for the demonstration of the project innovations. It makes use of the information included in the

- WP10/D10.3 Data Management Plan

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
T1.1	T1.1 describes all the data provided by the partners and the project KPIs that will be used for measuring the impact of the project innovations.
T1.5	T1.5 assess the improvements on PV plants reliability, performance and profitability, and the improvements on high-level PV grid integration, thanks to technology developments from the other WPs of this project. The KPIs defined in T1.1 will be used to assess the improvements.
T2.2	The specific measurement and validation plan for the assessment of the modelling of energy losses due to soling, snow and degradation processes being developed in T2.2 is described in section 2.1.3 of D8.1.
T2.3	The specific measurement and validation plan for the assessment of the modelling of new bifacial and floating technologies, being developed in T2.3 are described in section 2.1.1 and 2.1.2 of D8.1
T2.6	The specific measurement and validation plan for the assessment of commercial modelling solutions to be developed in T2.6 is described from sections 2.1.4 to 2.1.7 of D8.1
T3.2	The specific measurement and validation plan for the assessment of the specific data analytics for new floating and bifacial technologies being developed in T3.2 is described in section 2.2.1 and 2.2.2 of D8.1.
T3.4	The specific measurement and validation plan for the assessment of the fault diagnosis toolbox for improved O&M in large PV plants and aggregations being developed in T3.3 is described in section 2.2.5 of D8.1
T3.5	The specific measurement and validation plan for the assessment of IRT images for data analytics as well as the analysis of IRT images themselves in large PV plants and aggregations being developed in T3.5 is described in section 2.2.6 of D8.1
T3.6	The specific measurement and validation plan for the assessment of the inverter digital twin being developed in T3.6 is described in section 2.2.4 of D8.1
T3.7	The specific measurement and validation plan for the assessment of integration of new data analytics in the commercial solutions to be carried out in T3.7 is described from sections 2.2.7 to 2.2.9 of D8.1
T4.4	The specific measurement and validation plan for the assessment of the field and lab testing for inverters being defined in T4.4 is described in section 2.2.3 of D8.1
T7.4	Collaborative platform for design, simulation and monitoring data analytics. The results from this deliverable will be used to facilitate the collaboration with external stakeholders.
T8.1	The section 3 of D8.1 describes the detailed technical design of monitoring activities to be developed in T8.2.

1.4 Abbreviation list

Table 1.2: Abbreviation list

Abbreviation	Meaning
API	Application Programming Interface
BIPV	Building-integrated photovoltaics
BMS	Battery Management System
EMS	Energy management System
FPV	Floating photovoltaics
GHI	Global Horizontal Irradiation/Irradiance
GTI	Global Tilted Irradiation/Irradiance
IPP	Independent Power Producer
PoA	Plane of Array
QCP	Quality Control Procedure
QoS	Quality of Service

2 INTRODUCTION

2.1 Innovations in Work Packages 2-4

Chapter *2 Developments to be validated and demonstrations needs* of **D8.1** details all the innovations being developed in WP2, WP3 and WP4.

The WP2 innovations for large PV plants to be developed and demonstrated in SERENDI-PV project are:

- Modelling of bifacial PV systems.
- Modelling of floating PV systems
- Modelling of PV plants prone to soiling losses
- Modelling of PV plants prone to snow losses
- Modelling of degradation in PV plants

The WP3 innovations for large PV plants to be developed and demonstrated in SERENDI-PV project are:

- Specific data analytics for bifacial PV systems.
- Specific data analytics for floating PV systems
- Specific data analytics for soiling
- Specific data analytics for snow
- Specific data analytics for degradation
- IR imaging data analytics
- Failure detection and diagnosis methods
- PV inverter efficiency characterization
- PV Inverter digital twin

The WP4 innovations for large PV plants to be developed and demonstrated in SERENDI-PV project are:

- Specific procedures for bifacial PV systems
- Specific procedures for floating PV systems
- New procedures for PV inverters field testing
- QC Procedures for solar radiation and meteorological measurements
- Soiling measurement kits: E-Dust (QPV), and CEA´s kit (CEA)
- Capacitive I-V tracer (QPV)

ANNEX I: SUMMARY TOOLS - INNOVATIONS - PORTFOLIOS IN LARGE PV PLANTS, extracted from D8.1, summarizes the innovations being developed in WP2, WP3 and WP4, the partner developing each innovation and the selected Portfolios where they will be demonstrated.

2.2 Portfolios

Chapter *2 Developments to be validated and demonstrations needs* of **D8.1** details also the requirements for the demonstration plants to demonstrate the above-mentioned innovations:

- Monitoring system required for demonstrating the innovation:
  - Technical requirements, specific input measurements
  - Expected outputs
- Validation plan (first draft) for demonstration of the innovations and technical KPIs:
  - Validation plan (preliminary validation plan, that will be updated during the demonstration period and integrated into the final WP8 deliverables). The validation plan serves to test and proof that the innovations developed works correctly according to the partner specification.
  - Technical KPIs, that serve to measure the improvement introduced by the innovation compared with the situation before the project.

This deliverable D8.2 presents the monitoring system implemented and the data collected in the different PV plants (demo sites) of the portfolios for the **validation** (*test and proof the innovations developed)* and **assessment** (*measurement of technical KPIs*) of developed innovations in WP2, WP3 and WP4 for a better modelling, diagnostics and field testing for large PV plants.

A detailed validation plan for all the innovations (identified as Exploitable Results) development in the project will be elaborated during the demonstration phase (last 12 months) and they will be included into the deliverables D8.3, D8.4 and D8.6.

The main portfolios (and one clients´ portfolio) used for the validation of the developments (innovations) are the following:

- PORTFOLIO 1: provided by AKUO and CNR, for the development, validation, and assessment of the BIPV, floating and bifacial PV-related innovations applied to large PV plants:
  - Modelling of new PV applications (bifacial, floating and BIPV) and energy losses currently not well evaluated (soiling, snow and degradation) – demonstration of WP2 innovations.
  - Diagnostics of new PV applications (bifacial and floating) and energy losses currently not well evaluated (soiling, snow and degradation) through SCADA monitoring information and IR imaging – demonstration of WP3 innovations.
  - Field testing of the QC Procedures for solar radiation and meteorological measurements and the soiling kits developed during the project – demonstration of WP4 innovations.
- PORTFOLIO 2a: provided by GALP for the demonstration and assessment of the bifacial innovations applied to large PV plants:
  - Modelling of new PV applications (bifacial) and energy losses currently not well evaluated (soiling).
  - Diagnostics of new PV applications (bifacial); assessment of failure detection and diagnosis methods of large PV plants utilizing data from monitoring (SCADA), inverters, locally deployed sensors, meters, portable cameras, cameras attached to UAVs and local weather stations, although not limited to those innovations; diagnosis of soiling measurements through SCADA monitoring information – demonstration of WP3 innovations.
  - Field testing of QC procedures (for bifacial and solar radiation and meteorological measurements) and the soiling kits and the capacitive I-V tracer at 1,500V developed during the project – demonstration of WP4 innovations.

