Interreg Mediterranean

StoRES

Promotion of higher penetration of distributed PV through storage for all

Layman's Report

Project co-financed by the
European Regional Development Fund

Project Facts

The project “Promotion of higher penetration of distributed PV through storage for all” with the acronym StoRES, is co-financed by the European Union under the Interreg Mediterranean (MED) programme. It is a pilot demonstration project approved under Priority Axis 2 (Fostering low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas), aiming to increase the share of local Renewable Energy Sources (RES) in energy mix strategies and plans in specific MED territories.

StoRES is an Interreg MED modular project and was implemented by a consortium of 19 highly capable and well established organisations (both private and public) spanning across the MED region.

Coordinator: University of Cyprus

Duration: 1st November 2016 – 31st October 2019

Total budget: €2 mil.

ERDF contribution: €1.7 mil.

Project website: www.stores.interreg-med.eu

https://twitter.com/StoRES_project

www.facebook.com/interregmedstoresproject

Objective

The objective of the project is to boost photovoltaic (PV) self-consumption in the MED through an optimal storage solution via testing smart solutions in 6 MED islands and rural areas. StoRES aims to increase the PV penetration in the energy mix of these areas in the MED by integrating PV and Energy Storage Systems (ESS) under an optimal market policy and by removing the constraints of grid reliability and RES intermittency.

The MED, as the natural place for PV and where grid parity is a reality, has the opportunity to pioneer in testing such technologies in real time with authorities ready to contribute. This endeavour will increase the socio-economic competitiveness of the regions involved; most importantly will have an international impact as new knowledge for optimum PV-ESS interoperability is transferred to a broader geographical context where grid parity has not been reached yet.

Partners

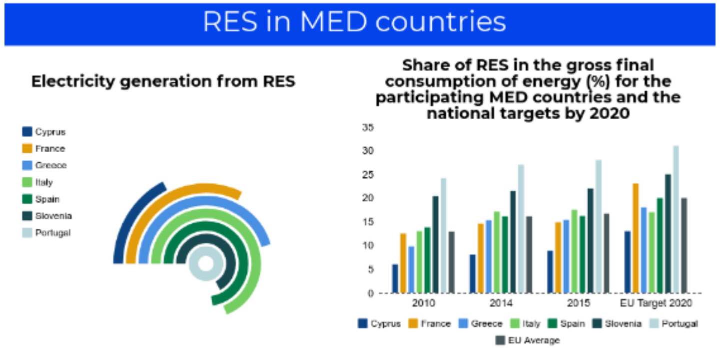
StoRES focuses on 7 EU Member States, namely Cyprus, France, Greece, Italy, Portugal, Slovenia and Spain.

StoRES Consortium

- University of Cyprus (CY)
- Aristotle University of Thessaloniki (GR)
- AREAL – Regional Energy and Environment Agency of Algarve (PO)
- SARGA – Government of Aragon (SP)
- Municipality of Slovenska Bistrica (SI)
- AURA-EE – Auvergne-Rhône-Alpes Énergie Environnement (FR)
- Ministry of Energy, Commerce and Industry (CY)
- Municipality of Ussaramanna (IT)
- Electricity Authority of Cyprus/Distribution System Operator (CY)

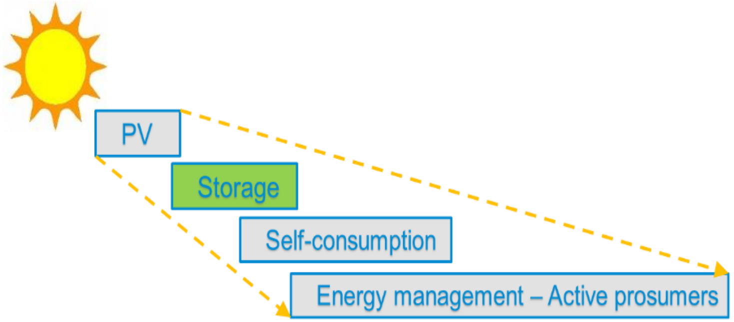
Associated Partners

- Mediterranean Technology Platform for Smart Grids
- University of Cagliari (IT)
- Cyprus Energy Regulatory Authority (CY)
- Autonomous Region of Sardinia – Regional Planning Centre (IT)
- Ministry of Environment and Energy/General Secretariat of Energy and Mineral Raw Materials/General Directorate of Energy/Directorate of Renewable Energy Sources and Electricity (GR)
- Municipality of Kozani (GR)
- Federacion Aragonesa De Municipios Comarcas Y Provincias (SP)
- Hellenic Electricity Distribution Network Operator S.A. (GR)
- EDP Distribuicao Energia S.A. (PO)
- SODO Electricity Distribution System Operator, d. o. o. (SI)



Background

Given the high solar potential in the MED, the increased PV penetration in the power networks and the particularities of the regions involved (islands with isolated networks, almost 100% fossil-fuel dependency and increasing energy demand; rural areas exhibiting weaker networks, possibly greater energy needs and higher environmental impact), StoRES proceeded to testing coupled PV+Storage solutions in different pilot sites to eliminate current barriers concerning grid reliability with higher RES deployment.



