



StoRES

Promotion of higher penetration of Distributed PV through storage for all

Priority Axis 2: Fostering low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas

2.2: To increase the share of renewable local energy sources in energy mix strategies and plans in specific MED territories

Deliverable n°: **2.3.9**

Deliverable Name: **Living Lab**

Disclaimer: This document reflects only the authors' view and the ERDF is not responsible for its contents or any use or exploitation of the information it contains.

1. Document Info

Project Name	Promotion of higher penetration of Distributed PV through storage for all (StoRES)
Funding Scheme	ERDF
Work Package Number	WP2
Name of Work Package	Project Communication
Number	D2.3.9
Title	Living Lab
Dissemination Level	PU
Date	30.10.2019
Authors	UCY / AURA-EE
Contributors / Reviewers	All partners have reviewed the document before finalised
Status	Final

2. Document History

Date	Author	Action	Status
15.04.2019	UCY/AURA-EE	Document creation	Draft
22.04.2019	UCY/AURA-EE	Document update	Draft
03.04.2019	UCY/AURA-EE	Document update	Draft
04.07.2019	UCY/AURA-EE	Document update	Draft
09.10.2019	UCY/AURA-EE	Document update	Draft
11.10.2019	UCY/AURA-EE	Document update	Draft
15.10.2019	UCY/AURA-EE	Document update	Draft
22.10.2019	UCY/AURA-EE	Document update	Draft
25.10.2019	UCY/AURA-EE	Document update	Draft
25.10.2019	AUTH	Official review	Draft
28.10.2019	UNICA	Official review	Draft
30.10.2019	UCY/AURA-EE	Document finalisation	Final

3. Contents

1.	Document Info.....	2
2.	Document History	2
3.	Contents	3
4.	List of Figures	4
5.	Project Summary	5
6.	Introduction to Deliverable 2.3.9	5
7.	Web platform.....	6
7.1	Page "Presentation of the data"	6
7.2	Page "Sites comparison"	9
7.3	Page "Parametric study"	10
8.	Other StoRES Living Lab actions.....	12
8.1	Cyprus.....	12
8.2	France	12
8.3	Greece.....	12
8.4	Italy	13
8.5	Portugal	14
8.6	Slovenia.....	14
8.7	Spain.....	15
9.	Long-term use of the web platform	15
10.	Conclusions	16

4. List of Figures

Figure 1: Graphic display of the public page of the StoRES Living Lab.	6
Figure 2: Graphic display of the pilot site's raw data for a selected period in the page "Presentation of the data".	7
Figure 3: Graphic display of the extracted average profile of a pilot site for a selected period in the page "Presentation of the data".	8
Figure 4: Indicators' display of the extracted average profile of a pilot site for a selected period in the page "Presentation of the data".	9
Figure 5: Graphic display of the average monthly SoC level of a pilot site for a selected period in the page "Presentation of the data".	9
Figure 6: Graphic display of the comparison between two different pilots in the page "Comparison of the sites".	10
Figure 7: Graphic display of the extracted average profiles comparison between three different pilots in the page "Comparison of the sites".	10
Figure 8: Graphic display of the battery efficiency comparison between three different pilots in the page "Comparison of the sites".	10
Figure 9: Graphic display of the parametric study (SCR, SSR and prosumer ratio) of a selected pilot in the page «Parametric study».	11
Figure 10: Graphic display of the variation of SCR and SSR according to the system sizing of a selected pilot in the page «Parametric study».	11
Figure 11: Data access on the server through an FTP.	16

5. Project Summary

The project addresses the development of an optimal policy for the effective integration of Renewable Energy Sources (RES) and Energy Storage Systems (ESS). The primary challenge is to achieve increased penetration of RES and predominantly Photovoltaics (PV), in the energy mix of islands and rural areas in the Mediterranean (MED) region without compromising grid stability. The main objective of StoRES is to boost self-consumption in the MED region with the integration of optimal storage solutions. Testing coupled PV-ESS solutions in different pilot sites and taking into account local particularities for optimization, current barriers concerning grid reliability with higher RES deployment will be eliminated. In addition to this, the development and integration of the proposed solution at both residential and community levels and the application of different policy scenarios will lift the barriers related to the grid integration of ESS and will extend the practical knowledge about this technology. It is expected that all the shortcomings regarding the intermittent nature of PV energy for increased penetration into the energy mix will be addressed whilst maintaining smooth operation of the grid.

