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interstore

D5.1 - Report on planning of demonstration actions across the pilot sites

WP 5 – Pilots Demonstration

T 5.1 – Development of shared testing approach and data management plan

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Information

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06-02-2024	0.4	Marcantonio La Franca (ENG) / Ferdinando Bosco (ENG)	3.2.3 Added Detailed paragraph for each KPIs
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ABBREVIATIONS AND ACRONYMS

DER	Distributed Energy Resource
DES	Distributed Energy Storage
DSO	Distribution System Operator
EMS	Energy Management System
HESS	Hybrid Energy Storage System
ICT	Information and Communications Technologies
IEEE	Institute of Electrical and Electronics Engineers
LPC	Legacy Protocol Converter
TSO	Transmission System Operator
WP	Work Package
KPI	Key Performance Indicator
DS	Data Space
UC	Use Case
SMTP	Simple Mail Transfer Protocol
ENX	Enel X
FZJ	Forschungszentrum Jülich
CYG	CyberGrid
HES	HESStec
CAP	CapWatt
BSP	Balancing Service Provider
EV	Electric Vehicle
VPP	Virtual Power Plant
DR	Demand Response
RES	Renewable Energy Sources
BESS	Battery Energy Storage System
DG	Distributed Generation
NATS	Neural Autonomic Transport System
HMS	Home Management Systems
HIL	Hardware In the Loop
LEED	Leadership in Energy and Environmental Design
HLUC	High Level Use Case
SOF	State of the Function
MQTT	Message Queuing Telemetry Transport
TCP/IP	Transmission Control Protocol and Internet Protocol
API	Application Programming Interface

CHP	Combined heat and power (CHP)

Table Of Contents

1 Executive Summary

This comprehensive document offers an exhaustive exploration of the process involved in planning, analyzing, and executing demonstration actions across a spectrum of pilot sites. It starts by conducting a thorough examination of relevant use cases, meticulously identifying key performance indicators (KPIs), and developing robust methodologies for target setting and estimation. By laying this foundational groundwork, the document ensures a strategic alignment with the overarching objectives of the project, thus setting a solid trajectory for subsequent actions.

As the document progresses, it delves deeper into the intricacies of data management, emphasizing the creation of datasets and the selection of requisite tools for effective data collection. This phase underscores the critical importance of meticulous data handling practices, ensuring accuracy, reliability, and relevance in the gathered information. Moreover, it emphasizes the vital task of aligning the acquired results and KPIs with the specific objectives of the project, thereby maximizing their utility in driving informed decision-making and impactful actions.

Subsequently, the document transitions its focus to strategic planning, meticulously outlining the steps taken to ensure successful implementation and optimize outcomes across all pilot sites. This includes a comprehensive analysis of contextual factors, resource allocation plans, and risk mitigation measures. By adopting a systematic approach to strategic planning, the document aims to streamline processes, mitigate potential challenges, and enhance the likelihood of achieving desired outcomes.

Finally, in its concluding section, the document synthesizes overarching insights and reflections derived from the planning, analysis, and execution phases. Drawing upon lessons learned and best practices identified throughout the process, it offers actionable strategies and recommendations for driving impactful change and fostering innovation across diverse contexts.

2 Introduction

In the dynamic realm of energy innovation and sustainability, the meticulous planning and execution of demonstration actions stand as crucial steps for validating and advancing transformative initiatives. This report delves into the strategic planning processes applied across diverse pilot sites within the energy domain, with a specific emphasis on Key Performance Indicators (KPIs). These pilot sites act as dynamic testing grounds, offering insights into the efficacy and impact of the project designed to address evolving challenges in the energy sector.

This exploration will meticulously dissect the intricacies of the planning phase, shedding light on the methodologies, considerations, and collaborative efforts dedicated to ensuring the seamless implementation of demonstration actions. The selected pilot sites serve as microcosms, capturing the spectrum of energy-related challenges and opportunities, and serving as real-world benchmarks for evaluating performance through identified KPIs.

As we progress through this exploration, it is crucial to recognize the interconnected nature of local and global energy challenges and underscore the importance of cooperative and sustainable solutions. Subsequent sections will illuminate the strategic frameworks, and adaptive approaches employed in planning demonstration actions, focusing particularly on the establishment and evaluation of Key Performance Indicators. This emphasis aims to underscore the critical role KPIs play in measuring success and guiding the trajectory of transformative initiatives toward a more resilient and sustainable energy future.

2.1 Purpose and Scope of the document

The purpose of this document is to comprehensively outline the planning of demonstration actions across the various pilot sites. This report aims to provide a clear and detailed overview of the strategic approach taken in organizing and executing the demonstration activities. It will delve into the scope of the planning efforts, elucidating the methodologies employed, key considerations, and the collaborative initiatives undertaken across relevant participants. The document further intends to establish a robust framework that not only facilitates seamless execution but also aligns with the overarching objectives of the project. By elucidating the strategic planning process, this report serves as a vital reference for partners involved in the pilot demonstration phase, fostering a shared understanding of the methodologies, timelines, and objectives set forth for successful implementation across diverse pilot sites.

2.2 Task 5.1

In this task, we will outline a collaborative testing strategy and data management strategy closely developed with WP1 and WP3. The aim of this deliverable is to guarantee that the pilot setups are configured to maximize integration potential. We will assess specified use cases, analyze how software tools and products will integrate into site-specific pilots by examining the necessary interfaces. Additionally, we will verify that the results gathered from various sites can be harmonized effectively to evaluate project objectives through the designated Key Performance Indicators (KPIs). This task is in relation with T5.2, T5.3, T5.4, T5.5 and will establish the foundation for executing the pilot demonstration actions and serve as the groundwork for the evaluation phase outlined in T5.6.

2.3 Outline of the deliverable

Chapter 3 of the document focus on Analysis of Use Cases and definition of KPIs, with target and estimation methodology.

Chapter 4 analyses and describe template for Dataset, identifying Supporting Tools for data collection. Also report about harmonization of the results and KPIs with the project objectives.

Chapter 5 focus on pilots planning, with a specific detailed section for each pilot.

Finally, Chapter 6 concludes this document.

3 Analysis of Use Cases and definition of KPIs

3.1 Introduction

This chapter delves into the comprehensive analysis of the outcomes derived from Work Package 1 (WP1), which focused on elucidating and detailing the essential elements of the project, including requirements, use cases, scenarios, specifications, and Key Performance Indicators (KPIs). The insights gathered in this phase lay the groundwork for subsequent project development and implementation.

3.1.1 Use Cases and Scenarios

Use cases and scenarios play a pivotal role in understanding how end-users interact with the project's intended functionalities. This section analyzes the identified use cases and scenarios, shedding light on user behaviors, potential challenges, and opportunities. The insights garnered here inform user-centered design principles and contribute to the development of a user-friendly and effective solution.

3.1.2 Key Performance Indicators (KPIs) Evaluation

Key Performance Indicators (KPIs) provide measurable benchmarks for project success. This section assesses the identified KPIs, examining their relevance, measurability, and alignment with project objectives. An effective set of KPIs ensures that project progress and outcomes can be systematically tracked, allowing for informed decision-making and continuous improvement.

3.2 Definition of methodology for KPIs calculation

This paragraph reports the analysis process that was conducted within task T5.1 regarding the KPI calculation methodology and their association with the expected use cases and project objectives.

3.2.1 Use cases

For simplicity we include below the list of use cases with the classes of project objectives, as identified and associated within the work carried out in WP1.

Table 1: Use Case Matrix with contributions to main objectives

UC #	Use Case name	HESS performance	Monetisation	Connected Data Spaces	Flexibility/ Consumer engagement	IEEE2030.5	2nd Life Batteries	EV Battery support
1	DES Flexibility Market Monetisation	x	x	x	x	x		
2	Energy community DES utilisation	x	x	x	x	x		
3	Grid supporting BESS	x		x		x		
4	Innovative Frequency services	x				x		
5	Hybrid floating storage flexibility monitoring	x			x	x	x	
6	Management of battery systems for Node capacity increase				x			x
7	Adaptive BESS management for autonomous grid operation	x		x	x	x		
8	Multiphysics flexibility Optimization for Home Management Systems and their global integration	x		x	x			
9	Management of EV charging clusters as HESS			x		x		x

3.2.2 KPIs Table

The KPI analysis was conducted starting from the results obtained in Work Package 1, especially focusing on the outcomes outlined in document D1.2. From there the KPIs and their association with the use cases were extracted.

The objective that we set ourselves with the partners was to start from the table of KPIs defined in D1.2 and obtain a single list of consolidated KPIs that could be suitable for all the pilots of the project. The table of KPIs defined in D1.2 was taken up and each KPI analyzed together with the partners in bilateral meetings.

Then for each KPI the following steps were taken:

- Clarification of the definition between partners
- Uniqueness evaluation: similar KPIs have been merged
- Definition, update or clarification of the calculation methodology
- Evaluation and revision of the target

Furthermore, some KPIs have been set as optional, as they are not applicable to some use cases. All decisions have always been evaluated and shared during the progress meetings of task T5.1.

The following table shows the complete set of KPIs with their name, description, association with use cases and optional flag.

Table 2: KPIs identified for target cpm use cases and calculation methodology.

KPI #	KPI Name	KPI description	Use Cases	Optional (If not used, a detailed reason will be provided for each use case)
1	DES multi-service support	Number of grid supporting service (DR, voltage, reactive etc.), provided by a specific DES.	1	
2	DES multi-service market participation	Number of possible balancing and power exchange markets (e.g. aFRR, mFRR, intra-day) on which specific DES can participate.	1	
3	Battery capacity	Amount of Flexibility provision in the demos from HESS	All	
4	Diversity of DER	Number of different DER devices successfully tested and demonstrated	All	
5	Asset management monitored by EMS	Number of assets monitored by the EMS solutions	All	
6	Number of assets aggregated	Number of assets integrated with the Aggregation platform presenting the basis for market participation	2	
7	Number of end users involved in HESS	N° of end users (workers, EV users, consumers) engaged in the demonstration of interoperable HESS	All except (UC1, UC2, UC4 and UC7)	

KPI #	KPI Name	KPI description	Use Cases	Optional (If not used, a detailed reason will be provided for each use case)
8	Demand Response cost	This KPI evaluates the connection cost per kWh of demand response flexibility.	2	X
9	Time savings	Time saved for end customers integrating DER	3	
10	Number of DER assets and EMS tested with IEEE2030.5	Number of different DER devices and EMS successfully tested with the IEEE2030.5 and demonstrated in real-life pilots	All except UC4.	
11	Data space digitized assets	Amount of digitized storage systems/platforms/hubs assets integrated in the common data space exchanging data	1, 2, 3, 5, 7, 8, 9	X
12	Time data savings	The time saved regarding the availability of measured data used for real time operation of the HESS.	4, 7	
13	Monitoring	N° of assets monitored in GridLab for the project	4, 7	
14	Time response	is considered as the overall HESS system time response which will be needed for providing the service complying TSO grid codes.	4, 7	
15	System NADIR	indicator that corresponds to the lowest frequency value during frequency regulation services	4, 7	
16	System ROCOF	Indicator which results during the first instants after the time of occurrence of an event during fast services	4, 7	
17	Data Valorisation cases	Number of cases developed with data valorisation (assess longevity, maintenance, pay-back, ROI,...)	3, 5, 8 and 9	X
18	HESS performance	Difference of cost reduction and/or lifetime extension (decrease in degradation) and emissions of energy supply from HESS when compared to a single battery	5	
19	Data Spaces	Nbr. Of shared services/files subscribed and published	3, 5, 8 and 9	
20	User Engagement	Improved acceptance and perception by end users (surveys at start and end of demo)	6	
21	Demand Response	Amount of flexibility provided (measured in kWh). Amount of KWh resulting from shift from baseline (forecast consumption)	6	
22	Node power increase time	Time (in minutes) in which the power demand was higher than the upstream capacity, by using the battery support for that increase.	6	

KPI #	KPI Name	KPI description	Use Cases	Optional (If not used, a detailed reason will be provided for each use case)
23	Node power increase percentage	Maximum percentage of Power surpassing the installation's capacity due to the use of the battery to charge the EVs	6	
24	User participation	Percentage of users (being monitored) actively following the DR inventive. Actively meaning that they follow the incentive (deviate from past behaviour) on the majority of days during the demonstration	6	
25	Integrated capacity	Integrated power of the HESS within the project demos	to be added to all UCs	
26	Increase of flexibility	Demand side flexibility potential increase due to hybridization implementation	to be added to all UCs	
27	Energy Volume exchanged	Energy volume Exchange (in kWh) between different assets within Enel X test plant	9	
28	Different hybridization configuration	Hybridization scenarios with 2 or more different assets	9	
29	Grid peak avoidance	Percentage of reduction of grid peak power due to flexibility activation	9	

3.2.3 Detailed analysis of KPIs and Methodology

Below are the details of each KPI in the previous table. For each one, detailed information and the calculation methodology (divided into steps) are reported.

3.2.3.1 KPI_1 - DES multi-service support

BASIC KPI INFORMATION			
KPI Name	DES multi-service support	**KPI ID**	KPI_1
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CyberGrid*		
KPI Description	Number of grid supporting service (DR, voltage, reactive etc.), provided by a specific DES.		
KPI Formula	Count		
Unit of measurement	Number		
Target / Thresholds	1		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Count number of different grid supporting services		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 1]	**Step**	**Responsible**
KPI_1_STEP_1	Find all different grid supporting services in Austria on which generated energy will be offered	Nikolaj Candellari & Peter Nemcek
KPI_1_STEP_2	Mark which services were actually provided among the offered	Nikolaj Candellari & Peter Nemcek
KPI_1_STEP_3	Count the provided services	Nikolaj Candellari & Peter Nemcek
KPI_1_STEP_3	Upload information in ZENODO and share it with FZJ for T5.6	Nikolaj Candellari & Peter Nemcek
KPI_1_STEP_4	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.2 KPI_2 - DES multi-service market participation

BASIC KPI INFORMATION			
KPI Name	DES multi-service market participation	**KPI ID**	KPI_2
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CyberGrid*		
KPI Description	Number of possible balancing and power exchange markets (e.g. aFRR, mFRR, intra-day) on which specific DES can participate		
KPI Formula	Count		
Unit of measurement	Number		
Target / Thresholds	1		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Direct metric (of number of platforms where the service can be placed)		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 2]	**Step**	**Responsible**
KPI_2_STEP_1	Find all different markets and platforms in Austria on which we will participate	Nikolaj Candellari & Peter Nemcek
KPI_2_STEP_2	Count number of markets	Nikolaj Candellari & Peter Nemcek
KPI_2_STEP_3	Upload information in ZENODO and share it with FZJ for T5.6	Nikolaj Candellari & Peter Nemcek
KPI_2_STEP_4	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.3 KPI_3 - Battery capacity

BASIC KPI INFORMATION			
KPI Name	Battery capacity	**KPI ID**	KPI_3
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All*		
KPI Description	Amount of Flexibility provision in the demos from HESS		
KPI Formula	Sum of nominal capacity		
Unit of measurement	Capacity/Energy		
Target / Thresholds	>0.2 MWh		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Overall sum of the nominal capacity, in MWh, of all integrated storage assets.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 3]	**Step**	**Responsible**
KPI_3_STEP_1	Recognise all storage systems participating in the project	All pilot responsible
KPI_3_STEP_2	Summarise the nominal capacities in MWh within the pilot	All pilot responsible
KPI_3_STEP_3	Upload information in ZENODO and with FZJ for T5.6	All pilot responsible
KPI_3_STEP_4	Summarise the nominal capacities in MWh	T5.6 (FZJ lead)

3.2.3.4 KPI_4 - Diversity of DER

BASIC KPI INFORMATION			
KPI Name	Diversity of DER	**KPI ID**	KPI_4
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All*		
KPI Description	Number of different DER devices successfully tested and demonstrated		
KPI Formula	Sum of number of DER TESTED and CONTROLLED.		
Unit of measurement	Count		
Target / Thresholds	>25		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Number of different DER devices (assets like inverters, EMS and the like) successfully tested and demonstrated Each integration counts individually. Thus, in case of systems with multiple inverters integrated individually, each inverter is counted individually. In case of inverters requiring multiple integrations (e.g., one for reading data and one to control the asset) each integration is counted individually. DER tested and controlled count as 1. DER tested but not controlled count as 0.5. Since here also the integrations not based on IEEE2030.5 are counted: Value_KPI4>=Value_KPI10 (KPI_10 - Nbr of DER as-sets and EMS tested with IEEE2030.5)		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 4]	**Step**	**Responsible**
KPI_4_STEP_1	Recognise and list all the assets and devices participating in InterSTORE	All pilot owners
KPI_4_STEP_2	Create categories of different asset types and specify the definitions for an asset to be included in	FZJ
KPI_4_STEP_3	Group all listed devices and assets in categories based on their definition	All pilot owners
KPI_4_STEP_4	Upload information in ZENODO and with FZJ for T5.6	All pilot responsible
KPI_4_STEP_5	Count number of different assets in the categories used in the project	T5.6 (FZJ lead)