- PORTFOLIO 2b: provided by QPV (data from its clients´ portfolio). QPV will use a portfolio for the development and testing phase only, then will demonstrate/validate on GALP's portfolio. QPV does not own any PV plant and therefore the QPV's portfolio is a client portfolio rather than a PV plant portfolio. This ensures that different EPCs, O&Ms, and PV plant managers are eligible from the variety of PV plants in the portfolio. The PV data will be used only by QPV for the development and assessment of the bifacial innovations applied to large PV plants:
    - Validation of modelling tools which deal with the assessment of bifacial PV and with losses due to soiling (air pollution and dust) and degradation processes (ageing) in large PV plants – validation of WP2 innovations.
    - Validation of the FDD (Failure Detection and Diagnosis) tool, which consists of advanced data analytics able to early detect some failures modes of PV arrays, modules and inverters and determine their potential causes in large PV plants (bifacial); the tool uses the analytic for IR imaging of PV modules validation of WP3 innovations.
    - Validation of the QC procedures which deal with the bifacial PV and with the meteorological equipment, and validation of the on-site QC equipment developed in the project: 1) soiling measurement kit (E-Dust), which evaluates the soil deposited on a PV module by comparing the I-V curve of such module with the I-V curve of a clean PV module; 2) capacitive I-V tracer, which allows to characterize PV module strings up to 1,500 V and 30 A, enabling to characterize larger strings with larger modules – validation of WP4 innovations.
- PORTFOLIO 3: provided by ING for the development and assessment of PV inverter digital twin.

Therefore, each of these portfolios has their own section on where it is explained:

- what is the **metadata** needed to describe the PV plant used (x.2.1)
- what **data set** is being monitored, for example, monitoring equipment architecture (sensors installed, data collected) and the frequency availability of the data (x.2.2)
- how the data set is **stored and shared** with the developing partners (x.2.3)
- **data quality procedures,** analysis of the data acquired and filtered (x.2.4)
- **limitations** for the use of the data and **problems found** in the installation of the monitoring system (x.2.5)

3 PORTFOLIO 1.1: AKUO PORTFOLIO

3.1 Portfolio summary description

The list of power PV plants selected from the Akuo's portfolio included in D8.1 and later presented further details in the General Assembly held in France in June 2023 to demonstrate the SERENDI-PV innovations in WP2, WP3 and WP4 (see *2.1 Innovations in Work Packages 2-4*) are:

- Ouaco (New Caledonia) for the innovations related with bifacial technology
- Omega1 (France) for the innovations related with floating technology
- Kita (Mali) for the innovations related with soiling (severe soiling issues)
- Kwita (New Caledonia) for the innovations related with bifacial technology and soiling
- Saint Charles (France) for the innovations related with BIPV technology (optional – another BIPV type demo at CYT offices building is currently prioritized)

The detailed description of these PV plants is included in D8.1. Please refer to this deliverable for further details.

3.2 Data monitored

3.2.1 Plant description data (metadata of data monitored)

The information included here belongs to the Plant description Data Category described in the *D10.3 Data Management Plan*. The purpose of the (meta)data is to describe each PV plant from where the monitoring data (data set) is collected and later used for the demonstration:

- **PV System (New) Technology** installed: Bifacial, BIPV (or BAPV), Floating, Ground mounted PV (GMPV) plant. It serves to classify the PV plants into the main technologies SERENDI-PV project is focused on.
- **Plant size (Capacity range)**: a numerical value of the power installed (in MW or KW). It serves to classify the size of the plant into Utility scale, Commercial size, Medium size, small (residential) size.
- **Module Technology**: describes the technology of the modules installed. Main classification for the project purpose is monofacial and bifacial.
- **Environment data**: environment data of the PV plant.
    - *Must-have* data include: rough coordinates; accurate coordinates; near shadings (if any); local albedo (if bifacial); horizon….
    - *Nice-to-have* data include: near objects; elevation; digital surface model; 3D design of BIPV installation, ….
- **Technical data** of the PV plant:
    - *Must-have* data include: Capacity; Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; shading angles between tables; DC / AC ratios; electrical drawings.
    - *Nice to have*: photos, 3D model; general O&M plan
- **Format**: the format of the data: integer or decimal number (and how many decimals): csv/excel, SQL or relevant;

The AKUO PV plants portfolio has the following metadata:

3.2.1.1 Ouaco

- **PV System (New) Technology** installed: Part of the installation is in Greenhouses and the technology is bifacial (625 kWp) and part of the installation is GMPV (4.375 MWp)
- **Plant size (Capacity range)**: 5MWp
- **Module Technology**: The modules installed in the Greenhouses are bifacial (625 kWp) and the modules in GMPV are monofacial
- **Environment data**: environment data of the PV plant:
  - accurate coordinates; near shadings; local albedo (in the greenhouses); elevation
  - it is a quite dry region, with relative soiling
- **Technical data** of the PV plant:
  - Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; shading angles between tables; DC / AC ratios; electrical drawings
- **Format**: the format of the data: decimal number: csv/excel;

3.2.1.2 Omega 1

- **PV System (New) Technology** installed: Floating.
- **Plant size (Capacity range)**: 17MWp
- **Module Technology**: monofacial
- **Environment data**: environment data of the PV plant.
  - accurate coordinates
  - lot of birds, next to quarry
- **Technical data** of the PV plant:
  - Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; shading angles between tables; DC / AC ratios; electrical drawings
- **Format**: the format of the data: decimal number: csv/excel;

3.2.1.3 Kita

- **PV System (New) Technology** installed: Ground mounted PV plant
- **Plant size (Capacity range)**: 50MWp
- **Module Technology**: monofacial
- **Environment data**: environment data of the PV plant.
  - accurate coordinates; also dry, some mountains in the area but not too close
- **Technical data** of the PV plant:
  - Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram; distance between tables; DC / AC ratio; electrical drawings
- **Format**: the format of the data: decimal number: csv/excel;