The project started on the 1st of November 2016 and is expected to be completed within 36 months.

6. Introduction to Deliverable 2.3.9

The project website hosts a platform entitled StoRES Living Lab, where actual data collected from the pilot sites are published so that users can interact performing tests and experimenting with the different parameters which influence energy storage.

In this report, the developed web platform is introduced. In addition, other actions taken by project partners for the purposes of the project and especially the dissemination of the StoRES Living Lab, such as the organisation of on-site tours and workshops/trainings, are presented.

7. Web platform

A web platform displaying and analysing the collected data and the results of all the project's residential PV-ESS pilots has been developed, for the purposes of the project's data analysis. This tool is hosted on the StoRES website (<https://stores.interreg-med.eu/>) and it can also be found on the dedicated web page <http://www.stores-livinglab.eu>. It can also be used for any other pilot plant that can provide input using the same data collection template, as explicitly described in Deliverable 3.4.3 report.

This web platform is developed to be displayed online on a personal computer and can be accessed in English. More specifically, for the purposes of the StoRES Living Lab, three different features have been developed within the abovementioned web platform, as it can be seen in Figure 1, namely:

- Page "Presentation of the data" to present the raw data as well as the extracted average profiles.
- Page "Sites comparison" to compare the various indicators and results of the plants between each other.
- Page "Parametric study" to simulate the impact of different PV and battery sizing.

Moreover, a "User manual" page gives guidelines to the use of the platform and explains how the calculations are occurred.



Figure 1: Graphic display of the public page of the StoRES Living Lab.

7.1 Page "Presentation of the data"

The "Presentation of the data" feature includes two sections:

- On the right side (point [1] on Figure 2):
Information of the pilot installation, i.e. picture and description with the main characteristics, such as:
 - Country
 - Location (municipality)
 - Type (residential / tertiary / industrial)
 - PV power (kWp)
 - PV inverter capacity (kVA)
 - Inverter manufacturer
 - Battery power (kW)
 - Battery nominal capacity (kWh)

- Battery usable capacity (kWh)
- Battery manufacturer
- Battery technology (Lithium-ion, Lead-acid, etc.)
- Coupling: AC- or DC-coupling
- Battery operation mode
- On the main page:
 - Display of the data with the possibility to choose either:
 - "Raw data": the data provided at a 15-minute resolution, as collected at the UCY webserver.
 - "Average profiles": the seasonal profiles and the main indicators, such as Self-Consumption Rate (SCR), Self-Sufficiency Rate (SSR), average State-of-Charge (SoC), etc. calculated.

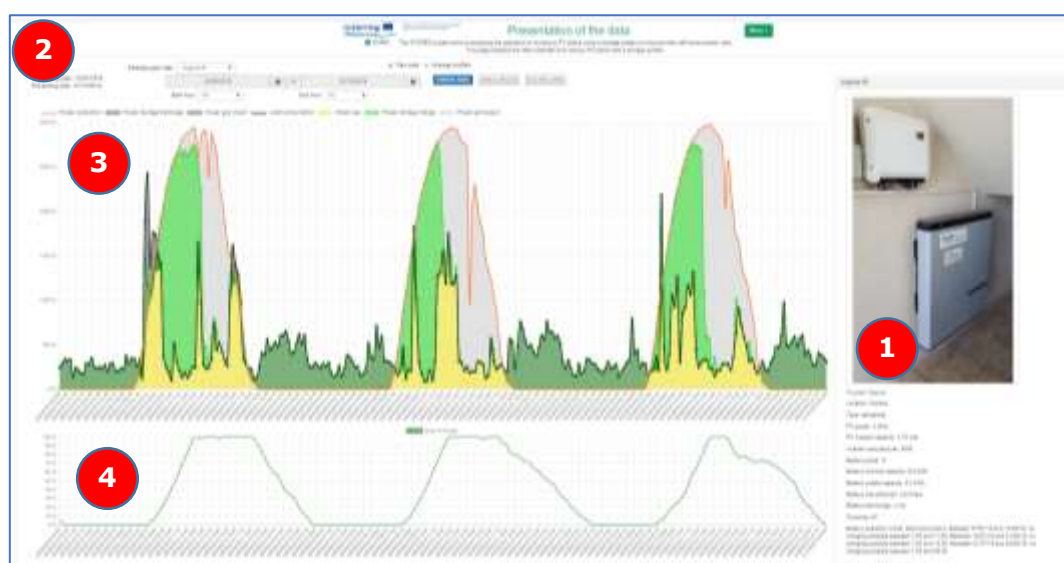


Figure 2: Graphic display of the pilot site's raw data for a selected period in the page "Presentation of the data".