Challenge

The challenge is to achieve high PV penetration in the energy mix of the regions involved (islands and rural areas) through solving all market/technical/grid/tariff issues, without compromising grid stability and security of supply.

Why PV+Storage systems?

StoRES is expected to change the current situation concerning grid reliability with higher RES deployment in islands/rural areas giving a cost-effective option to the public on more affordable and sustainable energy supply. This was achieved by testing PV+Storage systems to increase the consumer's PV self-consumption and self-sufficiency, now becoming a consumer-producer, i.e. prosumer, and therefore achieve the reduction of the interaction of the building with the grid.

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 is expected to lift the barriers related to the grid integration of ESS and extend the practical knowledge about this technology.

How to test PV+Storage systems?

By testing grid-connected distributed storage combined with smart self-consumption and Demand Side Management (DSM) by implementing pilots in 6 MED countries, covering thus, all particularities (geographical, cultural, etc.) of the MED basin. In most of the participating countries, the StoRES pilots are the first grid connected ESS in buildings and have been integrated in territories with a high solar potential, suitable for increased PV self-consumption of the end-users. The project's ESS assist the buildings towards significant increases in self-consumption and self-sufficiency.

Pilots

The StoRES project was a great opportunity to implement and validate different solutions available in the market in the MED region. The project's pilots include a wide range of system manufacturers, system sizes, battery technologies (e.g. Lithium-ion, Lead-acid, etc.) and configurations (AC-coupled, DC-coupled).

Fig. Number of pilots in the regions involved.

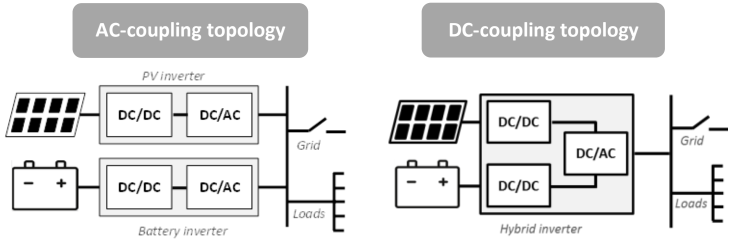


Fig. Battery system configuration.

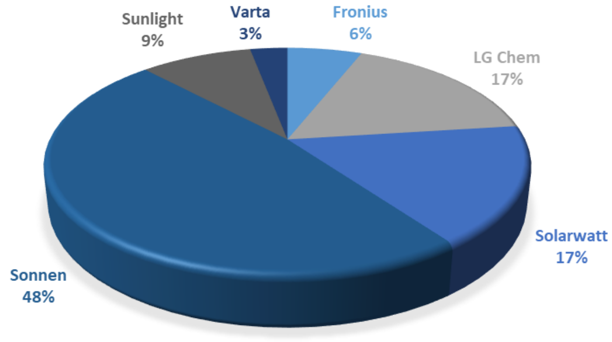


Fig. StoRES pilots' battery unit manufacturers.

Fig. Implemented pilots in the regions involved.

Fig. Implemented pilots in the regions involved.

Barriers

The absence of a clear regulatory framework regarding ESS restricts the introduction of such systems to the energy mix of most of the countries involved. Mostly, despite the fact that the existing schemes in these countries promote the further penetration of residential PV to the power system, they hinder the deployment of ESS. Moreover, the bureaucratic procedures faced at the time, which resulted to relatively short delays in the pilots' implementation, were another significant obstacle that project partners had to overcome. Finally, the high purchase cost of the equipment and the current lack of experience about ESS within the sector of installers and engineers were also observed.

Lessons Learnt

The Lessons Learnt are a valuable summary of the experience gain through the implementation of the project.

