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Use case detailed definitions and specifications of joint activities in the Demonstrators

V1.0

Deliverable D2.1

31/12/2017

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EXECUTIVE SUMMARY

As from the GA no. 731289 Annex 1 (GA-A1), the scope of task 2.1 is apart from the overall technical coordination of the six Demonstrators also the collection of Demos' functional requirements in order to provide an input for replicating the most promising results at EU level (in connection with WPG3) and allowing avoiding of the duplication and/or overlapping of activities. These objectives are reached by integrating the requirements and specifications of the defined Demos' UCs, identifying the complementariness and specifying relation with the KPIs.

A common methodology was considered necessary by all the partners and for this reason the UC collection method was adopted. This approach has been identified as suitable and was already used by the Smart Grid Coordination Group, working on the requirement collection and classification of the Smart Grid Solutions all over Europe.

At the same time the Architectures of the Demos and the UCs were collected and mapped using the SGAM (Smart Grid Architecture Model) layer representation. This method develops a unique consistent framework representing business models, functional requirements, the communication and data model standards among all the Demos.

The following Figure depicts the 5 InterFlex demos and their respective innovation streams:

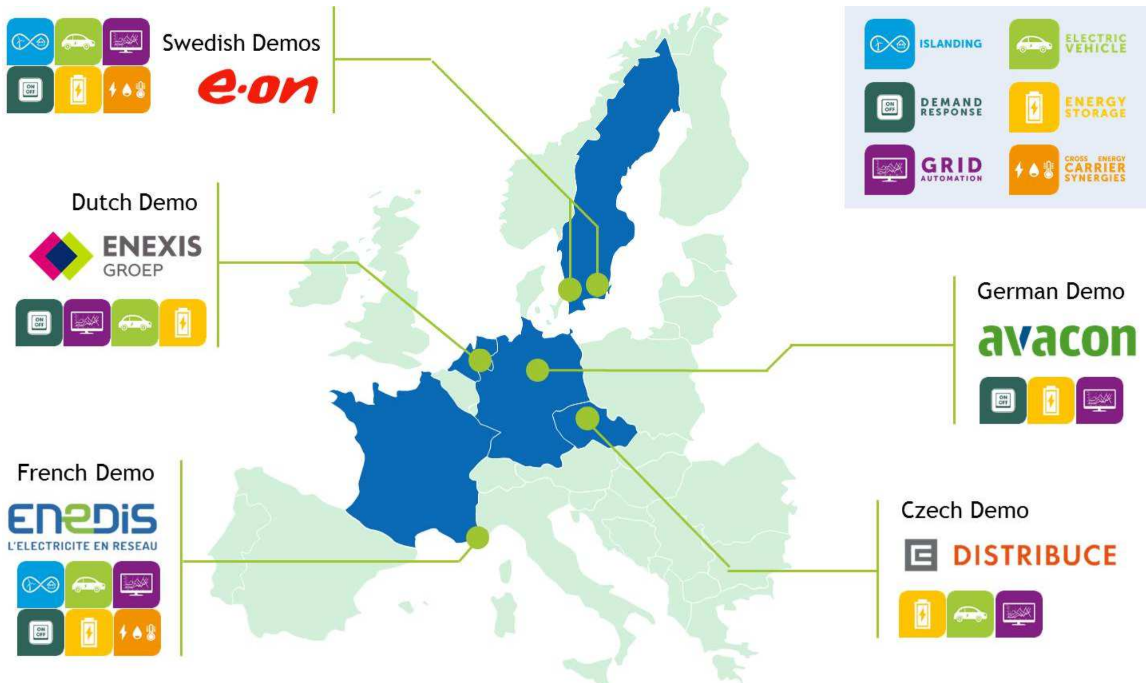

Figure 1: Map of Demos and innovation streams

Following up the analysis of the interactions and synergies of the Local Demonstrations as in the GA-A1, the Documents have been deconstructed and analysed obtaining different categories; each UC has been generally described and classified on the basis of:

- scope;
- solutions adopted;
- level of description;
- topology of the solution;
- standardized actors/system involved

This classification has facilitated the comparison among the UCs and it has shown how DSOs addressed similar scopes and objectives while adopting different technologies, system and infrastructure, thus aiming at increasing the further scalability and replicability analysis.

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1 INTRODUCTION AND SCOPE OF THE DOCUMENT

1.1 SCOPE OF THE DOCUMENT

The scope of the document is:

• the report of the requirement collection activities carried out since January 2017 by all the Demos;

• the representation of the standardized and international UC methodology for the requirement collection;

• analysis, classification and tuning the different Demo solutions and the UCs that describe them.

1.2 STRUCTURE OF THE DOCUMENT

The document is structured into 5 sections:

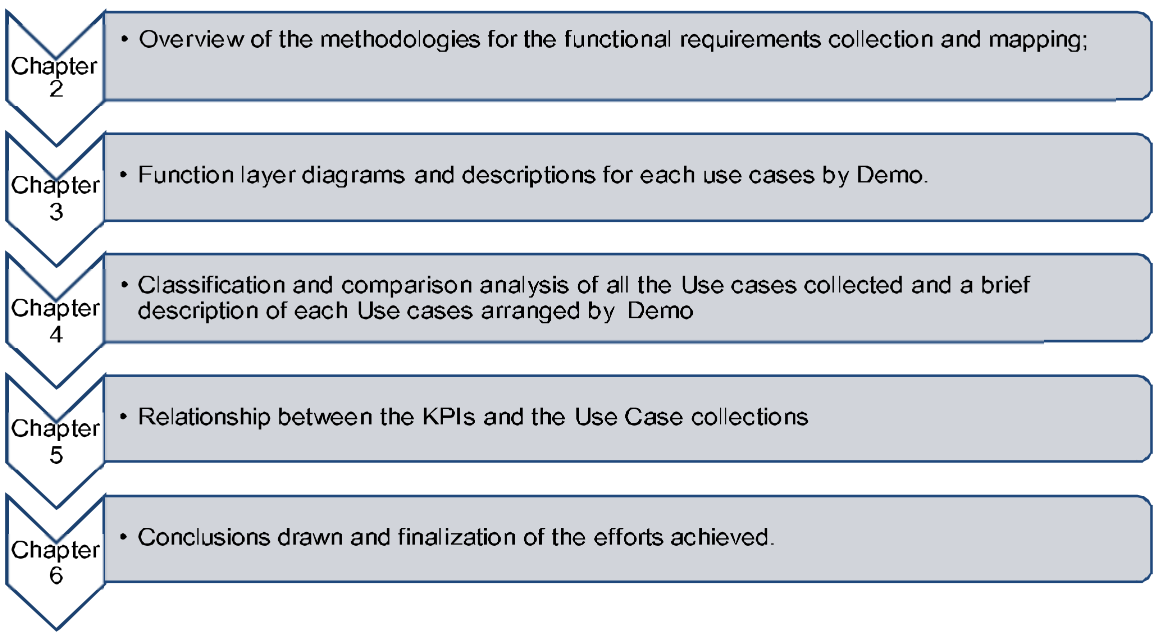


Figure 2: Structure of the document

Notations abbreviations and acronyms

API	Application Programing interface
DER	Distributed Energy Resources
DSO	Distribution System Operator
EV	Electric Vehicle
GA	Grant Agreement
HV	High Voltage
KPI	Key Performance Indicator
LV	Low Voltage
MV	Medium Voltage
PLC	Power Line Communication
PV	Photovoltaic
RES	Renewable Energy Sources
SGAM	Smart Grid Architecture Model
SGCG	Smart Grid Coordination Group
UC	Use Case

2 FUNCTIONAL REQUIREMENTS COLLECTION METHOD

2.1 SGAM AND UC DESCRIPTION COLLECTION

The Smart Grid Architecture Model (SGAM) was chosen as the best practice from GRID4EU and was proposed by M/490 Reference Architecture Working Group. It is deeply described in [1] and recalled in Standardization.

The function layer, applied on the Smart Grid plane (see Figure 2), represents UCs, functions and services independent from their physical implementations in systems and components. It is intended to map the UCs including actors, sub-functions or functional and non-functional requirements.

The UC describes the behaviour of the system under specification when external entities send one particular stimulus. Functional requirements capture the intended behaviour of the system. This behaviour may be expressed as services, tasks or functions the system is required to perform. Non-functional requirements capture general restrictions the system is subject to, such as:

- pre-existing architectural constraints;
- architectural qualities (extensibility, flexibility,…);
- security;
- performances;
- maintainability.

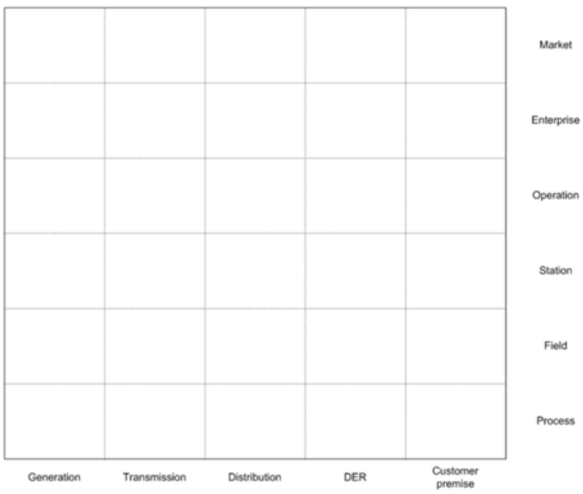


Figure 3: SGAM Function Layer

The present document describes requirement collection for Smart Grids demonstrators adopted in the InterFlex project and it mainly focuses on the function layer.

2.2 UC DESCRIPTION COLLECTION PROCESS

For collection process it was decided to use a simplified processes which were used in the GRID4EU project. For Interflex it was adopted Use Case approach suggested by the SGCG M/490 base on IEC Publicly Available Specification 62559. This technical reference specification, developed initially by the EPRI as part of the Intelligrid project and then adopted by the IEC in 2008, suggests a way to define requirements for Energy systems and has not to be considered as a standard.

The SGCG Sustainable Process Working Group has defined a template for UC collection. It comprises of three versions
i) Short version template (contains elementary fields to describe the basic idea of a use case)
ii) General version template (contains the basic information and additional basic information and criteria to manage and classify the use case),
iii) Detailed version template (contains short and general information plus additional information fields) InterFlex opted for the full information on the use cases, i.e. UCs description using Detailed version template.

The methodology proposed includes requesting that all stakeholders describe their requirements through formal UC methods to ensure that the functional requirements reflect all these needs. These UCs also define the constraints, performance, security, and data requirements of all new applications and systems – before any implementation activities are commenced.

After the UC methodology was decided, a workshop was organized in order to explain the process for the UC collection and the templates to be filled in. Additionally for some Demos (CZ, DE, SE Demos) dedicated workshops were organised.

Template for UCs descriptions was prepared and a guideline provided – see Annex 3 of this deliverable.

A list of collected detailed UC descriptions is shown in the Table 1:

DEMO	Leader	Use Case NAME	
DE DEMO	Avacon	UC1	Feed In Management
		UC2	Demand Side Management
		UC3	Ancillary Services
CZ DEMO	ČEZ Distribuce	UC1	Increase DER hosting capacity of LV distribution networks by smart PV inverters
		UC2	Increase DER hosting capacity in MV networks by volt-var control
		UC3	Smart EV charging
		UC4	Smart energy storage
NL DEMO	Enexis	UC1	Improve grid flexibility using Smart Storage Unit
		UC2	Improve grid flexibility using Electric Vehicle
		UC3	Usability of an integrated flex market
SE DEMO	E.ON	UC1	Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers
		UC2	Optimal use of a large heat pump asset providing the district heating grid with heat and electricity flexibility for grid management purposes
		UC3	Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation
		UC4	Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs
		UC5	Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints
FR DEMO	Enedis	UC1	Automatic Islanding
		UC2	Multiservice approach for centralized storage systems
		UC3	Local flexibility mechanism

Table 1: List of collected detailed UC descriptions

3 USE CASE MAPPING

This chapter explains how should be UC templates filled in and how should be UCs mapped to SGAM.

Introduction to SGAM

The Smart Grid Architecture Model (SGAM) is a reference model to analyse and visualise smart grid UCs in a technology-neutral manner. Furthermore, it supports comparison of different approaches to Smart Grid solutions so that differences and commonalities between various paradigms, roadmaps, and viewpoints can be identified. By supporting the principles of universality, localization, consistency, flexibility and interoperability, it also provides a systematic approach to cope with the complexity of smart grids, allowing a representation of the current state of implementations in the electrical grid as well as the evolution to future smart grid scenarios.

Smart grid plane

In general power system management distinguishes between electrical process and information management viewpoints. These viewpoints can be partitioned into the physical domains of the electrical energy conversion chain and the hierarchical zones for the management of the electrical process

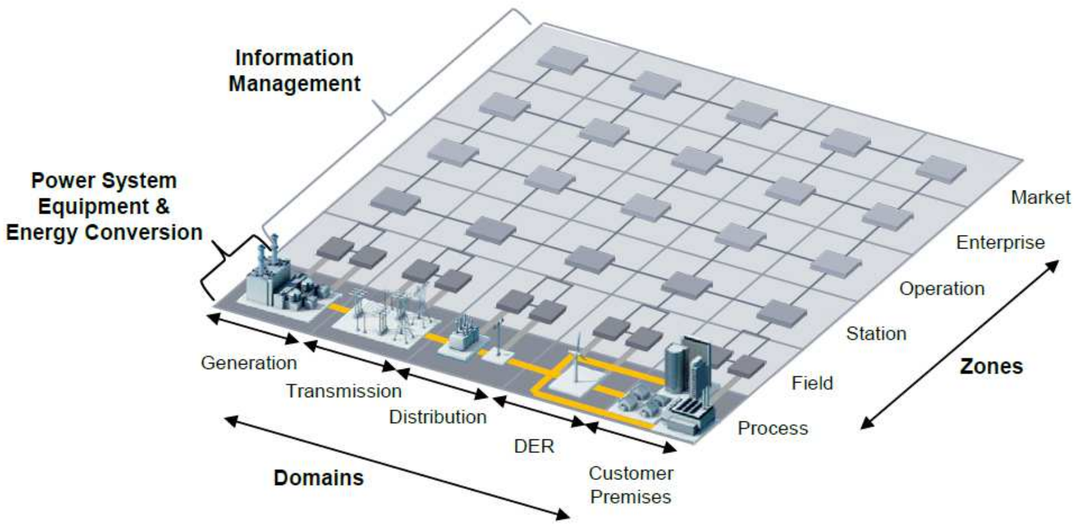


Figure 4: Visualization of Smart Grid Plane - Domains & Zones of SGAM

SGAM framework

The SGAM framework is established by merging the concept of the interoperability layers with the previous introduced smart grid plane. This merging results in a model that spans three dimensions:

1. SGAM domains
2. Zones
3. Interoperability layers

The complete three-dimensional representation of SGAM is depicted in Figure 4.

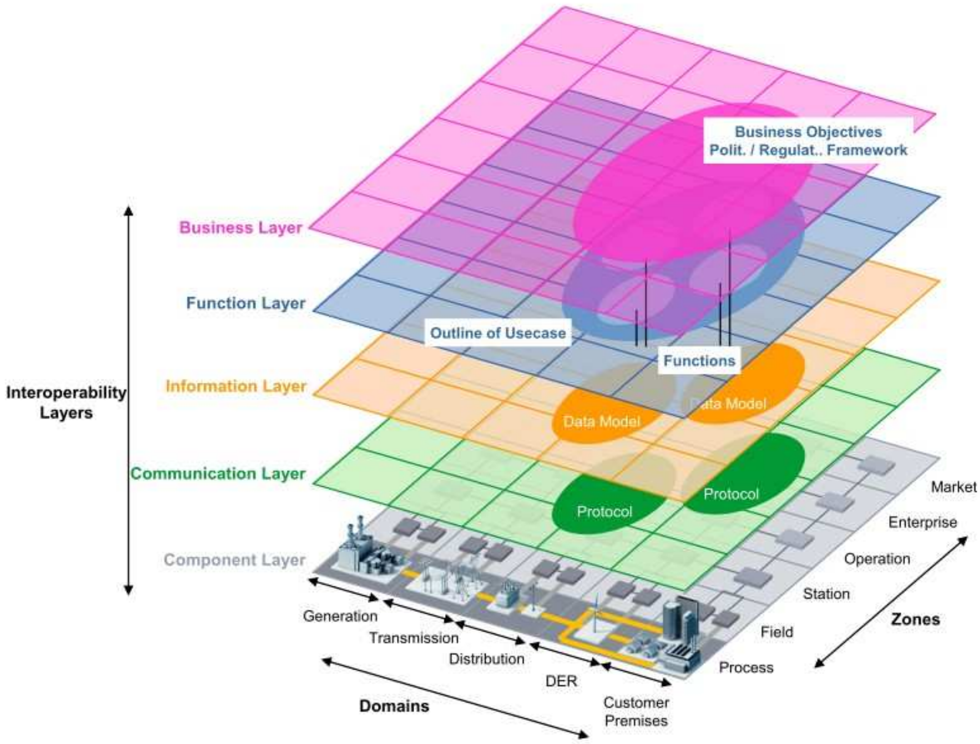


Figure 5: SGAM - Smart Grid Architecture Model

SGAM domains

The domains are physically related to the electrical grid ((Bulk-) Generation, Transmission, Distribution, DER, and Customer Premises) and they are arranged according to the electrical energy conversion chain. The conceptual domains Operations and Market are part of the information management and represent specific hierarchical zones.

Domain	Description
(Bulk) Generation	Representing generation of electrical energy in bulk quantities typically connected to the transmission system, such as by fossil, nuclear and hydro power plants, off-shore wind farms, large scale solar power plant (i.e. PV, CSP).
Transmission	Representing the infrastructure which transports electricity over long distances.
Distribution	Representing the infrastructure which distributes electricity to customers.
DER	Representing distributed electrical resources directly connected to the public distribution grid, applying small-scale power generation and consumption technologies (typically in the range of 3 kW to 10,000 kW). These distributed electrical resources may be directly controlled by a DSO or Balance Responsible Party (BRP).
Customer Premises	Hosting both end users of electricity and also local producers of electricity. The premises include industrial, commercial and home facilities (e.g. chemical plants, airports, harbors, shopping centers, homes). Also generation in form of e.g. photovoltaic generation, electric vehicles storage, batteries, micro turbines.

Table 2: SGAM domains

SGAM zones

The SGAM zones represent the hierarchical levels of power system management. These zones reflect a hierarchical model that considers the concept of aggregation and functional separation in power system management.

In addition to aggregation, the partitioning in zones follows the concept of functional separation. Different functions are assigned to specific zones. The reason for this assignment is typically the specific nature of functions, but also reflects user philosophies. Real-time functions are typically in the field and station zones (protection, phasor-measurement, automation…). Functions that cover an area, multiple substations or plants, or city districts are usually located in the operation zone (e.g. wide area monitoring, generation scheduling, load management, balancing, area power system supervision and control, meter data management…).

Zone	Description
Process	Including the physical, chemical or spatial transformations of energy (electricity, solar, heat, water, wind …) and the physical equipment directly involved (e.g. generators, transformers, circuit breakers, overhead lines, cables, electrical loads, any kind of sensors and actuators which are part or directly connected to the process…).
Field	Including equipment to protect, control and monitor the process of the power system, e.g. protection relays, bay controller, any kind of intelligent electronic devices which acquire and use process data from the power system.

Zone	Description
Station	Representing the areal aggregation level for field level, e.g. for data concentration, functional aggregation, substation automation, local SCADA systems, plant supervision…
Operation	Hosting power system control operation in the respective domain, e.g. distribution management systems (DMS), energy management systems (EMS) in generation and transmission systems, microgrid management systems, virtual power plant management systems (aggregating several DER), electric vehicle (EV) fleet charging management systems.
Enterprise	Including commercial and organizational processes, services and infrastructures for enterprises (utilities, service providers, energy traders …), e.g. asset management, logistics, work force management, staff training, customer relation management, billing and procurement
Market	Reflecting the market operations possible along the energy conversion chain, e.g. energy trading, retail market.

Table 3: SGAM zones

SGAM layers

In order to allow a clear presentation and simple handling of the architecture model, interoperability aspects are aggregated into five abstract interoperability layers representing business objectives and processes, functions, information exchange and models, communication protocols and components.

Layer	Description
Business	The business layer represents the business view on the information exchange related to smart grids. SGAM can be used to map regulatory and economic (market) structures (using harmonized roles and responsibilities) and policies, business models and use cases, business portfolios (products & services) of market parties involved. Also business capabilities, UCs and business processes can be represented in this layer. In this way it supports business executives in decision making related to (new) business models and specific business projects (business case) as well as regulators in defining new market models.
Function	The function layer describes system use cases, functions and services including their relationships from an architectural viewpoint. The functions are represented independent from actors and physical implementations in applications, systems and components. The functions are derived by extracting the UC functionality that is independent from actors.
Information	The information layer describes the information that is being used and exchanged between functions, services and components. It contains information objects and the underlying canonical data models. These information objects and canonical data models represent the common semantics for functions and services in order to allow an interoperable information exchange via communication means.
Communication	The emphasis of the communication layer is to describe protocols and mechanisms for the interoperable exchange of information between components in the context of the underlying use case, function or service and related information objects or data models.

Layer	Description
Component	The emphasis of the component layer is the physical distribution of all participating components in the smart grid context. This includes system & device actors, power system equipment (typically located at process and field level), protection and tele- control devices, network infrastructure (wired / wireless communication connections, routers, switches, servers) and any kind of computers.

Table 4: SGAM layers

3.1 Demo function layers

The function layer of Demos is described in the following section

3.1.1 DE Demo Avacon – WP5

3.1.1.1 General description of Demo

To demonstrate that a smart metering infrastructure can be integrated into grid control processes to control and coordinate DSO connected power generation and flexibility effectively, efficiently, and reliably

3.1.1.2 UC descriptions

DE UC 1 - Feed in Management

Feed in from renewable generation can cause temporal and local congestion in the distribution grid. Under German law the DSO has an obligation to integrate as much renewable feed in as possible and is only allowed to curtail renewable generators when grid congestion is imminent or when technical limits are being violated. With today’s technology the feed in management affects large areas and possibly a larger number of generators than necessary, curtailing a bigger volume of energy than would be necessary. UC WP5.1 shall leverage the Smart Grid Hub in combination with a smart meter infrastructure to automatically control and curtail individual small scale generators in order to relieve grid congestion while minimizing the number of generators affected and the amount of energy that gets curtailed.

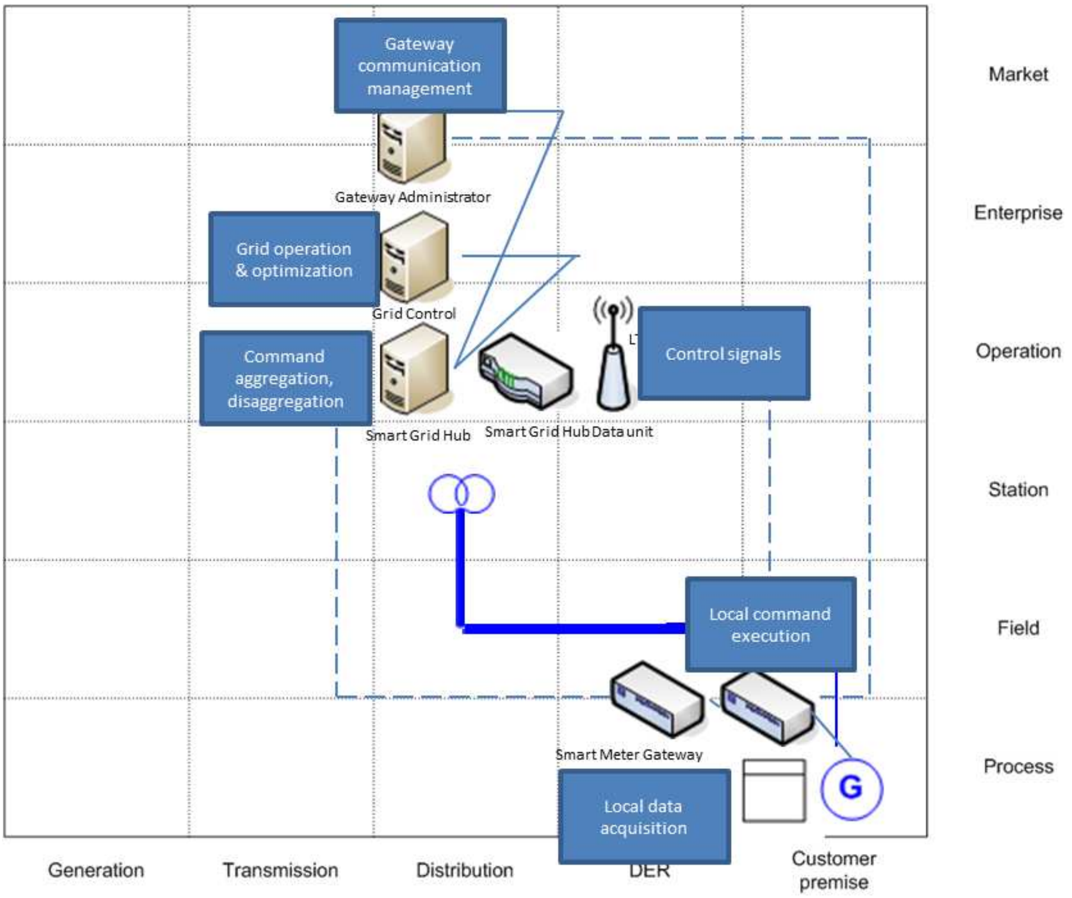


Figure 6: DE UC 1 function layer

DE UC 2 - Demand Side Management

Feed in from fluctuating renewable generation puts today´s power grids under a lot of strain. While more flexible and controllable generation is being replaced by fluctuating and non-controllable generators, the load remains as inflexible as ever. In order to increase the total flexibility in the energy system and to better balance the local grid, this UC shall show how the inherent flexibility of local loads could be leveraged to improve system stability and power quality and relieve local grid congestion.

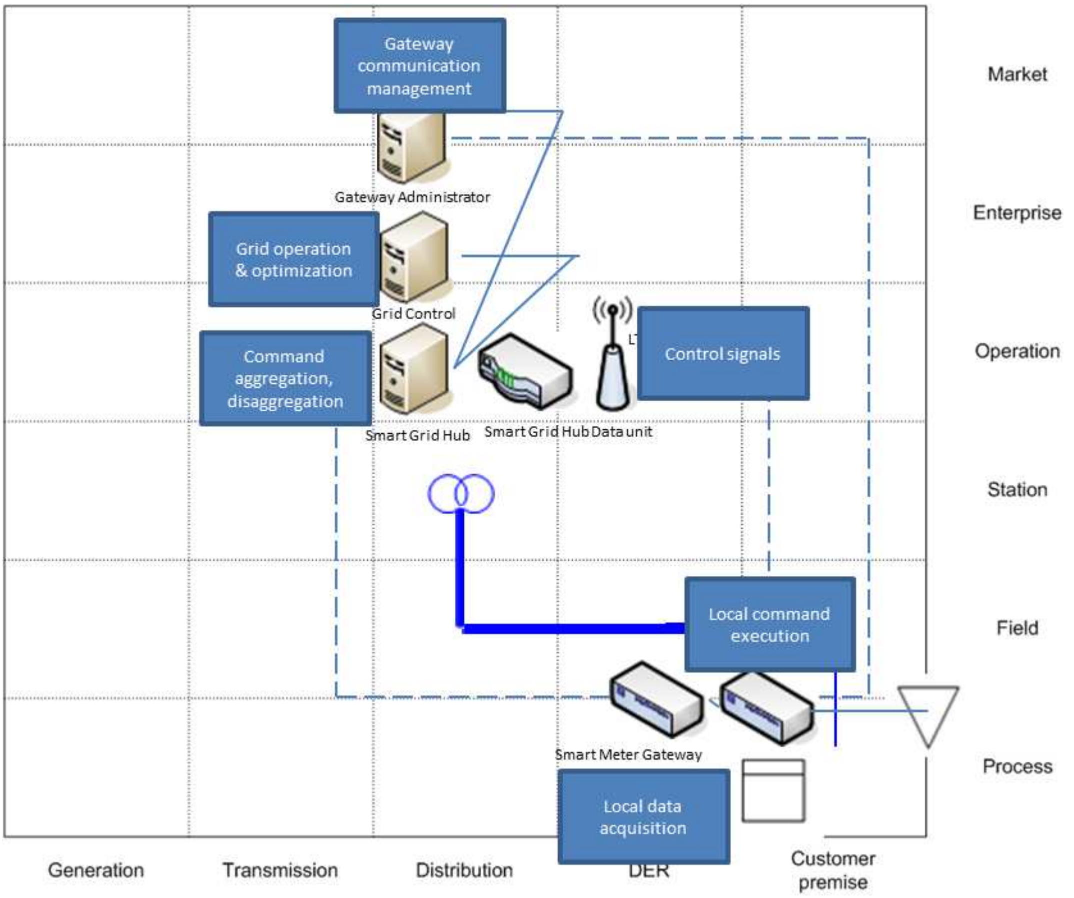


Figure 7: DE UC 2 function layer

DE UC 2 - Ancillary Services

Feed in from fluctuating renewable generation puts today´s power grids under a lot of strain. While flexible and controllable generation is being replaced by fluctuating and non-controllable generators, the challenge to balance supply and demand grows continuously. The Smart Grid Hub aims at connecting and aggregating dormant flexibility and leveraging this flexibility to provide ancillary services to stabilize the energy supply.

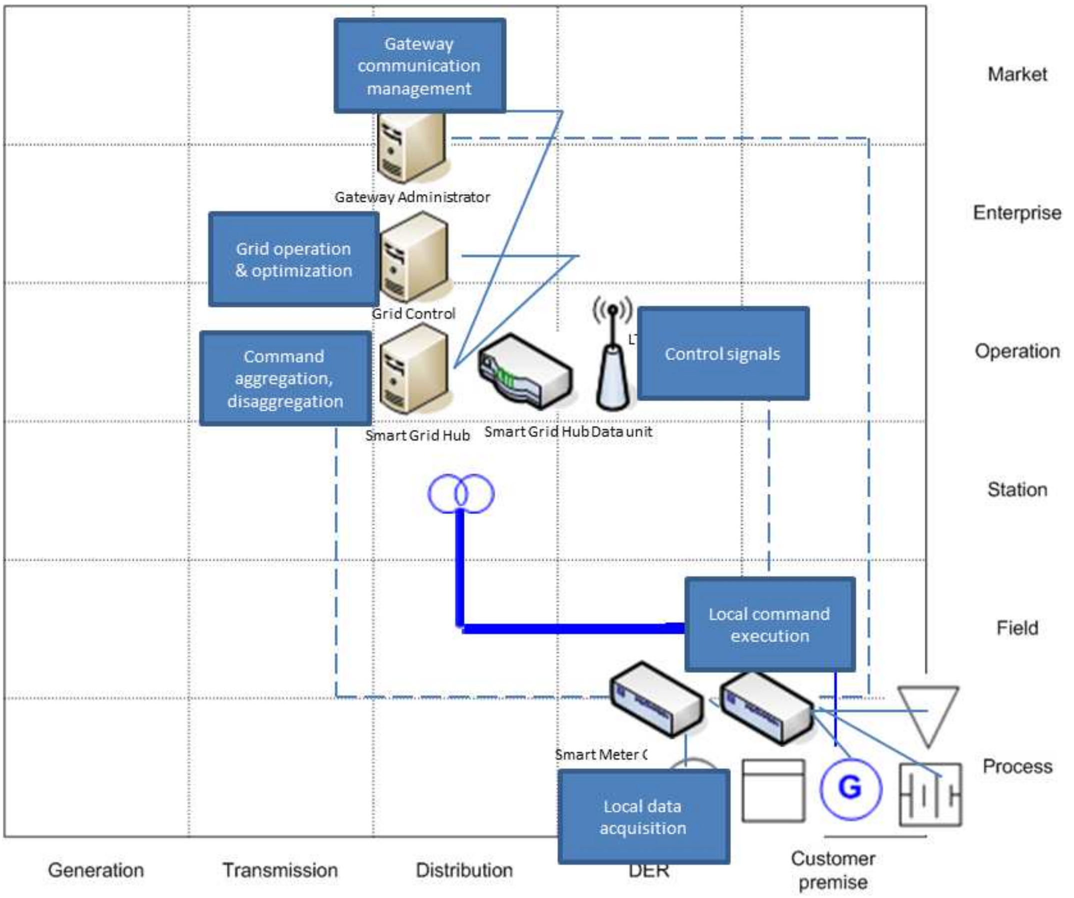


Figure 8: DE UC 3 function layer

3.1.2 CZ Demo ČEZ Distribuce – WP6

3.1.2.1 General description of Demo

To enhance the distribution network flexibility by:

• increasing the DER hosting capacity in LV distribution networks using smart PV inverter functions

(demonstration of the role of Q(U) and P(U)) (UC #1)

• increasing the DER hosting capacity in MV distribution network using volt-var control (V/Q

regulation) (UC #2)

• implementing smart functionalities of EV charging stations (UC #3)

• utilization of smart functions within home-energy storage units (UC #4)

3.1.2.2 UC descriptions

CZ UC 1 - Increase DER hosting capacity of LV distribution networks by smart PV inverters

Increasing of DER hosting capacity in LV distribution grid case that smart PV inverters are used.

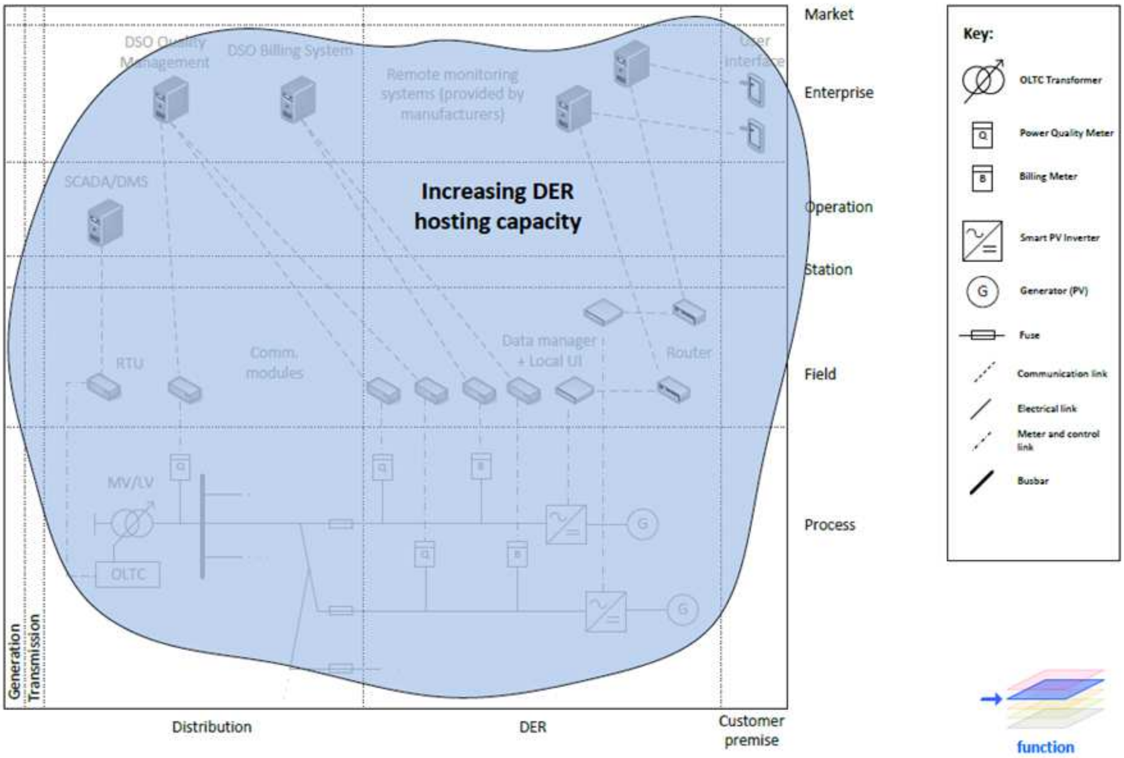


Figure 9: CZ UC 1a function layer

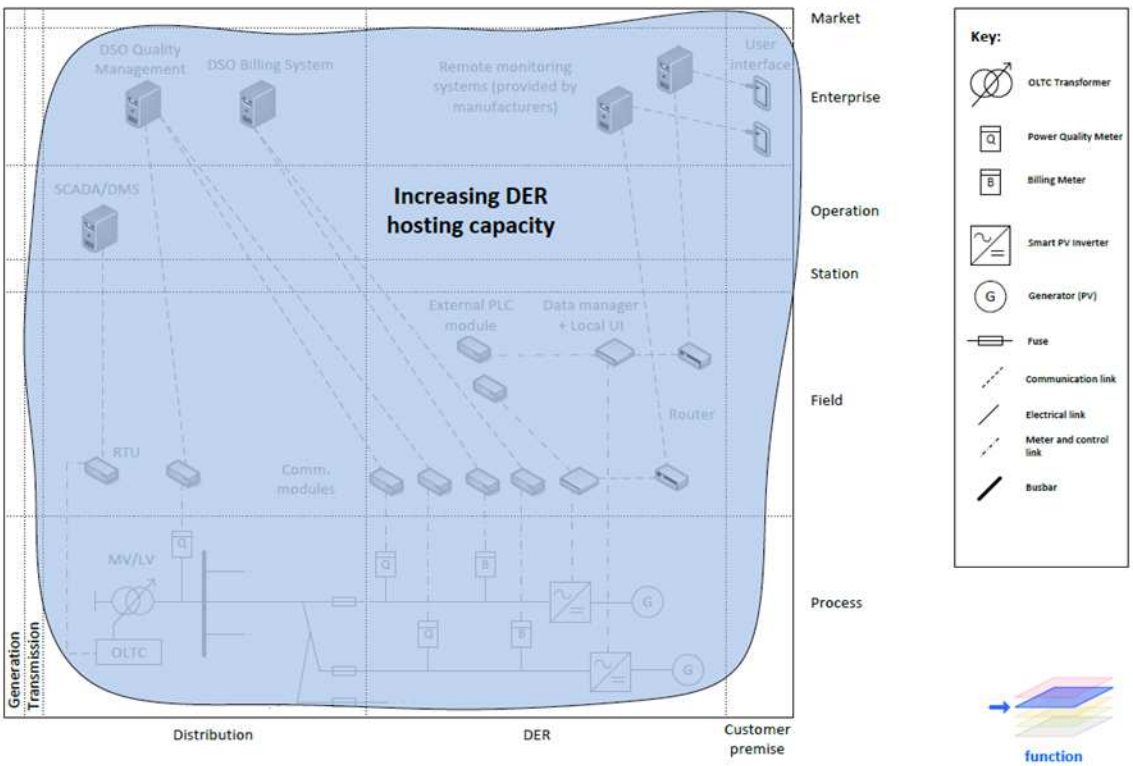


Figure 10: CZ UC 1b function layer

CZ UC 2 - Increase DER hosting capacity in MV networks by volt-var control

Increasing of DER hosting capacity in MV distribution grid in case that volt-var control system is used.

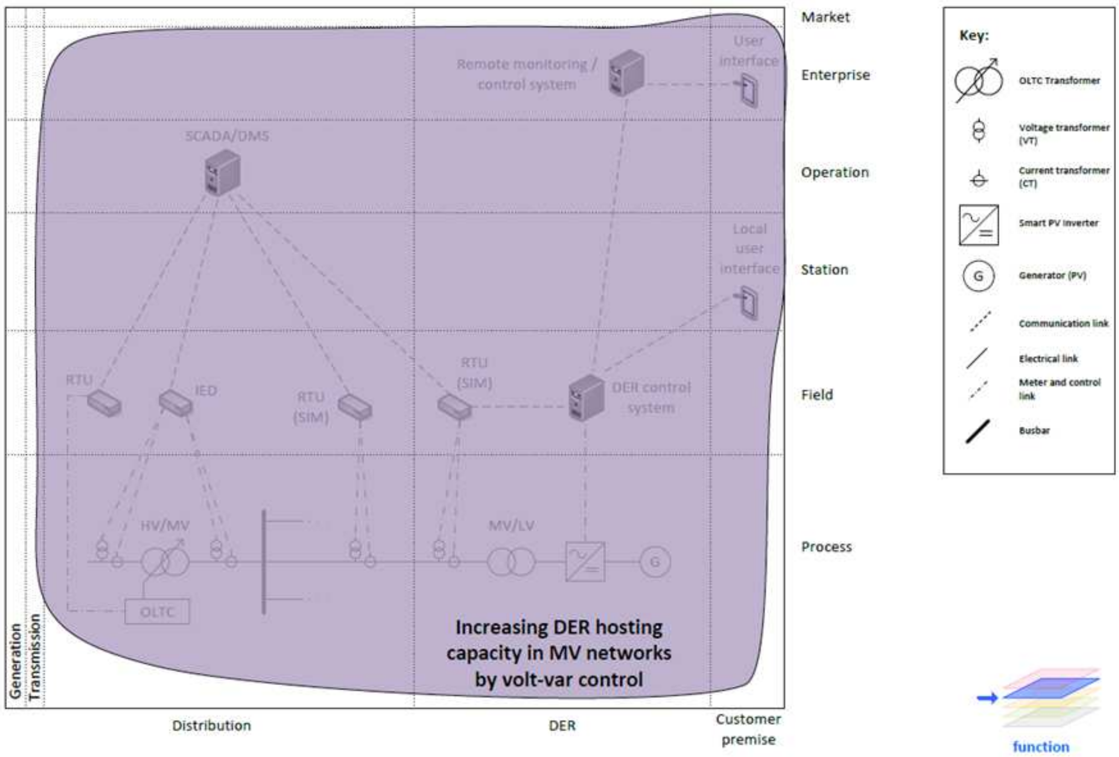


Figure 11: CZ UC 2 function layer

CZ UC 3 - Smart EV charging
Curtailment of EV charging power in case of under voltage, under frequency or in case of DSO needs.

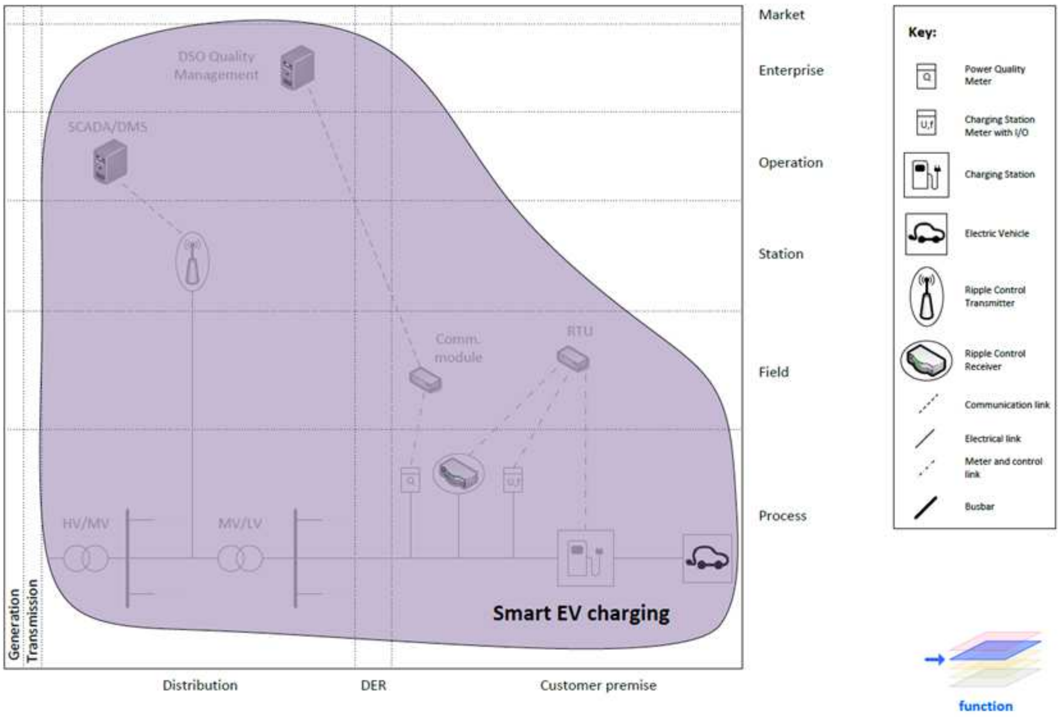


Figure 12: CZ UC 3a function layer

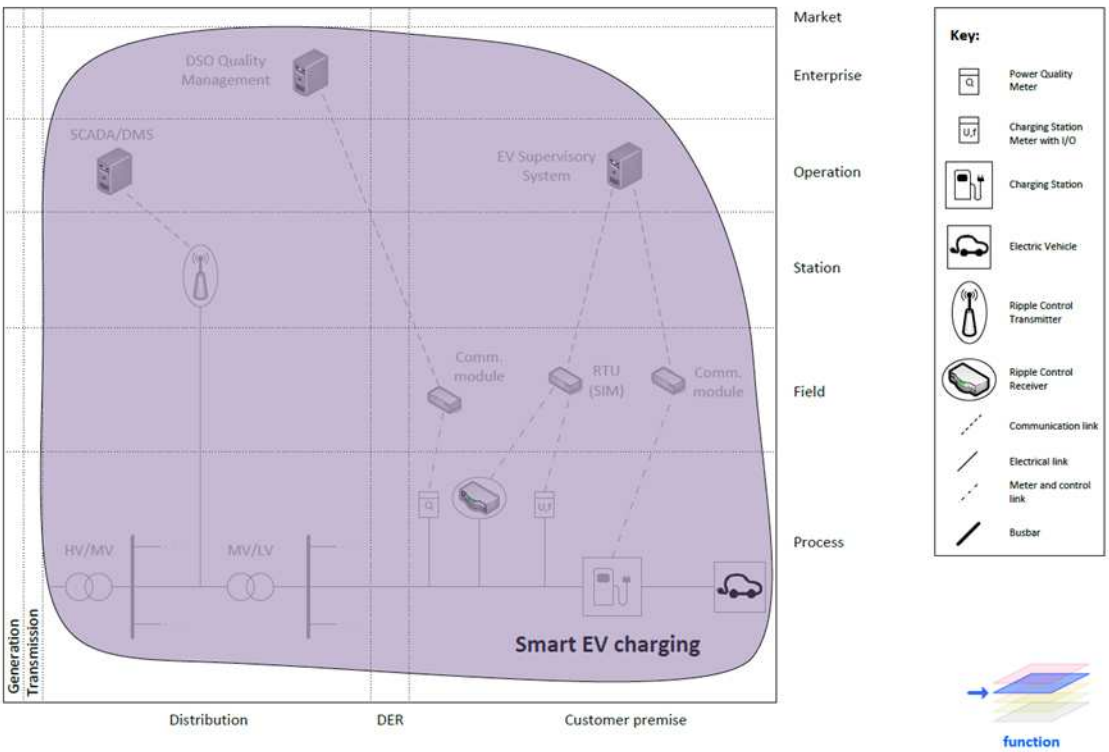


Figure 13: CZ UC 3b function layer

CZ UC 4 - Smart energy storage

Increasing of DER hosting capacity and reduction of PV production peak in case that smart PV inverters with energy storage are used.

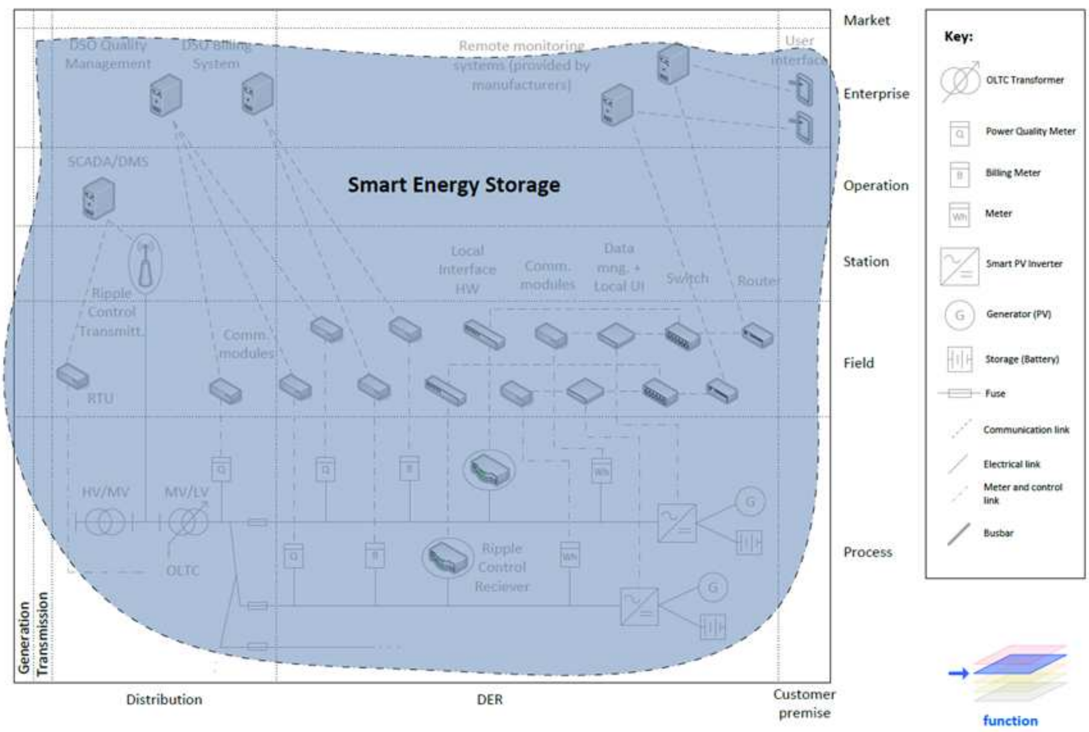


Figure 14: CZ UC 4a function layer

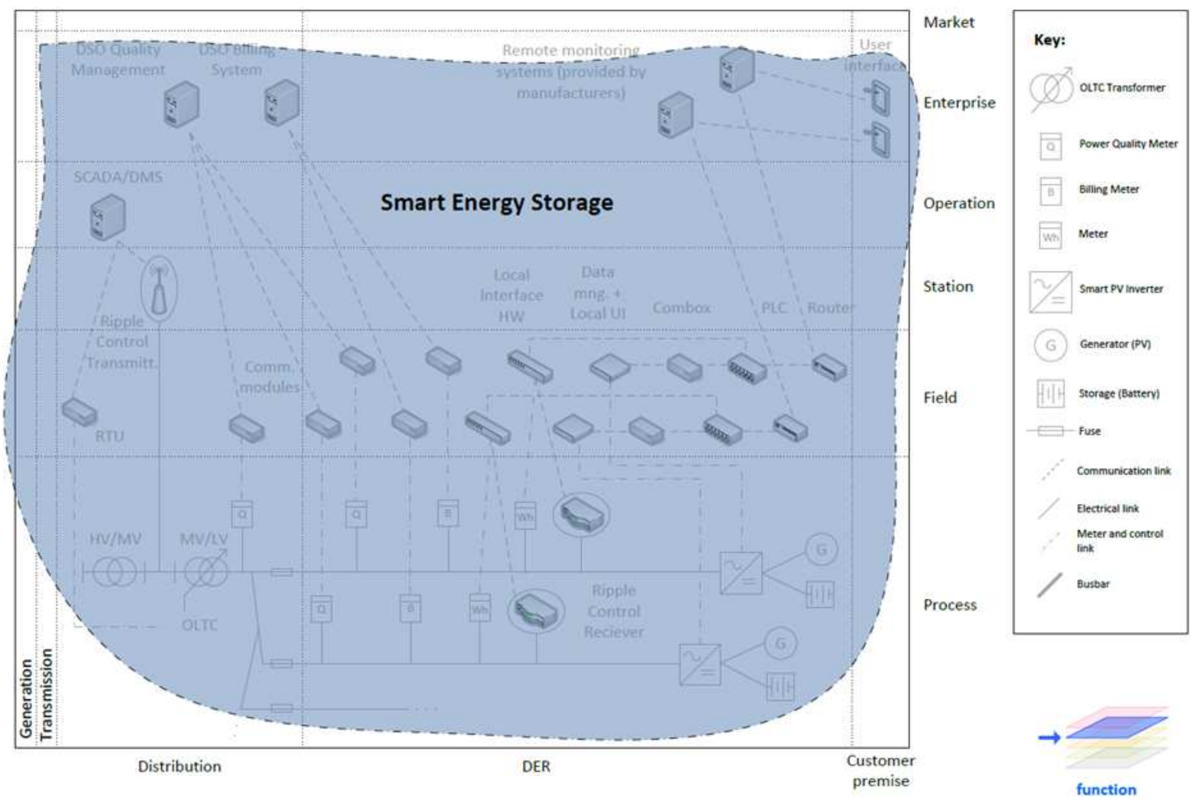


Figure 15: CZ UC 4b function layer

3.1.3 NL Demo Enexis – WP7

3.1.3.1 General description of Demo

To demonstrate technically, economically and contractually that a DSOs can provide merit orders for the flexibility coming from local PV electricity generation and consumption typical of electric vehicles

3.1.3.2 UC descriptions

NL UC 1 - Improve grid flexibility using Smart Storage Unit

The development and implementation of the LIMS which is used for connecting, measuring and controlling the local resources by the local aggregator. The commercial aggregator can use services of the local aggregator for flexibility in the local grid. The DSO forecasts flexibility demands.