As regards the raw data, the display is composed of three parts:

- Selection of the pilot site to be displayed and selection of the dates when the data are observed (point [2] on Figure 2).
- Display of power time series: power production, load consumption, battery charge, battery discharge, grid import, grid export (point [3] on Figure 2).
- Display of the SoC (point [4] on Figure 2).

The time series are entirely displayed and the user is able to zoom in on a specific period using dedicated cursors. The pilot data are provided by the webpage anonymously and can be visible to any visitor.

With regards to the average profiles, it is possible to display the average power flows calculated using the raw data for the following time periods: year, summer working and non-working days, winter working and non-working days and interseason working and non-working days. The annual indicators are calculated on the last 12 months available in the datasets.

In this selection, a set of indicators is calculated and presented, as it can be seen in Figures 3 to 5:

- Total energy produced during a year
- Total energy consumed during a year
- Total energy self-consumed during a year
- Total energy injected to the grid during a year
- Total energy received from the grid during a year
- Total energy charged to the ESS during a year
- Total energy discharged from the ESS during a year
- Total number of equivalent full cycles during a year (assessed as the ratio between the total energy discharged and the battery nominal capacity)
- Average monthly SoC of the battery
- SCR with and without battery
- SSR with and without battery

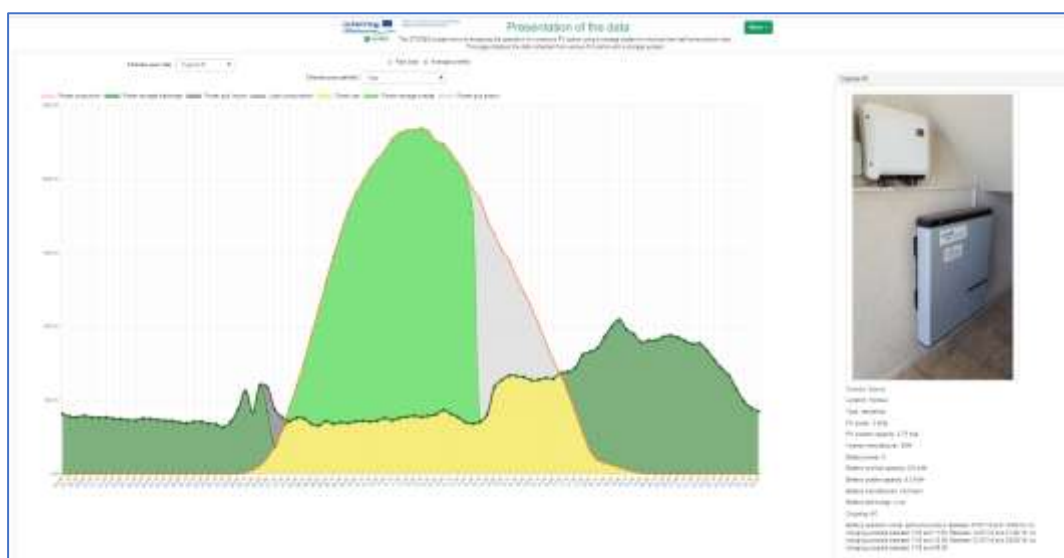


Figure 3: Graphic display of the extracted average profile of a pilot site for a selected period in the page "Presentation of the data".

Total Production	5905 kWh
Total Consumption	4669 kWh
Total Selfconsumption	1259 kWh
Total Grid Injection	1995 kWh
Total Grid Consumption	1292 kWh
Total Stored Energy	2654 kWh
Total Energy Delivered by Battery	2120 kWh
Battery Equivalent Cycles	228
Battery annual average SOC	46.29 %
SCR no battery (year)	21.3 %
SCR with battery (year)	66.2 %
SSR no battery (year)	27 %
SSR with battery (year)	72.4 %

Figure 4: Indicators' display of the extracted average profile of a pilot site for a selected period in the page "Presentation of the data".