- With the current conditions (high ESS prices, existing policies, pricing schemes, etc.), a PV system without storage is a more profitable investment under most circumstances in the studied MED countries.
- Policymakers who want to encourage the use of ESS coupled with PV, should consider the adaptation of existing schemes in order to make systems with storage more profitable than those without. Small tweaks upon existing schemes in the MED region could be enough to achieve that.
- Currently most MED countries do not have policies that favour the installation of storage alongside PV systems. Even in cases where higher self-consumption is encouraged (e.g. the Net- Billing scheme in Cyprus or the partial Net-Metering scheme in Greece), the resulting incentive is not adequate to make a PV+Storage system profitable (given the current ESS prices).
- The main parameters for a PV+Storage system's profitability (as quantified during the StoRES project) include:
    - Consumption and generation power profiles (system sizing)
    - Electricity costs
    - Existing policies/schemes
    - Solar irradiance profile of the installation location

  The optimal sizing of the hybrid system should take into account all the above parameters.

- The technology of the battery system should be carefully chosen. Lead-acid batteries may be economically preferable to Lithium-ion, but other characteristics (i.e. higher self-discharge rates) should be considered.
- The choice of AC-coupled systems is most preferred for existing PV installations (ability for independent sizing). Yet, the choice of DC-coupled systems is most preferred for new systems (limited losses).

Data Collection

In the context of the StoRES project a database has been created (administrated by the University of Cyprus), containing all the data collected by each partner. In the database actual data are stored, currently covering a period of more than a year for each pilot (starting from 2018). The StoRES database is a huge resource of actual data collected from implemented PV+Storage systems in the MED. The Data Collection process is continuous even after the end of the project.

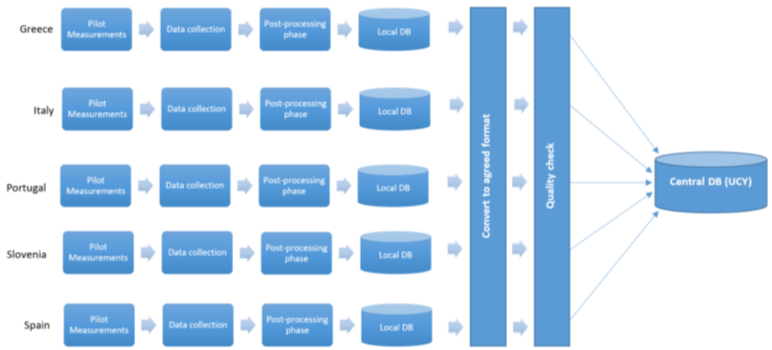


Fig. Data collection process.

Developed Tools

1. StoRES Living Lab

The StoRES Living Lab aggregates all the data collected from the pilot sites and displays them on a dedicated interactive web portal (*stores-livinglab.eu*). Average profiles are calculated for each season as well as key indicators such as Self-Consumption Rate (SCR) and Self-Sufficiency Rate (SSR), system efficiency, average State-of-Charge (SoC) level, etc. Different pilot plants can be compared between each other and a parametric study is also included to assess the sizing of the PV and of the ESS.

For each profile, the following values are represented:

- PV production power
- Load consumption power
- Direct PV power use
- Power charged/discharged in/from the battery
- Power imported/exported from/to the grid
- SoC percentage level

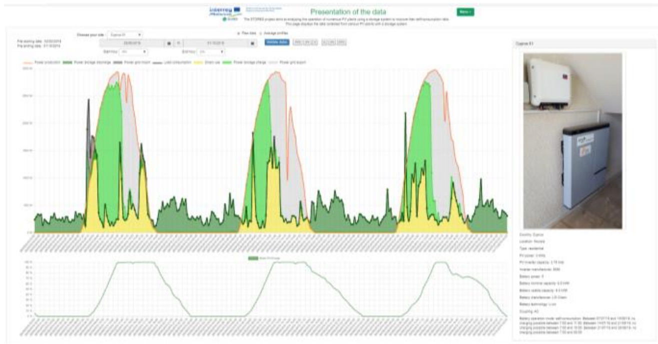


Fig. StoRES Living Lab.

2. StoRES Online PV+Storage Optimisation Tool

This online tool (*storestool.eu*) enables an installer or a prosumer to evaluate the economic viability of a PV+Storage system by taking into account various parameters such as detailed load and production profiles, detailed electricity costs, various supporting schemes, etc. At the end, the Levelised Cost of Electricity (LCOE), the Net Present Value (NPV) and the Internal Rate of Return (IRR) are calculated. The tool can also be used to precisely estimate the best system sizing from an economic point of view.