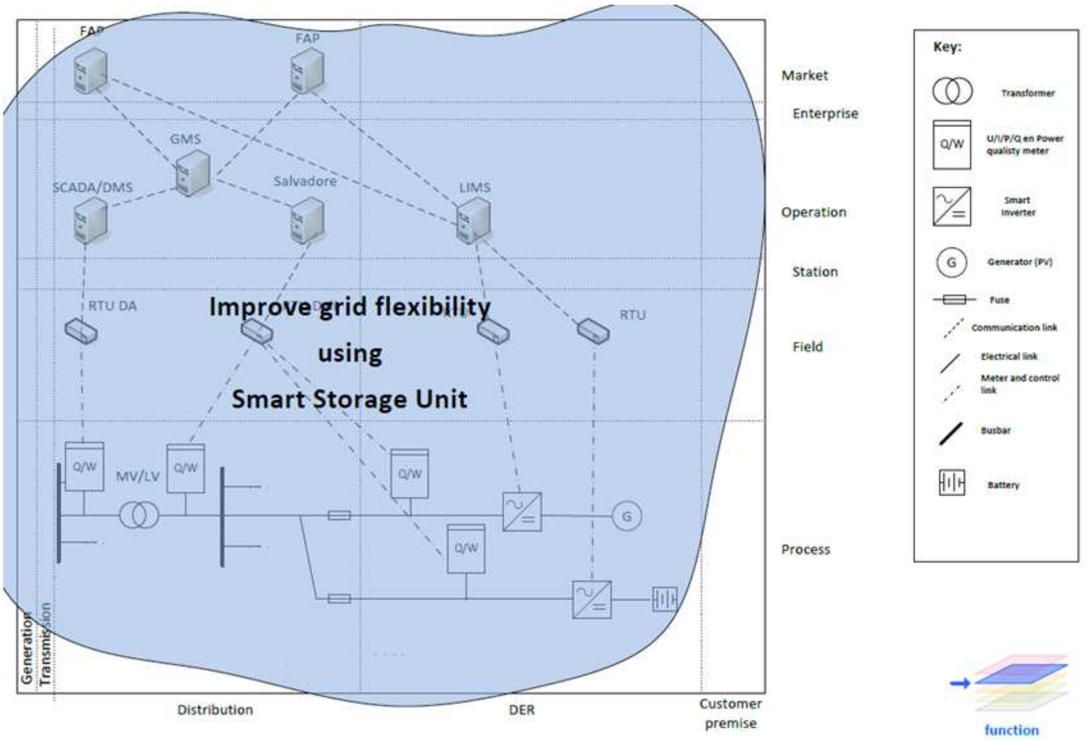


Figure 16: NL UC 1 function layer

NL UC 2 - Improve grid flexibility using Electric Vehicle

Enabling the optimal activation of all available local flexibilities offered by the locally installed EVSE’s for congestion management.

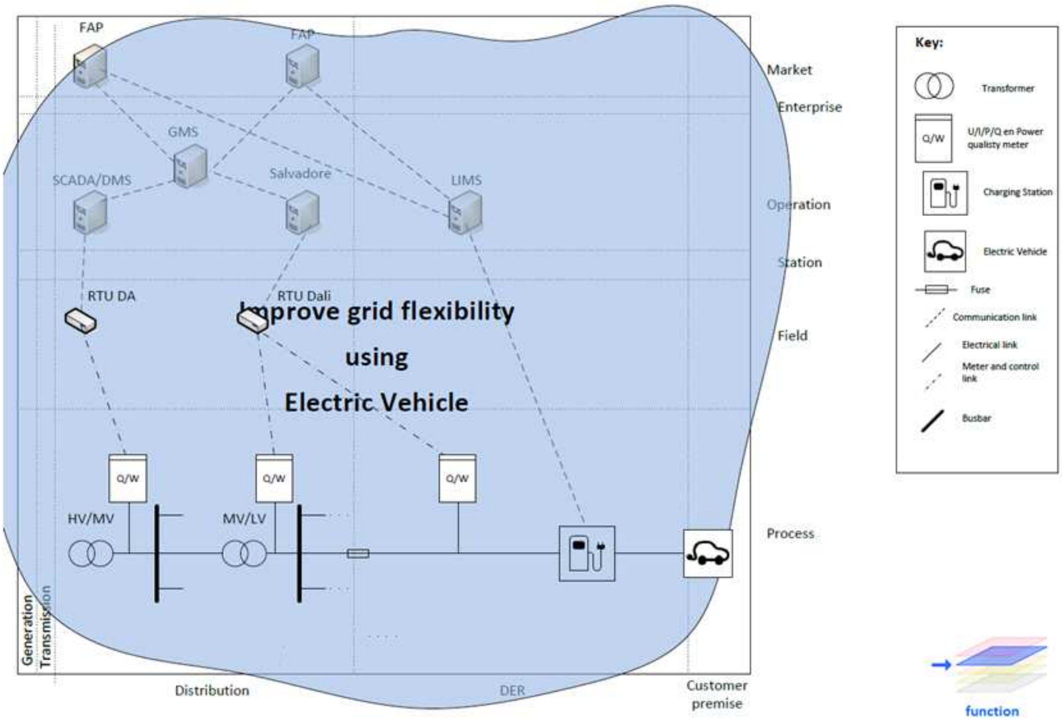


Figure 17: NL UC 2 function layer

NL UC 3 - Usability of an integrated flex market
Validating technically, economically and contractually the usability of an integrated flex market based on a combination of static battery storage and EV. Pricing mechanisms and market liquidity are analyzed, including the usability for a given type of flexibility for the different purposes (congestion, market optimization (day-ahead and intra-day markets), ancillary services).

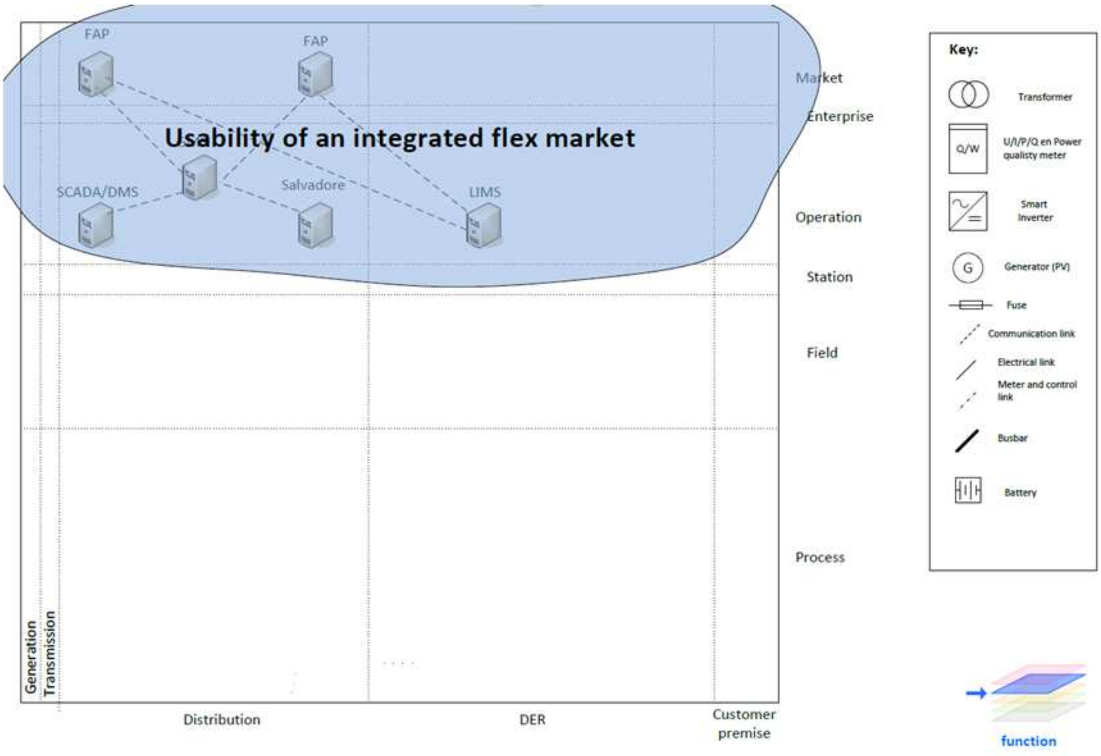


Figure 18: NL UC 3 function layer

3.1.4 SE Demo E.ON – WP8

3.1.4.1 General description of Demo

To demonstrate that a DSO is able to actively observe and smartly use the rural micro-grid's ability to respond to merit orders for flexibility

3.1.4.2 UC descriptions

SE UC 1 - Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers

The UC evaluates how the integration of different energy carriers can support the integration of renewables, by demonstrating the available flexibility given in the thermal inertia of a buildings envelope and in the thermal inertia of thermal grids (heating and cooling).

The evaluation of the impact of using these sources of flexibility in the integration of renewables will be done via simulation software, by creating an electrical model of the Demo4b micro-grid and evaluating how the surplus renewable energy could have been converted to heat and utilized for heating purposes, without affecting the customer´s comfort.

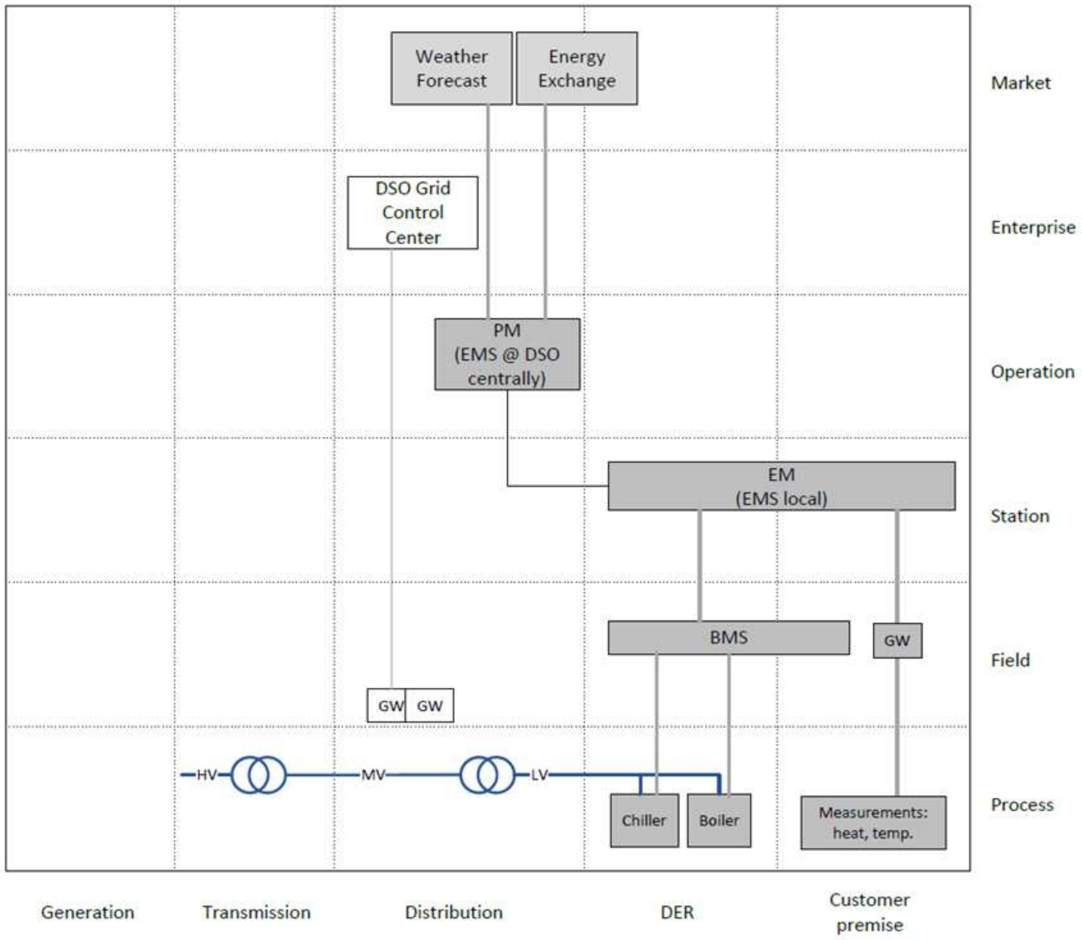


Figure 19: SE UC 1 function layer

SE UC 2 - Optimal use of a commercial heat pump and cooling pump asset providing energy efficiency and electricity flexibility for grid management purposes

The objective of this use case is to enable optimal usage and multiple use cases for a commercial heat and cooling pump asset. These kind of heat and cooling pumps are foreseen to be part of low temperature local heating and cooling grids that can be interconnected to a main district heating grid. By optimizing its production of heat and consumption of electricity based on the current most profitable energy source such heat and cooling pumps connected to low temperature grids can act as an important flexibility source for both the thermal system and the electrical grid.

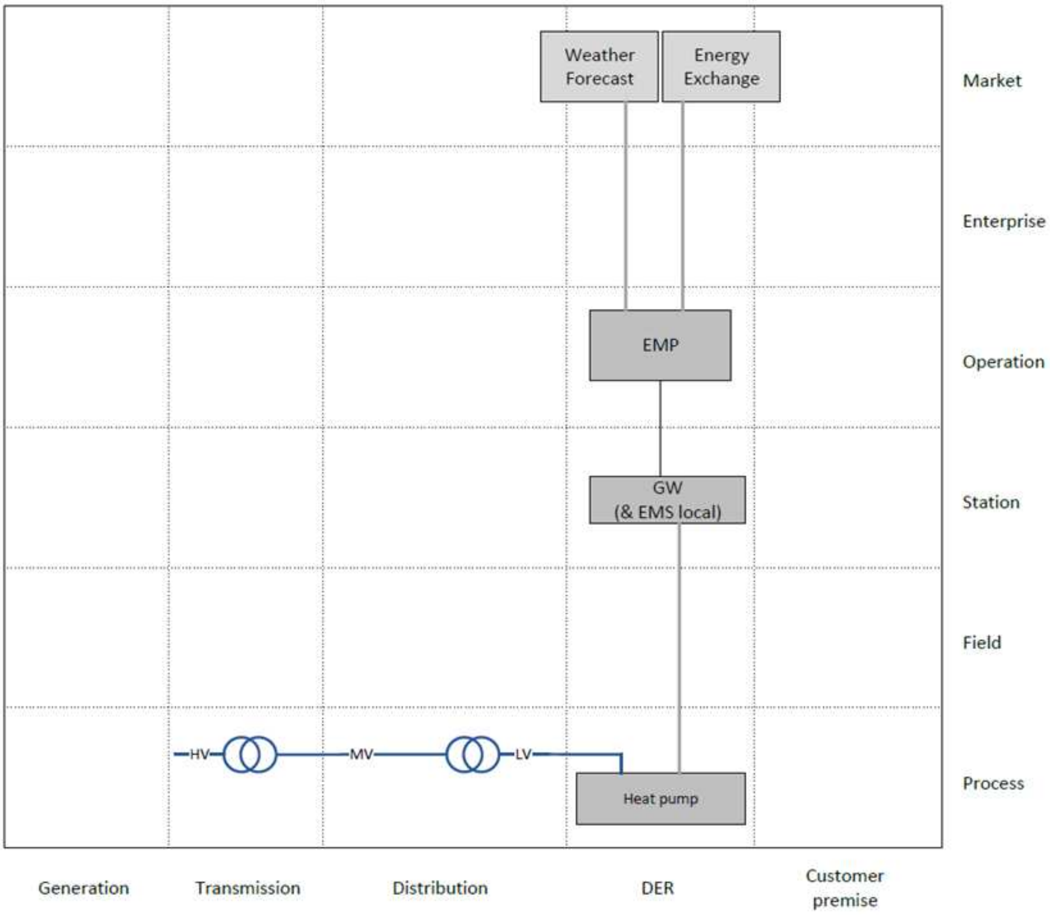


Figure 20: SE UC 2 function layer

SE UC 3 - Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation

Designing at Microgrid system which aggregates balancing technologies (power to heat and power to power), including the deployment a DSR platform, managing the demand side flexibility and steer the loads accordingly.

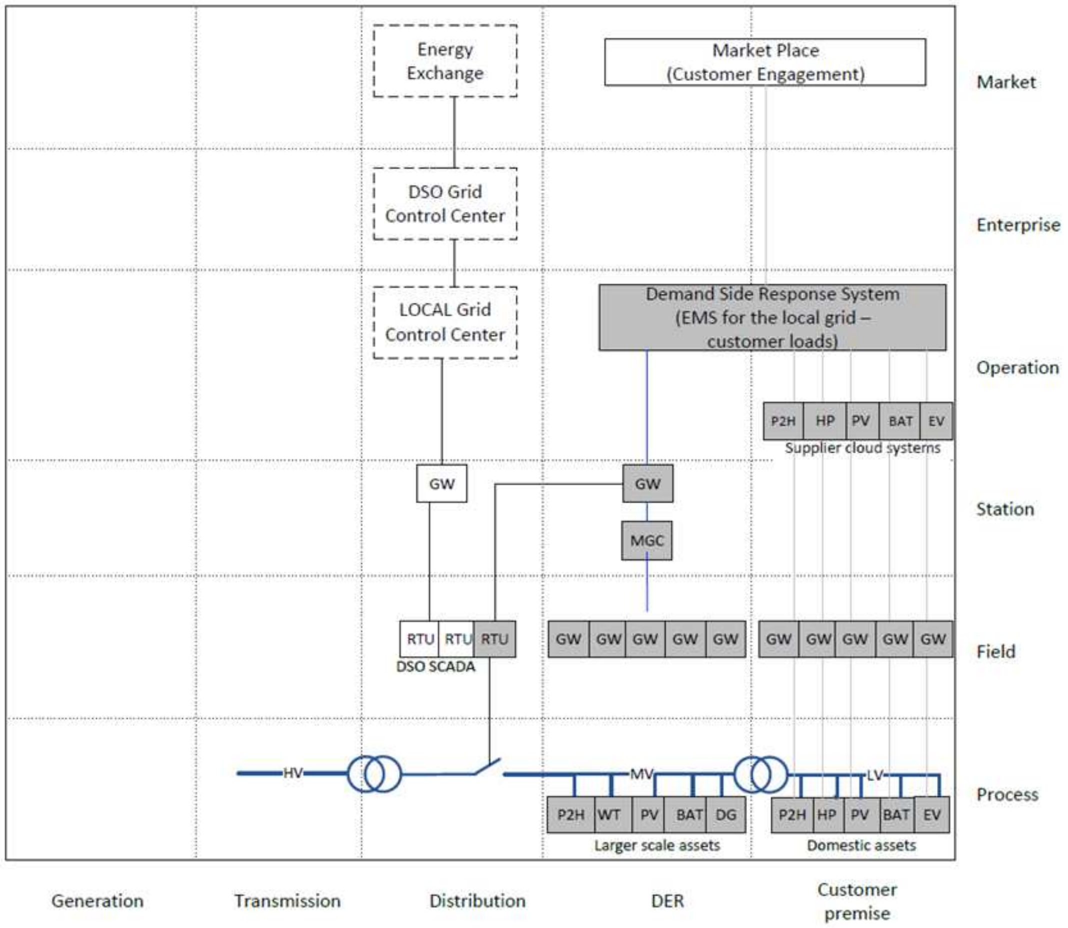


Figure 21: SE UC 3 function layer

SE UC 4 - Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs
Development of Local Energy Market Platform, allowing customers to visualize their consumption, their contribution through balancing technologies installed on premise, their impact on the grid and the state of the system (e.g. renewable surplus or deficit)

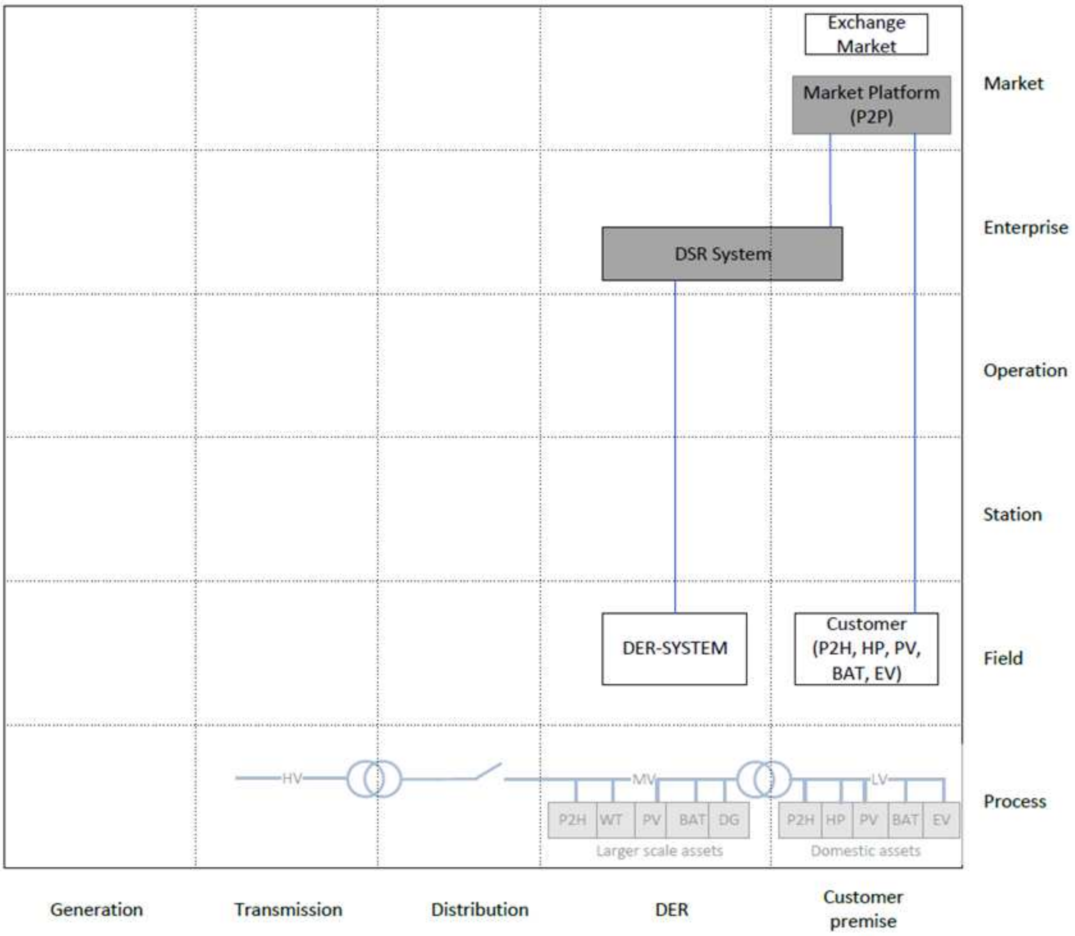


Figure 22: SE UC 4 function layer

SE UC 5 - Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints

The system controls will enable the smooth steering of the customer balancing technologies. Artificial intelligence will be exploited, learning elements of the customer behaviour and forecasting the feed-in of any local generation. The expectation is that these improved system control will increase the Microgrid's resilience and ability to provide grid support.

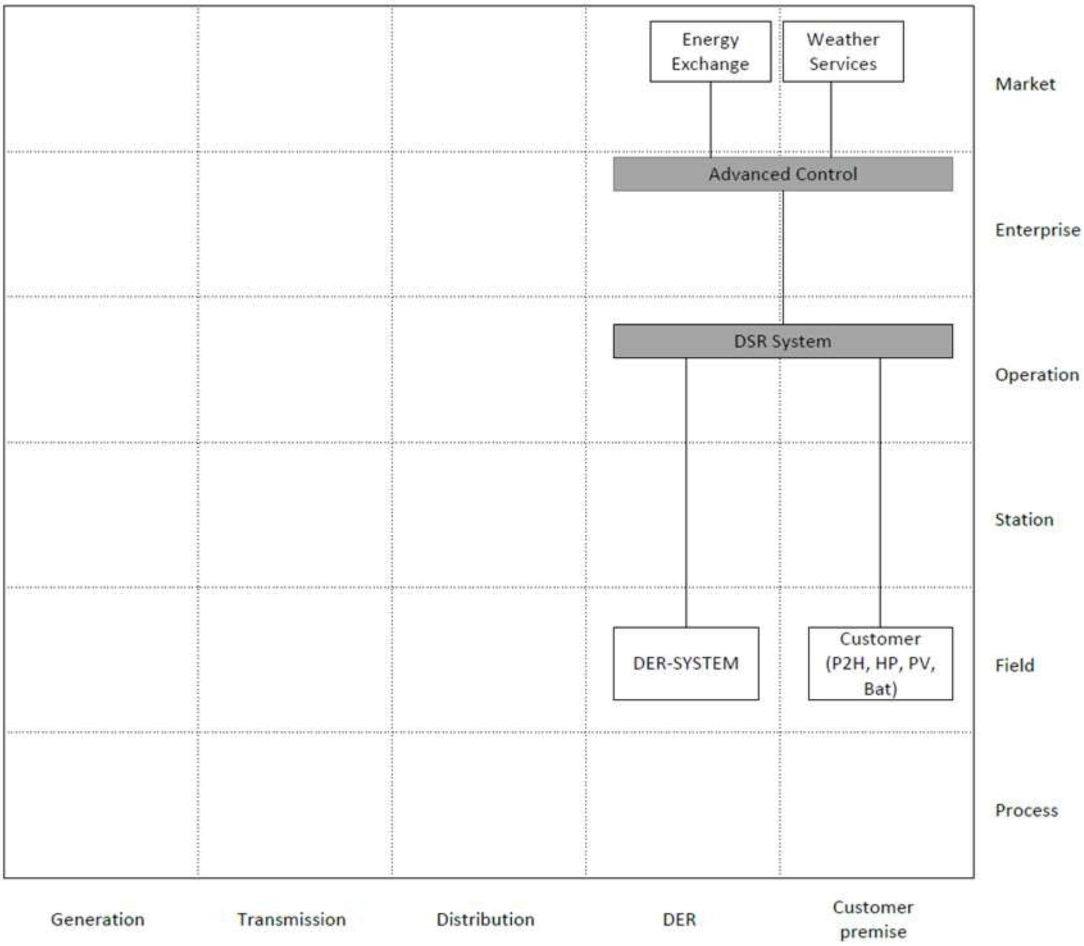


Figure 23: SE UC 5 function layer

3.1.5 FR Demo Enedis – WP9

3.1.5.1 General description of Demo

The French DEMO is located in several areas in the Alpes Maritimes department in Southern France.

The main objective of the project is validate technically, economically, and contractually the market enabling role of DSOs to increase the local energy system efficiency, viz. activating all the network and local production/consumption flexibilities managed by aggregators, in view of meeting the local electricity system needs at minimal costs for all parties, while maximizing the expected impacts for the society. Aggregators will be in charge of deploying flexibility and monetizing it on the different value pockets, including local use by the DSO and national markets/mechanisms. UCs description

3.1.5.2 UC descriptions

FR UC 1 - Automatic Islanding
This use case is dedicated to the temporary islanding of a portion of the distribution. It aims to develop an innovative islanding solution based on local generation, storage systems and customers.

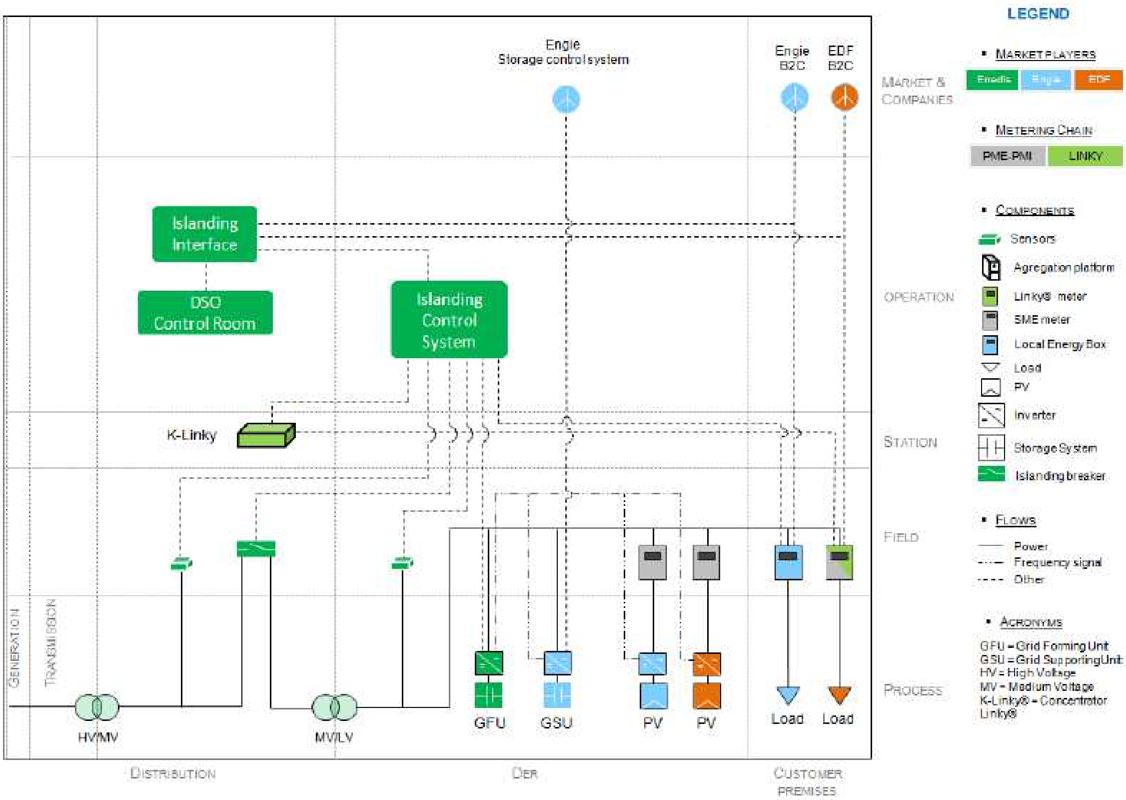


Figure 24: FR UC 1 function layer

FR UC 2 - Multiservice approach for centralized storage systems
This use case is dedicated to the multiservice approach for grid-connected storage systems. Storage systems will be used to deliver different services: islanding, distribution grid constraints mitigation, self consumption, ancillary services...

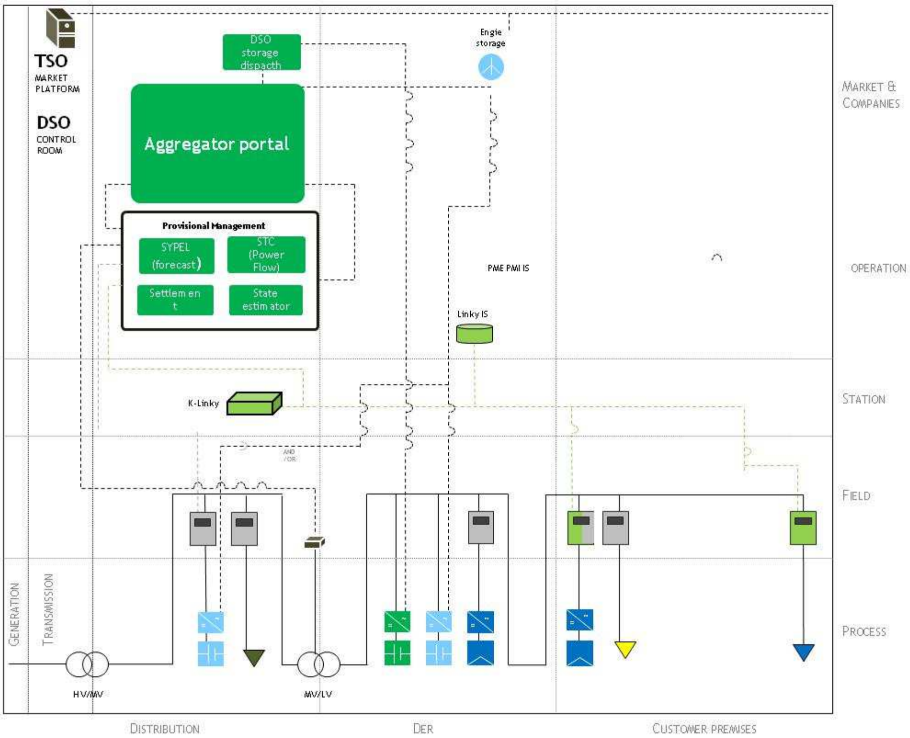


Figure 25: FR UC 2 function layer

FR UC 3 - Local flexibility mechanism

The flexibility can potentially be used to relieve grid constraints and defer investments. A local flexibility system will be developed in order to anticipate future flexibility needs and allow aggregators to value their flexibility offers. This use case contains the different scenarios in which the DSO requires flexibility, the process between the aggregators and the DSO, and the role of the local flexibility mechanism.

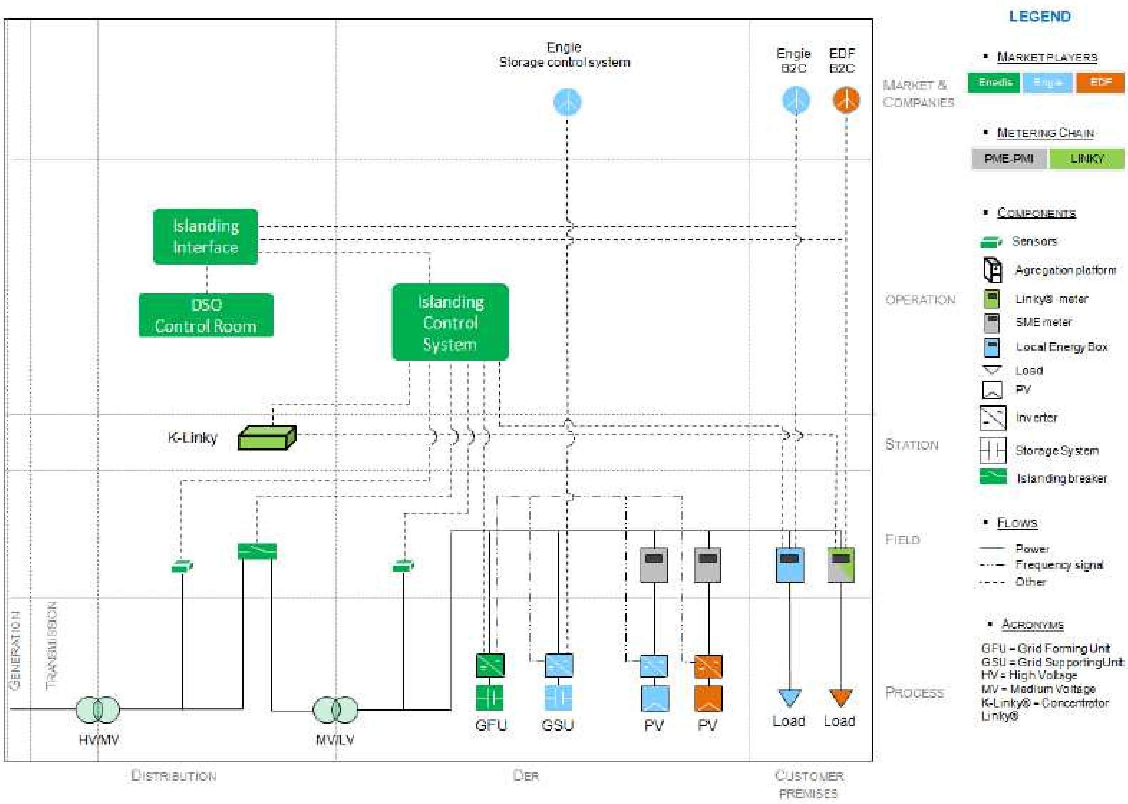


Figure 17. SGAM Model for Use Case 1

Figure 26: FR UC 3 function layer

4 RESULTS OF THE USE CASE COLLECTION

4.1 USE CASE COMPARISONS

Taking into account the **Erreur ! Source du renvoi introuvable.** from the GA-A1, conceived to describe the interactions and synergies between the local demonstrations, a similar approach was proposed regarding the UC collection.

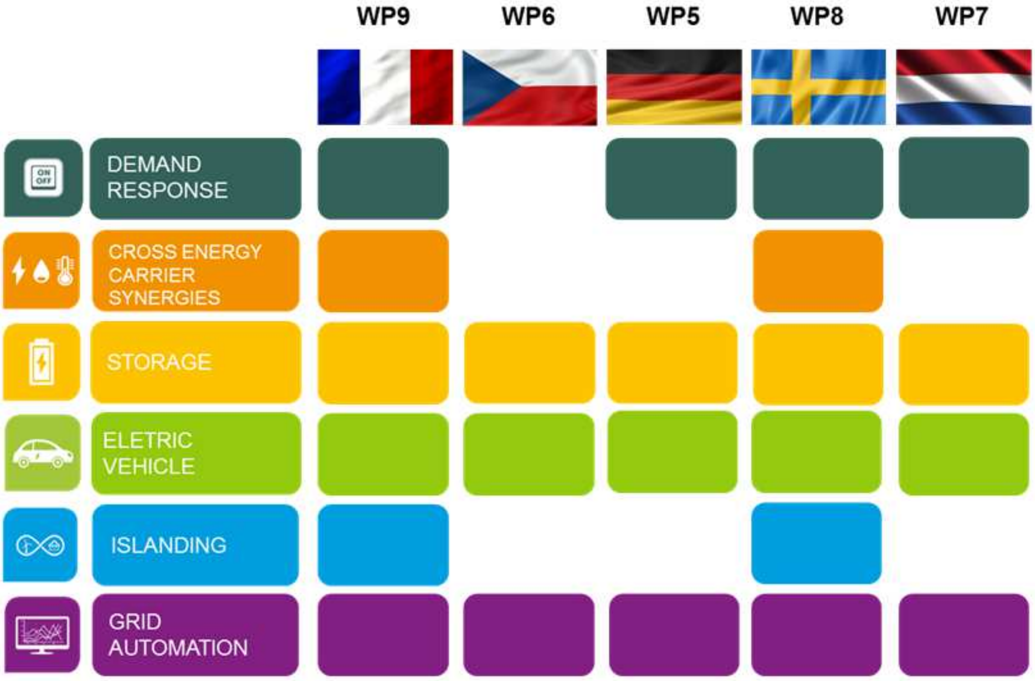


Figure 27: Local Demonstrations - Interactions and synergies

4.1.1 Definition of clusters of the Use Cases by application area

Based on the H2020-LCE-2016-2017 call, which stand on the beginning of InterFlex and the UCs proposed by the Demo partners it was identified 6 general areas.

- Demand Response - Across Europe InterFlex seeks to empower customers and encourage them to bring their flexible loads to the energy system. By offering their assets to system operators and markets – heat pumps, water boilers, electric vehicles or battery systems – the customers help to make the grid more efficient and reliable even with an increasing share of renewables, without sacrificing their comfort nor economic principles.
- Cross energy carrier synergies - InterFlex is experimenting on cross-energy-carrier integration to exploit untapped potentials for flexibility provision. By enabling the interaction to other grids (e.g. gas, heat and cooling) electricity grid constraints

caused by renewables shall be solved in an efficient and cost-effective way.

- Storage - Energy storage solutions aim at accumulating extra renewable power generated during consumption lows, and its use during consumption peaks. Interflex demonstrators are testing residential as well as larger, shared battery systems to relieve network congestion, and increase the renewable hosting capacity of the grid.
- Electric vehicle - E-Mobility challenges the grid, as quick electric vehicle charging stations require big power loads. Interflex demonstrators integrate Electric vehicle user profiles to enable temporary decrease of charging power during congestion periods, with mitigation of negative impacts on customerswithout affecting the electric vehicle user's experience. Congestion problems on the grid are solved by using flexible energy resources or batteries and by postponing or even interrupting the EV charge according to a predictive analysis, and with the consent of the customer or by curtailment of charging power in case of emergency.
- Islanding - InterFlex is demonstrating islanding capabilities while assessing the potential business models of real microgrids that are based on on-site generation from 100% renewable sources such as PV or Wind
- Grid automation - Grid automation aims at improving the monitoring and control of both power generation and distribution so as to allow for increasing shares of renewables and new load patterns including EV charging. Grid automation also enables the reduction of fault localization and isolation times thus improving the reliability of power supply.

This harmonization has been summarized in **Erreur ! Source du renvoi introuvable.**, showing the UCs mapped in each related area:

	Islanding	Electric Vehicle	Cross Energy Carrier Synergies	Energy Storage	Demand Response	Grid Automation
DE UC 1						
DE UC 2						
DE UC 3						
CZ UC 1						
CZ UC 2						
CZ UC 3						
CZ UC 4						
NL UC 1						
NL UC 2						
NL UC 3						
SE UC 1						
SE UC 2						
SE UC 3						
SE UC 4						
SE UC 5						
FR UC 1						
FR UC 2						
FR UC 3						

Table 5: UCs classifications

4.1.2 Use Case comparison methodology and basis outcomes

Since the all Demos delivered their Use Cases, the information provided in Table 2 was implemented with a more accurate analysis; this was performed isolating similarities and divergences between the Use Cases. Many clusters have been defined in order to reach a first comparison approach, analysing the common aspects among the UCs within each area / domain. Each UC was studied/classified with respect to five criteria:

- Aims/Scope
- Level
- Solution Cluster
- Topology
- System involved

4.1.2.1 Aims/Scope classification

Firstly objectives from the different UCs were merged in a limited number of common scopes. From all delivered UCs were defined 8 main Aims/Scope of the UCs.

- Flexibility – to provide flexibility which can be used for network balancing
- Hosting capacity – aims to UCs that allow the connection of a higher share of DER by implementing diverse local and/or remote steering mechanism without negative influence of the distribution network
- Islanding – aims to UCs focused on the operation of islanded energy system with a high penetration of renewables (up to 100%) by controlling DER and DSR/DR.

- Power Quality – avoiding overvoltage and voltage unbalance – aims to UCs that measure or monitor power quality
- Cross energy carrier synergies – UCs transforming electric energy to other carriers of energy that can be stored or used in a better way
- Automation – automation of some activities, calculation, control in UCs
- Business platform – aims to UCs with business platforms/user interfaces that allow retailers, customers, aggregators, DSO or others to look into current or/and a plan production or/and consumption, control production or/and consumption and communicate between individual parts

4.1.2.2 Level classification

Identification of the levels of the electric grid architecture that host the implementation of a UC.

Distribution to MV/MV Customer and LV/LV Customer is applied for the UCs where the DSO/customers own devices. In case the Level classification is Operational, it means the UC is independent on voltage level. Operational is designed for UCs which e.g. set rules for communication between actors or process information for better network control.

- MV - DSO
- LV - DSO
- MV - Customer
- LV - Customer
- Operational

4.1.2.3 Solution cluster classification

Main points of solution that lead to reach the aims/scope of the UC

- Load control and load shifting – allow someone/something to control or to shift their/its consumption
- Control DER – allows someone/something to control production from DER
- Quality measurement – measuring of network parameters (power, voltage, frequency, current)
- Simulation model – model of some systems help control unit to maximize usability of electric energy
- Control charging EV – allows someone/something to control EV charging
- Control charging/discharging battery
- Support services provision – providing production/non-production, consumption/non consumption to someone who can use it as he/she wants

- Network calculation – calculate from history/current/prediction data load flow, network congestion/limits
- Communication – communication between entities or devices
- Forecast calculation – focusing on weather forecast, customer behaviour forecast, consumption forecast
- Islanding operation – maintain the island operation

4.1.2.4 Topology classification

Defines elements of the electric grid architecture included in the UCs

- Control centre
- HV/MV Substation
- MV/LV Substation
- MV Customer Premises
- LV Customer Premises
- LV network
- MV network

4.1.2.5 System classification

Systems and entities (actors) included in UCs responsible to carry out actions ofSolution Cluster

- DSO-DMS
- TSO
- Aggregator
- Customer
- Retailer

This description could be a good overview to Technical groups and it is readable for those who approach the project InterFlex for the first time. On the basis of this description model a standard classification for each UC was proposed on the tables below.

WP	UC	Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
WP5	DE UC 1	Feed In Management	LV Customer	Hosting capacity & Power Quality & Automation & Flexibility	Communication	Control center HV/MV Substation LV Customer premises MV/LV Substation	DMS
					Network Calculation	Control center	DMS
					Control DER	LV Customer premises	DMS
					Quality measurement	LV Customer premises MV/LV Substation HV/MV Substation	DMS
	DE UC 2	Demand Side Management	LV Customer	Flexibility & Power Quality & Automation & Hosting Capacity	Load Shifting	LV Customer premises	DMS
					Quality measurement	HV/MV Substation MV/LV Substation	
					Control Charging/Discharging Battery	LV Customer premises	DMS
					Network Calculation	Control center	DMS
					Communication	Control center LV Customer premises HV/MV Substation MV/LV Substation	DMS
	DE UC 3	Ancillary Services	LV Customer	Flexibility & Power Quality &	Load Shifting	LV Customer premises	DMS
					Quality measurement	HV/MV Substation MV/LV Substation	

				Automation & Hosting Capacity	Control Charging/Discharging Battery	LV Customer premises	DMS
					Control DER	LV Customer premises	DMS
					Provide Support Services	LV Customer premises	DMS
					Communication	Control center LV Customer premises HV/MV Substation MV/LV Substation	DMS
WP6	CZ UC 1	Increase DER hosting capacity of LV distribution networks by smart PV inverters	LV & LV Customer	Hosting Capacity & Power Quality & Automation	Control DER	LV Customer premises	
					Quality measurement	LV	
					Network calculation	Control center	DMS
					Communication	Control center LV	DMS DMS
	CZ UC 2	Increase DER hosting capacity in MV networks by volt-var control	MV & MV Customer	Hosting Capacity & Power Quality & Automation	Control DER	MV Customer premises	DMS
					Quality measurement	MV	
					Network Calculation	Control center	DMS
					Communication	Control center MV Customer premises MV	DMS DMS DMS
	CZ UC 3	Smart EV charging	LV	Flexibility & Power Quality & Automation	Quality measurement	LV	
					Control charging EV	LV	DMS
					Network Calculation	Control center	DMS
					Communication	Control center	DMS

						LV	DMS
	CZ UC 4	Smart energy storage	LV & LV Customer	Flexibility & Hosting Capacity & Power Quality & Automation	Control DER	LV Customer premises	
					Control Charging/Discharging Battery	LV Customer premises	Customer DMS
					Network Calculation	Control center	DMS
					Communication	Control center	DMS
						LV Customer premises	DMS
						LV	DMS
					Quality measurement	LV	
WP 7	NL UC 1	Improve grid flexibility using Smart Storage Unit	LV & MV	Flexibility & Power Quality & Business platform	Quality measurement	LV	
						MV/LV Substation	
					Control Charging/Discharging Battery	LV	Aggregator
					Provide Support Services	LV	Aggregator
					Network Calculation	Control center	DMS
					Communication	Control center	DMS
						LV	Aggregator
						MV/LV Substation	DMS
	NL UC 2	Improve grid flexibility using Electric Vehicle	LV & MV	Flexibility & Business platform	Control charging EV	LV Customer premises	Aggregator
					Provide Support Services	LV	Aggregator
					Quality measurement	LV	
						MV/LV Substation	
					Forecast Calculation	Control center	DMS
					Communication	Control center	DMS
						LV	Aggregator
						LV Customer premises	Aggregator & Customer
						MV/LV Substation	DMS

	NL UC 3	Usability of an integrated flex market	Operational	Flexibility	Communication	Control center LV	DMS Aggregator
WP8	SE UC 1	Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers	LV Customer	Flexibility & Hosting Capacity & Cross energy carrier synergies & Automation & Business platform	Load Shifting	LV Customer premises	Aggregator
					Simulation model	LV Customer premises	Customer
					Provide Support Services	LV Customer premises	Aggregator
					Communication	LV Customer premises Control center	Aggregator & Customer DMS
	SE UC 2	Optimal use of a large heat pump asset providing the district heating grid with heat and electricity flexibility for grid management purposes	LV Customer	Flexibility & Hosting Capacity & Cross energy carrier synergies & Automation & Business platform	Load Shifting	LV Customer premises	Aggregator
					Simulation model	LV Customer premises	Customer
					Provide Support Services	LV Customer premises	Aggregator
					Communication	Control center LV Customer premises	DMS Aggregator & Customer
	SE UC 3	Technical management of a grid-connected	MV & LV	Flexibility & Islanding &	Load Shifting	LV Customer premises	DMS
					Control DER	LV Customer premises LV	DMS

		Local Energy System that can run in an islanded mode with 100% renewable generation	& LV Customer	Cross energy carrier synergies & Automation & Hosting capacity & Power Quality	Quality measurement	LV MV/LV Substation	
					Control Charging/Discharging Battery	LV Customer premises LV	DMS
					Network Calculation	Control center	DMS
					Islanding operation	LV Customer premises LV	DMS
					Communication	LV Customer premises Control center LV MV/LV Substation	customer DMS
	SE UC 4	Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs	Operational & LV Customer	Flexibility & Business platform	Load Shifting	LV Customer premises	Customer
					Communication	LV Customer premises Control center	Customer retailer/Aggregator
	SE UC 5	Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints	Operational	Automation	Network Calculation	Control center	DMS
					Simulation model	Control center	DMS
					Communication	Control center	DMS
					Forecast Calculation	Control center	DMS
WP9	FR UC 3		Operational		Load Shifting	LV Customer premises	Aggregator

		Local flexibility mechanism		Flexibility & Business platform	Control DER	LV Customer premises	Aggregator
					Network Calculation	Control center	DMS
					Communication	Control center	Aggregator
						LV Customer premises	Aggregator
					Forecast Calculation	Control center	Aggregator
	FR UC 1	Automatic Islanding	MV - DSO & LV - DSO & LV-Customer	Flexibility & Islanding & Automation & Power Quality & Cross energy carrier synergies	Support services provision	LV Customer Premises	Aggregator
					Communication	Control centre, LV network	DSO-DMS, Retailer
					Forecast calculation	MV network	DSO-DMS, Retailer
					Islanding operation	MV network, MV/LV Substations	DSO-DMS, Aggregator, Customers
					Control DER	LV network	DSO-DMS, Retailer/Aggregator
					Load Shifting	LV Customer premises	Aggregator

Table 6: Joint Activity

As the table 6 shows, the partners adopted many solutions for different aims. In order to provide a comparison among the solutions to be adopted to reach the same aims, an overview of the classification, based on the scopes, is described below.

4.2 Joint activities description

4.2.1 Flexiblity

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
DE UC 1	LV Customer	Flexibility	control DER	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS
DE UC 2	LV Customer	Flexibility	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS
DE UC 3	LV Customer	Flexibility	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS
			Provide support Services	LV Customer premises	DMS
CZ UC 3	LV DSO	Flexibility	control EV charging	LV	DMS
			Communication	LV Control center	DMS
CZ UC 4	LV Customer	Flexibility	Control charging / Discharging Battery	LV Customer premises	DMS
			Communication	Control center LV Customer premises	DMS
NL UC 1	LV - DSO & MV - DSO	Flexibility	Control charging / Discharging Battery	LV	Aggregator
			Communication	Control center	DMS

				LV	Aggregator
			Provide support Services	LV	Aggregator
NL UC 2	LV - DSO & MV - DSO	Flexibility	control EV charging	LV	Aggregator
			Communication	Control center	DMS
				LV	Aggregator
			Forecast Calculation	Control center	DMS
			Provide support Services	LV	Aggregator
NL UC 3	Operational	Flexibility	Communication	Control center	DMS
				LV	Aggregator
SE UC 1	LV Customer	Flexibility	load Shifting	LV Customer premises	Aggregator
			Simulation model	LV Customer premises	Customer
			Communication	Control center	DMS
				LV Customer premises	Aggregator
			Provide support Services	LV Customer premises	Aggregator
SE UC 2	LV Customer	Flexibility	load Shifting	LV Customer premises	aggregator
			Simulation model	LV Customer premises	customer
			Communication	Control center	DMS
				LV Customer premises	aggregator
			Provide support Services	LV Customer premises	Aggregator
SE UC 3	LV - DSO & LV Customer	Flexibility	load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises	DMS
				LV	
			Control charging / Discharging Battery	LV Customer premises	DMS
				LV	
			Communication	Control center	DMS
				LV Customer premises	
				LV	
SE UC 4	Operational & LV Customer	Flexibility	load Shifting	LV Customer premises	Customer
			Communication	Control center	retailer / aggregator
				LV Customer premises	Customer

FR UC 3	Operational	Flexibility	load Shifting	LV Customer premises	Aggregator
			Control DER	LV Customer premises	Aggregator
			network Calculation	Control center	DMS
			Communication	Control center	DMS
				LV Customer premises	Aggregator
			Forecast Calculatino	LV Customer premises	Aggregator
FR UC 1	MV - DSO & LV - DSO & LV Customer	Flexibility	load Shifting	LV Customer premises	DMS, Reatiler/ Aggregator
			Control DER	LV	Aggregator
			Communication	LV Customer premises	DMS, Reatiler/ Aggregator
				LV	Aggregator
				Control center	aggregator

Table 7: Flexibility

In most of the UCs flexibility is connected with demand management (heat and electricity), electric vehicles charging and battery charging/discharging. Flexibility provision is done on the local or central level. Local level is defined by each customer where the management is carried out by one of the following: DSO, retailer, an aggregator or a current status of the network. The central level represents larger power technology management than in each household, which has an impact to all involved customers. The technology providing the flexibility uses a Communication. Based on continuous network quality measurement and network calculations (used to identify of potential failure/disbalance of the network), a flexibility activation signal is sent by UC actor. Flexibility could be provided to other member of the energy market as a supportive service.