3.2.3.5 KPI_5 - Asset management monitored by EMS

BASIC KPI INFORMATION			
KPI Name	Asset management monitored by EMS	**KPI ID**	KPI_5
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All*		
KPI Description	Number of assets monitored by the EMS solutions		
KPI Formula	Sum of number of DER MONITORED (some could be not tested) Each integration counts individually. Thus, in case of systems with multiple inverters integrated individually, each inverter is counted individually. In the case of inverters requiring multiple integrations (e.g., one for reading data and one to control the asset) each integration is counted individually.		
Unit of measurement	Count		
Target / Thresholds	50		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Number of assets monitored by the InterSTORE EMS solutions		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 5]	**Step**	**Responsible**
KPI_5_STEP_1	Recognise and list all the assets and devices monitored in the InterSTORE UCs	All pilot owners
KPI_5_STEP_2	Count number of assets monitored in the InterSTORE UCs	All pilot owners
KPI_5_STEP_3	Upload information in ZENODO and with FZJ for T5.6	All pilot responsible
KPI_5_STEP_4	Count total number of assets monitored in the project	T5.6 (FZJ lead)

3.2.3.6 KPI_6 - Number of assets aggregated

BASIC KPI INFORMATION			
KPI Name	Number of assets aggregated	**KPI ID**	KPI_6
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CyberGrid*		
KPI Description	Number of assets integrated with the Aggregation platform presenting the basis for market participation		
KPI Formula	Count		
Unit of measurement	Number		
Target / Thresholds	20		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Direct metric (sum of the number of assets successfully integrated in EMS)		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 6]	**Step**	**Responsible**
KPI_6_STEP_1	Connect assets to aggregation platform	Nikolaj Candellari & Peter Nemcek
KPI_6_STEP_2	Count number of assets connected, monitored and controlled by aggregation platform	Nikolaj Candellari & Peter Nemcek
KPI_6_STEP_3	Upload information in ZENODO and with FZJ for T5.6	Nikolaj Candellari & Peter Nemcek
KPI_6_STEP_4	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.7 KPI_7 - N° of end users involved in HES

BASIC KPI INFORMATION			
KPI Name	Number of end users involved in HESS	**KPI ID**	KPI_7
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All* except UC1, UC2, UC4, UC7.		
KPI Description	Number of end users (workers, EV users, consumers) engaged in the demonstration of interoperable HESS		
KPI Formula	Sum of number of end users engaged in the pilots. End users are: workers, EV users, consumers, system operators, assets operator, assets owners.		
Unit of measurement	Count		
Target / Thresholds	>20		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Number of end users engaged in InterSTORE		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 7]	**Step**	**Responsible**
KPI_7_STEP_1	Recognise and list all the possible users engaged in the InterSTORE UCs	All pilot owners
KPI_7_STEP_2	Count number of users engaged in the InterSTORE UCs	All pilot owners
KPI_7_STEP_3	Upload information in ZENODO and with FZJ for T5.6	All pilot responsible
KPI_7_STEP_4	Count total number of users engaged in the project	T5.6 (FZJ lead)

3.2.3.8 KPI_8 - Demand Response cost - optional

BASIC KPI INFORMATION			
KPI Name	Demand Response cost	**KPI ID**	KPI_8
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CyberGrid*		
KPI Description	This KPI evaluates the connection cost per kWh of demand response flexibility .		
KPI Formula	Total cost of connecting new asset to balancing market divided by its nominal power		
Unit of measurement	€/kWh		
Target / Thresholds	100 €/kWh		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	The relative costs (€/kWh) of chosen connection plan of additional assets for offering flexible services compared to alternatives		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 8]	**Step**	**Responsible**
KPI_8_STEP_1	Make a list of new assets to participate in offering flexibility	Nikolaj Candellari & Peter Nemcek
KPI_8_STEP_2	While connecting the assets track the costs of equipment and installation	Nikolaj Candellari & Peter Nemcek
KPI_8_STEP_3	Summarise the costs of all new assets offering flexibility service and divide by sum of their nominal capacities	Nikolaj Candellari & Peter Nemcek
KPI_8_STEP_4	Compare relative cost to the target	Nikolaj Candellari & Peter Nemcek
KPI_8_STEP_5	Upload information in ZENODO and with FZJ for T5.6	Nikolaj Candellari & Peter Nemcek
KPI_8_STEP_6	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.9 KPI_9 - Time savings

BASIC KPI INFORMATION			
KPI Name	Time savings	**KPI ID**	KPI_9
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*FZJ*		
KPI Description	Time saved for end customers integrating DER		
KPI Formula	(avg_t_InterSTORE / avg_t_FIWARE)*100 with avg_t = (avg_t_u1+ avg_t_u2+ avg_t_u3 + avg_t_u4 + avg_t_u5)/5 Where avg_t_u1 is the time needed by user_1 to implement a certain solution		
Unit of measurement	%		
Target / Thresholds	<80%		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Difference of average time needed for the implementation of the traditional solution (FIWARE-based) VS the InterSTORE solution (LPC-based). 5 to 10 users will be requested to try both implementations, in order to evaluate the average time		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 9]	**Step**	**Responsible**
KPI_9_STEP_1	Identification of the users	Daniele Carta
KPI_9_STEP_2	Time recording for the implementation of FIWARE-based solution by each user	Daniele Carta
KPI_9_STEP_3	Time recording for the implementation of InterSTORE-based solution by each user	Daniele Carta
KPI_9_STEP_4	Calculate the average time needed for each implementation	Daniele Carta
KPI_9_STEP_5	Calculation of the total saved time	Daniele Carta
KPI_9_STEP_6	Upload information in ZENODO and share it with FZJ for T5.6	Daniele Carta
KPI_9_STEP_7	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.10 KPI_10 - Nbr of DER as-sets and EMS tested with IEEE2030.5

BASIC KPI INFORMATION			
KPI Name	Number of DER assets and EMS tested with IEEE2030.5	**KPI ID**	KPI_10
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All*		
KPI Description	Amount of different DER devices and EMS successfully tested with the IEEE2030.5 and demonstrated in real-life pilots		
KPI Formula	Sum of tested and integrated devices with IEEE2030.5. Each integration counts individually. Thus, in case of systems with multiple inverters integrated individually, each inverter is counted individually. In case of inverters requiring multiple integrations (e.g., one for reading data and one to control the asset) each integration is counted individually. DER tested and controlled count as 1. DER tested but not controlled count as 0.5. Since here only the integrations based on IEEE2030.5 are counted: Value_KPI4>=Value_KPI10 (KPI_4 - Diversity of DER)		
Unit of measurement	Count		
Target / Thresholds	10		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Number of different DER devices and EMS successfully tested with the IEEE2030.5 and demonstrated in real-life pilots.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 10]	**Step**	**Responsible**
KPI_10_STEP_1	Install, configure IEEE2030.5 over NATS protocol or IEEE2030.5, in the devices and EMS	All pilot owners
KPI_10_STEP_2	Test if the new protocol is properly configured	RWTH supporting All pilot owners
KPI_10_STEP_3	Count number of tested devices	All pilot owners
KPI_10_STEP_4	Demonstrate UCs with the tested devices	All pilot owners
KPI_10_STEP_5	Count number of demonstrated devices	All pilot owners
KPI_10_STEP_6	Upload information in ZENODO and share it with FZJ for T5.6	All pilot owners
KPI_10_STEP_7	Count total number of assets tested and demonstrated in the project	T5.6 (FZJ lead)

3.2.3.11 KPI_11 - Data space digitized assets - optional

BASIC KPI INFORMATION			
KPI Name	Data space digitized assets	**KPI ID**	KPI_11
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All, except UC4*		
KPI Description	Amount of digitized storage systems/platforms/hubs assets integrated in the common data space exchanging data		
KPI Formula	Sum of digitalised storage assets divided by the number of assets counted in KPI 6, multiplied by 100.		
Unit of measurement	Percentage		
Target / Thresholds	50% of the assets		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Direct measure of assets (EMS, batteries, inverters, chargers) sending data to data space. This value is in percentage with respect to the number of assets counted from KPI_6 - Number of assets aggregated. An asset (EMS, battery, inverter, charger or the like) is counted as integrated if at least one of its data is stored on the data spaces. The way data are stored (real-time, in a second phase by a third-party or the like) does not affect this count. The way data are stored (real-time, in a second phase by a third-party or the like) must be recorded and noted, for a detailed overview of the implementations.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 11]	**Step**	**Responsible**
KPI_11_STEP_1	Digitalise storage assets by connecting them to open data spaces	All pilot owners
KPI_11_STEP_2	Count of number of assets digitalised in each pilot and note on the way data is stored	All pilot owners
KPI_11_STEP_3	Sum of number of assets digitalised in each pilot	All pilot owners
KPI_11_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	All pilot owners
KPI_11_STEP_5	Count total number of digitalised assets in IntreSTORE	T5.6 (FZJ lead)

3.2.3.12 KPI_12 - Time data saving

BASIC KPI INFORMATION			
KPI Name	Time data saving	**KPI ID**	KPI_12
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*HESS*		
KPI Description	The time saved regarding the availability of measured data used for real time operation of the HESS.		
KPI Formula	Calculation of the measured time needed for the implementation of the state of the art solution in GridLAb respect to the InterSTORE methodology with LPC.		
Unit of measurement	%		
Target / Thresholds	>20%		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Recoding the time consumed in data saving in different methods.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 12]	**Step**	**Responsible**
KPI_12_STEP_1	Time recording for the implementation of benchmark method within the use case tests.	HESS: (Elyas Rakhshani, Francisco Marcelo)
KPI_12_STEP_2	Time recording for the implementation of InterSTORE-based method per use case test.	HESS: (Elyas Rakhshani, Francisco Marcelo)
KPI_12_STEP_3	Calculate the average time needed for each implementation.	HESS: (Elyas Rakhshani, Francisco Marcelo)
KPI_12_STEP_4	Calculation of the total saved time between the two methods.	HESS: (Elyas Rakhshani, Francisco Marcelo)
KPI_12_STEP_5	Upload information in ZENODO and share it with FZJ for T5.6	HESS: (Elyas Rakhshani, Francisco Marcelo)
KPI_12_STEP_6	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.13 KPI_13 – Monitoring

BASIC KPI INFORMATION			
KPI Name	Monitoring	**KPI ID**	KPI_13
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*HESS*		
KPI Description	N° of assets monitored in GridLab for the project		
KPI Formula	Direct measure of availability of the distributed source of storage energy.		
Unit of measurement	Count		
Target / Thresholds	N°≥ 2		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Monitor and counting the number of available storage devices which are successfully tested in GridLab under the defined test scenario.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 13]	**Step**	**Responsible**
KPI_13_STEP_1	Define the test scenario and activate the system	HESS
KPI_13_STEP_2	RUN the test scenario with HyDEMS in connection with DERs and aggregator.	HESS
KPI_13_STEP_3	Monitor and record the available devices during the event.	HESS
KPI_13_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	HESS
KPI_13_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.14 KPI_14 - Time response

BASIC KPI INFORMATION			
KPI Name	Time response	**KPI ID**	KPI_14
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*HESS*		
KPI Description	is considered as the overall HESS system time response which will be needed for providing the service complying TSO grid codes.		
KPI Formula	T=t1+t2+t3≤ Tf or Ts t1=communication time from aggregator to EMS (by API or ModBUS) t2=time from EMS to DER1 GFM (MODBUS) t3=time from DER1 GFM to Danfoss inverter (LPC) (Tf=0.5 RoCof calculation time window for fast service and Ts=1 sec for slow energy services.)		
Unit of measurement	sec		
Target / Thresholds	0.5 for fast service, 1 sec for slow services.		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Record the time response of the system which is tested in GridLab for the defined services.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 14]	**Step**	**Responsible**
KPI_14_STEP_1	Define the test scenario, requested service (fast or slow) and activate the system.	HESS
KPI_14_STEP_2	RUN the test scenario with HyDEMS in connection with components.	HESS
KPI_14_STEP_3	Monitor and record the time response of the control for providing the service.	HESS
KPI_14_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	HESS
KPI_14_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.15 KPI_15 - System NADIR

BASIC KPI INFORMATION			
KPI Name	System NADIR	**KPI ID**	KPI_15
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*HESS*		
KPI Description	indicator that corresponds to the lowest frequency value during frequency regulation services.		
KPI Formula	Direct monitoring and measuring the lowest drop value in the system frequency.		
Unit of measurement	Hz		
Target / Thresholds	≥49.5 Hz		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Measure and record the frequency signal.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 15]	**Step**	**Responsible**
KPI_15_STEP_1	Define the test scenario, requested service (fast or slow) and activate the system.	HESS
KPI_15_STEP_2	RUN the test scenario with the EMS in connection with components.	HESS
KPI_15_STEP_3	Monitor and record the system frequency during the event.	HESS
KPI_15_STEP_4	Analyse and calculate the value of Nadir	HESS
KPI_15_STEP_5	Upload information in ZENODO and share it with FZJ for T5.6	HESS
KPI_15_STEP_6	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.16 KPI_16 - System ROCOF

BASIC KPI INFORMATION			
KPI Name	System ROCOF	**KPI ID**	KPI_16
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*HESS*		
KPI Description	Indicator which results during the first instants after the time of occurrence of an event during fast services.		
KPI Formula	Calculate the rate of change of frequency signal in 0.5 sec time window after the event: ROCOF=df/dt.		
Unit of measurement	Hz/s		
Target / Thresholds	≤ 2Hz/s		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Direct measuring/estimation of system frequency using an appropriate device.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 16]	**Step**	**Responsible**
KPI_16_STEP_1	Define the test scenario, requested service (fast or slow) and activate the system.	HESS
KPI_16_STEP_2	RUN the test scenario with the EMS in connection with components.	HESS
KPI_16_STEP_3	Monitor and record the system frequency during the event.	HESS
KPI_16_STEP_4	Analyse and calculate the value of RoCoF.	HESS
KPI_16_STEP_5	Upload information in ZENODO and share it with FZJ for T5.6	HESS
KPI_16_STEP_6	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.17 KPI_17 - Data Valorisation cases

BASIC KPI INFORMATION			
KPI Name	Data Valorisation cases	**KPI ID**	KPI_17
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All* except UC1, UC2, UC4, UC7.		
KPI Description	Number of cases developed with data valorisation (assess longevity, maintenance, pay-back, ROI)		
KPI Formula	Nbr. Cases = Models run using several partners data.		
Unit of measurement	units		
Target / Thresholds	4		
Reporting Period	☐Monthly ☐Yearly ☐ Once per project		
Measurement Process	Results from each of the models ran. Described and developed in D4.3		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 17]	**Step**	**Responsible**
KPI_18_STEP_1	Acquire datasets using Data spaces from partner	EnelX FZJ and InescTec
KPI_18_STEP_2	Run each of the models for the datasets	InescTec
KPI_18_STEP_3	Upload information in ZENODO and with FZJ for T5.6	All pilot responsible
KPI_18_STEP_4	Count total number of cases with data valorization	T5.6 (FZJ lead)

3.2.3.18 KPI_18 - HESS performance

BASIC KPI INFORMATION			
KPI Name	HESS performance	**KPI ID**	KPI_18
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CapWatt and INESCTEC*		
KPI Description	Difference of cost reduction and/or lifetime extension (decrease in degradation) and emissions of energy supply from HESS when compared to a single battery		
KPI Formula	Diffc=Cost of dispatching Single Battery-Cost of Dispatch HESS		

	Diffe=Emissions from single battery dispatch – emissions from HESS dispatch
Unit of measurement	Percentage of difference of €/day Percentage of difference gCO2/day
Target / Thresholds	> 0 %
Reporting Period	☐Monthly ☐Yearly ☐Once per project
Measurement Process	Compare HESS dispatch data from CapWatt to a single battery dispatch. Input the corresponding price and emissions for each day and subtract the latter by the former
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 18]	**Step**	**Responsible**
KPI_18_STEP_1	Provide reference HESS dispatch data to CapWatt	InescTec
KPI_18_STEP_2	CapWatt shares the actual dispatch of the HESS through the database	Capwatt
KPI_18_STEP_3	InescTec after the demo gets the prices and emissions for the comparing days and processes the difference	InescTec
KPI_18_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	InescTec
KPI_18_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.19 KPI_19 – Data Spaces

BASIC KPI INFORMATION			
KPI Name	Data Spaces	**KPI ID**	KPI_19
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*ENELX*		
KPI Description	Nbr. Of shared services/files subscribed and published		
KPI Formula	Nbr = Nbr_s + Nbr_f Nbr_s=Number of services created and used in the DS Nbr_f=Number of files shared (uploaded and downloaded) in the DS		