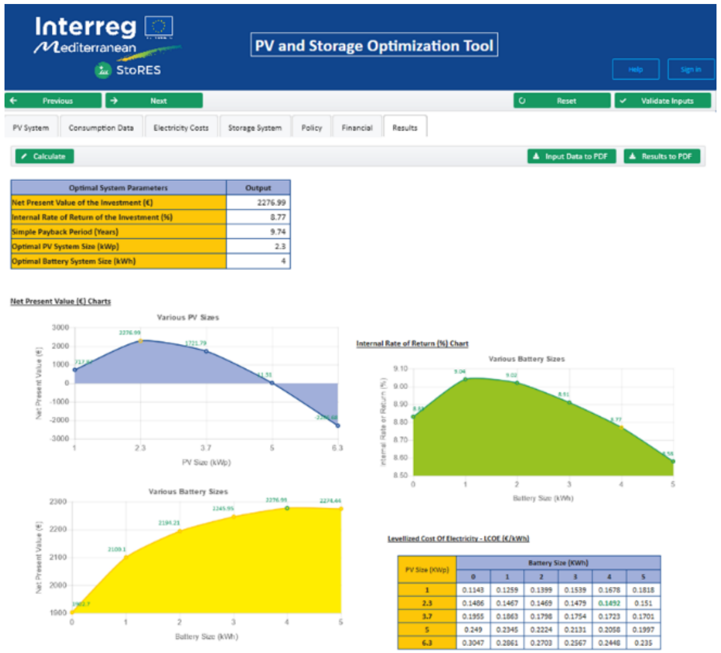


Fig. StoRES Online PV and Storage Optimisation Tool.

Cost & Benefit Analysis

During the project, a comprehensive computational method of residential ESS centred on a Cost-Benefit Analysis (CBA) was performed. The StoRES project was used as a case study to demonstrate the developed CBA and to illustrate the proposed assessment framework. The latter was structured into a set of guidelines to tailor assumptions to local conditions in order to identify and then monetise costs and benefits associated with a residential ESS installation. A sensitivity analysis of the most critical values was also performed. Lastly, externalities and social impacts, which are the result of the ESS installation but cannot be easily monetised and factored into the cost-benefit computation are included.

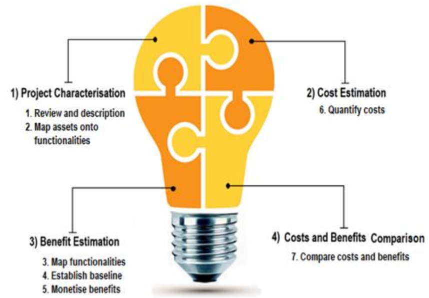


Fig. CBA methodology followed.

Benefits	Functionalities						
	Accurate power measurements	Enable communication between components	System control and quality of supply	Store generated PV energy	Store energy from the grid	Provide energy to the house	Provide energy to the grid
1. Ancillary services	•	•	•	•	•		•
2. Congestion relief				•		•	
3. Transmission support				•		•	
4. Substation on-site power				•	•	•	•
5. Extending life of infrastructures				•		•	•
6. Black-start				•	•		•
7. Increase of self-consumption				•	•		
8. Decrease peak dependence				•	•		
9. Maximise ToU	•	•			•	•	
10. Participating in DR	•	•		•	•	•	•
11. Emergency backup				•		•	
12. Electricity resilient				•	•	•	
13. Reduction of CO2 emissions				•		•	•

Fig. Functionality an ESS can have on the power network as considered in the StoRES CBA.

PV+Storage Monitor

In the context of the project, the design and circulation of a report that consists of an analysis of the proposed ESS solution and results from the implementation of the developed tools was performed. It composes of an economic evaluation of the storage integration in the different MED countries participating in the project, utilising the Levelized Cost of Use (LCOU) indicator with a direct focus on residential systems.

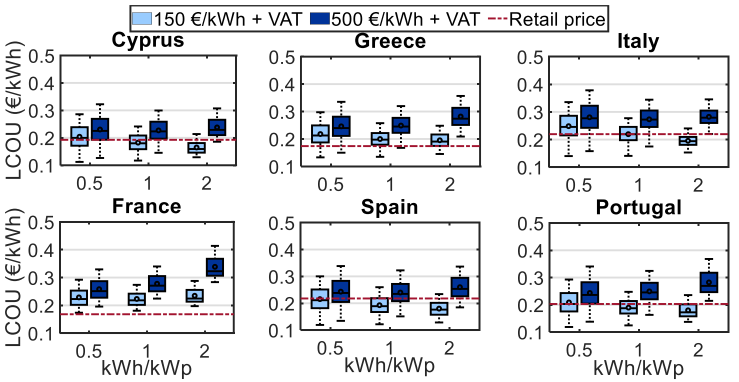


Fig. Statistical analysis of the PV+Storage system LCOU in each country.