DE Demo

Flexibility presented in the DE UC 1 focuses on limitation of power production of selected DER in case of overload/congestion identified by network calculations.

In DE UC 2, the flexibility is provided by the load control/load shifting and charging/discharging battery management. According to this solution it is possible to connect more devices and renewable resources without change of network configuration.

DE UC 3 combines the benefits of previous two UCs.

CZ Demo

Flexibility in the CZ UC 3 is provided by the limitations of EVs charging. In case of emergency, DSO could curtail the maximum charging power by the narrow band simple one way PLC communication. Also in case that power quality is beyond prescribed limits there is a possibility of autonomous limitation of the charging power that helps stabilize voltage or frequency.

In CZ UC 4, batteries are located at customer premises and help to shave PV feed-in peeks and thus provide flexibility. Also energy from batteries will be discharged to distribution grid in case of emergency by the narrow band simple one way PLC communication or autonomously in case of under voltage or underfrequency.

NL Demo

In NL UC 1, flexibility is provided by the central battery system controlled by aggregator. The aggregator activates battery system based on the requirement from energy market player that buys energy and utilizes it for his own need.

The aggregator provides flexibility in NL UC 2 by controlling EV charging. This flexibility can be sold to different subjects on the energy market.

NL UC 3 is focused on flexibility market design - contract, technical and economy verification of possibilities how to provide described flexibility.

SE Demo

Flexibility in SE UC 1 is provided by heating building system that accumulates the energy during the power generation by RES The amount of accumulated thermal energy is based on the results of heating simulation building model and status of its heating system.

Central heating pump is used in SE UC 2 for flexibility and it's connected to the heating and cooling network in Malmö. Simulating model of the heating network and heating pump is used for heat energy accumulation. Load control allows increasing hosting capacity of the renewable resources.

SE UC 3 focuses on a micro grid project. The island operation is based on RES. Flexibility is provided by micro controller that controls production and consumption in order to manage a power quality of distribution grid.

Flexibility in SE UC 4 is based on demand response i.e. customers get information about the current state of the network, their impact on it and incentives to adapt their energy consumption.

FR Demo

The FR UC 3 aims at using flexibility delivered by aggregators to manage local constraints on the distribution grid. The DSO must ensure the operation of the grid in case of constraint or incident. Flexibility can be thus used to relieve those constraints and postpone investments. The French demonstrator will study several flexibility use activation scenarios: day ahead and intraday. According to the use of flexibility (works, incidents), the flexibility could be guaranteed on a yearly basis for example.

The FR UC 1 aims at using flexibility by aggregators to increase the theoretical duration of the islanding. When the storage system owned by Enedis is either full or empty, flexibility can be activated to increase or decrease the state of charge of the islanding storage.

4.2.2 Hosting capacity

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
DE UC 1	LV Customer	Hosting capacity	control DER	LV Customer premises	DMS
			Communication	LV Customer premises / Control center	DMS
DE UC 2	LV Customer	Hosting capacity	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			Communication	LV Customer premises / Control center	DMS
DE UC 3	LV Customer	Hosting capacity	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Communication	LV Customer premises / Control center	DMS
CZ UC 1	LV - DSO & LV Customer	Hosting capacity	Control DER	LV Customer premises	
CZ UC 2	MV - DSO & MV Customer	Hosting capacity	Control DER	MV Customer premises	DMS
			Communication	MV Customer premises / Control center	DMS

CZ UC 3	LV - DSO & LV Customer	Hosting capacity	Control DER	LV Customer premises	
			Control charging / Discharging Battery	LV Customer premises	Customer
			Communication	Control center	DMS
				LV Customer premises	
SE UC 1	LV Customer	Hosting capacity	Communication	Control center	DMS
				LV Customer premises	Aggregator
			Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
SE UC 2	LV Cusotmer	Hosting capacity	Communication	Control center	DMS
				LV Customer premises	Aggregator
			Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
SE UC 3	LV - DSO & LV Customer	Hosting capacity	load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises	DMS
				LV	
			Control charging / Discharging Battery	LV Customer premises	DMS
				LV	
			Communication	Control center	DMS
				LV Customer premises	
				LV	

Table 8: Hosting capacity

UCs with hosting capacity mostly focus on DER control, load control/load shifting or both. Control is performed automatically either by distributor control centre or by an aggregator, this action is carried out in accordance with the required parameters (such as voltage levels, temperature…) or made by the customers themself using a business platform based on the received incentives.

DE Demo

In DE UC 1 the distributor has opportunity, in case of need, to curtail production from DER, that allows for connecting more DER. DE UC 1 will create more efficient tools to carry out emergency curtailments and hence help to minimize the amount of energy that is being curtailed

In DE UC 2 the distributor is testing the opportunity to shift consumption of electric energy to period with maximum production from RES, and thereby reducing congestion of distribution network. This load control/load shifting allows for connection of more DER and consumptions without investments to distribution grid reinforcements.

DE UC 3 combines benefits from load shifting and generation curtailment in DE UC 1 a DE UC 2

CZ Demo

CZ UC 1 demonstrates how smart PV inverters which use the set QU and PU characteristic allow increasing DER hosting capacity. These functions of smart PV inverters allow for connection of more DER on LV level.

UC2 implements volt-var control on 3 different DER types (PV, Wind, Biogas) in 3 different areas. DERs are connected to the MV grid. Volt/var control will allow significant increase of DER hosting capacity.

In CZ UC 4 smart PV inverter with battery system allow to increase network hosting capacity by peak shaving. PV production is to battery. PV inverter together with battery system help distributor with voltage and frequency stabilization.

SE Demo

SE UC 1 is based on controlled consumption of electric energy for production of heat energy in office building which enables higher DER to be connected to the distribution network. The building accumulation capacity can be used to shift the heat production, without influencing thermal comfort.

SE UC 2 focuses on control of the electricity consumption related to heating/cooling energy used by individual customers. The heat accumulation in thermal grid enables to shift the heat production from heat pump to a time with maximum production from RES.

SE UC 3 enables, thanks load control and DER control, connection of more RES and consumptions to the distribution grid.

4.2.3 Islanding

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
SE UC 3	LV - DSO & LV Customer	Islanding	Quality measurement	MV/LV Substation	
				LV	
			load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises	DMS
				LV	
			Control charging / Discharging Battery	LV Customer premises	DMS
				LV	
			Islanding operation	LV	DMS
				LV Customer premises	DMS
			Communication	Control center	DMS
				LV Customer premises	
				LV	
				MV/LV Substation	
			network Calculation	Control center	DMS
FR UC 1	MV - DSO & LV - DSO & LV Customer	Islanding	Islanding operation	MV	DMS, Aggregator
				MV/LV Substation	
			load Shifting	LV Customer premises	DMS, Reatiler/ Aggregator
			Control DER	LV	Aggregator
			Communication	LV Customer premises	DMS, Reatiler/ Aggregator
				LV	Aggregator
				Control center	aggregator
			Quality measurement	LV	(sensors at secondary substation)

Table 9: Islanding

Islanding within InterFlex project means the operation of part of the distribution grid independently from the surrounding area. Islanding is demonstrated in the areas with high penetration of RES. Primarily the island operation is based on RES however in case low RES production, other DER are also involved. Therefore, it is necessary to continuously measure a quality of network, monitor network status, perform network calculations, and control all locally available DER and local consumption. Due to a lower grid capacity of islanded area, it is needed to have fast and secure Communication between devices which enable automatic control during island operation.

SE Demo

SE UC 3 deals with operation of dedicated distribution area to island mode based on power generation from renewable sources (up to 100%). During this operation an automatic control system will be used in order to reach and maintain the independent operation.

FR Demo

FR UC 1 is dedicated to the temporary islanding of a portion of the distribution. It aims to develop an innovative islanding solution based on local generation, storage systems and customers'.

4.2.4 Power Quality

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
DE UC 1	LV Customer	Power Quality	Quality measurement	HV/MV Substation MV/LV Substation	DSO
			network Calculation	Control center	DMS
			Communication	HV/MV Substation MV/LV Substation Control center	DMS
			control DER	LV Customer premises	DMS
DE UC 2	LV Customer	Power Quality	Quality measurement	HV/MV Substation MV/LV Substation	DSO
			Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
DE UC 3	LV Customer	Power Quality	Quality measurement	HV/MV Substation MV/LV Substation	DSO
			Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS

			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Provide support Services	LV Customer premises	DMS
CZ UC 1	LV - DSO & LV Customer	Power Quality	Quality measurement	LV	DSO
			Communication	LV Control center	DMS
			network Calculation	Control center	DMS
			Control DER	LV Customer premises	
CZ UC 2	MV - DSO & MV Customer	Power Quality	Quality measurement	MV	DSO
			Communication	MV Control center MV Customer premises	DMS
			network Calculation	Control center	DMS
			Control DER	MV Customer premises	DMS
CZ UC 3	LV - DSO	Power Quality	Quality measurement	LV	DSO
			Communication	LV Control center	DMS
			network Calculation	Control center	DMS
			control EV charging	LV	DMS
CZ UC 4	LV - DSO & LV Customer	Power Quality	Quality measurement	LV	
			Communication	LV Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			Control DER	LV Customer premises	
			Control charging / Discharging Battery	LV Customer premises	DMS

NL UC 1	LV - DSO & MV - DSO	Power Quality	Quality measurement	LV	
				MV/LV Substation	
				HV/MV Substation	
			Communication	LV	DMS & aggregator
				MV/LV Substation	DMS
				HV/MV Substation	
				Control center	
			network Calculation	Control center	DMS
			Control charging / Discharging Battery	LV	Aggregator
			Provide support Services	LV	Aggregator
SE UC 3	MV - DSO & LV - DSO & LV Customer	Power Quality	Quality measurement	LV	
				MV/LV Substation	
			network Calculation	Control center	DMS
			Communication	LV Customer premises	DMS
				Control center	
				LV	
				MV/LV Substation	
			load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises	DMS
				LV	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
				LV	DMS
FR UC 1	MV - DSO & LV - DSO & LV Customer	Power Quality	Quality measurement	LV	(sensors at secondary substation)
			Communication	LV	(sensors at secondary substation)
				Control center	DMS

	network Calculation	Control center	DMS
	load Shifting	LV Customer premises	DMS, Reatiler/ Aggregator
	Control DER	LV	Aggregator
	Provide support Services	LV Customer premises	Aggregator

Table 10: Power Quality

This aim is addressed by UCs aiming to keep power quality in distribution grid on determined level and allow prevention of congestion and undesirable changes of frequency. The remote control devices collect information about current network status, perform network calculation and control devices which provide required flexibility. In case of automation control, electric generation/consumption is controlled according to predefined rules.

DE Demo

In all 3 UCs the DSO will leverage power quality data from a residential smart meter infrastructure to improve grid monitoring capabilities and enable advanced decision making in grid operation. With better access to more comprehensible data and greater data processing capabilities the DSO will be able to control flexibilities more effectively and more efficiently. This helps to keep the grid stable at all times and to determine appropriate actions in the case of grid congestion.

CZ Demo

CZ Demo smart solutions will be clearly monitored, the aim of CZ Demo testing is not to negatively affect the power quality parameters.

NL Demo

NL UC 1 achieves the required power quality by smart storage unit. Aggregator sells available flexibility to the distributor or another member of energetic market.

SE Demo

SE Demo4b ensures that the power quality defined by regulation is kept during all modes of operation. During interconnected mode, the impact of the distributed assets is measured via a dedicated set of measurement devices installed in different parts of the micro-grid. When in islanded and during the transition mode, the central controller monitors the power quality values and manages the micro-grid assets, so that the power quality is kept within limits. If any of these values would be surpassed e.g. due to a failure in the system, the central controller automatically reconnects the micro-grid to the overlying grid. In a similar way, if a power quality issue occurs in the main grid e.g. sustained under voltage, the micro-grid has the capability to automatically disconnect itself from the main grid in order to reinstate the power quality in the system.

FR Demo

FR UC 1 aims at having a power quality as good as if there were no islanding. The power quality will be assessed by metering at different point of the grid.

4.2.5 Cross energy carrier synergies

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
SE UC 1	LV Customer	Cross energy carrier synergies	Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
SE UC 2	LV Cusotmer	Cross energy carrier synergies	Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	aggregator
SE UC 3	LV - DSO & LV Customer	Cross energy carrier synergies	load Shifting	LV Customer premises	DMS
FR UC 1	MV - DSO & LV - DSO & LV Customer	Cross energy carrier synergies	load Shifting	LV Customer premises	Aggregator

Table 11: Cross energy carrier synergies

Involved UCs use technology which transforms electric energy to a different energy carrier and thus it can be stored or used in different way. In most cases, it is the conversion of electrical energy into thermal energy which is further used for heating or cooling. Frequently, calculations are made on the simulation model to ensure safe and reliable operation of the thermal system. Heat accumulation is advantageous in terms of a possible shift in time to the moment when the price of electricity is the cheapest. Running this technology is usually managed by a distributor or retailer who makes a use of the most favourable conditions. The business platform is often used for technology control. The platform serves to display the actual system parameters and states and to set the desired values.

SE Demo

SE UC 1 focuses on the building thermal system. The simulation model used is used to calculate the free heat capacity to determine the amount of electricity that can be consumed from the grid and thereby relieve it of any surplus electricity from renewable sources.

SE UC 2 is similar to SE UC 1, with the difference that electric power is used to a large heat pump that supplies heat to the large thermal system.

SE UC 3 serves to convert electricity into heat as a flexible load to control and maintain island traffic.

FR Demo

FR UC 1 will involve gas/electrical flexibility to manage distribution grid constraints. Gas/electrical flexibilities are flexibilities that leverage the synergies between electric and gas distribution systems. Hybrid boilers (i.e heating, and in some case cooling systems which combine a condensing boiler and an electric heat pump) and combined heat and power systems are the main gas / electrical flexibilities used in the project. They can respectively modulate the power consumption or production according to the distribution grid needs.

4.2.6 Grid Automation

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
DE UC 1	LV Customer	Automation	network Calculation	Control center	DMS
			Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			control DER	LV Customer premises	DMS
DE UC 2	LV Customer	Automation	Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
DE UC 3	LV Customer	Automation	Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS

CZ UC 1	LV - DSO & LV Customer	Automation	Control DER	LV Customer premises	
CZ UC 2	MV - DSO & MV Customer	Automation	Communication	MV Customer premises / Control center	DMS
			Control DER	MV Customer premises	DMS
CZ UC 3	LV - DSO	Automation	network Calculation	Control center	DMS
			control EV charging	LV	DMS
CZ UC 4	LV - DSO & LV Customer	Automation	Communication	Control center / LV Customer premises	DMS
			network Calculation	Control center	DMS
			Control DER	LV Customer premises	
			Control charging / Discharging Battery	LV Customer premises	DMS
SE UC 1	LV Customer	Automation	Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
			Provide support Services	LV Customer premises	Aggregator
SE UC 2	LV Cusotmer	Automation	Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
			Provide support Services	LV Customer premises	Aggregator
SE UC 3	LV - DSO & LV Customer	automation	load Shifting	LV Customer premises	DMS
			Islanding operation	LV	DMS

				LV Customer premises	DMS
			Control DER	LV Customer premises	DMS
				LV	
			Control charging / Discharging Battery	LV Customer premises	DMS
				LV	
			network Calculation	Control center	DMS
SE UC 5	Operational	Automation	network Calculation	Control center	DMS
			Simulation model	Control center	DMS
			Forecast Calculatino	Control center	DMS
			Communication	Control center	DMS
FR UC 1	MV - DSO & LV - DSO & LV Customer	Automation	Islanding operational	Control center	DMS (control switch)
				LV	(sensors at secondary substation)
FR UC 3	Operational	Automation	load Shifting	LV Customer premises	Aggregator
			Control DER	LV Customer premises	Aggregator

Table 12: Grid Automatio

The automation topic is covered by UCs in which all or some steps are performed automatically according to a defined algorithm and independent of human interaction. Most frequently the automation is applied on, production, consumption, parameter setting, or data evaluation which includes predictive development, network calculations, weather forecast or customer behaviour. Most often the automation is related to power quality measurement, network calculations, forecast calculation, and for the transfer of information (Communication).

DE Demo

All DE UCs are focused on evaluating network status from power quality measurements and network calculations, and then automatically responding to emerging congestion in distribution network by automatic control of small units of flexibility. The tools developed will have the capability to aggregate flexibilities on different levels to respond to grid congestion and emergency situations effectively and in a timely manner. In all DE UCs a disaggregation of control signals from SCADA into a set of individual commands for flexibilities will be demonstrated.

CZ Demo

CZ UC 1 - The smart inverters autonomously regulate reactive or active power based on Q(U), P(U) settings

CZ UC 2 – DERs retrofitted by volt-var control system regulate on voltage set point, which is remotely sent from DSO SCADA, by regulation of reactive power. The volt-var control system works autonomously.

CZ UC 3 – EV charging stations autonomously curtail maximum charging power in case of undervoltage or in case of underfrequency

CZ UC 4 – PV inverter with battery system autonomously discharge some amount of the battery capacity in case of undervoltage or in case of underfrequency

SE Demo

SE UC 1 and SE UC 2 use automation to identify the available heat capacity of the system based on a simulation model. This model is used to identify potential capacity to shift the electricity consumption.

Automation within SE UC 5 represents the evaluation of data from network calculation and all forecast calculations (customer behaviour, weather etc.) that help to create advance algorithms to create a self-learning grid that is independent of human control.

FR Demo

FR UC 1 will involve additional sensors on the grid, mainly located at secondary substation, to monitor voltage and current. An islanding switch will be controlled from the Enedis control room, and a dedicated interface will be deployed at the control room to monitor remotely the islanding

FR UC3 will involve sensors on the grid connected to the “provisional management” of Enedis within the control room. This will allow for anticipating distribution grid constraints.

4.2.7 Business platform

UC	Level	Aims/Scope	Solution cluster	Topology	System involved
NL UC 1	LV - DSO & MV - DSO	Business platform	Communication	Control center	DMS
				LV	Aggregator
NL UC 2	LV - DSO & MV - DSO	Business platform	Communication	Control center	DMS
				LV Customer premises	Aggregator & Customer
				LV	Aggregator
SE UC 1	LV Customer	Business platform	Communication	LV Customer premises	Aggregator & Customer
SE UC 2	LV Cusotmer	Business platform	Communication	LV Customer premises	Aggregator & Customer
SE UC 4	Operational & LV Customer	Business platform	Communication	Control center	retailer / aggregator
				LV Customer premises	Customer
FR UC 3	Operational	Business platform	Communication	Control center	Aggregator (portal)
				LV Customer premises	Aggregator (platform)

Table 13: Business platform

The business platform is used in UCs where there is an interaction among various actors (such as DSOs, retailers, aggregators, customers)

NL Demo

The business platform is a communication interface between the aggregator and the distributor and the aggregator and the technical aggregator where information on the flexibility required by the distributor, the amount of flexibility offered and the price of the aggregator is exchanged. For SE UC 2 it also means the communication interface between the aggregator and the EV users.

SE Demo

In SE UC 1 and SE UC 2 a business platform covers supervision and control of the heat system and includes the communication about the electricity price.

In SE UC 4, a business platform represents the status of the network and the impact of individual customers' behaviour on the network.

FR Demo

In FR UC 3, it is the aggregator portal which is an interfacing tool that the DSO and the Aggregators use to exchange data. It provides all the necessary features that both parties need in order to create valid flexibility offers, examine and choose between those offers.

4.3 CUSTOMER RECRUITMENT

Based on the fact the flexibility is provided by customers in almost every UC, it was needed at the beginning of the Interflex project to recruit customers. The approach of every Demo to recruit the customers was mapped within the WP2. Based on the inputs from Demos, the summary e summary of approach of each Demo was outlined:

Customer empowerment as a corner stone for the InterFlex project

In case of providing flexibility by DER, this is done mostly by residential customers and owners of DER. Flexibility related to power consumption and EV charging is provided by a variety of actors from residential customers/households to big companies. For some UCs (CZ UC 3, NL UC 1, SE UC 5, 5, FR UC ?) are customer not needed and there is no customer recruitment.

Customer recruitment process

Communication strategy towards customers is very similar for all Demos. The most often the recruitment is done via emails, letters, local press, building organization, advertisements, public meeting, webpages, face to face etc.

The aggregator will not be included CZ and DE Demo. Other Demos will have aggregator which will be responsible for negotiation contracts, recruitment of participants, installation and control of the equipment at customer premises and delivering of required flexibility.

What is the minimum number of customers for Demo activities

Success of recruitment is most often measured by number of registered/recruited customers, In CZ Demo the success is measured not by the number of customers involved but by increasing hosting capacity and successful regulation of DER.

The number of customers that Demo aims at is not important for CZ and NL Demos. The other Demos defined a minimal number of customers they need reach.

Issues related with the customer involvement

One main challenge is similar for every Demo: to persuade customers to contribute to the project and join its activities. Demos look for incentives to promote providing flexibilities by customers.

Main issues with respect to customer involvement in Demos:

DE Demo faces public concern about security of a digitalized energy system and has to solve technical challenges with end-2-end architecture from grid control to customer device without involved third party API.

Local conditions within the SE Demo such as roof quality for PV installations is not sufficient and the investment cost for new equipment is higher than expected.

Incentives for customer participation in the project

The incentives to attract the customers to participate in project could be divided to three categories:

1) Discounts for new technologies and their installations, discounts for retrofit of control equipment for existing technologies
2) New tariffs, special prices for flexibilities, discounts on grid bill and compensation

for the energy that the DSO is using in the customers equipment

3) Financial benefits, provide material benefits, sweepstake for interested parties

Customer's role and contribution to the project

Customers involved in the project provide various flexibilities via controlled power generation, battery storage and consumption. Demos create and assess a real life conditions for future roll out, find adequate contractual conditions between parties, provide additional information to make full use of flexibility and increase customer awareness of their impact on the network.

Installed technologies

For flexibility Demos use existing technologies, retrofit existing equipment by control system or install new technologies. For the communication of the equipment, it is mostly used LTE/4G, 3G, PLC and Ethernet.

Future plans of the demonstrated solution

Plan for future integration of the demonstrated solution is for most Demo rollout or inclusion to distribution portfolio.

4.4 USE CASE OVERVIEW

In order to offer an overview of each Use Case, the *scope and objective* and the *Description* has been extracted from each UC description and it is summed below. The complete collection of the detailed description of the UCs can be found in the **Erreur ! Source du renvoi introuvable.**.

4.4.1 DE Demo Avacon – WP5

4.4.1.1 DE UC 1 - Feed In Management

Scope and Objective:

Small scale renewable generators on customer premises shall be monitored and controlled individually by a central Smart Grid controller (Smart Grid Hub) in response to local and temporal grid congestion.

1. Relieve grid congestion by curtailing local energy production.
2. Provide precise reading of power output of small scale generators and grid parameters at any given point in time.
3. Establish a secure, reliable and effective connection between grid control / smart grid hub and local renewable generators. (Reliability)
4. Minimize energy curtailed and number of generators affected.
5. Minimize the total cost of the integration of local small scale renewable generators.

Description:

The Smart Grid Hub (SGH) is envisioned as a process unit that connects to the grid control center of a DSO. The SGH monitors the state of local small scale generators via a digital metering infrastructure which transmits power, voltage and current at the customer's premises. Combined with data from the grid control center about the state of the grid the SGH can forecast and recognize impeding or existing violations of technical limits and control and curtail the momentary feed in of local generators to such an extent, that all technical limits will be respected at all times. The Smart Grid Hub determines the curtailment strategy in such a way, that the number of generators affected and the total volume of energy curtailed remains the minimum necessary to keep the grid within technical limits.

4.4.1.2 DE UC 2 - Demand Side Management

Scope and Objective:

Flexible loads on customer premises shall be monitored and controlled individually by a central Smart Grid controller (Smart Grid Hub) in response to local and temporal grid congestion.

1. Relieve grid congestion by ramping up or down local energy consumption.
2. Provide precise reading of momentary consumption of small flexible loads and grid parameters at any given point in time.
3. Establish a secure, reliable and effective connection between grid control / smart grid hub and local loads. (Reliability)
4. Minimize the amount of energy that's being shifted and number of customers affected.
5. Minimize the total cost of keeping the grid within technical limits..

Description:

Once DE UC 1 has demonstrated that the existing strategy of controlling small scale DER from SCADA via a Smart Grid controller can be achieved by leveraging a private smart meter infrastructure DE UC 2 shall demonstrate that the same can be achieved with the control of small scale flexible loads. Under this UC small scale flexibilities from private customers shall be controlled in order to increase consumption during times of high local renewable generation and to decrease consumption during times of low local renewable generation.

4.4.1.3 DE UC 3 - Ancillary Services

Scope and Objective:

Based on UC5.1 and UC5.2 UC5.3 combines these two to bring generators and loads together as one pool of flexibility to provide ancillary service or balancing energy to the national, regional or local grid.

1. Provide ancillary services to the national grid (primary control, secondary control, tertiary control) in a simulated environment (actual participation not possible).
2. Provide balancing energy to regional grid to relieve feeder or transformer congestion.
3. Provide balancing energy to local grid to relieve feeder or transformer congestion.
4. Provide precise reading of momentary power output of small scale renewable generators and consumption of small flexible loads and grid

parameters at any given point in time.

5. Establish a secure, reliable and effective connection between grid control / smart grid hub and local loads. (Reliability)
6. Maximize the effectiveness of the available flexibility.
7. Minimize deviations between control signal and change in power output or consumption.

Description:

The Smart Grid Hub (SGH) is envisioned as a process unit that connects to the grid control center of a DSO. The SGH monitors the state of local renewable generators and local loads via a digital metering infrastructure which transmits power, voltage and current at the customer's premises. Combined with data from the grid control center about the state of the grid the SGH can forecast and recognize impeding or existing violations of technical limits and control the momentary consumption of local loads to such an extent, that all technical limits will be respected at all times. The Smart Grid Hub can also aggregate loads and generators to create a virtual source of flexibility which could provide ancillary services on national, regional or local level. On a regional level it could mean that the aggregate flexibility is leveraged to relieve congestion on a regional 20 kV feeder or to lessen the load on a TSO / DSO transformer. On the local level the aggregate flexibility could be leveraged to relieve congestion on local 1 kV feeders or to keep the voltage level of low voltage feeders within limits.

4.4.2 CZ Demo CEZ Distribuce – WP6

4.4.2.1 CZ UC 1 - Increase DER hosting capacity of LV distribution networks by smart PV inverters

Scope and Objective:

The aim of the UC is field demonstration of smart PV inverters functions which enables increasing of DER hosting capacity in two different areas with different LV grid topology.

Increase of DER hosting capacity in LV grids thanks to the installation of smart PV inverters and securing the power quality according to EN 50160 standard.

Description:

ČEZ Distribuce and its partners aims at demonstrating how the combination of new smart PV inverter functions Q(U) and P(U) under real operating conditions within LV distribution networks can increase the DER hosting capacity. A successful demonstration requires appropriate conditions for testing roof PV systems using smart PV inverters (fulfilling the EN 50438 ed.2 standard) installed massively under preselected 2 MV/LV secondary substations. Two areas with different topologies but high penetration of PV systems are needed. Crucial tasks for this UC are the recruitment of customers within the selected areas, the installation of PV systems with smart PV inverters and the delivery of technical operational data and results from the PV inverter monitoring systems with the customer's consent.

4.4.2.2 CZ UC 2 - Increase DER hosting capacity in MV networks by volt-var control

Scope and Objective:

The aim of the UC is field demonstration of volt-var control system which enables increasing of DER hosting capacity in three different areas with three different DER (PV, Wind, Biogas) connected to the MV grid.

Increase of DER hosting capacity in MV grids thanks to the installation of smart PV inverters and securing the power quality according to EN 50160 standard.

Description:

ČEZ Distribuce integrates selected DER connected to MV networks into volt-var control system (PV: 1.1MW, biogas station: 1.25MW, wind: 4.6MW). The DSO can send required voltage set points from its SCADA to DER unit, which then react and regulate at the required voltage set points (thanks to reactive power generation/consumption. For this volt-var control strategy, ČEZ Distribuce leans on existing DER over 100kW with communication capabilities (usually GPRS) towards the DSO dispatching control system (SCADA).

4.4.2.3 CZ UC 3 - Smart EV charging

Scope and Objective:

The aim is to quantify the impacts of the Smart charging of EVs onto the distribution grid flexibility in case of emergency.

Reduce maximum charging power of smart charging station in case of underfrequency, undervoltage or in case of receiving signal from DSO through ripple control system (emergency functions) and power quality measurement during EV charging process (evaluated according to EN 50160).

Description:

ČEZ Distribuce together with partners aims at testing the influence of smart EV charging stations functions to show their potential for increasing the network flexibility through improved EV charging stations implementation into the distribution networks (services to the distribution network), and optimizing the future EV charging stations implementation to prevent from power quality issues and to contribute to the system stability and flexibility without reduction of customer comfort. The Smart functions to be tested (first in a laboratory then in the field) are partial active power curtailment of EV charging in case of under frequency or under voltage in the DS and partial remote active power curtailment from DSO SCADA in case of emergency.

4.4.2.4 CZ UC 4 - Smart energy storage

Scope and Objective:

The aim of the UC is field demonstration of smart PV inverters with batteries which enables increasing of DER hosting capacity in one area thanks to the peak shaving of PV production. Provision of flexibility to DSO in case of emergency.

Increase of DER hosting capacity in LV grids thanks to the installation of smart PV inverters with batteries which allow peak shaving of PV production and securing the power quality according to EN 50160 standard. Delivery of active power from batteries in case of underfrequency, undervoltage or in case of receiving signal from DSO through ripple control system (emergency functions).

Description:

ČEZ Distribuce tests the influence of using the residential energy storage systems (PV + battery) on the PV peak shaving in LV distribution network and assesses the potential of grid-connected energy storage systems (for increasing the flexibility by providing grid services). The smart energy storage functions which are going to be tested are: active power injection in case of DSO request and active power injection in case of under frequency or under voltage in the distribution network. Customer participation is essential. Testing the influence of residential energy storage systems on solar peak shaving helps determining how these systems affect the power quality and how they contribute to avoiding congestions in the distribution network.

4.4.3 NL Demo Enexis – WP7

4.4.3.1 NL UC 1 - Improve grid flexibility using Smart Storage Unit

Scope and Objective:

Enabling ancillary services, congestion management, voltage support for PV integration using centralized, grid-connected storage systems to improve grid observability of prosumers, promoting batteries in multi-service approach.

In scope:
-Battery infrastructure and deployment
-Congestion management
-Voltage support for PV integration
-Multi-service approach
-Local Infrastructure Management System

Out of scope:
-Other ancillary services (is not in pilot, but aggregator can use the battery for ancillary services if part of its business model)
-Power quality improvement (other than voltage support)
-Domestic battery systems

In this pilot, and therefore this UC document, the battery will be called Smart Storage Unit or the abbreviation SSU will be used.
Small headline:
This UC conceptualizes, implements the systems and interactions necessary to achieve a stable grid through flexibility using Smart Storage Unit and PV systems.

By implementing UC 1, Enexis and the involved aggregators test and validate the application of a smart storage unit for the following purposes:
-Congestion management
-Energy trading / portfolio management through spot market, imbalance market and/or ancillary service provision
-Power quality improvement & voltage control upon request from DSO

Specific:
Design local infrastructure management systems and extend aggregators platform to translate DSO requirements (based on real-time measurements or predictions) into actual load balancing and voltage control requests.

Measurable:
Battery-based storage efficiency (KPI_NL1).
Percentage of time during which the storage is available (KPI_NL2).

The percentage of shifted energy, contribution to load shedding and ancillary services (KPI_NL3).
Share of energy/power displaced for each type of flexibility (KPI_NL4).
Percentage of decrease on ratio Peak/average at MV feeder level (third level area) (KPI_NL5).

Assignable:
Technical/local aggregator (with its LIMS) and commercial aggregators (with its FAP) have a primary role to implement this capability in their systems. Initiation of this functionality can be done by DSO (flex requirements/request) and aggregators (change in availability of resources).

The DSO is responsible for availability: Smart Storage unit (SSU), PV systems, LIMS, GMS (incl. grid measurements from distribution automation boxes and smart meters), solar car
The commercial aggregator is responsible for availability: FAP
TNO is responsible for interoperability and interchangeability of the systems.

Realistic:
Flexibility availability by using locally available Smart Storage Unit and PV systems.

Time-related:
When the Smart Storage Unit and PV systems are in place and the aggregator systems have been developed and/or adapted, see project planning.

Description:
The goal of this demonstration is to validate technically, economically and contractually the usability of a smart storage unit embedded as a commercial storage. Centralised storage must be valued with the support of all the players involved: the TSO, the DSO, the storage operator, the prosumers. It demonstrates the applicability of large scale centralized storage units at the substation/street level to demand side management. The deployed capacity of the centralized storage unit is in the range of 250 kW / 500 kWh.

To enable interaction between actors, markets and local resources a Local Infrastructure Management System (LIMS) is defined. The goal is to realise a local interface from and to the potential flexibility sources.

The LIMS should consist of the following technical functions:

- Realise an interface from and to the smart storage unit and PV installation

o Collect and forward measurement data from smart storage unit and PV installation for the purpose of congestion management

o Collect and forward measurement data from smart storage unit and PV installation for the purpose of voltage management

o Monitor and maintenance of the smart storage unit

o Operation of the smart storage unit

o Power quality improvement

Realise interfaces with various potential flexibility sources (e.g. DC households, solar car, household storage solutions, PV installations, heat pumps and white goods).

o Collect and forward measurement data from smart storage unit and PV installation for the purpose of congestion management

o Collect and forward measurement data from smart storage unit and PV installation for the purpose of voltage management

o Operation of the smart storage unit

o Power quality improvement

-Implementation conform standardised protocols for the interaction with commercial aggregators. Protocols are selected in consultation with the aggregator.

The LIMS should have the following organisational functions:

-Provide local flexibility sources to the commercial aggregators

-Technically and organisationally responsible for (the interface with) these flexibility sources

Negotiate contractual agreements with aggregators for the provision of flexibility

4.4.3.2 NL UC 2 - Improve grid flexibility using Electric Vehicle

Scope and Objective:

Enabling the optimal activation of all available local flexibilities offered by the locally installed EVSE's for congestion management. This is done by allowing the DSO, that monitors the grid, to send flexibility requests towards commercial aggregators that will, through interacting with the CPO, end up as adapted charging schedules on EVSE's, making the necessary flexibility happen.

In scope:

-EV infrastructure

-Chain process from EV driver (preferences) to DSO (requirements) through roles and protocols that are necessary to make the flexibility happen

Out of scope:

-Non EV infrastructure

-Other ancillary services

-Commercial viability is part of UC WP7_3

This UC conceptualizes and implements the systems and interactions necessary to achieve a stable grid through flexibility using EV systems.

By implementing UC 2, Enexis/Elaad/involved aggregators test and validate a technical framework for realizing DSO requested flexibility from EVs in order to prove the concept and develop knowledge on the applicability and the future scalability of the concept.

By implementing UC 2, Enexis/Elaad/involved aggregators will gain an in-depth understanding on how flexibility can be managed between DSOs and multiple aggregators and how the required systems should interact.

By implementing UC 2, the involved aggregators can validate the maturity (and shortcomings) of communication chain and its protocols, so we can propose changes and extensions to the relevant standardization bodies.

Description:

The CPO manages the charging of EV's, applying different mechanisms to 'unleash' the EV's flexibility. It can aggregate the flexibility and offer it to the DSO, TSO and BRP via the flexibility aggregator platform (FAP). This UC conceptualizes, implements and validates the technical aspects of 'long-term flex purchase contracts' facilitating the DSO flexibility needs. The rest of the flexibility / capacity can be purchased by the BRP and TSO. This increase of locally accessible flexibility allows for a large number of consumers to actively offer their flexibility to the DSO or within energy markets. The DSO becomes a market organizer by coordinating with FAP's, delivering order of merits for each of the candidate flexibilities, asking for day ahead bids. This is very likely the case for matters of congestion, but it is also possible that the BRP and/or TSO fulfil this role. Such a system includes market settlement to assess the flexibility effects and compensate the aggregators.

Aggregators manage various types of flexibilities.

4.4.3.3 NL UC 3 - Usability of an integrated flex market

Scope and Objective:

Validating technically, economically and contractually the usability of an integrated flex market based on a combination of static battery storage and EV chargers.

Multiple Aggregators offer flexibility from different flexibility sources (Smart Storage Unit, EV chargers) on a flexibility market so that the DSO can procure flexibility from multiple parties for grid supporting services (e.g. congestion management). All contracts and transactions needed for the procurement of flexibility will be described. Furthermore, agreements between the parties about the availability of energy flexibility services will be described in a service level agreement (SLA). The needed contracts, transactions and SLAs will be formed in the implementation of this use case.

Out of scope:
Other ancillary services

By implementing UC 3, Enexis/TNO/involved aggregators test and validate a technical framework for trading flexibility between multiple aggregators and DSO in order to prove the concept and develop knowledge on the applicability and the future scalability of the concept.

By implementing UC 3, Enexis/TNO/involved aggregators will gain an in-depth understanding on how flexibility can be traded between DSO and multiple-Aggregators and how the required contracts and transactions can be formed and handled.

By implementing UC 3, the involved aggregators can validate the proposition for trading flexibility for multi-goal to multi-party (e.g. congestion management + spot market trading). Therefore, gain knowledge on the monetary value of flexibility for their business.

Description:

This demonstration validates technically, economically and contractually the usability of an integrated flex market based on a combination of static battery storage (smart storage unit) and EV. One aggregator is operating the storage and another operating the EV (SE)'s. The two aggregators compete on the flexibility market, both offering flexibility to the different stakeholders (DSO, TSO and BRP). The two types of flexibility (storage and EV) have different characteristics and very likely different user constraints (e.g. EV drivers want their car to be charged within a given time), resulting in different marginal costs of flexibility and therefore a more dynamic merit order and more competition. In this UC a market mechanism is used to trade flexibility between the two aggregators and the DSO based on a monetary value of flexibility. To avoid a forecasted congestion in the grid, the DSO purchases the required flexibility from one of the aggregators based on the merit order of flexibility. This results in the most cost efficient solution for the DSO.

4.4.4 SE Demo E.ON – WP8

4.4.4.1 SE UC 1 - Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers

Scope and Objective:

Evaluation of the thermal inertia of the buildings envelope and the thermal inertia of the thermal grid as a source of flexibility. The evaluation of the impact of using these sources of flexibility in the integration of renewables will be done via simulation software.

•Determine how to evaluate how much flexibility is in these two sources.

•Determine the impact of exploiting these flexibility sources in the integration of renewables.

•Determine the impact on the thermal systems of them being used for the integration of renewables.

Description:

The UC utilizes hardware and software developed in the EU FINESCE project, to connect new buildings and execute the necessary tests to validate the thermal inertia models to be developed during the project. The recruited buildings are connected to the steering system (CESO), by placing a hardware (Energy Manager) at the customer premises, which is integrated into the already existing building energy management system (BEMS).

The steering principle will be that an activation signal will be created based on the power balance status of Demo4b, which will indicate the status of the renewable energy in the grid (e.g. deficit or surplus of onsite RES). When there is an excess of renewables, the signal will have a positive price and vice versa. Given this activation signal, an algorithm located in the distributed controllers (Energy Manager) translates this signal into specific offset values which will finally create a new set point for the inlet temperature of the heating systems.

Full description of the Use Case, a complete narrative of the function from a domain expert user's point of view, describing what occurs when, why, with what expectation, and under what conditions. It has to be written in a way that it can also be understood by non-experts.

For determining the flexibility available in the thermal inertia of the buildings envelope, diverse physical models will be tested to validate the technical assumptions and to create a model that will be able to provide accurate predictions about the available flexibility in the building so that this can be accessed in an automated way.

The thermal grid´s inertia will be simulated and evaluated via dedicated software specialized in thermal grids. Utilizing the input from Demo4b, an activation signal will be created which will trigger the generation of extra heat/cooling in the thermal systems. Via simulation this excess heat/cooling will be integrated into the thermal grids and the impact on the grid temperatures and differential pressure levels will be evaluated, as well as the amount of excess power that these systems are able to take before reaching any system limit.

For the deployment of this type of solutions a model chain will be created in collaboration with RWTH Aachen.

4.4.4.2 SE UC 2 - Optimal use of a commercial heat pump and cooling pump asset providing energy efficiency and electricity flexibility for grid management purposes

Scope and Objective:

Evaluation of the steering possibilities of a commercial heating and cooling pump for accessing the thermal inertia of a heating/cooling system complementary to the district thermal grid as a source of flexibility.

- Creation of the simulation model for the commercial heating and cooling pump
- Development of the steering logic for this asset
- Validating the simulation model of heat pump through the operational data
- Integrating the simulation model of the heat pump in the thermal network model.
- Testing the solution for one year operational data..

Description:

The UC will try to evaluate the potential of the large heat pump to increase the RES penetration. The district heating and district cooling networks in Malmö are operated by E.ON Värme. In these grids diverse sources of heating a cooling energy are utilized. In the case of the heating grid, a new large industrial heat pump will be installed and commissioned in 2018.

It is planned to steer such a central heat pump. Owing to the large size of such Heat pump in MWs, it would be sought as one the most important balancing technology for the grid service support. It would offer great opportunities for flexibility at the DSO level as it can react instantaneously as per the needs of Demo 4b-UC 3, when connected by a fiber-optic cable. But for the actual implementation of such steering functionality in the large heat pump requires significant efforts to overcome the IT security standards of the production site. Consequently it will be modelled on the simulation platform, to replicate the characteristics. This simulation model will be validated by the real operational data. The control software for the steering logic will be developed for this simulated model of the heat pump, so that RES integration functionality can be verified in the simulation.

Once the simulation model along with its control software is developed and verified, it will be then integrated in the thermal network model. The thermal model together with the heat pump model will be part of the larger Local Energy System (LES) model. This final LES model will consider the Simris (demo4b) site and its high renewable penetration, how its customer receive their power through their electricity network and will virtually include what would happen if a the town of Simris would cover their energy demands via a thermal grid with central heat generation (heat pump) rather than by other distributed technologies (current scenarios).

The final outcome of this simulation activity is to evaluate the impact of integrating energy resources (Power and Heat) on the penetration of on-site renewable power generation. This solution will be tested for one year by using the real operational data from the heat pump for validation purposes of the created simulation model.

This UC is aimed to demonstrate the optimization of the available thermal flexibility of the heating and cooling grids through the simulation of an industrial heat pump, which will validate the effective increase in RES penetration.

4.4.4.3 SE UC 3 - Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation

Scope and Objective:

Design, deployment and operation of distributed balancing technologies (power to heat and power to power) to support the balancing of the micro-grid when in islanded mode i.e. to support the integration of on-site renewables.

•Maximizing the renewable energy utilization by using different energy carriers.

Select balancing technologies to be offered/deployed and suppliers (E.ON). Due on M6.

•Developing special Demand Side Response platform for efficient steering of customer loads. Design and implementation of a DSR Platform (E.ON and third party supplier). Due on M9.

•Integration of the distributed balancing technologies to a DSR platform (E.ON). Due on M12.

•Managing and operation of the micro-grid and activation of the distributed balancing resources to enhance the operation of the overall system (E.ON). M12-18 to M24-30.

•Analysis and evaluation of the impact of DSR technologies on the system (E.ON). Due on M18.

•Modelling, simulation and evaluation of the impact of DSR in the integration of renewables (E.ON and RWTH). Due on M24.

Description:

The success of this UC largely depends on the fact that the Microgrid should run on an Islanded mode for maximum duration of the time without compromising the power quality. The system will always monitor the Microgrid health to stay in the Islanding-mode, and in-case the system parameters start deviating from the standard nominal values, the Microgrid will be reconnected to the main grid. In order to handle the operation of the energy system while in islanded mode, a dedicated micro-grid controller is put in place. This system communicates to all the main central assets of the energy system via a fiber network, allowing a high speed communication and control of the systems. This microgrid controller will act as a central controller for the renewable generation and based on the available generation it will update the setpoints for the allowable Loading on the system, and will provide inputs to the central DSR platform.

For maximizing the renewable energy penetration and supporting the balancing of the micro-grid in a non-centralized way, distributed balancing technologies will be installed at customer households. This UC integrates all the assets in the Microgrid viz. Wind turbine, PV-farm, Battery Storage system, balancing technologies like Hot Tap Water Boiler, Heat Pumps, and PV+Battery.

This use-case aims to enhance the operation of a micro-grid that can go to islanded mode with up to 100% penetration of renewables generation, by steering these flexible-loads in the customer premises. These technologies will be steered from a central DSR platform which will communicate to the central micro-grid controller.

The DSR platform will be the place where data will be concentrated from most of the micro-grid relevant data points as well as from external services. This platform will host the advanced intelligence of the system and will interact with the other main components of the system e.g. P2P platform, micro-grid controller.

4.4.4.4 SE UC 4 - Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs

Scope and Objective:

Acquisition of a Local Energy Market Platform e.g. P2P, to allow customers to visualize their consumption, the operation and performance of their balancing technologies, their impact on the grid and the state of the overall local energy system (e.g. renewable surplus or deficit). The P2P platform will track retroactively the DSR activations executed and will perform the billing accordingly. The P2P platform will not allow customers to do active brokering with their available flexibility.

•Contact customers and start recruiting (E.ON). M3-M12

•Define Local Energy Market Platform concept (E.ON). Due on M9.

•Select P2P platform supplier (E.ON). Due on M9

•Integrate selected P2P platform to the overall system architecture (E.ON). Due on M12-M15

•Track use and feedback from customers about the use of the P2P platform (E.ON). Due on M12-18 to 24-30

•

Evaluate results and lessons learnt (E.ON). Due on M36

•Incentivize the load flexibility offered by the customer

Description:

This UC will try to achieve following things:

1.Grid transparency via a visualization tool

2.Billing platform

1.Grid transparency via a visualization tool:

Customers will have the possibility to view via a User Interface i.e. visualization tool, the state of the energy system and the impact their technologies have on the overall system. This UI will be part of a Local Energy Market (P2P) platform, which will have also the possibility to calculate the incentives that customers will receive by allowing the system to utilize their flexibility. This platform aims at eliciting customer participation into the project and providing transparency in order to increase the energy awareness of the participants.

2.Billing platform:

This visualization tool also proves instrumental in displaying the individual customer bills for the usage of electricity. It performs the billing process to track and calculate the incentives to be given to each customer participating based on their actual contribution to the system.

This UC involves creating the IT platform which extends the functionality of the DSR platform and accumulates the data from the data aggregator and then analyses the data. This analyzed data will be then updated to each user via their UI/visualization tool. This UC aims to provide the customers awareness about the grid activities and their own contribution, which will be later measured through the customer surveys and interviews.

4.4.4.5 SE UC 5 - Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints

Scope and Objective:

Create advanced algorithms that will support the automation of the grid and of the systems involved to:

-minimize customer behavioral change.

-maximize integration of renewables.

-increase observability and controllability of the micro-grid.

Intelligent Algorithms for

•Define potential UCs that would benefit from the creation of advanced algorithms (E.ON & RWTH). M6-M12

•Development of advanced algorithms (E.ON & RWTH). M6-M24

•Implementation and evaluation of the impact of the developed algorithms (E.ON & RWTH). M12-M30.

Description:

A control system operating based on simple logic (such as little or no customer flexibility and basic persistence-forecasting of local generation) is likely to be functional but sub-optimal: additional customer flexibility could be used to time-shift operations and the system performance (measured in terms of renewables utilization and/or stability) could be improved. These advanced elements underpin activity within UC 5.

Advanced controls shall allow the DSR platform (introduced under UC 3) to improve the estimation accuracy of the available flexibility in the system (both in terms of magnitude and timing) and to improve forecasting and prediction of relevant quantities and events; these improvements will allow a better dispatch of the available resources. A number of different disaggregation levels will be relevant and will warrant independent forecasting activity within UC 5, depending on where the generation and flexibility resources are located within the network, what network properties are of interest and where the network constraints are relevant – in the below diagram, forecasting an individual customer's energy properties (represented as demand [Dn,m], generation [Gn,m] and flexibility [Fn,m]) may be relevant, as may the whole feeder's properties (Dn, Gn, Fn), as may the whole microgrid (D, G, F). UC 5 will explore forecasting methods for a number of aggregation levels and for a number of quantities.
Advanced algorithms implemented in this UC will aim to create a self-learning grid with minimal human-response requirement (including manual re-forecasting), increase the automation of the system and provide less reliance on human maneuvering of the grid. Consequently due to various monitoring devices, significant amount of data will be generated. This data will be instrumental for enriching the machine learning algorithms (either as self-learning or via offline modelling) and drawing/visualizing the patterns of energy management with Data-analytics.

Subsequently, as RES penetrations are increased, the grid inertia is substantially decreased which endangers the grid stability. Trying to implement synthetic inertia, amongst various approaches, will also be explored by this UC.

4.4.5 FR Demo Enedis – WP9

4.4.5.1 FR UC 1 - Automatic Islanding

Scope and Objective:

Islanding consists in disconnecting a part of a distribution grid from the main distribution grid while enabling its power supply with local energy resources for a limited duration of time. In the context of Nice Smart Valley, these resources are:

¤Two storage systems (GFU & GSU);
¤Customer's levers;
¤Local photovoltaic generation.

The project plans to go beyond NICE GRID demonstrator:

¤Perform innovative, replicable, ecological islanding (no greenhouse emission);
¤Start MV islanding and start islanding beyond the smart meter (1-site scale);
¤Use a main storage system (GFU) as master of the islanding which controls and maintains the frequency and the voltage in the thresholds;
¤Remotely start an automatic and maneuverable islanding by Enedis' technicians from the Regional Grid Supervisor;
¤Use the support of aggregators through the clients' load management to increase the theoretical duration of the islanding by delivering a service to Enedis;
¤Use a secondary storage system (GSU) owned and operated by ENGIE to deliver a service to Enedis.

Description:

This use case is dedicated to the islanding of a portion of the distribution grid using local resources. It will be studied in two approaches:

¤Testing on field

The experiments, forecasted for the beginning of 2019, will allow for:

-Using storage system in order to improve the power supply quality of the customers of the national distribution grid.

-Determining the conditions to start islanding manually or automatically and remotely to minimize the duration of a blackout.

- Determining the technical link between the different assets contributing to islanding accordingly to the contracts.

-Assessing customers' contribution to support the islanding.

-For the aggregator assets, optimizing the storage management accordingly to the contracted maximum duration and to the forecast loads and productions within the islandable area.

-For the DSO's asset, optimizing the state of charge of the storage system over the year in order to maximize the duration of potential islanding.

¤Simulation, business models and market design approach

On the other hand, this theoretical approach should:

-Evaluate business models for district islanding purpose and the associated offers and contract with local flexibilities and local power suppliers.

-Assess consumers and producers' interest of an islanding service.

-Approach a pricing structure for such product in order to maximize the value for the system.

4.4.5.2 FR UC 2 - Multiservice approach for centralized storage systems

Scope and Objective:

This use case is dedicated to the multiservice approach for grid-connected storage systems. It will be studied in two approaches:

¤Testing on the field

The experiments, forecasted for the beginning of 2019, will allow for dispatching storage systems delivering the following services:

-"Cloud storage": using community energy storage assets to increase self-consumption for customers

-Ancillary services and services on the national level (e.g. capacity and reserve mechanisms)

-Simulating grid constraints for the distribution grid on the MV level

-Islanding

-Optimization of power sourcing for end customer, including load report from peak to offpeak period and reduction of subscribed power

¤Simulation, business models and market design approach

On the other hand, this theoretical approach should:

-Evaluate business models for the storage systems

-Process simulations in a context of 50% renewable energy

-Analyze grid fees scenarios for storage systems in a context of 50% renewable

-Assess regulatory issues

Description:

This use case aims at providing multiple services from energy storage assets:

- Ancillary services
- Contribution to national markets
- Distribution grid constraints mitigation (*see UC3*)
- Islanding (*see UC1*)
- Cloud storage (*see below*)

The "cloud storage" solution proposed by this document will encompass several prosumers that are connected to the distribution grid. In this Use Case, some prosumers could have PV panels even before recruitment takes place, and the target area for the demonstrator will be chosen among the areas with the highest numbers of PV producers already installed. In addition, Enedis expects that some, if not most, of them already have smart meters measuring both the energy produced and consumed.

The storage system is thus a layer to be added to an already existing and functioning system, and it must also take into consideration that not all consumers connected to the same feeder will agree to participate. A possible structure is shown below, where the storage system is integrated into an existent feeder.

4.4.5.3 FR UC 3 - Local flexibility mechanism

Scope and Objective:

Flexibility represents any active means of load, storage or production management, able to temporarily modulate their load curves to deliver services to the electrical system. Nice Smart Valley will study the flexibilities connected either to the LV or to the MV grid, in order to manage distribution grid constraints.

¤Overall process between DSO and aggregators

This use case aims at defining the way the DSO can use the flexibilities for its needs, the role of its actors and the technical details/the process of how they implement the flexibility. The anticipated constraints that appear on the MV grid are predicted based on the information provided by the forecast management. The aggregator portal is an interface between the control room of the DSO and the aggregation platforms of the aggregators.

¤Gas/electrical flexibilities

GRDF is in charge of deploying the gas/electrical flexibilities and building the control architecture. GRDF is connecting its platform to the aggregation platforms of aggregator 1 and 2 (each flexibility is connected to a unique aggregation platform). The aggregators are then aggregating this flexibility then are offering it to the DSO, and sending control orders to the GRDF control platform.