Unit of measurement	units
Target / Thresholds	20
Reporting Period	☐Monthly ☐Yearly ☐Once per project
Measurement Process	In T4.2, the owner will support the demo partners with the creation of the services (i.e., topic/quantities) in the InterStore Data Space UI developed by Engineering. Each service/shared file will be counted as 1 if at least one partner subscribes to it.
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 19]	**Step**	**Responsible**
KPI_19_STEP_1	EnelX supports the creation of the services with each demo partner	EnelX and Demo partners
KPI_19_STEP_2	Demo partners subscribe to each others services and the publisher accepts them	All partners
KPI_19_STEP_3	Demo partners share the files in each service created by them and others download them	Demo partners
KPI_19_STEP_4	Partners publishing (sharing services/files) keep track of number of shared files	Publishing partners
KPI_19_STEP_5	Partners subscribing (download service/file) keep track of the number of subscription(s)	Subscribing partners
KPI_19_STEP_6	Upload information in ZENODO and share it with FZJ for T5.6	All pilot owners
KPI_19_STEP_7	Sum of the overall shared services/file	T5.6 (FZJ lead)

3.2.3.20 KPI_20 - User Engagement

BASIC KPI INFORMATION			
KPI Name	User Engagement	**KPI ID**	KPI_20
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*InescTec and Capwatt*		
KPI Description	Improved acceptance and perception by end users to DR services (surveys at start and end of demo)		
KPI Formula	% change in acceptance = (Nbr. of users reporting willingness to change charging behaviour in the initial survey) / (Nbr. of users reporting willingness to change charging behaviour in the final survey)		
Unit of measurement	%		
Target / Thresholds	>20%		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Submit the survey at the beginning of the demo and at the end. Choose key questions to serve as comparison and assign weight to them and multiply by the number of answers. Compute the difference between the surveys		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 20]	**Step**	**Responsible**
KPI_20_STEP_1	Submit the survey to recruited CapWatt EV users	CapWatt
KPI_20_STEP_2	Collect and analyse the responses	InescTec
KPI_20_STEP_3	Assign the weights to the key questions about acceptance regarding DR mechanisms	InescTec
KPI_20_STEP_4	Repeat the steps with the final survey	CapWatt and InescTec
KPI_20_STEP_5	Estimate the KPI according to the formula	InescTec
KPI_20_STEP_6	Upload information in ZENODO and share it with FZJ for T5.6	CapWatt and InescTec
KPI_20_STEP_7	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.21 KPI_21 - Demand Response

BASIC KPI INFORMATION			
KPI Name	Demand Response	**KPI ID**	KPI_21
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CapWatt and InescTec*		
KPI Description	Amount of flexibility provided (measured in kWh). Amount of kWh resulting from shift from baseline (forecast consumption)		
KPI Formula	Will be create a baseline of consumption, with the previous data of the EV Users, and then it will be compared with the data during the tests period.		
Unit of measurement	kWh		
Target / Thresholds	>6 kWh/day		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Analyse past data and data after incentives are given. Estimate the difference in change on average for all users		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 21]	**Step**	**Responsible**
KPI_21_STEP_1	Get data for each EV user participant from CapWatt	CapWatt
KPI_21_STEP_2	Analyse charging patterns for each user	InescTec
KPI_21_STEP_3	Provide incentives to the users and collect all charging session data	CapWatt
KPI_21_STEP_4	Compare the change in shift towards green hours when compared to red hours	InescTec
KPI_21_STEP_5	Upload information in ZENODO and share it with FZJ for T5.6	CapWatt and InescTec
KPI_21_STEP_6	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.22 KPI_22 - Node power increase time

BASIC KPI INFORMATION			
KPI Name	Node power increase time	**KPI ID**	KPI_22
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	CapWatt		
KPI Description	Time (in minutes) in which the power demand was higher than the upstream capacity, by using the battery support for that increase.		
KPI Formula	WorkingTime = Discharge_time_of_battery		
Unit of measurement	hours		
Target / Thresholds	60 min/workday		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Monitor the discharging time of the support battery, when it operates to support the determined overpower demand of the parking lot		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 22]	**Step**	**Responsible**
KPI_22_STEP_1	Monitor the Power of the parking lot	CapWatt
KPI_22_STEP_2	Register the time that the battery entered as support	CapWatt
KPI_22_STEP_3	Upload information in ZENODO and share it with FZJ for T5.6	CapWatt
KPI_22_STEP_4	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.23 KPI_23- Node power increase percentage

BASIC KPI INFORMATION			
KPI Name	Node power increase percentage	**KPI ID**	KPI_23
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	CapWatt		
KPI Description	Maximum percentage of Power surpassing the installation's capacity due to the use of the battery to charge the EVs		
KPI Formula	WorkingSupport=Max_Discharge_Power/(Parking Lot total Power)		
Unit of measurement	% (kW/kW)		

Target / Thresholds	>5%
Reporting Period	☐Monthly ☐Yearly ☐Once per project
Measurement Process	Monitor the max support power discharged by the battery when supporting the overpower demand of the EV chargers on the parking lot
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 23]	**Step**	**Responsible**
KPI_23_STEP_1	Monitor discharge power of the battery	CapWatt
KPI_23_STEP_2	Compute max power divided by the installation power	CapWatt
KPI_23_STEP_3	Upload information in ZENODO and share it with FZJ for T5.6	CapWatt
KPI_23_STEP_4	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.24 KPI_24 – User participation

BASIC KPI INFORMATION			
KPI Name	User participation	**KPI ID**	KPI_24
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*CapWatt and InescTec*		
KPI Description	Percentage of users (being monitored) actively following the DR inventive. Actively meaning that they follow the incentive (deviate from past behaviour) on the majority of days during the demonstration		
KPI Formula	Percentage % = ActiveUsers/Participants		
Unit of measurement	%		
Target / Thresholds	> 10%		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Based on the KPI23 analysis we will be able to assess the Nbr of active users, i.e. users that shifted demand compared to a baseline		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 24]	**Step**	**Responsible**
KPI_24_STEP_1	Determine the base line based on CapWatt dataset of users cards	CapWatt
KPI_24_STEP_2	Monitor charging sessions of each users of the demo time window in which the users get an environmental incentive to change their behaviour	InescTec
KPI_24_STEP_3	Compare average shift per user	InescTec
KPI_24_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	CapWatt and InescTec
KPI_24_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.25 KPI_25 – Integrated capacity

BASIC KPI INFORMATION			
KPI Name	Integrated capacity	**KPI ID**	KPI_25
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All partners*		
KPI Description	Integrated power of the HESS within the project demos		
KPI Formula	Sum of the rated powers (in MW) integrated in the demos		
Unit of measurement	MW		
Target / Thresholds	1MW		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Sum of the rated powers (in MW) integrated in the demos		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 25]	**Step**	**Responsible**
KPI_25_STEP_1	Recognise all HESS integrated in the UC	All pilot responsible
KPI_25_STEP_2	Summarise the nominal rated powers in MW within the UC	All pilot responsible

KPI_25_STEP_3	Upload information in ZENODO and share it with FZJ for T5.6	All pilot owners
KPI_25_STEP_4	Summarise the rated powers in MW	T5.6 (FZJ lead)

3.2.3.26 KPI_26 - Increase of flexibility

BASIC KPI INFORMATION			
KPI Name	Increase of flexibility	**KPI ID**	KPI_26
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*All*		
KPI Description	Demand side flexibility potential increase due to hybridization implementation.		
KPI Formula	Sum of total capacity (in MWh) that is integrated in the demos and remains available to provide flexible services (not-used). Divided by the total capacity indicated in KPI 4.		
Unit of measurement	Percentage		
Target / Thresholds	>20%		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Available capacity of a battery is evaluated multiplying the power stored in the battery for the time in which the same battery is not used (thus the time in which the stored power is available). To avoid percentages higher than 100%, the capacity is evaluated over intervals with maximum duration of 1 hour. In case of two batteries, one can be discharging while the other one can remain available for further services. The capacity of the latter, should be included in the measurement of this KPI as percentage of the total installed capacity.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 26]	**Step**	**Responsible**
KPI_26_STEP_1	Identification of batteries integrated in the UCs	All pilot responsible
KPI_26_STEP_2	Monitoring of the amount of power available in the battery not being used and corresponding time.	All pilot responsible

KPI_26_STEP_3	Evaluation of available capacity by multiplying the power by the time.	All pilot responsible
KPI_26_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	All pilot owners
KPI_26_STEP_5	Summarize available capacities and evaluate percentage with respect to KPI 4	T5.6 (FZJ lead)

3.2.3.27 KPI_27 - Energy Volume exchanged

BASIC KPI INFORMATION			
KPI Name	Energy Volume exchanged	**KPI ID**	KPI_27
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*ENX*		
KPI Description	Energy volume Exchange (in kWh) between different assets within Enel X test plant		
KPI Formula	MIN (ΣEpi; ΣEai)		
Unit of measurement	kWh		
Target / Thresholds	500kWh		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Ei is the sum of energy measurement of single DES when they are producing, EAi is the sum of energy measures of single DES when they are absorbing by including loads. The measure is made yearly.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 27]	**Step**	**Responsible**
KPI_27_STEP_1	Identification of batteries integrated in the UCs	ENX
KPI_27_STEP_2	Monitoring of Energy produced and absorbed every 15 minutes	ENX
KPI_27_STEP_3	Calculate every 15 minute the global amount of Energy produced and absorbed for each virtual POD representing each scenario of UCs	ENX

KPI_27_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	ENX
KPI_27_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.28 KPI_28 – Different hybridization configuration

BASIC KPI INFORMATION			
KPI Name	Different hybridization configuration	**KPI ID**	KPI_28
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*ENX*		
KPI Description	Hybridization scenarios with 2 or more different assets		
KPI Formula	Sum of the rated powers (in kW) integrated in the 3 configuration listed		
Unit of measurement	kW		
Target / Thresholds	250kW		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	The maximum amount of power entered in the network for each scenario. EMS calculate this maximum power.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 28]	**Step**	**Responsible**
KPI_28_STEP_1	Create in ESM 3 configuration to simulate 3 virtual pods with different customers	ENX
KPI_28_STEP_2	Implement the flexibility service for each simulated scenario	ENX
KPI_28_STEP_3	Calculate for each scenario the amount of power entered in the network	ENX
KPI_28_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	ENX
KPI_28_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.3.29 KPI_29 – Grid peak avoidance

BASIC KPI INFORMATION			
KPI Name	Grid peak avoidance	**KPI ID**	KPI_29
DEMO where KPI applies	☐IT ☐SP ☐DE ☐AU ☐PO		
Owner	*ENX*		
KPI Description	Percentage of reduction of grid peak power due to flexibility activation		
KPI Formula	(P_load+P_batt)/Pload		
Unit of measurement	Percentage		
Target / Thresholds	80%		
Reporting Period	☐Monthly ☐Yearly ☐Once per project		
Measurement Process	Active Power is continuously monitored by a dedicated measurement chain.		
Reporting Audience and Access Rights	☐Public ☐InterSTORE ☐Demo ☐Other		

KPI CALCULATION METHODOLOGY		
KPI Step Methodology ID [KPI ID 29]	**Step**	**Responsible**
KPI_29_STEP_1	Continuous measurement of the P during peak time for all the loads and batteries.	ENX
KPI_29_STEP_2	Post evaluation of the KPI in two different perimeters: mean values and at the moment when the P_load is max.	ENX
KPI_29_STEP_3	Calculation of KPI in accordance with KPI formula defined	ENX
KPI_29_STEP_4	Upload information in ZENODO and share it with FZJ for T5.6	ENX
KPI_29_STEP_5	Validation of KPI measure	T5.6 (FZJ lead)

3.2.4 Pilot KPIs Responsible

The following table indicates for each pilot the person responsible for the KPIs.

Table 3: Pilot KPIs Responsible

Pilot	Responsible	Email Address	Notes
CAP	Pedro Matos	pmmatos@capwatt.com	Supported by Alexandre Lucas (alexandre.lucas@inesctec.pt
CYG	Peter Nemcek	peter.nemcek@cyber-grid.com	Backup: Nikolaj Candellari (nikolaj.candellari@cyber-grid.com
ENX	Stefano Rosolia	Stefano.rosolia@enel.com	Backup: Christian.noce@enel.com; Alessandra.martino2@enel.com
FZJ	Daniele Carta	d.carta@fz-juelich.de	Backup: Andrea Benigni (a.benigni@fz-juelich.de)
HES	Elyas Rakhshani	erakhshani@hesstec.net	Supported by Francisco Marcelo, fmarcelo@hesstec.net

3.3 Harmonization of the results and KPIs with the project objectives

The harmonization of results and Key Performance Indicators (KPIs) with project objectives is a fundamental step in project management, essential for the successful realization of goals. This process involves aligning the identified KPIs and results with the overarching objectives of the project to ensure a cohesive and purposeful approach. By establishing a clear connection between the chosen metrics and the project's mission, teams can effectively measure progress, track performance, and make informed decisions. This harmonization fosters a unified understanding among partners, providing a strategic framework to assess whether the project is advancing in the desired direction. It not only enhances accountability but also enables adaptability, allowing for timely adjustments to ensure that the project remains in sync with its intended objectives throughout its lifecycle.

3.3.1 Project Objectives and KPIs

Within task T5.1, starting from the initial project objectives, an analysis was conducted with all the partners and the objectives were better detailed. The detailed list of objectives resulting from the analysis is as follows:

1. Assess the performance of Hybrid Energy Storage Systems
2. Monetization of flexibility from energy communities
3. Data Space improvements and valorization cases
4. Flexibility/Consumer engagement
5. Interoperable tools - IEEE implementation (IEEE2030.5)
6. Different distributed Energy resources integration
7. Battery support for EVs

The following table shows the KPIs that have been identified for each objective:

Table 4: Project Objectives and KPIs

#	Objective	KPIs
1	Assess the performance of Hybrid Energy Storage Systems	KPI4, Diversity of DER KPI5, Asset management monitored by EMS KPI15, System Nadir KPI16, System RoCoF KPI26, Increase of flexibility
2	Monetization of flexibility from energy communities	KPI1, DES multi-service support KPI2, DES multi-service market participation KPI6, Number of assets aggregated KPI8, Demand Response cost
3	Data Space improvements and valorization cases	KPI11, Data space digitized assets KPI17, Data Valorisation cases KPI19, Data Spaces
4	Flexibility/Consumer engagement	KPI7, N° of end users involved in HESS KPI18, HESS performance KPI20, User Engagement KPI21, Demand Response KPI24, User participation KPI26 Increase Flexibility due to Hybridization implementation KPI28 Different Hybridization configuration KPI29 Grid peak avoidance
5	Interoperable tools - IEEE implementation (IEEE2030.5)	KPI9, Time savings KPI10, Nbr of DER assets and EMS tested with IEEE2030.5 KPI12, Time data savings
6	Different distributed Energy resources integration	KPI3, Battery capacity KPI4, Diversity of DER KPI5, Asset management monitored by EMS KPI9, Time savings KPI10, Nbr of DER assets and EMS tested with IEEE2030.5 KPI13, Monitoring KPI14, Time response KPI25, Integrated capacity KPI27, Energy volume Exchange (in kWh) between different assets within Enel X test plan
7	Battery support for EVs	KPI22, Node power increase time KPI23, Node power increase percentage KPI27, Energy volume Exchange (in kWh) between different assets within Enel X test plan KPI28 Different Hybridization configuration

4 Dataset provisioning

In the rapidly evolving landscape of the energy sector, the significance of leveraging comprehensive datasets and advanced supporting tools cannot be overstated. The fusion of data-driven insights with sophisticated tools has become a cornerstone in addressing the complexities of the energy environment, facilitating informed decision-making, optimizing resource utilization, and steering innovation. This introduction embarks on a journey through the critical role that datasets play in capturing the nuances of the energy landscape and the instrumental supporting tools that enhance our capacity to analyze, model, and optimize energy-related processes.

Datasets within the energy domain are diverse, encompassing information from sources such as smart grids, renewable energy production, consumption patterns, and environmental factors. These datasets provide the empirical foundation upon which strategic decisions are made, policies formulated, and sustainable energy solutions developed. As we delve into the realm of supporting tools, the focus will extend to advanced technologies designed to enhance data accuracy, streamline analysis, and empower stakeholders with actionable insights.

This exploration aims to unravel the symbiotic relationship between datasets and supporting tools, showcasing their collective power in driving advancements within the energy sector. From predictive analytics for grid management to simulation tools for renewable energy optimization, the integration of datasets and supporting tools is reshaping the energy landscape, propelling us towards a more sustainable and resilient energy future.

4.1 Dataset Template

Within Task T5.1, an analysis was conducted regarding the template to be used for the datasets. Various proposals were shared, evaluated and compared within the task progress meetings.

The goal was to find a single, generic and comprehensive template that could be used by all pilots for data collection and publication.

The following table represents a consolidated and suggested list of fields to be used as templates for data collection.

Table 5: Dataset Template Fields.