The results provide an insight into the difference of the cost of a residential PV+Storage system when compared to the retail electricity price. Generally, in most cases, the PV+Storage Grid Parity cannot be reached under the current market prices, unless the cost of ESS is further decreased. This applies for all countries under study. The assessment of the national support to energy storage and especially ESS integrated with PVs at the residential level revealed that further actions are needed towards the support of the technology, especially when considering the low viability level of residential PV+Storage systems under the current market conditions.

Interreg Mediterranean StoRES

Data Analysis

The in-depth analysis of the pilot sites brought a lot of knowledge on the battery behaviour and on the way they can improve a building's self-consumption and self-sufficiency. The analysis not only demonstrated the high impact of the battery on the self-consumption profiles but also showed that the operation mode can be optimised in order to both serve the prosumer's needs, as well as the grid (i.e. peak shaving).

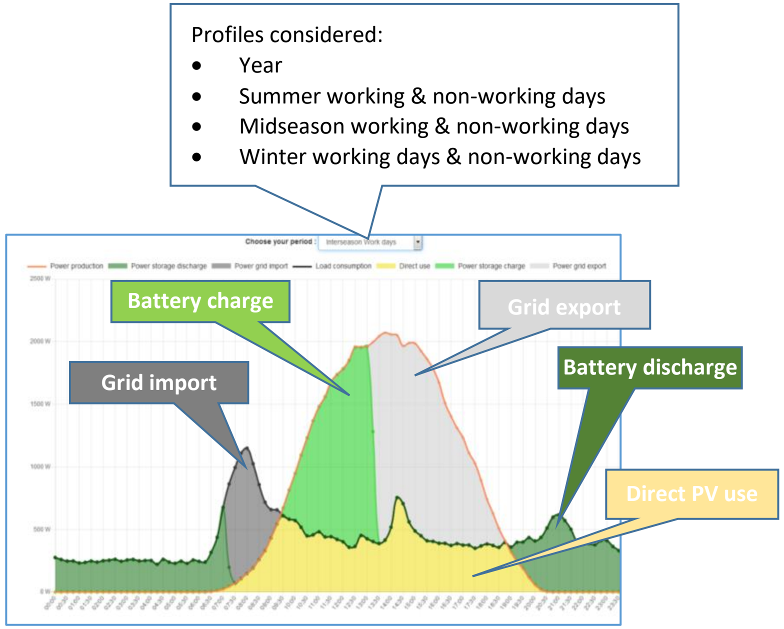


Fig. Energy profile of a selected pilot.

For each pilot site, average profiles were elaborated based on the average values calculated by periods and types of days. Three seasons (summer, midseason and winter profiles) and two different types of days (working and non-working days) were considered and the yearly profile was also extracted. Various indicators, such as the total energy produced, consumed, and self-consumed, as well as the SCR and SSR indicators (with and without storage) were calculated for each pilot site for a period of more than a year.

In general, significant increase of self-consumption and self-sufficiency and reduction of PV export to the grid was observed. Total energy consumption was mostly covered by PV+Storage for Cyprus, Italy and Spain and significantly for Greece, Portugal and Slovenia.

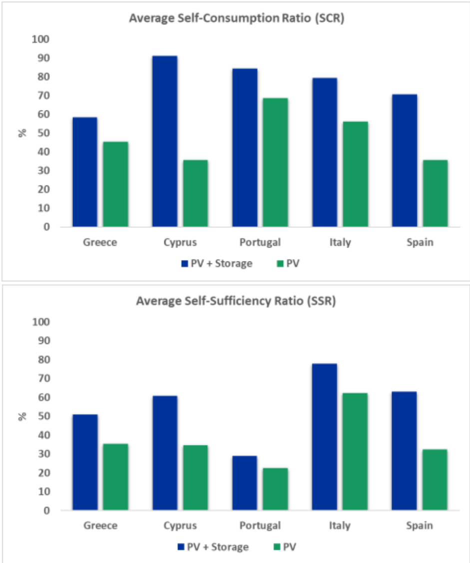


Fig. Increase in self-consumption and self-sufficiency in the pilots.

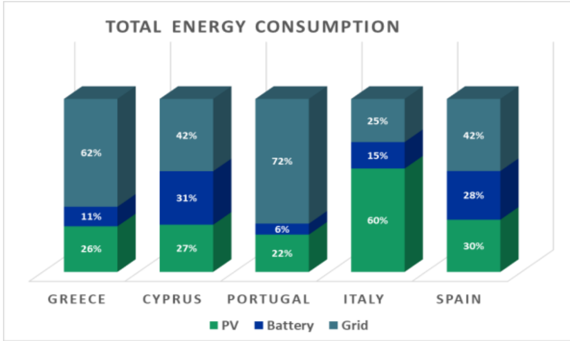


Fig. Share of energy source in the pilots.