¤Principles

The local flexibility system is a set of information systems allowing for the DSO to anticipate grid constraints and to activate flexibilities managed by aggregators. It is composed of two main tools, the forecast management tool and the aggregator portal.
The forecast management tool is a continuous process of real-time grid planning. It consists of a set of information systems, electrical grid sensors, procedures and organizations that help grid control and operation to manage the changing uses of the grid
It improves grid observability for the DSO. It also serves as a support to the interfaces between Enedis and the transmission system operator and energy generators.
An aggregation platform is an information system including sensor and remote control devices that the aggregators use in order to manage their flexibilities assets (e.g. demand side management at customer premises, storage and local generation). It allows for operating the flexibilities in order to monetize them for example to solve local grid constraints. This platform includes mainly the following functionalities: flexibility forecasting, aggregating and dispatching
The aggregator portal is an interfacing tool that the DSO and the Aggregators use to exchange data. It is an information system that provides all the necessary features that both parties need in order to create valid flexibility offers, examine and chose those offers.

¤Testing on the field
The experiments, forecasted for mid 2018, will allow for:

-Develop and test local forecasting methods for the aggregators: the idea is to predict the flexibility resource at the relevant local scale

-Test the process of local optimization, aggregation and dispatch of flexibilities by the aggregators

-Test client behavior and responsiveness for aggregators

-Test the reliability of the use of flexibilities by the distribution system operator

-Test the entire chain of flexibility activation, from Enedis to the flexibilities (customers or storage assets)

-Test the forecasting method (predictions and constraint simulations) at an operational level (e.g. control room) for Enedis

-Understand the addition or cannibalization between two flexibility uses for the distribution grid and other services in competition (e.g. ancillary services)

-Test the ability to take advantage of the gas grid to make electrical flexibility available, through innovative gas appliances (gas/electrical flexibility)

-Test other types of flexibility for the use of the distribution grid: EV, storage…

¤Simulation, business models and market design approach

On the other hand, this theoretical approach should:

-Evaluate need for flexibilities in a context of 50% of renewable energy generation and penetration of EVs

-Estimate the value of the aggregators' flexibilities on the distribution level

-Converge on a market design for flexibilities, in term of contracting and compensation

-Estimate a potential "missing money" (difference between current value and cost of the flexibility) within the flexibility business model, in order to pave the way for flexibility in the future, when they will be needed for the grid operation

¤ Note:

The constraints on the distribution grid can occur on the MV or LV grid, and can be related to current power or voltage issues. In this deliverable, the constraints on the MV grid, which have been extensively computed, are described in the different areas of the demonstrator. The document describes also the system to involve flexibilities to solve these MV constraints. Flexibilities connected to the MV and LV grid can take part to mitigate MV constraints.

Description:

For the DSO, flexibility can potentially be used as an alternative to the reinforcement of the grid and can be therefore activated in case of incident for instance. Scheduled constructions on the grid can also require the use of flexibility since they lead to a reconfiguration. There are three use cases of the flexibility: **incidents** and **constructions** at the primary substations and on the MV grid. It can also be used to **postpone investments** on the grid. The demonstrator will not study the third flexibility use case "deferring investments" since it has no application in the perimeter of the Nice Smart Valley project plus there is no guarantee the flexibility in the project would be reliable and operational. Enedis wants to experiment incidents and construction use case before studying postponement of investments.

In this context comes the aggregator portal, a digital platform that conveys the DSO's requests (offers request and activation orders) to the aggregators. It allows the aggregators for submitting their flexibility offers and serves as an interface between the DSO and the aggregators.

This use case explains the process followed by both the aggregator and the DSO technicians in order to request, offer and activate flexibilities. The different steps can be summarized as follows:

- Register market participants (aggregators)
- Aggregators recruit customers
- Aggregators register flexibilities
- DSO launches grid preparation phase (a year ahead for example) and carries out grid computations
- DSO publishes its flexibility needs
- *Eventual flexibility guarantee* from aggregator to the DSO (not always the case)
- DSO requests offers
- Aggregators submit flexibility offers
- DSO analyzes offers
- DSO notifies the selected aggregators whose offers have been selected
- Aggregators send activation order(s)
- DSO collects consumption data
- DSO settles the market

DSO bills the transaction

5 RELATIONSHIP WITH INTERFLEX KPIs

The table below summarizes the relationship with the InterFlex Use Caes and the defined Project Key Performance Indicators

Project KPI	DE			CZ				NL			SE					FR		
	UC1	UC2	UC3	UC1	UC2	UC3	UC4	UC1	UC2	UC3	UC1	UC2	UC3	UC4	UC5	UC1	UC2	UC3
	Feed In Management	Demand Side Management	Ancillary Services	Increase DER hosting capacity of LV distribution networks by smart PV	Increase DER hosting capacity in MV networks by volt-var control	Smart EV charging	Smart energy storage	Improve grid flexibility	Improve grid flexibility	Usability of an integrated flex market	Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers	Use of an industrial Heat Pump to optimize DSO operation by exploiting the interaction with different energy carriers	Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation	Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs	Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints	Automatic Islanding	Multiservice approach for centralized storage systems	Local flexibility mechanism
Flexibility WP2.2_KPI_1	✓	✓	✓			✓	✓			✓	✓	✓	✓					✓
Hosting capacity WP2.2_KPI_2	✓	✓	✓	✓	✓		✓				✓	✓	✓		✓			
Islanding WP2.2_KPI_3													✓			✓		
Customer recruitment WP2.2_KPI_4	✓	✓	✓								✓		✓	✓				✓
Active participation WP2.2_KPI_5			✓								✓		✓	✓				✓

Table 14: Matrix Interflex Project KPI addressing Use Cases

Note: Customer recruitment KPI represents in the above mentioned table a performance indicator that shows how every Demo fulfils defined project goal regarding customer involvement in the UCs. For some Demos the number of customers isn’t important and for these the Customer recruitment is not set as a KPI. Nonetheless the involvement of customers is essential for all Demos. For that reason the Customer recruitment was included in project joint activities overview and described as a separate topic. Description was based on inputs form all Demos.

6 CONCLUSIONS

This Deliverable identifies and compares joint activities based on inputs from all UCs. Following steps were undertaken in order to describe in a coherent way the project joint activities:

- Definition of the level of detail of UC description and method of information collection
- Harmonisation of Demo general description and UC description
- Comparison of individual UCs based on defined criteria (Aims/Scope, Level, Solution Cluster, Topology, System involved)
- Description of joint activities and their relation to individuals UCs
- Overview of Demo UCs

Explanation of Demo UCs relationship with project KPIs

Joint activities were identified based on the detailed UC descriptions and Smart Grid Architecture Models provided by each Demo. Overall it was identified 7 Aims/Scopes of the UCs, which are fulfilled by solution cluster according to the Topology.

The entire project Interflex is being implemented by 5 DSOs – Avacon, ČEZ Distribuce, Enexis, E.On, Enedis that carry out 6 Demos. Having various DSOs and a variety of UCs involved in one project brings the benefits of different solutions and approaches to reach alike goals. Another benefit is the implementation of individual projects in different legislative environments, which brings a positive contribution for Replicability and Scalability of the demonstrated UCs. The detailed knowledge about individual Demo activities, obtained by the detailed UC descriptions provided by Demo leaders, led to identification of no overlapping or duplication of Demo UCs. Demos have common goals, but each project proposes different solutions. Only the long-term operation and development of these projects shall show if some of the solutions to achieve the common goal are better than the others. Sharing of knowledge and experience in the technical specification, implementation, deployment and management of new technologies brings the benefit both for InterFlex consortium and the European DSO community as such.

7 REFERENCES

7.1 Project Documents

List of reference document produced in the project or part of the grant agreement

[GA] Grant agreement

[D2.2] Minimal Set Of KPIs CEZd Interflex

7.2 External documents

[1] SGCG Report Reference Architecture (Smart Grid Coordination Group material)

[2] Use Case Description (Smart Grid Coordination Group material)

ANNEX 1: TABLE - JOINT ACTIVITIES AND UCS

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
DE UC 1	LV Customer	Hosting capacity	control DER	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS
		Power Quality	Quality measurement	HV/MV Substation MV/LV Substation	DSO
			network Calculation	Control center	DMS
			Communication	HV/MV Substation MV/LV Substation Control center	DMS
			control DER	LV Customer premises	DMS
		Automation	network Calculation	Control center	DMS
			Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
		Flexibility	control DER	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS
DE UC 2	LV Customer	Hosting capacity	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS
		Power Quality	Quality measurement	HV/MV Substation MV/LV Substation	DSO
			Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
		Automation	Communication	HV/MV Substation MV/LV Substation Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
		Flexibility	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			Communication	LV Customer premises Control center	DMS

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
DE UC 3	LV Customer	Hosting capacity	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Communication	LV Customer premises	DMS
				Control center	
		Power Quality	Quality measurement	HV/MV Substation	DSO
				MV/LV Substation	
			Communication	HV/MV Substation	DMS
				MV/LV Substation	
				Control center	
				LV Customer premises	
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Provide support Services	LV Customer premises	DMS
		Automation	Communication	HV/MV Substation	DMS
				MV/LV Substation	
				Control center	
				LV Customer premises	
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
		Flexibility	load Shifting	LV Customer premises	DMS
			Control charging / Discharging Battery	LV Customer premises	DMS
			control DER	LV Customer premises	DMS
			Communication	LV Customer premises	DMS
				Control center	
			Provide support Services	LV Customer premises	DMS

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
CZ UC 1	LV - DSO & LV Customer	Hosting capacity	Control DER	LV Customer premises	
		Power Quality	Quality measurement	LV	DSO
			Communication	LV Control center	DMS
			network Calculation	Control center	DMS
			Control DER	LV Customer premises	
		Automation	Control DER	LV Customer premises	
CZ UC 2	MV - DSO & MV Customer	Hosting capacity	Control DER	MV Customer premises	DMS
			Communication	MV Customer premises Control center	DMS
		Power Quality	Quality measurement	MV	DSO
			Communication	MV Control center MV Customer premises	DMS
			network Calculation	Control center	DMS
			Control DER	MV Customer premises	DMS
		Automation	Communication	MV Customer premises Control center	DMS
			Control DER	MV Customer premises	DMS
CZ UC 3	LV - DSO	Flexibility	control EV charging	LV	DMS
			Communication	LV Control center	DMS
		Power Quality	Quality measurement	LV	DSO
			Communication	LV Control center	DMS
			network Calculation	Control center	DMS
			control EV charging	LV	DMS
		Automation	network Calculation	Control center	DMS
			control EV charging	LV	DMS
CZ UC 4	LV - DSO & LV Customer	Flexibility	Control charging / Discharging Battery	LV Customer premises	DMS
			Communication	Control center LV Customer premises	DMS
		Hosting capacity	Control DER	LV Customer premises	
			Control charging / Discharging Battery	LV Customer premises	Customer
			Communication	Control center LV Customer premises	DMS
		Power Quality	Quality measurement	LV	
			Communication	LV Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			Control DER	LV Customer premises	
			Control charging / Discharging Battery	LV Customer premises	DMS
		Automation	Communication	Control center LV Customer premises	DMS
			network Calculation	Control center	DMS
			Control DER	LV Customer premises	
			Control charging / Discharging Battery	LV Customer premises	DMS

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
NL UC 1	LV - DSO & MV - DSO	Flexibility	Control charging / Discharging Battery	LV	Aggregator
			Communication	Control center	DMS
				LV	Aggregator
			Provide support Services	LV	Aggregator
		Power Quality	Quality measurement	LV	
				MV/LV Substation	
			Communication	LV	DMS & aggregator
				MV/LV Substation	DMS
				Control center	
			network Calculation	Control center	DMS
			Control charging / Discharging Battery	LV	Aggregator
			Provide support Services	LV	Aggregator
		Business platform	Communication	Control center	DMS
				LV	Aggregator
NL UC 2	LV - DSO & MV - DSO	Flexibility	control EV charging	LV	Aggregator
			Communication	Control center	DMS
				LV	Aggregator
			Forecast Calculation	Control center	DMS
			Provide support Services	LV	Aggregator
		Business platform	Communication	Control center	DMS
				LV Customer premises	Aggregator
				LV	Aggregator
NL UC 3	Operational	Flexibility	Communication	Control center	DMS
				LV	Aggregator

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
SE UC 1	LV Customer	Flexibility	load Shifting	LV Customer premises	Aggregator
			Simulation model	LV Customer premises	Customer
			Communication	Control center	DMS
				LV Customer premises	Aggregator
			Provide support Services	LV Customer premises	Aggregator
		Cross energy carrier synergies	Simulation model	LV Customer premises	Customer
		Hosting capacity	Communication	Control center	DMS
				LV Customer premises	Aggregator
			Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
		Automation	Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
			Provide support Services	LV Customer premises	Aggregator
		Business platform	Communication	LV Customer premises	Aggregator & Customer
SE UC 2	LV Cusotmer	Flexibility	load Shifting	LV Customer premises	aggregator
			Simulation model	LV Customer premises	customer
			Communication	Control center	DMS
				LV Customer premises	aggregator
			Provide support Services	LV Customer premises	Aggregator
		Cross energy carrier synergies	Simulation model	LV Customer premises	Customer
		Hosting capacity	Communication	Control center	DMS
				LV Customer premises	Aggregator
			Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
		Automation	Simulation model	LV Customer premises	Customer
			load Shifting	LV Customer premises	Aggregator
			Provide support Services	LV Customer premises	Aggregator
		Business platform	Communication	LV Customer premises	Aggregator & Customer

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
SE UC 3	LV - DSO & LV Customer	Flexibility	load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises LV	DMS
			Control charging / Discharging Battery	LV Customer premises LV	DMS
			Communication	Control center LV Customer premises LV	DMS
		Cross energy carrier synergies	load Shifting	LV Customer premises	DMS
		Islanding	Quality measurement	MV/LV Substation LV	
			load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises LV	DMS
			Control charging / Discharging Battery	LV Customer premises LV	DMS
			Islanding operation	LV LV Customer premises	DMS DMS
			Communication	Control center LV Customer premises LV MV/LV Substation	DMS
			network Calculation	Control center	DMS
		Hosting capacity	load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises LV	DMS
			Control charging / Discharging Battery	LV Customer premises LV	DMS
			Communication	Control center LV Customer premises LV	DMS
		automation	load Shifting	LV Customer premises LV	DMS DMS
			Islanding operation	LV Customer premises	DMS
			Control DER	LV Customer premises LV	DMS
			Control charging / Discharging Battery	LV Customer premises LV	DMS
			network Calculation	Control center	DMS
		Power Quality	Quality measurement	LV MV/LV Substation	
			network Calculation	Control center LV Customer premises	DMS
			Communication	Control center LV MV/LV Substation	DMS
			load Shifting	LV Customer premises	DMS
			Control DER	LV Customer premises LV	DMS DMS
			Control charging / Discharging Battery	LV Customer premises LV	DMS DMS
SE UC 4	Operational & LV Customer	Flexibility	load Shifting	LV Customer premises	Customer
			Communication	Control center LV Customer premises	retailer / aggregator Customer
		Business platform	Communication	Control center LV Customer premises	retailer / aggregator Customer
SE UC 5	Operational	Automation	network Calculation	Control center	DMS
			Simulation model	Control center	DMS
			Forecast Calculatino	Control center	DMS
			Communication	Control center	DMS

Use Case name	Level	Aims/Scope	Solution cluster	Topology	System involved
FR UC 1	MV - DSO & LV - DSO & LV Customer	Automation	Islanding operational	Control center	DMS (control switch)
				LV	(sensors at secondary substation)
		Cross energy carrier synergies	load Shifting	LV Customer premises	Aggregator
		Power Quality	Quality measurement	LV	(sensors at secondary substation)
			Communication	LV	(sensors at secondary substation)
				Control center	DMS
			network Calculation	Control center	DMS
			load Shifting	LV Customer premises	DMS, Reatiler/ Aggregator
			Control DER	LV	Aggregator
			Provide support Services	LV Customer premises	Aggregator
		Flexibility	load Shifting	LV Customer premises	DMS, Reatiler/ Aggregator
			Control DER	LV	Aggregator
			Communication	LV Customer premises	DMS, Reatiler/ Aggregator
				LV	Aggregator
				Control center	aggregator
		Islanding	Islanding operation	MV MV/LV Substation	DMS, Aggregator
			load Shifting	LV Customer premises	DMS, Reatiler/ Aggregator
			Control DER	LV	Aggregator
			Communication	LV Customer premises	DMS, Reatiler/ Aggregator
				LV	Aggregator
				Control center	aggregator
			Quality measurement	LV	(sensors at secondary substation)
FR UC 3	Operational	Flexibility	load Shifting	LV Customer premises	Aggregator
			Control DER	LV Customer premises	Aggregator
			network Calculation	Control center	DMS
			Communication	LV Customer premises	Aggregator
				Control center	Aggregator
			Forecast Calculatino	Control center	Aggregator
		Automation	load Shifting	LV Customer premises	Aggregator
			Control DER	LV Customer premises	Aggregator
		Business platform	Communication	Control center	Aggregator
				LV Customer premises	Aggregator

Annex 2

USE CASES COLLECTED FROM EACH DEMO

DEMO	Leader	Use Case NAME	
DE DEMO	Avacon	UC1	Feed In Management
		UC2	Demand Side Management
		UC3	Ancillary Services
CZ DEMO	ČEZ Distribuce	UC1	Increase DER hosting capacity of LV distribution networks by smart PV inverters
		UC2	Increase DER hosting capacity in MV networks by volt-var control
		UC3	Smart EV charging
		UC4	Smart energy storage
NL DEMO	Enexis	UC1	Improve grid flexibility using Smart Storage Unit
		UC2	Improve grid flexibility using Electric Vehicle
		UC3	Usability of an integrated flex market
SE DEMO	E.ON	UC1	Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers
		UC2	Optimal use of a large heat pump asset providing the district heating grid with heat and electricity flexibility for grid management purposes
		UC3	Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation
		UC4	Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs
		UC5	Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints
FR DEMO	Enedis	UC1	Automatic Islanding
		UC2	Multiservice approach for centralized storage systems
		UC3	Local flexibility mechanism

TABLE OF CONTENT - ANNEX 2

WP8 – Swedish Demos, E.ON

Use Case Description

UC WP5.1 – Feed In Management

Scope

This document describes the Use Case **WP5.1 – Feed In Management**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

1. Description of the Use Case WP5.1

1.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP5.1 _1	**Domains:** Distribution Customer Premises **Zones:** Process Field Station Operation	Control and curtail small scale renewable generators individually to relieve local and temporal grid congestion.	Cluster

1.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
e. g. V0.1 – Document initiation		Person or e.g. standardization committee	Describe the changes made
V0.1	26.04.2017	Thorsten Gross	Document Initialized

1.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	Small scale renewable generators on customer premises shall be monitored and controlled individually by a central Smart Grid controller (Smart Grid Hub) in response to local and temporal grid congestion..
Objective	1. Relieve grid congestion by curtailing local energy production. 2. Provide precise reading of power output of small scale generators and grid parameters at any given point in time. 3. Establish a secure, reliable and effective connection between grid control / smart grid hub and local renewable generators. (Reliability) 4. Minimize energy curtailed and number of generators affected. 5. Minimize the total cost of the integration of local small scale renewable generators.
Related Business Case	Minizing DER curtailments, deferral of investments

1.4. Narrative of Use Case

Short description – max 3 sentences
Feed in from renewable generation can cause temporal and local congestion in the distribution grid. Under German law the DSO has an obligation to integrate as much renewable feed in as possible and is only allowed to curtail renewable generators when grid congestion is imminent or when technical limits are being violated. With today's technology the feed in management affects large areas and possibly a larger number of generators than necessary, curtailing a bigger volume of energy than would be necessary. Use Case WP5.1 shall leverage the Smart Grid Hub in combination with a smart meter infrastructure to automatically control and curtail individual small scale generators in order to relieve grid congestion while minimizing the number of generators affected and the amount of energy that gets curtailed.
Complete description

The Smart Grid Hub (SGH) is envisioned as a process unit that connects to the grid control center of a DSO. The SGH monitors the state of local small scale generators via a digital metering infrastructure which transmits power, voltage and current at the customer's premises. Combined with data from the grid control center about the state of the grid the SGH can forecast and recognize impeding or existing violations of technical limits and control and curtail the momentary feed in of local generators to such an extent, that all technical limits will be respected at all times. The Smart Grid Hub determines the curtailment strategy in such a way, that the number of generators affected and the total volume of energy curtailed remains the minimum necessary to keep the grid within technical limits.

1.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
5.1.1	Speed of data transmission	Amount of time between control signal sent and confirmation signal received	4
5.1.2	Security of data transmission	Number of connection losses per time period	4
5.1.3	Reliability of data transmission	Number of connection losses and / or faulty data packages per time period	4
5.1.4	Observance of grid restrictions	Number of violations of relevant technical limits (voltage, current, ampacity)	1
5.1.5	Anticipation of impeding violation of grid constraints and quality of counter measures	(IF) Correct forecast of violations of technical limits, number of generators affected and total energy curtailed compared to today's standard procedures.	3
5.1.6	Amount of energy curtailed	Total amount of energy curtailed to relieve local grid congestion, compared to todays standard procedures	3
5.1.7	Speed of command execution	Number of executed commands per time interval	4
5.1.8	Overall costs	Cost savings on standard procedures	5
5.1.9	Precision of SGH - actions	Minimal deviation of SGH from desired outcome	4
5.1.10	Number of interventions at customers site	Minimize number of interventions at customers premises while still respecting technical limits of grid	3

1.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
Describe which Actor(s) trigger(s) this Use Case	Describe what event(s) trigger(s) this Use Case	Describe what condition(s) should have been met before this Use Case happens	Describe the assumptions about conditions or system configurations.
Voltage sensor	(Forecast) violation of technical limits of distribution grid	- Voltage limit exceeded - Ampacity of infrastructure exceeded	System is operating under normal conditions, small scale generators are producing and contributing to grid congestion

Actor	Triggering Event	Pre-conditions	Assumption
Grid control	Command	- Simulated voltage limit exceeded - Simulated ampacity exceeded	System is operating under normal conditions, small scale generators are producing and contributing to simulated grid congestion

1.7. Classification information

Relation to Other Use Cases in the same project or area
Associated with UC5.2 and UC 5.3
Level of Depth - the degree of specialization of the Use Case
Cluster
Prioritization
Obligatory
Generic, Regional or National Regional relation
National Regional
Nature of the viewpoint- describes the viewpoint and field of attention
technical
Further Keywords for Classification
Distribution Network Operation, Grid Optimization, Feed In Management, Renewable Integration
Maturity of Use Case
in business operation but on a different level

2. Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Every actor needs a unique actor name. E. g. Voltage sensor/ switch/IED/Scada/ DMS/operator	System/Role	Select from Annex A/Introduce a new subcategory		Describe specific role of an Actor within this Use Case.		e.g. Requirements from grid code YES (if yes, please provide the reference)/NO	YES (please provide the reference)/NO
Grid Operator	Role	DSO	DSO responsible for network operation				
Smart Grid Hub	Role	IS IT	Grid control unit		EFR		
Digital Power Meter	Role	Network Device	Power metering device to track local voltage, current, power		Iltron		
Control Box	Role	Network Device	Data modem to execute SGH commands		EFR		

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
DER Installation	System		Any DER installation on customer premise			VDE AR-4105	
TSO	Role	TSO	Connected TSO				

3. Step by Step Analysis of the Use Case

3.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Local Equipment Overload	Smart Grid Hub detects overload of local equipment	Digital Power Meter	Regional surplus of DER feed in	Sufficient power rating of DER installations and suitable weather conditions.	SGH reduces regional power feed in until equipment operates within limits.
AS1	Regional Grid congestion Equipment Overload	TSO identifies grid congestions, demands power production curtailment in DSO grid	TSO	Regional, national surplus of DER feed in	Sufficient power rating of DER installations and suitable weather conditions.	SGH reduces local power feed in as per demand of TSO.

3.2. Steps – Primary Scenario

Scenario Name :Local Equipment Overload									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
PS 1_ 1	Detection of overload	Smart Grid Hub monitors state of grid and detects (imminent) violation of technical limits	Digital Meter	Smart Grid Hub	Grid KPI	Get/Create/ Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	LTE / 4G	Protocol

Scenario Name :Local Equipment Overload									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
PS 1_2	Calculation of mitigation strategy	Smart Grid Hub determines set of actions to reduce regional power production and return system to uncritical state.	Smart Grid Hub	DER installations	Command signal			LTE / 4G	Protocol
PS 1_3	DER acts upon command signal	Individual DER systems reduce power output temporarily according to command received from SGH							
PS 1_4	Control of command execution	Smart Grid Hub monitors situation and determines whether commands have been acted upon and whether grid is back to uncritical state.	Smart Grid Hub						

3.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
AS 1_1	Congestion in regional, national transmission grid	TSO identifies critical situation, requests power curtailment at underlying DSO.	TSO	DSO	Amount of power to be curtailed	Get/Create/Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	Phone, Email	Voice, text

Scenario Name :									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
AS 1_2	Translation to actionable control signals	Smart Grid Hub disaggregates TSO request to individual control signals	Smart Grid Hub	DER	Power to be reduced			LTE / 4G	Protocol
AS	See PS1_3								
AS	See PS1_4								

4. Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
	Grid KPI	Voltage, current and power at point of connection		Smart meter incl. gateway
	Command signal	Change in power output		Control Box, Smart grid hub, Smart Meter incl. Gateway
	TSO request	Change in power output		Control Box, Smart grid hub, Smart Meter incl. Gateway

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer’s meter state and outputs information	- Customer’s consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract’s data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP5.2 – Demand Side Management

Scope

This document describes the Use Case **WP5.2 – Demand Side Management**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

5. Description of the Use Case WP5.2

5.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP5.2	**Domains:** Distribution Customer Premises **Zones:** Process Field Station Operation	Control flexible loads on customer's premises to balance the local grid and relieve grid congestion.	Cluster

5.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
e. g. V0.1 – Document initiation		Person or e.g. standardization committee	Describe the changes made
V0.1	26.04.2017	Thorsten Gross	Document Initialized

5.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	Flexible loads on customer premises shall be monitored and controlled individually by a central Smart Grid controller (Smart Grid Hub) in response to local and temporal grid congestion.
Objective	6. Relieve grid congestion by ramping up or down local energy consumption. 7. Provide precise reading of momentary consumption of small flexible loads and grid parameters at any given point in time. 8. Establish a secure, reliable and effective connection between grid control / smart grid hub and local loads. (Reliability) 9. Minimize the amount of energy that's being shifted and number of customers affected. 10. Minimize the total cost of keeping the grid within technical limits..
Related Business Case	Distribution grid operation, renewable energy integration, demand side management

5.4. Narrative of Use Case

Short description – max 3 sentences
Feed in from fluctuating renewable generation puts today´s power grids under a lot of strain. While more flexible and controllable generation is being replaced by fluctuating and non-controllable generators, the load remains as inflexible as ever. In order to increase the total flexibility in the energy system and to better balance the local grid, this use case shall show how the inherent flexibility of local loads could be leveraged to improve system stability and power quality and relieve local grid congestion.
Complete description

The Smart Grid Hub (SGH) is envisioned as a process unit that connects to the grid control center of a DSO. The SGH monitors the state of local loads via a digital metering infrastructure which transmits power, voltage and current at the customer's premises. Combined with data from the grid control center about the state of the grid the SGH can forecast and recognize impeding or existing violations of technical limits and control the momentary consumption of local loads to such an extent, that all technical limits will be respected at all times. The Smart Grid Hub determines the control schedule in such a way, that the number of loads affected and the total volume of energy shifted remains the minimum necessary to keep the grid within technical limits.

5.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
5.1.1	Speed of data transmission	Amount of time between control signal sent and confirmation signal received	4
5.1.2	Security of data transmission	Number of connection losses per time period	4
5.1.3	Reliability of data transmission	Number of connection losses and / or faulty data packages per time period	4
5.1.4	Observance of grid restrictions	Number of violations of relevant technical limits (voltage, current, ampacity)	1
5.1.5	Anticipation of impeding violation of grid constraints and quality of counter measures	(IF) Correct forecast of violations of technical limits, number of generators affected and total energy curtailed compared to today's standard procedures.	3
5.1.6	Amount of energy curtailed / shifted	Total amount of energy curtailed or shifted to relieve local grid congestion, compared to todays standard procedures	3
5.1.7	Speed of command execution	Number of executed commands per time interval	4
5.1.8	Overall costs	Cost savings on standard procedures	5
5.1.9	Precision of SGH - actions	Minimal deviation of SGH from desired outcome	4
5.1.10	Number of interventions at customers site	Minimize number of interventions at customers premises while still respecting technical limits of grid	3

5.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
Describe which Actor(s) trigger(s) this Use Case	Describe what event(s) trigger(s) this Use Case	Describe what condition(s) should have been met before this Use Case happens	Describe the assumptions about conditions or system configurations.
Voltage sensor	(Forecast) violation of technical limits of distribution grid	- Voltage limit exceeded - Ampacity of infrastructure exceeded	System is operating under normal conditions, small scale generators are producing and contributing to grid congestion

Actor	Triggering Event	Pre-conditions	Assumption
Grid control	Command	- Simulated voltage limit exceeded - Simulated ampacity exceeded	System is operating under normal conditions, small scale generators are producing and contributing to simulated grid congestion

5.7. Classification information

Relation to Other Use Cases in the same project or area
Associated with UC5.1 and UC 5.3
Level of Depth - the degree of specialization of the Use Case
Cluster
Prioritization
Obligatory
Generic, Regional or National Regional relation
National Regional
Nature of the viewpoint- describes the viewpoint and field of attention
technical
Further Keywords for Classification
Distribution Network Operation, Grid Optimization, Feed In Management, Renewable Integration
Maturity of Use Case
Experimental

6. Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Every actor needs a unique actor name. E. g. Voltage sensor/ switch/IED/Scada/ DMS/operator	System/Role	Select from Annex A/Introduce a new subcategory		Describe specific role of an Actor within this Use Case.		e.g. Requirements from grid code YES (if yes, please provide the reference)/NO	YES (please provide the reference)/NO
Grid operator	Role	DSO	DSO responsible for network operation				
Smart Grid Hub	Role	IS IT	Grid Control Unit		EFR		

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Digital Power Meter	Role	Network Device	Power metering device to track local voltage, current, power		Iltron		
Control Box	Role	Network Device	Data modem to execute SGH commands		EFR		
Flexible load	Role		Any electrical residential load that can be switched off or on within a reasonable timeframe				

7. Step by Step Analysis of the Use Case

7.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Local Equipment Overload	Local demand exceeds equipment limits	Digital power meter	Current and / or voltage on local distribution equipment operate outside technical limits	Local demand exceeds local power production	Describe what condition(s) should prevail after this scenario happens. The post conditions may also define "success" or "failure" conditions for each Use Case.
AS1			Describe which Actor(s) trigger(s) this scenario	Describe what event(s) trigger(s) this scenario	Describe what condition(s) should have been met before this scenario happens.	Describe what condition(s) should prevail after this scenario happens. The post conditions may also define "success" or "failure" conditions for each Use Case.

7.2. Steps – Primary Scenario

Scenario Name : Local equipment overload									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
PS1_1	Detection of overload	Smart grid hub monitors state of grid and detects (imminent) violation of technical limits	Digital meter	Smart grid hub	Grid KPI	Get/Create/Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	LTE / 4G	Protocol

Scenario Name : Local equipment overload									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
PS 1_ 2	Calculation of mitigation strategy	Smart Grid Hub determines set of actions to reduce local power demand and return system to uncritical state.	Smart Grid Hub	Households	Command signals			LTE / 4G	Protocol
PS 1_ 3	Household acts upon command signal	Individual households temporarily reduce power demand according to command signal from smart grid hub.							
PS 1_ 4	Control of command execution	Smart Grid Hub monitors situation and determines whether commands have been acted upon and whether grid is back to uncritical state.	Smart grid hub						

7.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1					ID or description	Get/Create/ Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	e.g. GPRS, Fibre, PLC	e.g. voice, GUI, protocol

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means

8. Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
1	Grid KPI	Voltage, current and power at point of connection		Smart meter incl. gateway
2	Command signal	Change in power demand		Control Box, Smart grid hub, Smart Meter incl. Gateway

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP5.3 – Ancillary Services

Scope

This document describes the Use Case **WP5.3 – Ancillary Services**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

9. Description of the Use Case 5.3

9.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP5.3	**Domains:** Distribution Customer Premises **Zones:** Process Field Station Operation	Combine small scale renewable generators and local loads to aggregate a pool of flexibility which can be leveraged to provide balancing energy to the national, regional or local grid.	Cluster

9.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
e. g. V0.1 – Document initiation		Person or e.g. standardization committee	Describe the changes made
V0.1	26.04.2017	Thorsten Gross	Document Initialized

9.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	Based on UC5.1 and UC5.2 UC5.3 combines these two to bring generators and loads together as one pool of flexibility to provide ancillary service or balancing energy to the national, regional or local grid.
Objective	11. Provide ancillary services to the national grid (primary control, secondary control, tertiary control) in a simulated environment (actual participation not possible). 12. Provide balancing energy to regional grid to relieve feeder or transformer congestion. 13. Provide balancing energy to local grid to relieve feeder or transformer congestion. 14. Provide precise reading of momentary power output of small scale renewable generators and consumption of small flexible loads and grid parameters at any given point in time. 15. Establish a secure, reliable and effective connection between grid control / smart grid hub and local loads. (Reliability) 16. Maximize the effectiveness of the available flexibility. 17. Minimize deviations between control signal and change in power output or consumption.
Related Business Case	Distribution grid operation, renewable energy integration, demand side management

9.4. Narrative of Use Case

Short description – max 3 sentences

Feed in from fluctuating renewable generation puts today´s power grids under a lot of strain. While flexible and controllable generation is being replaced by fluctuating and non-controllable generators, the challenge to balance supply and demand grows continuously. The Smart Grid Hub aims at connecting and aggregating dormant flexibility and leveraging this flexibility to provide ancillary services to stabilize the energy supply.

Complete description

The Smart Grid Hub (SGH) is envisioned as a process unit that connects to the grid control center of a DSO. The SGH monitors the state of local renewable generators and local loads via a digital metering infrastructure which transmits power, voltage and current at the customer's premises. Combined with data from the grid control center about the state of the grid the SGH can forecast and recognize impeding or existing violations of technical limits and control the momentary consumption of local loads to such an extent, that all technical limits will be respected at all times. The Smart Grid Hub can also aggregate loads and generators to create a virtual source of flexibility which could provide ancillary services on national, regional or local level. This could mean that the operator bids into the existing markets for primary or secondary control. On a regional level it could mean that for example that the aggregate flexibility is leveraged to relieve congestion on a regional 20 kV feeder or to lessen the load on a TSO / DSO transformer. On the local level the aggregate flexibility could be leveraged to relieve congestion on local 1 kV feeders or to keep the voltage level of low voltage feeders within limits.

9.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
5.1.1	Speed of data transmission	Amount of time between control signal sent and confirmation signal received	4
5.1.2	Security of data transmission	Number of connection losses per time period	4
5.1.3	Reliability of data transmission	Number of connection losses and / or faulty data packages per time period	4
5.1.4	Observance of grid restrictions	Number of violations of relevant technical limits (voltage, current, ampacity)	1
5.1.5	Anticipation of impeding violation of grid constraints and quality of counter measures	(IF) Correct forecast of violations of technical limits, number of generators affected and total energy curtailed compared to today's standard procedures.	3
5.1.6	Amount of energy curtailed / shifted	Total amount of energy curtailed or shifted to relieve local grid congestion, compared to todays standard procedures	3
5.1.7	Speed of command execution	Number of executed commands per time interval	4
5.1.8	Overall costs	Cost savings on standard procedures	5
5.1.9	Precision of SGH - actions	Minimal deviation of SGH from desired outcome	4
5.1.10	Number of interventions at customers site	Minimize number of interventions at customers premises while still respecting technical limits of grid	3

9.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
Describe which Actor(s) trigger(s) this Use Case	Describe what event(s) trigger(s) this Use Case	Describe what condition(s) should have been met before this Use Case happens	Describe the assumptions about conditions or system configurations.

Actor	Triggering Event	Pre-conditions	Assumption
Voltage sensor	(Forecast) violation of technical limits of distribution grid	- Voltage limit exceeded - Ampacity of infrastructure exceeded	System is operating under normal conditions, small scale generators are producing and contributing to grid congestion
Grid control	Command	- Simulated voltage limit exceeded - Simulated ampacity exceeded	System is operating under normal conditions, small scale generators are producing and contributing to simulated grid congestion
Frequency sensor	Power system frequency off limits	- Sufficient flexibility online and connected to SGH	System is operating under normal conditions and grid control simulates participation in primary control market

9.7. Classification information

Relation to Other Use Cases in the same project or area
Associated with UC5.1 and UC 5.2
Level of Depth - the degree of specialization of the Use Case
Cluster
Prioritization
Obligatory
Generic, Regional or National Regional relation
National Regional
Nature of the viewpoint- describes the viewpoint and field of attention
technical
Further Keywords for Classification
Distribution Network Operation, Grid Optimization, Feed In Management, Renewable Integration
Maturity of Use Case
Experimental

10.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Every actor needs a unique actor name. E. g. Voltage sensor/ switch/IED/Scada/ DMS/operator	System/Role	Select from Annex A/Introduce a new subcategory		Describe specific role of an Actor within this Use Case.		e.g. Requirements from grid code YES (if yes, please provide the reference)/NO	YES (please provide the reference)/NO
Grid operator	Role	DSO	DSO responsible for network operation				
Smart Grid Hub	Role	IS IT	Grid control unit		EFR		
Digital Power Meter	Role	Network Device	Power metering device to track local voltage,		Iltron		
Control Box	Role	Network Device	Data modem to execute SGH commands		EFR		

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
DER installation	System		Any DER installation on customers premise			VDE-4105	
Residential load	Role		Any load on customers premise that can be switched on or off within a reasonable timeframe				
Frequency meter	Role	Network Device	Monitoring system frequency				

11.Step by Step Analysis of the Use Case

11.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Delivery of primary control	Smart grid hub acts as an aggregator and controls all connected DER and residential loads as one virtual source of flexibility	Frequency meter	System frequency deviation	System frequency is monitored with high granularity, sufficient load and generation online and available	(Success) DER and loads are being dispatched in accordance with PRC-guidelines and react within suitable timeframe.
AS1	Delivery of secondary control	Smart grid hub acts as an aggregator and controls all connected DER and residential loads as one virtual source of flexibility	Frequency meter	System frequency deviation	System frequency is monitored with high granularity, sufficient load and generation online and available	(Success) DER and loads are being dispatched in accordance with PRC-guidelines and react within suitable timeframe.

11.2. Steps – Primary Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
PS 1_1	Frequency deviation	SGH monitors system frequency and whether frequency is within limits. If not, SGH determines amount of power to be delivered or curtailed to fulfill PRC requirements	Smart grid hub		ID or description	Get/Create/Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	e.g. GPRS, Fibre, PLC	e.g. voice, GUI, protocol
PS 1_2	Calculation of control strategy	Based on PS1_1 results smart grid hub translates power change request into a set of individual control signals for connected DER and loads.	Smart grid hub	DER, residential loads	Command signal			LTE / 4G	Protocol

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
PS 1_ 3	DER, loads respond to control signal	According to SGH command signal DER and residential loads reduce or increase power output or demand.							
PS 1_ 4	Control of command execution	Smart grid hub monitors whether commands have been acted upon and determines correction commands when necessary							

11.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
AS 1_ 1	Detection of frequency deviation	SGH monitors system frequency and whether frequency is within limits. If not, SGH determines amount of power to be delivered or curtailed to fulfill SRC requirements	Smart grid hub		ID or description	Get/Create/ Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	e.g. GPRS, Fibre, PLC	e.g. voice, GUI, protocol
AS 1_ 2	Calculation of control strategy	Based on AS1_1 results smart grid hub translates power change request into a set of individual control signals for connected DER and loads.	Smart grid hub	DER, residential loads	Command signal			LTE / 4G	Protocol

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
AS 1_3	DER, loads respond to control signal	According to SGH command signal DER and residential loads reduce or increase power output or demand.							
AS 1_4	Control of command execution	Smart grid hub monitors whether commands have been acted upon and determines correction commands when necessary.							

12.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
1	Grid KPI	Voltage, current and power at point of connection		Smart meter incl. gateway
2	Command signal	Change in power output or demand		Control Box, Smart grid hub, Smart Meter incl. Gateway

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP6_1 – Increase DER hosting capacity of LV distribution networks by smart PV inverters

Scope

This document describes the Use Case **UC WP6_1 – Increase DER hosting capacity of LV distribution networks by smart PV inverters**.

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

13. Description of the Use Case WP6.1

13.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 6_1	DER/PROCESS	Increase DER hosting capacity of LV distribution networks by smart PV inverters	Detailed Use case

13.2. Version Management

Versi	Date	Name Author(s) or	Changes
V1.0	24.5.201 7	Jan Švec	First version of the document

13.3. Scope and objectives

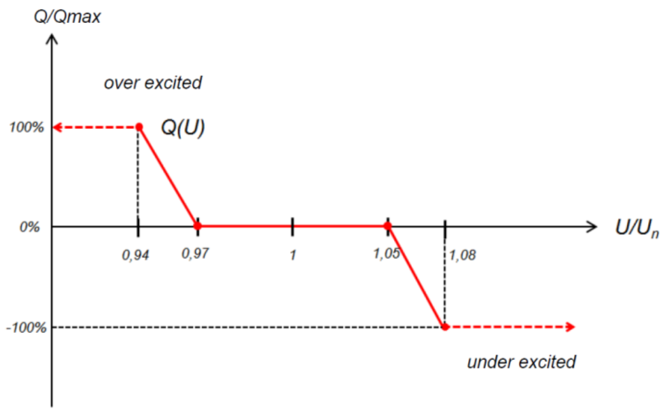
Scope and Objectives of the Use Case	
Scope	The aim of the use case is field demonstration of smart PV inverters functions which enables increasing of DER hosting capacity in two different areas with different LV grid topology.
Objective	Increase of DER hosting capacity in LV grids thanks to the installation of smart PV inverters and securing the power quality according to EN 50160 standard.
Related Business Case	*CEZ Distribuce could defer investments to grid reinforcement.*

13.4. Narrative of Use Case

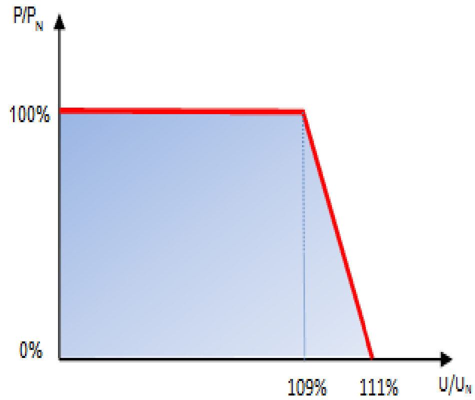
Short description – max 3 sentences
Increasing of DER hosting capacity in LV distribution grid case that smart PV inverters are used.

Complete description

ČEZ Distribuce and its partners aims at demonstrating how the combination of new smart PV inverter functions Q(U) and P(U) under real operating conditions within LV distribution networks can increase the DER hosting capacity. A successful demonstration requires appropriate conditions for testing roof PV systems using smart PV inverters (fulfilling the EN 50438 ed.2 standard) installed massively under preselected 2 MV/LV secondary substations. Two areas with different topologies but high penetration of PV systems are needed. Crucial tasks for this use case are the recruitment of customers within the selected areas, the installation of PV systems with smart PV inverters and the delivery of technical operational data and results from the PV inverter monitoring systems with the customer's consent.

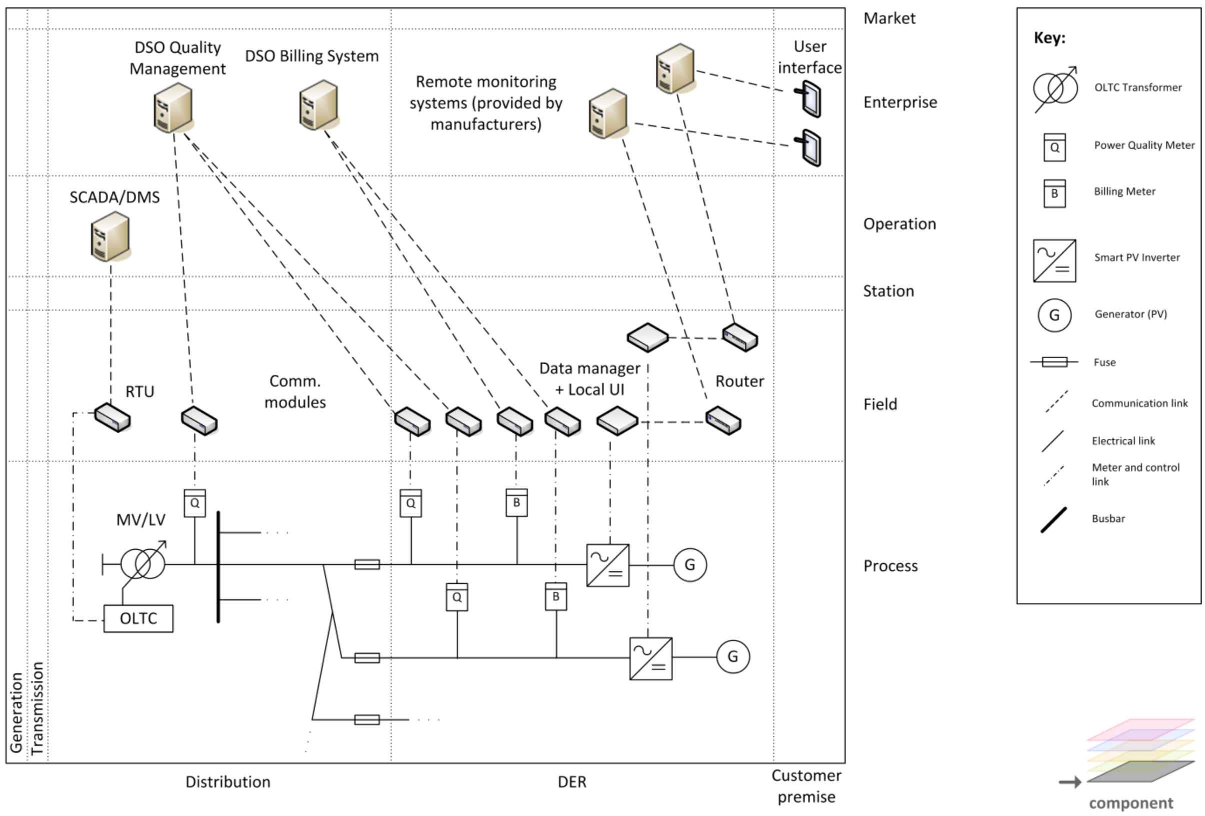


Q(U) function - example



P(U) function – example

WP6 Use-case #1



13.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI6_1	Increasing DER hosting capacity	in % compared with the baseline situation	WP6_1, WP6_2, WP6_4
KPI6_2	Power quality (according to EN 50160 standard)	Power quality will not be negatively affected by implementation of solutions	WP6_1, WP6_2, WP6_3, WP6_4

13.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
Voltage in the point of DER connection	In case voltage is higher than threshold, PV inverter starts to consume reactive power thanks to Q(U) function, in case the voltage rise even more, PV inverter starts to reduce active power production thanks to P(U) function. In case voltage is lower than threshold, PV inverter starts to generate reactive power thanks to Q(U) function.	PV inverters must be equipped with Q(U) and P(U) functions.	Q(U) and P(U) functions are set during the commissioning of PV inverter.

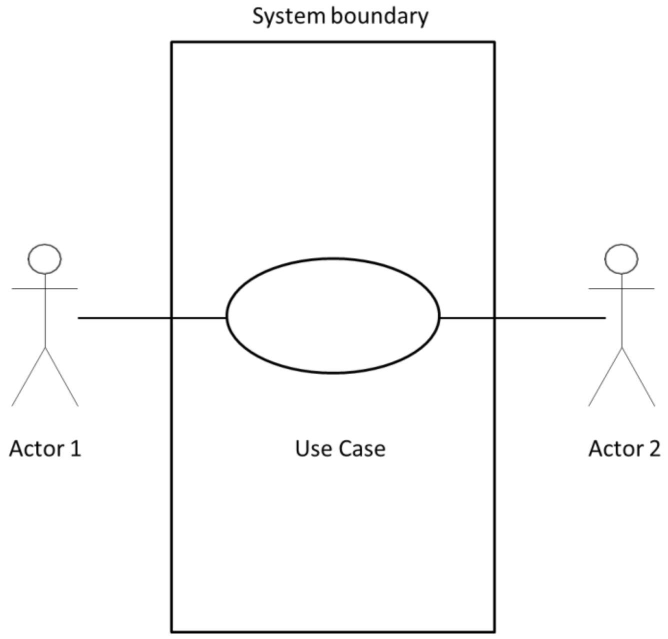
13.7. Classification information

Relation to Other Use Cases in the same project or area
Associate – use cases WP6_1, WP6_2, WP6_4 aim to increase DER hosting capacity of distribution grids.
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Very important
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
Technical point of view
Further Keywords for Classification
PV inverter, EN 50160, EN 50438:2013, hosting capacity, DER, LV grid, Q(U), P(U)
Maturity of Use Case
Realized in demonstration project

14.Diagrams of the Use Case

14.1. Diagram of the Use Case

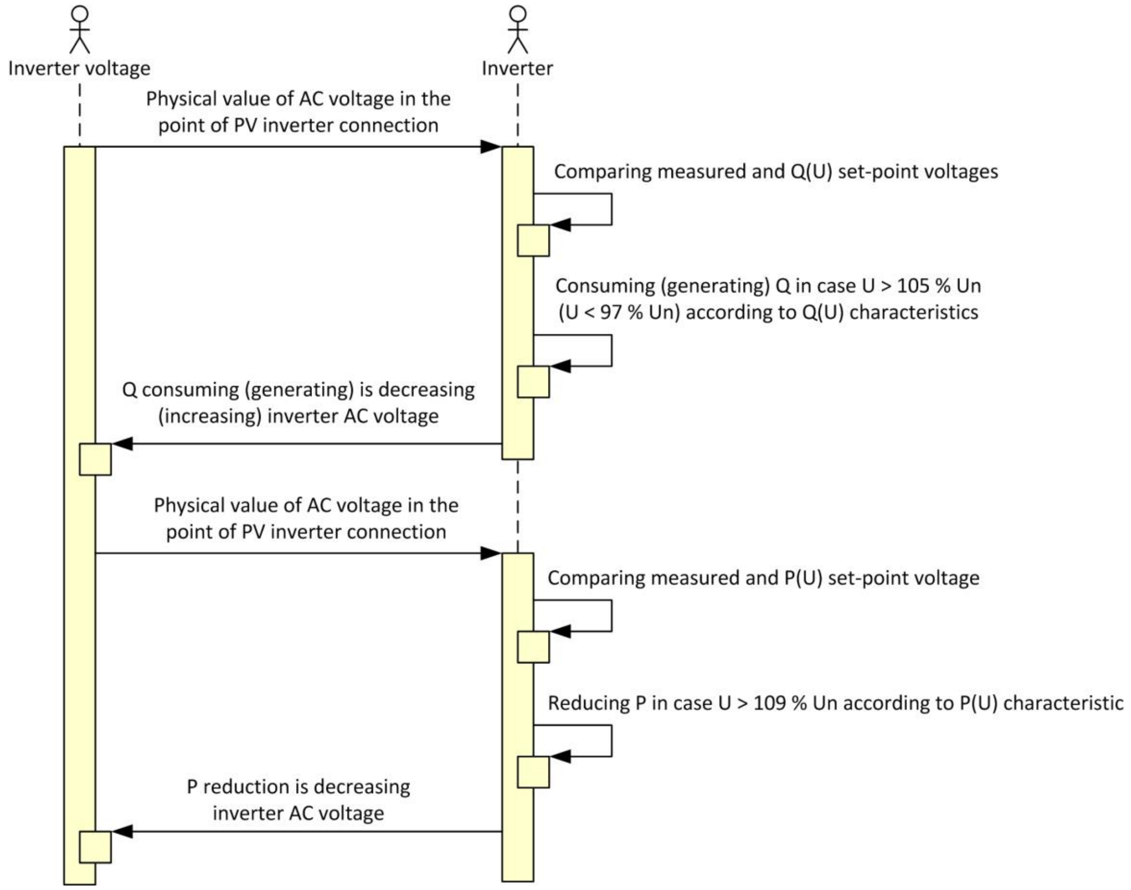
actor 1 = voltage in the point of PV inverter connection before the Q(U) or P(U) functions are activated; voltage in the point of PV inverter connection after the Q(U) or P(U) functions are activated; system boundary – please see SGAM



14.2. Sequence diagram of the Use Case

1 – voltage in the point of PV inverter connection is higher than Q(U) set-point (105 % Un) thus the PV inverter starts consuming reactive power according to the curve – this will reduce the voltage in the point of connection
2 – voltage in the point of PV inverter connection is higher than P(U) set-point (109 % Un) thus the PV inverter starts curtailing active power according to the curve – this will reduce the voltage in the point of connection
3 – voltage in the point of PV inverter connection is lower than Q(U) set-point (97 % Un) thus the PV inverter starts generating reactive power according to the curve - this will reduce the voltage in the point of connection

MV/LV OLTC transformer is used for simulation of different voltage levels in LV grid. Taps could be regulated through DMS. Power quality is monitored in the LV grid through DSO power quality management system. For use case evaluation also data from DSO billing system are used. Data from PV inverter are also used for use case evaluation.



