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°: **4.2.1**

Deliverable Name: **Lessons learnt for systems with PV and storage**

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3. Contents

4. 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 applying different policy scenarios will lift the barriers related to the grid integration of ESS and 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 1st of November 2016 and is expected to be completed within 30 months.

5. Introduction to Deliverable 4.2.1

Documenting lessons learnt is an integral part of the StoRES project. Lessons learnt is the learning gained from the process of performing the project activities. It captures the challenges faced throughout the project's lifecycle as well as the solutions found to ensure a better execution in the future.

In order to determine what problems occurred and how those problems were handled, all project partners will answer a series of questions presented in a survey. The survey will contain parameters affecting the solution with focus on technical and other barriers identified from pilots, taking into account latest ESS solutions, trends and prices. It is important to describe in detail all relevant categories in order to create a coherent description of necessary steps for future use. The focus will be on the following issues: policy, technical, administrative and financial barriers.

The aim is for this document to be beneficial in all regions, including those outside pilot countries. Regions outside pilot countries may have different needs and characteristics as far as policies and energy tariffs are concerned, so we will also have to consider potential risk scenarios and corresponding solutions.

The lessons learnt will be formally communicated with the project partners and used as a foundation for transferring the project results to the relevant project stakeholders.

5.1 Scope of the action

The first step of the lessons learnt process is the identification of challenges, solutions, good practices and potential risks. When this data is documented in an organised way, the next step is to conduct the analysis and summarize the findings in a clear and consistent manner.

5.2 Objectives of the action

The lessons learnt process is based on identifying comments and recommendations that could be valuable for future projects. The purpose of this process is not only to describe the bottlenecks, shortcomings and what went wrong during the project, but also to describe what went right and how similar projects may benefit from this information. It provides solutions that will assist the project partners in future activities with the transition from their current level to the next level.

The lessons in this document represents an opportunity to learn from the actual experiences of project partners. They will serve as a valuable tool for transferring the results of the project to the stakeholders. On the basis of this document different types of reports can be produced for specific audiences.

This document should be updated regularly after the project's end, covering the MED region and beyond.

6. Lessons learnt for systems with PV and storage

6.1 Pilot installations in partner countries

The following table presents the characteristics of all pilot installations in all 6 pilot countries.

Table 1: Pilot installations characteristics

Country	Description
Cyprus	- Before pilot installation no grid connected BSS. - Permission of DSO required. - Residential + community pilot (1st community pilot). - Storage is not covered by the Grid and Market rules. - No clear policy about the investment, no incentives to invest in storage. - The prevailing tariffs do not support investments in storage for domestic prosumers even though there is a clear need for dynamic pricing or Time-of-Use tariffs. - Cyprus Energy Regulatory Authority (CERA), refused to give any financial incentive to the project participants.

	- The Community Storage Pilot has been installed and is being operated by the local DSO. - There is no clear policy on the ancillary services that can be provided by storage on the grid and hence DSOs and TSOs are not incentivised to take appropriate investment decisions in support of the system. - The Social Storage Pilot was intentionally erected on the same LV feeder as the fed prosumers to evaluate complementarities between the two systems and gather evidence for the innovative objectives described above. - A substation manager/controller responds to pre-programmed operational objectives utilising all the available resources on the specific feeder for evaluating useful responses that will assist the DSO in drafting policy recommendations for (a) sizing of social storage in managing distribution grid resources and (b) smart substation needs for delivering the required intelligence for optimal use of resources. - Pilots started to operate: P1: feb 18; P2: nov 18; P3: feb 18; P4: jul 18; P6: feb 18
Greece	- Five pilot installations - battery storage systems (BSSs) in a residential installation (PS1), in a commercial warehouse (PS2), in an office building (PS3), and in two public buildings, pilot installations PS4 and PS5, respectively. - All pilots operate under a (partial) net-metering scheme available in Greece, which favors increased self-consumption. - All pilots are in flat rate electricity tariff. - The pilots have been in operation since April 2018. - At the time of the installation storage was not allowed officially, hence a special permit was acquired by the DSO.
Italy	- The installation of the storage, metering and communication systems has been performed within the middle of March 2018 for all thirteen pilots identified by the Municipality of Ussaramanna (MoU). - Technical solution has been customised in order to allocate efficiently the thirteen storage systems in the different households with suitable technical schemes. - Electrical design of each household by incorporating the storage system equipment including the battery unit, the inverter, meters and protection devices has been prepared and submitted to the DSO for approval before proceeding to the installation and the connection to the grid. - Storage systems must be installed indoor in order to preserve the best temperature for their efficiency, as close as possible to the battery inverter; in some pilot sites small building operations were necessary to solve this issue.

	- It was not easy to schedule dates/time for the installation, considering the different households' needs and availability, even if the citizens have been informed and involved in the StoRES project from the beginning. - Finally, sometimes Internet connection in the pilot sites was not stable and of high quality. In order to address this issue, the MoU implemented some new Internet connections able to assure the stable and reliable monitoring for all sites. - In Italy, the Regulatory Authority for Energy, Networks and Environment ("ARERA") has defined appropriate provisions aimed at allowing the integration in the Italian network of storage systems. ARERA stated that storage systems, being capable of exchanging electricity with the network, shall be treated as production plants or, in cases where they are installed at production facilities, as generation groups. Storage systems must be integrated into the energy network accordingly to the provisions related to connection services, transmission, distribution, measurement and dispatching of electrical energy provided by the resolutions of the Authority, as well as in compliance with the national technical rules of the Italian Electrotechnical Committee (CEI): CEI 0-16, for connection of Distributed Generation in MV and HV systems, and CEI 0-21, in LV networks.
Portugal	- The pilots' installation and commissioning ended on February 2018, for all five pilots selected at the Algarve region. - Subcontractor for BSS installation has the knowledge to perform a primary service in order to perform an adequate assessment to match the PV system production with the consumption profile. BSS are not 'plug-and-play' solutions. - Installation requirements will change on a project-by-project and client-by-client basis. - Subcontractor had to have track record, provide equipment and warranties. - Storage systems must be installed indoor in order ensure safety and performance issues. - It must also integrate data acquisition requirements in order to ensure the regular transmission of data. - Data transmission failures can result in poor performance of the BSS. - As all locations already had solar photovoltaic systems in self-consumption mode, the main bottleneck was to integrate the storage system to the installed PV system. - Commissioning the system was not a main issue to the team and systems start sending information right away.