3.2.1.4 Kwita

- **PV System (New) Technology** installed: Ground mounted PV plant
- **Plant size (Capacity range)**: 6 MW solar and 3MWh Storage
- **Module Technology**: bifacial
- **Environment data**: environment data of the PV plant.
    - accurate coordinates; local albedo; near objects; elevation; it is a Agrienergie greenhouse.
- **Technical data** of the PV plant:
    - Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; shading angles between tables; DC / AC ratios; electrical drawings
- **Format**: the format of the data: decimal number: csv/excel

3.2.1.5 Saint Charles

- **PV System (New) Technology** installed: BIPV (photovoltaics tails)
- **Plant size (Capacity range)**: 8,7 MWp
- **Module Technology**: monofacial
- **Environment data**: environment data of the PV plant.
    - accurate coordinates; urban / industrial area – Mediterranean climate (around 15 km from the sea)
- **Technical data** of the PV plant:
    - Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; shading angles between tables; DC / AC ratios; electrical drawings
- **Format**: the format of the data: decimal number: csv/excel;

3.2.2 Data Set and granularity

3.2.2.1 Ouaco

The Ouaco data set shared is collected by the SCADA set in place and is made of:

- Information collected at the injection level:
    - ✓ active and reactive power injected in the grid,
    - ✓ voltage, current, frequency, cos phi
- Information collected at the inverter level:
    - ✓ voltage and current on the AC side
    - ✓ voltage and current on the DC side
- Data from the sensors that were originally installed in the PV Plant (both on the GMPV part and on the greenhouse area (bifacial PV)):

Table 3.1: List of sensors originally installed in Ouaco PV Plant

Measurement	Sensor Type	Number
GHI (global horizontal irradiation)	Pyranometer (Kipp&Zonen)	1
GTI (global tilted irradiation)	Pyranometer (Kipp&Zonen)	4
Ambient temperature	PT100	1
Module temperature	PT100	4
Wind speed	Ultrasound	1
Wind direction	Ultrasound	1
Humidity	Relative humidity	1
Atmospheric pressure		1

- Finally, it was not needed to install new sensors in this PV plant for the innovations that were going to be demonstrated.

For these signals, the frequency (granularity) is:

- one measurement per minute is made, and the data can be shared with a 10-minute granularity.
- 10 min for corrected PVOUT

3.2.2.2 Omega 1

The Omega 1 data set shared is collected by the SCADA set in place and is made of:

- Information collected at the injection level:
  - ✓ active and reactive power injected in the grid,
  - ✓ voltage, current, frequency, cos phi, JB Current
- Information collected at the inverter level:
  - ✓ voltage and current on the AC side
  - ✓ voltage and current on the DC side
  - ✓ each string is not monitored but we can have global data for the JB
- Data from the sensors that were originally installed in the floating PV Plant:

Table 3.2: List of sensors originally installed in O'MEGA 1 Floating PV Plant

Measurement	Sensor Type	Number
GHI (global horizontal irradiation)	Pyranometer (Kipp&Zonen)	1
GTI (global tilted irradiation)	Pyranometer (Kipp&Zonen)	3
Ambient temperature	TMS82/83	1
Module temperature	PT100	4
Wind speed	3-armed cup anemometer	1
Wind direction	Wind vane	1

Additionally, a small ground mounted PV plant with the same layout characteristics (pitch, tilt, orientation) is being built next to the floating PV plant. This test bed is monitored with one additional pyranometer and module temperature sensor.

Akuo is also working on the installation of a floating measurement platform to measure wind speed on the water, and possibly wave movement and temperature of the water.

- And the new sensors installed in O'MEGA 1 Floating PV Plant since 03/03/2023 to address the technical requirements of the innovations:

Table 3.3: List of new sensors installed in O'MEGA 1 Floating PV Plant

Measurement	Sensor Type	Number
Soiling rate	Soiling Kit	1
Relative Humidity	Provided by the soiling kit	
Air temperature	Provided by the soiling kit	
Solar Elevation	Provided by the soiling kit	
Tilt /inclination	Provided by the soiling kit	
Water temperature measurement for floating PV plants		
Real time measurement of tilt and orientation of the PV modules on the floating structures		

The frequency for these signals is:

- minute for soiling (second also in the SD card),
- minute for RawData,
- 10 min for corrected PVOUT

3.2.2.3 Kita

The Kita data set shared is collected by the SCADA set in place and is made of:

- Information collected at the injection level:
  - ✓ active and reactive power injected in the grid,
  - ✓ voltage, current, frequency, cos phi
- Information collected at the inverter level:
  - ✓ voltage and current on the AC side
  - ✓ voltage and current on the DC side
  - ✓ MV Cells temperature data and inverter temperature data
- Data from the sensors that were originally installed in the PV Plant:

Table 3.4: List of sensors originally installed in Kita PV Plant

Measurement	Sensor Type	Number
GHI (global horizontal irradiation) Installed in the MW substation	Pyranometer	2
GTI (global tilted irradiation) Installed in the modules area	Pyranometer	5
GTI (global tilted irradiation) Installed in the MW substation	Pyranometer	1
Ambient temperature	PT100	1
Module temperature	PT100	1

- Akuo also installed a sensor in Kita PV Plant since 21/10/2022 to address the technical requirements of the innovations:

Table 3.5: List of new sensors installed in Kita PV Plant

Measurement	Sensor Type	Number
Soiling rate	DustIQ Kit	1

For these signals, the frequency (granularity) is:

- one measurement per minute is made, and the data can be shared with a 10-minute granularity.
- 10 min for corrected PVOUT

3.2.2.4 ***Kwita***

The Kwita data set shared is collected by the SCADA set in place and is made of:

- Information collected at the injection level:
  - ✓ active and reactive power injected in the grid,
  - ✓ voltage, current, frequency, cos phi
- Information collected at the inverter level:
  - ✓ voltage and current on the AC side
  - ✓ voltage and current on the DC side
- Data from the sensors that were originally installed in the PV Plant:

Table 3.6: List of sensors originally installed in Kwita PV Plant

Measurement	Sensor Type	Number
GHI (global horizontal irradiation) Installed in the MW substation	Pyranometer	2
GTI (global tilted irradiation) Installed in the modules area	Pyranometer	5

GTI (global tilted irradiation) Installed in the MW substation	Pyranometer	1
Ambient temperature	PT100	1
Module temperature	PT100	1

- Akuo also installed in Kwita PV Plant these sensors since 20/03/2023 to address the technical requirements of the innovations:

Table 3.7: List of new sensors installed in Kita PV Plant

Measurement	Sensor Type	Number
Albedometer/ Pyranometers in the back of the panels	Pyranometers	1

For these signals, the frequency (granularity) is:

- one measurement per minute is made, and the data can be shared with a 10-minute granularity;
- 10 min for corrected PVOUT

3.2.2.5 St Charles

The St Charles data set shared is collected by the SCADA set in place and is made of:

- Information collected at the injection level:
  - ✓ active and reactive power injected in the grid,
  - ✓ voltage, current, frequency, cos phi
- Information collected at the inverter level:
  - ✓ voltage and current on the AC side
  - ✓ voltage and current on the DC side
- Data from the sensors that were originally installed in the PV Plant:

Table 3.8: List of sensors installed in St Charles PV Plant (BIPV)

Measurement	Sensor Type	Number
GHI (global horizontal irradiation)	Pyranometer (Kipp&Zonen)	9
Module temperature	PT100	28

No new sensors will be installed in this BIPV installation.

For these signals, the frequency (granularity) is:

- one measurement per minute is made, and the data can be shared with a 10-minute granularity
- 10 min for corrected PVOUT

3.2.3 Data storage and data access

Data from Akuo's PV plants is available on an in-house developed platform. It is possible to set up servers or shared folders to share data with the technology developers. Depending on the technology and the partner involved, the data can be provided at different frequencies and timesteps.

The data of all the AKUO´s PV plants will be stored in the *Akuo DataRoom Serendi,* that is a dedicated SharePoint created and managed by AKUO.

The access to this SharePoint is through login and password after requesting access to AKUO. It is a private access.

3.2.4 Data quality procedures

The data quality procedures for the AKUO PV plants are the following:

- **Ouaco**: analysis of the data acquired, filter data, identification of data gaps
- **Omega 1**: analysis of the data acquired, availability calculations and corrections PVOUT, identification of data gaps
- **Kita**: analysis of the data acquired and filtered for good period of dustIQ, corrected PVOUT, identification of data gaps
- **Kwita**: analysis of the data acquired and filtered, corrected PVOUT, identification of data gaps
- **Saint Charles**: analysis of the data acquired and filtering, identification of data gaps.

3.2.5 Data Limitations & problems found with the installation

The data limitations for the AKUO PV plants are the following:

- **Ouaco**: There is no data limitations or issues with any signal,
- **Omega 1**: Soiling kit installed the 4 March 2023. Apparently, the data is good, but Sunstrace, the installer, has asked to check the cleaning of the sensors, and they have found a problem in their irradiance measurements that they said would soon be solved and corrected for previous reports and measures.
- **Kita**: DustIQ worked well from 20/10/2022 (at 10h05) to 01/12/2022 (at 05h46), trying to see if there is also more good recent data.
- **Kwita**: Pyranometer installed at the end of the table (upside down to measure the irradiation received from the rear)
- **Saint Charles**: There is no data limitations or issues with any signal. One "limitation" has to do with the particularity of the PV technology (non-commercial BIPV modules), rather than with the data themselves.

3.3 Demonstration Objectives

The detailed demonstration objectives for each PV plants are:

- Ouaco (New Caledonia) for the innovations related with bifacial technology:
  - Modelling of bifacial PV systems: innovations from CEA, CYT, SGIS, FHG, QPV and LUC
  - Modelling of soiling: innovations from CEA, SGIS and QPV.

- Specific data analytics for bifacial PV systems: innovations from CEA, QPV, SGIS and LUC

- Omega1 (France) for the innovations related with floating technology:
  - Modelling of floating PV systems: innovations from CEA, SGIS, FHG, QPV and LUC.
  - Modelling of soiling: innovations from CEA, SGIS and QPV.
  - Specific data analytics for floating PV systems: innovations from CEA, SGIS, QPV and LUC
- Kita (Mali) for the innovations related with soiling (severe soiling issues):
  - Modelling of soiling: innovations from CEA, SGIS and QPV will be demonstrated
  - Specific data analytics for soiling from CEA, SGIS, QPV and LUC will be demonstrated
- Kwita (New Caledonia) for the innovations related with bifacial technology and soiling:
  - Modelling of bifacial PV systems: innovations from CEA, CYT, SGIS, FHG, QPV and LUC will be demonstrated.
  - Modelling of soiling: innovations from CEA, SGIS and QPV will be demonstrated.
  - Specific data analytics for bifacial PV systems: innovations from CEA, QPV, SGIS and LUC
  - Specific data analytics for soiling from CEA, SGIS, QPV and LUC will be demonstrated
- Saint Charles (France) for the innovations related with BIPV technology:
  - Modelling of BIPV systems (any size: small, medium or large): innovations from CYT and LUC will be demonstrated.

4 PORTFOLIO 1.2: CNR PORTFOLIO

4.1 Portfolio summary description

The list of power PV plants in CNR's portfolio was presented in D8.1. From that portfolio, several PV plants were selected to demonstrate the SERENDI-PV innovations:

- Sablons (France) for the innovations related with bifacial technology
- La Madone (France) for the innovations related with floating technology
- Trescléoux (France) for the innovations related with soiling and (optionally) degradation

The detailed description of these PV plants is included in D8.1. Please refer to this deliverable for further details.

4.2 Data monitored

4.2.1 Plant description data (metadata of data monitored)

The information included here belongs to the Plant description Data Category described in the *D10.3 Data Management Plan*. The purpose of the (meta)data is to describe each PV plant from where the monitoring data (data set) is collected and later used for the demonstration (see 3.2.1 for a short explanation of the list of the metadata required)

The CNR portfolio has the following metadata information of the PV plants:

4.2.1.1 Sablons

- **PV System (New) Technology installed:** Bifacial PV – Linear – Micro inverter
- **Plant size (Capacity range)**: 0.1MWp
- **Module Technology**: Bifacial dual glass monocrystalline
- **Environment data**:
  - Accurate coordinates; Photos
  - Dust, gravel & natural grass; Near trees causing shading
- **Technical data of the PV plant:**
  - *Must-have* data include: Capacity; Orientation; Tilt; Module's layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; electrical drawings.
  - *Nice to have*: Photos; general O&M plan; Maintenance logs and operational events.
- **Format**: Decimal numbers in MW (16 decimals): CVS/Excel format

4.2.1.2 La Madone

- **PV System (New) Technology installed:** floating PV
- **Plant size (Capacity range)**: 0.2MWp
- **Module Technology**: Monofacial monocrystalline