15.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
SCADA/DMS	System	IS IT	Operator via SCADA/DMS sends control commands to action devices.	Sends commands to set OLTC tap changer.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	60870-5-104 over GPRS
OLTC tap changer (incl. RTU)	System	Network device	Sets OLTC tap to change voltage level in DS.	RTU receives commands from SCADA/DMS and send them to OLTC tap changer to set the tap and simulate voltage changes in DS.	Will be selected by procurement later.	N/A	60870-5-104 Over GPRS
DER control system (incl. Data manager, Local UI, Router)	System	DER installation	Sends data to supervisory systems and interfaces.	Sends monitoring data to user interfaces and remote monitoring/control systems.	Fronius, Schneider	N/A	Ethernet TCP/IP internet
Generator/Inverter	System	DER installation	Supplies active power to DS. Exchanges reactive power in inductive or capacitive mode with DS.	Measures voltage and autonomously changes reactive power in inductive or capacitive mode with DS according to volt-var control requirements.	Fronius, Schneider	EN 50438:2013	N/A

16.Step by Step Analysis of the Use Case

16.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
UC1_1	Voltage regulation	In case voltage is higher than threshold, PV inverter starts to consume reactive power thanks to Q(U) function, in case the voltage rise even more, PV inverter starts to reduce active power production thanks to P(U) function. In case voltage is lower than threshold, PV inverter starts to generate reactive power thanks to Q(U) function.	Generator/Inverter	Voltage in the point of DER connection is out of limits defined in Q(U) or P(U) characteristics.	DER inverter connected to LV grid is equipped with activated and properly set Q(U) or P(U) characteristics.	Voltage in the point of DER connection is in the limits of Q(U) or P(U) characteristics.

No other scenarios (alternative, error,…) are considered in this use case.

16.2. Steps – Primary Scenario

Scenario Name: Voltage regulation									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Set up tap on OLTC	Operator through SCADA sets tap on OLTC transformer to simulate different overvoltage/under voltage situations.	SCADA/DMS	OLTC (incl. RTU)	I-01	CREATE	N/A	IEC 60870-5-104	protocol

Scenario Name: Voltage regulation									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
2	Voltage and power quality measurements	Meters at LV busbar and connection points measure voltage and quality of supply. This information is collected in DSO Quality mgmt. and Billing Systems.	LV meters + comm. modules	DSO Quality Management, DSO Billing System	I-02	REPORT	N/A	IEC 60870-5-104	protocol
3	Voltage regulation	Inverter measures voltage in connection point and autonomously changes reactive or active power to stay in voltage limits defined by DSO.	Inverter	Inverter	I-03	EXECUTE	N/A	Measurement is internal part of inverter.	Internal protocol
4	PV monitoring	DER data manager and local UI sends monitoring data to remote monitoring system and user interface.	Data manager (incl. local UI, router)	Remote monitoring system, user interface	I-04	REPORT	N/A	Depends on inverter manufacturer.	protocol

16.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name: N/A									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

17.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
I-01	Tap on OLTC	Operator through SCADA sets tap on OLTC transformer to simulate different overvoltage/under voltage situations.	Information exchanged between IS or sent to device	N/A
I-02	Voltage and power quality measurements	Meters at LV busbar and connection points measure voltage and quality of supply. This information is collected in DSO Quality mgmt. and Billing Systems.	Electrical parameter	N/A
I-03	Reactive power control	Inverter measures voltage in connection point and autonomously changes reactive or active power to stay in voltage limits defined by DSO.	Algorithm, formula, rule, specific model	N/A
I-04	PV monitoring	DER data manager and local UI sends monitoring data to remote monitoring system and user interface.	Electrical parameter	N/A

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP6_2 – Increase DER hosting capacity in MV networks by volt-var control

Scope

This document describes the Use Case **UC WP6_2 – Increase DER hosting capacity in MV networks by volt-var control**.

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

18.Description of the Use Case WP6.2

18.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 6_2	DER/PROCESS	Increase DER hosting capacity in MV networks by volt-var control	Detailed Use case

18.2. Version Management

Versi	Date	Name Author(s) or	Changes
V1.0	24.5.201 7	Jan Švec	First version of the document

18.3. Scope and objectives

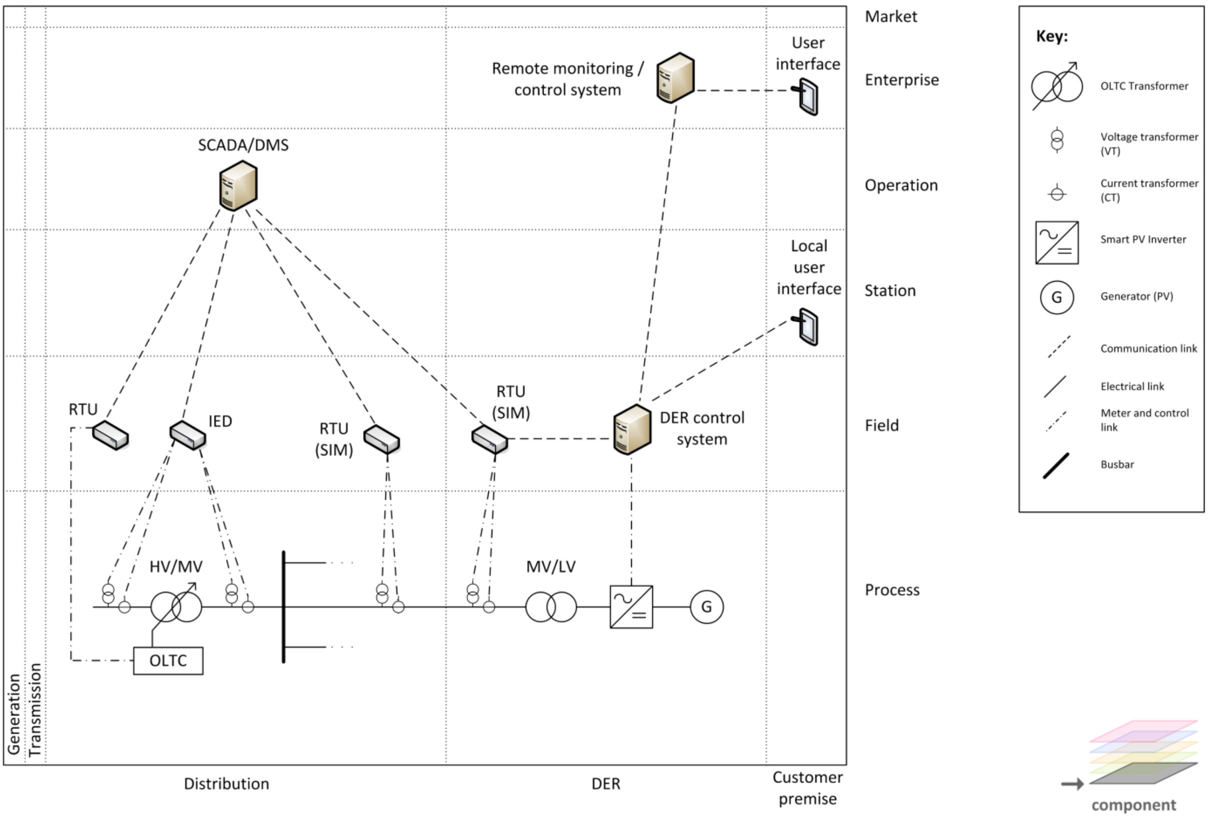
Scope and Objectives of the Use Case	
Scope	The aim of the use case is field demonstration of volt-var control system which enables increasing of DER hosting capacity in three different areas with three different DER (PV, Wind, Biogas) connected to the MV grid.
Objective	Increase of DER hosting capacity in MV grids thanks to the installation of smart PV inverters and securing the power quality according to EN 50160 standard.
Related Business Case	*CEZ Distribuce could defer investments to grid reinforcement.*

18.4. Narrative of Use Case

Short description – max 3 sentences
Increasing of DER hosting capacity in MV distribution grid in case that volt-var control system is used.

Complete description
ČEZ Distribuce integrates selected DER connected to MV networks into volt-var control system (PV: 1.1MW, biogas station: 1.25MW, wind: 4.6MW). The DSO can send required voltage set points from its SCADA to DER unit, which then react and regulate at the required voltage set points (thanks to reactive power generation/consumption. For this volt-var control strategy, ČEZ Distribuce leans on existing DER over 100kW with communication capabilities (usually GPRS) towards the DSO dispatching control system (SCADA).

WP6 Use-case #2



18.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI6_1	Increasing DER hosting capacity	in % compared with the baseline situation	WP6_1, WP6_2, WP6_4
KPI6_2	Power quality (according to EN 50160 standard)	Power quality will not be negatively affected by implementation of solutions	WP6_1, WP6_2, WP6_3, WP6_4

18.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
Dispatcher	DSO dispatcher sends command for start of volt-var control of DER together with required voltage set point.	Dispatcher needs DER to regulate voltage in MV grid.	DER connected to MV grid is equipped with volt-var control system.

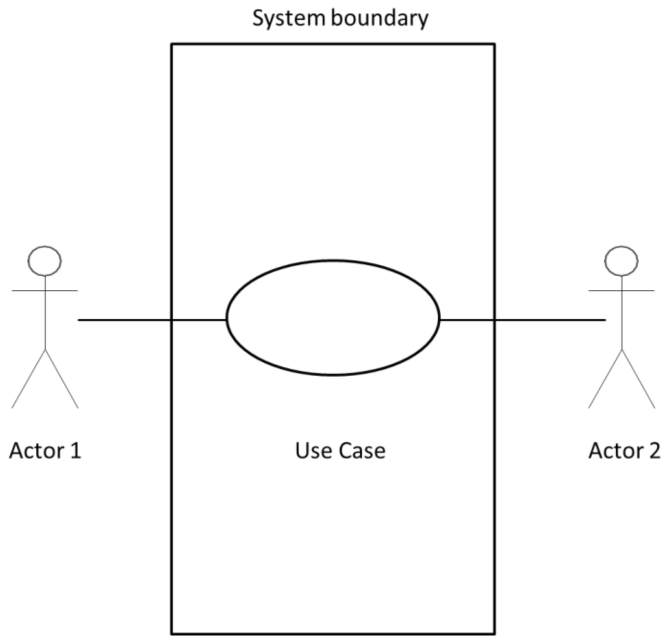
18.7. Classification information

Relation to Other Use Cases in the same project or area
Associate – use cases WP6_1, WP6_2, WP6_4 aim to increase DER hosting capacity of distribution grids.
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Very important
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
Technical point of view
Further Keywords for Classification
EN 50160, hosting capacity, DER, MV grid, volt-var control, reactive power
Maturity of Use Case
Realized in demonstration project

19.Diagrams of the Use Case

19.1. Diagram of the Use Case

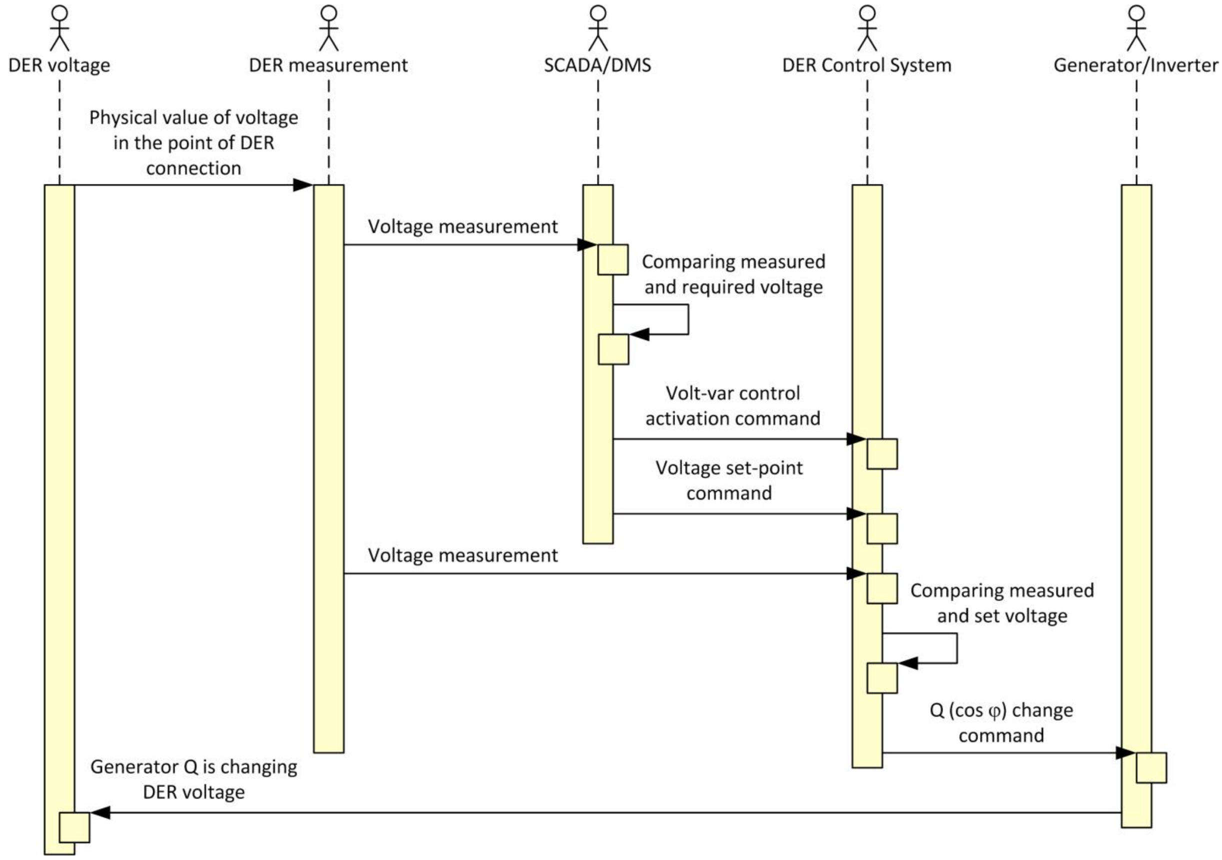
actor 1 = voltage in the point of DER connection before volt-var control system is activated; voltage in the point of DER connection after volt-var control is activated; system boundary – please see SGAM



19.2. Sequence diagram of the Use Case

1 – voltage in the point of DER connection is not according to the DSO dispatcher needs, thus the DSO dispatcher send command for the start of volt-var control together with the voltage set point. In case that voltage set point is higher than actual measured voltage value, the DER will start to generate reactive power in order to increase the voltage. In case that voltage set-point is lower than actual measured voltage value, DER will start to consume reactive power in order to decrease the voltage.

Voltage levels in different locations in MV and HV grid are monitored by DMS in order to provide relevant information for DSO dispatcher.



20.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
HV/MV transformer measurement	System	Network device	Measures voltages and currents on HV and MV transformer	Measured data are used for setting HV/MV OLTC taps.	Type of manufacturer doesn't affect use case function	N/A	N/A
MV busbar measurement	System	Network device	Measures voltage level on MV busbar in distribution system.	Measured voltage is used for setting HV/MV OLTC taps and/or for DER volt-var control.	Type of manufacturer doesn't affect use case function.	N/A	N/A
DER MV measurement	System	Network device	Measures voltage level on DER MV busbar.	Measured voltage is used for DER volt-var control.	Depends on DER owner. Type of manufacturer doesn't affect use case function.	PPDS – Czech grid code.	N/A
OLTC tap changer	System	Network device	Sets OLTC tap to change voltage level in DS.	Tap changing simulates voltage changes in DS.	Type of manufacturer doesn't affect use case function.	N/A	N/A
Generator/Inverter	System	DER installation	Supplies active power to DS. Exchanges reactive power in inductive or capacitive mode with DS.	Exchanges reactive power in inductive or capacitive mode with DS according to volt-var control requirements.	Type of manufacturer doesn't affect use case function.	PPDS – Czech grid code.	N/A
RTU_OLTC	System	Network device	Ensures commands sending from SCADA/DMS to OLTC tap changer.	Receives commands from SCADA/DMS and send them to OLTC tap changer to set the tap.	Type of manufacturer doesn't affect use case function.	N/A	60870-5-104 over fiber optic
IED_OLTC	System	Network device	Sends measured data to SCADA/DMS.	Measured data are used for setting HV/MV OLTC taps.	Type of manufacturer doesn't affect use case function.	N/A	60870-5-104 over fiber optic

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
RTU(SIM)_MV	System	Network device	Sends measured data to SCADA/DMS.	Measured voltage is used for setting HV/MV OLTC taps and/or for DER volt-var control	Type of manufacturer doesn't affect use case function.	N/A	60870-5-104 over fiber optic
RTU(SIM)_DER	System	Network device	Communicates with SCADA/DMS and DER control system.	Sends measured data to SCADA/DMS and DER control system. Receives voltage set-point commands from SCADA/DMS and	Type of manufacturer doesn't affect use case function.	PPDS – Czech grid code.	60870-5-104 over fiber optic and other
DER control system	System	DER installation	Controls DER reactive power and sends data to supervisory systems and interfaces	Receives measured data and voltage set-point commands from RTU. Sends reactive power or power factor set points to generator/inverter. Sends monitoring data to user interfaces and remote monitoring/control	Type of manufacturer doesn't affect use case function.	PPDS – Czech grid code.	N/A
SCADA/DMS	System	IS IT	Receives measured data from DS and sends control commands to action devices.	Receives measured data from MV point in DS and from DER. Send commands to set OLTC tap and DER control system.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	60870-5-104 over fiber optic
Remote monitoring /control system	System	IS IT	Collects data about DS state and controls its operation.	Receives monitoring data from DER control system.	Type of manufacturer doesn't affect use case function.	N/A	N/A

21.Step by Step Analysis of the Use Case

21.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
UC2_1	Voltage control	Voltage in the point of DER connection is not according to the DSO dispatcher needs, thus the DSO dispatcher sends command for the start of volt-var control together with the voltage set point. In case that voltage set point is higher than actual measured voltage value, the DER will start to generate reactive power in order to increase the voltage. In case that voltage set point is lower than actual measured voltage value, DER will start to consume reactive power in order to decrease the voltage.	DER MV measurement	Voltage in the point of DER connection is far from the DSO dispatcher needs.	DER connected to MV grid is equipped with volt-var control system. This system is activated and connected to DSO dispatcher.	Voltage in the point of DER connection is equal or close to the DSO dispatcher needs.

No other scenarios (alternative, error,…) are considered in this use case.

21.2. Steps – Primary Scenario

Scenario Name: Voltage control									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Voltage measurement	DER MV measurement measures voltage in the point of DER connection. The measured data are sent to SCADA/DMS and to DER control system.	DER MV measurement	SCADA/DMS + DER control system	I-01	REPORT	N/A	IEC 60870-5-104	protocol
2	Voltage set-point command	If the measured voltage is different from the required one, commands for volt-var control activation and for voltage set-point are sent from SCADA/DMS to DER control system.	SCADA/DMS	DER control system	I-02, I-03	CREATE	N/A	IEC 60870-5-104	protocol
3	DER control command	DER control system evaluates the voltage set point command and DER voltage measurement and sent adequately calculated command for changing reactive power or power factor to generator/inverter.	DER control system	Generator/ Inverter	I-04	CREATE	N/A	Depends on DER owner.	protocol
4	Reactive power change	Generator/inverter changes its reactive power according to DER control system commands until there are commands for Q changing from DER control system, i.e. until the measured voltage is close to the required one.	DER control system	Generator/ Inverter	I-04	EXECUTE	N/A	Depends on generator/inverter manufacturer.	protocol

21.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name: N/A									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

22.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
I-01	DER measured voltage	Measured values of voltage on MV level in the point of DER connection to the grid. Values are sent to SCADA/DMS and to DER control system.	Electrical parameter	N/A
I-02	Volt-var control activation	If the measured DER voltage is different from the desired one, SCADA/DMS send a command to DER control system to activate volt-var control.	Algorithm, formula, rule, specific model	N/A
I-03	Voltage set-point	When volt-var control is activated, the desired voltage value is sent from SCADA/DMS to DER control system.	Electrical parameter	N/A
I-04	Reactive power control	The value of required DER reactive power is continuously sent from DER control system to the generator/inverter to match the real voltage with the desired one as precisely as possible.	Algorithm, formula, rule, specific model	N/A

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP6_3 – Smart EV charging

Scope

This document describes the Use Case **UC WP6_3 – Smart EV charging**.

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

23.Description of the Use Case WP6.3

23.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 6_3	CUSTOMER PREMISES/PROCESS	Smart EV charging	Detailed Use case

23.2. Version Management

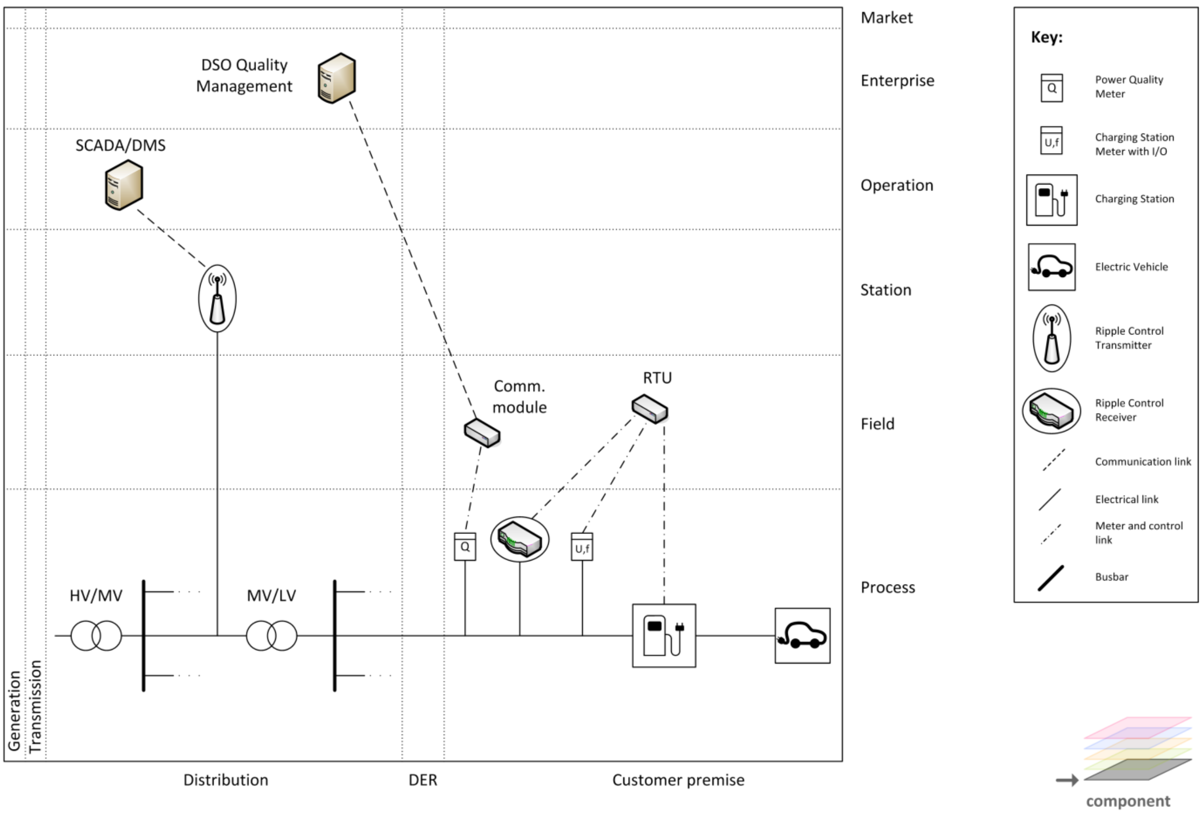
Versi	Date	Name Author(s) or	Changes
V1.0	24.5.201 7	Jan Švec	First version of the document

23.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	The aim is to quantify the impacts of the Smart charging of EVs onto the distribution grid flexibility in case of emergency.
Objective	Reduce maximum charging power of smart charging station in case of underfrequency, undervoltage or in case of receiving signal from DSO through ripple control system (emergency functions) and power quality measurement during EV charging process (evaluated according to EN 50160).
Related Business Case	*CEZ Distribuce could defer investments to grid reinforcement.*

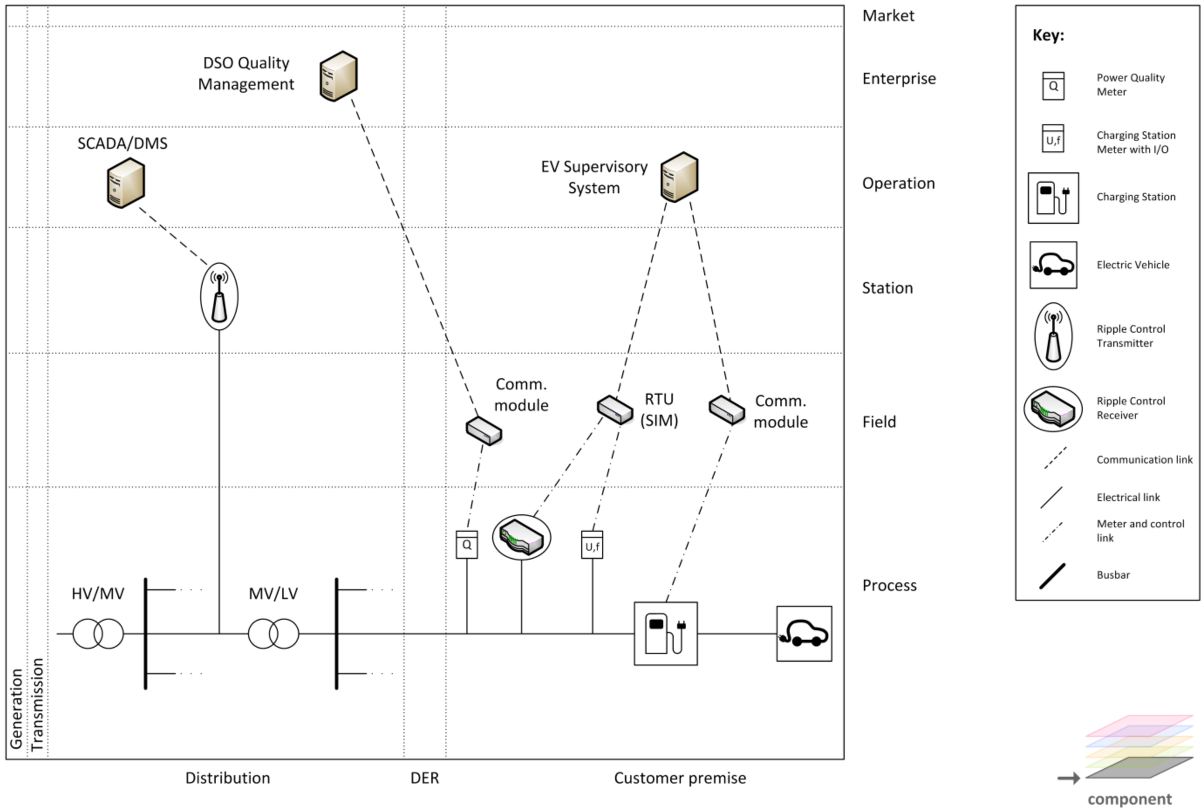
23.4. Narrative of Use Case

Short description – max 3 sentences
Curtailment of EV charging power in case of under voltage, under frequency or in case of DSO needs.

Complete description
ČEZ Distribuce together with partners aims at testing the influence of smart EV charging stations functions to show their potential for increasing the network flexibility through improved EV charging stations implementation into the distribution networks (services to the distribution network), and optimizing the future EV charging stations implementation to prevent from power quality issues and to contribute to the system stability and flexibility without reduction of customer comfort. The Smart functions to be tested (first in a laboratory then in the field) are partial active power curtailment of EV charging in case of under frequency or under voltage in the DS and partial remote active power curtailment from DSO SCADA in case of emergency. Use Case 3a – Schneider Electric **WP6 Use-case #3a** 

Use Case 3b – Siemens

WP6 Use-case #3b



23.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI6_2	Power quality (according to EN 50160 standard)	Power quality will not be negatively affected by implementation of solutions	WP6_1, WP6_2, WP6_3, WP6_4
KPI6_3	EV charging stations load curtailment in emergency situations	% of decrease of EV charging power	WP6_3

23.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO dispatcher and voltage or frequency in the point of smart charging station connection	DSO dispatcher sends command for reduction of charging power. Smart charging station will also reduce charging power in case of under frequency or under voltage.	Emergency in distribution or transmission system and reaction of DSO dispatcher or under voltage or under frequency in the point of connection of smart charging station.	Smart charging station solution is able to react on DSO commands and on under voltage or under frequency in distribution system.

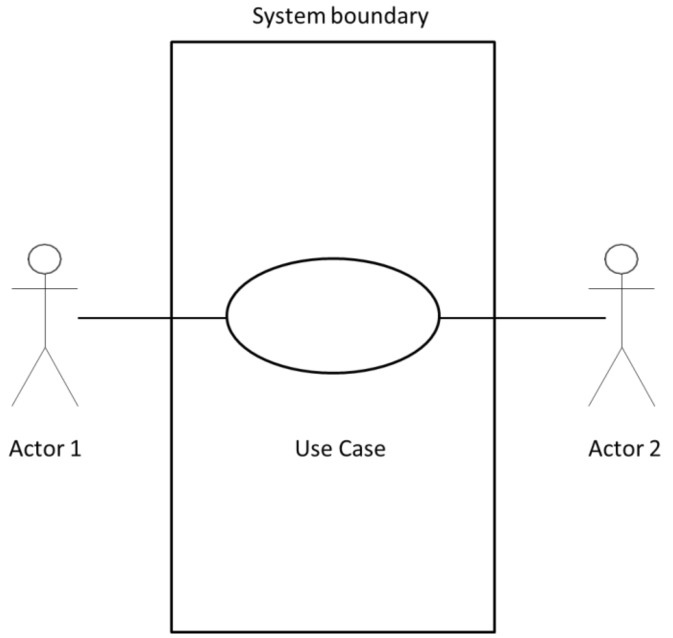
23.8. Classification information

Relation to Other Use Cases in the same project or area
N/A
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Very important
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
Technical point of view
Further Keywords for Classification
Charging station, EV, EN 60160, EN, ripple control system, voltage, frequency, emergency
Maturity of Use Case
Realized in demonstration project

24.Diagrams of the Use Case

24.1. Diagram of the Use Case

actor 1 = voltage or frequency in the point of smart charging station connection before reduction of charging power is activated (activation is based on voltage or frequency measurement or based on DSO dispatcher command); voltage or frequency in the point of smart charging station connection after reduction of charging power is activated (activation is based on voltage or frequency measurement or based on DSO dispatcher command – please see SGAM



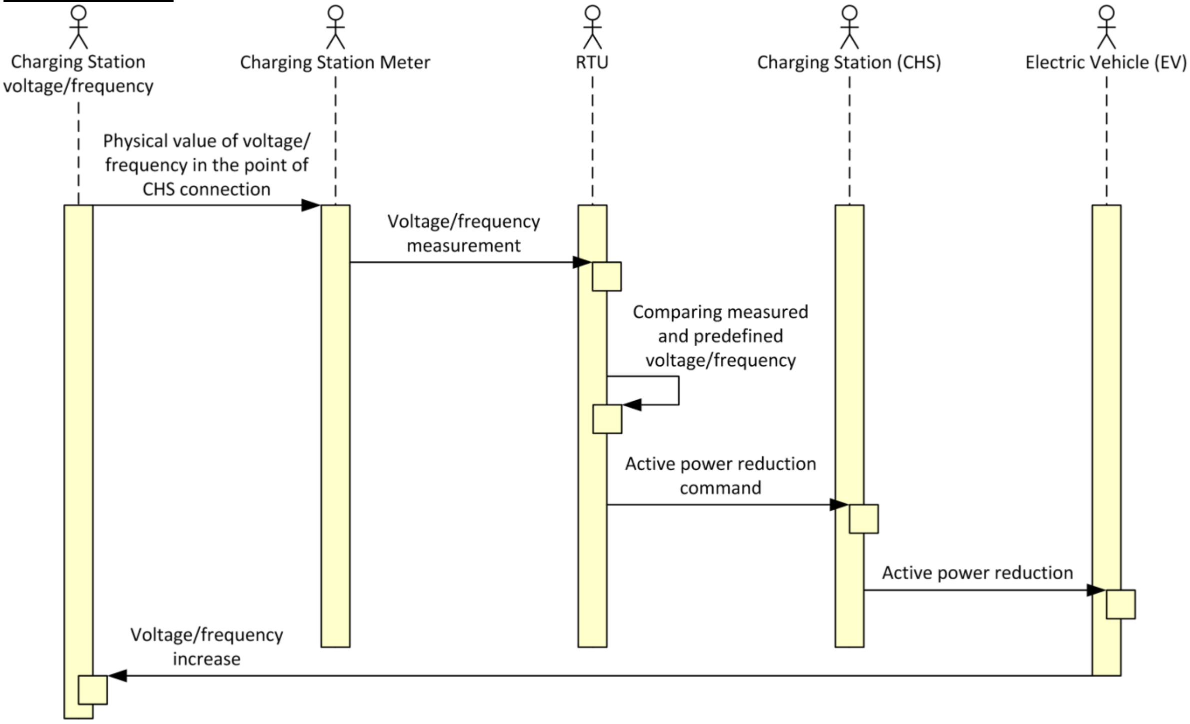
24.2. Sequence diagram of the Use Case

1 – voltage in the point of smart charging station connection is lower than predefined value, thus the smart charging station will reduce charging power – this will help to increase the voltage in the point of connection
2 – frequency in the point of smart charging station connection is lower than predefined value, thus the smart charging station will reduce charging power – this will help to increase the frequency in the point of connection
3 – in case of emergency, the DSO dispatcher will decide to reduce charging power and sends a command through PLC (power line communication), based on that signal, smart charging station will reduce charging power and this will help to reduce load in the selected area

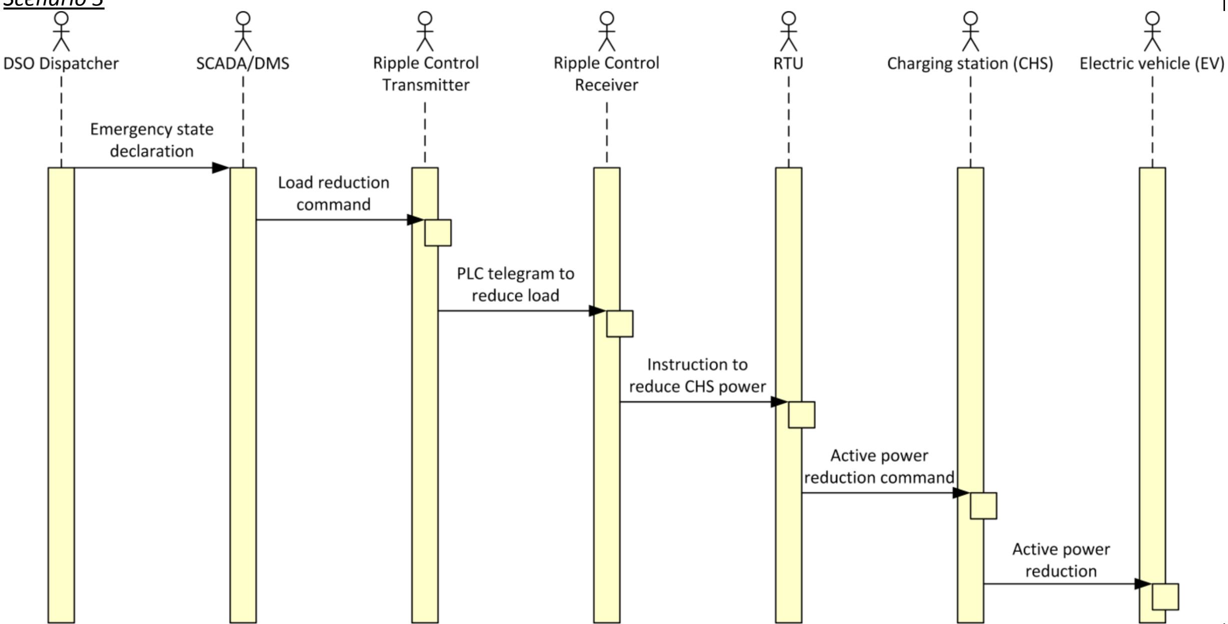
Power quality during charging is monitored through DSO power quality management system.

Use Case 3a – Schneider Electric

Scenarios 1 and 2

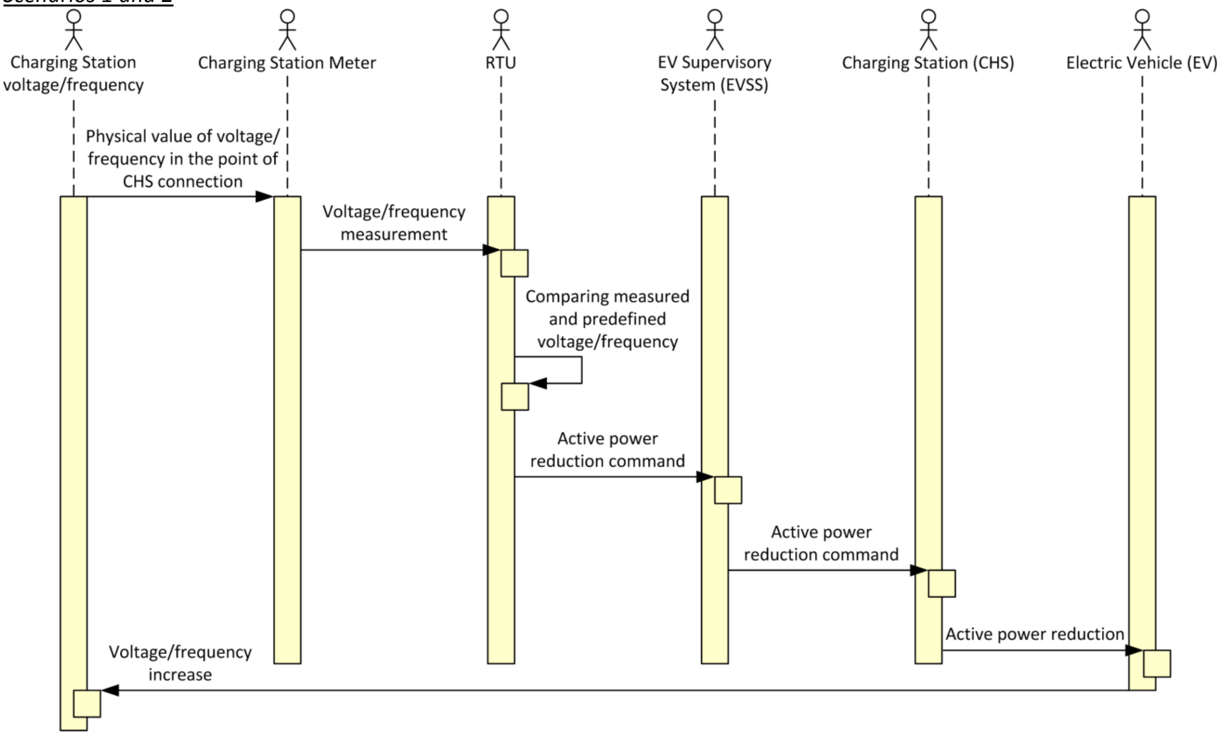


Scenario 3

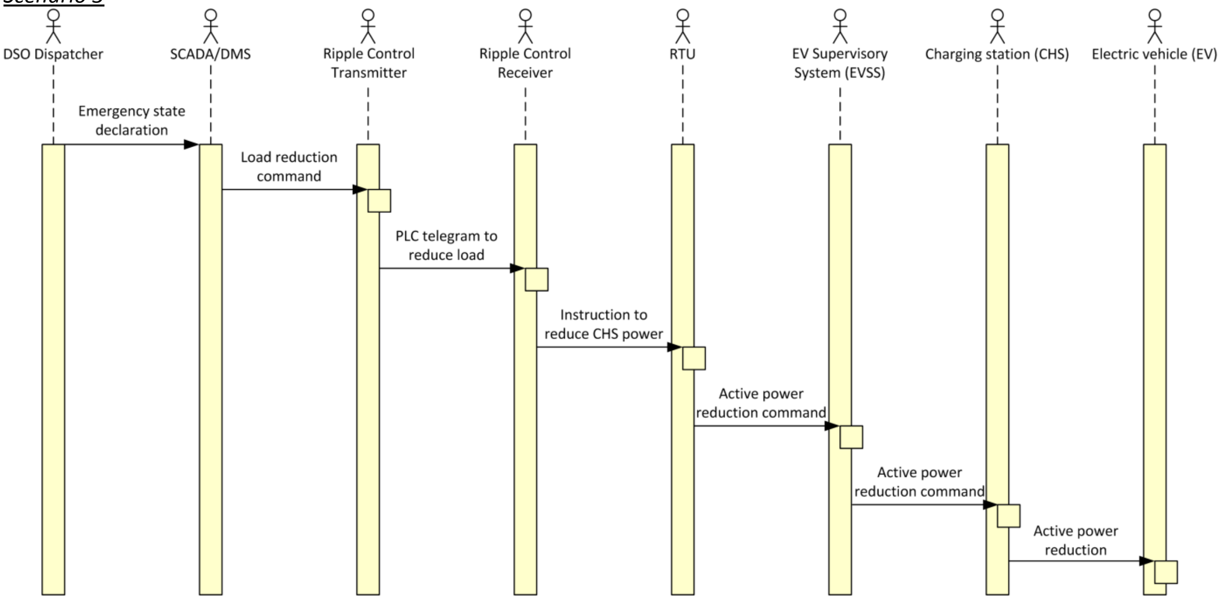


Use Case 3b – Siemens

Scenarios 1 and 2



Scenario 3



25.Technical details of the Use Case – Actors

UC3a

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Charging Station	System	Charging facilities	Supplies electric vehicle with electric energy from the grid. It can be controlled from a supervisory system.	Supplies electric vehicle with electric energy from the grid. Its power can be reduced based on signals from RTU.	Schneider Electric	N/A	IEC 61851
Electric Vehicle	System	In house device	Consumes electricity from the charging station.	Consumes electricity from the charging station. Its consumption can be reduced based on the charging station control.	Different types of EV – the only requirement for testing is ability of EV to charge AC over 3x16A	N/A	IEC 61851
Quality Meter	System	Network device	Measures power quality data (voltages, currents, disturbances, fluctuations, …)	Measures power quality data and sends them to DSO quality management system.	MEgA	N/A	IEC 60870-5-104
Charging Station Meter	System	Network device	Measures basic electric quantities (voltage, frequency) to verify DS operational state.	Measures voltage and frequency and sends the data to RTU. If U or f is too low, the charging station should reduce its power	Schneider Electric	N/A	N/A

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
RTU	System	Network device	Communicates with ripple control receiver, Charging Station Meter and charging station.	Receives data from ripple control receiver (signals – telegrams) and from Charging Station Meter (voltage, frequency). It sends commands to the charging station to change its power	Type of manufacturer doesn't affect use case function.	N/A	N/A
Ripple Control Transmitter	System	Network device	Sends signals (telegrams) to DS to connect/disconnect specific groups of load in the grid.	Sends signals (telegrams) to the receiver at the charging station to reduce its consumed power in case of DS emergency.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	N/A
Ripple Control Receiver	System	Network device	Receives signals (telegrams) from the transmitter to connect/disconnect the load which it is connected to.	Receives signals (telegrams) from the transmitter to reduce charging station power.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	N/A
SCADA/DMS	System	IS IT	Receives measured data from DS and sends control commands to action devices.	Sends commands to ripple control transmitter to activate its signals to DS (telegrams).	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	IEC 60870-5-104
DSO Quality Management	System	IS IT	Receives power quality data from different DS points.	Receives power quality data from quality meter at the charging station connection point.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	IEC 60870-5-104

UC3b

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Charging Station	System	Charging facilities	Supplies electric vehicle with electric energy from the grid. It can be controlled from a supervisory system.	Supplies electric vehicle with electric energy from the grid. Its power can be reduced based on signals from EV	Siemens	N/A	IEC 61851
Electric Vehicle	System	In house device	Consumes electricity from the charging station.	Consumes electricity from the charging station. Its consumption can be reduced based on the charging station control.	Different types of EV – the only requirement for testing is ability of EV to charge AC over 3x16A	N/A	IEC 61851
Quality Meter	System	Network device	Measures power quality data (voltages, currents, disturbances, fluctuations, …)	Measures power quality data and send them to DSO quality management system	MEgA	N/A	IEC 60870-5-104
Charging Station Meter	System	Network device	Measures basic electric quantities (voltage, frequency) to verify DS operational state.	Measures voltage and frequency and sends the data to RTU. If U or f is too low, the charging station should reduce its power	Siemens	N/A	N/A
RTU	System	Network device	Communicates with ripple control receiver, Charging Station Meter and EV supervisory system.	Receives data from ripple control receiver (signals – telegrams) and from Charging Station Meter (voltage, frequency). It sends data to EV supervisory system so that influence charging power	Type of manufacturer doesn't affect use case function.	N/A	N/A

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
EV supervisory system	System	IS IT	Controls EV charging based on commands from other system units.	Receives data from ripple control receiver or Charging Station Meter to change EV charging power and sends adequate commands to the charging station.	Siemens	N/A	N/A
Ripple Control Transmitter	System	Network device	Sends signals (telegrams) to DS to connect/disconnect specific groups of load in the grid.	Sends signals (telegrams) to the receiver at the charging station to reduce its consumed power in case of DS emergency.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	N/A
Ripple Control Receiver	System	Network device	Receives signals (telegrams) from the transmitter to connect/disconnect the load which it is connected to.	Receives signals (telegrams) from the transmitter to reduce charging station power.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	N/A
SCADA/DMS	System	IS IT	Receives measured data from DS and sends control commands to action devices.	Sends commands to ripple control transmitter to activate its signals to DS (telegrams).	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	IEC 60870-5-104
DSO Quality Management	System	IS IT	Receives power quality data from different DS points.	Receives power quality data from quality meter at the charging station connection point.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	IEC 60870-5-104

26.Step by Step Analysis of the Use Case

26.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
UC3_1	Voltage based reduction	Voltage in the point of smart charging station connection is lower than predefined value, thus the smart charging station will reduce charging power – this will help to increase the voltage in the point of connection.	Charging Station Meter	Voltage in the point of charging station connection is lower than predefined value.	Smart charging station is capable to reduce its consumption power based on RTU (or EV supervisory system) signals.	Due to charging power reduction, voltage in the point of charging station connection is increased in comparison with the state when no action is realized.
UC3_2	Frequency based reduction	Frequency in the point of smart charging station connection is lower than predefined value, thus the smart charging station will reduce charging power – this will help to increase the frequency in the point of	Charging Station Meter	Frequency in the point of charging station connection is lower than predefined value.	Smart charging station is capable to reduce its consumption power based on RTU (or EV supervisory system) signals.	Due to charging power reduction, frequency in the point of charging station connection is increased in comparison with the state when no action is realized.
UC3_3	Emergency based reduction	In case of emergency, the DSO dispatcher will decide to reduce charging power and sends a ripple control command (telegram) through PLC (power line communication). Based on that signal, smart charging station will reduce charging power and this will help to reduce load in the selected	SCADA/DMS	DSO dispatcher declares an emergency state in the specific part of the grid.	Smart charging station is capable to reduce its consumption power based on RTU (or EV supervisory system) signals.	Charging power reduction results in selected area load reduction and hence possible cancelling the emergency state.

26.2. Steps – Primary Scenario

UC3a

Scenario Name: Voltage based reduction									
Ste p No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Voltage measurement	Charging Station Meter measures voltage in the point of charging station connection. The measured data are sent to RTU.	Charging Station Meter	RTU	I-01	REPORT	N/A	Charging station Meter is a physical part of RTU.	Internal protocol
2	Charging reduction command	If the measured voltage is lower than predefined value, RTU sends a command to the charging station to reduce its consumption power.	RTU	Charging Station	I-02	CREATE	N/A	Digital Input/Output	Protocol
3	Charging reduction	Charging station supplies electric vehicle with lower active power.	Charging Station	Electric Vehicle	I-03	EXECUTE	N/A	IEC 61851	Protocol

Scenario Name: Frequency based reduction									
Ste p No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Frequency measurement	Charging Station Meter measures frequency in the point of charging station connection. The measured data are sent to RTU.	Charging Station Meter	RTU	I-01	REPORT	N/A	Charging station Meter is a physical part of RTU.	Internal protocol
2	Charging reduction command	If the measured frequency is lower than predefined value, RTU sends a command to the charging station to reduce its consumption power.	RTU	Charging Station	I-02	CREATE	N/A	Digital Input/Output	Protocol

Scenario Name: Frequency based reduction									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
3	Charging reduction	Charging station supplies electric vehicle with lower active power.	Charging Station	Electric Vehicle	I-03	EXECUTE	N/A	IEC 61851	Protocol

Scenario Name: Emergency based reduction									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Emergency state command	If DSO dispatcher declares an emergency state in a selected grid area, SCADA/DMS sends a command to ripple control transmitter to activate load change.	SCADA/DMS	Ripple Control Transmitter	I-04	CREATE	N/A	IEC 60870-5-104	Protocol
2	Ripple control command	Ripple control transmitter sends signals (telegrams) via PLC to ripple control receiver in the selected area to activate load change.	Ripple Control Transmitter	Ripple Control Receiver	I-05	CREATE	N/A	CEZ Distribuce ripple control NB-PLC	Protocol
3	Charging reduction command - ripple	Based on the telegram, ripple control receiver sends a command to RTU to reduce charging station consumption power.	Ripple Control Receiver	RTU	I-06	CREATE	N/A	Digital Input/Output	Protocol
4	Charging reduction command - RTU	Based on the ripple control receiver signal, RTU sends a command to the charging station to reduce its consumption power.	RTU	Charging Station	I-02	CREATE	N/A	Digital Input/Output	Protocol
5	Charging reduction	Charging station supplies electric vehicle with lower active power.	Charging Station	Electric Vehicle	I-03	EXECUTE	N/A	IEC 61851	Protocol

UC3b

Scenario Name: Voltage based reduction									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Voltage measurement	Charging Station Meter measures voltage in the point of charging station connection. The measured data are sent to RTU.	Charging Station Meter	RTU	I-01	REPORT	N/A	Charging station Meter is a physical part of RTU.	Internal protocol
2	Charging reduction command - RTU	If the measured voltage is lower than predefined value, RTU sends a command to EV supervisory system to reduce charging station consumption power.	RTU	EV supervisory system	I-02	REPORT	N/A	IEC over LTE or GPRS	Protocol
3	Charging reduction command - EVSS	EV supervisory system resends the command from RTU further to the charging station via its communication module to reduce its consumption power.	EV supervisory system	Charging Station	I-03	CREATE	N/A	IEC over LTE or GPRS	Protocol
4	Charging reduction	Charging station supplies electric vehicle with lower active power.	Charging Station	Electric Vehicle	I-04	EXECUTE	N/A	IEC 61851	Protocol

Scenario Name: Frequency based reduction									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Frequency measurement	Charging Station Meter measures frequency in the point of charging station connection. The measured data are sent to RTU.	Charging Station Meter	RTU	I-01	REPORT	N/A	Charging station Meter is a physical part of RTU.	Internal protocol

Scenario Name: Frequency based reduction									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
2	Charging reduction command - RTU	If the measured frequency is lower than predefined value, RTU sends a command to EV supervisory system to reduce charging station consumption power.	RTU	EV supervisory system	I-02	REPORT	N/A	IEC over LTE or GPRS	Protocol
3	Charging reduction command - EVSS	EV supervisory system resends the command from RTU further to the charging station via its communication module to reduce its consumption power.	EV supervisory system	Charging Station	I-03	CREATE	N/A	IEC over LTE or GPRS	Protocol
4	Charging reduction	Charging station supplies electric vehicle with lower active power.	Charging Station	Electric Vehicle	I-04	EXECUTE	N/A	IEC 61851	Protocol

Scenario Name: Emergency based reduction									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Emergency state command	If DSO dispatcher declares an emergency state in a selected grid area, SCADA/DMS sends a command to ripple control transmitter to activate load change.	SCADA/DMS	Ripple Control Transmitter	I-05	CREATE	N/A	IEC 60870-5-104	Protocol
2	Ripple control command	Ripple control transmitter sends signals (telegrams) via PLC to ripple control receiver in the selected area to activate load change.	Ripple Control Transmitter	Ripple Control Receiver	I-06	CREATE	N/A	CEZ Distribuce ripple control NB-PLC	Protocol

Scenario Name: Emergency based reduction									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
3	Charging reduction command - ripple	Based on the telegram, ripple control receiver sends a command to RTU to reduce charging station consumption power.	Ripple Control Receiver	RTU	I-07	CREATE	N/A	Digital Input/Output	Protocol
4	Charging reduction command - RTU	RTU evaluates a command from ripple control receiver and sends a command to EV supervisory system to reduce charging station consumption power.	RTU	EV supervisory system	I-02	REPORT	N/A	IEC over LTE or GPRS	Protocol
5	Charging reduction command - EVSS	EV supervisory system resends the command from RTU further to the charging station via its communication module to reduce its consumption power.	EV supervisory system	Charging Station	I-03	CREATE	N/A	IEC over LTE or GPRS	Protocol
6	Charging reduction	Charging station supplies electric vehicle with lower active power.	Charging Station	Electric Vehicle	I-04	EXECUTE	N/A	IEC 61851	Protocol

No other scenarios (alternative, error,…) are considered in this use case.