	- The lack of regulations of BSS creates uncertainly to developers and end users. - All pilots were residential buildings
Slovenia	- First direction is in the functional operation of PV systems in combination with energy storage and the second is in the research that is needed for more precise planning of future operations. With the second we have faced of course more obstacles, shortcomings and barriers. - At the beginning of pilot installation Slovenia had no special regulation to install battery systems. But the installations were also not prohibited. - First concern was to find the subcontractor for the implementation of installation who would not only install the battery, but also have research and development capacity. - The choice of battery inverter was from the same producer as for PV inverter, because at the beginning we tried to simplify the compatibility and data collection without additional software or hardware equipment. - After the installation of the battery the battery failure occurred an it was not possible to "wake up" the battery. - Because the residential building owner insured the battery the insurance covered the expenses of new battery electronics. - Because the available web portal with PV and battery inverters didn't provide sufficient data the pilot was upgraded with additional sensors and its web application. - Available battery inverter was single phase and available solar inverter three phase.

6.2 Technical/market/administrative barriers

Identification of technical/market/administrative barriers has been carried out with indicators presented and compared among the partners in the following Tables.

Table 2: Presence of barriers

Cyprus	- No major technical barriers exist. They have faced some administrative barriers with the procurement office for tenders for the equipment such as small time delay.
Greece	- Currently, the operation of battery storage system is prohibited by DSO and Greek regulatory authority. - Only in March 2019, a first draft of a new law was proposed that officially allows storage facilities. - For the installation of BSSs in buildings, an extended certification of the overall electrical installation is required. This certification can be expensive and time consuming, especially for large installations.

	- The major PV companies are not yet accustomed to such installations, hence communication was not smooth and technical issues that arouse could not be solved directly.
Italy	- Few bidders were able to offer what was required in the tender and practically nobody was able to offer the most ambitious/innovative level (including all optional scenarios).
Spain	- No technical barriers
Portugal	- Lack of equipment suppliers at the Portuguese market. - No limitations by DSO, grid operator no regulator regarding the installation of battery storage systems. - As market develops there will be other optimized solutions. - Battery life.
Slovenia	- To find the partner who would install the equipment at affordable price and which would fulfil the expectations for the research part. Because the companies dealing with the installation have to be more market oriented and their main concern is only the basic functioning of the equipment. When the basic pilot equipment was installed and started to operate, many of shortcomings/barriers of commercial equipment appeared in order to fulfil the conditions for the research/development part, although the functional operation of the system was solved. - Important barrier was that market Solaredge offered only single phase battery inverter, but the connection of pilot house to the grid is three phase. The PV system therefore cannot work in a backup mode if the grid is disconnected. - Important barrier was that components for storage, communication and monitoring are not open for additional functionalities and adjustments and for this reason, separate measurement units (e.g. current sensors) had to be purchased (e.g. measured quantities should be exported automatically to the server we collect data, but the commercial software was not open for the connection). - Important barrier was with the battery failure. Because the battery was imported, there was a problem with proving who is responsible for failure and even when we found out that it was lightning and that equipment was insured at the insurance company it was still a problem what part is eligible for payment. It took a certain time to make correct agreement with authorized repairer, because of the purchase of the battery abroad.

Table 3: Cost of pilot installation

Cyprus	1.265,91 EUR/kWh (residential pilot); 1.350,00 EUR/kWh (community pilot), both without VAT

Greece	86.056,00 EUR in total including 24% VAT; average 1.140 EUR/kWh - included maintenance for 2 years (24% VAT included)
Italy	Average 1.260,00 EUR/kWh with 10% VAT included (the average cost for kWh, obtained by considering the total cost of equipment, installation, system configuration of our pilots, divided for the total amount of kWh installed)
Spain	10.226,87 EUR total per pilot of 8.8 kWh with included VAT
Portugal	6,000.00 EUR per pilot of 2 kWh (includes equipment, installation, system configuration) without VAT (23%)
Slovenia	8.784 EUR for 7 kWh (VAT not included)

Table 4: Battery inverter type

Cyprus	1-phase battery inverter (residential); 3-phase inverter (community/social)
Greece	3-phase Fronius Symo Hybrid 5.0 storage inverters (in one residential, and one public); 3 1-phase storage inverters SMA Sunny Island 3.0 (in one commercial, and two public); 3 special energy meters Janitza UMG604 for each pilot (PV production, charging/discharging, imported/exported to the grid)
Italy	1-ph battery inverter Sonnen and 3-ph battery inverter VARTA
Spain	Solarwatt
Portugal	Sonnen inverter
Slovenia	1-phase battery inverter (social pilot), 3-phase connection to the grid (residential pilot)

Table 5: Battery capacity

Cyprus	9,8 kWh nominal, 9,3 kWh usable (residential); 50kWh (community/social)
Greece	7,5 kWh (residential, public building) x2, lithium-ion 20,16 kWh (warehouse, office building, public building) x4, lead acid
Italy	13 residential pilots: 2 x 8 kWh, 5 x 6kWh, 6 x 4 kWh (adding 2 kWh modules)
Spain	4 pilots 8,8 KWh, one 4,4 kWh
Portugal	2 kWh
Slovenia	7 kwh

Table 6: AC or DC coupled system

Cyprus	AC (residential) - due to existing PV inverter; AC (community/social)
Greece	AC coupled for all systems, in order not to interfere with the existing PV system installation
Italy	AC – due to existing PV inverter

Spain	DC
Portugal	AC
Slovenia	AC

Table 7: Battery power and PV peak power

Cyprus	2,5 kW permanently; 5kW - maximum (undefined time); 7kW - 10s at discharging (residential); PV peak power: 3kWp (common practise in Cyprus)
Greece	PV: 5 kWp (residential), 20 kWp (commercial), 10 kWp, 10 kWp, 10 kWp (3 public buildings)
Italy	2,5 ÷ 3,3 kW; PV peak power: 3 ÷ 12 kWp
Spain	PV: 3,2 kWp, 4,1 kWp, 4,2 kWp, 4,2 kWp, 5,6 kWp
Portugal	1,5 kWp PV power peak in combination with 2 kWh of BSS; except in one case is PV power peak 1 kWp; maximum charging power is 1,5 kW (the same as solar peak)
Slovenia	2,1 kW (3 kW) battery inverter with interface Most of the time the consumption power is below 1 kW, but since additional installation of electric heaters 2x4kW (combined with solar collectors and wood) and the winter season the power increases to 9 kW in certain periods. Electric heaters are mainly the owner's experiment how to use the expected surplus energy in net metering system which would be otherwise lost. But the real case shows, that the consumption of these heater is too high.