- **Environment data:**
  - Accurate coordinates; Photos
  - Algae, dust, birds; Increased soiling
- **Technical data of the PV plant:**
  - *Must-have* data include: Capacity; Orientation; Tilt; Module's layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; electrical drawings.
  - *Nice to have*: Photos; general O&M plan; Maintenance logs and operational events.
- **Format**: Decimal numbers in MW (16 decimals): CVS/Excel format

4.2.1.3 Trescléoux

- **PV System (New) Technology installed:** Ground mounted PV plant
- **Plant size (Capacity range)**: 1.8 MWp
- **Module Technology**: Monofacial monocrystallin
- **Environment data**: environment data of the PV plant.
  - Accurate coordinates; photos, near objects; elevation;
  - Dirt, rocks & natural grass ; Near concrete carrier increasing soiling
- **Technical data of the PV plant:**
  - *Must-have* data include: Capacity; Orientation; Tilt; Module's layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; electrical drawings.
  - *Nice to have*: Photos; general O&M plan; IR campaign; Maintenance logs and operational events.
- **Format**: Decimal numbers in MW (16 decimals): CVS/Excel format

4.2.2 Data Set and granularity

4.2.2.1 Sablons

The data available for Sablons PV plant since 09/06/2022 is the following:

Table 4.1: List of data installed in Sablons PV Plant

Measurement	Number
Plant active power	1

For this measurement, the data are recorded at 10' step.

The data set from the inverter manufacturer can be shared. CNR does not have control over these data, their quality, and their format.

The new sensors installed in Sablons PV Plant since 04/10/2022 to address the technical requirements of the innovations are:

Table 4.2: List of new sensors installed in Sablons PV Plant

Measurement	Sensor Type	Number
Soiling rate	Dust IQ – Kipp&Zonen	1
Wind speed	05103 – Young	1
Wind direction	05103 – Young	1
GHI	SMP10 – Kipp&Zonen	1
GTI (vertical plant – both sides)	SMP10 – Kipp&Zonen	2
Pressure	PB110 - VAISALA	1
Ambient temperature	Hygrovue 5 – Campbell	1
Module temperature	CS241 – Campbell Dust IQ – Kipp&Zonen	1 1
Humidity	Hygrovue 5 – Campbell	1
Pluviometry	52202 - Young	1

For these signals, the frequency (granularity) is one measurement every 10' step.

4.2.2.2 La Madone

The data available for La Madone PV plant since 11/01/2022 is the following:

Table 4.3: List of data installed in La Madone PV Plant

Measurement	Number
Plant active power	1
Inverter active power	3

For these signals, the frequency (granularity) is one measurement every 10' step.

The data set from the inverter manufacturer can be shared. CNR does not have control over these data and their format.

The new sensors installed in La Madone PV Plant since 05/10/2022 to address the technical requirements of the innovations are:

Table 4.4: List of new sensors installed in La Madone PV Plant

Measurement	Sensor Type	Number
Soiling rate	Dust IQ – Kipp&Zonen	1
GHI	SMP10 – Kipp&Zonen	1
GTI	SMP10 – Kipp&Zonen	1

Pressure	PB110 - VAISALA	1
Ambient temperature	Hygrovue 5 – Campbell	1
Water temperature	107 Thermistor Probe - Campbell	1
Module temperature	CS241 – Campbell Dust IQ – Kipp&Zonen	1 1
Humidity	Hygrovue 5 – Campbell	1
Pluviometry	52202 - Young	1
Orientation	VN-100 IMU/AHRS - VECTORNAV	1

For these signals, the frequency (granularity) is one measurement every 10' step.

4.2.2.3 Trescléoux

The data available for Trescléoux PV plant since 29/11/2019 is the following:

Table 4.5: List of data installed in Trescléoux PV Plant

Measurement	Number
Plant active power	1
Plant reactive power	1
Inverter active power	1
Inverter current DC input	1
GTI	1
GHI	2
Wind speed	1
Wind direction	1
Ambient temperature	1
Module temperature	1

For these signals, the frequency (granularity) is one measurement every 10' step.

The new sensors installed in Trescléoux PV Plant since 08/2022 to address the technical requirements of the innovations are:

Table 4.6: List of new sensors installed in Trescléoux PV Plant

Measurement	Sensor Type	Number
Soiling ratio	Mars atonometrics	1
Humidity	Thies 1.1005.54.160	1
Rain falls events	Thies 5.4103.10.112	1

For these signals, the frequency (granularity) is one measurement every 10' step. Format DAT. Data at 1' step available if needed.

4.2.3 Data storage and data access

All the data retrieved by CNR portfolio PV plants are stored internally on secured servers. CNR will extract the data sets monthly or more often depending on the partner's needs.

The data sets will be uploaded on a dedicated CNR SharePoint. An access is granted to all the innovations developers (which are not IPP partners) involved in the demonstrations.

The access to the CNR SharePoint is through login and password after requesting access to CNR. It is a private access.

4.2.4 Data quality procedures

The raw data will be shared to the partners with no specific data quality check.

The server ensures one level of data quality by detecting the lack of data due to communication issues. For these cases the error code *[-11059] No Good Data For Calculation* is displayed.

4.2.5 Data Limitations & problems found with the installation

Data sets are subject to various limitations due to operating events.

In most cases the impacts are:

- Missing data
- Frozen values

The known events on the portfolio are:

4.2.5.1 Sablons

Near shading affecting the electrical supply of the standalone meteo-station with the new sensors.

Several period without data:

- 23/12/2023 – 26/12/2023
- 02/01/2023 – 04/01/2023
- 06/01/2023 – 09/01/2023
- 13/01/2023 – 16/01/2023
- 18/01/2023 – 19/01/2023
- 20/01/2023 – 21/01/2023
- 22/01/2023 – 30/01/2023

4.2.5.2 La Madone

- Rodents cutting the communication cable of the onsite pyranometer. No historical data available for this sensor.
- Rodents cutting the communication cable of the standalone meteo-station orientation sensor. No data between 11/03/2023 and 20/03/2023.

- Rodents cutting the communication cable of the standalone meteo-station pyranometers. No data since 06/03/2023.
- Rodents cutting the communication cable of the standalone meteo-station orientation sensors. No data since 06/04/2023. Intervention to be planned.

4.2.5.3 Trescléoux

On site and new sensors functional since the commissioning of the plant and the standalone meteo-station.