#	Field Name	Field Description
1	Dataset reference	Reference to the source or origin of the data
2	Name/Title	Name or title of Dataset
3	Description	Short Description of Dataset
4	Type	Type of Dataset
5	Format	Format of Dataset
6	Standard of usage	Standard to (re)use dataset (e.g., Data privacy, attribution, terms of use, licensing, security, accessibility, etc)
7	Data privacy level	Level of privacy (e.g., restricted, confidential, internal, public)
8	Data owner	Owner/Producer of dataset
9	Data publisher	Publisher of dataset
10	Date	Reference date
11	Version	Version of dataset (es. v1.1)

The identified template will be used by the partners to subsequently provide the datasets.

Detailed information regarding the Data Management process will be reported partly in the Pilot Planning chapter of this document and mainly within the Data Management Plan.

4.2 Data Sharing

In the energy sector, particularly in the realm of energy storage, data sharing is indispensable for advancing technology and optimizing operations. By openly exchanging data on energy storage systems, including performance metrics, charging and discharging patterns, and degradation rates, researchers and industry professionals can collectively enhance the efficiency and reliability of storage solutions. Shared data allows for the identification of best practices, improvement of system design, and development of predictive maintenance algorithms, thereby prolonging the lifespan and maximizing the performance of energy storage infrastructure. Additionally, data sharing facilitates collaboration among stakeholders involved in integrating energy storage with renewable energy sources and grid systems, enabling the seamless integration of these technologies to enhance grid stability and support the transition towards a cleaner, more sustainable energy future. By fostering a culture of collaboration and transparency through data sharing, the energy sector can unlock the full potential of energy storage technologies, driving innovation and resilience in the pursuit of a greener energy landscape.

4.2.1 ZENODO

ZENODO [1], a widely utilized platform for sharing research outputs, promotes collaboration and knowledge dissemination by providing a repository where researchers can freely deposit and access diverse datasets. Through ZENODO, researchers contribute to the collective advancement of science by making their data openly available, promoting transparency and reproducibility in research practices. This open approach to data sharing not only enhances the visibility and impact of research but also facilitates collaboration across disciplines, driving innovation and accelerating scientific progress. ZENODO's user-friendly interface and comprehensive metadata support ensure that shared datasets are easily discoverable and accessible to the global research community, fostering a culture of openness and collaboration in academia and beyond.

All data produced by pilots and partners, needed for the evaluation of the KPIs, must be uploaded into the ZENODO platform.

For information on the procedure to follow to upload data to ZENODO, refer to the official guide: https://help.zenodo.org/docs/get-started/quickstart/.

4.3 Supporting Tools

The Data Management is an integral part of the KPI evaluations, the data which comes from various sources as results of the pilots' study in different locations. These data have to collect seamlessly and aggregate it in a platform where the data analysis can be done using charts or plots before doing the KPI analysis. All the above can be done by a tool called Leibniz Data Manager. [2]

Leibniz Data Manager is an Open-Source tool developed by the Leibniz University Hannover. This tool is composed of many services. This software currently offers supports data collections and publications with different formats, different views on the same data set (2D and 3D support), visualization of Auto CAD files, Jupiter Not Notes for demonstrating live code, RDF Description of data collections. The file specific viewers were implemented using CKAN (Comprehensive Knowledge Archive Network) plug-ins to render existing viewers for the datasets included in the CKAN instance. The LDM software is built on many services and all the services work together to achieve the above-mentioned features.

4.3.1 Components of Leibniz Data Manager

CKAN: Open-source DMS (data management system) for powering data hubs and data portal

CKAN is used for creating open data websites, similar to how WordPress is used for creating blogs and pages. With CKAN, data is used to create the website, helping to publish open data. Once the data is published, consumers or users can search for and access the data on the website. CKAN offers various kinds of data visualizations, including tables, plots, and maps.

PostgreSQL

Open-source object-relational database management system. Postgres is considered the most powerful databases that uses in commercial projects, and it's integrated in LDM manager. PostgreSQL is a client-server database system where a server can host multiple databases. Users interact with these databases using SQL queries. It supports large data models, including videos and photos, and handles complex queries. Additionally, custom data types can be defined. PostgreSQL allows multiple concurrent users without compromising performance.

SOLR

Open-source enterprise search platform. Given the data-intensive nature of this process, a variety of data types and a large volume of data are expected to be amassed in the LDM platform. In this regard, Apache Solr is needed to manage and sort the data. It facilitates various searching options, supports complex search criteria, and offers faceted search and filtering. This, in turn, helps users narrow down their search results based on various attributes.

Postfix

Open-source mail transfer agent (MTA) that routes and delivers electronic mail, this email agent doesn't compromise on security, it eases the administration. It's well known for its efficiency and reduced complexity of the configuration files. It handles various protocols such SMTP (Simple Mail Transfer Protocol), seamlessly integrate with other mail technologies like spam filters and antivirus software.

The robustness and power of the Leibniz Data Manager (LDM) stem from its open-source integration of various dedicated and continuously developing services. Integration and deployment of these services with LDM are facilitated through Docker Compose, enabling all services to work together seamlessly and be deployed on any cloud infrastructure. Given that LDM continuously updates and monitors data while providing instantaneous publishing, additional tools are necessary due to its distributed system, akin to the Internet of Things (IoT). Therefore, the architecture required for this purpose is described in the next section.

4.3.2 Platform Architecture

The following image describes the block architecture of the Leibniz Data Manager platform.

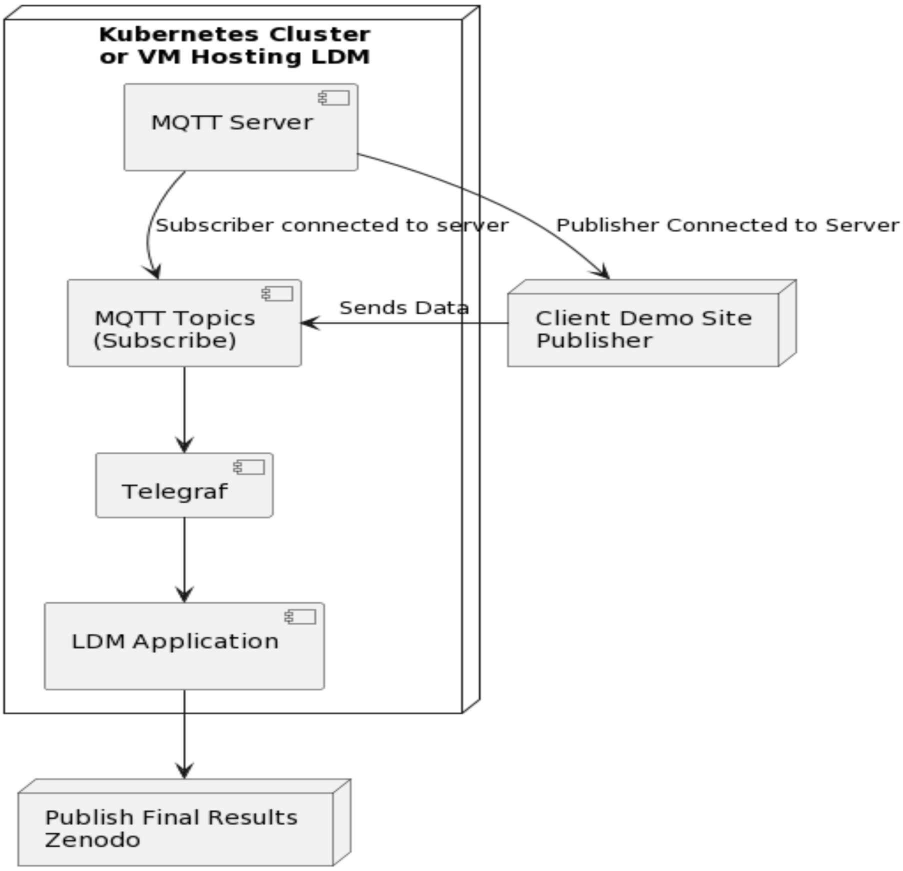

Image 1: Leibniz Platform Architecture

The workflow of the above architecture involves hosting the application on virtual machines (VMs) or Kubernetes, with OpenStack being a good option. The application is LDM (Leibniz Data Manager) as described in the previous pages. An MQTT server connects with publishers and subscribers. Demo sites act as publishers by setting up an MQTT publisher plugin to send both real-time and historical data. Each demo site has a topic to which they can publish. The subscription to these topics occurs in the VM or Kubernetes, where you will find the MQTT subscriber plugin and the MQTT server.

Once a message is subscribed to, Telegraf directs it to the LDM Application, where KPI analysis can be performed, and the data is gathered in PostgreSQL (part of the LDM). Jupyter Notebook can be used to create programs for visualization and further analysis, keeping everything under one umbrella.

When the analysis is complete and ready for publication, ZENODO comes into play. This platform is well-known for publishing results on a global scale. There are multiple ways to connect to ZENODO: using an API key or through the software developer mode, which is convenient with the proposed architecture. Alternatively, you can create credentials to upload data in the usual way.

MQTT

It is a lightweight protocol based on message transfer between MQTT clients and a server known as the message broker. Clients can publish data under specific topics and subscribe to messages from the MQTT server. The server handles authentication and authorization. The broker receives all messages, filters them, identifies the interested parties, and publishes them to all subscribed clients for particular topics. It coordinates all actions between clients. MQTT ensures that each message is delivered at least once correctly. MQTT clients are IoT devices, such as sensors, Raspberry Pi, or other low-power onboard devices, that send the data.

Telegraf

Telegraf[3] is a tool developed by InfluxData designed to gather metrics and events from various sources, such as databases and IoT agents. Telegraf supports a plugin-driven architecture with over 200 plugins, allowing users to collect metrics from various sources, process them, and send them to multiple outputs.

ZENODO

Publishing the final data and instances of the LDM to another platform, such as ZENODO, is possible. The ZENODO platform is designed for publishing analysis results, thereby maximizing the project's reachability. While it is also possible to publish data using LDM, you may need to contact those who host this platform externally, possibly at Leibniz University, for further assistance.

5 Pilots planning and configuration

This chapter describes, for each pilot site, the configuration used and the respective planning. We also report in detail all the actions taken to carry out the demos.

5.1 Italy (ENX)

5.1.1 Planning

5.1.1.1 Pilot Scope and Objectives

To enable the energy transition to clean generation, it is important to have an increasingly automated and intelligent electricity grid in order to independently manage the presence of more and more distributed renewable energy systems.

In this scenario, the balancing service provider (BSP) must help the DSO/TSO to manage distributed power flexibility and use the flexibility to provide grid services in order to solve problems on the distribution grid (Low Voltage / Medium Voltage) grid.

The main **scope** of the use case is experimenting in the XLAB in Rome an entire end-to-end process to simulate an aggregate of different sites supplying local flexibility service to the DSO grid.

In Rome Areti, which is the local DSO, Enel X will launch a pilot project to test local ancillary services to solve congestion grid problems.

The scope is to use the Flexibility platform to allow a set of different sites/assets to participate as a portfolio in flexibility market services.

This Use Case identifies and analyses how different type of storages technologies (Industrial, Residential,Commercial&Industial, EVs) can contribute in a unique cluster to provide flexibility and grid services.

Each individual flexibility resource does not hold adequate market value unless aggregated in larger pool with capacity and characteristics that fulfil balancing services and market requirements.

In this way, each resource can contribute to grid service markets as part of a VPP (Virtual Power Plant), despite having different power profiles and capabilities (capacity, time constraints, response and ramp times).

This use case will be implemented, tested, and validated in Rome, in Enel's XLAB.

The assets in the XLAB will ultimately respond to a test signal, to simulate grid responsiveness. Ultimately, this project tests necessary know-how that will enable using mixed assets, i.e. storage + EV chargers, to execute a simulated balancing order, similar to one that would come from Rome's DSO.

The **objectives** can be summarized in:

1. Hybridization: we develop a unique environment where different kind of assets are integrated
2. Energy monitoring assets consumption/production making use of IEEE2030.5, or the protocol appropriate for the asset control reporting to connected dataspace

3. Exchange several messagesl between different distributed assets and the VPP through the Asset Manager
4. Identify the minimum set of information needed to be exchanged between assets and Asset Manager and the VPP Manager for providing flexibility to the DSO.

Script for the pilot demonstration

The demonstration shows how flexibility services provide support to the network and fulfil DSO/TSO requirements.

Balancing Services Providers (BSP), in this case Enel X, operate within the market to manage different resources and customers to provide balancing services to the network; by aggregating distributed flexibility resources, aggregator can participate in Flexibility service market and generate revenue.

Once the BSP is qualified to supply flexibility services, the BSP receives the request coming from DSO/TSO. The VPP Manager manages market communication, portfolio optimization, and aggregate events orchestration.

The TSO/DSO market operator buys flexibility through a DR/VPP program, which is independent from the energy supply contract.

Following the detailed description of how the different system are involved in Flex service implementation:

Virtual Power Plant Manager (VPP Manager) is a component of the Enel X Flexibility platform that interfaces external Energy Markets (e.g. Grid Operators, Utilities) and an Asset Manager. The VPP Manager enables the Asset Manager's assets to be registered in VPP programs, to communicate according to VPP commands, and to collect information necessary to run VPP programs and event.

It also provides tools to internal operations to enable event performance and monitoring at the aggregate level. The VPP Manager groups together two major components:

- "Flex" which is the DR Platform, the foundation layer of the VPP Manager
- "Flexible Asset Interface (FAI)" which is a set of VPP Integration Standards that defines all interactions with the VPP Manager and the participating flexible assets. The standards consist of a set of APIs, events and protocols

The main responsibilities of the VPP Manager includes:

- Offer management: This includes customer offers as well as market offers.
- Respond and execute Event Dispatches triggered by the Market, or, in this case, a simulated Market Event Dispatch.
- Manage market specific DR and VPP programs.
- Optimize/rank assets for use during events.
- Orchestrate the execution of assets participation.
- Measure energy usage and/or production of assets during executions.

Flexible asset interface provides the necessary endpoints and communication pathways for an Asset Manager to communicate with the Flex Platform.

The Energy Services group is the Asset Manager, and they have the following responsibilities:

- Controls physical assets
- Acquires Telemetry
- Forecast asset flexibility available
- Flexibility estimation
- Communicates with the VPP manager using the Flexible Asset Interface (FAI)
- Aggregates/Disaggregates the energy consumption/generation of all physical assets that comprise the VFA (Virtual flexible asset).
- VFA represents an aggregation of a set of Flexible Assets that have the same behaviour as a Flexible Asset (an asset that can participate in a demand response event or energy management activity requiring energy to be generated or curtailed).

IoT Platform

Is the platform which accelerates the delivery times to integrate new components and Enel vertical solutions providing an easy mechanism to integrate third parties systems, services and devices through open and standard protocols

Field Assets listed in the following paragraphs.

The test implements a Flexibility order coming from DSO in order to implement Local Ancillary Services in Rome (values are just for the description of the example):

For instance:

- **Assumption:** Charging station = -1200W, Batteries=-200W and Solar Panels= 400W (producing energy): the total consumption is 1000W
- **Flex Order example:** Simulation of Market process where we decide to reduce the consumption (for instance 500W)
- **Activity requested:** Dispatch signal is sent (from the VPP to Energy Management System in order to curtail the consumption
- **Activity execution:** Calculation (on Energy service plot) which devices will we impacted and how much for each of them (Forecast) will be the reduction (flexibility estimation)
- **Result:** For the final state we will have a new scenario where each asset/device consumption has changed. For instance, Charging station = -1000W, Batteries=100W (using stored energy) and Solar Panels= 400W (producing energy). Total consumption is now 500W.

5.1.1.2 Timeline and Milestones

To achieve these objectives, the timeline reported in the tables below is foreseen.

Table 6: Use Case 9 forseen timeline

Task name/description	Start [m #]	End [m #]	Duration [mm]
Flex Platform/Team: Development of the Flexible Asset Interface (offering, interval data transfer, dispatch notification) and integration documentation	16	21	5
Integration Team (ESV4 team) must read documentation and integrate against Flexible Asset Interface.	18	24	6
Energy Services Platform:	18	19	1

Load Areas definition: assets configuration			
Integration with Enel Flex for Storages Management	18	20	2
Algorithms definition and development	18	22	4
Integration with IoT and EVOS (Mobility stack)	18	21	3
IoT ASSETS integration via MQTT	17	22	5
XLAB	17	24	7
Schneider Assets configuration in IEEE2030.5	16	18	2
LPC installation and configuration	17	19	2
Connected data space installation and configuration on virtual machine in LAB	17	21	4
Router and MVNO SIM Configuration	17	19	2
EV charger Preparation	17	19	2
EV data configuration and integration to EVOS	19	24	5
Demonstration phase	24	36	13

The timeline presented 4 major milestone:

1) Flex Platform and Flex Asset Interface developments
2) Energy services Management and algorithms developments to handle the scenarios and asset configurations (PV, Storages, EVs)
3) IoT Assets messages configurations
4) LAB assets preparation and router connectivity

5.1.1.3 Risk Assessment

- Hardware
  - Risks in the LAB regarding asset-level failures, equipment issues, etc.
  - Configuration of external inverter with IEEE protocol and its connection to MQTT
- Software
  - Protocol IEEE2030.5 may be a sub-optimal protocol to openADR.
  - The number of EVs asset may not be sufficient to effectively do aggregation

5.1.2 Configuration

5.1.2.1 Technology Setup

- The picture below shows the high level of architectural scheme of the systems needed to implement UC9 in Rome Lab.