Figure 5: Graphic display of the average monthly SoC level of a pilot site for a selected period in the page "Presentation of the data".

7.2 Page "Sites comparison"

The "Sites comparison" feature regards the comparison of different pilot sites. Specifically, the platform includes the feature to compare various pilot sites (up to 5) simultaneously. Figure 6 demonstrates this selection. This page is divided into 4 sections:

- A table comparing the indicators on the left. It can include up to 5 columns (point [1] in Figure 6).
- A graphic comparison of the load and production on the right side (point [2] in Figure 6.)
- A comparison of the annual average profiles just below (point [3] in Figure 7).
- A comparison of the storage system efficiencies at the bottom (point [4] in Figure 8).



Figure 6: Graphic display of the comparison between two different pilots in the page "Comparison of the sites".

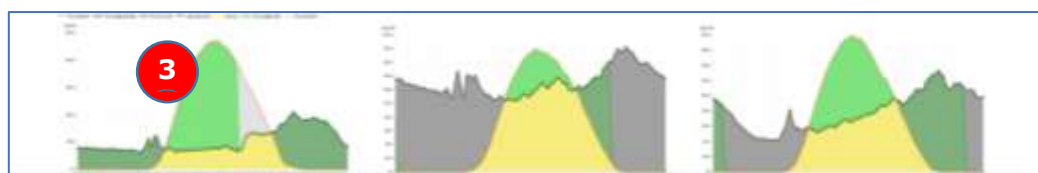


Figure 7: Graphic display of the extracted average profiles comparison between three different pilots in the page "Comparison of the sites".

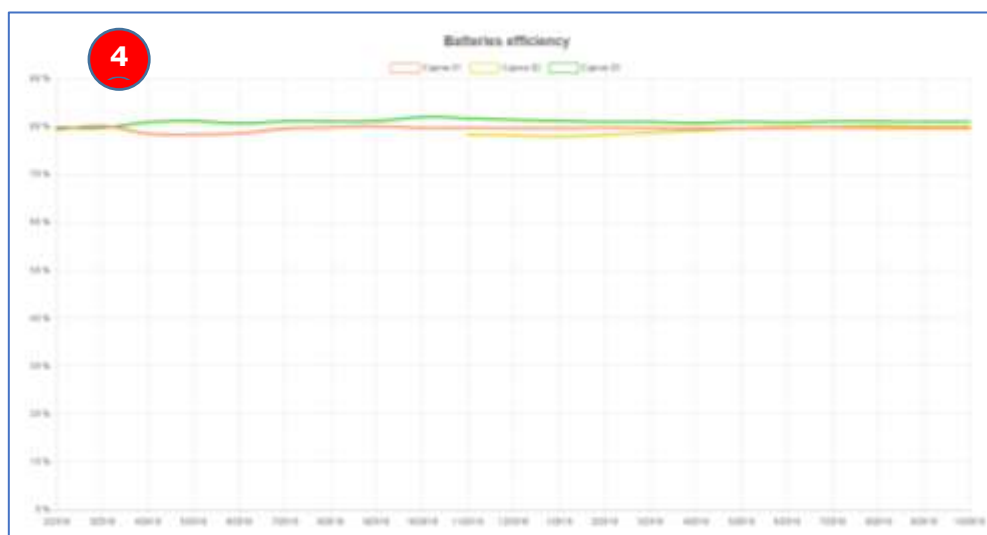


Figure 8: Graphic display of the battery efficiency comparison between three different pilots in the page "Comparison of the sites".

7.3 Page "Parametric study"

The StoRES Living Lab also includes a sensitivity analysis of the data, taking into consideration the pilot sizing (PV capacity, storage capacity), different pilot operation modes, battery efficiency ranges, etc. In this feature, the user can modify the size of the PV capacity and/or the

storage system size and observe how the performance rates are impacted.

The dedicated web page is divided into three parts, as it can be seen in Figures 9 and 10:

- Two graphs illustrating the SCR and SSR according to the ESS size and the PV capacity (point [1] in Figure 9).
- Two graphs presenting the prosumer ratio according to the variation of PV capacity (point [2] in Figure 9).
- Two curves presenting the SCR and SSR according to the variation of the PV capacity or the battery capacity (point [3] in Figure 10).