Data limitations found:

- No production data 02/11/2020 - 17/01/2021 -> communication issue
- Frozen data on soiling sensor since 17/06/2023 -> Intervention to be planned

4.3 Demonstration Objectives

The detailed demonstration objectives for each PV plants are:

- Sablons for the innovations related with bifacial technology:
  - Modelling of bifacial PV systems: innovations from CEA, CYT, SGIS, FHG, QPV and LUC will be demonstrated.
  - Modelling of soiling: innovations from CEA, SGIS and QPV will be demonstrated.
  - Specific data analytics for bifacial PV systems: innovations from CEA, QPV, SGIS and LUC
- La Madone for the innovations related with floating technology:
  - Modelling of floating PV systems: innovations from CEA, SGIS, FHG, QPV and LUC will be demonstrated.
  - Modelling of soiling: innovations from CEA, SGIS and QPV will be demonstrated.
  - Specific data analytics for floating PV systems: innovations from CEA, SGIS, QPV and LUC
  - Soiling measurement kit from CEA
- Trescléoux for the innovations related with soiling:
  - Modelling of soiling: innovations from CEA, SGIS and QPV will be demonstrated
  - Specific data analytics for soiling from CEA, SGIS, QPV and LUC will be demonstrated

The partners have chosen the plants to serve their demonstrations following Annex 1.

5 PORTFOLIO 2.1: GALP PORTFOLIO

5.1 Portfolio summary description

The list of power PV plants in GALP's portfolio was presented in the updated version of D8.1. From that portfolio, several PV plants were selected to demonstrate the SERENDI-PV innovations:

- Pitarco for the innovations related with bifacial technology
- Several plants for the innovations related with soiling: GALP will have some other plants available in case that the partners need to test any innovation related with soiling. However, as it is still not sure if they will be needed, the plants are not described in this deliverable.

The detailed description of these PV plants was not included in the official D8.1, only in an updated version, as GALP entered the project after the D8.1 was approved.

5.2 Data monitored

5.2.1 Plant description data (metadata of data monitored)

The information included here belongs to the Plant description Data Category described in the *D10.3 Data Management Plan*. The purpose of the (meta)data is to describe each PV plant from where the monitoring data (data set) is collected and later used for the demonstration (see 3.2.1 for a short explanation of the list of the metadata required).

The GALP Pitarco PV plant has the following metadata information:

- **PV System (New) Technology** installed: Bifacial tracker, string inverter
- **Plant size (Capacity range)**: 62 MWp
- **Module Technology**: 540W Bifacial modules in GMPV with tracker
- **Environment (location) data**: environment data of the PV plant:
    - accurate coordinates in Muel, Zaragoza (Spain) 41°28'27.1"N 1°06'20.4"W
    - near shadings 1,94%
    - Albedo 0,255 (annual)
    - Elevation between 435 and 450m
    - Installed power and type of modules 61,91MW (JA Solar Bifacial 540W)
    - windy and dry, with a fair amount of dust.
    - Photos of the site/powerplant/ground:

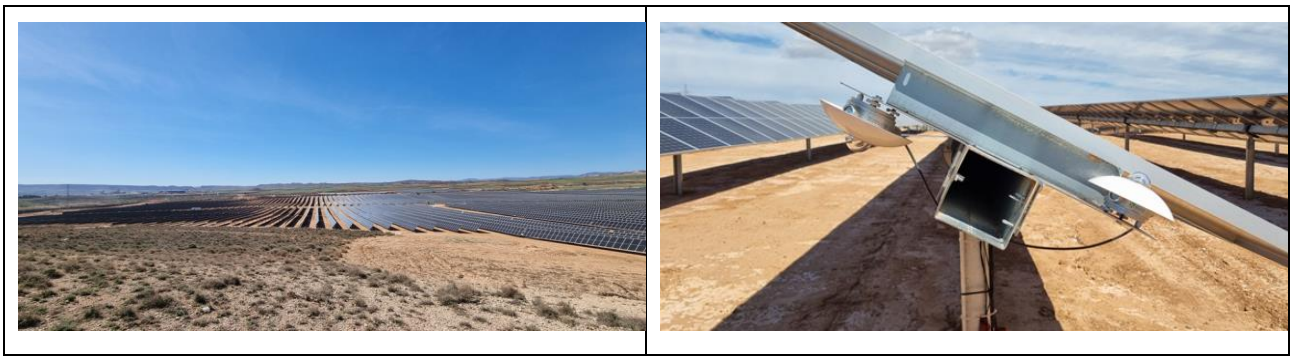

Figure 5.1: Pitarco PV plant

- **Technical data** of the PV plant:
  - DC Capacity 61,91MW and AC Capacity 47,925 MVA (@40ºC)
  - 114.632 JA Solar 540W (Half-cell double glass) modules in 4.074 strings
  - 213 Sungrow string inverters SG250HX with 250kVA output power (@30ºC)
  - PVH trackers N-S with a rotation angle of +-55º and 5,50m pitch
  - Axis tilt 0 and axis azimuth 0
  - Connection to the SET Pitarco Enerland 45/15kV step up substation
  - Attached (folder): Datasheets (modules and inverters), Cabling layout and Single Line
  - GCR 0,439
- **Format**: csv

5.2.2 Data Set and granularity

The Pitarco data set shared is collected by the SCADA set in place and is made of:

- Information collected at the inverter level:
  - ✓ Voltage and current on the AC side
  - ✓ Voltage and current on the DC side
  - ✓ power production data at the level of strings inverters in 15-minute time resolution

Table 5.1: List of sensors installed in Pitarco PV Plant

Description	Signals/Docs	Location
Weather data	air temperature, wind speed and direction	
Plane-of-Array irradiance (GTI)	Front irradiance in the plane of array (POA)	There are measures at middle height and PV Panel heights
GHI		
DNI		
DIF		
Rear irradiance	Rear irradiance at middle height or possibly at different heights	There are measures at middle height and PV Panel heights
Albedo	Albedo of the ground in an open area	There are pyranometers that are in weather stations and in some trackers that are pointing towards the ground
Module temperature	Temperature at the back side. Module temperature with a suited sensor in order to limit cell shading	The module temperature sensor is located in the middle of the panel to take advantage of the shadow projected by the torque tube on the panel and reduce losses.
Soiling rate (front side of modules) from a soiling kit		

It was not needed to install new sensors in this PV plant for the innovations that were going to demonstrate. After the site visit to the plant, some minor adjustments were suggested, such as the position of the pyranometers, considered to be more representative of the albedo measurement if they were relocated to a middle position in the row.