Table 8: Background for battery capacity selection

Cyprus	daily energy self-sufficiency (one charge/discharge cycle/day)
Greece	LiFePO4 x2 for smaller capacities (7,5 kWh), OPzV x4 - lead acid bigger capacities for keeping low costs (20,16 kWh) The drive was mainly the need to satisfy all applications with the available budget. This means that the choice of battery capacity was not optimized for each installation, but it is expected to increase both self-consumption and self-sufficiency.
Italy	Li-Ion/LiFePO4 (long life time, low self-discharge) 13x (4-8 kWh) - to fulfill the energy needs and optimal utilization. The identification of the consumption/production profiles of the households is key to properly size the ESS. Nevertheless, since the daily load curves for the selected prosumers were not available, it has been necessary to refer to typical daily load/production curves. To solve this issue typical PV production and energy consumption profiles for typical household in Italy have been considered (delivered by ATLANTIDE Project, in cooperation with ENEL). The self-consumption rate of a typical household in Italy is moderate, since PV generation and load consumption occur at different time

	slots. So, the electricity is delivered from the public grid to cover the demand during the periods where PV production is low. The actual ESS capacity was sized in order to increase at maximum the potential of self-consumption of the PV owners, by performing the comparison between the energy delivered to the network during the daylight (that can be stored in the ESS system) and the energy consumption absorbed by the grid during evening-night hours (that can be provided by the charged ESS). The maximum Depth of Discharge (DoD) and the required cycle life of the batteries were also considered as key parameters in the choice of ESS. Modular batteries with capacity of 2 kWh have been chosen to reach the suitable capacity (4-6-8kWh). Definitely it is revealed a smart choice, and not only because it permits incremental energy storage, if needed. In the installation phase, due to a misunderstanding an 8kWh battery was installed in one pilot site, whereas the optimised size was 4kWh. The modular solution permitted to quickly solve this issue, by moving two modules to another prosumer.
Spain	Daily energy self-sufficiency in summer (one charge/discharge cycle/day).
Portugal	Preliminary study was carried out. Only standard battery systems addressed in the study.
Slovenia	Batteries with higher capacities enable better self-sufficiency. According to the project financial limits, we have planned the storage of energy available for self-sufficiency at least for evening hours without sun. We have estimated, that 7 kWh battery should cover the evening's needs.

Table 9: Battery with desired functionalities available on the market

Cyprus	Yes (from an abroad market though, shipped to Cyprus).
Greece	Yes, however the main market players had to directly obtain the equipment from abroad due to the currently non-existent market in Greece.
Italy	Yes.
Spain	Yes.
Portugal	Yes, storage systems integrated with PV commercially available on the market.
Slovenia	It was expected, that we can access the data of Solar Edge portal and measured data in inverter though RS485 and send them to arbitrary server. But it showed up, that these options are not available. We had to buy additional sensors and meter to solve that, but there are still not all the problems solved. Now it is the development stage of API.

Table 10: Standards, permissions to connect battery and PV on the grid; responsible entity

Cyprus	Standard VDE-AR-N 4105; DSO.
Greece	In prosumers' installations operating with net-metering it is allowed to install battery storage under the following conditions. Batteries are not charging from or discharging to the grid. The rated power of the batteries inverter should not exceed the rated power of the PV inverter and in all cases should be less than 30 kVA.
Italy	CEI 0-21 (DC or AC coupled); on behalf of pilot users Municipality of Ussaramanna took over the permission procedures towards DSO, such as: connection request; approval of connection conditions received from DSO; stipulation of the operation agreement; communication at the end of installation activities; commissioning of PV system with physical connection to the grid. Good practice is the cooperation between Municipality of Ussaramanna, UNICA (University) and DSO.
Spain	For power below 10 kWp, connection to the grid is possible.
Portugal	The producer of a Self-Consumption Production Unit (UPAC) connected to the DSO must first ensure adequate technical conditions for the delivery of surplus electricity to the grid, in particular by carrying out voltage measurements, safeguarding the nominal voltage limits and conditions established in the Quality of Service Regulation and in the Technical and Quality Regulation. In terms of power limitation, among others the following points should be considered: - The UPAC connection power (injection) must be ≤ 100% of the power contracted in the installation of use; - The installed power in the UPAC cannot be more than twice the power of connection;
Slovenia	Associated partner is also DSO and they allow us to install pilot without any additional permissions, because they would also like to know what lessons will be learnt. When the storage systems installations will become interesting for users, they will probably require the permission for connection. Limitation of PV system installed power is 80% of total connection power of building.

Table 11: Communication used

Cyprus	Ethernet for the web connection.
Greece	Ethernet, dedicated VPN server for each installation.
Italy	Wi-Fi or Ethernet for Web portal.
Spain	Wi-Fi.
Portugal	Ethernet for the web connection and monitoring.

Slovenia	Wi-Fi, Ethernet.

Table 12: Available communications among components

Cyprus	RS485, Modbus, CAN bus, Ethernet
Greece	TCP/IP Modbus
Italy	RS485 - Modbus, Ethernet
Spain	RS485
Portugal	RS485 Modbus between consumption, production, Ethernet
Slovenia	In Slovenian pilot all the components have RS 485 protocol, so components can communicate to each other. To the Socomec producer web portal communication currently used is internet connection of additional current and voltage sensors including (Diris) local storage. Data transfer is possible from Socomec server to our server.

Table 13: Data flow

Cyprus	Directly from the online portal (residential); data storage at the manufacturer and daily sent to the FOSS via email (social).
Greece	GridVIs software (made by Janitza company) - communicate with Janitza energy meters and inverters and sends data to GridVIs software (made by Janitza company) - communicate with Janitza energy meters and inverters and sends data to the server PC every night using MySQL database. It visualizes measurements (visualisation dashboard) in real-time (using integrated tool of the GridVis software) including historical data and can be accessed through the public IP. GridVis can export an xls file, which is then imported to Matlab for post processing. Additionally, there is a local memory card, and once per month, data are extracted to a MS Excel (xls) format. These actions are performed by GridVis and their actions are less than a minute for each pilot. Once per month a routine developed in Matlab to create the file which is sent to UCY in its final required format through the server PC every night using MySQL database; it visualizes measurements (visualisation dashboard) in real-time (using integrated tool of the GridVis software) including historical data and can be accessed through the public IP; GridVis enable to export xls file, which is then imported to Matlab for post processing; additionally local memory card; once per month, data are extracted to a MS Excel (xls) format. These actions are performed by GridVis and their actions are less than a minute for each pilot. Once per month a routine developed in Matlab create the file which is sent to UCY in its final required format.