26.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name: N/A									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
N/	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

27.Information exchanged

UC3a

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
I-01	DS state quantities	Measured voltage and frequency in the point of charging station connection to the grid. Values are sent from Charging Station Meter to RTU.	Electrical parameter	N/A
I-02	RTU charging command	If RTU evaluates low voltage or frequency or receives a command from ripple control receiver, it sends a command to the charging station to reduce its power.	Information exchanged between IS or sent to device	N/A
I-03	EV instruction	If charging station is controlled to reduce its power, it exchanges information with electric vehicle about the proper charging.	Information exchanged between IS or sent to device	N/A
I-04	Emergency command	If DSO dispatcher declares an emergency state in a selected grid area, SCADA/DMS sends an emergency command to ripple control transmitter to activate load change.	Information exchanged between IS or sent to device	N/A
I-05	Ripple control signal	Ripple control transmitter sends signals (telegrams) via PLC to ripple control receiver in the selected area to activate load change.	Information exchanged between IS or sent to device	N/A
I-06	Ripple control charging command	Based on the telegram, ripple control receiver sends a command to RTU to reduce charging station consumption power.	Information exchanged between IS or sent to device	N/A

UC3b

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
I-01	DS state quantities	Measured voltage and frequency in the point of charging station connection to the grid. Values are sent from Charging Station Meter to RTU.	Electrical parameter	N/A
I-02	RTU command	Voltage or frequency measurement or ripple control command resent from RTU to EV supervisory system for their evaluation.	Information exchanged between IS or sent to device	N/A
I-03	EVSS charging command	If EV supervisory system evaluates low voltage or frequency or receives a command from ripple control receiver, it sends a command to the charging station to reduce its power.	Information exchanged between IS or sent to device	N/A
I-04	EV instruction	If charging station is controlled to reduce its power, it exchanges information with electric vehicle about the proper charging.	Information exchanged between IS or sent to device	N/A
I-05	Emergency command	If DSO dispatcher declares an emergency state in a selected grid area, SCADA/DMS sends an emergency command to ripple control transmitter to activate load change.	Information exchanged between IS or sent to device	N/A
I-06	Ripple control signal	Ripple control transmitter sends signals (telegrams) via PLC to ripple control receiver in the selected area to activate load change.	Information exchanged between IS or sent to device	N/A
I-07	Ripple control charging command	Based on the telegram, ripple control receiver sends a command to RTU to reduce charging station consumption power.	Information exchanged between IS or sent to device	N/A

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP6_4 – Smart energy storage

Scope

This document describes the Use Case **UC WP6_4 – Smart energy storage**.

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on "information exchanged")
- Information exchanged

28. Description of the Use Case WP6.4

28.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 6_4	DER/PROCESS	Smart energy storage	Detailed Use case

28.2. Version Management

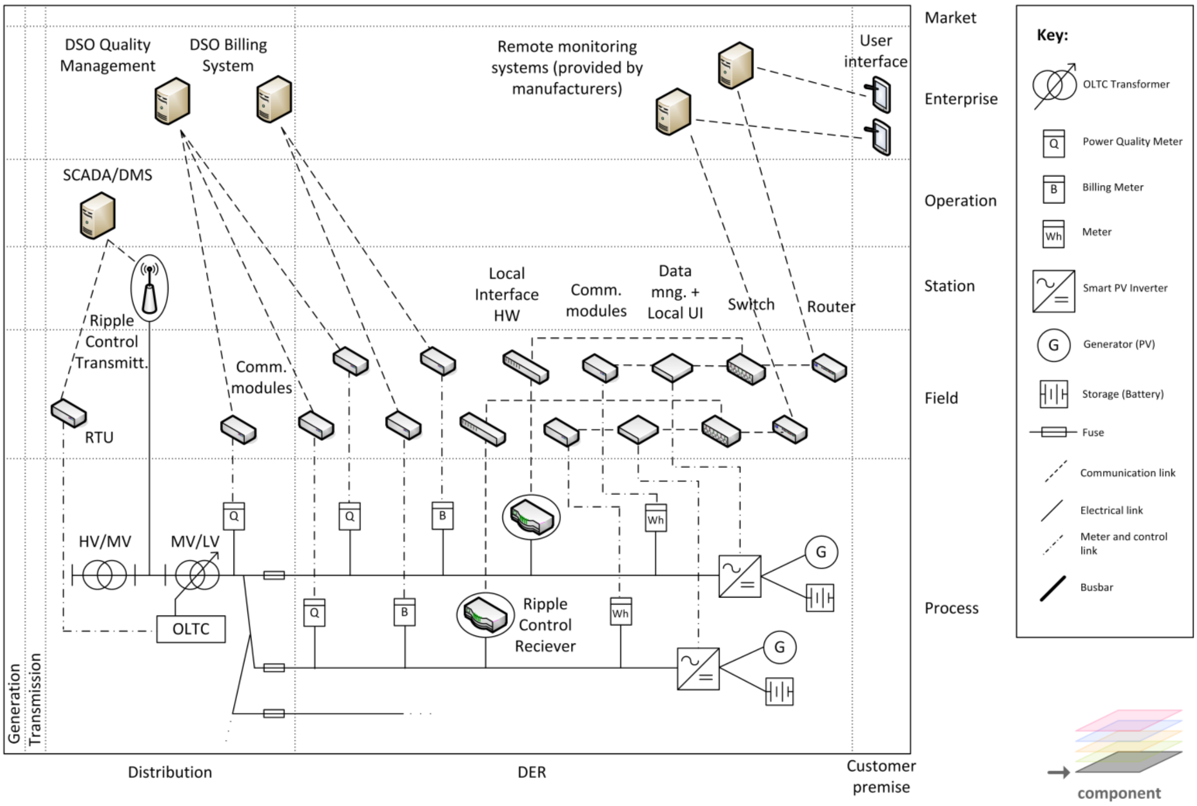
Versi	Date	Name Author(s) or	Changes
V1.0	24.5.201 7	Jan Švec	First version of the document
V1.1	26.5.201 7	Jan Kůla	Added chapters 3,4,5

28.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	The aim of the use case is field demonstration of smart PV inverters with batteries which enables increasing of DER hosting capacity in one area thanks to the peak shaving of PV production. Provision of flexibility to DSO in case of emergency.
Objective	Increase of DER hosting capacity in LV grids thanks to the installation of smart PV inverters with batteries which allow peak shaving of PV production and securing the power quality according to EN 50160 standard. Delivery of active power from batteries in case of underfrequency, undervoltage or in case of receiving signal from DSO through ripple control system (emergency functions).
Related Business Case	*CEZ Distribuce could defer investments to grid reinforcement.*

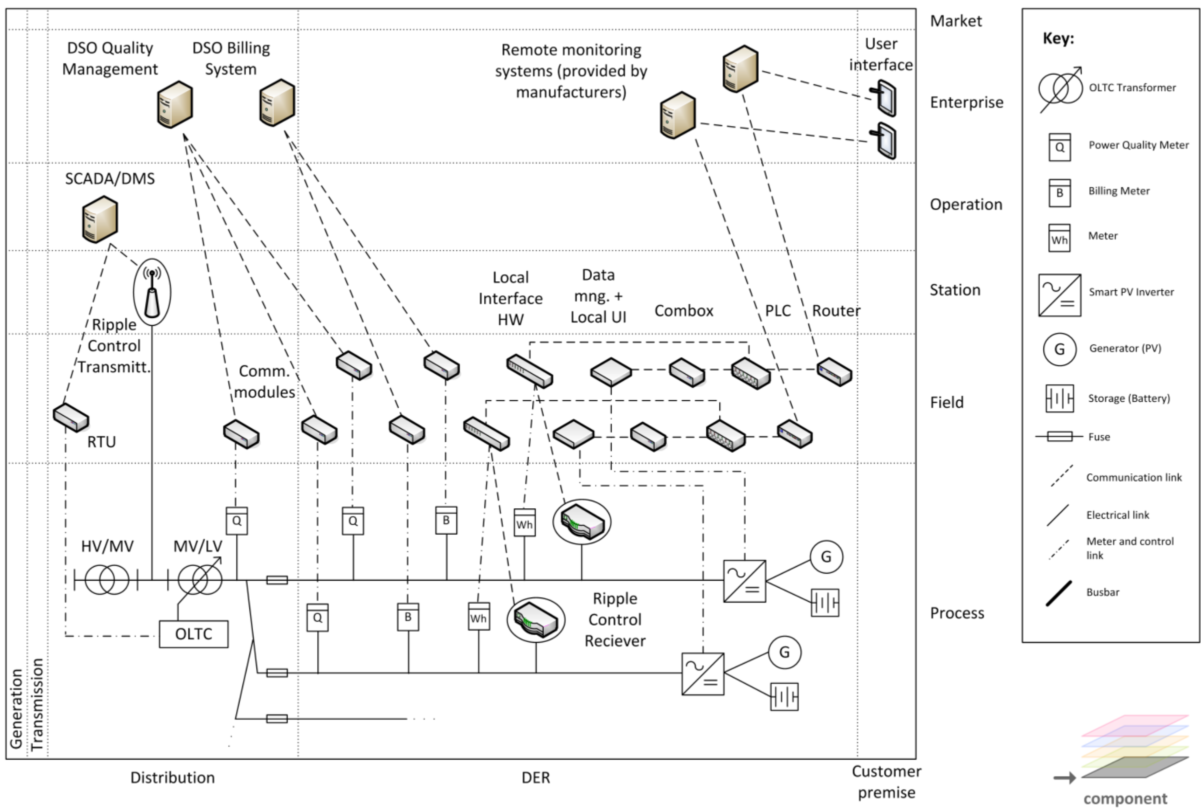
28.4. Narrative of Use Case

Short description – max 3 sentences
Increasing of DER hosting capacity and reduction of PV production peak in case that smart PV inverters with energy storage are used.

Complete description
ČEZ Distribuce tests the influence of using the residential energy storage systems (PV + battery) on the PV peak shaving in LV distribution network and assesses the potential of grid-connected energy storage systems (for increasing the flexibility by providing grid services). The smart energy storage functions which are going to be tested are: active power injection in case of DSO request and active power injection in case of under frequency or under voltage in the distribution network. Customer participation is essential. Testing the influence of residential energy storage systems on solar peak shaving helps determining how these systems affect the power quality and how they contribute to avoiding congestions in the distribution network. Use Case 4a – Fronius **WP6 Use-case #4** 

Use Case 4b – Schneider Electric

WP6 Use-case #4 (Schneider)



28.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI6_1	Increasing DER hosting capacity	in % compared with the baseline situation	WP6_1, WP6_2, WP6_4
KPI6_2	Power quality (according to EN 50160 standard)	Power quality will not be negatively affected by implementation of solutions	WP6_1, WP6_2, WP6_3, WP6_4
KPI6_4	PV production peak shaving	% of decrease of PV production peak	WP6_4

28.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO dispatcher and voltage or frequency in the point of PV + battery connection	DSO dispatcher sends command for discharging of the battery. Battery will also discharge in case of under frequency or under voltage.	Emergency in distribution or transmission system and reaction of DSO dispatcher or under voltage or under frequency in the point of connection of PV + battery.	PV + battery solution is able to react on DSO commands and on under voltage or under frequency in distribution system.

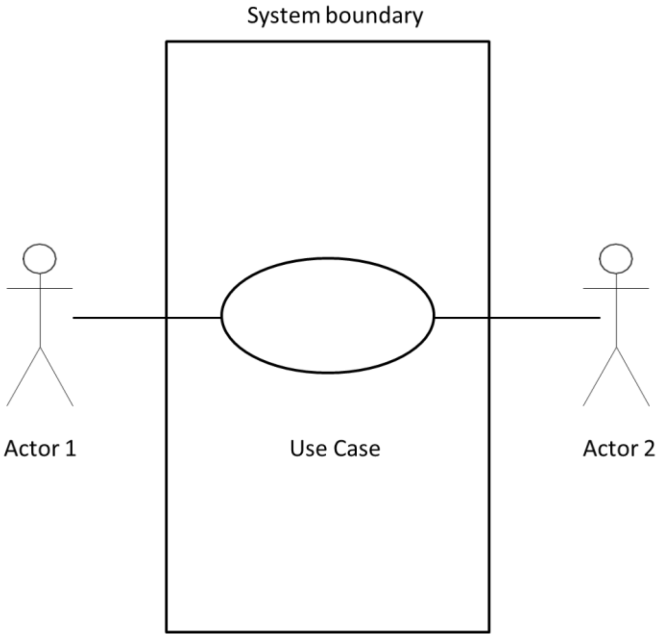
28.7. Classification information

Relation to Other Use Cases in the same project or area
Associate – use cases WP6_1, WP6_2, WP6_4 aim to increase DER hosting capacity of distribution grids.
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Very important
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
Technical point of view
Further Keywords for Classification
PV inverter, EN 50160, hosting capacity, DER, energy storage, peak shaving, ripple control system, LV grid, Q(U), P(U), voltage, frequency, emergency
Maturity of Use Case
Realized in demonstration project

29.Diagrams of the Use Case

29.1. Diagram of the Use Case

actor 1 = voltage or frequency in the point of PV + battery connection before discharging is activated (activation is based on voltage or frequency measurement or based on DSO dispatcher command); voltage or frequency in the point of PV + battery connection after discharging is activated (activation is based on voltage or frequency measurement or based on DSO dispatcher command – please see SGAM



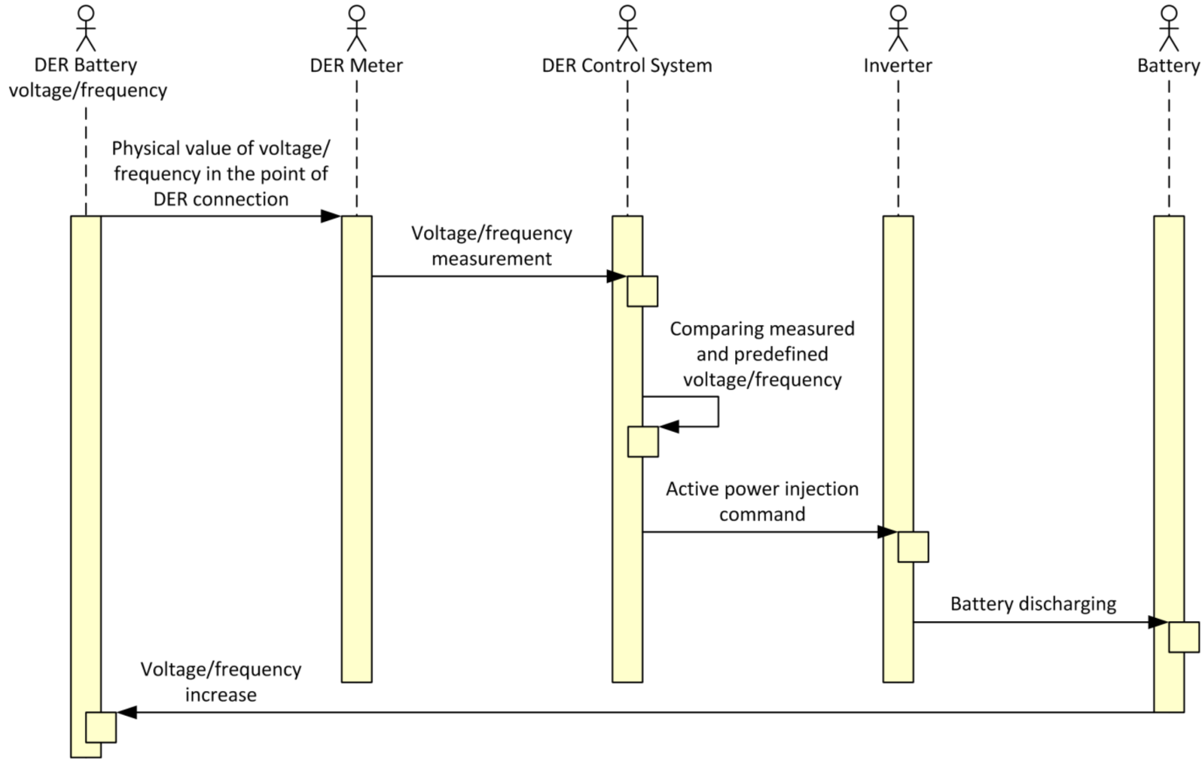
29.2. Sequence diagram of the Use Case

1 – voltage in the point of PV inverter + battery connection is lower than predefined value, thus the s PV inverter + battery will discharge – this will help to increase the voltage in the point of connection
2 – frequency in the point of PV inverter + battery connection is lower than predefined value, thus the PV inverter + battery will discharge – this will help to increase the frequency in the point of connection
3 – in case of emergency, the DSO dispatcher will decide to discharge the battery and sends a command through PLC (power line communication), based on that signal, PV inverter + battery will discharge and this will help to reduce load in the selected area

Maximum feed in power of the system (PV + battery) back to the distribution grid is limited to 50 % of the PV installed capacity. This is secured by Wh meter and communication towards the PV inverter.
MV/LV OLTC transformer is used for simulation of different voltage levels in LV grid. Taps could be regulated through DMS.
Power quality is monitored in the LV grid through DSO power quality management system. For use case evaluation also data from DSO billing system are used. Data from PV inverter are also used for use case evaluation.

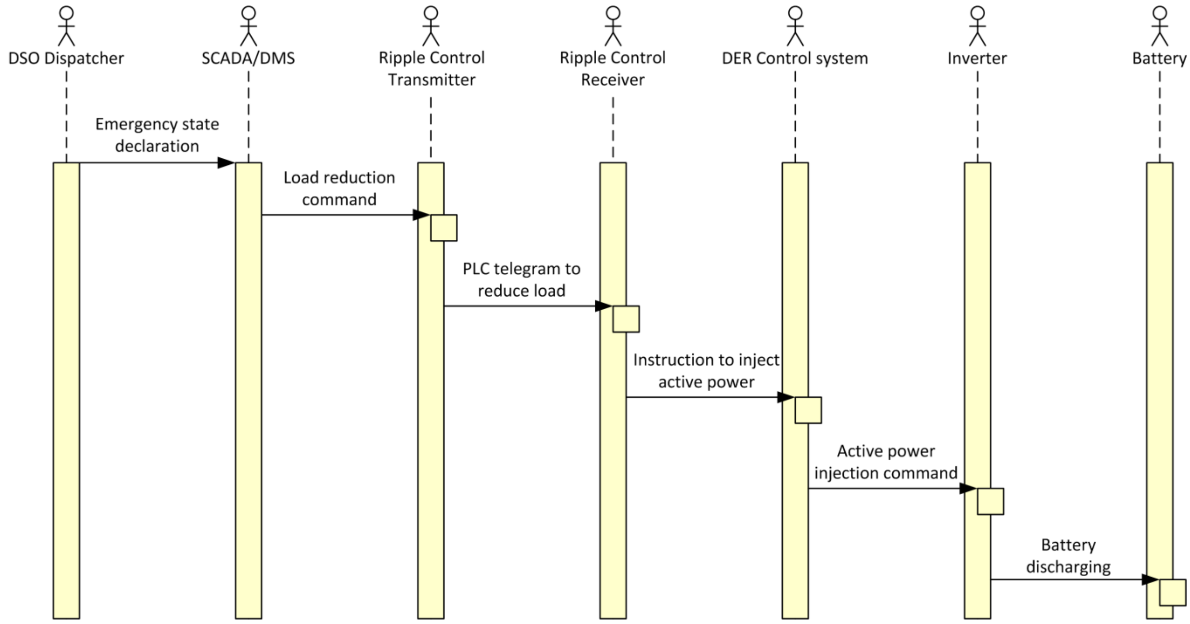
Use Case 4 (both Fronius and Schneider)

Scenarios 1 and 2



Use Case 4 (both Fronius and Schneider)

Scenario 3



30.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection	IEC Standards
SCADA/DMS (Dispatcher command)	System	IS IT	Receives measured data from DS and sends control commands to action devices.	Sends commands to ripple control transmitter to activate its signals to DS (telegrams).	Will not be specified because of security reason. Type of manufacturer doesn't affect use case	N/A	IEC 60870-5-104
OLTC tap changer (incl. RTU)	System	Network device	Sets OLTC tap to change voltage level in DS.	RTU receives commands from SCADA/DMS and send them to OLTC tap changer to set the tap and simulate voltage changes in DS.	Will be selected by procurement later.	N/A	60870-5-104 Over GPRS
DER control system (incl. Data manager, Local UI, Router, Local Interface HW)	System	DER installation	Receives signals from Ripple Control Receiver. Sends data to supervisory systems and interfaces.	Sends monitoring data to user interfaces and remote monitoring/control systems. Send command to battery whether battery discharge is needed.	Fronius, Schneider	N/A	Ethernet TCP/IP internet
Generator + Inverter + Battery storage	System	DER installation	Battery discharge in case of DSO request or under frequency or under voltage in the distribution network.	Measures voltage and receives signals from ripple control transmitter. Local UI determines whether battery could be used for power injection.	Fronius, Schneider	EN 50438:2013	N/A
Ripple Control Transmitter	System	Network device	Sends signals (telegrams) to DS to connect/disconnect specific groups of load in the grid.	Sends signals (telegrams) to the receiver to reduce its consumed power in case of DS emergency.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	N/A
Ripple Control Receiver	System	Network device	Receives signals (telegrams) from the transmitter to connect/disconnect the load which it is connected to.	Receives signals (telegrams) from the transmitter to reduce injected power.	Will not be specified because of security reason. Type of manufacturer doesn't affect use case function.	N/A	N/A

31.Step by Step Analysis of the Use Case

31.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
UC4_1	Voltage based discharge	Voltage in the point of DER + battery connection is lower than predefined value, thus the Battery will discharge – this will help to increase the voltage in the point of connection	DER control system (incl. Data manager, Local UI, Router, Local Interface HW)	Voltage in the point of DER connection is lower than predefined value.	DER with storage is capable to charge/discharger based on received signal signals.	Due to battery discharging, voltage in the point of DER connection is increased in comparison with the state when no action is realized.
UC4_2	Frequency based discharge	Frequency in the point DER connection is lower than predefined value, thus the PV inverter + battery will discharge – this will help to increase the frequency in the point of connection	DER control system (incl. Data manager, Local UI, Router, Local Interface HW)	Frequency in the point of DER connection is lower than predefined value.	DER with storage is capable to charge/discharger based on received signal signals.	Due to battery discharging, frequency in the point of DER connection is increased in comparison with the state when no action is realized.
UC4_3	Emergency based discharge	In case of emergency, the DSO dispatcher will decide to discharge the battery and sends a command through PLC (power line communication), based on that signal, PV inverter + battery will discharge and this will help to reduce load in the selected area	SCADA/DMS (Dispatcher command)	DSO dispatcher declares an emergency state in the specific part of the grid.	DER with storage is capable to discharger based on received signal signals.	Due to battery discharging in selected area load reduction is realized and hence it is possible cancelling the emergency state.

31.2. Steps – Primary Scenario

Scenario Name: Voltage based discharge									
Step No.	**Event**	**Description of Process/Activity**	**Information**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Voltage measurement	DER Meter measures voltage in the point of connection. The measured data are sent to Local interface HW of DER.	DER meter	Local UI of DER	I-01	REPORT	N/A	Meter is a physical part of Local interface HW	Internal protocol
2	Discharging command	DER system decides if the battery is charged and sends command to the inverter connected to battery via its communication module to discharge.	Local UI	Inverter	I-02	CREATE	N/A	Ethernet Modbus TCP (Sunspec)	Protocol
3	Battery Discharging	Battery produces active power injection to the grid. This will help to increase the voltage in the point of connection	Inverter	Battery	I-03	EXECUTE	N/A	Ethernet Modbus TCP (Sunspec)	Protocol

Scenario Name: Frequency based discharge									
Step No.	**Event**	**Description of Process/Activity**	**Information**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Frequency measurement	DER Meter measures frequency in the point of connection. The measured data are sent to Local interface HW of DER.	DER meter	Local UI of DER	I-01	REPORT	N/A	Meter is a physical part of Local interface HW	Internal protocol
2	Discharging command	DER system decides if the battery is charged and sends command to the inverter connected to battery via its communication module to discharge.	Local UI	Inverter	I-02	CREATE	N/A	Ethernet Modbus TCP (Sunspec)	Protocol
3	Battery Discharging	Battery produces active power injection to the grid. This will help to increase the frequency in the point of connection	Inverter	Battery	I-03	EXECUTE	N/A	Ethernet Modbus TCP (Sunspec)	Protocol

Scenario Name: Emergency based discharge									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Emergency state command	If DSO dispatcher declares an emergency state in a selected grid area, SCADA/DMS sends a command to ripple control transmitter to activate load change.	SCADA/DMS	Ripple Control Transmitter	I-04	CREATE	N/A	IEC 60870-5-104	Protocol
2	Ripple control command	Ripple control transmitter sends signals (telegrams) via PLC to ripple control receiver in the selected area to activate load change.	Ripple Control Transmitter	Ripple Control Receiver	I-05	CREATE	N/A	CEZ Distribuce ripple control NB-PLC	Protocol
3	DER command	Based on the telegram, ripple control receiver sends a command to DER Control system to inject active power from battery.	Ripple Control Receiver	DR Control System	I-06	CREATE	N/A	Digital Input/Output	Protocol
4	Discharging command	DER system decides if the battery is charged and sends command to the inverter connected to battery via its communication module to discharge.	Local UI	Inverter	I-02	CREATE	N/A	Ethernet Modbus TCP (Sunspec)	Protocol
5	Battery Discharging	Battery produces active power injection to the grid. This will help to increase the frequency in the point of connection	Inverter	Battery	I-03	EXECUTE	N/A	Ethernet Modbus TCP (Sunspec)	Protocol

No other scenarios (alternative, error,…) are considered in this use case.

31.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name: N/A									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
N/	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

32. Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
I-01	DS state quantities	Measured voltage or frequency in the point of DER connection to the grid. Values are sent from DER Meter to DER Control system.	Electrical parameter	N/A
I-02	Discharging command	If DER Control system evaluates low voltage or frequency or receives a command from ripple control receiver, it sends a command to Inverter to inject active power.	Information exchanged between IS or sent to device	N/A
I-03	Battery Discharging	If inverter is controlled to inject active power, it exchanges information with battery and execute.	Information exchanged between IS or sent to device	N/A
I-04	Emergency command	If DSO dispatcher declares an emergency state in a selected grid area, SCADA/DMS sends an emergency command to ripple control transmitter to activate load change.	Information exchanged between IS or sent to device	N/A
I-05	Ripple control signal	Ripple control transmitter sends signals (telegrams) via PLC to ripple control receiver in the selected area to activate load change.	Information exchanged between IS or sent to device	N/A
I-06	Ripple control discharging command	Based on the telegram, ripple control receiver sends a command to DER control system to inject active power from battery.	Information exchanged between IS or sent to device	N/A

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP7_1

Improve grid flexibility

using

Smart Storage Unit

Scope

This document describes the Use Case **WP7_1 – Improve grid flexibility using Smart Storage Unit**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

33.Description of the Use Case WP7.1

33.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP7_0	**DER/Market**	Create flexibility to prevent grid investments	Cluster
WP7_1	**DER/Operation**	**Improve grid flexibility using Smart Storage Unit**	**High level**
WP7_2	**DER/Operation**	Improve grid flexibility using Electric Vehicle	High level
WP7_3	**DER/Market**	Usability of an integrated flex market	High level

33.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
V0.1 – 0.8	5-5-17	Marcel Willems Kees van Zwienen Ivan Theunissen Olga Westerlaken	Document initiation
V0.9	31-05-17	Team	Group review changes

33.3. Scope and objectives

Scope	Enabling ancillary services, congestion management, voltage support for PV integration using centralized, grid-connected storage systems to improve grid observability of prosumers, promoting batteries in multi-service approach. In scope: - Battery infrastructure and deployment - Congestion management - Voltage support for PV integration - Multi-service approach - Local Infrastructure Management System Out of scope: - Other ancillary services (is not in pilot, but aggregator can use the battery for ancillary services if part of its business model) - Power quality improvement (other than voltage support) - Domestic battery systems In this pilot, and therefore this use case document, the battery will be called Smart Storage Unit or the abbreviation SSU will be used.
Objective	*Small headline:* This use case conceptualizes, implements the systems and interactions necessary to achieve a stable grid through flexibility using Smart Storage Unit and PV systems. By implementing use case 1, Enexis and the involved aggregators test and validate the application of a smart storage unit for the following purposes: - Congestion management - Energy trading / portfolio management through spot market, imbalance market and/or ancillary service provision - Power quality improvement & voltage control upon request from DSO *Specific*: Design local infrastructure management systems and extend aggregators platform to translate DSO requirements (based on real-time measurements or predictions) into actual load balancing and voltage control requests. *Measurable*: Battery-based storage efficiency (KPI_NL1). Percentage of time during which the storage is available (KPI_NL2). The percentage of shifted energy, contribution to load shedding and ancillary services (KPI_NL3). Share of energy/power displaced for each type of flexibility (KPI_NL4). Percentage of decrease on ratio Peak/average at MV feeder level (third level area) (KPI_NL5). *Assignable*: Technical/local aggregator (with its LIMS) and commercial aggregators (with its FAP) have a primary role to implement this capability in their systems. Initiation of this functionality can be done by DSO (flex requirements/request) and aggregators (change in availability of resources).

	The DSO is responsible for availability: Smart Storage unit (SSU), PV systems, LIMS, GMS (incl. grid measurements from distribution automation boxes and smart meters), solar car The commercial aggregator is responsible for availability: FAP TNO is responsible for interoperability and interchangeability of the systems. *Realistic*: Flexibility availability by using locally available Smart Storage Unit and PV systems. *Time-related*: When the Smart Storage Unit and PV systems are in place and the aggregator systems have been developed and/or adapted, see project planning.
Related Business Case	Not applicable

33.4. Narrative of Use Case

Short description
The development and implementation of the LIMS which is used for connecting, measuring and controlling the local resources by the local aggregator. The commercial aggregator can use services of the local aggregator for flexibility in the local grid. The DSO forecasts flexibility demands.
Complete description

The goal of this demonstration is to validate technically, economically and contractually the usability of a smart storage unit embedded as a commercial storage. Centralised storage must be valued with the support of all the players involved: the TSO, the DSO, the storage operator, the prosumers. It demonstrates the applicability of large scale centralized storage units at the substation/street level to demand side management. The deployed capacity of the centralized storage unit is in the range of 250 kW / 500 kWh.

To enable interaction between actors, markets and local resources a Local Infrastructure Management System (LIMS) is defined. The goal is to realise a local interface from and to the potential flexibility sources.

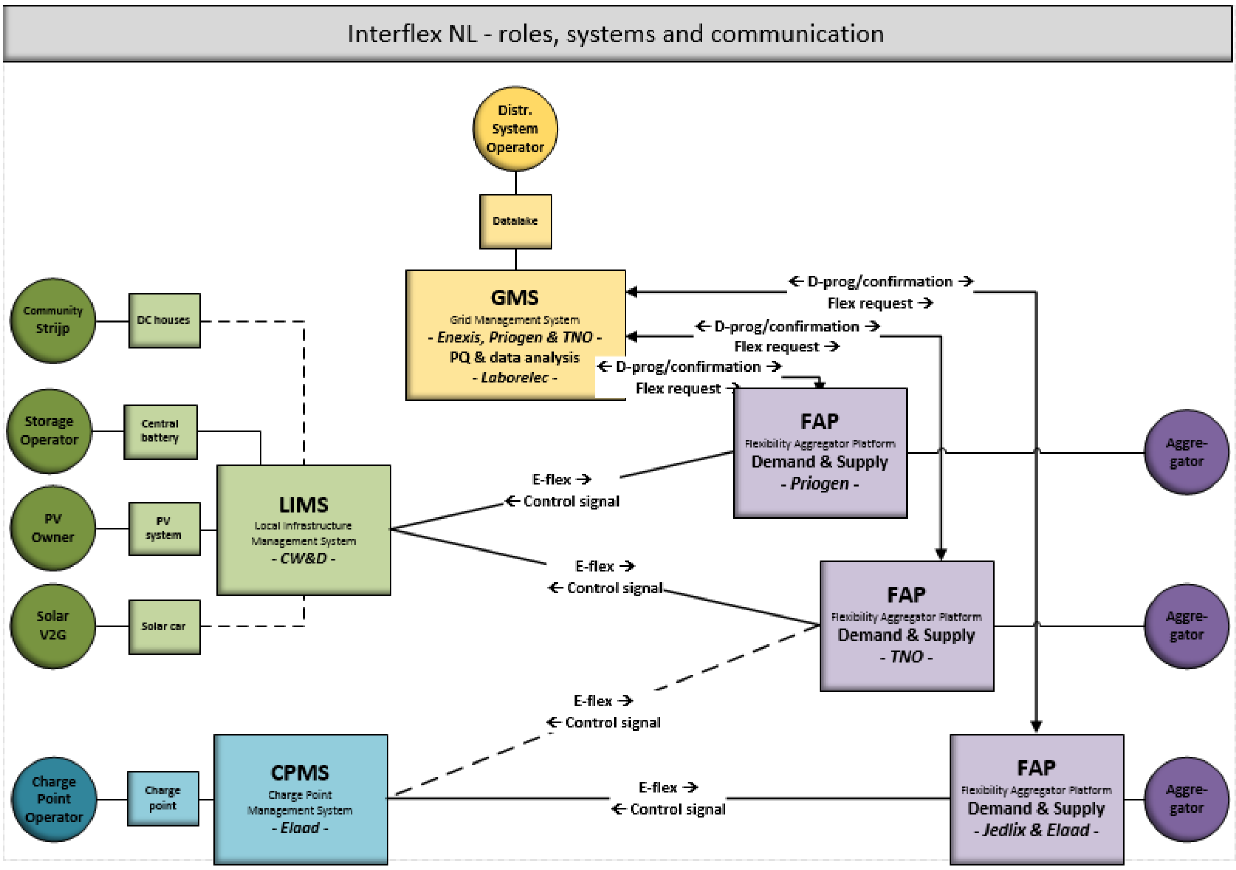
The LIMS should consist of the following technical functions:

- Realise an interface from and to the smart storage unit and PV installation
  - Collect and forward measurement data from smart storage unit and PV installation for the purpose of congestion management
  - Collect and forward measurement data from smart storage unit and PV installation for the purpose of voltage management
  - Monitor and maintenance of the smart storage unit
  - Operation of the smart storage unit
  - Power quality improvement
- Realise interfaces with various potential flexibility sources (e.g. DC households, solar car, household storage solutions, PV installations, heat pumps and white goods).
  - Collect and forward measurement data from smart storage unit and PV installation for the purpose of congestion management
  - Collect and forward measurement data from smart storage unit and PV installation for the purpose of voltage management
  - Operation of the smart storage unit
  - Power quality improvement
- Implementation conform standardised protocols for the interaction with commercial aggregators. Protocols are selected in consultation with the aggregator.

The LIMS should have the following organisational functions:

- Provide local flexibility sources to the commercial aggregators
- Technically and organisationally responsible for (the interface with) these flexibility sources

Negotiate contractual agreements with aggregators for the provision of flexibility



Brief system descriptions:

GMS: Grid management system, this system is operated by the DSO and is responsible for keeping track of the actual and forecasted state of the grid. If a congestion occurs the GMS is will try to buy flexibility from one or more commercial aggregators.
LIMS: Local Infrastructure Management system, this system is operated by the party who is responsible for the hardware in the field. The LIMS connects the physical hardware via a secure internet connection to the commercial aggregators.
FAP: The Flexibility Aggregation Platform is operated by the commercial aggregator and is responsible for controlling the flexibility assets of the aggregator. Also the FAP provides a interface to the DSO (e.g. via USEF)
CPMS: Charge Pole Management System, this system is the backend of the charging stations and is operated by the owner of the charging stations. The CPMS is provides an interface to an aggregator so flexibility of the electrical vehicles can be monetized

33.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI_NL1	**Efficiency**	**Battery-based storage efficiency**	**WP7_1**, WP7_2
KPI_NL2	**Availability**	**% of time during which the storage is available**	**WP7_1**
KPI_NL3	**Impact on the grid**	**% of shifted energy** **Contribution to load shedding** **Contribution to ancillary services**	**WP7_1**, WP7_2
KPI_NL4	**Potential to shift demand**	**Share of energy/power displaced for each type of flexibility**	**WP7_1**, WP7_2, WP7_3
KPI_NL5	**Local peak load reduction**	**% of decrease on ratio Peak / average at MV feeder level (third level area)**	**WP7_1**, WP7_2, WP7_3
KPI_NL6	Activation of flexibilities	% of energy savings (kWh)	*WP7_3*
KPI_NL7	Lower energy bills	% of increase power selling in kWh	*WP7_3*

33.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO: Grid Management System (GMS)	forecasts a flexibility need	- Grid forecasting e.g. based on historical measurements - Current grid status - Flex interface between GMS and FAP(s)	- Availability of sufficient relevant data to make predictions - Definition of process triggers e.g. thresholds - Interoperability of interfaces
DSO: Grid Management System (GMS)	triggers a load emergency event	- Emergency detection - Current grid status - Flex interface between GMS and FAP(s)	- Definition of relevant emergency situations - Interoperability of interfaces
DSO: Grid Management System (GMS)	receives a daily energy Energy prognosis from a FAP (commercial aggregator) that, added to the prediction, exceeds thresholds	- Grid forecasting e.g. based on historical measurements - Flex interface between GMS and FAP(s)	- Availability of sufficient relevant data: to make predictions by DSO and calculate Energy prognosis by commercial aggregators - Definition of process triggers e.g. thresholds - Interoperability of interfaces

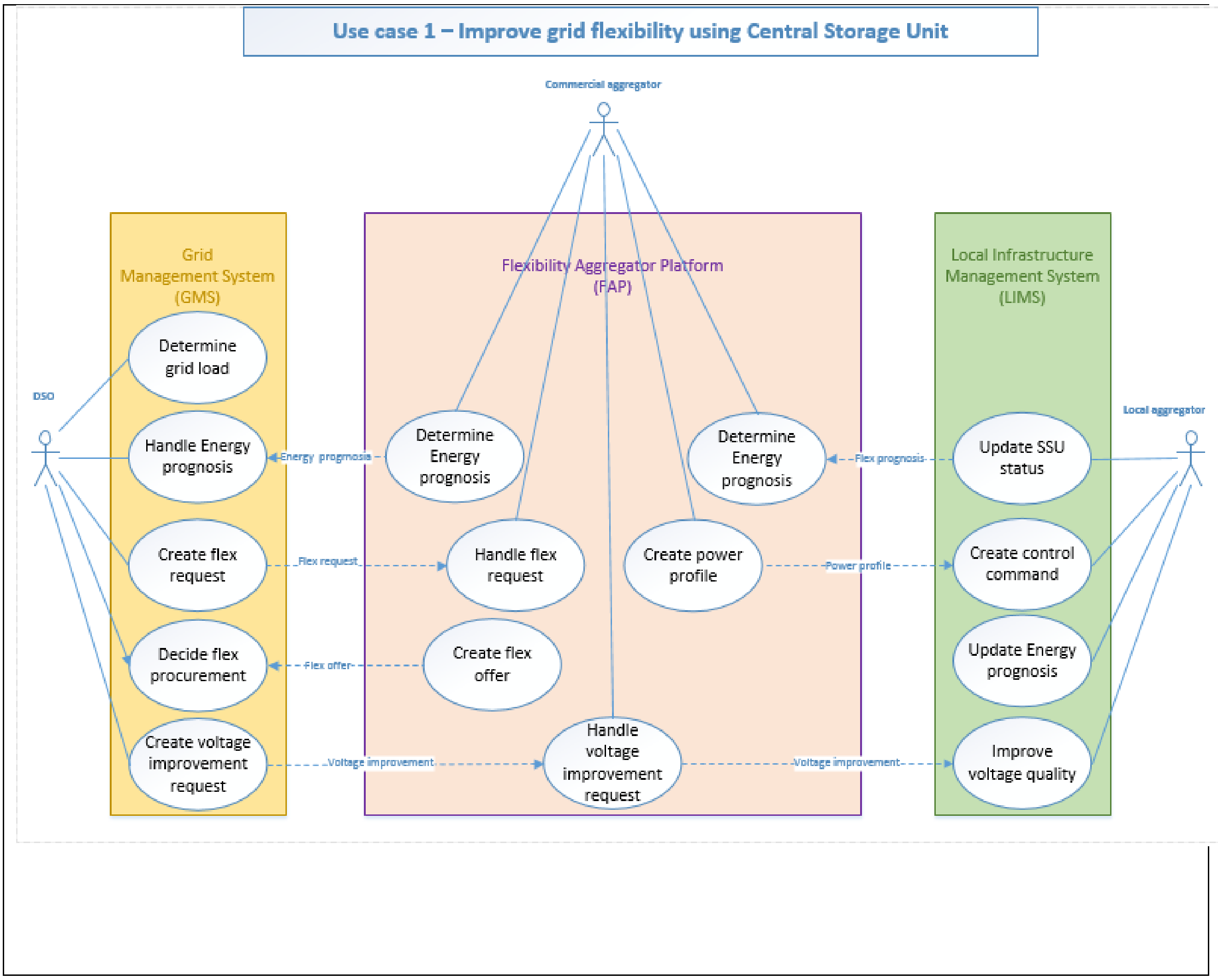
Actor	Triggering Event	Pre-conditions	Assumption
Local Aggregator: Local Infrastructure Management System (LIMS)	Availability changes (status)	- Interface between LIMS and smart storage unit/PV systems - Flex interface between LIMS and FAP(s)	- Availability of sufficient relevant data - Definition of process triggers e.g. thresholds - Interoperability of interfaces

33.7. Classification information

Relation to Other Use Cases in the same project or area
Use case WP7_2 is very similar but there we focus on charge points as a flexibility source instead of batteries (this use case). Use case WP7_3 combines the two use cases WP7_1 and WP7_2 into an integrated flex market including contracts and financial flow.
Level of Depth - the degree of specialization of the Use Case
High Level Use Case
Prioritization
Mandatory, since it is prerequisite for use case WP7_3.
Generic, Regional or National Regional relation
Regional scaling to (inter)national
Nature of the viewpoint- describes the viewpoint and field of attention
Technical (WP7_1 and WP7_2) - business/market and political in case of regulation change (WP7_3)
Further Keywords for Classification
- *Smart grid* - *Flexibility* - *Congestion management* - *Smart storage unit* - *PV* - *Flexibility forecast* - *Commercial aggregator* - *Local aggregator*
Maturity of Use Case
- *in business operation* - *realized in demonstration project*

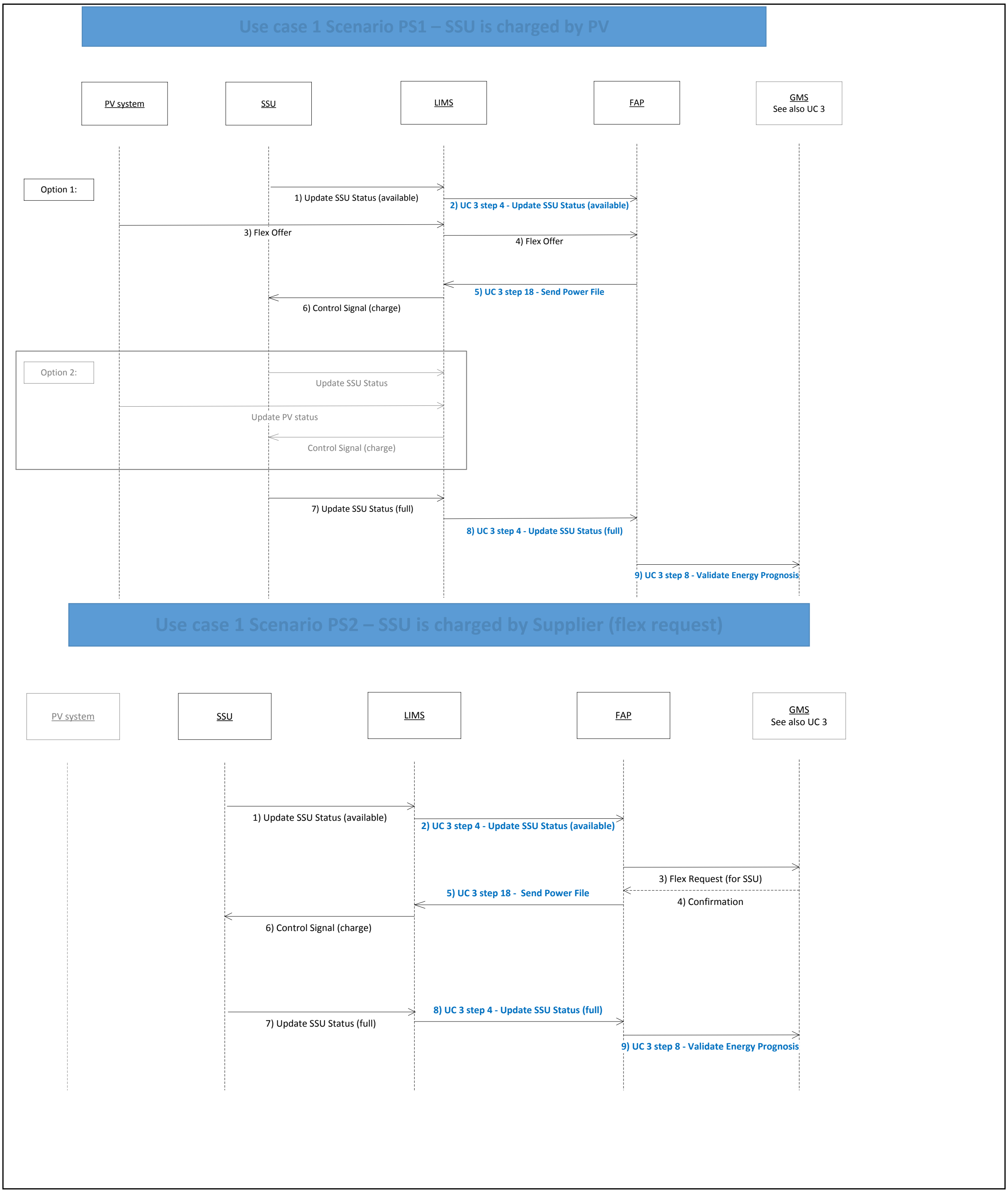
34. Diagrams of the Use Case

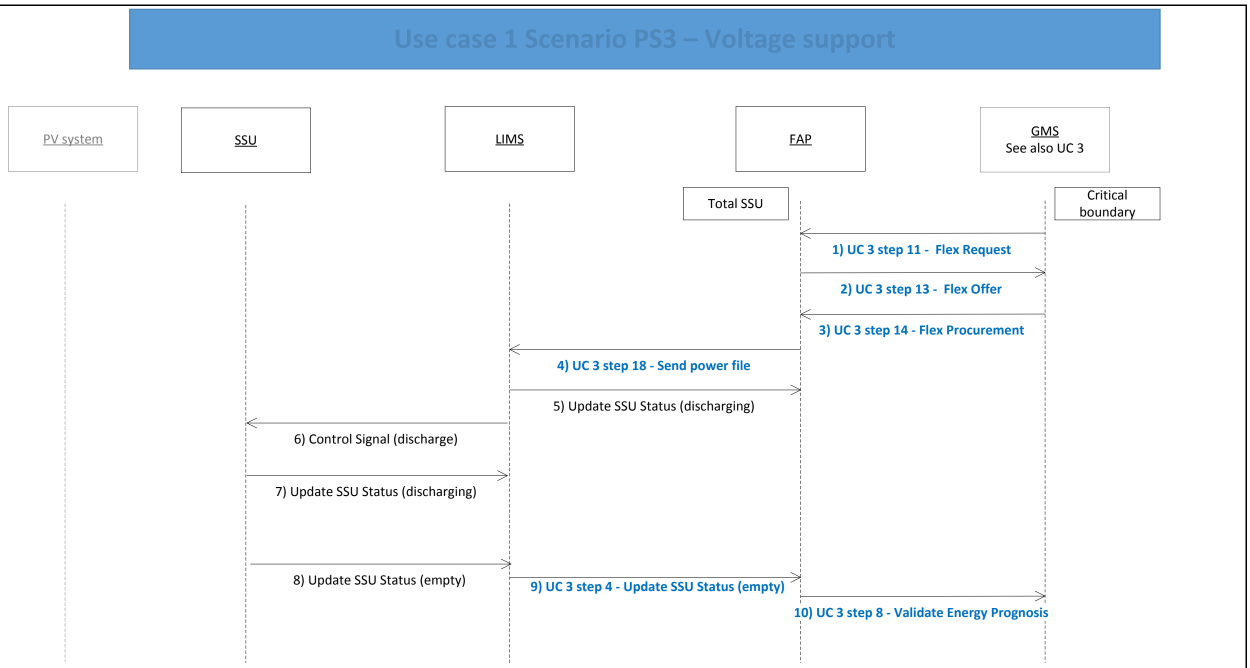
34.1. Diagram of the Use Case

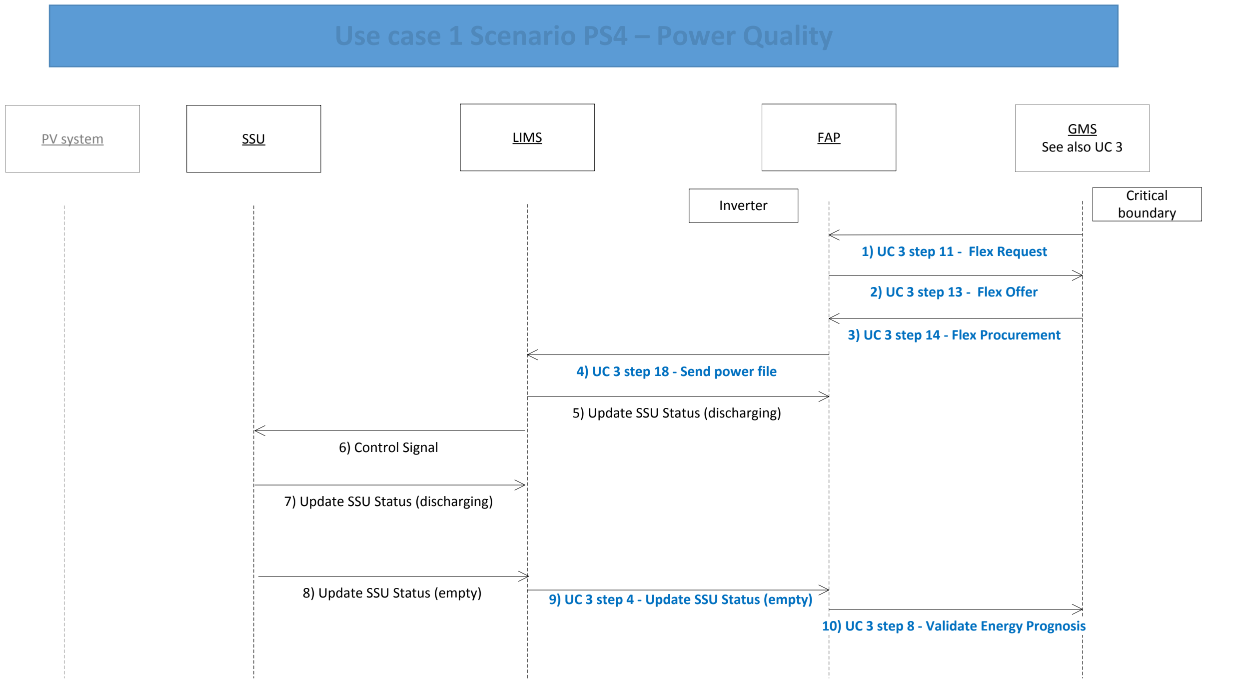


34.2. Sequence diagram(s) of Use Case

Assumption in the sequence diagrams below is that the flex agreement cycle between FAP and GMS is active.