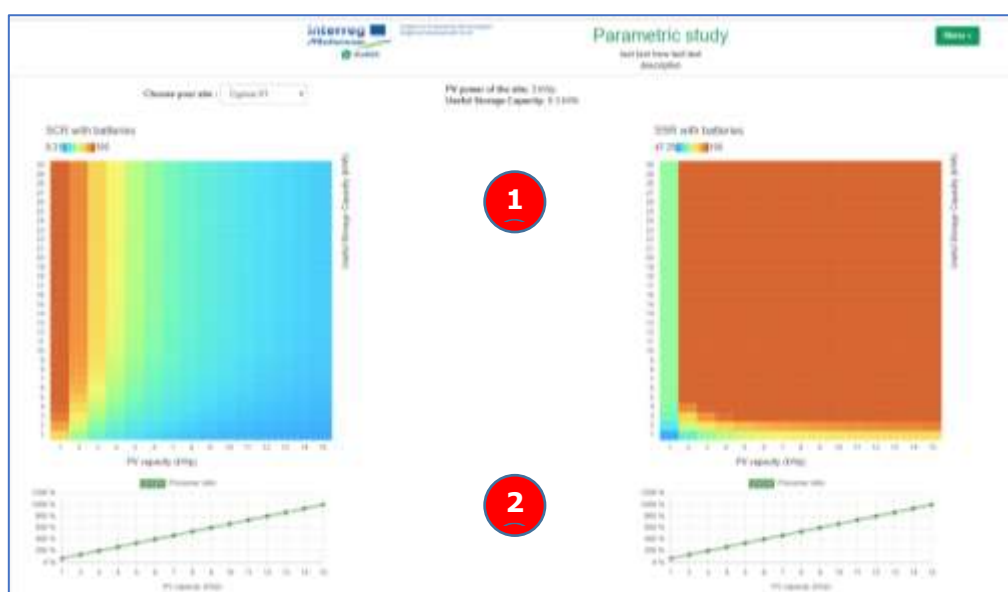


Figure 9: Graphic display of the parametric study (SCR, SSR and prosumer ratio) of a selected pilot in the page «Parametric study”.

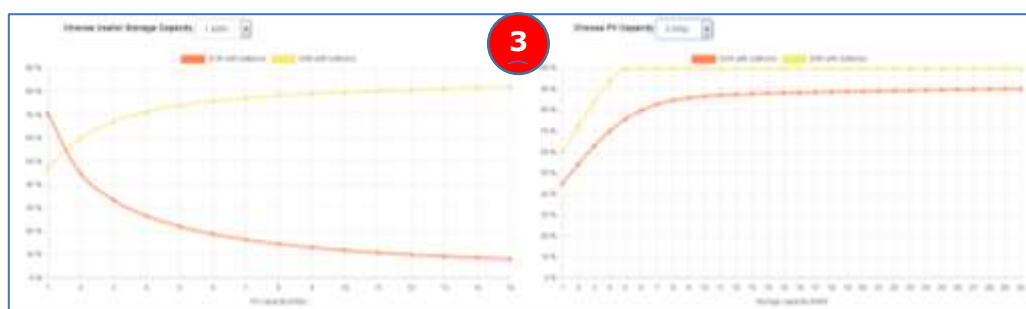


Figure 10: Graphic display of the variation of SCR and SSR according to the system sizing of a selected pilot in the page «Parametric study”.

8. Other StoRES Living Lab actions

In addition to the web platform developed, which will be accessible to all interested parties, project partners will continuously proceed to the promotion of this tool with other actions for the further promotion of the StoRES Living Lab.

Mostly, on-site tours and workshops/trainings have been held by partners (based on their availability) in order to promote the StoRES Living Lab and subsequently the StoRES project to stakeholders, interested parties and finally, the wider public.

8.1 Cyprus

The University of Cyprus (UCY) will proceed to the promotion of the web platform developed within the scope of the project via its communication channels. Specifically, the aim is to demonstrate the energy profiles and balances of the pilots installed, making it possible to evaluate the performance of solar PV and ESS in Cyprus. Furthermore, it plans to demonstrate the StoRES Living Lab in courses of pre-graduate and post-graduate students of the UCY, focusing on the pilot cases of Cyprus. Students may be further involved with the living lab features through special course projects requiring the use of the StoRES Living Lab platform.