Italy	The home's energy production and consumption are tracked through the web Portal for both the systems adopted (Sonnen and VARTA). Sonnen and VARTA produce batteries and data collection platform. The serial number and password are provided in the Customer Welcome Letter and permits the access to the online platform, which includes the available information and monitoring data. The pilot data per month has been stored for each site (13 xls files that include the data for all the days of a month). A post-processing of data is necessary to obtain the format of data collection decided at the beginning by the StoRES partners. In particular, in the Sonnen systems the time step of the measurements is 5 minutes instead of 15 minutes. Moreover, the monitored parameters are all measured in Watt-hours (Wh), whereas in the data collection the requested type of the data is Watts (W). Regarding the issue of data missing in the mandatory data defined, the battery State of Charge (%SoC) was not provided by the Sonnen platform at the beginning of the project. Since it is a mandatory data defined for the data collection, a discussion with Sonnen assistance started to solve this issue, also trying to find custom-made data collection solution for the pilots. In fact, due to the high number of pilots in Italy (thirteen) and the mandatory values to be calculated every 15 minutes the post processing procedure is very time-consuming. It would be useful to manage the monitoring of different ESS together, most of all in a prospective view of smart grid and microgrid operation. After the beginning of the project Sonnen provided an upgrade, so the SoC can be provided.
Spain	Data are sent via WI-FI to the central web server; software Solarwatt enables access to the web. This software allows to graphically obtain the most important data (battery state of charge, network consumption, battery consumption and self-consumption, percentage of energy saving?); it allows to download in xls format.
Portugal	Online platform Sonnen with 3-minute delay, data exported to a spreadsheet, such as .csv or .xls. Data of the past month, past year and 2 years ago can be exported through the website for several variables: • energy and power discharged, charged, produced by the PV system and consumed; • energy imported and exported from/to the grid; • battery State of Charge (SOC).
Slovenia	Data flow is from Sensors to the Diris local storage and then to the Socomec portal (server). From Socomec server we collect the data.

Table 14: Measurement interval, monitoring, aggregated interval, format

Cyprus	Every second, real time, aggregated in 15 min average values, .csv file.
Greece	15 min average, minimum and maximum values.
Italy	Every 5 minutes; measurements in Watt-hours (Wh) → post processing aggregates data in 15 minutes and Watts (W) to satisfy the established data collection form.
Spain	Every 15 minutes of storing information.
Portugal	Minute-to-minute integration basis, available in an online platform with 3-minute delay.
Slovenia	15-minute interval. Data flow is from the sensors to the local data storage Diris and then to the Socomec server and further to project server in real time, unless there is an interruption in internet connection. In this case all non-transferred data are transferred when the connection is established again.

Table 15: Reasons for missing data

Cyprus	Loss of communication or loss of power among the system components.
Greece	Communication failure, and failure if outage of utility grid occurs, inverter cannot store data (they are lost if not transmitted).
Italy	- Loss of communication in some cases. When communication is recovered, the data are available again thanks to the memory record of the battery. - In the 3-ph system (VARTA) different samples are missed. In that ranges, data are not considered reliable and not monitored.
Spain	Problems with sending data via Wi-Fi to the central web server in some pilots - no updated information.
Portugal	Loss of communication or loss of power among the system components.
Slovenia	Interruption in internet connection.

Table 16: How are missing data solved

Cyprus	"NaN" are replaced by averaging nearby values.
Greece	Identification of missing data, 'NaN' denote that missing cell (using Matlab).
Italy	'NaN' denotes missing data (not monitored or not communicated).
Spain	Identification of missing data, 'NaN' denote that missing cell.
Portugal	Data rebuilt in accordance with the average values for weekdays and weekends in the current month.

Slovenia	In this case all non-transferred data are transferred when the connection is established again.

Table 17: Producer of the platform for data collection

Cyprus	SMA Sunny Portal (residential); Autarsys GmbH (community)
Greece	Janitza company.
Italy	Sonnen and VARTA produce batteries and data collection platform.
Spain	Solarwatt.
Portugal	Developed and managed by the manufacturer of the storage systems. (Sonnen).
Slovenia	We have used existing SolarEdge portal for data collected from SolarEdge devices. These data we had to transfer to desired server.

Table 18: Data post processing

Cyprus	To extract, to sort the parameters in the right order and adjust data to the Data collection template file (residential); no post-processing is needed / subcontractor post process them (community).
Greece	Post processing is performed with GridVis and Matlab in order to obtain a csv file in appropriate form and to identify if data is missing at certain time intervals.
Italy	Post processing is necessary, because the Sonnen systems the time step of the measurements is 5 minutes instead of 15 minutes. Moreover, the monitored parameters are all measured in Watt-hours (Wh), whereas in the data collection the requested type of the data is Watts (W). Data are stored in .csv file.
Spain	Only unit changes in .xls file had to be adjusted.
Portugal	Platform makes it possible to export data in a spreadsheet file (.csv/.xls). Post processing is required to perform economic analysis. Data analysis is performed offline using R scripts and excel. As input, it requires Sonnen’s platform. At the end of each month, an analysis of the previous month is performed manually.
Slovenia	In planned living lab, data in SQL can be automatically converted in the csv format appropriate for the analysis needs.

Table 19: Missing/limited functionalities of data collection system

Cyprus	No missing functionalities, however only one pilot can be observed at the same time; only daily files can be downloaded (e.g. for one week, 7 different files are formed and downloaded).
Greece	No missing functionalities.
Italy	Regarding the issue of data missing in the mandatory data defined, the battery State of Charge (%SoC) is not provided by the Sonnen platform. Since it is a mandatory data defined for the data collection, a discussion with Sonnen assistance started to solve this issue, also trying to find custom-made data collection solution for the pilots. Long post-processing procedure due to high number of pilots.
Spain	No missing functionalities.
Portugal	No data is measured regarding individual loads, only the global installation's consumption in each installation.
Slovenia	No missing functionalities. Sometimes some data are missing, but in negligible share.