Abbreviations:

CPMS = Charge Point Management System
FAP1 = Flexibility Aggregator Platform (with EV contract)
FAP2 = Flexibility Aggregator Platform (with Battery contract)
BRP = Balance Responsible
LIMS = Local Infrastructure Management System
GMS = Grid Management System
SSU = Smart Storage Unit

35.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enexis	Role	DSO	Responsible for the planning, operation and maintenance of the distribution networks	The DSO performs load management of its grid and acts in case of an (forecasted) emergency. The DSO pays for requested flexibility in the net and has a flex contract with the aggregator.	-	YES, conform Dutch electricity act (elektriciteitswet), grid code (netcode), measurement code (meetcode), and system code (systeemcode)[1]	NO
GMS	System	IS IT	Load Management System	The DSO uses this system to perform load management of its grid and send messages to the aggregator	-	NO	NO

[1] https://www.acm.nl/nl/onderwerpen/energie/wet--en-regelgeving/wet--en-regelgeving-energie/

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
DA(LI) / smart meters	System	Network device	Data collection from local infrastructure and households	-	Phoenix (DALI) / SAE (DA) / Kamstrup, Landes & Gyr, IBM-kaifa (slimme meters	NO	NO
	System	Communication infrastructure	Facilitates communication between various platforms	Based on mobile network (3G/4G)	KPN	NO	NO
TNO	Role	Research partner	Applied research institute	TNO provides a Flexibility Aggregation Platform, also acts as a simulated aggregator.	-	NO	NO
Priogen	Role	Commercial Aggregator	Commercial aggregator of the flexibility of a grid battery	Trades flexibility to wholesale markets and to the DSO	-	NO	NO

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
TNO	Role	Commercial Aggregator	Applied research institute	TNO provides a Flexibility Aggregation Platform, also acts as a simulated aggregator.	-	NO	NO
FAP TNO	System	IS IT	Flexibility Aggregator Platform for commercial aggregator	The flexibility aggregation platform used by the aggregator to control its flexible assets	-	NO	NO
FAP Priogen	System	IS IT	Flexibility Aggregator Platform for commercial aggregator	The flexibility aggregation platform used by the aggregator to control its flexible battery and other assets	-	NO	NO
Smart Storage Unit (Battery)	System		Facilitate storage of energy	-	tbd	NO	61000 61427-2 62281 62485-1 62619 62620

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Croonwolter&dros	Role	Local Aggregator	Provider and operator of LIMS	The local aggregator receives payment for used flexibility in the net and has a flex contract with the commercial aggregator.	-	NO	NO
LIMS	System	IS IT	Local Infrastructure Management System	Operation, measurements & maintenance of local flexibility sources	tbd	NO	NO

36.Step by Step Analysis of the Use Case

36.1. List of scenarios (local)

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	SSU is charged by PV	LIMS lets SSU be charged by available PV energy. Because local aggregator wants to have maximum flexibility available	Local aggregator/LIMS	SSU is not fully charged and availability of PV energy	SSU partly charged PV energy available LIMS is online	**Success if:** SSU is (completely) charged **Failure if:** SSU is offline
PS2	SSU is charged via energy supplier	LIMS lets SSU be charged by energy supplier. Because local aggregator wants to have maximum flexibility available	Local aggregator/LIMS	SSU is not target charged	SSU partly charged LIMS is online	**Success if:** SSU is (completely) charged **Failure if:** SSU is offline
PS3	Voltage support	When the voltage reaches a critical boundary, voltage control is initiated	DSO	GMS receives real time a warning	GMS is online Real time measurements available LIMS is online SSU online and sufficiently charged	**Success if:** When the voltage stays within its critical boundaries **Failure if:** When the voltage does not stay within its critical boundaries or the preconditions are not available
PS4	Power quality	When the power quality reaches a critical boundary, power quality control is initiated	DSO	GMS receives real time a warning	GMS is online Real time measurements available LIMS is online SSU online and sufficiently charged	**Success if:** When the power quality stays within its critical boundaries **Failure if:** When the voltage does not stay within its critical boundaries or the preconditions are not available

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition

36.2. Steps – Primary Scenario

36.2.1. PS1: SSU is charged by PV

Scenario Name :									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication	Communication Means
1	Update SSU Status (available)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
2	Update SSU Status (available)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
3	Flex Offer	The PV system has flexibility available and sends an offer to the LIMS.	PV system	LIMS	Flex Offer	Get	Security, Privacy,	Fibre	PV specific
4	Flex Offer	The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-prognosis)	LIMS	FAP	Flex Offer	Get	Security, Privacy,	Fibre	Protocol (OpenADR or EFI)
5	Send Power File	*Use case 3 step 18:* The FAP sends the power consumption for the next period to the LIMS	FAP	LIMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication**	**Communication Means**
6	Control Signal (charge)	The LIMS sends a control signal to the SSU to start charging	LIMS	SSU	Control signal	Create	Security, Privacy,	GPRS	SSU specific
7	Update SSU Status (full)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
8	Update SSU Status (full)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
9	Validate Energy Prognosis	*Use case 3 step 8:* The FAP sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

36.2.2. PS2: SSU is charged by Supplier (flex request)

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication**	**Communication Means**
1	Update SSU Status (available)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
2	Update SSU Status (available)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
3	Flex request (for SSU)	The FAP sends a flex request to the GMS for charging the smart storage unit (t solve a problem)	FAP	GMS	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

Scenario Name :									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication	Communication Means
4	Confirmation	The GMS sends a confirmation of the flex request	GMS	FAP	Confirmation	Get	Security, Privacy,	Fibre	Protocol (e.g. USEF)
5	Send Power File	*Use case 3 step 18:* The FAP sends the power consumption for the next period to the LIMS	FAP	LIMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
6	Control Signal (charge)	The LIMS sends a control signal to the SSU to start charging	LIMS	SSU	Control signal	Create	Security, Privacy,	GPRS	SSU specific
7	Update SSU Status (full)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
8	UC 3 step 4 - Update SSU Status (full)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-prognosis)	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
9	UC 3 step 8 - Validate Energy Prognosis	*Use case 3 step 8:* The FAP sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

36.2.3. PS3: Voltage Support

Scenario Name :									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication	Communication Means
1	Flex request	*Use case 3 step 11:* The DSO sends a Flex request to FAP in order to request flexibility during the expected congestion period.	GMS	FAP	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

Scenario Name :									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication**	**Communication Means**
2	Flex Offer	*Use case 3 step 13:* The FAP has flexibility during the expected congestion period and sends an offer to the DSO.	FAP	GMS	Flex Offer	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
3	Flex Procurement	*Use case 3 step 14:* The DSO evaluates the received flex offers, determines that FAP offered flexibility the cheapest. So the DSO sends a flex procurement message to FAP.	GMS	FAP	Flex Procurement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
4	Send Power File	*Use case 3 step 18:* The FAP sends the power consumption for the next period to the LIMS	FAP	LIMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
5	Update SSU Status (discharging)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-prognosis)	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
6	Control Signal (discharge)	The LIMS sends a control signal to the SSU to start discharging	LIMS	SSU	Control Signal	Create	Security, Privacy,	GPRS	SSU specific
7	Update SSU Status (discharging)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
8	Update SSU Status (empty)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
9	Update SSU Status (empty)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-prognosis)	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)

Scenario Name :									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication	Communication Means
10	Validate Energy Prognosis	*Use case 3 step 8:* The FAP sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

36.2.4. PS4: Power Quality

Scenario Name :									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication	Communication Means
1	Flex request	*Use case 3 step 11:* The DSO sends a Flex request to FAP in order to request flexibility during the expected congestion period.	GMS	FAP	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
2	Flex Offer	*Use case 3 step 13:* The FAP has flexibility during the expected congestion period and sends an offer to the DSO.	FAP	GMS	Flex Offer	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
3	Flex Procurement	*Use case 3 step 14:* The DSO evaluates the received flex offers, determines that FAP offered flexibility the cheapest. So the DSO sends a flex procurement message to FAP.	GMS	FAP	Flex Procurement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
4	Send Power File	*Use case 3 step 18:* The FAP sends the power consumption for the next period to the LIMS	FAP	LIMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication**	**Communication Means**
5	Update SSU Status (discharging)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-prognosis)	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
6	Control Signal	The LIMS sends a control signal to the SSU to start charging	LIMS	SSU	Control Signal	Create	Security, Privacy,	GPRS	SSU specific
7	Update SSU Status (discharging)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
8	Update SSU Status (empty)	The SSU sends its latest status information towards the LIMS.	SSU	LIMS	SSU Status Update	Get	Security, Privacy,	GPRS	SSU specific
9	Update SSU Status (empty)	*Use case 3 step 4:* The LIMS sends its latest status information towards the FAP. With this information the FAP creates an expected power consumption profile (A-prognosis)	LIMS	FAP	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
10	Validate Energy Prognosis	*Use case 3 step 8:* The FAP sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

36.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**

37.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5] (see Annex B)	Requirements
UC3_S4	SSU status	Information about the status of the grid SSU (State of Charge, Capacity, etc)	Other device state and output	
UC3_S2/5	Energy Prognosis	Prognosis of the power consumption of	Forecast data	
UC3_S8	Energy Prognosis	Prognosis of the available flexibility within the smart storage unit or electric vehicle	Forecast data	
UC3_S10/11	Flex Request	Request from the DSO for a load adjustments of the aggregators portfolio peak reduction or additional electricity	Solution cost and selling price	
UC3_S12/13	Flex Offer	An offer send from the aggregator to the DSO as a reply on the Flex Request, the offer contains an offered amount of flex	Solution cost and selling price	
UC3_S14	Flex Procurement	A procurement message to acknowledge the agreement for flex procurement between DSO and aggregator	Solution cost and selling price	
UC3_S18/19	Power file	The load profile send to appliances to control their power consumption over time	Forecast data	
UC1_S6	Control signal	Actual fulfilment of the offered flexibility	Algorithm, formula, rule, specific model	

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production

Category	Type	Subcategory	Definition	Example
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP7_2

Improve grid flexibility

using

Electric Vehicle

Scope

This document describes the Use Case **WP7_2 – Improve grid flexibility using Electric Vehicle**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on "information exchanged")
- Information exchanged

38.Description of the Use Case WP7.2

38.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP7_0	**DER/Market**	Create flexibility to prevent grid investments	Cluster
WP7_1	**DER/Operation**	Improve grid flexibility using Smart Storage Unit	High level
WP7_2	**DER/Operation**	**Improve grid flexibility using Electric Vehicle**	**High level**
WP7_3	**DER/Market**	Usability of an integrated flex market	High level

38.2. Version Management

Version	Date	Name Author(s) or	Changes
V0.1 - V0.8	5-5-17	Patrick Rademakers Olga Westerlaken	Document initiation
V0.9	31-05-17	Team	Group review changes

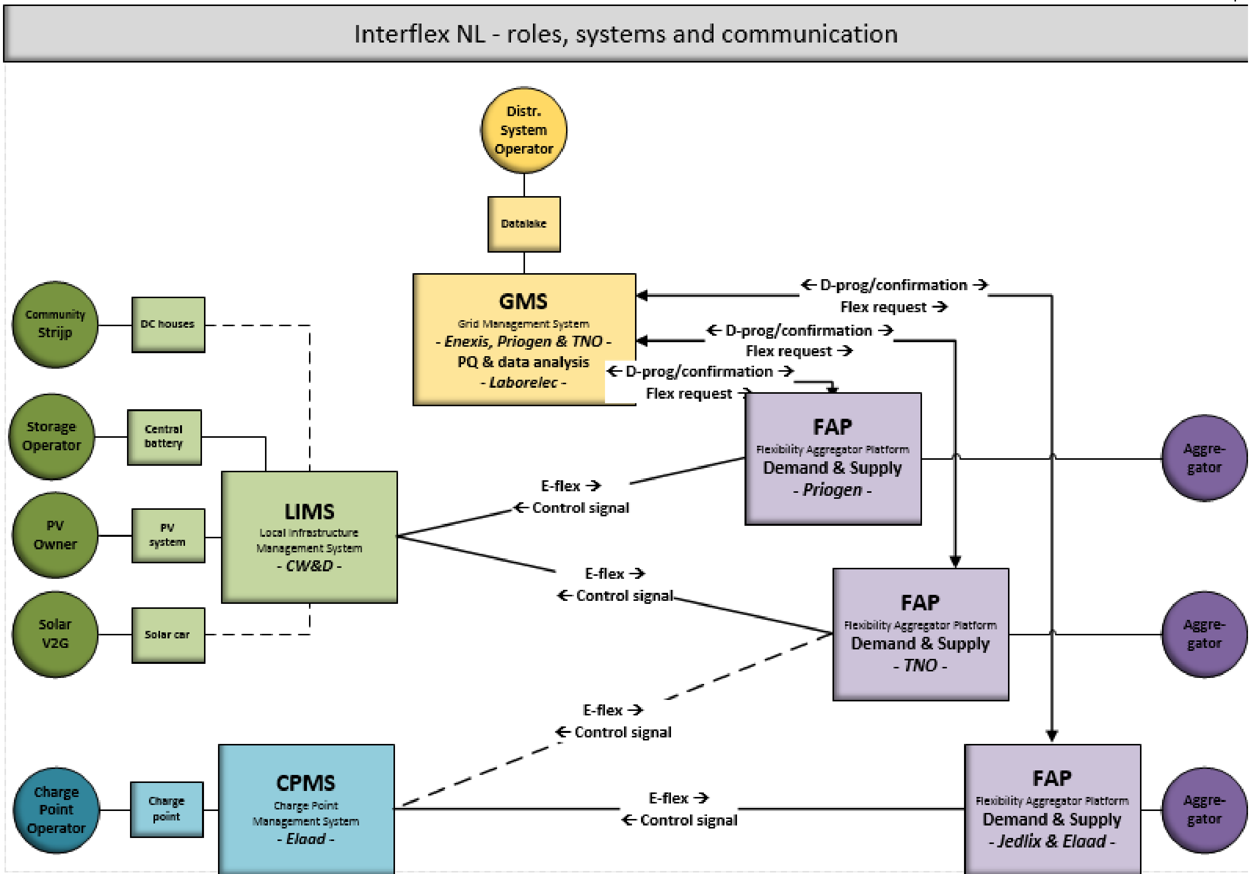
38.3. Scope and objectives

Scope	Enabling the optimal activation of all available local flexibilities offered by the locally installed EVSE's for congestion management. This is done by allowing the DSO, that monitors the grid, to send flexibility requests towards commercial aggregators that will, through interacting with the CPO, end up as adapted charging schedules on EVSE's, making the necessary flexibility happen. In scope: - EV infrastructure - Chain process from EV driver (preferences) to DSO (requirements) through roles and protocols that are necessary to make the flexibility happen Out of scope: - Non EV infrastructure - Other ancillary services - Commercial viability is part of use case WP7_3
Objective	This use case conceptualizes and implements the systems and interactions necessary to achieve a stable grid through flexibility using EV systems. By implementing use case 2, Enexis/Elaad/involved aggregators test and validate a technical framework for realizing DSO requested flexibility from EVs in order to prove the concept and develop knowledge on the applicability and the future scalability of the concept. By implementing use case 2, Enexis/Elaad/involved aggregators will gain an in-depth understanding on how flexibility can be managed between DSOs and multiple aggregators and how the required systems should interact. By implementing use case 2, the involved aggregators can validate the maturity (and shortcomings) of communication chain and its protocols, so we can propose changes and extensions to the relevant standardization bodies.
Related Business Case	Not applicable

38.4. Narrative of Use Case

Short description
Enabling the optimal activation of all available local flexibilities offered by the locally installed EVSE's for congestion management.
Complete description

The CPO manages the charging of EV's, applying different mechanisms to 'unleash' the EV's flexibility. It can aggregate the flexibility and offer it to the DSO, TSO and BRP via the flexibility aggregator platform (FAP). This use case conceptualizes, implements and validates the technical aspects of 'long-term flex purchase contracts' facilitating the DSO flexibility needs. The rest of the flexibility / capacity can be purchased by the BRP and TSO. This increase of locally accessible flexibility allows for a large number of consumers to actively offer their flexibility to the DSO or within energy markets. The DSO becomes a market organizer by coordinating with FAP's, delivering order of merits for each of the candidate flexibilities, asking for day ahead bids. This is very likely the case for matters of congestion, but it is also possible that the BRP and/or TSO fulfil this role. Such a system includes market settlement to assess the flexibility effects and compensate the aggregators. Aggregators manage various types of flexibilities.



Brief system descriptions:

GMS: Grid management system, this system is operated by the DSO and is responsible for keeping track of the actual and forecasted state of the grid. If a congestion occurs the GMS is will try to buy flexibility from one or more commercial aggregators.
LIMS: Local Infrastructure Management system, this system is operated by the party who is responsible for the hardware in the field. The LIMS connects the physical hardware via a secure internet connection to the commercial aggregators.
FAP: The Flexibility Aggregation Platform is operated by the commercial aggregator and is responsible for controlling the flexibility assets of the aggregator. Also the FAP provides a interface to the DSO (e.g. via USEF)
CPMS: Charge Pole Management System, this system is the backend of the charging stations and is operated by the owner of the charging stations. The CPMS is provides an interface to an aggregator so flexibility of the electrical vehicles can be monetized

38.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI_NL1	Efficiency	Battery-based storage efficiency	*WP7_1*, ***WP7_2***

ID	Name	Description	Reference to mentioned Use Case objectives
KPI_NL2	Availability	% of time during which the storage is available	*WP7_1*
KPI_NL3	**Impact on the grid**	**% of shifted energy** **Contribution to load shedding** **Contribution to ancillary services**	*WP7_1, **WP7_2***
KPI_NL4	**Potential to shift demand**	**Share of energy/power displaced for each type of flexibility**	*WP7_1, **WP7_2**, WP7_3*
KPI_NL5	**Local peak load reduction**	**% of decrease on ratio Peak / average at MV feeder level (third level area)**	*WP7_1, **WP7_2**, WP7_3*
KPI_NL6	Activation of flexibilities	% of energy savings (kWh)	*WP7_3*
KPI_NL7	Lower energy bills	% of increase power selling in kWh	*WP7_3*

38.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO: Grid Management System (GMS)	forecasts a flexibility need	- Grid forecasting e.g. based on historical measurements - Current grid status - Flex interface between GMS and FAP(s)	- Availability of sufficient relevant data to make predictions - Definition of process triggers e.g. thresholds - Interoperability of interfaces
DSO: Grid Management System (GMS)	triggers a load emergency event	- Emergency detection - Current grid status - Flex interface between GMS and FAP(s)	- Definition of relevant emergency situations - Interoperability of interfaces
DSO: Grid Management System (GMS)	receives a daily energy A-program from a FAP (commercial aggregator) that, added to the prediction, exceeds thresholds	- Grid forecasting e.g. based on historical measurements - Flex interface between GMS and FAP(s)	- Availability of sufficient relevant data: to make predictions by DSO and calculate A-programs by commercial aggregators - Definition of process triggers e.g. thresholds - Interoperability of interfaces
CPO: Charge Point Management System (LIMS/CPMS)	Status changes in the actual charging sessions	- Interface between CPMS and charge points supports charging schedules and updates - Status change detection - User preferences and cooperation/permission - State of charge of active EV (if possible) - Vehicle-to-grid capability of the EV - Flex interface between CPMS and FAP(s) – Energy prognosis	- Definition of status triggers e.g. thresholds - Definition of user preferences to be acted on - Accessibility of state of charge information and vehicle-to-grid capability information

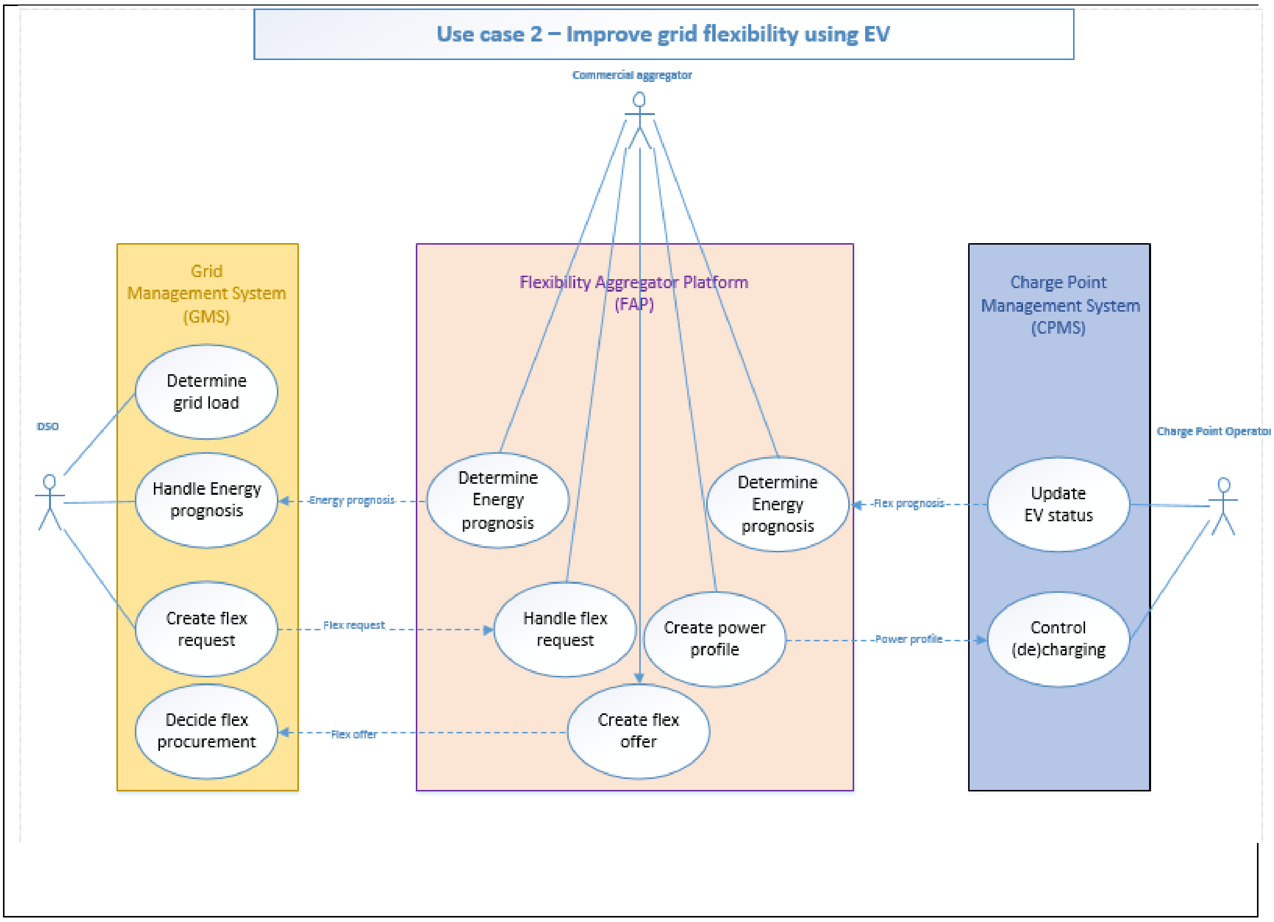
38.7. Classification information

Relation to Other Use Cases in the same project or area

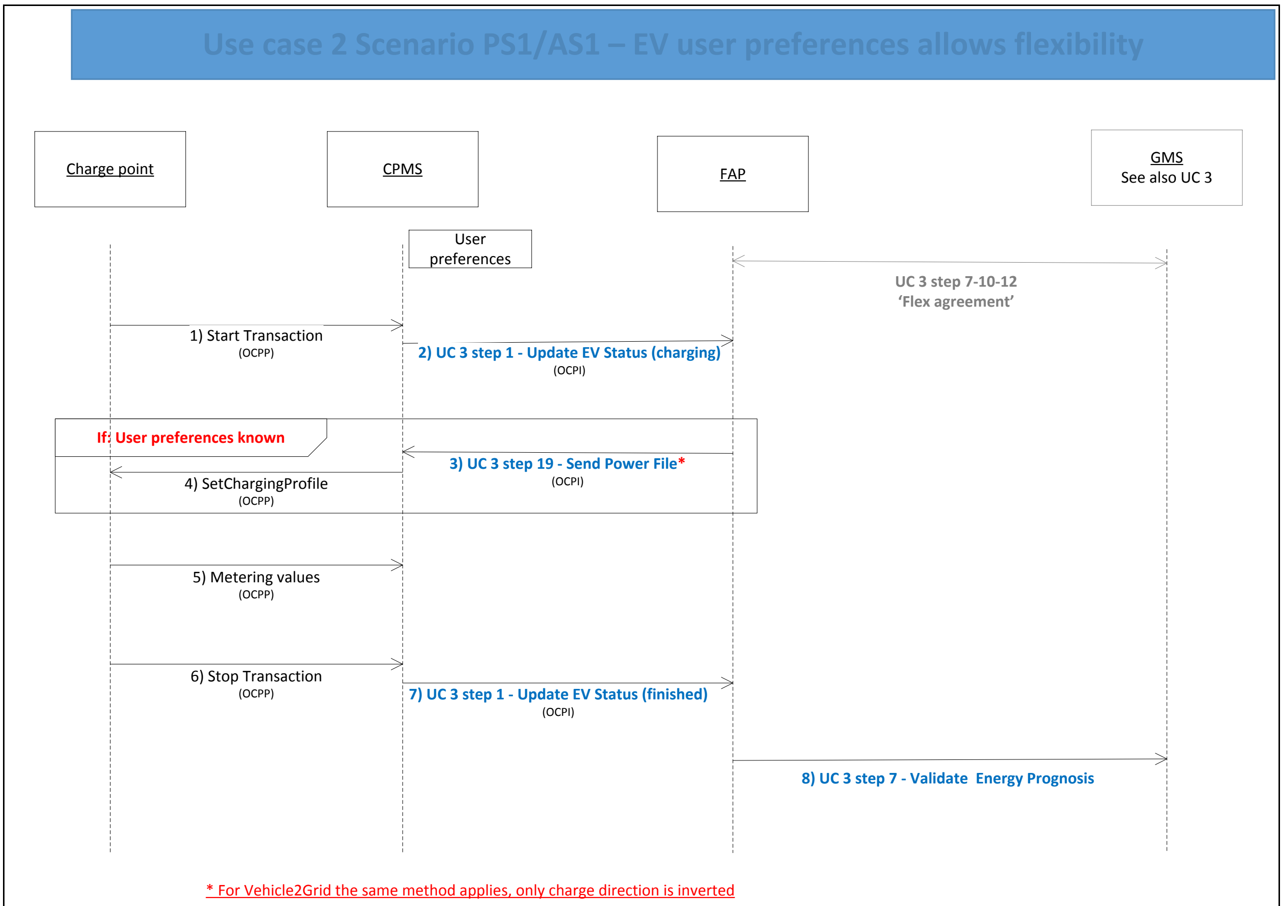
Use case WP7_1 is similar but there we focus on battery storage as a flexibility source instead of charge points (this use case). Use case WP7_3 combines use cases WP7_1 and WP7_2 into an integrated flex market including contracts and financial flow.
Level of Depth - the degree of specialization of the Use Case
High Level Use Case
Prioritization
Mandatory, since it is prerequisite for use case WP7_3.
Generic, Regional or National Regional relation
Regional scaling to (inter)national
Nature of the viewpoint- describes the viewpoint and field of attention
Technical (WP7_1 and WP7_2) - business/market and political in case of regulation change (WP7_3)
Further Keywords for Classification
- *Smart grid* - *Flexibility* - *Congestion management* - *Integrated flexibility market* - *EV* - *Vehicle2Grid (V2G)* - *Flexibility forecasts* - *Commercial aggregator* - *Local aggregator*
Maturity of Use Case
- *in business operation* - *realized in demonstration project* - *realized in R&D (V2G)*

39. Diagrams of the Use Case

39.1. Diagram of the Use Case



39.2. Sequence diagram of the Use Case



Abbreviations:

CPMS = Charge Point Management System
FAP = Flexibility Aggregator Platform (with EV contract)
GMS = Grid Management System
OCPP = Open Charge Point Protocol
OCPI = Open Charge Point Interface

40.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enexis	Role	DSO	Responsible for the planning, operation and maintenance of the distribution networks	The DSO performs load management of its grid and acts in case of an (forecasted) emergency. The DSO pays for requested flexibility in the net and has a flex contract with the aggregator.	-	YES, conform Dutch electricity act (elektriciteitswet), grid code (netcode), measurement code (meetcode), and system code (systeemcode)[2]	NO
GMS	System	IS IT	Grid Management System	The DSO uses this system to perform load management of its grid and send messages to the aggregator	-	NO	NO
TNO	Role	Research partner	Applied research institute	TNO provides a Flexibility Aggregation Platform, also acts as a simulated aggregator.	-	NO	NO

[2] https://www.acm.nl/nl/onderwerpen/energie/wet--en-regelgeving/wet--en-regelgeving-energie/

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Jedlix/Elaad	Role	Commercial Aggregator	Commercial aggregator of the flexibility of a EV charging stations	Trades flexibility to wholesale markets and to the DSO	-	NO	NO
FAP Jedlix/Elaad	System	IS IT	Flexibility Aggregator Platform for commercial aggregator	The flexibility aggregation platform used by the aggregator to control its flexible battery and other assets	-	NO	NO
Elaad	Role	Charge Point Operator (CPO)	Foundation of Dutch DSO's focused on gathering and sharing EV/grid related knowledge	In this role Elaad manages charge point infrastructure	-	NO	NO
Charge Point	System	Charging facilities	Device used to charge EV	The charge point carries out/enforces the charging schedule sent by the CPMS	Ecotap?	-?	- IEC61850 - IEC15118? - OCPP 1.6

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
CPMS	System	IS IT	Charge Point Management System	CPMS is the LIMS for EV. The charge point operator controls its charge points through this system and messages are send	-	NO	- OCPP 1.6 - OCPI 2.0
EV user	Role	Physical client	The person that operates the charge point to charge his/her EV	The EV user wants his/her charging wishes to be met.	-	NO	NO

41.Step by Step Analysis of the Use Case

41.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	EV user preferences allows flexibility	In this scenario the EV user start a charging session, allowing the session to be used as a flexibility resource.	EV Driver	New charging session on EVSE	The EV driver has made his/her preferences for flexibility clear before the session starts	**Success if:** The expected congestion is mitigated by adjusting the power consumption through a charging schedule for the EVSE. **Failure if:** The charging session is ended prematurely so the schedule cannot be completed.
AS1	EV user preferences allows no flexibility	In this scenario the EV user start a charging session, not allowing the session to be used as a flexibility resource.	EV Driver	New charging session on EVSE	The EV driver has made his/her preferences for flexibility clear before the session starts	**Success if:** **Failure if:**

41.2. Steps – Primary Scenario

Scenario Name :									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication**	**Communication Means**
1	Start Transaction	EV user connects his EV to a charge point and initiates a charging session	Charge Point	CPMS	Charge status	Create (transaction)	EV connected	GPRS/Network cable	OCPP

Scenario Name :									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication**	**Communication Means**
2	Update EV Status (charging)	*Use case 3 step 1:* The CPMS sends its latest status information towards the FAP. With this information, the FAP creates an expected power consumption profile (A-prognosis).	CPMS	FAP	EV Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
3	Send Power File	*Use case 3 step 19:* The FAP sends the power consumption for the next period to the LIMS	FAP	CPMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
4	SetChargingProfile	CPMS transmits a charging schedule to charge point	CPMS	Charge Point	Charge schedule	Change (schedule)	Transaction ongoing	GRPS/Network cable	OCPP
5	Metering Values	Charge point periodically transmits charging session metering values	Charge Point	CPMS	Meter values	Report	Transaction ongoing	GRPS/Network cable	OCPP
6	Stop Transaction	EV user ends a charging session at the charge point and disconnects the EV	Charge Point	CPMS	Charge status	Change (transaction finished)	Transaction ongoing	GRPS/Network cable	OCPP
7	Update EV Status (finished)	*Use case 3 step 1:* The CPMS sends its latest status information towards the FAP. With this information, the FAP creates an expected power consumption profile (A-prognosis).	CPMS	FAP	EV Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
8	Validate Energy Prognosis	*Use case 3 step 7:* The FAP sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

41.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication
1	Start Transaction	EV user connects his EV to a charge point and initiates a charging session	Charge Point	CPMS	Charge status	Create (transaction)	EV connected	GPRS/Network cable	OCPP
2	Update EV Status (charging)	*Use case 3 step 1:* The CPMS sends its latest status information towards the FAP. With this information, the FAP creates an expected power consumption profile (A-prognosis).	CPMS	FAP	EV Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
3	-								
4	-								
5	Metering Values	Charge point periodically transmits charging session metering values	Charge Point	CPMS	Meter values	Report	Transaction ongoing	GRPS/Network cable	OCPP
6	Stop Transaction	EV user ends a charging session at the charge point and disconnects the EV	Charge Point	CPMS	Charge status	Change (transaction finished)	Transaction ongoing	GRPS/Network cable	OCPP
7	Update EV Status (finished)	*Use case 3 step 1:* The CPMS sends its latest status information towards the FAP. With this information, the FAP creates an expected power consumption profile (A-prognosis).	CPMS	FAP	EV Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication
8	Validate Energy Prognosis	*Use case 3 step 7:* The FAP sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

42.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5] (see Annex B)	Requirements
UC2_1/6	Charge status	Status of the charging session on a specific charge point f.e. percentage full	Information exchanged between IS or sent to device	
UC_5	EV consumption	The energy consumption of a charging sessions on a specific charge point	Data for KPI (input raw data)	
UC3_1	EV status	The information about the active and expected charging sessions. (State of Charge, desired departure time, etc.)	Other device state and output	
UC3_2/5	Energy Prognosis	Prognosis of the power consumption of	Forecast data	
UC3_8	Energy Prognosis	Prognosis of the available flexibility within the smart storage unit or electric vehicle	Forecast data	
UC3_10/11	Flex Request	Request from the DSO for a load adjustments of the aggregators portfolio peak reduction or additional electricity	Solution cost and selling price	
UC3_12/13	Flex offer	An offer send from the aggregator to the DSO as a reply on the Flex Request, the offer contains an offered amount of flex	Solution cost and selling price	
UC3_14	Flex procurement	A procurement message to acknowledge the agreement for flex procurement between DSO and aggregator	Solution cost and selling price	
UC3_18/19	Power file	The load profile send to appliances to control their power consumption over time	Forecast data	
	Charge wish	Wish of the EV user with regard to the started charge service of its electric vehicle, f.e. time limit of the charging session	Information sent to /received from customer	

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production

Category	Type	Subcategory	Definition	Example
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP7_3

Usability of an integrated flex market

Scope

This document describes the Use Case **WP7_3 – Usability of an integrated flex market**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

43. Description of the Use Case WP7.3

43.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP7_0	DER/Market	Create flexibility to prevent grid investments	Cluster
WP7_1	DER/Operation	Improve grid flexibility using Smart Storage Unit	High level
WP7_2	DER/Operation	Improve grid flexibility using Electric Vehicle	High level
WP7_3	**DER/Market**	**Usability of an integrated flex market**	**High level**

43.2. Version Management

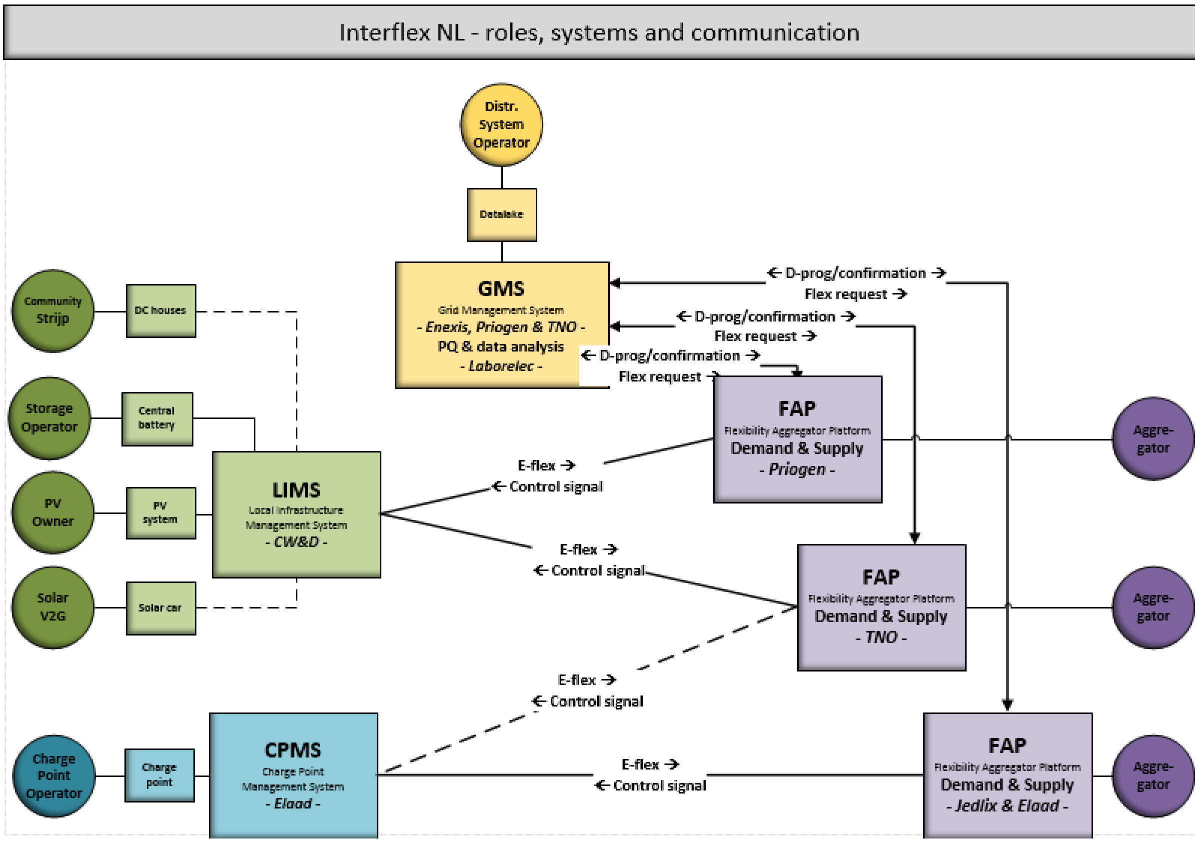
Version	Date	Name Author(s) or	Changes
V0.1	5-5-17	Joost Laarakkers Bob Ran Olga Westerlaken	Document initiation
V0.2	10-5-17	Bob Ran	Sequence diagram, scenarios and steps in primary scenario added
V0.3	19-5-17	Bob Ran	Scope and Objective, Narrative of Use Case added
V0.6	22-05-17	Olga Westerlaken	Changed diagram 2.1 , Information exchanged
V0.7	22-05-17	Olga Westerlaken	Link sequence diagram to use case 1 and 2 sequence diagrams. Technical details from other use cases.
V0.8	30-05-17	Bob Ran	
V0.9	30-05-17	Olga Westerlaken	General changes

43.3. Scope and objectives

Scope	Validating technically, economically and contractually the usability of an integrated flex market based on a combination of static battery storage and EV chargers. Multiple Aggregators offer flexibility from different flexibility sources (Smart Storage Unit, EV chargers) on a flexibility market so that the DSO can procure flexibility from multiple parties for grid supporting services (e.g. congestion management). All contracts and transactions needed for the procurement of flexibility will be described. Furthermore, agreements between the parties about the availability of energy flexibility services will

	be described in a service level agreement (SLA). The needed contracts, transactions and SLAs will be formed in the implementation of this use case. **Out of scope:** Other ancillary services
Objective	By implementing use case 3, Enexis/TNO/involved aggregators test and validate a technical framework for trading flexibility between multiple aggregators and DSO in order to prove the concept and develop knowledge on the applicability and the future scalability of the concept. By implementing use case 3, Enexis/TNO/involved aggregators will gain an in-depth understanding on how flexibility can be traded between DSO and multiple-Aggregators and how the required contracts and transactions can be formed and handled. By implementing use case 3, the involved aggregators can validate the proposition for trading flexibility for multi-goal to multi-party(e.g. congestion management + spot market trading). Therefore, gain knowledge on the monetary value of flexibility for their business.
Related Business Case	Not applicable

43.4. Narrative of Use Case

Short description
Validating technically, economically and contractually the usability of an integrated flex market based on a combination of static battery storage and EV. Pricing mechanisms and market liquidity are analyzed, including the usability for a given type of flexibility for the different purposes (congestion, market optimization (day-ahead and intra-day markets), ancillary services).
Complete description
This demonstration validates technically, economically and contractually the usability of an integrated flex market based on a combination of static battery storage (smart storage unit) and EV. One aggregator is operating the storage and another operating the EV (SE)'s. The two aggregators compete on the flexibility market, both offering flexibility to the different stakeholders (DSO, TSO and BRP). The two types of flexibility (storage and EV) have different characteristics and very likely different user constraints (e.g. EV drivers want their car to be charged within a given time), resulting in different marginal costs of flexibility and therefore a more dynamic merit order and more competition. In this use case a market mechanism is used to trade flexibility between the two aggregators and the DSO based on a monetary value of flexibility. To avoid a forecasted congestion in the grid, the DSO purchases the required flexibility from one of the aggregators based on the merit order of flexibility. This results in the most cost efficient solution for the DSO. 
Brief system descriptions: **GMS:** Grid management system, this system is operated by the DSO and is responsible for keeping track of the actual and forecasted state of the grid. If a congestion occurs the GMS is will try to buy flexibility from one or more commercial aggregators. **LIMS:** Local Infrastructure Management system, this system is operated by the party who is responsible for the hardware in the field. The LIMS connects the physical hardware via a secure internet connection to the commercial aggregators. **FAP:** The Flexibility Aggregation Platform is operated by the commercial aggregator and is responsible for controlling the flexibility assets of the aggregator. Also the FAP provides a interface to the DSO (e.g. via USEF) **CPMS:** Charge Pole Management System, this system is the backend of the charging stations and is operated by the owner of the charging stations. The CPMS is provides an interface to an aggregator so flexibility of the electrical vehicles can be monetized

43.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
KPI_NL1	Efficiency	Battery-based storage efficiency	*WP7_1, WP7_2*
KPI_NL2	Availability	% of time during which the storage is available % of shifted energy	*WP7_1*
KPI_NL3	Impact on the grid	Contribution to load shedding Contribution to ancillary services	*WP7_1, WP7_2*
KPI_NL4	**Potential to shift demand**	**Share of energy/power displaced for each type of flexibility**	*WP7_1, WP7_2, **WP7_3***
KPI_NL5	**Local peak load reduction**	**% of decrease on ratio Peak / average at MV feeder level (third level area)**	*WP7_1, WP7_2, **WP7_3***
KPI_NL6	**Activation of flexibilities**	**% of energy savings (kWh)**	***WP7_3***
KPI_NL7	**Lower energy bills**	**% of increase power selling in kWh**	***WP7_3***

43.6. Use Case conditions

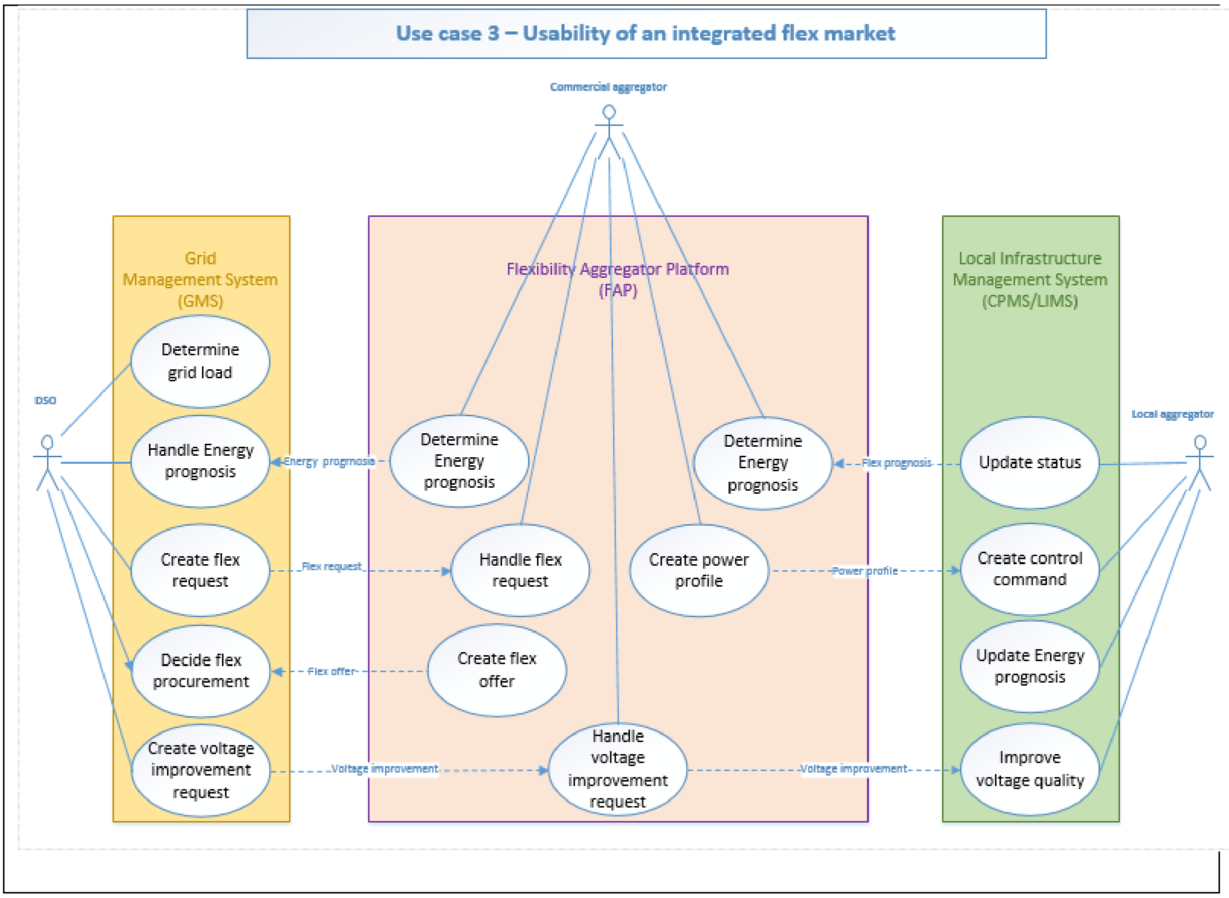
Actor	Triggering Event	Pre-conditions	Assumption
The commercial Aggregator(s): FAP(s)	Expected congestion	The DSO has a contract with 2 commercial aggregators in the specific congestion area describing the possibilities to procure flexibility from the aggregators by the DSO.	The involved aggregators are willing to trade the available flexibility. The DSO is capable of forecasting the grid load The Aggregators are capable of forecasting their expected demand and flexibility. The information communication is: in-place, functioning, reliable and secure. The DSO is aware of the existence of the aggregators.
DSO: Grid Management System (GMS)	Unexpected congestion (emergency)	The DSO has a contract with 2 aggregators in the specific congestion area describing the possibilities to procure flexibility from the aggregators by the DSO	The involved aggregators are willing to trade the available flexibility. The DSO is capable of forecasting the grid load The Aggregators are capable of forecasting their expected demand and flexibility. The information communication is: in-place, functioning, reliable and secure. The DSO is aware of the existence of the aggregators.

43.7. Classification information

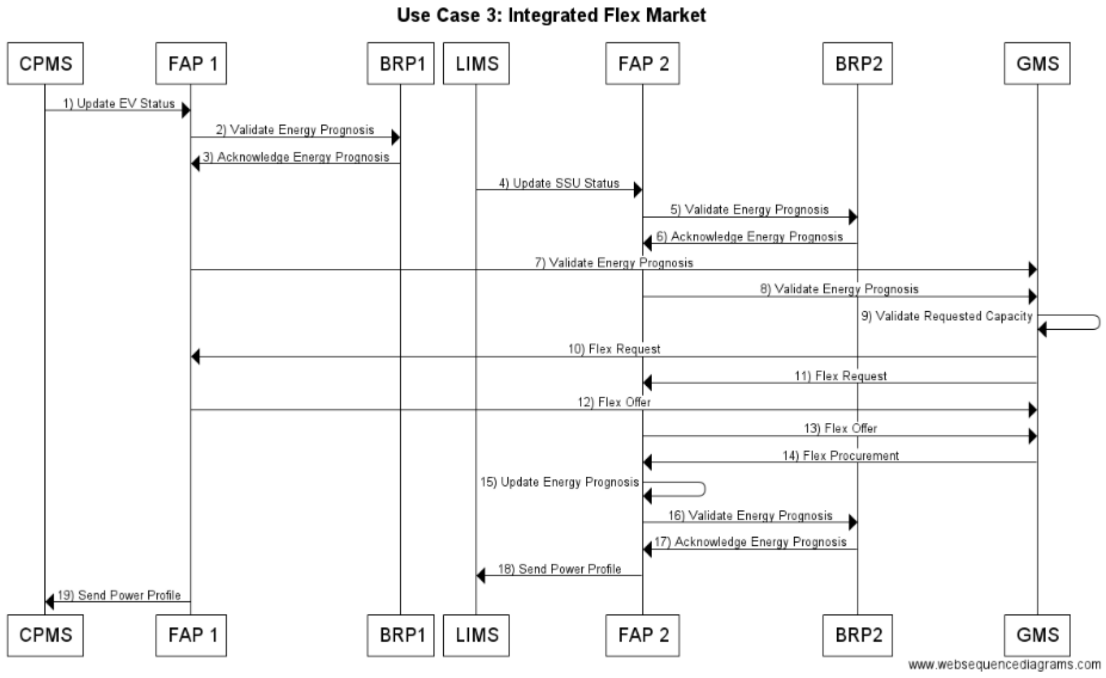
Relation to Other Use Cases in the same project or area
This use case combines the first two use cases (WP7_1 Smart Storage Unit and WP7_2 EV) into an integrated flex market including contracts and financial flow.
Level of Depth - the degree of specialization of the Use Case
High Level Use Case
Prioritization
Mandatory, since it is the combination of the first two use cases (WP7_1 and WP7_2).
Generic, Regional or National Regional relation
Regional scaling to (inter)national
Nature of the viewpoint- describes the viewpoint and field of attention
Technical (WP7_1 and WP7_2) - business/market and political in case of regulation change (WP7_3)
Further Keywords for Classification
- *Smart grid* - *Flexibility* - *Congestion management* - *Integrated flexibility market* - *EV* - *Vehicle2Grid (V2G)* - *Smart storage unit* - *PV* - *Flexibility forecasts* - *Commercial aggregator* - *Local aggregator*
Maturity of Use Case
- *in business operation* - *realized in demonstration project* - *realized in R&D (V2G)*

44. Diagrams of the Use Case

44.1. Diagram of the Use Case



44.2. Sequence diagram of the Use Case



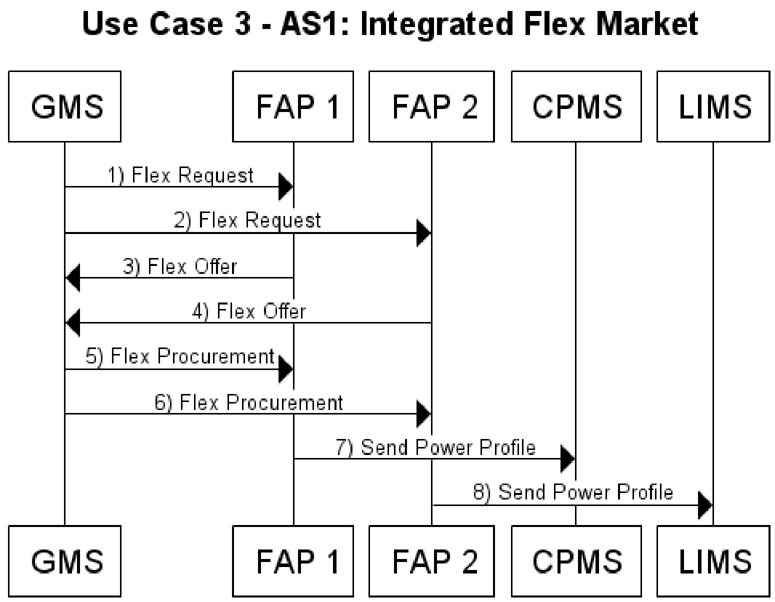
Abbreviations:

CPMS = Charge Point Management System
FAP 1 = Flexibility Aggregator Platform (with EV contract)
FAP 2 = Flexibility Aggregator Platform (with Battery contract)
BRP = Balance Responsible
LIMS = Local Infrastructure Management System
GMS = Grid Management System
SSU = Smart Storage Unit (Battery)

In use case 1 and 2 some of the steps are references to the overall sequence diagram of use case 3. In the table below the scenario's that refer to a specific step.