In addition, it also proceeded to the following on the training course organised on the 8th October 2019:

- Tour-based demonstration of one Residential pilot at the facilities of the PV Technology Laboratory of the University of Cyprus in Nicosia. During this demonstration, the equipment and its use were presented to the stakeholders, interest parties and wider public in general.
- Thorough presentation of the StoRES Living Lab among the course's participants.

8.2 France

Auvergne Rhone-Alpes – Energie Environnement (AURA-EE) has promoted the StoRES Living Lab during the training course and the workshop organized on 10th October 2019 and on 16th October 2019 respectively. The fact that the platform will be still in use for some years after the project's end has been particularly appreciated.

The AURA-EE will proceed to the further promotion of the web platform developed within the scope of the project via its communication channels

8.3 Greece

The Aristotle University of Thessaloniki (AUTH) will proceed to the promotion of the web platform developed within the scope of the project via its communication channels. Specifically, the aim is to demonstrate

the energy profiles and balances of the pilots installed making it possible to evaluate the performance of solar PV and ESS in Greece.

In addition, it will also proceed to the following:

- Demonstration of the StoRES Living Lab features and capabilities during the workshops, meetings and conferences organized by AUTH for key stakeholders. Specifically, the web platform address will be offered to the participants, while the capabilities of the platform and a set of test cases will be demonstrated.
- Present the StoRES Living Lab in courses of pre-graduate and post-graduate students of the AUTH, focusing on the pilot cases of Greece. Students may be further involved with the living lab features through special course projects requiring the use of the StoRES Living Lab platform.
- Upload and maintain a link to the web address of the StoRES Living Lab platform to the official website of Power Systems Laboratory of AUTH. The uploaded content referring to the web platform will contain a description of the capabilities offered and instructions on the use of the web platform.
- Upload and maintain a link to the web address of the StoRES Living Lab platform to AUTH dissemination platforms designed for students, engineers and the wider public.

8.4 Italy

The Municipality of Ussaramanna (MoU) and the University of Cagliari (UNICA) will proceed to the promotion of the web platform developed within the scope of the project via their communication channels. Specifically, the aim is to demonstrate the energy profiles and balances of the pilots installed making it possible to evaluate the performance of solar PV and ESS in Italy.

Moreover, a demonstration of the StoRES Living Lab features and capabilities was performed during the workshop/training course for stakeholders jointly organized by the UNICA and the MoU on the 21st October 2019 in Ussaramanna. During the event, the equipment and its operation were presented to the interested public/stakeholders.

In addition, the Italian partners will also proceed to the following:

- Present the StoRES Living Lab in under-graduate and post-graduate student courses of the UNICA, with deep details on the Italian pilots. The idea is to involve the students in the management of the data acquired for the analysis of the results or for future research activities.
- Spread the link to the web address of the StoRES Living Lab platform in the future official website of Power Systems Group of the UNICA and through the personal pages of the researchers involved.

8.5 Portugal

The Regional Energy and Environment Agency of Algarve (AREAL) will proceed to the promotion of the web platform developed within the scope of the project via its communication channels. Specifically, the aim is to demonstrate the energy profiles and balances of the pilots installed making it possible to evaluate the performance of solar PV and ESS in Portugal.

Moreover, a demonstration of the StoRES Living Lab features and capabilities was performed during the training course organized by AREAL on the 18th October 2019. The training course especially involved municipal technicians. The StoRES Living Lab platform was a key element for the transmission of knowledge to the targeted audience that takes a key role in implementing public initiatives. During the training course, the equipment and its operation were also presented to the participants.

In addition, it will also proceed to the following:

- Workshop with technical visits. The visits to field sites aim to deep the knowledge of the systems by presenting technical solutions available in the market.
- Promoting and sharing the StoRES Living Lab platform with higher education institutions, industry associations and the general public.
- Disclosure of the platform in the usual means of communication of AREAL.
- Provision of assistance related to questions or clarifications related to the use of the platform or interpretation of some results.
- Maintain an effort to keep the Algarve data upload process beyond the end of the project, extending the reach of the benefits of the StoRES Living Lab.

8.6 Slovenia

The Municipality of Slovenska-Bistrica (MSB) will proceed to the promotion of the web platform developed within the scope of the project via its communication channels. Specifically, the aim is to demonstrate the energy profiles and balances of the pilot installed making it possible to evaluate the performance of solar PV and ESS in Slovenia.