Table 20: Indication of useful future improvements; the need for custom-made data collection solution

Cyprus	Monitoring of different pilot residential system at the same time; downloadable should be more than one day at one download.
Greece	Avoidance of missing data: measurements of data at all points of interest (redundancy - calculation check) and additional local data memory.
Italy	It would be useful to manage the monitoring of different ESS together, most of all in a prospective view of smart grid and microgrid operation.
Spain	It would be useful to jointly manage the monitoring of the different ESSs, as well as the possibility of customising the units of measurement and the export of data, including the possibility of new data calculated through the monitored data.
Portugal	Automated data analysis instead of manual.
Slovenia	We could try also with next development possibility – to use Solar Edge API, but it is related to additional costs. Because all users that are neighbours have the sun/biggest production at the same

	time and distribution lines can become overloaded. Additional motivation to use the energy storage is also participation in different models to assure reserve in the power system. Therefore local storage will be a part of the future energy solutions.

Table 21: Indicator if the producer of the platform for data collection is the same as producer of battery inverter

Cyprus	Yes (SMA Sunny Portal (residential); Autarsys GmbH (community).
Greece	No, the GridVIs software is owned by Janitza, while the battery inverters are either Fronius or SMA.
Italy	Yes, Sonnen and VARTA produce batteries and data collection platform.
Spain	Yes, Solarwatt.
Portugal	Yes, Sonnen.
Slovenia	Yes, partially (partially Solaredge, partially own solution).

Table 22: Reasons for unavailable optional data

Cyprus	Hardware and software limitation, too expensive solutions for optional data.
Greece	Mainly lack of available budget to install more metering devices.
Italy	Hardware and software limitations.
Spain	Hardware and software limitations.
Portugal	Hardware and software limitations.
Slovenia	Lack of knowledge of companies on the market for development issues, lack of budget.

Table 23: Modes of battery operation

Cyprus	Increase self-consumption - grid export limitation (residential), time schedule.
Greece	- Maximize self-consumption; - Peak generation shaving according to DSO's specifications; - Timed use of charge and discharge (in predefined intervals - can be predefined by DSO);

Italy	Self-consumption mode (default), back-up mode, time of use mode, microgrid. ESS modes of operation: The installed ESSs have different operating modes: • Self-consumption Mode (Default Mode): Under this setting, the batteries will utilize solar energy to first feed loads and then charge the batteries with the extra energy produced from solar panels. After solar generation has stopped, the battery will supplement the grid in powering loads. • Backup Mode: Under this setting, the battery will maintain a higher state of charge and will only discharge power during a grid outage. • Time of Use Mode: This setting is for residents who have utilities that charge Time of Use rates. Under this setting, you can input which times your utility charges higher tariff rates, and the ESS will begin discharging power if no solar is available to meet the required loads. Thus, the ESS will help you avoid using power during periods with expensive peak tariff rates. • Microgrid (available only in the Sonnen systems): This feature is available in the event of an extended grid failure and there is no solar power available to charge the ESS for multiple days. The Sonnen ESS is designed to preserve the life of its batteries, so once the battery's state of charge, or remaining battery life, drops below 5%, the unit will shut down to conserve power. However, the Sonnen ESS can be programmed to try to restart and search for a grid or solar to create a microgrid. This last operation mode could be very useful in a future where the distribution system will be operated in different microgrids, able to exploit local resources to avoid contingencies and preserve the continuity of service even in case of fault of the main grid.
Spain	Self-composition mode.
Portugal	- Batteries are operating by default, in an automatic mode (maximum self-consumption). - Mode can be changed to manual mode (Time of use) through Sonnen's API - battery can be charged and discharged using commands (automated) and scheduled.
Slovenia	Three modes of operation: self-sufficiency, limited export and time shifting. All modes of operation should be tested, but currently there is a problem with measuring charging and discharging

	energy in the battery so we cannot test clearly self-sufficient mode.

Table 24: Battery with PV commercial practice

Cyprus	No, these pilots are the first and only grid connected battery storage system (BSS).
Greece	No, storage systems are currently prohibited by DSO and Greek regulation authority. StoRES pilots where the first employed in real installations and not laboratory ones.
Italy	Yes, storage systems integrated with PV are now commercially available.
Spain	Yes. There are many integrated PV solutions plus batteries especially for isolated installations.
Portugal	Yes, storage systems integrated with PV are commercially available.
Slovenia	No, in Slovenia is net metering support scheme, which doesn’t require storage system. Storage system with PV is interesting only for the buildings, where the grid is not available.

Table 25: Maintenance, insurance, warranties

Cyprus	Installer is responsible for maintenance, manufacturer for warranty of hardware, pilots are insured.
Greece	Maintenance was included in the installation costs. Ongoing discussions for insurance especially theft, liability toward third parties for damages and hazards against life (100-150 EUR/year).
Italy	Warranty must be provided from manufacturer, installation can be done only by certified installers (procurements for equipment and installation are separated).
Spain	Installer is responsible for maintenance, manufacturer for warranty of hardware, pilots are insured.
Portugal	- Each company has its own maintenance policy. - EDP?? Commercial, as a battery system ECP??, is responsible for maintenance and assistance. - Manufacturers have their own equipment warranty.
Slovenia	The company who installed pilot is also responsible for maintenance, the price is included in the total price of the

	installation. Slovenia also have the insurance of the equipment. The insurance made the owner on his expenses and was 80 euro.

Table 26: Key stakeholders

Cyprus	Stakeholders are companies within the energy sector in Cyprus, mainly in the Renewable and Power Generation industries, associated partners, the local DSO/TSO, the Ministry of Energy, Commerce, Industry and Tourism of Cyprus (MECIT), policy makers, citizens and other interested parties such as organisations, municipalities etc.
Greece	- Stakeholders related to policy making, aiding them to assess whether a scheme creates an attractive investment environment, - stakeholders related to the PV industry, aiding them to identify when certain PV installations with storage can create profits and thus become a business case for them, - potential investors that can quickly assess if investing in storage makes sense financially, - financing institutions that can determine if a proposed solution is financially viable, and - the general public.
Italy	Associated partners, DSO, regulators, policy makers, municipalities (Municipalities Union of Marmilla, Sardinian municipalities), Autonomous Region of Sardinia, prosumers.
Spain	Policy makers, regions and municipalities, Renewable and power generation companies, Consumer Associations, SME, professional associations as architects, engineers and property managers. Energy clusters, business association.
Portugal	Regulators, policy makers, DSO, associated partners, municipalities and companies - technical/market; additionally AREAL and Algarve intermunicipal community and companies (for data analysis and optimization), additionally consumer associations (for social), additionally ESCO companies, banks, Commission for coordination and regional development of Algarve (CCDR), prosumers (financial barriers).
Slovenia	DSO, Ministry for infrastructure, Municipalities, companies, other residential users, producers of EV charging stations because of combination with batteries.