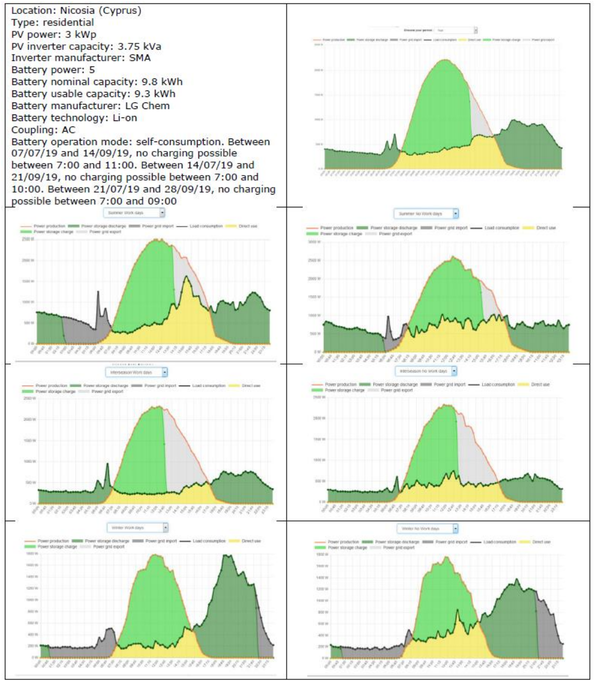


Fig. Energy profile calculation of Pilot 1 in Cyprus.

Future Scenarios

The possible impact of a wide development of ESS was assessed for each region involved in the project, by extrapolating the results obtained within the data analysis task, using pilot and historic data from all participating countries. Scenarios represent the electricity that could be saved from the grid if more ESS were deployed in the energy mix of the participating countries (mainly on residential premises), focusing on the effect of higher PV penetration in the energy mix of the regions involved.

On average, a value of 11% of savings from the total electricity demand could be reached. When considering that not all households can be equipped with a PV+Storage system, this rate decreases to about 6%, which is still a notable value.

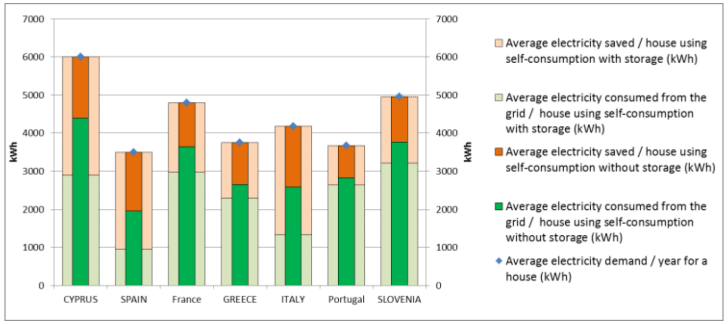


Fig. Electricity savings (orange bars) compared to the whole demand per household with PV self-consumption, without storage and with storage.

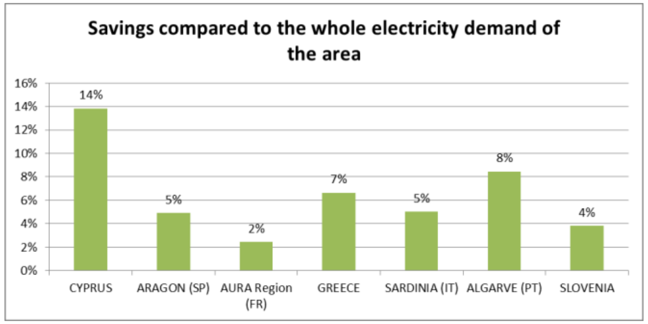


Fig. Electricity savings compared to the whole area's electricity demand.

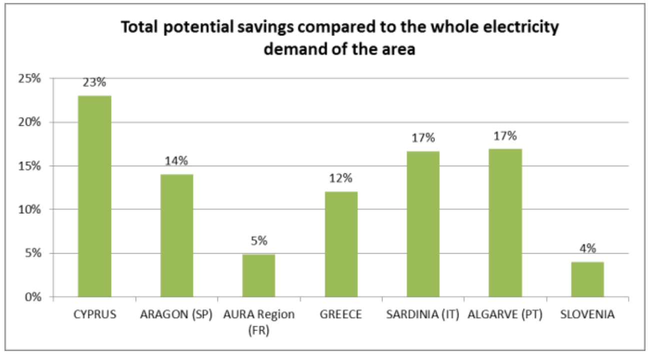


Fig. Maximum potential savings compared to the area's whole electricity demand.