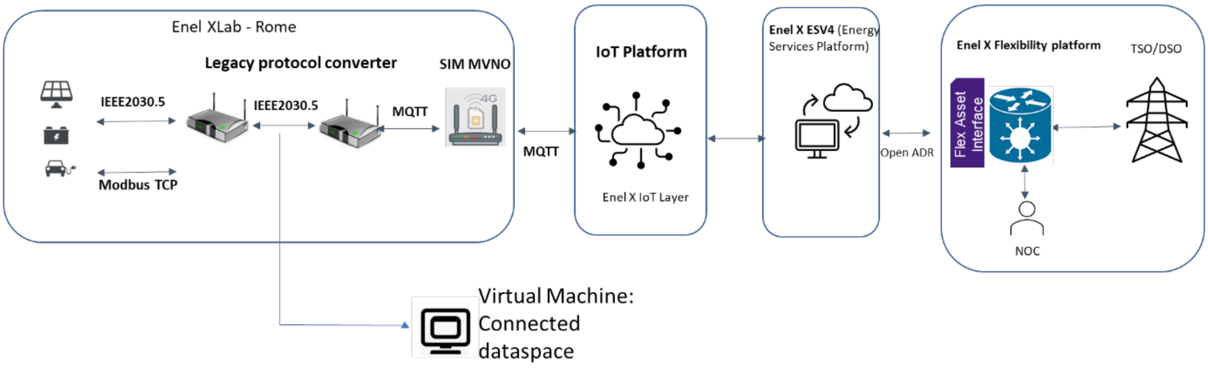

Image 2: ENX – Architectural scheme of the systems needed to implement UC9

- In detail the technology setup of the equipment in XLAB:

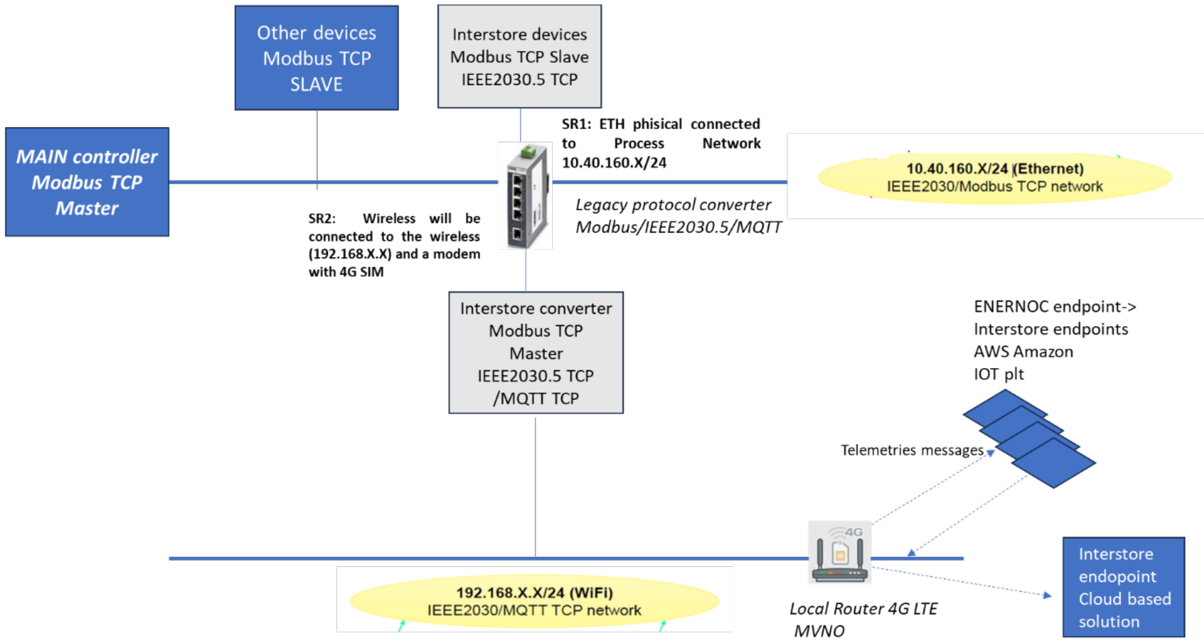

Image 3: ENX – the technology setup of the equipment in XLAB

Following the list of the systems involved and relative configurations:

1 **Assets**[1]**:**

Lab 1 (Small C&I) includes:

- PV: 2x12kWp= 24 kWp (29kWp in bifacial way) 3SUN configurated to support IEEE2030 Protocol
- Storage Pylontech (LI-Ion) 4X 4,8 kW configurated to support IEEE2030 Protocol

[1] The configurations of Lab 2 and Lab 4 are not reported because they are used by other business for electric vehicles (EVs).

Lab 3 (Residential) includes:

- 3SUN PV Small 2X3,7kWp= 7,4 (9 kWp in Bifacial way) configurated to support IEEE2030 Protocol
- Greentech Storage: 1X5,5kW super capacitor energy intensive configurated to support IEEE2030 Protocol
- V2G residential EV charger CHAdeMO –15kW; +15kW configurated to support Modbus Protocol

Lab 5 (Large C&I) includes:

- 3SUN PV: 102kWp (125kWp in Bifacial way) configurated to support IEEE2030 Protocol
- LG Storage large assembled by SOCOMEC 132 kVA- 274kWh Lithium Battery configurated to support IEEE2030 Protocol

2. Gateway:

Components

1	210-BBQD	Alienware Aurora R14
1	338-CCUV	AMD Ryzen ™ 9 5950X(16-Core,72MB Total Cache, MAX Boost Clock of 4,9GHz)
1	379-BBDF	OS Media Kit Not Included
1	321-BHCQ	750W Platinum PSU, Dark. Liquid-Cooled CPU&Clear Side Panel
1	321-BHIL	Upper Cooling Fan
1	370 AGRQ	64GB, 4x16GB, DDR4,3466MHz,XMP
1	400-BMPF	2TB NVMe M2PCIe SSD(Boot)+2TB 7200RPM SATA 6Gb/s (Storage)
1	470-AADV	Power Cord-Italian
1	389-DYKY	AMD Ryzen ™9 Label
1	490-BHBW	NVIDIA R GeForce RTX TM 3090 24GB GDDR6X
1	555-BHBN	MediaTek MT7921 W-Fi 6 (2X2) MIMO802.11ax Wireless LAN and Bluetooth 5.2
1	570-AACN	No Optical Mouse (Upgrade to an Alienware Gaming Mouse below in Accessories)
1	580-AACD	No keyboard Requested
1	328-BEMC	AW Aurora R14 Shipping Material Including Placemat

Software

1	619-AQMC	Windows 11 Pro, English, Dutch, French, German, Italian

Image 4: EnelX Gateway

The Gateway will be used to host Legacy Protocol Converter SW.

The LPC will be configured to operate protocol conversion from Modbus protocol to IEEE2030.5 protocol, and from IEEE2030.5 to MQTT. Most of the asset have implemented IEEE2030.5 protocol, for those assets LPC operate just the conversion to MQTT protocol to route the signals to ICT platforms.

3.Router:

Image 5: EnelX router

Technical Specifications	R04
General	
Device Interfaces	4 x 10/100 Mbps LAN ports, 1 x 10/100 Mbps Ethernet WAN port, 1 x Reset/WPS button, 1 x power connector
LED	Power/ Status
Antenna Type	3 x external dipole antennas (5 dBi)
Wi-Fi Data Rate	2.4 GHz Up to 300 Mbps
Wireless IEEE Standard	IEEE 802.11n/g/b, IEEE 802.3u/b, IEEE 802.11kv
WAN Interface	Static IP, Dynamic IP, PPPoE, PPTP, L2TP, DS-Lite, Supports 802.1p & 802.1q VLAN tagging and Priority bit, Concurrent session: 32,000
Functionality	
Security Protocol	WPA/WPA2-Personal, WPA2-Personal only, WPA2/WPA3 – Personal (WPS not supported), WPA3-Personal only (WPS Not supported)
Firewall	DoS, SPI, Anti-spoofing Checking, IP Address, 1 x DMZ
QoS	D-Link QoS Technology
Software	
Device Management	EAGLE PRO AI app (iOS and Android), Web UI
Voice Assistant	Amazon Alexa, the Google Assistant
Physical	
Hardware version	A1
Dimensions	158 x 131.35 x 43.73 mm (L*W*H)
Weight	168 g
Power Input	12 V 1A
Maximum Operating Voltage	12 V
Operating Temperature	0 to 40 °C (32 to 104 °F)
Storage Temperature	-20 to 65 °C (-4 to 149 °F)
Operating Humidity	10% to 90% non-condensing

Image 6: EnelX router technical specifications

4. Data Management

The data collected from the field assets will be used to feed INESTEC analysis.

The data will be stored in locally.

The data used by the UC9 will be send to digital platform in order to be elaborated by the algorithms.

The relevant data of UC9 will be stored in Connected Data space.

Data needed for the evaluation of the KPIs will be uploaded manually on ZENODO.

The file data profile will contain the following data:

PV: Timestamp, Production Power (W)

Storage: Timestamp; Current (3phase), Voltage (3 phase), Grid Active Power, Grid reactive Power, Grid Frequency, SOC, SOH, Battery Ambient Temperature

V2G EVs: Charger type (based on charging speed); Charging Power KW), Efficiency (%),Connector type (Type of plug or connector the charger uses),Charging Time (Time requested to charge EV battery to full),Status (the current operational status of the charging station (available, in use, out of service).

The protocol used will be Modbus and IEEE2030.5 at asset level and MQTT and openADR at Digital platform Level.

5.1.3 Demonstration

5.1.3.1 Feedback Collection

- The Users are not involved in the Demo. The Assets simulate the customers' behaviour so implements real power curves through simulators input data.

5.1.3.2 Performance Metrics (KPI)

The KPIs for this project are defined in Section 3.1.2. This includes:

- **KPI 3 - Battery Capacit**y: Amount of Flexibility provision in demos from HESS.
  For the evaluation of this KPI, the nominal capacity of the integrated assets (expressed in kWh) is considered. The expected value from Battery capacity for flexibility service is 300 kWh.
- **KPI 4 - Diversity of DER**: Number of different devices successfully tested and demonstrated.
  For the evaluation of this KPI, the sum of the different DER tested and controlled will be considered; In UC9 the different devices are 5 (PV; 3 types of Storages, 1 V2G EVs)
- **KPI 5 - Number of assets monitored by EMS** solutions.
  For the evaluation of this KPI, the number of assets monitored by EX Energy Service management are 8 assets monitored (3 PV + Storages, 2 EV)
- **KPI 6 - Number of Assets aggregated**
  For the evaluation of this KPI, the direct count (sum of the number of assets) will be considered. The expected value for Residential, Industrial and Commercial flexibility pilot is 9.
- **KPI 7 - Number of Users**
  For the evaluation of this KPI, the direct count of asset and simulated users will be considered. The number of users simulated in LAB is 5 (2 PV+ Storage Residential, 1 PV+ 1 Storage Industrial, 1 PV+Storage C&I and 1 EVs).
- **KPI 10 - Number of DER assets** and EMS tested with IEEE2030.5.

For the evaluation of this KPI the number of Assets tested in IEEE2030.5. The Schneider assets are all PV and Storages residential and Commercial & Industrial (C&I) (N°6).

- **KPI 11 - Data spaces digitize assets** connected to dataspaces 8 (PVs and Storage, not EVSE)
- **KPI 17 - Number of cases** developed with data valorization (assess longevity, maintenance, pay-back, ROI,...).
  For the evaluation of this KPI,
- **KPI 19 – Number of shared services/files subscribed and published**
  For the evaluation of this KPI, the number of assets integrated in the common data space exchanging data is considered.
  Number of assets defined in KPI11 will send data to the data space and it will be counted.
- **KPI 25 – Integrated power of HESS within the project demo (150kW).**
  For the evaluation of this KPI, the sum of the rated powers (in MW) integrated in the demo is considered.
- **KPI 26 – Increase flexibility: Demand side flexibility potential increase due to hybridization implementation.**
  For the evaluation of this KPI the sum of total capacity (in MWh) that is integrated in the demos and remains available to provide flexible services (not-used) is considered.
- **KPI 27 - Energy Volume exchanged:** Energy volume Exchange (in kWh) between different assets within Enel X test plant.
  For the evaluation of this KPI, the Min between the production power and total capacity (in MWh) is considered.
- **KPI 28 - Increase of flexibility:** Demand side flexibility potential increase due to hybridization implementation.
  For the evaluation of this KPI, the sum of total capacity (in MWh) that is integrated in the UC and remains available to provide flexible services (thus not-used) is considered. The expected value for aggregated assets flexibility pilot is 0.03 MW.
- **KPI29 – Grid peak avoidance:** Percentage of reduction of grid peak power due to flexibility activation.
  For the evaluation of this KPI it's calculate the reduction as the amount of power supplied by the batteries during peak time. The KPI is expressed in the percentage with respect to the total power (P_load+P_batt)/Pload

Documentation

- Enel X can offer the following documentation:
  - a User Guide to FAI to qualified Asset Managers
  - IEEE2030.5 documentation provided by Schneider
  - IoT guidance on MQTT communication
- Ensure comprehensive documentation for future reference.

5.2 Austria (CYG)

5.2.1 Planning

CyberGrid is entering InterSTORE project with a clear plan on how to use and upgrade its state of the art software CyberNoc to support the integration of different types of flexibilities within the same hybridized portfolio. The most common use case until now was the combination of C&I demand response with distributed generation like Combined Heat and Power (CHP), diesel-gen sets and RES. The recent increase of BESS installations makes an opportunity for integrating them with other flexibilities, thus enabling more optimal combinations of complementary flexibilities with better market utilisation, efficiency, and monetisation. During the project a new generation of CyberNoc will be developed, enhanced with developed interoperability toolkit, option for integrating BESS, its hybridization, Market Arbitrage tool, Energy Community software tools and Open data space connection.

5.2.1.1 Pilot Scope and Objectives

UC1 - DES Flexibility Market Monetisation focuses on a user of CyberNoc (e.g. an aggregator) which would like to offer its customers a possibility to generate flexibility revenues. To technically achieve this, aggregator deploys and operates a Flexibility Management Platform – an ICT system which aggregates and manages flexibility from diverse sources. The flexibility will be provided mostly through power curtailment set-points sent to DES in real time and hybridization of them with other flexibilities (loads, RES, DG, etc.) into marketable products. It will autonomously bid the hybrid flexibility products to the most appropriate markets (balancing, TSO and DSO balancing services, intra-day, etc.) and executes the provision of the flexibility.

In UC2 - Energy community DES utilization CyberNoc will be upgraded to suit the specific case of energy communities. The reason for this additional development lies in the fact that energy communities could generate flows of real time data from electricity meters placed at renewable electricity sources, consumption sites, battery energy storage systems, heat pumps, etc. Most of these could provide some electric flexibility which can be utilized either locally, within the community supporting self-sufficiency mode or at different electricity markets, like helping balance the transmission grid, improving voltage levels at distribution grid or taping into price opportunities of intraday markets.

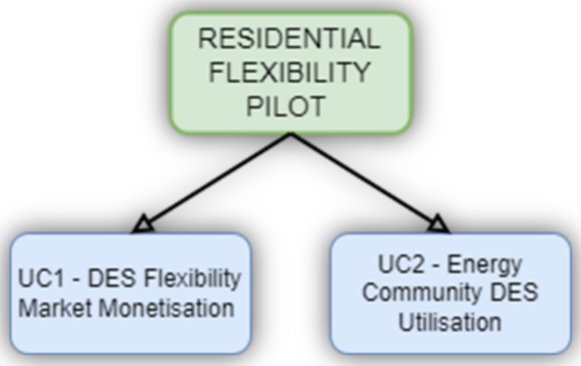

Image 7: Austrians UC1 and UC2

All together CyberGrid will connect both use cases to residential pilot – presented by two energy communities in which both use cases will be showcased. This means that each DES and other energy resources will be connected, monitored and controlled to CyberNoc via novel protocol IEEE2030.5 over NATS. The controlling will be done so that self-optimisation is maximised and additional flexibility is monetised on appropriate markets.

5.2.1.2 Timeline

To achieve before-mentioned objectives CyberGrid devised a detailed schedule which you can find below.