	DSO: they are interested in our optimum solutions; Policy makers (Ministry for infrastructure): they are interested in increasing of the investment in RES; Municipalities: to see if these system can be useful also for public buildings; Companies; to see if these system can be useful to them and as additional offer in PV systems installation or in combined heating system solutions; Other residential users: to see the good practice of the pilot, savings, possibilities; Producers of EV charging stations because of the combination with batteries; Producers of EV (bikes, scooters, other vehicles); Key stakeholders for data analysis are owners and DSOs, energy traders, policy decision makers and companies for installation works.

Table 27: Benefits for key stakeholders

Cyprus	For DSO/TSO - acquisition of technical know-how of battery storage; policy makers - alleviate the barriers to achieve easier and less time consuming process for the utility and end users; for all stakeholders: performance of battery assets, optimum sizing of assets to maximize the performance/self-consumption and minimize costs.
Greece	- Use of BSS can potentially mitigate overvoltage during high production periods (beneficial for DSO), but this should be tested. - Increase of prosumers self-consumption rate considerably. - Data analysis can be beneficial for DSO, financial and PV industry stakeholders.
Italy	Addressing social barriers: Informative events and demonstration, dissemination about BSS: for Municipalities Union of Marmilla, Sardinian municipalities, Autonomous Region of Sardinia.
Spain	It is very important to take advantage of the synergies between the different stakeholders; in the case of policy makers it is important to facilitate the legislation. As for the professional coelgios lso are important to raise awareness and inform this technology to the end users. Public administrations are important as impellers of these activities.
Portugal	Respond to the problem of the gap between production and consumption hours. Importing and exporting energy on the grid is limited by DSO connection power that is settled individually in each installation.

Slovenia	For policy makers: they are interested in increasing of the investment in RES. For municipalities: to see if these systems can be useful also for public buildings. For companies: to see if these system can be usefull to them and and as additional offer in PV systems installation or in combined heating system solutions.

Table 28: Self-consumption

Cyprus	System (3 kWp PV, 2,5 kW/9,3 kWh BSS) increases self-consumption by approximately 50%. From 45% to 95% on the whole period.
Greece	On average there has been an increase in the SCR of all pilot of 13,2% (June-Febr) from 51 to 68%.
Italy	From 28 to 63% on the whole year
Spain	Increases self-consumption from 54 to 82%.
Portugal	Pilot 1: (System 1,5 kWp PV, 2.0 kWh BSS) increases self-consumption by 30%. Direct consumption represents 20% and BBS represents 10%. Pilot 2: (System 1,5 kWp PV, 2.0 kWh BSS) increases self-consumption by 41%. Direct consumption represents 33% and BBS represents 8%. Pilot 3: (System 1,0 kWp PV, 2.0 kWh BSS) increases self-consumption by 19%. Direct consumption represents 16% and BBS represents 3%. Pilot 4: (System 1,5 kWp PV, 2.0 kWh BSS) increases self-consumption by 30%. Direct consumption represents 25% and BBS represents 5%. Pilot 5: (System 1,5 kWp PV, 2.0 kWh BSS) increases self-consumption by 26%. Direct consumption represents 20% and BBS represents 6%. Average self consumption is increased from 66% to 95%.
Slovenia	Self-consumption is increased from 46% to 69%

Table 29: Self-sufficiency

Cyprus	System (3 kWp PV, 2,5 kW/9,3 kWh BSS) increases self-consumption by approximately 20-30%. From 25% to 49% in average for whole year and all sites.

Greece	On average there has been an increase in the SSR of all pilot of 16,37% (June-Febr) (from 28% to 37%).
Italy	From 33% to 64%
Spain	from 47% to 70%
Portugal	from 22 to 27%
Slovenia	From 21 to 28%

Table 30: Current support schemes

Cyprus	Net metering.
Greece	A type of partial net-metering that incentivize the increase of self-consumption (thus there is a business case for storage systems).
Italy	Net metering.
Spain	Regulation in change.
Portugal	The system is not classical net metering. The systems installed operate in a self-consumption mode. It has a bidirectional meter that measures the energy that is consumed directly from the network, but also the surplus of energy production that is injected into the public network. In this case, the surplus injected into the public network is paid currently about 4 cents per kWh. (ie 90% of the spot market price of electricity).
Slovenia	Net metering.

Table 31: Social barriers

Cyprus	Availability of owners’ time and space for carrying out the installation; UCY and DSO together persuaded household owners to participate in the project with BSS installation.
Greece	Social barriers are connected to other barriers and cannot be separated; lack of trust to PV technology in general due to certain policy and decisions in the past; hesitation of prosumers to include storage in their existing PV system due to lack of proper information about safety issues, space requirements and financial issues; in FIT scheme the profit was high so, the owners have still expectations about similarly high profits and therefore do not accept BSS.
Italy	Lack of information about storage systems.

Spain	Lack of information about storage systems.
Portugal	Lack of information regarding possibilities and advantages, performance standards.
Slovenia	- Low interest of residential buildings users to respond to the public call. - Next social barrier is that among general public batteries are not recognized as beneficial solution, especially with the combination with existing net metering scheme. - People are sceptical about the life span of such expensive batteries. The solution which has to be developed and presented to them to overcome this barrier is that the battery providers would have to set the guarantee to maintain the battery capacity for certain acceptable time period.

Table 32: Attitudes of residential households owners

Cyprus	Owners are convinced about the advantages of BSS but as prosumers are not willing to integrate BSS to their households unless they can achieve substantial financial savings.
Greece	Hesitation of prosumers to include storage in their existing PV system due to lack of proper information about safety issues, space requirements and financial issues.
Italy	Owners are confident about the benefits of storage systems, but it is yet too expensive the use of this technology without a proper financial support scheme.
Spain	All owners are convinced about the benefits of BSS.
Portugal	The residential households are convinced of the potential of using BSS, but the price remains a big barrier.
Slovenia	Owner is oriented towards the development and very open for innovations.