Environmental & Socioeconomic Impact

Significant savings in terms of emission costs for the countries involved were indicated due to the reduction of CO_2 emissions resulting from the pilots' operation. An additional beneficial reduction is expected from the implementation of the project actions at larger scales.

Positive impact on prosumer's perceptions, attitudes and energy behaviour resulted from the implementation of the pilots. The public that participated in training activities are much more aware about energy storage and its benefit both on the power system, as well as to system owners. Consumers now become active prosumers, managing their energy profiles (both demand and production) to gain financial benefits.

Policy Recommendations

The StoRES Policy Recommendations are a valuable summary of promotion proposals to the responsible authorities of the regions involved for the exploitation of ESS, considering the experience gain through the implementation of the project. The StoRES Policy Recommendations provided guidelines to the following practises (which are considered suitable for ESS exploitation):

- Net-Billing and other promoting self-consumption policies/schemes
- Open market access for ESS participation
- Cost-reflective pricing of energy consumption
- Energy Communities formation

Dissemination & Communication Activities

One of the main outcomes of the StoRES project is the spread of the lessons learnt and of the knowledge acquired during its implementation, both in the regions involved and beyond. This regards the organisation and performance of conferences, dedicated tours, workshops, other local and international events and training courses. Pilot site visits were organised by each project partner, where live demonstrations of the systems, the developed tools etc. were performed.

Furthermore, the project was disseminated through scientific journals, various articles in local media and newsletters. An additional communication path is the active website, where all project deliverables (news, reports and information material) are presented and are available for download.

Training Courses

The training courses allowed engaging the stakeholders with the solutions arisen during the project, with the aim of convincing them to adopt the main guidelines and suggestions and transfer the knowledge gain through the project with regards to technical and regulatory aspects. Each training course was prepared given the audience.

At least 20 stakeholders have been identified in each participating country, including policymakers, local/national authorities, Distribution System Operators (DSOs), Transmission System Operators (TSOs), academic bodies, governmental bodies, manufacturers, engineers, citizens, Non-Governmental Organisations (NGOs), etc.


Certificate of Attendance

This is to certify that

has attended the 2-hour StoRES Training on Battery Energy Storage Systems coupled with Photovoltaics

Nicosia, Cyprus

Fig. Certificate of attendance of the training course.

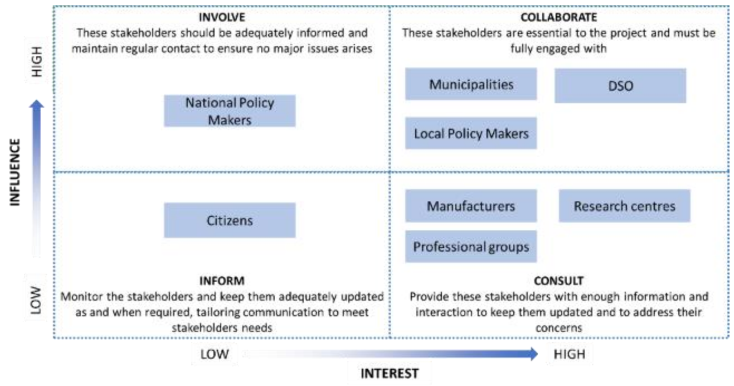


Fig. Identification of stakeholders.

Organised Workshops

In each country, different events with a varied content attended by participants from various areas of the energy sector have been organised, in order to effectively rollout the results of the project to interested stakeholders. The target audience was very diverse and included (among others), the local DSOs/TSOs, governmental, regional and national authorities, municipalities, service and equipment providers (i.e. installers, engineers), the scientific community (i.e. professors and students in universities, research institutes, etc.), non-governmental organisations (NGOs), various associations, local media, other interested parties and the general public.

Fig. Training courses and organised workshops in the participating countries.

The 1st International Conference on Energy Transition in the Mediterranean Area (SyNERGY MED 2019) & StoRES Final Event

The 1st International Conference on Energy Transition in the Mediterranean Area – SyNERGY MED 2019 and the StoRES Final Event (entitled "Innovative solutions for fostering low-carbon strategies and increasing renewable energy sources in the energy mix of the MED area") were both organized by the University of Cagliari and the Municipality of Ussaramanna and co-organized by the StoRES Project Consortium in Cagliari, Italy in May 2019. The main aims of the StoRES Final Event were to present the project's achievements as well as the main results and to discuss complementarities with other MED projects from the renewable energy community of projects. Both events gathered significant attention from all over Europe.

Fig. SyNERGY MED 2019 international conference logo.