1. Presentation of project to community members – February 2024
2. Signing the contract with energy community – May 2024
3. Planning the connection of energy community in CyberNoc:
    a. Gathering info about members and their assets (what types, capacities, are they smart grid ready or not) –June 2024
    b. Order needed hardware to host LPC implementation– June 2024
    c. Protocols inspection (which are used, how to map them to IEEE2030.5) – July 2024
    d. Install LPC to the hardware devices – August 2024
    e. Implement the hardware devices with LPC onsite – September 2024
4. Receive the data in CyberNoc – October 2024
5. Demonstration phase – till December 2025

To achieve these objectives, the timeline reported in the tables below is forseen.

Table 7: Use cases 1 and 2 forseen timeline

Task name/description	Start [m #]	End [m #]	Duration [mm]
Presentation of project to community members	14	16	3
Signing the contract with energy community	17	20	4
Gathering info about members and their assets	18	19	2
Order needed hardware to host LPC implementation	18	18	1
Protocols inspection	19	22	3
Install LPC to the hardware devices	20	22	2
Test LPC and its mapping in Lab environment	21	23	2
Implement the hardware devices with LPC onsite	21	23	3
Receive the data in CyberNoc	22	23	2
Demonstration phase	24	36	13

5.2.1.3 Risk assessment

The possible risk factors are connected mainly to legal aspects of participation of energy community and its members in the project. Another major risk would be increasing displeasure with the project by energy community members as their abandonment of project can threaten the feasibility of residential flexibility pilot due to lack of data to demonstrate its achieved goals.

5.2.2 Configuration

5.2.2.1 CyberNoc and client/server of IEEE2030.5 over NATS

CyberGrid follows the project´s vision of interoperability by embracing the newly developed protocol IEEE2030.5 over NATS in its daily business. To show its usefulness and applicability CyberGrid will use only this protocol in communication with the residential flexibility pilot and its devices.

5.2.2.2 Legacy protocol converter

As most of the devices located in energy community do not support IEEE2030.5 over NATS natively legacy protocol converters (LPC here after) will be used to translate to it. After a detailed research IoTmaxx maxx GW4100 device was selected as best suited for the job of hosting LPC (link: https://www.iotmaxx.com/de/produkte/gateway/maxx-gw4100). With this in mind each such device will be configured by CyberGrid and installed on the premises of each DER to communicate with EMS system.

5.2.3 Demonstration

5.2.3.1 Data management

As most of the data gathered in CyberNoc will be from members a special care must put into preserving the security of information. For the purpose of the project only summarised and anonymised data will be shared. In addition, contract between CyberGrid and energy communities will include data management plan with emphasis on security. The flow will be from members or community through CyberNoc to market and InterSTORE consortium.

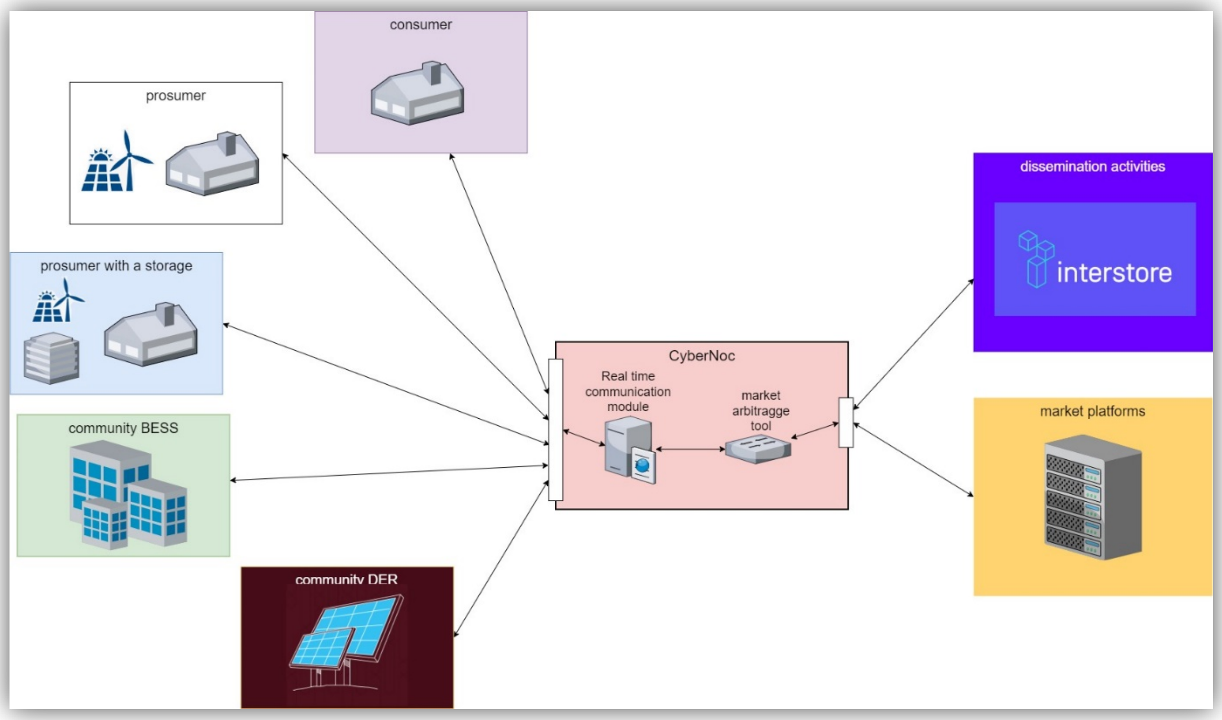

Image 8: Austrian pilot data management

Data needed for the evaluation of the KPIs will be uploaded manually on ZENODO platform.

5.2.3.2 Performance metrics

- KPI1, DES multi-service support
  For the evaluation of this KPI, number of services provided by all DERs will be considered.
  The expected number of services for residential flexibility pilot is 1.
- KPI2, DES multi-service market participation
  For the evaluation of this KPI, the number of services provided by all DERs will be considered.
  The expected value for residential flexibility pilot is 1.
- KPI3, Battery capacity
  For the evaluation of this KPI, the nominal capacities of the integrated assets (expressed in MWh) will be considered.
  The expected capacity for residential flexibility pilot is 30 kWh.
- KPI4, Diversity of DER
  For the evaluation of this KPI, the sum of the different DER tested and controlled will be considered. If a DER is only tested, but not controlled, it will be counted as 0.5, instead of 1. The expected value for residential flexibility pilot is 2.5.
- KPI5, Asset management monitored by EMS

For the evaluation of this KPI, the number of assets monitored by CyberNoc, thanks to the integration via the InterSTORE solution, will be considered.
The expected value is 20.

- KPI6, Number of assets aggregated
  For the evaluation of this KPI, the direct count (sum of the number of assets) will be considered.
  The expected value for residential flexibility pilot is 20.
- KPI8, Demand Response cost – optional
  This KPI evaluates the electricity cost per kWh which is to check the optimization of the energy plan of flexible demands. The expected outcome is: Monthly average flexibility service price < Monthly average intraday market price
- KPI10, Number of DER assets and EMS tested with IEEE2030.5
  For the evaluation of this KPI, the number of DER successfully integrated by communicating via IEEE2030.5 over NATS protocol (legacy protocol converter or client/service option) and demonstrated in real-life pilots is considered.
  The expected value for residential flexibility pilot is 21.
- KPI11, Data space connection of assets
  For the evaluation of this KPI, the number of assets integrated in the common data space exchanging data is considered. In particular, only the number of assets counted for KPI6 that will send data to the data space will be counted.
  The expected value for residential flexibility pilot is 50% (meaning that half battery systems will send data to the data spaces, at least once).
- KPI25, Integrated capacity
  For the evaluation of this KPI, the sum of the rated powers (in MW) of the assets integrated in the demo will be considered.
  The expected value for residential flexibility pilot is 0.03 MW.
- KPI26, Increase of flexibility
  For the evaluation of this KPI, the sum of total capacity (in MWh) that is integrated in the UC and remains available to provide flexible services (thus not-used) is considered.
  The expected value for residential flexibility pilot is 0.03 MWh.

5.3 Germany Forschungszentrum Jülich

5.3.1 Planning

5.3.1.1 Pilot Scope and Objectives

A major goal of FZJ in the energy research field is to support transitions towards carbon-neutral, sustainable and safe operation of energy systems. In this context, we aim not only to provide innovative research solutions but also to serve, with our campus, as an example for the operation of such systems. The integration of the tools developed in InterSTORE in our ICT platform will also facilitate the integration of additional storage units in the FZJ campus, facilitating the transition towards a carbon-neutral operation of the campus itself. It is worth noting that FIWARE [4] is an open-source framework providing components and standard architectures for smart solutions in different domains. This middleware allows the integration of various field devices, thanks to the support of numerous standard IoT protocols (e.g., Modbus). In addition, FIWARE offers a catalogue of open-source components built on top of mature and widely used databases (e.g., MongoDB, and TimescaleDB), which are based on REST (representational state transfer), and can be combined according to the projects' needs. Nevertheless, at the moment, IEEE 2030.5 is not supported, yet, and thus our ICT platform can benefit from the integration of the tools developed in InterSTORE. With this aim, two use cases will be demonstrated in this pilot.

In UC3, Grid Supporting BESS, the InterSTORE legacy protocol converter (LPC) will be integrated into the campus ICT platform based on FIWARE and compared with the solution traditionally developed at FZJ. A series of commissioning tests will be performed to verify the effective interoperability of the communication interface, considering 2 battery systems. The first is a Riello system, and the second one is a TESLA Megapack system. The former is considered to be a high-power system, with 1.5 MW and 500 kWh, while the latter is high-energy, with 0.5 MW/2.6 MWh. Furthermore, given the flexibility of the LPC, the FZJ ICT platform will become more open and flexible, facilitating the integration of other DERs in the system.

In UC8, Multiphysics flexibility optimization for Home Management Systems (HMSs) and their global integration, the middleware developed in InterSTORE will be used to verify that the integration of the HESS is effective and enables the flexibility optimization of a multi-physics-based system on a local (building) level, and on a community (multiple buildings) level. In this regard, a series of commissioning tests will be performed to verify the effective interoperability of the communication interface. Then, the integration of the HESSs in the novel HMS will be evaluated, with respect to the successful exchange of control set-points. The HESS system is composed of 2 battery systems, the same as UC3, 1 heat pump and a large photovoltaic installation (1.1 MW).

5.3.1.2 Timeline and Milestones

To achieve these objectives, the timeline reported in the tables below is forseen.

Table 8: Use Case 3 forseen timeline

Task name/description	Start [m #]	End [m #]	Duration [mm]
Deployment of data spaces	13	14	2
Riello - ICT platform interface with "traditional" solution	13	22	10

Riello - ICT platform interface with LPC solution	16	22	7
Riello - Test of controllability	20	36	17
Tesla - commissioning	13	19	7
Tesla - ICT platform interface with "traditional" solution	20	26	7
Tesla - ICT platform interface with LPC solution	20	26	7
Tesla- Test of controllability	25	36	12

Table 9: Use Case 8 forseen timeline

Task name/description	Start [m #]	End [m #]	Duration [mm]
EATON - EMS Delivery	14	18	5
EATON - EMS algorithm development	15	30	16
RIELLO-EMS communication	19	22	4
RIELLO-EMS setpoints	23	25	3
Tesla commissioning	13	19	7
TESLA-EMS communication	20	22	3
TESLA-EMS setpoints	23	25	3
PV-EMS communication	19	21	3
PV-EMS setpoints	22	25	4
HP commissioning	13	20	8
HP-EMS communication	21	24	4
HP-EMS setpoints	25	28	4
Flexibility building level	25	36	12
Flexibility community level	25	36	12

It has to be noted that the foreseen timeline for the tests (e.g., Test of controllability in UC3) refers to the time period in which the tests will be conducted, but does not mean that the tests will run continuously for the overall period.

Particular attention has to be considered for UC8, since the HMS provided by EATON has first to be tested in their laboratory environment. Then, after it is delivered and installed at FZJ, the incremental prototyping approach will be followed. In this regard, the communication with each asset will be tested individually, first considering the default communication protocol of the asset (e.g., Modbus) and then implementing the LPC. Once the base communication is successful, the correct exchange of measurements and setpoints will be tested. Only when all of these conditions have been met by each asset individually, the flexibility tests (building and community level) will be performed. Given the strict safety concerns in place at FZJ, the incremental prototyping approach will be used also in the flexibility tests phase. Thus, the proper functionalities of the EMS will be first tested in the hardware in the loop (HiL) co-simulation environment, using the digital twin of the campus and a detailed model of the LTDH network that makes use of the heat pumps, with measurements coming from the field.

5.3.1.3 Risk Assessment

Possible risks are associated with the implementation of control setpoints to the assets installed on the field. In particular, a local controller (Fernwirkanlage, FWK) is being installed by the external distribution system operator, to implement high-priority control actions for the safe management of the system. This controller is expected to act as a bottleneck for setpoints sent to the devices on the field. Control setpoints exceeding the limits, will be simply neglected. To mitigate this risk, the co-simulation environment available in our hardware in the loop (HIL) laboratory, which includes real data feed to the digital twin of the campus power system and a detailed model of the LTDH network that makes use of the heat pumps, can be used as a backup solution.

5.3.2 Configuration

5.3.2.1 Technology Setup

The usage of following hardware and software components is foreseen in the pilot:

- UC3
  - Riello, high-power battery system (1500 kW/500 kWh), composed by 3 inverters model SPS HE 500. Base communication via Modbus.
  - Tesla "Megapack", high-energy battery system (500 kW/2.5 MWh). Base communication via Modbus.
  - FZJ ICT platform, FIWARE-based. Base communication via MQTT.
- UC8
  - Riello, high-power battery system (1500 kW/500 kWh), composed by 3 inverters model SPS HE 500. Base communication via Modbus.
  - Tesla "Megapack", high-energy battery system (500 kW/2.5 MWh). Base communication via Modbus.
  - PV system, 1.1 MWp. Composed by 8*110 kVA inverters, model Sunny Tripower CORE2, and 2*SMA Data Manager for monitoring and controlling the inverters. Base communication via Modbus.
  - Heat pump, Viessmann Vitocal 350-HT Pro. Average thermal power 200 kW. Base communication via MQTT.
  - EATON EMS, model SMP DA-3050. Base communication via Modbus.

5.3.2.2 Data Management

Collected data will be stored locally, for safety reasons. In particular, when possible, tests results will be stored directly in the FZJ ICT platform, based on FIWARE.

Data needed for the evaluation of the KPIs will be uploaded manually on ZENODO.

5.3.3 Demonstration

5.3.3.1 Feedback Collection

Not forseen in the initial definition of the use cases.

The possibility of collecting feedback from users involved in the implementation of the tools in UC3 is currently under evaluation.

5.3.3.2 Performance Metrics (KPI)

- UC3

- KPI3, Battery capacity

For the evaluation of this KPI, the nominal capacities of the integrated assets (expressed in MWh) will be considered.

The maximum expected value is 3 MWh (0.5 MWh and 2.5 MWh for the integration of the Riello and the Tesla battery, respectively).

- KPI4, Diversity of DER

For the evaluation of this KPI, the sum of the different DER tested and controlled will be considered. If a DER is only tested, but not controlled, it will be counted as 0.5, instead of 1.

Since each integration counts individually, and the Riello battery system is composed by 3 inverters, each one needing 2 integrations (1 for the communication and 1 for the control), the maximum expected value is 7 (6 for the Riello battery system and 1 for the Tesla).

- KPI5, Asset management monitored by EMS

For the evaluation of this KPI, the number of assets monitored by the FZJ EMS, thanks to the integration via the InterSTORE solution, will be considered.

Since each integration counts individually, and the Riello battery system is composed by 3 inverters, each one needing 2 integrations (1 for the communication and 1 for the control), the maximum expected value is 7 (6 for the Riello battery system and 1 for the Tesla).

- KPI7, N° of end users involved in HESS

For the evaluation of this KPI, the number of users involved in the control and management of the DER is considered.

The expected value is 4 (1 for the user performing the test, 1 for the owner of the Riello battery system, 1 for the owner of the Tesla, 1 for the internal system operator).

- KPI9, Time savings

For the evaluation of this KPI, the different time needed for the integration of the BESS by means of the traditional solution (FIWARE-based) versus the InterSTORE solution (legacy protocol converter). In order to make some meaningful comparison, 5 to 10 users will be requested to try both implementations. Then, the average time required for the integration by means of each solution will be evaluated, and the two average times will be compared.

The expected value is (avg_t_InterSTORE / avg_t_FIWARE) <0.8, meaning that the average time required for the integration via the InterSTORE solution (avg_t_InterSTORE) is maximum 0.8 times the average time required for the traditional integration (avg_t_FIWARE).