Table 33: Attitudes of grid owner

Cyprus	DSO actively participated and was fully aware of benefits.
Greece	DSO is an associated partner to the project and has been collaborating from the beginning to the pilot installations. Generally, the DSO is sceptical for BSS as they consider it as an additional power source. However, the DSO also acknowledges that the widespread of BSS is unavoidable and this is mainly why they

	participate in the project in order to gain knowledge from practical pilot installations
Italy	DSO is interested in the evolution of the project and distributed storage, and starts experiment with centralized ESS solutions.
Spain	Bad attitude. The legalization of the facilities is complicated by its cause.
Portugal	There is an initiative by the DSO to explore and find the most viable solutions.
Slovenia	Grid owner wants to be sure, that BSS is the right technology and then is going to support it. It is also open for different pilot projects.

Table 34: Social impacts

Cyprus	Research and environmental impacts.
Greece	Raise awareness in market, policy and utilities stakeholders as well as the public. Positive research and environmental impacts. Prosumers can now install storage alongside PVs.
Italy	Climate challenges, prosumers aim at near-zero energy target.
Spain	Research and environmental impacts.
Portugal	Address climate challenges.
Slovenia	Pilot project is raising awareness among the stakeholders and supports the research. BSS increases the energy self-sufficiency.

Table 35: Educational impacts

Cyprus	Promoting the achievement of behavioural changes; raising citizens' awareness what BSS can provide on grid and residential level and about potential financial benefits; training of participants about the benefits of their self-consumption increase.
Greece	Demonstrations of what a BSS can achieve; Education/information may overcome different barriers and increase the number of PV and storage.
Italy	Informative events, demonstration of potential benefits.
Spain	Articles in magazines, interventions in conferences, educational events.

Portugal	Promoting peer to peer meetings and other meetings to inform and clarify the owners of the pilot installations.
Slovenia	Transfer of experiences on BSS to educational process at the University and increasing the level of knowledge about energy storage among the stakeholders.

6.3 Policy barriers

Table 36: Policy barriers

Cyprus	Lack of adequate policies regarding BSS; not clear who invests. Prevailing tariffs do not support investments in storage for domestic prosumers even there is clear need for dynamic pricing; no incentives to invest in storage.
Greece	- BSS is currently prohibited by Greek DSO; - The current scheme (partial net-metering) do not favour storage systems alongside PVs. It is generally more profitable not to install storage at all. - The scheme can be adapted by small tweaks to make investments with storage more profitable instead of without storage. - Otherwise, direct incentives for those wanting to install storage systems should be available, either in the form of small grants, or as tax exemptions.
Italy	- Lack of proper policies, new policies under discussion.
Spain	- Installations of more than 10 kW have a special legalization procedure that takes longer time (weeks, months) and may in the future force the owner to pay additional fees to access electricity grid - important barrier.
Portugal	- Outdated regulatory and legal framework. - No appropriate EU regulation.
Slovenia	- Absence of support scheme for storage system, which would enable more users to decide for the battery installation.

6.4 Financial barriers

Table 37: Financial barriers

Cyprus	- Non-subsidized commercial installations have very long pay-back period (up to 15 years). - Net metering without storage is the most economical option currently leading to payback period of less than 6 years. - Net billing scheme would provide annual additional saving of only about 61 EUR, which does not pay back the investment of BSS. - Subsidies for BSS have to be provided. - Optimal sizing of BSS is crucial to harvest maximum benefits at minimum costs (Future policies should identify the right combination for tariff system that is cost efficiency vs. line congestion, quality of supply in harmonic content, voltage profile etc.)
Greece	- Just 2 years of maintenance in included and for additional period payment will be required. - Also other unexpected expenses may occur. - BSS investments costs are still considerably high - not profitable. - No concrete incentives for BSS, although the current scheme favours increased self-consumption.
Italy	- High market price compared to estimated savings. Incentives are necessary. - Budget may be enough to satisfy but it's unknown.
Spain	- It is necessary to activate financing solutions.
Portugal	- Initial investment. - Reinvestment in much shorter time than the rest of the system. - Uncertainty of the O&M costs and battery life time .
Slovenia	- Expensive storage systems and currently the residential houses owners currently do not really need them unless they would like to have backup system. - Financial barrier is connected with the policy barrier not providing the support scheme for storage. - Next barrier was the price of the battery, because the interest of owners was to increase the rate of energy self-sufficiency if possible up to 100 %.

6.5 Lessons learnt

Table 38: Lessons learnt

Cyprus	- The optimal balance between socialised and private storage behind the meter has been observed and future installations can benefit from it. - As storage behind the meter is not rewarded with the current tariff schemes, it requires a cost reflective assessment of the services it offers through aggregated solutions for system use. - Quality of supply and increase in self-consumption with their corresponding benefits favour the installation of storage systems. - Stakeholders and policy makers can pave the way for new energy schemes and regulations. - Policy adoption (grid rules, market rules, regulation etc.) is necessary. - Guidelines for policy makers include the promotion of smart metering, the promotion of time-varying pricing, the promotion of smart homes and the promotion of awareness that can lead to effective consumer engagement through education. - Finally, lowering the cost of storage systems is key and hence, subsidies can be provided to benefit both the utility and the user.
Greece	- Regulation authorities and public authorities should develop specific incentive schemes for BSS to boost them. - Post processing actions that are required for the treatment of missing measurement data. - To avoid missing data, measurements at all points of interest are advised (redundancy). - Measuring device with local data memory is strongly advised.
Italy	- Importance of the modularity of the batteries e.g. with capacity of 2 kWh to reach the suitable capacity (4-6-8kWh) is appropriate if data about consumption profile is not available or we are not sure about it. - It would be useful to manage the monitoring of different ESS together, most of all in a prospective view of smart grid and microgrid operation. - ESS allows prosumers access to innovative business model due to the contract between Sonnen and one of Italian energy utilities: prosumers can switch to new utility partner (with proper agreement) avoiding all of taxes and system costs normally charged in the energy bill.
Spain	- The selection of the type of battery and its technology has been in accordance with the inverter and this has guaranteed the absence of problems.