Fig. The StoRES consortium during the SyNERGY MED 2019 conference.

Fig. The StoRES consortium during the StoRES Final Event.

Fig. Audience during the StoRES Final Event.

Teaching

The StoRES project was widely disseminated through teaching courses at both under-graduate and post-graduate levels by the University of Cyprus in the University's programmes, as well as through dedicated workshops in Cyprus and beyond (i.e. in Uruguay, South America), gathering attention from academics (professors, undergraduate and postgraduate students) from Jordan, Syria, Morocco, Uruguay, Brazil and other countries.

Fig. Teaching courses in Nicosia, Cyprus and Montevideo, Uruguay.

Other International Events

The project's consortium participated in various international events in Europe such as the EU Sustainable Energy Week 2019 in Brussels, Belgium, the Energy Day 2019 in Nicosia, Cyprus, the POLLUTEC 2018 in Lyon, France, the European Mobility Week 2017 in Slovenska Bistrica, the Smart Energy Week 2017 in Nicosia, Cyprus and more.

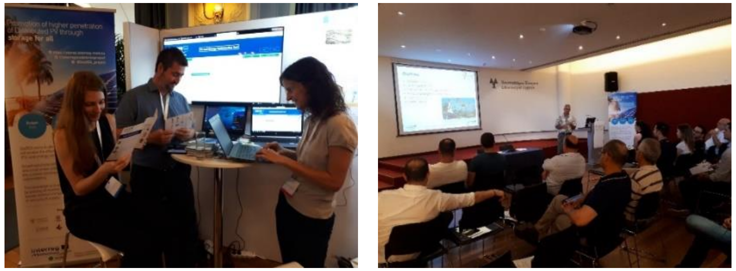


Fig. StoRES participation in the EUSEW 2019 in Brussels, Belgium and in the Energy Day 2019 in Nicosia, Cyprus.

Project Replication

The StoRES project has a significant capacity of replication as its main outcomes (i.e. the lessons learnt from the project, the StoRES Online PV and Storage Optimization Tool, the StoRES Living Lab, etc.) can be easily replicated in nearby countries of the broader region. Specifically, countries aiming at the promotion of PV through residential storage solutions, with similar environmental conditions (i.e. solar irradiance) and status of PV in their energy mix can benefit from the main outcomes of the project. Furthermore, the main outcomes can also be utilised by other European countries beyond the MED region.

Engagement through enriched SECAPs/signed MoUs

Regional and local authorities play a crucial role in mitigating climate change by promoting energy efficiency and renewable energy. They need to trigger the use of PV+Storage by initiating or amending Sustainable Energy and Climate Action Plans (SECAPs) and/or signing a Memorandum of Understanding (MoU) within their territories. With this action, the SECAPs will be upgraded in order to increase local production of renewable energy sources and reduce CO_2 emissions.

The StoRES project has made an interesting contribution to the encouragement of local/regional authorities to enrich the SECAPs/signed MoUs with the integration of RES and with the objective to increase PV targets in MED or signing relevant MoUs through the awareness that PV+Storage is one of the ways to respond to such alarming challenges as climate change.

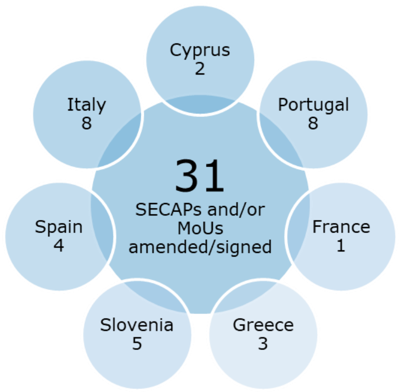


Fig. StoRES established target of SECAPs and/or MoUs amended/signed per country.

After StoRES

The developed tools (i.e. StoRES Living Lab, StoRES Online PV and Storage Optimisation Tool) are available for interested parties and the wider public. The large scale roll-out of the StoRES Lessons Learnt, the StoRES Policy Recommendations, the CBA results, etc. is anticipated to the regions involved, by also expanding knowledge to other geographical areas within and outside Europe, i.e. South America, Middle East and North Africa (MENA) region.

The introduction of Energy Storage in the regions involved and specifically of active prosumers will bring drastic changes to the energy mix.

THINK BIG, START SMALL!

If more consumers are engaged in the energy transition by possessing PV+Storage systems, thus becoming active prosumers, given also that new energy policies are developed, then the further promotion of distributed PV can be a significant step towards a sustainable and green planet.

Our motto is “Think Big, Start Small”! Assisting the power network for the further integration of renewable energy depends on each and every one!