Besides, a drone IR service will be available (since 22/03/2024) in order to test the developments of T3.5 (validation of the IR imaging-based analytics: innovations from CEA (ASPIRE).

5.2.3 Data storage and data access

Data from GALP's PV plants is available on a SharePoint or on an FTP as the partners decide. It will be possible to set up shared folders to share data with the technology developers. The data can be provided at different frequencies and timesteps.

The data of all the GALP´s PV plants will be stored in the *Galp DataRoom Serendi,* that is a dedicated SharePoint created and managed by GALP or an FTP server if the access to the data is easier.

The access to this SharePoint is through login and password after requesting access to GALP. It is a private access.

5.2.4 Data quality procedures

The data shared to the partners has been analysed and data has been filtered.

5.2.5 Data Limitations & problems found with the installation

There are no data limitations for the GALP PV plants.

5.3 Demonstration Objectives

The detailed demonstration objectives for Pitarco PV plant are the demonstration of the following innovations, mostly related with bifacial technology and soiling:

- Validation of Modelling of bifacial PV systems: innovations from CEA, CYT, SGIS, FHG, QPV and LUC
- Validation of Modelling of soiling: innovations from CEA, SGIS and QPV
- Validation of Specific data analytics for bifacial PV systems: innovations from CEA, QPV, SGIS and LUC
- Validation of the FDD (Failure Detection and Diagnosis) tool, which consists of advanced data analytics able to early detect some failures modes of PV arrays, modules and inverters and determine their potential causes in large PV plants (bifacial PV plants): innovations from TEC, CEA, QPV, SGIS and LUC
- Validation of the QC procedures which deal with the bifacial PV and with the meteorological equipment
- Validation of the on-site QC equipment developed in the project: 1) soiling measurement kit (E-Dust), which evaluates the soil deposited on a PV module by comparing the I-V curve of such module with the I-V curve of a clean PV module; 2) capacitive I-V tracer, which allows to characterize PV module strings up to 1,500 V and 30 A, enabling to characterize larger strings with larger modules

The detailed demonstration objectives for Alcoutim & Hazaña PV plants are the demonstration of the following innovations, mostly related with soiling:

- Validation of the FDD (Failure Detection and Diagnosis) tool: innovations from QPV (PVET)
- Validation of the IR imaging-based analytics: innovations from CEA (ASPIRE)
- Validation of the on-site QC equipment developed in the project: 1) soiling measurement kit (E-Dust), which evaluates the soil deposited on a PV module by comparing the I-V curve of such module with the I-V curve of a clean PV module.

6 PORTFOLIO 2.2: QPV PORTFOLIO

6.1 Portfolio description

QPV do not own any PV plant and therefore the QPV's portfolio is a client portfolio rather than a PV plant portfolio. This ensures that different EPCs, O&Ms, and PV plant managers are eligible from the variety of PV plants in the portfolio. However, the data that can be shared depending on the agreements reached with each client. For the particular purposes of the SERENDI-PV project, the capacity of the portfolio that could be eligible to choose some PV plants from, adds up to about 800 MW. This results in PV plants eligible from at least seven countries and three continents from which information of 20 MW has already been provided to the project. From that portfolio, several PV plants will be selected to test the QPV´s innovations developed during the SERENDI-PV:

- Several client's plants for the innovations related with bifacial technology
- Several client's plants for the innovations related with soiling
- Several client's plants for WP4 innovations

As a general description of the client assets, all of them are ground-based PV plants built between 2014 and 2020. Almost half of them have no tracking system, being the other half 1-axis tracking, and less than 10% azimuthal 1-axis tracking. The dominant technology of the portfolio is polycrystalline silicon solar cells with about two thirds of the total portfolio, being the remaining plants based on crystalline silicon solar cells. Similarly, the vast majority of it make use of monofacial solar cells, with about 10% of bifacial PV plants. As a side note, no floating PV plants are owned by any of the clients among the QPV's portfolio.

However, no further information is needed to share with the rest of the partners, as the data from QPV portfolio will be only available to QPV, and only for testing purposes, not for demonstration (assessment) of the project innovations.

7 PORTFOLIO 3: INGETEAM PORTFOLIO

7.1 Portfolio description

The PV plants participating in the demonstration activities are:

- 2 Client's PV plants for adjusting, assessing and validating the digital twin model.

The detailed description of these PV plants was included in D8.1

7.2 Data monitored

7.2.1 Plant description data (metadata of data monitored)

Plant #1, located in Spain, at southeast of the Iberian Peninsula is a 400 MW photovoltaic installation with 238 PV inverters of model Ingeteam Power B Series 1690TLB650 from which more than 1-year of historic 2-minutal data can be retrieved. Inverter's data are gathered by the plant's PPC through ModBUS TCP protocol and stored in a proprietary cloud platform from where they can be downloaded in csv format.

Plant #2 is a smaller plant of 40 MW made up of 26 central inverters of model Ingeteam Power B Series 1640TLB630. It has 2-minutal data since March 2021. The network topology and data retrieving methodology is similar to Plant #1.

The INGETEAM portfolio has the following metadata information of the PV plants:

- **PV System (New) Technology** installed: Plant #1 & Plant #2 Ground mounted PV plants
- **Plant size (Capacity range)**: Plant #1 400MW; Plant #2 40MW
- **Module Technology**: monofacial
- **Environment data**: environment data of the PV plant.
    - accurate coordinates.
- **Technical data** of the PV plant:
    - Capacity; Orientation; Tilt; Modules layout; cabling layout; datasheets of modules and inverters; single-line diagram (or equivalent); distance between tables; shading angles between tables; DC / AC ratios; electrical drawings; photos, general O&M plan
    - Plan #1: 238 PV inverters of model Ingeteam Power B Series 1690TLB650
    - Plan #2: 26 central inverters of model Ingeteam Power B Series 1640TLB630
- **Format**: the format of the data: decimal number: csv/excel;

7.2.2 Data Set and granularity

Portfolio 3 will provide datalogger raw data from the inverters. Parameters available are:

- Inverter's input DC voltage and current
- Inverter's output AC voltage and current
- Active output power
- Reactive output power
- AC frequency
- Critical component's temperatures:

- Heat Sink
- Ambient
- Power Inductor

- Inverter's events: Alarms, Warnings, Derating mode, …

The portfolio 3 will provide datalogger raw data with a time resolution of 2-minute average data.