	- Cooperation between installer and end user is important.
Portugal	- A correct selection of the EPC subcontractor is a key aspect for a successful operation of the installation. The EPC subcontractor must have the knowledge to perform a primary service in order to perform an adequate assessment to match the PV system production and the consumption profile. - Data analysis that takes an hour can be faster with automated steps. - Development of scheme and business model for financial support of BSS is needed.
Slovenia	- Lessons learnt is that in the future also development part should be separately financially evaluated in such projects. - The lessons learned was that we always have to take into account additional adjustments and development if the equipment is not from the same producer. - Lessons learnt is that even if the equipment is from the same producer it is not necessary it will assure all the functionalities. - The lesson that we learned was that the equipment has to be insured. - Diris is also data logger for local/redundant data storage for 3 months for default operation and up to 63 harmonic components for reduced time of storage. - Good practice is the living lab concept with joint platform with SQL database, which automatically collects bigger amounts of data and connect different devices and existing platforms. But on the other hand it needs some knowledge about databases. - Minimizing necessary energy storage with the combination of DSM and other power network services.

7. Findings and recommendations

Lessons learnt can be summarized as follows:

1. Non-subsidized BSS installations have longer pay-back periods.
    a. With the prices of storage still relatively high, a PV system without storage is more profitable to an investor under most circumstances in the studied MED countries.
    b. The profitability of a PV+storage system depends upon several parameters and, hence, requires careful planning. The parameters include a) consumption profile, b) electricity costs, c) existing policy/scheme, d) solar irradiance and temperature profile of the installation location, e) technical related data of PV and storage. The

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

2. Besides the initial investment expenses also reinvestment expenses in BSS are expected to come in much shorter time than for PV components.
3. Optimum sizing of BSS is crucial to harvest maximum benefits at minimum costs.
    a. With optimum balance between community and final user's BSS.
    b. With aggregated solutions for power system use.
    c. With time-varying pricing.
    d. With the combination of demand site management/using other user's flexibility.
4. BSS increases self-consumption and reduces interaction with power network.
    a. Exception: The inclusion of storage systems should not be considered in cases where the load consumption is very high compared to PV installed capacity. In that case, the storage system will rarely be charged by the PV excess energy and this will lead to either its fast degradation, or to charging from the grid for maintenance reasons (keep SoC within operational limits).
5. Due to some existing full net-metering schemes in the MED region, owners of residential houses have no financial inventive to install a BSS unless they would like to have backup system.
    a. The distribution system operators in MED region should adapt their regulations in order to facilitate the widespread of PV+storage hybrid systems as soon as possible. Clear guidelines should be given to prospective investors in concise and simple way.
6. Stakeholders and policy makers can pave the way for new incentive schemes, simplifications (reducing costs), business models (bringing additional revenues for BSS users) and regulations that enable both.
    a. Currently the MED countries do not have policies that favor the installation of storage alongside PV systems. Even in the cases where higher self-consumption is encouraged (e.g. the Net-Billing of Cyprus or the partial Net-Metering scheme in Greece), the resulting incentive is not adequate to make a hybrid PV and storage system more profitable (with the current storage system prices).
    b. Policy makers that want to encourage the use of storage systems alongside PV's, 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 may be enough to achieve that.
7. Lowering the cost of storage systems and incentives for the utility and the user are key factors.
8. Measuring devices with local data memory is strongly advised in order to reduce the risk of missing data. Data redundancy can be achieved also with four energy measurement points: at the connection to the grid

(bidirectional), to the battery (bidirectional), to the PV system and to the consumers. If one of the measurements is missing it can be calculated from the remaining ones from the energy balance.

9. Importance of the modularity of the batteries e.g. with capacity of 2 kWh to reach the suitable capacity (e.g. 4-6-8 kWh) is appropriate, if data about prosumer consumption profile is not available or we are not sure about it. This is one of the measures how to keep the BSS costs lowest possible.
10. Inverter and web portal collecting data are usually by the same producer, but the software lacks some functionalities needed for complete insight into the necessary indicators that investor/owner, energy manager or final user can change the behaviour to be oriented in future improvements of energy efficiency.
11. Improvements of data collection software is generally needed.
    a. With monitoring different BSS together.
    b. Automated data adjustments/post processing according to the final needs.
    c. Access to data, data postprocessing, data download and visualization should be more flexible.
    d. Some obligatory data in Stores are not accessible through commercial platform (e.g. state of charge in case of Italy)
    e. Additional customized ICT services are required.
    f. Interruptions in internet connection should be mitigated.
12. If the users build the system modularly, it is possible that equipment is not from the same producer, which cause potential incompatibilities and partial functionalities and additional ICT services are required.
13. It is strongly advised to insure the BSS equipment.
14. Technical issues regarding the batteries technology and the overall system architecture should be carefully decided.
    a. Lead-acid batteries may be economically preferable than Lithium-ion ones, but one should consider that they exploit a lower level of their nominal capacity (lower usable kWh/nominal kWh rate) and they present higher self-discharge rates.
    b. The choice of AC-coupled systems is the most preferable one for existing PV installations, since it can be sized independently and with more technical available choices.
    c. The choice of DC-coupled systems may be preferable for new systems, as the cost is kept low compared to AC-coupled ones, while losses may be limited.
15. BSS have positive social impacts in supporting research activities and environment through supporting renewable energy sources support.
16. Education of all stakeholders, informative events, dissemination and demonstration projects are a crucial part for paving the way towards BSS.
    a. DSOs/grid owners were already aware of benefits.
    b. Because of the lack of profit in these technologies prosumers hesitated in implementation of BSS although it was fully financed.

c. Prosumers are sceptical about the batteries life-span.
d. Self-consumption and self-sufficiency rates are increasing.
e. Difference between needed energy and power in BSS.
f. In Stores BSS operate in the one or several of the following modes of operation: (1) maximum self-consumption/limited export, (2) backup mode, (3) time of use mode, (4) dynamic operation as a part of microgrid
g. Some parameters (in Stores optional) cannot be monitored in existing commercial platforms due to hardware and software limitations.

17. Stores is beneficial for key stakeholders.
    a. DSO/TSO get technical know-how. BSS can mitigate overvoltages during high production periods. Due to the potential congestions DSO will limit export/import energy.
    b. Policy makers get the information about the political barriers and time consuming processes.
    c. All stakeholders get operating performance of BSS through data analysis. This should be upgraded with living lab.

Table 39: Key stakeholders

Cyprus	Stakeholders are companies within the energy sector in Cyprus, mainly in the Renewable and Power Generation industries, associated partners, the local DSO/TSO, the Ministry of Energy, Commerce, Industry and Tourism of Cyprus (MECIT), policy makers, citizens and other interested parties such as organisations, municipalities etc.
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