In addition, it also proceeded to the following:

- Training course organised on the 9th October 2019:
 - Thorough presentation of the StoRES Living Lab among the course's participants.
- Workshop organized on the 5th May 2019:
 - Study visit and demonstration of the residential pilot. During this demonstration, the equipment and its use were presented to the stakeholders, interest parties and wider public in general.

- Video recording residential pilot for local television station (KTV Slovenska Bistrica).
- Video recording of the residential pilot by national television station (TV Slovenia) for the educational-consulting television show on Sunday noon, which was presented with approximately 5 minute contribution on the 16th June 2019.

8.7 Spain

The SARGA - Government of Aragon will proceed to the promotion of the web platform developed within the scope of the project via its communication channels. Specifically, the aim is to demonstrate the energy profiles and balances of the pilots installed making it possible to evaluate the performance of solar PV and ESS in Spain.

Moreover, a demonstration of the StoRES Living Lab features and capabilities was performed during the workshop/training course for stakeholders organized by SARGA on the 16th September 2019. During the event, the equipment and its operation were presented to the interested public/stakeholders. In general, it was observed that end-users are very involved in the project and make every effort to continue using the data obtained from the pilots, as well as the companies operating in the sector of PV system installation and energy storage assets are interested in studying the behaviour of the pilots. For this reason, the StoRES Living Lab is considered as an excellent and suitable tool.

In addition, SARGA, through its collaborators, is giving visibility to the StoRES Living Lab in different technical magazines and through specialised articles in blogs spread by social networks. This activity will continue, as far as the monitoring platform is operational in the future.

9. Long-term use of the web platform

The web platform has been designed to be active beyond the lifetime of the project. Project partners will be able to upload new data of the existing plants or to even include new sites on the platform.

For this purpose, a private webpage has been designed and sent to each project partner. Each partner can generate the data that are necessary for the public page and upload it on the server of AURA-EE through a File Transfer Protocol (FTP), as it can be seen in Figure 11.

The web portal's algorithms can then calculate automatically all the new indicators and profiles corresponding to the data uploaded and illustrate them to the relevant pages.

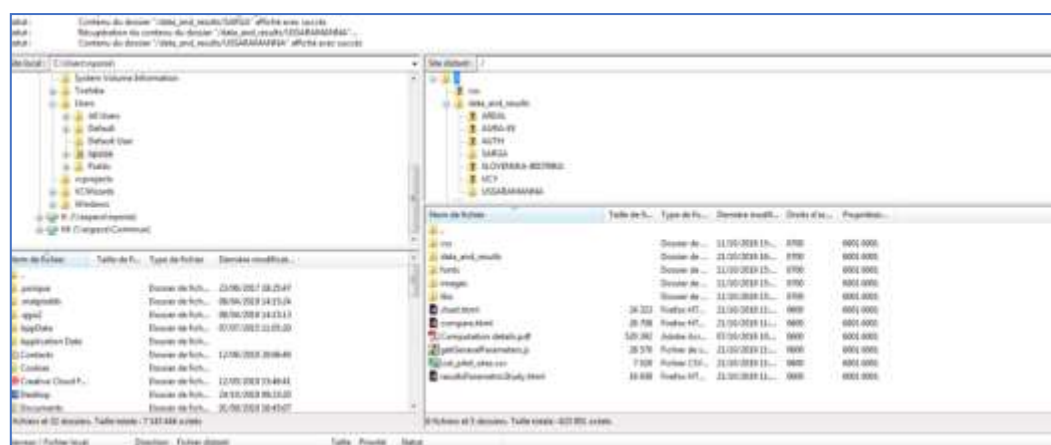


Figure 11: Data access on the server through an FTP.

10. Conclusions

This report aims to give a brief overview of the web platform developed for the purposes of the StoRES Living Lab, which is hosted on a dedicated web address and also on the project's website. Actual data collected from the pilot sites are published in the web platform so that users can interact performing tests and experimenting with the different parameters, which influence storage. In addition, calculations are made to present the main performance indicators and profiles and to compare sites between each other. A parametric study is included to shed light on the sizing of the equipment. The StoRES Living Lab has been promoted through on-site tours and workshops/trainings held by the project partners, as a useful support to bring more knowledge on storage for residential prosumers. It will last beyond the lifetime of the project, as all project partners are able to upload data through an FTP access.