- KPI10, Nbr of DER assets and EMS tested with IEEE2030.5

For the evaluation of this KPI, the number of DER successfully integrated by means of the IEEE2030.5 (legacy protocol converter, in this case) and demonstrated in real-life pilots is considered. Since legacy protocol converter will be used, the single implementation has to be considered, so each inverter will count as 1.

The maximum expected value is 7 (6 for the Riello battery system -3 inverters with 2 modules each- and 1 for the Tesla).

- KPI11, Data space digitized assets

For the evaluation of this KPI, the number of assets integrated in the common data space exchanging data is considered. In particular, only the number of assets counted for KPI6 that will send data to the data space will be counted.
The maximum expected value is 100% (meaning that both battery systems will send data to the data spaces, at least once).

- KPI17, Data Valorisation cases

With respect to this KPI, FZJ will contribute providing support for the usage of the shared services (KPI19) that will be implemented with the models developed in T4.3.

- KPI19, Data Spaces

For the evaluation of this KPI, the sum of services and files subscribed and published in the demo will be considered.

- KPI25, Integrated capacity

For the evaluation of this KPI, the sum of the rated powers (in MW) of the assets integrated in the demo will be considered.

The maximum expected value is 2 MW (1.5 MW for the Riello battery, and 0.5 MW for the Tesla battery).

- KPI26, Increase of flexibility

For the evaluation of this KPI, the sum of the available capacity (in MWh) that is integrated in the UC and remains available to provide flexible services (thus not used) is considered. This value will be obtained by multiplying the power stored in the battery, not being used, by the corresponding time. This value will be then evaluated in percentage with respect to the total capacity indicated in KPI4.

The maximum expected available capacity is 3 MWh (0.5 MWh and 2.5 MWh for the integration of the Riello and the Tesla battery, respectively).

- UC8
    - KPI3, Battery capacity

For the evaluation of this KPI, the nominal capacities of the integrated assets (expressed in MWh) will be considered.

The maximum expected value is 3 MWh (0.5 MWh and 2.5 MWh for the integration of the Riello and the Tesla battery, respectively).

- KPI4, Diversity of DER

For the evaluation of this KPI, the sum of the different DER tested and controlled will be considered. If a DER is only tested, but not controlled, it will be counted as 0.5, instead of 1.

Since each integration counts individually, and the Riello battery system is composed by 3 inverters, each one needing 2 integrations (1 for the communication and 1 for the control), and the PV field is composed by 2 data managers, the maximum expected value is 10 (6 for the Riello battery system, 1 for the Tesla, 2 for the PV, 1 for the heat pump).

- KPI5, Asset management monitored by EMS

For the evaluation of this KPI, the number of assets monitored by the EATON EMS, thanks to the integration via the InterSTORE solution, will be considered.

Since each integration counts individually, and the Riello battery system is composed by 3 inverters, each one needing 2 integrations (1 for the communication and 1 for the control), the maximum expected value is 10 (6 for the Riello battery system, 1 for the Tesla, 2 for the PV and 1 for the heat pump).

- KPI7, N° of end users involved in HESS

For the evaluation of this KPI, the number of users involved in the control and management of the DER is considered.

The expected value is 6 (1 for the user performing the test, 1 for the owner of the Riello battery, 1 for the owner of the Tesla battery, 1 for the owner of the PV, 1 for the owner of the heat pump, 1 for the internal system operator).

- KPI10, Nbr of DER assets and EMS tested with IEEE2030.5

For the evaluation of this KPI, the number of DER successfully integrated by means of the IEEE2030.5 (legacy protocol converter, in this case) and demonstrated in real-life pilots is considered. Since legacy protocol converter will be used, the single implementation has to be considered, so each inverter will count as 1.

The maximum expected value is 10 (6 for the Riello battery system -3 inverters with 2 modules each- 1 for the Tesla, 2 for the PV -2 data manager aggregating the inverters-, 1 for the heat pump).

- KPI11, Data space digitized assets

For the evaluation of this KPI, the number of assets integrated in the common data space exchanging data is considered. In particular, only the number of assets counted for KPI6 that will send data to the data space will be counted.
The maximum expected value is 100% (meaning that both battery systems will send data to the data spaces, at least once).

- KPI17, Data Valorisation cases

With respect to this KPI, FZJ will contribute providing support for the usage of the shared services (KPI19) that will be implemented with the models developed in T4.3.

- KPI19, Data Spaces

For the evaluation of this KPI, the sum of services and files subscribed and published in the demo will be considered.

- KPI25, Integrated capacity

For the evaluation of this KPI, the sum of the rated powers (in MW) of the assets integrated in the demo will be considered.

The maximum expected value is 3.3 MW (1.5 MW for the Riello battery, 0.5 MW for the Tesla battery, 1.1 MW for the PV system, 0.2 MW for the heat pump).

- KPI26, Increase of flexibility

For the evaluation of this KPI, the sum of the available capacity (in MWh) that is integrated in the UC and remains available to provide flexible services (thus not used) is considered. This value will be obtained by multiplying the power stored in the battery, not being used, by the corresponding time. This value will be then evaluated in percentage with respect to the total capacity indicated in KPI4.

The maximum expected available capacity is 3 MWh (0.5 MWh and 2.5 MWh for the integration of the Riello and the Tesla battery, respectively).

5.4 Portugal (CAP)

5.4.1 Planning

5.4.1.1 Pilot Scope and Objectives

The Portugal Living Lab is responsible for the implementation of the UC5 and UC6 of the Interstore project. This two UCs will be situated in the Sonae Campus that covers roughly 300.000 sq. meters and working population of more than three thousand people, where several services are and sustainable solutions such as efficient water solutions, solar energy, production, electric mobility alternatives, Leadership in Energy and Environmental Design (LEED) certified buildings, green places inside and outside buildings.

At Sonae Campus, Capwatt has installed power plants including two PV solar plants (total of 1MW), one cogeneration plant of 7,4MWe that provides thermal energy for the industrial processes and for the climatization (heat and hot water to the absorption chiller).

Also has several charging points for electric vehicles (AC of 22kW and one DC of 160kW) that feed the fleet of the companies located in the industrial park, and an electric energy storage system of 320kW/798kWh.

All the medium and low voltage electrical network, all the thermal and water infrastructure and all the infrastructures and energy are supervised, operated and managed by Capwatt 24/7 in a centralized way by its Metering and Control Center, assuring the optimization of all the energy assets.

The two use cases:

- **UC5** - A HESS is installed in a building basement. The HESS is composed by two batteries: one of vanadium redox flow, with 10kW and 40kWh and the other is a set of second life lithium batteries with 100kW and 92 kWh. Those batteries are connected to their inverters and are operated according to an EMS installed in a local PC. The HESS is connected to the building, 'behind the meter'. The building has also a PV system of 100kW installed on the rooftop. In the present UC, HESS operation strategies are expected to be demonstrated, that aim to optimize two cost functions (cost and emissions), comparing Hybrid systems to single battery systems. The UC will also analyse the integration and if possible real test of the IEEE2030.5 in the BMS, to showcase the interoperable solution of InterStore, applied to distributed resources. It will also share data with the connected data spaces developed in T2.4.
- **UC6** - At a parking lot of Sonae Campus site, there are a set of EV chargers whose total power exceed the upstream board and cable power capacity if the simultaneity factor (use) is high. Installing and using a local ESS, expected to be around 40-50kW, it will enable the simultaneous operation of the chargers and even install others that surpass the up-stream installed power at the moment. Part of the Use Case is also to define a set of EV users that typically charge in that parking lot and share with them an incentive schedule for implicit demand response based on an environmental signal.

5.4.1.2 Timeline and Milestones

To achieve these objectives, the timeline reported in the tables below is foreseen.

Table 10: Use Cases 5 and 6 forseen timeline

Task name/description	Start [m #]	End [m #]	Duration [mm]
Common sub-task: Data Base (CW-INESCTEC) creation	14	14	1
Common sub-task: Data share (CW-INESCTEC)	15	28	14
Common sub-task: Conclusions report	34	36	3
UC5: Definition of the data that will be shared from the batteries, from the building and from the PV system	13	14	2
UC5: Implementation of the necessary software on the computer	14	18	5
UC5: IEEE2030.5 test	19	20	2
UC6: Definition of the data that will be shared from the chargers	13	14	2
UC6: Definition of the pilot architecture	9	15	7
UC6: List the EV users of the test	14	15	2
UC6: Inquire the EV users	15	15	1
UC6: Procurement phase	6	15	10
UC6: Installation of the battery and all the necessary equipment	17	18	2
UC6: Grid node capacity test	19	29	11
UC6: User acceptance test	16	24	9

5.4.1.3 Risk Assessment

- IT security restrictions may hinder the deployment
- Parallel operation with current configuration may not work
- User engagement on the work place, may not work because of schedule impediments
- Dependence on infrastructure that still on the planed phase, can have impact on the planned schedule

5.4.2 Configuration

5.4.2.1 Technology Setup

- Configure the necessary hardware and software for the pilot.
- Ensure compatibility and integration with existing systems.
- Set up a controlled testing environment for the pilot.

5.4.2.2 Data Management

- All the data will be shared with INESCTEC via a common data based shared by both partners. All the logfiles will be kept for KPI estimation purposes, for future upload in ZENODO and as a bridge to the Data Space.

5.4.3 Demonstration

5.4.3.1 Feedback Collection

- A google forms has been shared with the EV users that will allow us to define their profile and their engagement to the tests

5.4.3.2 Performance Metrics (KPI)

- UC5:

ID	Name	Description	Reference to mentioned use case objectives	Target
17	Data valorisation cases	Number of cases developed with data valorisation (for example including information about longevity, maintenance, pay-back or ROI,…)	3	4
18	HESS performance	Optimization in cost reduction / lifetime extension /energy supply due to HESS when compared to an ESS with only one single battery	2	>0%
10	IEEE verification	Number of assets successfully integrating the IEEE2030.5 standard	1	10
19	Data Spaces	Number. of shared services/files subscribed	3	20

- UC6:

ID	Name	Description	Reference to mentioned use case objectives	Target
7	User Engagement	Improved acceptance and perception by end users (surveys at start and end of demo)	(3)	>20
21	Demand Response	Amount of flexibility provided (measured in kWh). Amount of kWh resulting from shift from baseline (forecast consumption)	(3, 2)	>6 kWh/day
22	Node power increase time	Time (in minutes) in which the power demand was higher than the upstream capacity, by using the battery support for that increase.	(1)	60 min/workday
23	Node power increase percentage	Maximum percentage of Power surpassing the installation's capacity due to the use of the battery to charge the EVs	(1)	>5%
24	User participation	Percentage of users (being monitored) actively following the DR incentive. Actively meaning that they follow the incentive (deviate from past behaviour) on the majority of days during the demonstration	(3)	>10%

5.4.3.3 Documentation

- All the technical documentation is saved and the defined one is shared between the entities involved.

5.5 Spain (HES)

The Advanced Grid Laboratory is located in Valencia (Spain) with the following main features:

- 1.5 MW of connected power systems
- Recirculation capacity up to 500 kW with UCAPs and Battery pack
- Facility managed by the advanced energy management platform.
- Connection buses both DC and AC parts
- Ability to emulate a supply grid and its associated events:
    - Voltage deviations
    - Frequency deviations
    - Virtual inertia emulation
    - Island mode operation
    - Power Oscillation damping
    - Unbalance of phases and loads / generation
    - Ability to emulate renewable sources and/or consumption (variable loads)

The HESS system in GridLab facilitated by an integrated hybrid storage based on 200 kW/200 kWh of lithium batteries and 250 kW/60 sec of ultracapacitors, integrating the HyDEMS to be developed by HESStec under the InterSTORE project.

5.5.1 Planning

5.5.1.1 Pilot Scope and Objectives

The laboratory pilot within the InterSTORE project serves as a crucial testing ground for the integration and demonstration of advanced energy storage technologies and management systems. The scope and objectives of this pilot encompass a comprehensive exploration of flexible hybrid energy storage systems (HESS) within various application areas, including ultracapacitors, battery packs as different DERs with gird forming and grid following capabilities.

The primary aim of the laboratory pilot is to enable the flexible use of HESS across diverse applications, leveraging beyond-the-state-of-the-art methods to hybridize and utilize storage flexibility while ensuring data space standardization. The specific objectives of the pilot include:

- **Demonstration of High-Impact Use Cases:** Two use cases, including UC4 and UC7, are designated for demonstration within real-life living labs. UC4 focuses on frequency and inertia services, while UC7 pertains to HESS management systems for autonomous operation across different modes.
- **Integration of different Distributed Energy Resources (DER):** This laboratory pilot seeks to integrate different DERs to enable the hybridization and utilization of storage flexibility within real-life environments. This integration fosters the optimal utilization of diverse storage technologies, maximizing their synergies and extending the performance of energy storage solutions.
- **Hybrid Energy Storage Solutions:** Embracing a hybrid approach, the pilot explores the combination of various storage technologies to expand possibilities and enhance performance. By leveraging the strengths of different technologies, a hybrid solution mitigates oversizing issues, reducing both capital and operational expenditures.
- **Development of Hybrid Distributed Energy Management Systems (HyDEMS):** This laboratory pilot aims to develop innovative DEMS capable of hybridizing and virtualizing distributed energy resources to optimize seamless performance. These

cloud-based software control platforms feature advanced asset modeling, optimal operation, hybridization algorithms, and state-of-function virtualization layers.

- **Enhanced Interoperability and Functionality:** Through the integration of DEMS, the pilot seeks to maximize interoperability and functionality, translating technical parameters into actionable insights for multiple grid services. This approach facilitates real-time control and operation of aggregated energy storage systems, ensuring reliability and robustness.

The laboratory pilot within the InterSTORE project is poised to revolutionize the deployment of energy storage solutions across diverse applications. By addressing key objectives such as flexible use, integration of distributed resources, and development of advanced management systems, the pilot paves the way for a more resilient and efficient energy infrastructure. Through collaboration and innovation, InterSTORE aims to redefine the capabilities of energy storage, unlocking new opportunities for grid stability, sustainability, and resilience.

UC4:

This use-case presents a procedure to test and validate the performance of the HESS unit for providing fast grid services to coupe with future challenges of low inertia systems. To do so, first the grid forming capability of the HESS conversions system will be tested in island mode and then provision of providing fast services such as virtual inertia, frequency regulation and oscillation damping will be evaluated in grid connected mode.

The main focus of this HLUC can be broke-down as follows:

1. This Use Case identify and analyse how the system can be used for providing different innovative grid services with grid forming capabilities in low inertia networks.
2. Test and validate the possibility of HESS conversion system in island mode and reconnection, after synchronization activation, with the main grid with proper communication.
3. Offer additional services in grid connected mode such as frequency regulation with the goal of improving the dynamic response of the system consisting of different type of storages (High power UCAPS + High energy Batteries).
4. Fast advanced control solution for virtual inertia emulation and frequency regulation.

UC7:

The developed HyDEMS product in this project is a software-based control platform with cloud computing capabilities, conceive to seamlessly integrate and optimize energy resources in a distributed scenario. It comprises a set of proprietary hybridization, degradation, and virtualization algorithms, oriented towards an optimal planning and interoperable distributed energy storage (DES) operation with the final purpose of enabling the provision of a stacked pool of multiple flexibility services to grid operators.

A DERMS in this use case will analyse the real time data that can help integrate, manage, and control flexible and intermittent DERs and electric demand. In this scenario, HES envision to provide alternative solutions to integrate DERs more quickly into the energy mix. For this use case, two distinctive DERs have been selected. One DER consists of two different storage technology, UCAP and battery while the other DER can be defined an intermitted source of renewable based generation. Additional components are employed in the lab facilities for emulating real grid conditions. The defined DER1 will be operated in grid forming mode (GFM) while DER number 2 will operate in grid following mode. At the lower level, each DER will have its own management system with hybridization (in this case DER1). At the upper level the HyDEMS tool will be operated as a bridge between the aggregator with data in cloud and local statue of different DERs. The State of the Function (SoF) for different components of the defined DER will be generated and transmit a relative SoF for each selected service. So full operation of HyDEMS for hybridization considering the vector of SoF can be checked and tested.

The main focus of this HLUC can be broken-down as follows:

1. This use case should identify and analyse how the hybridization algorithm can be incorporated and tested for HyDEMS application with aggregator on top and multiple DER in laboratory scenario.
2. To test and incorporate the use of SoF for an interoperable distributed energy storage (DES) operation for one selected grid service.
3. To test and validate the developed energy management system on incorporation and coordination of different DERs with different mode of operation: Grid Forming (GFM) and Grid Following (GFL) in laboratory scenario.

5.5.1.2 Timeline and Milestones

To achieve these objectives, the timeline reported in the table below is foreseen.