7.2.3 Data storage and data access

Inverter's data are gathered by the plant's PPC through ModBUS TCP protocol and stored in a proprietary cloud platform from where they can be downloaded in csv format.

7.2.4 Data quality procedures

The data comes directly from the PV inverters and is shared as is, with no need for further processing or filtering.

The cloud system ensures data continuity without gaps. In case of an eventual lack of data, the system retries until the gap is filled. The only chance for missing data would be if the corresponding inverter is out of order and the control board damaged or not powered.

7.2.5 Data Limitations & problems found with the installation

There's no limitation on data for the objectives' purposes.

7.3 Demonstration Objectives

The demonstration objectives of the 2 Client's PV plants are adjusting, assessing and validating the digital twin model developed in WP3.

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9 ANNEX I: SUMMARY TOOLS - INNOVATIONS - PORTFOLIOS IN LARGE PV PLANTS

The relationship between the developments to be demonstrated and the portfolios is as follows: (*this information is extracted from D8.1*)

WP	Tool (if integrated)	Innovation	Developper	AKUO portfolio	Plant name	CNR portfolio	Plant name	GALP portfolio	Plant name	QPV portfolio	INGETEAM portfolio	Comments
2	archelios PRO (CYT)	Modelling of bifacial PV systems	CEA, CYT	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	No		
		Modelling of floating PV systems	CEA	Yes	OMEGA1	Yes	La Madone	No		No		
		Modelling of soiling	CEA	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	No		
		Modelling of degradation	CEA	Yes	several plants	Yes- Need further discussion		No		Maybe (see comment)		CNR: Need further discussion
		Modelling of bifacial PV systems	SGIS	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	No		
2	Solargis-PV Simulator (SGIS)	Modelling of floating PV systems	SGIS	Yes	OMEGA1	Yes	La Madone	No		No		
		Modelling of soiling	SGIS	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	No		
		Modelling of snow	SGIS	No		No		No		No		
		Modelling of degradation	SGIS	Yes	several plants	Yes- Need further discussion	Several plants	No		No)		CNR: Need further discussion.
		Modelling of bifacial PV systems	FHG?	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	No		
2	Zenit	Modelling of floating PV systems	FHG	Yes	OMEGA1	Yes	La Madone	No		No		
		Modelling of bifacial PV systems	QPV	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	Yes		
2	SISIFO	Modelling of floating PV systems	QPV	Yes	OMEGA1	Yes	La Madone	No		No		
		Modelling of soiling	QPV	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	Yes		
		Modelling of snow	QPV	No		No		No		No		
		Modelling of degradation	QPV	Yes	several plants	Yes- Need further discussion	Several plants	No		Yes		CNR: Need further discussion.

WP	Tool (if integrated)	Innovation	Developper	AKUO portfolio	Plant name	CNR portfolio	Plant name	GALP portfolio	Plant name	QPV portfolio	INGETEAM portfolio	Comments
		Specific data analytics for bifacial PV systems	CEA	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	No		
		Specific data analytics for floating PV systems	CEA	Yes	OMEGA1	Yes	La Madone	No		No		
		Specific data analytics for soiling	CEA	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	No		
		Specific data analytics for snow	CEA?	No		No		No		No		
3	archelios (CYT)	Specific data analytics for degradation	CEA?	Yes	several plants	Yes- Need further discussion	Several plants	No		No		CNR: Need further discussion.
		IR imaging data analytics	CEA	Yes	several plants available but to TBC	No		Yes	Pitarco	No		Subcontracting company to take pictures; IR images of the same plant we have data for FDD
		PV inverter efficiency characterization	CYT	No		No		Yes, might be tested	Pitarco	No		Daily exchange of data via FTP
		Specific data analytics for bifacial PV systems	QPV	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	Yes		
		Specific data analytics for floating PV systems	QPV	Yes	OMEGA1	Yes	La Madone			No		
		Specific data analytics for soiling	QPV	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	Yes		
		Specific data analytics for snow	QPV	No		No				No		
3	PVET (QPV)	Specific data analytics for degradation	QPV	Yes	several plants	Yes- Need further discussion	Several plants			Yes		CNR: Need further discussion.
		Failure detection and diagnosis methods	TEC, COB	No		Maybe	Various plants	Yes	Pitarco	No		CNR: Interested in FDD tool but need to check if monitoring at module level is possible
		IR imaging data analytics	QPV			No		Yes	Pitarco	No		
		Specific data analytics for bifacial PV systems	SGIS	Yes	Ouaco	Yes	Sablons	Yes	Pitarco	No		Data: Daily exchange of data via FTP; also API (optional). Granularity: if possible hourly
3	Solargis-PV Monitor (SGIS)	Specific data analytics for floating PV systems	SGIS	Yes	OMEGA1	Yes	La Madone			No		
		Specific data analytics for soiling	SGIS	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	No		

WP	Tool (if integrated)	Innovation	Developper	AKUO portfolio	Plant name	CNR portfolio	Plant name	GALP portfolio	Plant name	QPV portfolio	INGETEAM portfolio	Comments
		Specific data analytics for snow	SGIS	No		No				No		
		Specific data analytics for degradation	SGIS	Yes	several plants	Yes- Need further discussion	Various plants			No		CNR: Need further discussion.
		PV inverter digital twin	TEC+ING	No		No		Maybe	Pitarco	No	Yes	
3	-											
		Specific procedures for bifacial PV systems	CEA+QPV+SGIS	No		No		Yes	Pitarco	Yes (see comment)		QPV: Yes, although the access to other partners (CEA, SGIS) is subjected to the agreement of the PV plant owner
4	-	Specific procedures for floating PV systems	CEA+QPV+SGIS	No		No		No		No		
4	-	New procedures for PV inverters field testing	ING+QPV+TEC	No		No		?? / need discussion	Pitarco or any other PV plant	Yes (see comment)	Yes	QPV: Yes, although the access to other partners (ING, TEC) is subjected to the agreement of the PV plant owner
4	-	QC Procedures for solar radiation and meteorological measurements	SGIS			No		Yes	Pitarco	No		
4	-	soiling measurement kit	QPV	Yes	Kita (GMPV in Mali)	No		Yes	Pitarco	Yes		
4	E-Dust (QPV)	soiling measurement kit	CEA	Yes	Trescleoux (CNR)	No		Yes	Pitarco	No		
4	CEA´s kit (QPV)	capacitive I-V tracer at 1,500V	QPV	No		No		Yes	Pitarco	Yes		
4	Capacitive I-V tracer (QPV)											