Table 11: Use Cases forseen timeline

Task name/description	Start [m #]	End [m #]	Duration [mm]
DER1 and DER2 preparation	14	17	3
Communication check: IEEE2030.5 and software tool	15	20	5
HyDEMS upgrade and generic tests	12	24	12
UC7 test: HyDEMS with black start and energization test	22	26	4
UC7 test: HyDEMS Island mode and grid connected operational test	25	28	3
UC7 test: HyDEMS Vdip, V dip detection and Automatic ATS test	25	29	4
UC7 test: HyDEMS reporting of full real life Gridlab tests	27	32	5

Based on the progress and anticipated outcomes of Work Packages 3 and 4, we foresee this timeline that aligns with project milestones and objectives in WP5. Our projections account for the sequential execution of activities, ensuring a coherent and efficient advancement towards project completion.

Milestones:

- Software Tool integration with HyDEMS in UC7: 01/03/2025.
- Full real life operational test of HyDEMS in Gridlab: 01/05/2025.
- Final documentation: 01/08/2025.

It's important to clarify that the estimated timetable for these tests (e.g., HyDEMS upgrade and generic tests) indicates the timeframe during which the tests will occur and be finalized with an approximate due date. However, due to the dependency of these tests on the activities of previous work packages and system developments during the project, this does not imply that the tests will be conducted continuously throughout that entire period.

5.5.1.3 Risk Assessment

- Incorporating the new communication standard IEEE2030.5 into our developments may introduces the possibility of encountering some limitations of challenges or unforeseen technical complexities for testing very fast services. We are prepared to address these risks through parallel approaches with testing with local facilities and proactive troubleshooting measures to ensure the seamless integration and reliable operation of our hybrid energy storage solution.
- Communications over the internet mean that device is accessible and the information it sends can be intercepted or modified. Communications should be secured using TLS to avoid security leaks and the authority to access the device must be checked.

5.5.2 Configuration

In our lab facilities two different configuration according to two different use cases are accessible. But for testing and final real-life validation of our developed EMS, HyDEMS, the configurations presenting in UC7 will be used in WP5 activities.

5.5.2.1 Technology Setup

Configuration and setup for UC4:

The methodology described in this UC4, is generic steps and test to be followed for demonstrating the successfulness of the HESS on providing fast services such as virtual inertia and frequency regulation with inherent virtual inertia and damping of oscillations.

This may involve developing protocols for communication and control and ensuring that the different technologies can be connected and managed in a way that maximizes their performance.

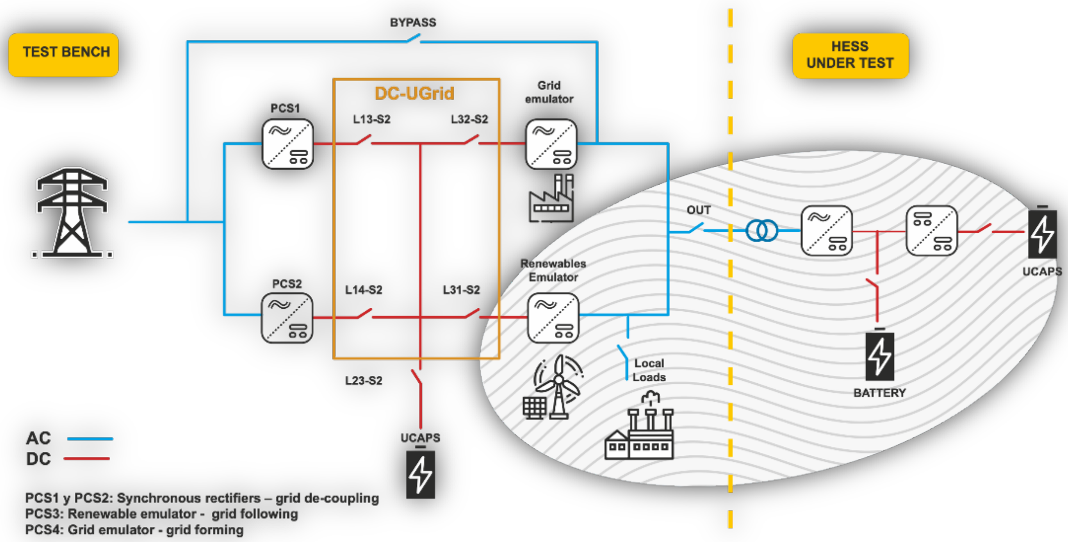

Image 9: GridLab scenario for implementing the UC4 for fast grid service test in WP3

Configuration and setup for UC7:

The methodology described in this UC7, is generic steps and test to be following for demonstrating the successfulness operation of the developed HyDEMS on hybridization with incorporation of System Operability Framework (SoF) for smooth response on providing the selected services from the aggregator.

This may involve developing protocols for communication and control and ensuring that the different technologies can be connected and managed in a way that maximizes their performance.

In this scheme, DER1 and DER2 are distributed source of energies. DER1 consists of hybrid storage (UCAP and Battery) operating in GFM approach and DER2 will play a role of a renewable source of generation working in GFL mode and PCS4 is a grid emulator creating the rest of the external grid during test in GridLab.

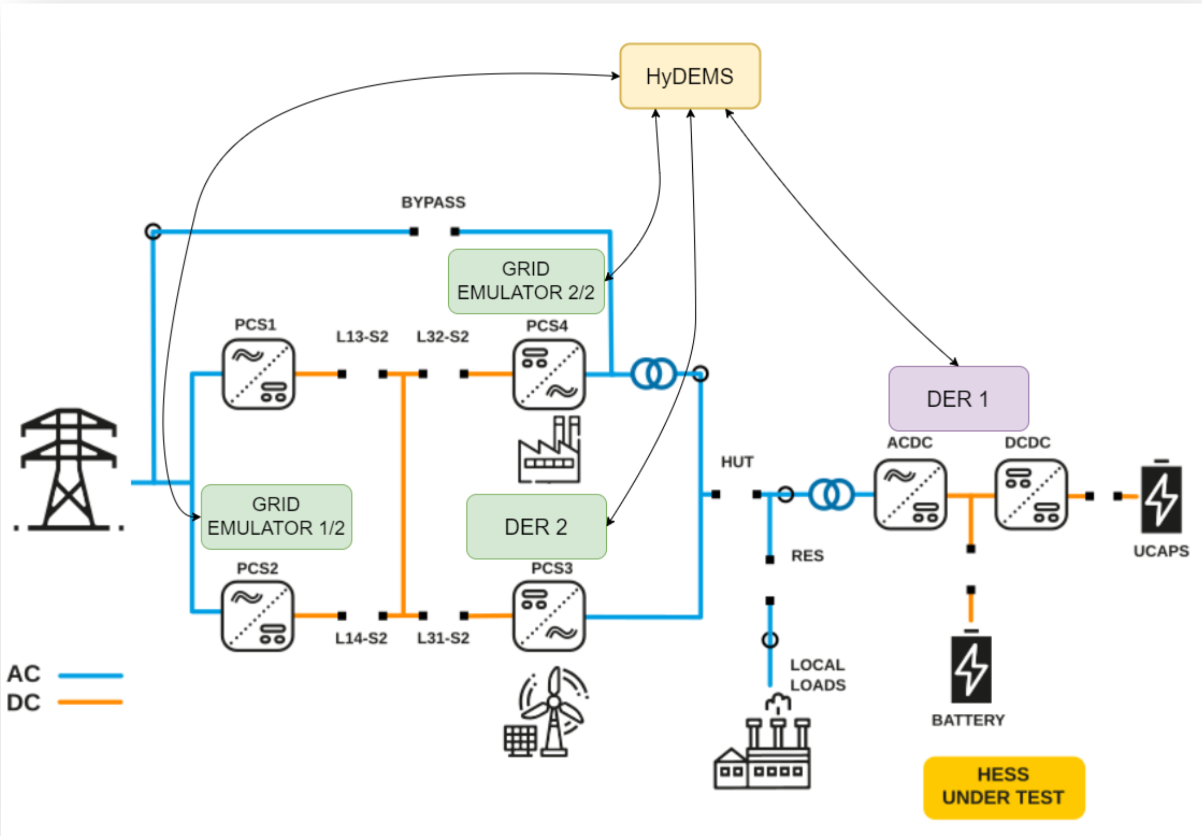

Image 10: GridLab scenario for implementing the UC7 for HyDEMS generic test in WP5

5.5.2.2 Data Management

Hesstec devices are connected thought a bi-directional channel using a message queuing server called NATS.

The communication protocol is called "NATS protocol", is a proprietary client protocol implemented to communicate with a NATS server. Establishes a TCP/IP socket connection and is TLS-securely enforced.

Hesstec devices send their status periodically and can receive information and commands via this server. Cloud general overview is presenting in the following figure:

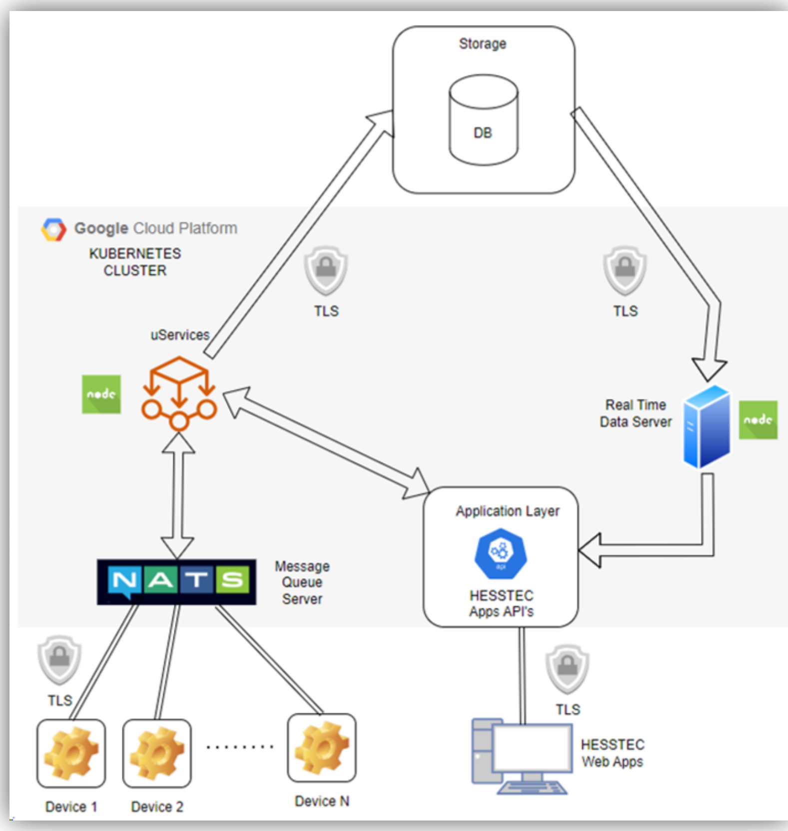

Image 11: Cloud general overview according to HESStec approach

To connect Hesstec devices to Interstore Data Space Connector, two solutions are being under evaluation: Connection through Cloud or Devices Direct Connection. While both options are feasible, their implementation will be decided during project development.

It should be note that following the completion of each test, the main data used for the calculation of Key Performance Indicator (KPI) will be manually uploaded utilizing the ZENODO web interface. This process ensures the systematic integration of test results into our repository, facilitating comprehensive data analysis and reporting.

5.5.3 Demonstration

In our facilities laboratory, we conduct comprehensive demonstrations of our developed Energy Management System (EMS) integrated with hybrid energy storage solutions. These demonstrations are meticulously designed to simulate various real-life scenarios, closely mirroring the complexities encountered in practical applications.

Our approach to demonstration involves the following key steps:

- *Real-life event scenarios*: We recreate diverse operational conditions within the laboratory setting to closely emulate real-world environments. This includes varying load profiles, renewable energy inputs, and grid interactions.
- *Assessment Framework*: We employ a structured assessment framework to evaluate the performance of our EMS under different scenarios. This framework incorporates predefined Key Performance Indicators (KPIs) tailored to measure efficiency, reliability, and overall effectiveness.
- *Comparative assessment*: By systematically comparing outcomes across distinct scenarios, we gain valuable insights into the efficacy of our developed EMS with hybrid energy storage solution. This comparative analysis enables us to identify optimal configurations and operational strategies which will be accompanied with necessary feedback Collection and KPI analysis.

5.5.3.1 Feedback Collection

- Throughout the demonstration process, we actively solicit feedback from our expert users. Their insights contribute to a better understanding of system behaviour and inform iterative improvements.

5.5.3.2 Performance Metrics (KPI)

Through rigorous assessment against predefined KPIs, we validate the performance and reliability of our EMS across a spectrum of real-life conditions. Upon completion of each test, the KPI data will be uploaded manually via the ZENODO web interface.

- Relevant defined KPIs from HESS for UC4 and U7:

KPI 12 Time data savings:

The time saved regarding the availability of measured data used for real time operation of the HESS. This KPI will be used for both UC4 and UC7. The time consumed in the traditional method of data saving versus the methodology proposed in the InterSTORE project need to be calculated. With the InterSTORE project it involves assessing the time saved through the utilization of the Open Data Space approach in clouds. Specifically, we aim to check the time savings achieved by our system when transmitting data between HyDEMS and the open data space. It is crucial to accurately measure and analyze this timing to ascertain the extent of improvement.

KPI 13 Monitoring:

N° of assets monitored in GridLab for the project used for both UC4 and 7. Direct measure of availability of the distributed source of energy. In use case 4 and 7 sources like Battery, UCAPs, DER1 and DER2 as monitoring devices can be added. During InterSTORE project with implementation of SoF the real time availability of number of devices can be checked.

KPI 14 Time response:

is considered as the overall HESS system time response which will be needed for providing the service complying TSO grid codes used for both UC4 and 7. Evaluation of time between the request sent by the TSO and the full response from the assets. The time boundaries are related to the communication technology used for the project. To calculate the time response, we consider different timings: the (t1) as time from aggregator to HyDEMS (it will use API or Modbus), (t2): timing from HyDEM EMS to DER1 GFM (Modbus and (t3): timing from DER1 to Danfoss converter (Legacy protocol converter).

T=t1+t2+t3≤ Tf or Ts

Where t1 is related to the communication time from aggregator to EMS (by API or ModBUS), t2 is the time from EMS to DER1 GFM (MODBUS) and t3 will be the time from DER1 GFM to Danfoss inverter (LPC).

(Tf=0.5 RoCof calculation time window for fast service and Ts=1 sec for slow energy services.)

KPI 15 System NADIR:

indicator that corresponds to the lowest frequency value during frequency regulation services in both UC4 and 7. Direct measure of NADIR from the frequency at the point of interconnection to the grid (POI).

The criterion that defines the limit for NADIR is expressed as

$$f_{Nadir} \geq f_{min}$$

where f_{min} is the minimum acceptable frequency defined in the grid code.

KPI 16 System ROCOF:

Indicator which results during the first instants after the time of occurrence of an event during fast services used for both UC4 and 7. Direct measure of the rate of change of frequency measured at the point of connection to the grid (POI). It will be calculated in 0.5 sec time window after the occurrence of the fault. The ROCOF is defined as follows:

ROCOF=df/dt

6 Conclusion

All activities and analyses that contributed to the writing of this document were conducted in a highly collaborative manner, with each partner actively participating in every phase. This included joint planning virtual meetings and collective evaluation processes. Each partner brought their unique expertise and perspective, ensuring a comprehensive and well-rounded final document.

The document provides a comprehensive overview of all activities and actions planned at the pilot sites, meticulously detailing its scope, methodologies, and implementation across various stages and different geographical pilot's locations. Beginning with the executive summary, it establishes the purpose and scope, introducing the core objectives and tasks. The initial sections lay the foundation by elucidating the project's intent and setting the stage for a thorough analysis of use cases and KPIs.

The third section delves deeply into the use cases, defining key performance indicators (KPIs) essential to evaluate the achievement of project objectives. This includes a detailed methodology for KPI calculation, ensuring a standardized approach across different pilots, scenarios and use cases. The alignment of these KPIs with the project objectives underscores the strategic planning involved, emphasizing harmonization with broader project goals.

Dataset provisioning is addressed in the fourth section, where templates, data sharing mechanisms, and supporting tools are detailed. This includes a high-level look at the ZENODO platform, used for publishing all the data that will be collected across the various pilot sites and demonstrations.

Section five focuses on the practical application of all the processes and standards, described in the previous chapters, through pilots in five countries: Italy, Austria, Germany, Portugal, and Spain. Each pilot's planning, configuration, and demonstration phases are meticulously documented, reflecting the project's adaptability and operational execution across diverse environments and locations.

Overall, this document serves as a detailed starting point and roadmap for all project activities that will be conducted within the pilot sites, from conceptualization to execution, with a strong emphasis on data-driven evaluation and cross-pilots collaboration.

Furthermore, the document lays the foundations for all the WP5 work that will be carried out within the subsequent tasks: the execution of the pilot demonstration actions (T5.2-T5.5) and the final evaluation phase (T5.6). This deliverable will also be used as input for subsequent WP5 documents (D5.2 - Report on software tools integration and test execution across the pilot sites and D5.3 - Report on evaluation of use cases and KPIs evaluation).

7 References

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8 List Of Tables

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