Use case	***Use case***	***Scenarios***	***Name Scenario***
Update EV status (1)	2	PS1, AS1	PS1: EV user preferences allows flexibility AS1: EV user preferences allows no flexibility
Update SSU Status (4)	1	PS1 - 4	PS1: SSU is charged by PV PS2: SSU is charged by supplier PS3: Voltage support PS4: Power quality
Validate Energy Prognosis (7)	2	PS1, AS1	
Validate Energy Prognosis (8)	1	PS1 - 4	
Flex Request (10)	2	PS1, AS1	
Flex Request (11)	1	PS3 + 4	
Flex Offer (12)	2	PS1, AS1	
Flex Offer (13)	1	PS3 + 4	
Flex Procurement(14)	1	PS3 + 4	
Send Power File (18)	1	PS1 - 4	
Send Power File (19)	2	PS1	

Alternative Scenario 1: Emergency Flex Request



Abbreviations:

CPMS = Charge Point Management System
FAP 1 = Flexibility Aggregator Platform (with EV contract)
FAP 2 = Flexibility Aggregator Platform (with Battery contract)
BRP = Balance Responsible
LIMS = Local Infrastructure Management System
GMS = Grid Management System
SSU = Smart Storage Unit (Battery)

45.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enexis	Role	DSO	Responsible for the planning, operation and maintenance of the distribution networks	The DSO performs load management of its grid and acts in case of an (forecasted) emergency. The DSO pays for requested flexibility in the net and has a flex contract with the aggregator.	-	YES, conform Dutch electricity act (elektriciteitswet), grid code (netcode), measurement code (meetcode), and system code (systeemcode)[3]	NO
GMS	System	IS IT	Load Management System	The DSO uses this system to perform load management of its grid and send messages to the aggregator	-	NO	NO

[3] https://www.acm.nl/nl/onderwerpen/energie/wet--en-regelgeving/wet--en-regelgeving-energie/

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
DA(LI) / smart meters	System	Network device	Data collection from local infrastructure and households	-	Phoenix (DALI) / SAE (DA) / Kamstrup, Landes & Gyr, IBM-kaifa (slimme meters	NO	NO
	System	Communication infrastructure	Facilitates communication between various platforms	Based on mobile network (3G/4G)	KPN	NO	NO
TNO	Role	Research partner	Applied research institute	TNO provides a Flexibility Aggregation Platform, also acts as a simulated aggregator.	-	NO	NO
Priogen	Role	Commercial aggregator	Commercial aggregator of the flexibility of a grid battery	Trades flexibility to wholesale markets and to the DSO	-	NO	NO
TNO	Role	Commercial aggregator	Applied research institute	TNO provides a Flexibility Aggregation Platform, also acts as a simulated aggregator.	-	NO	NO

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Jedlix/Elaad	Role	Commercial aggregator	Commercial aggregator of the flexibility of a EV charging stations	Trades flexibility to wholesale markets and to the DSO	-	NO	NO
FAP TNO	System	IS IT	Flexibility Aggregator Platform for commercial aggregator	The flexibility aggregation platform used by the aggregator to control its flexible assets	-	NO	NO
FAP Priogen	System	IS IT	Flexibility Aggregator Platform for commercial aggregator	The flexibility aggregation platform used by the aggregator to control its flexible battery and other assets	-	NO	NO
FAP Jedlix/Elaad	System	IS IT	Flexibility Aggregator Platform for commercial aggregator	The flexibility aggregation platform used by the aggregator to control its flexible battery and other assets	-	NO	NO

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Croonwolter&dros	Role	Local aggregator	Provider and operator of LIMS	The local aggregator receives payment for used flexibility in the net and has a flex contract with the commercial aggregator.	-	NO	NO
Smart Storage Unit (battery)	System		Facilitate storage of energy	-	tbd	NO	61000 61427-2 62281 62485-1 62619 62620
LIMS	System	IS IT	Local Infrastructure Management System	Operation, measurements & maintenance of local flexibility sources	tbd	NO	NO
Elaad	Role	Charge Point Operator (CPO)	Foundation of Dutch DSO's focused on gathering and sharing EV/grid related knowledge	In this role Elaad manages charge point infrastructure	-	NO	NO

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Charge Point	System	Charging facilities	Device used to charge EV	The charge point carries out/enforces the charging schedule sent by the CPMS	Ecotap?	-?	- IEC61850 - IEC15118? - OCPP 1.6
CPMS	System	IS IT	Charge Point Management System	CPMS is the LIMS for EV. The charge point operator controls its charge points through this system and messages are send	-	NO	- OCPP 1.6 - OCPI 2.0
EV user	Role	Physical client	The person that operates the charge point to charge his/her EV	The EV user wants his/her charging wishes to be met.	-	NO	NO
Energy Supplier	Role	Retailer	Energy supplier, that sends the energy bill	Supplies the energy needed to charge the grid battery and the EVs	-	NO	NO

Actor Name	Actor Type	Actor Subcategories (see Annex A)	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Balance Responsible Party	Role	BRP	Balance Responsible, that balances the purchase and sales of energy for the energy supplier	Has balance responsibility for the grid battery and the EV charger portfolio	-	NO	NO

46.Step by Step Analysis of the Use Case

46.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Flex Procurement from aggregator	In this scenario the DSO procures flexibility from an aggregator to avoid an expected congestion. In this specific congestion area 2 aggregators are active. The DSO procures flexibility from the aggregator that provides the flexibility the cheapest.	The Aggregator(s)	Expected congestion	The DSO has a contract with 2 aggregators in the specific congestion area describing the possibilities to procure flexibility from the aggregators by the DSO.	**The DSO purchased flexibility from one or more aggregators.** **Success if:** The expected congestion is mitigated by adjusting the power consumption of 1 or more devices in the congested area. **Failure if:** The expected congestion is not mitigated.
AS1	Flex requested from the aggregators in an emergency situation	An unexpected congestion is observed by the DSO. The DSO sends an emergency message to the aggregators in order to adjust the power consumption of their devices and avoid an overload.	DSO	Unexpected congestion (emergency)	The DSO has a contract with 2 aggregators in the specific congestion area describing the possibilities to procure flexibility from the aggregators by the DSO	**The DSO purchased flexibility from one or more aggregators.** **Success if:** The expected congestion is mitigated by adjusting the power consumption of 1 or more devices in the congested area. **Failure if:** The expected congestion is not mitigated and a physical safety (e.g. fuse) in the grid is invoked causing a (partial) blackout.

46.2. Steps – Primary Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Update EV Status	The CPMS sends its latest status information towards the FAP1. With this information, the FAP1 creates an expected power consumption profile (A-	CPMS	FAP1	EV Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
2	Validate Energy Prognosis	The FAP1 sends the calculated Energy prognosis to its BRP.	FAP1	BRP1	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
3	Acknowledge Energy prognosis	After validating the Energy prognosis the BRP sends an acknowledgement to the FAP1	BRP1	FAP1	Acknowledgement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
4	Update SSU Status	The LIMS sends its latest status information towards the FAP2. With this information, the FAP2 creates an expected power consumption profile (A-prognosis).	LIMS	FAP2	SSU Status Update	Get	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
5	Validate Energy Prognosis	The FAP2 sends the calculated Energy Prognosis to its BRP.	FAP2	BRP2	Energy Prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
6	Acknowledge Energy Prognosis	After validating the Energy Prognosis the BRP sends an acknowledgement to the FAP1	BRP2	FAP2	Acknowledgement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
7	Validate Energy Prognosis	The FAP1 sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP1	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
8	Validate Energy Prognosis	The FAP2 sends the expected power consumption profile for congestion area 1 (Energy prognosis) to the GMS.	FAP2	GMS	Energy prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
9	Validate Capacity	The DSO evaluates the expected load on congestion point 1 with the help of its load forecast together with the received Energy prognosis. The DSO determines an expected congestion	GMS	GMS	-	-	Constrains	-	-
10	Flex Request	The DSO sends a Flex request to FAP1 in order to request flexibility during the expected congestion period.	GMS	FAP1	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
11	Flex Request	The DSO sends a Flex request to FAP2 in order to request flexibility during the expected congestion period.	GMS	FAP2	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
12	Flex Offer	The FAP1 has flexibility during the expected congestion period and sends an offer to the DSO.	FAP1	GMS	Flex Offer	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
13	Flex Offer	The FAP2 has flexibility during the expected congestion period and sends an offer to the DSO.	FAP2	GMS	Flex Offer	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
14	Flex Procurement	The DSO evaluates the received flex offers, determines that FAP2 offered flexibility the cheapest. So the DSO sends a flex procurement message to FAP2.	GMS	FAP2	Flex Procurement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
15	Update Energy Prognosis	The FAP2 accepts the flex procurement and updates its power consumption profile.	FAP2	FAP2	-	Create	Constrains	-	-
16	Validate Energy Prognosis	The FAP2 sends the calculated Energy Prognosis to its BRP.	FAP2	BRP2	Energy Prognosis	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
17	Acknowledge Energy Prognosis	After validating the Energy Prognosis the BRP sends an acknowledgement to the FAP1	BRP2	FAP2	Acknowledgement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
18	Send Power Profile	The FAP2 sends the power consumption for the next period to the LIMS	FAP2	LIMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)
19	Send Power Profile	The FAP1 sends the power consumption for the next period to the LIMS	FAP1	CPMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)

46.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Flex Request	The DSO sends a Flex request to FAP1 in order to request flexibility directly (emergency occurred)	GMS	FAP1	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
2	Flex Request	The DSO sends a Flex request to FAP2 in order to request flexibility directly (emergency occurred)	GMS	FAP2	Flex Request	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
3	Flex Offer	The FAP1 has flexibility during the congestion period and sends an offer to the DSO.	FAP1	GMS	Flex Offer	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
4	Flex Offer	The FAP2 has flexibility during the congestion period and sends an offer to the DSO.	FAP2	GMS	Flex Offer	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
5	Flex Procurement	The DSO evaluates the received flex offers, that he needs all the offered flex. So the DSO sends a flex procurement message to FAP1.	GMS	FAP2	Flex Procurement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
6	Flex Procurement	The DSO evaluates the received flex offers, that he needs all the offered flex. So the DSO sends a flex procurement message to FAP2	GMS	FAP2	Flex Procurement	Create	Security, Privacy,	Fibre	Protocol (e.g. USEF)
7	Send Power Profile	The FAP1 sends the power consumption for the next period to the LIMS	FAP1	LIMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or
8	Send Power Profile	The FAP2 sends the power consumption for the next period to the LIMS	FAP2	CPMS	Power Profile Allocation	Create	Security, Privacy,	Fibre	Protocol (e.g. OpenADR or EFI)

47.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5] (see Annex B)	Requirements
UC3_1	EV status	The information about the active and expected charging sessions. (State of Charge, desired departure time, etc.)	Other device state and output	
UC3_4	SSU status	Information about the status of the grid SSU (State of Charge, Capacity, etc)	Other device state and output	
UC3_2/5	Energy Prognosis	Prognosis of the power consumption of	Forecast data	
UC3_7/8	Energy Prognosis	Prognosis of the available flexibility within the smart storage unit or electric vehicle	Forecast data	
UC3_10/11	Flex Request	Request from the DSO for a load adjustments of the aggregators portfolio peak reduction or additional electricity	Solution cost and selling price	
UC3_12/13	Flex offer	An offer send from the aggregator to the DSO as a reply on the Flex Request, the offer contains an offered amount of flex together with a price.	Solution cost and selling price	
UC3_14	Flex procurement	A procurement message to acknowledge the agreement for flex procurement between DSO and aggregator	Solution cost and selling price	
UC3_18/19	Power profile	The load profile send to appliances to control their power consumption over time	Forecast data	
UC1_	Control signal	Actual fulfillment of the requested flexibility	Algorithm, formula, rule, specific model	
Pre Use case	Flex contract	A contract between the aggregator and an actor that requests or supplies flexibility in the net	Customer contract's data	
Pre Use case	Flex invoice	The invoice for supply of requested flexibility in the net	Solution cost and selling price	

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP8_1 – Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers

Scope

This document describes the Use Case **WP8_1 - Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on "information exchanged")
- Information exchanged

48.Description of the Use Case WP8.1

48.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 8_1	**Domain:** Customer Premises **Zone:** Operation	Use of DSR to optimize DSO operation by exploiting the interaction with different energy carriers, such as district heating and district cooling	Detailed Use Case

48.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
V0.1	15.04.17	Gaurav Chingale Thomas Fischer Hardik Balar	Document initiation
V1.0	30.04.17	Luis Hernández	Revision and completion
V1.1	28.07.17	Gaurav Chingale	Revised
V2.0	04.08.17	Luis Hernández	Final revision

48.3. Scope and objectives

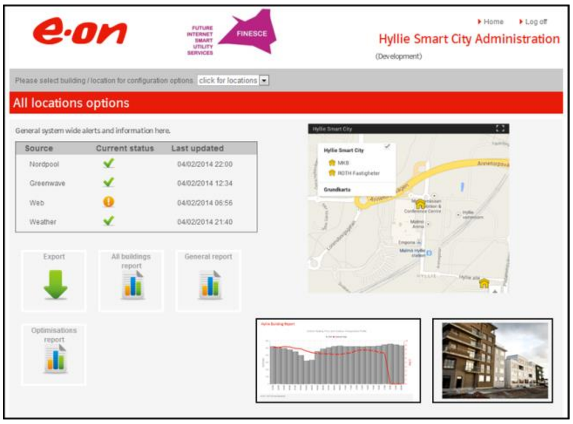
Scope and Objectives of the Use Case 1	
Scope	Evaluation of the thermal inertia of the buildings envelope and the thermal inertia of the thermal grid as a source of flexibility. The evaluation of the impact of using these sources of flexibility in the integration of renewables will be done via simulation software.
Objective	• Determine how to evaluate how much flexibility is in these two sources. • Determine the impact of exploiting these flexibility sources in the integration of renewables. • Determine the impact on the thermal systems of them being used for the integration of renewables.
Related Business Case	*Distribution thermal grid optimization*

48.4. Narrative of Use Case

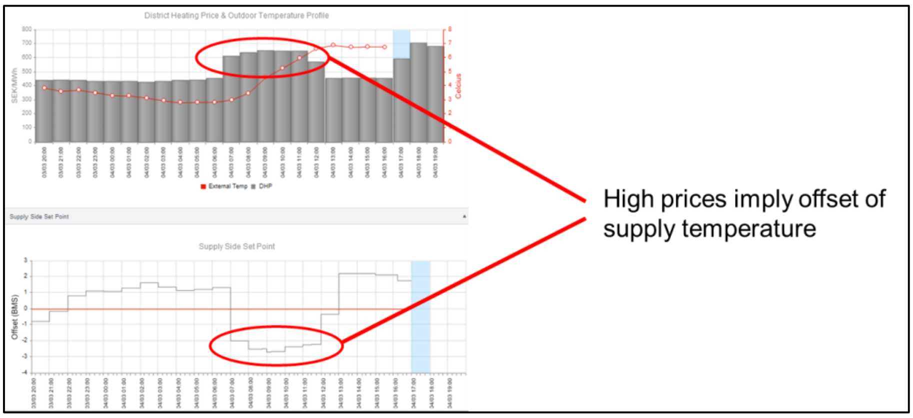
Short description – max 3 sentences
The use case evaluates how the integration of different energy carriers can support the integration of renewables, by demonstrating the available flexibility given in the thermal inertia of a buildings envelope and in the thermal inertia of thermal grids (heating and cooling). The evaluation of the impact of using these sources of flexibility in the integration of renewables will be done via simulation software, by creating an electrical model of the Demo4b micro-grid and evaluating how the surplus renewable energy could have been converted to heat and utilized for heating purposes, without affecting the customer´s comfort.

Complete description

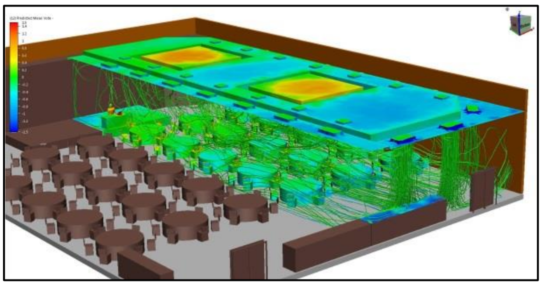
The use case utilizes hardware and software developed in the EU FINESCE project, to connect new buildings and execute the necessary tests to validate the thermal inertia models to be developed during the project. The recruited buildings are connected to the steering system (CESO), by placing a hardware (Energy Manager) at the customer premises, which is integrated into the already existing building energy management system (BEMS).



The steering principle will be that an activation signal will be created based on the power balance status of Demo4b, which will indicate the status of the renewable energy in the grid (e.g. deficit or surplus of onsite RES). When there is an excess of renewables, the signal will have a positive price and vice versa. Given this activation signal, an algorithm located in the distributed controllers (Energy Manager) translates this signal into specific offset values which will finally create a new set point for the inlet temperature of the heating systems.



Full description of the Use Case, a complete narrative of the function from a domain expert user's point of view, describing what occurs when, why, with what expectation, and under what conditions. It has to be written in a way that it can also be understood by non-experts.



For determining the flexibility available in the thermal inertia of the buildings envelope, diverse physical models will be tested to validate the technical assumptions and to create a model that will be able to provide accurate predictions about the available flexibility in the building so that this can be accessed in an automated way.
The thermal grid´s inertia will be simulated and evaluated via dedicated software specialized in thermal grids. Utilizing the input from Demo4b, an activation signal will be created which will trigger the generation of extra heat/cooling in the thermal systems. Via simulation this excess heat/cooling will be integrated into the thermal grids and the impact on the

grid temperatures and differential pressure levels will be evaluated, as well as the amount of excess power that these systems are able to take before reaching any system limit. For the deployment of this type of solutions a model chain will be created in collaboration with RWTH Aachen.

48.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
N1	DSR economic and operational impact on distribution network (district Heating/cooling)	One of the outcomes of the project is a cost impact analysis of deploying DSR in a thermal network.	UC 1 and UC 2
N2	System Peak load reduction (district cooling grid)	% of decrease on ratio Peak / Peak average at system level for the district cooling grid	UC 1
N3	DSR Dispatch Quality	Improving forecasting capabilities of residential DSR assets	UC 1, UC 2, UC3, & UC 5
N5	Increase of renewable penetration	Evaluating how each one of the use cases contribute to the penetration of renewable energy.	UC 1, UC 2, UC3, UC 4 & UC 5
N6	DSR technical availability	Maximize asset availability	UC 1, UC3, & UC 4
N7	DSR flexibility response time	Achieve a response time per asset appropriate for the cost of the balancing technology and the availability of the flexibility.	UC 1, & UC 3
N8	DSR Potential	Evaluating each asset technology to realize the highest potential assets. External benchmarking of each technology.	UC 1, UC 2, & UC3
N9	Customer Energy Awareness	% of increase in the active participation in energy related activities. (measured at the start and close to the end of the trial)	UC 1, & UC 4
N10	Customer Satisfaction Index	Project to create an index based on relevant existing satisfaction surveys to measure customer satisfaction.	UC 1, & UC 4

48.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO (Microgrid – Demo 4b)	Imbalance in the micro-grid – activation of the thermal flexibility	• Building owner's participation in the project. • To have central heating systems with a local controller. • Buildings have an Energy Manager installed at their premises. The indoor temperature of the buildings involved are within the desired set-point i.e. comfort limits at the time of activation.	• Have a functioning BEMS with the possibility to be integrated to the DSR system. • The thermal flexibility is enough to allow the shift of load for a predetermined period of time without affecting the customer´s comfort.

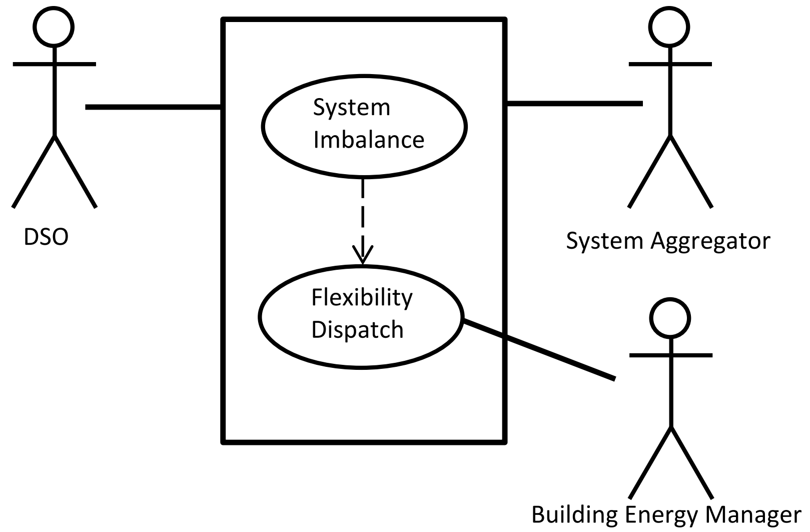
48.7. Classification information

Relation to Other Use Cases in the same project or area
This UC is an addition to UC3, as it evaluates an alternative source of flexibility.
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case

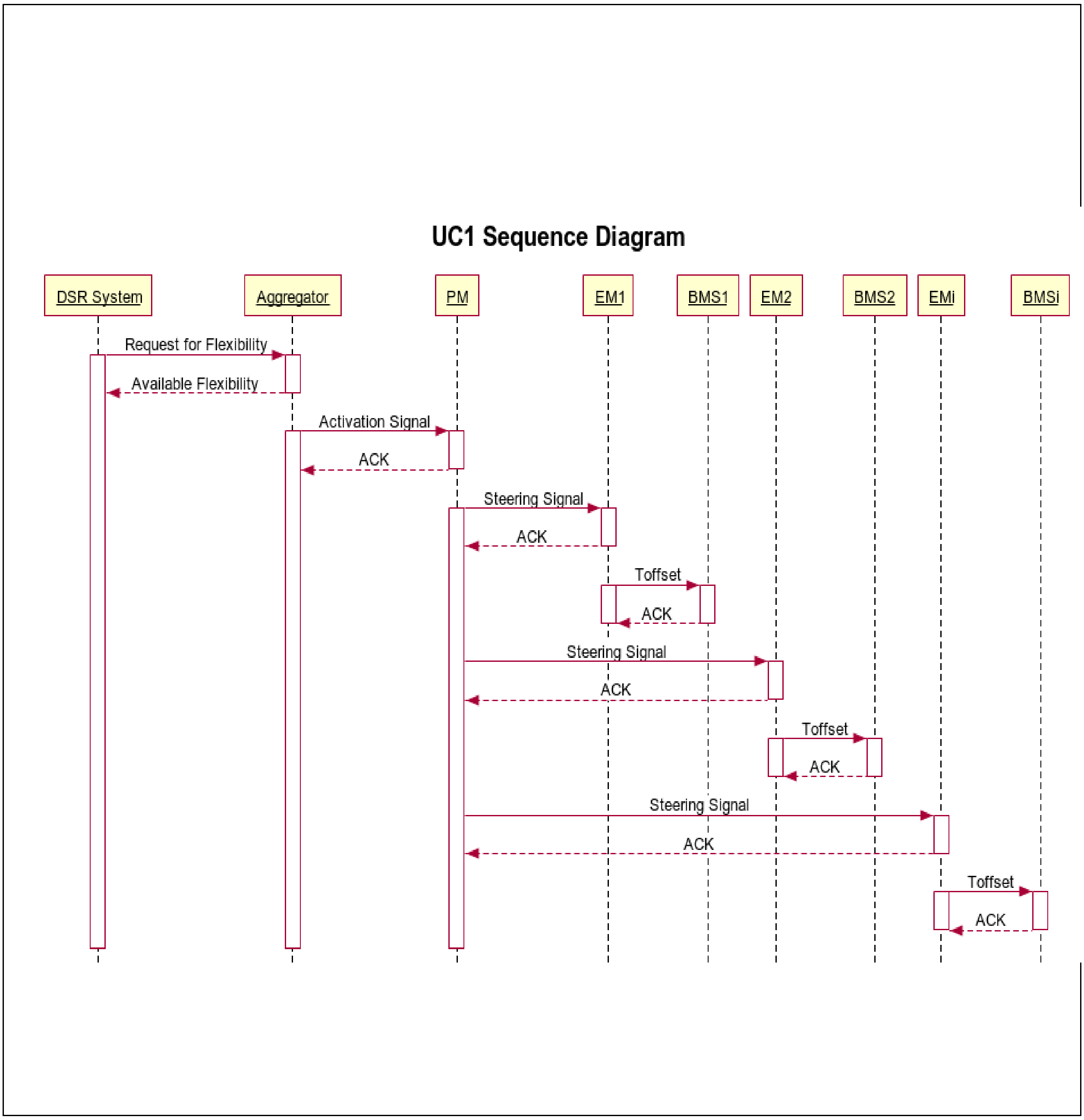
Prioritization
mandatory
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
technical
Further Keywords for Classification
Thermal Inertia / Demand Side Response / Thermal Systems
Maturity of Use Case
- *Moving to - in business operation* - *past - realized in demonstration project*

49.Diagrams of the Use Case

49.1. Diagram of the Use Case



49.2. Sequence diagram of the Use Case



50.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Building Energy Management System (BEMS)	System	Local controller	Local controller which controls and monitor the systems installed at the building.	Takes care about the correct operation of the connected systems.	Diverse suppliers.	NO	N/A
Energy Manager	System	Network device	Local Hardware which functions as a Gateway and a local controller.	translates activation schedules into optimal set points	NPE, raspberry PI, others.	NO	N/A
Portfolio Manager	System	IS IT	Cloud platform that acts as an aggregator.	Translates flexibility requirements into activation signals to the appropriate buildings.	E.ON	NO	N/A
Simulation SW	System	IS IT	Dedicated software which serves as a tool to simulate the impact of actions.	To evaluate the impact of any DSR action before this are implemented and with this reduce the risk of surpassing any system limit.	Tbc	NO	N/A

51.Step by Step Analysis of the Use Case

51.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Power grid imbalance – Building´s thermal inertia	When the generation from the renewables does not match the load on the Microgrid then the thermal flexibility is used to support the compensation of the imbalance.	Steering signal from DSR Platform – Demo 4b. Offline transfer.	System imbalance	The indoor temperature of the buildings involved are within the desired set-point i.e. comfort limits	Success if the flexibility source is activated for the predefined/estimated period without surpassing the comfort limits of the customer (+/-0,5°C).

51.2. Steps – Primary Scenario

Scenario Name : Power grid imbalance – Building´s thermal inertia									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Building´s thermal flexibility activation	Activation signal uploaded Flexibility dispatch schedules created.	Demo4b DSR platform	CESO – Demo4a platform	Activation signal based on power balance of renewables in the micro-grid i.e. renewable surplus signal	GET		Data file	Manual upload
2	Activation of selected distributed buildings	Schedules sent to Energy Manager	PM	EM	Renewable surplus signal	EXECUTE		Internet	HTTPs
3	Run optimization algorithm	Schedule processing and creation of set point offset signal.	EM	EM		CREATE			
4	Set point overwrite	New set point overwrites BEMS flowtemp set point values	EM	BEMS	Offset signal	CHANGE		Wired	Modbus TCP
Scenario Name :									

Scenario Name : Power grid imbalance – Building´s thermal inertia									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means

51.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1									

52.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer’s meter state and outputs information	- Customer’s consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract’s data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP8_2 – Optimal use of a large heat pump asset providing the district heating grid with heat and electricity flexibility for grid management purposes

Scope

This document describes the Use Case **WP8_2 - Optimal use of a large heat pump asset providing the district heating grid with heat and electricity flexibility for grid management purposes**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

53. Description of the Use Case WP8.2

53.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 8_2	**Domain:** Customer Premises **Zone:** Operation	Optimal use of a large heat pump asset providing the district heating grid with heat and electricity flexibility for grid management purposes	Detailed Use Case

53.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
V0.1	25.07.2017	Gaurav Chingale	Document initiation
V1.0	04.08.17	Luis Hernández	Final revision

53.3. Scope and objectives

Scope and Objectives of the Use Case 1	
Scope	Evaluation of the steering possibilities of a large heat pump for accessing the thermal inertia of the district thermal grid as a source of flexibility via simulation software.
Objective	• Creation of the simulation model for the industrial heat pump • Development of the steering logic for this heat pump • Validating the simulation model of heat pump through the operational data • Integrating the simulation model of the heat pump in the thermal network model. • Testing the solution for one year operational data.
Related Business Case	*Distribution thermal grid optimization*

53.4. Narrative of Use Case

Short description – max 3 sentences
The use case aims to develop a simulation model for the large industrial heat pump which can be later validated with the operational real time data. This model is then planned to be integrated in the thermal network model to study the effect of steering this heat pump according to renewable generation.

Complete description
The UC will try to evaluate the potential of the large heat pump to increase the RES penetration. The district heating and district cooling networks in Malmö are operated by E.ON Värme. In these grids diverse sources of heating a cooling energy are utilized. In the case of the heating grid, a new large industrial heat pump will be installed and commissioned in 2018. It is planned to steer such a central heat pump. Owing to the large size of such Heat pump in MWs, it would be sought as one the most important balancing technology for the grid service support. It would offer great opportunities for flexibility at the DSO level as it can react instantaneously as per the needs of Demo 4b-UC 3, when connected by a fiber-optic cable. But for the actual implementation of such steering functionality in the large heat pump requires significant efforts to overcome the IT security standards of the production site. Consequently it will be modelled on the simulation platform, to replicate the characteristics. This simulation model will be validated by the real operational data. The control software for the steering logic will be developed for this simulated model of the heat pump, so that RES integration functionality can be verified in the simulation. Once the simulation model along with its control software is developed and verified, it will be then integrated in the thermal network model. The thermal model together with the heat pump model will be part of the larger Local Energy System (LES) model. This final LES model will consider the Simris (demo4b) site and its high renewable penetration, how its customer receive their power through their electricity network and will virtually include what would happen if a the town of Simris would cover their energy demands via a thermal grid with central heat generation (heat pump) rather than by other distributed technologies (current scenarios). The final outcome of this simulation activity is to evaluate the impact of integrating energy resources (Power and Heat) on the penetration of on-site renewable power generation. This solution will be tested for one year by using the real operational data from the heat pump for validation purposes of the created simulation model. This UC is aimed to demonstrate the optimization of the available thermal flexibility of the heating and cooling grids through the simulation of an industrial heat pump, which will validate the effective increase in RES penetration.

53.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
N3	DSR Dispatch Quality	Improving forecasting capabilities of residential DSR assets	UC 1, UC 2, UC 3 & UC 5
N5	Increase of renewable penetration	Evaluating how each one of the use cases contribute to the penetration of renewable energy.	UC 1, UC 2, UC 3 UC 4 & UC 5
N8	DSR Potential	Evaluating each asset technology to realize the highest potential assets. External benchmarking of each technology.	UC 1, UC 2, & UC 3

53.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO	Imbalance in the micro-grid – steering of the large heat pump	• Validated simulation model of the large heat pump • RES generation real time operational data	The thermal flexibility is one of the most effective measures to increase the RES penetration.

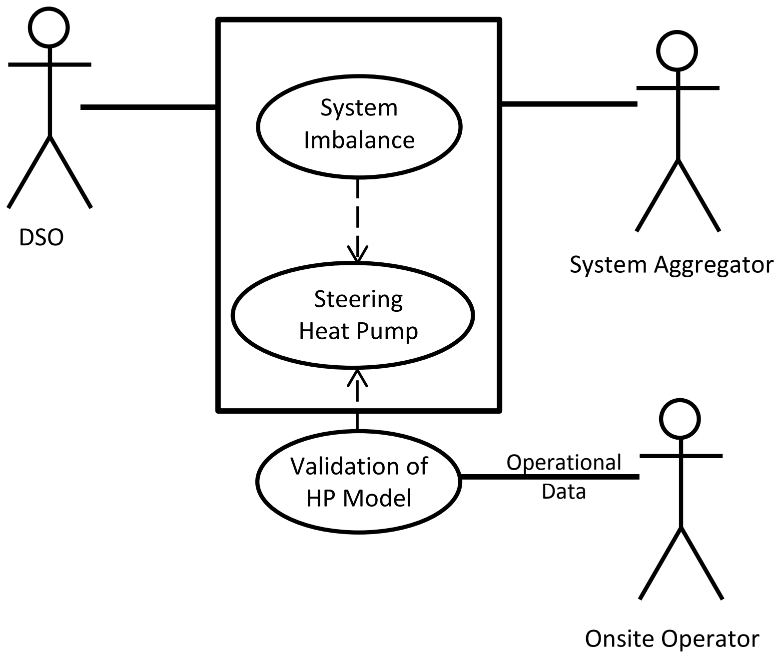
53.7. Classification information

Relation to Other Use Cases in the same project or area
This UC is related to UC3, as it evaluates an alternative potential source of flexibility.
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case

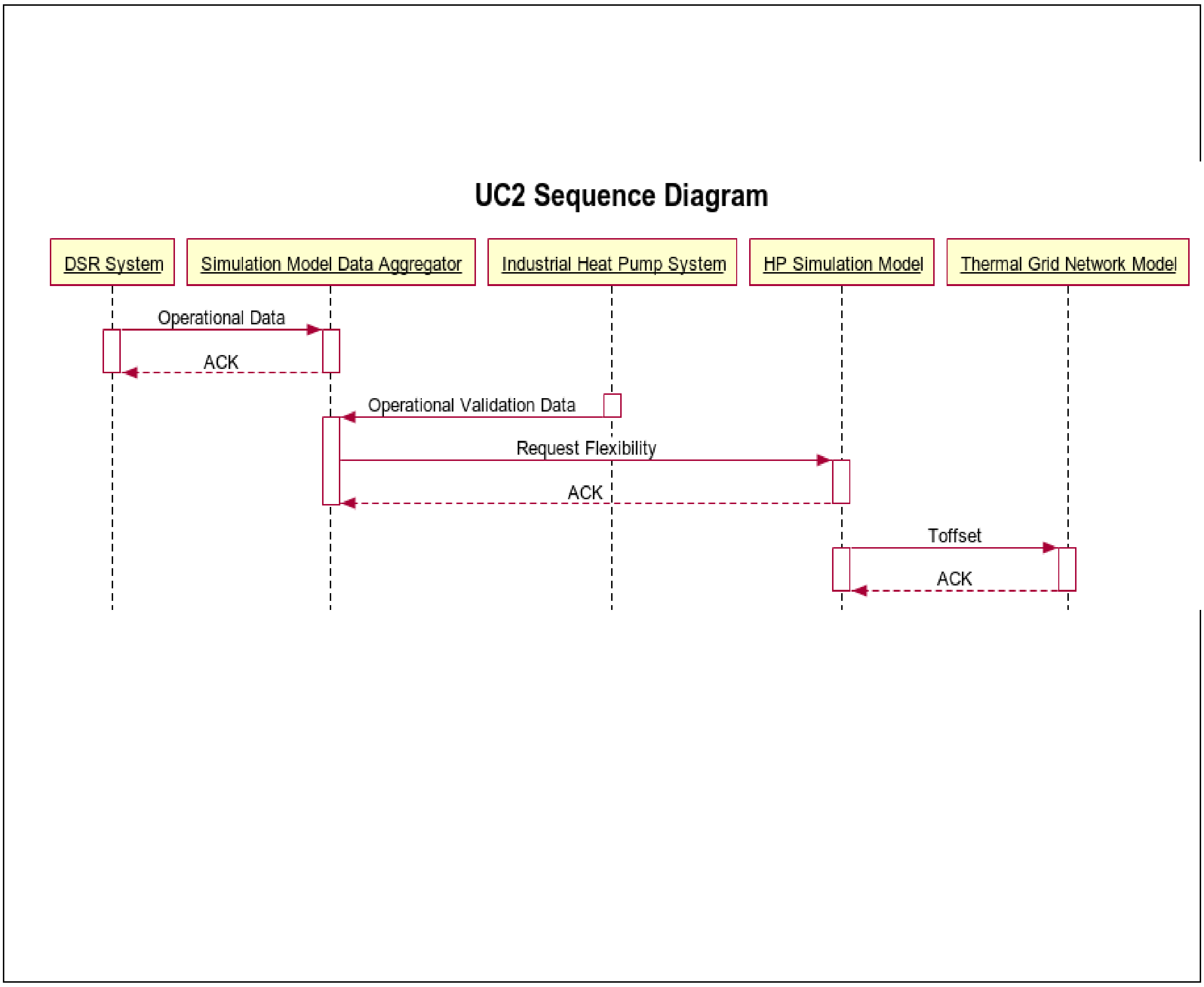
Prioritization
mandatory
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
technical
Further Keywords for Classification
Thermal Inertia / Demand Side Response / Thermal Systems
Maturity of Use Case
- *Moving to - in business operation* - *past - realized in demonstration project*

54.Diagrams of the Use Case

54.1. Diagram of the Use Case



54.2. Sequence diagram of the Use Case



55.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Industrial Heat Pump	System	IS IT	Simulation of industrial Heat Pump	Mimics the behavior of the large Heat pump responsible for the energy carriers	Simulation Platform TBC	NO	N/A
Integration Module	System	IS IT	Integration of the Heat Pump model into the thermal network model	Translated the real operational data in to the modeled Heat Pump	Simulation Platform TBC	NO	N/A
Steering Control	System	IS IT	Steering logic developed and simulated for the heat pump	Translates flexibility requirements into activation signals to the heat pump.	Simulation Platform TBC	NO	N/A
Simulation SW	System	IS IT	Dedicated software which serves as a tool to simulate the impact of RES penetrations.	To evaluate the impact of any DSR action before this are implemented and with this reduce the risk of surpassing any system limit.	Simulation Platform TBC	NO	N/A

56. Step by Step Analysis of the Use Case

56.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Power grid imbalance – Heat Pump Simulation	When the generation from the renewables does not match the load on the Microgrid then the thermal flexibility is used to support the compensation of the imbalance.	Steering signal from DSR Platform – Demo 4b. Offline transfer.	System imbalance	• The heat pump model is validated by the real operational data. • This model is integrated in the thermal network grid. • Heat pump steering logic is developed for the control commands from the DSO.	Success if the Heat Pump is steered in the desired manner to result in to increased RES penetrations and grid stabilization.

56.2. Steps – Primary Scenario

Scenario Name : Power grid imbalance – Heat Pump Simulation									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1	Heat Pump Model's thermal flexibility activation	Activation signal uploaded Flexibility dispatch schedules created.	Demo4b DSR platform	CESO – Demo4a platform	Activation signal based on power balance of renewables in the micro-grid i.e. renewable surplus signal	GET	Validated simulation model of the HP with the operational data	Data file	Manual upload
2	Activation of Heat Pump Model	Schedules sent to Steering Control	CESO – Demo4a platform	CESO – Demo4a platform	Renewable surplus signal	EXECUTE		Data file	Software input
3	Run optimization algorithm	Schedule processing and creation of set point offset signal.	CESO – Demo4a platform	CESO – Demo4a platform	Optimized schedules	CREATE			
4	Set point overwrite	New set point overwrites Heat Pump Model's operating set	CESO – Demo4a	CESO – Demo4a	Offset signal	CHANGE		Data file	Software input

Scenario Name : Power grid imbalance – Heat Pump Simulation									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
		point values	platform	platform					

56.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1									

57. Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer’s meter state and outputs information	- Customer’s consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract’s data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP8_3 – Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation

Scope

This document describes the Use Case **WP8_3 - Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on "information exchanged")
- Information exchanged

58. Description of the Use Case WP8.3

58.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 8_3	**Domain:** DER, Customer Premises **Zone:** Operation	Technical management of a grid-connected Local Energy System that can run in an islanded mode with 100% renewable generation	High level Use Case

58.2. Version Management

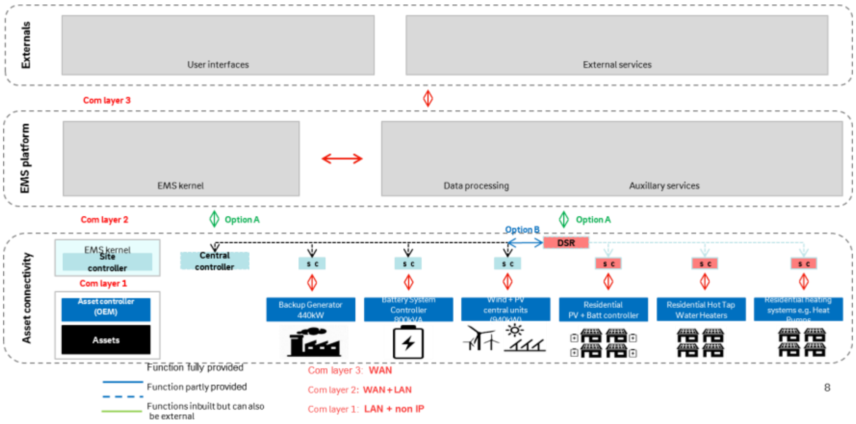
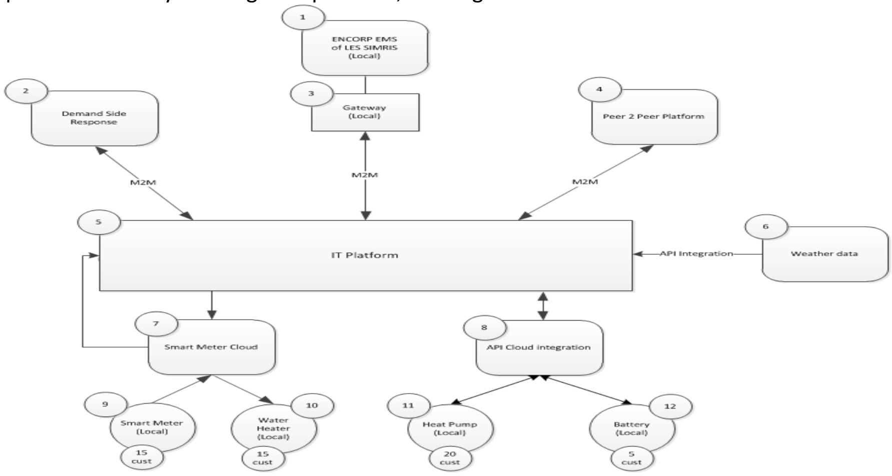
Version	Date	Name Author(s) or Committee	Changes
V0.1	15.04.17	Gaurav Chingale Thomas Fischer Hardik Balar	Document initiation
V1.0	01.05.17	Luis Hernández	Revision and completion
V1.1	28.07.17	Gaurav Chingale	Revised
V2.0	04.08.17	Luis Hernández	Final revision

58.3. Scope and objectives

Scope and Objectives of the Use Case 3	
Scope	Design, deployment and operation of distributed balancing technologies (power to heat and power to power) to support the balancing of the micro-grid when in islanded mode i.e. to support the integration of on-site renewables.
Objective	• Maximizing the renewable energy utilization by using different energy carriers. Select balancing technologies to be offered/deployed and suppliers (E.ON). Due on M6. • Developing special Demand Side Response platform for efficient steering of customer loads. Design and implementation of a DSR Platform (E.ON and third party supplier). Due on M9. • Integration of the distributed balancing technologies to a DSR platform (E.ON). Due on M12. • Managing and operation of the micro-grid and activation of the distributed balancing resources to enhance the operation of the overall system (E.ON). M12-18 to M24-30. • Analysis and evaluation of the impact of DSR technologies on the system (E.ON). Due on M18. • Modelling, simulation and evaluation of the impact of DSR in the integration of renewables (E.ON and RWTH). Due on M24.
Related Business Case	*Demand Side Response*

58.4. Narrative of Use Case

Short description – max 3 sentences
Designing the Microgrid system which aggregates the balancing technologies (power to heat and power to power) in the present system, and then deploying a DSR platform which will manage the demand side flexibility and steer the loads accordingly.

Complete description
The success of this UC largely depends on the fact that the Microgrid should run on an Islanded mode for maximum duration of the time without compromising the power quality. The system will always monitor the Microgrid health to stay in the Islanding-mode, and in-case the system parameters start deviating from the standard nominal values, the Microgrid will be reconnected to the main grid. In order to handle the operation of the energy system while in islanded mode, a dedicated micro-grid controller is put in place. This system communicates to all the main central assets of the energy system via a fiber network, allowing a high speed communication and control of the systems. This microgrid controller will act as a central controller for the renewable generation and based on the available generation it will update the setpoints for the allowable Loading on the system, and will provide inputs to the central DSR platform. For maximizing the renewable energy penetration and supporting the balancing of the micro-grid in a non-centralized way, distributed balancing technologies will be installed at customer households. This use case integrates all the assets in the Microgrid viz. Wind turbine, PV-farm, Battery Storage system, balancing technologies like Hot Tap Water Boiler, Heat Pumps, and PV+Battery. This use-case aims to enhance the operation of a micro-grid that can go to islanded mode with up to 100% penetration of renewables generation, by steering these flexible-loads in the customer premises. These technologies will be steered from a central DSR platform which will communicate to the central micro-grid controller.    The DSR platform will be the place where data will be concentrated from most of the micro-grid relevant data points as well as from external services. This platform will host the advanced intelligence of the system and will interact with the other main components of the system e.g. P2P platform, micro-grid controller. 

58.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
N3	DSR Dispatch Quality	Improving forecasting capabilities of residential DSR assets	UC1, UC2, UC3, and UC5
N5	Increase of renewable penetration	Evaluating how much each use case can contribute is one of the outcomes of the project	UC1, UC2, UC3, UC4 and UC5
N6	DSR technical availability	Maximize asset availability	UC1, UC3 and UC4
N7	DSR flexibility response time	Achieve a response time per asset appropriate for the cost of the balancing technology and the availability of the flexibility.	UC 1, & UC 3
N8	DSR Potential	Evaluating each asset technology to realize the highest potential assets. External benchmarking of each technology.	UC 1, UC 2, & UC3

58.6. Use Case conditions

Actor	Triggering Event	Pre-conditions	Assumption
DSO, Customer	Excess of Renewable energy triggers the activation of the customer loads	The Microgrid is on Islanded mode and RES is greater than the demand	The customer flexibility is sufficient to increase utilization of RES

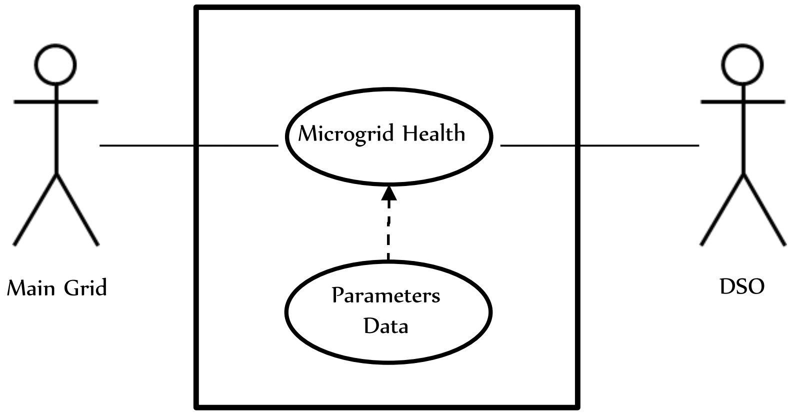
58.7. Classification information

Relation to Other Use Cases in the same project or area
This is the prime UC and this provides the groundwork for UC 4 and UC 5
Level of Depth - the degree of specialization of the Use Case
High Level Use Case
Prioritization
- obligatory
Generic, Regional or National Regional relation
Regional
Nature of the viewpoint- describes the viewpoint and field of attention
technical, business/market
Further Keywords for Classification
Asset Integration, Demand side response, Distribution Network Operation
Maturity of Use Case
realized in demonstration project

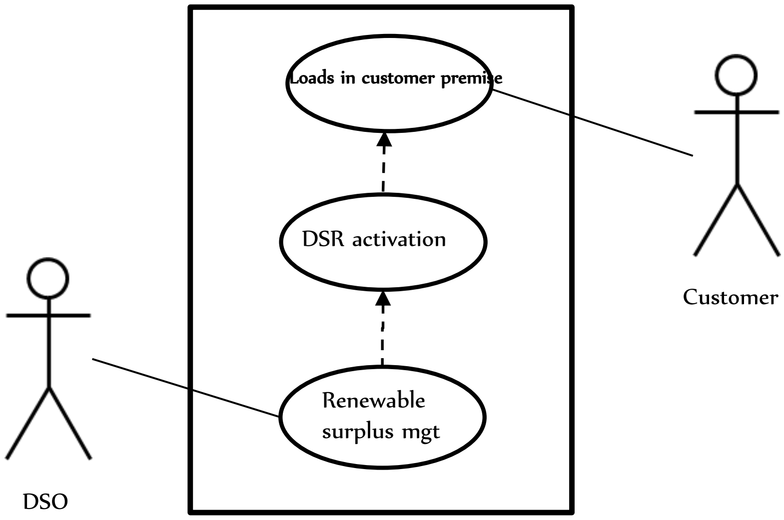
59. Diagrams of the Use Case

59.1. Diagram of the Use Case

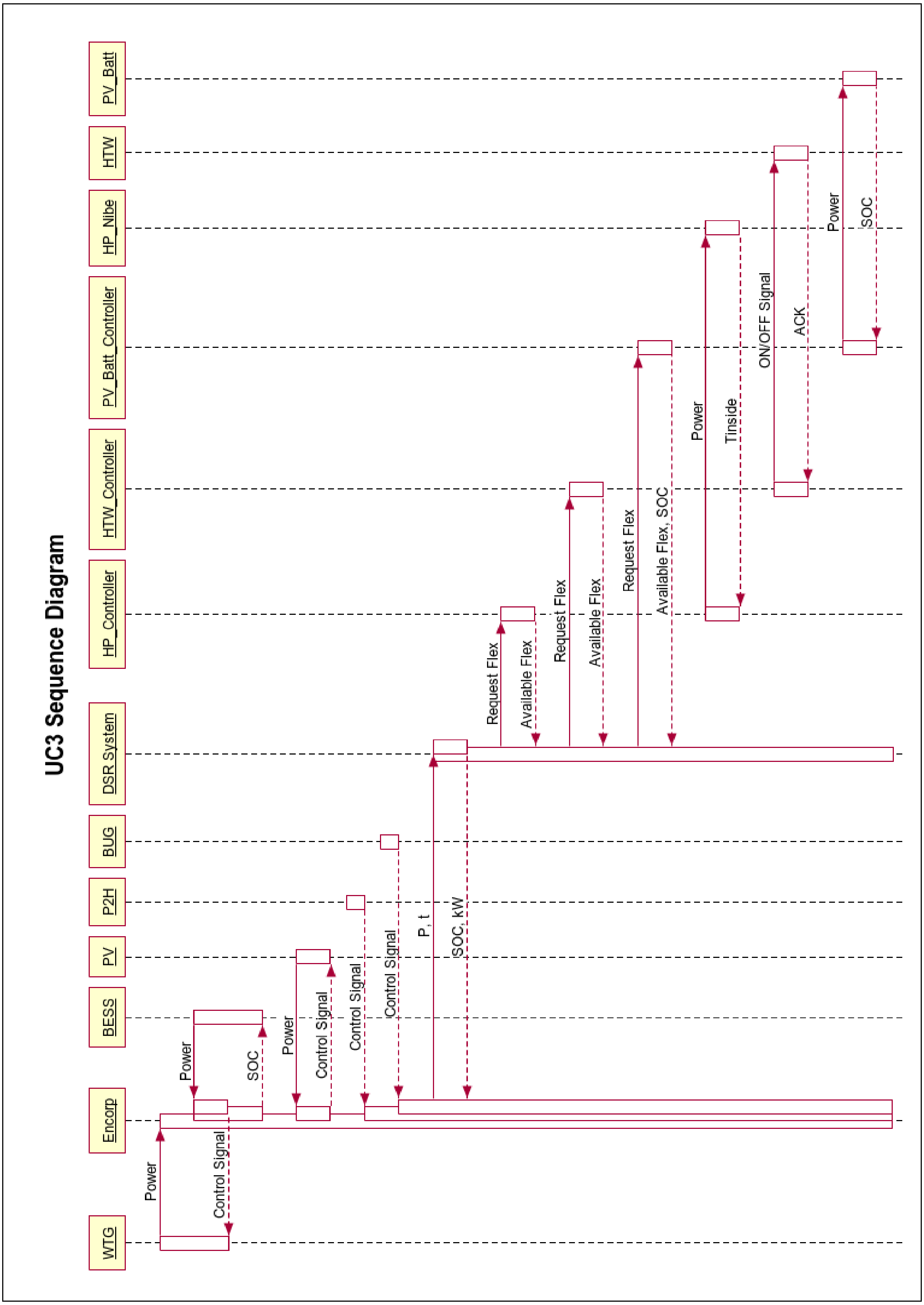
a. *Islanding Mode Operation: The primary aim is to demonstrate maximum time of Islanding operation without compromising with the power quality. The system can be islanded only if the generation and demand is efficiently balanced. The central controller from Encorp will communicate with the DSR system, and when all the technical parameters are in their normal operating bands, the Microgrid health will be signaled as healthy and Microgrid will be Islanded.*



b. *DSR Operation: Once the system is islanded the DSR platform manages the system assets. It uses the distributed flexible technologies for supporting and balancing the Microgrid. The surplus renewable energy is fed in the system in prior to the actual customer need, with an intention that this energy can be used later. This activity is completely automated and doesn't interfere with the comfort of the customer.*



59.2. Sequence diagram of the Use Case



60.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Grid Operator	Role	DSO	The DSO operator as the person that oversees the correct operation of the micro-grid.	The DSO monitors the status of the micro-grid. The micro-grid is fully automated but can always be override by the DSO operator.	N/A	Yes	Tbc
Micro-grid controller	System	IS IT	The system that controls and steers all the centralized assets of the micro-grid.	This system is the master and its goal is to guarantee the security of supply whilst keeping safety conditions.	Encorp - US	YES	Tbc
DSR	System	IS IT	The central monitoring and control system for the distributed assets.	This system is in charge of hosting the advanced control algorithms and of controlling the distributed balancing	To be decided via private competitive tender.	No	Tbc
Power analyzer	System	Network device	These devices are needed for monitoring the LV/MV network.		Janitza	Yes	Tbc
Frequency Analyzer	System	Network device	These devices are needed for monitoring the network frequency.		Janitza	Yes	Tbc

61.Step by Step Analysis of the Use Case

61.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	DSR activation	When there is a renewable generation deficit/surplus, distributed balancing resources are activated to support the central systems.	DSR Platform	System Power Imbalance	The micro-grid is on islanded mode	Success: Distributed balancing technologies are activated and requested balancing power is dispatched with +/- 10% of accuracy.

61.2. Steps – Primary Scenario

Scenario Name : DSR activation									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Flexibility request	Micro-grid controller sends a signal to the DSR platform requesting for the dispatch of flexibility (kW, kWh).	Micro-grid controller	DSR Platform	Flexibility dispatch signal	GET		4G	OPC UA or MQTT
2	Flexibility activation	DSR Platform decides which of the enabled assets to dispatch and sends a steering signal to	DSR Platform	Distributed assets/Platform	Dispatch schedule				
3	Flexibility dispatch	Asset gateway receives the dispatch schedule and creates an activation signal.	Local Gateway	Embedded controller	Set Point				

61.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name : AS1									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means

62.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP8_4 – Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs

Scope

This document describes the Use Case **WP8_4 - Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

63. Description of the Use Case WP8.4

63.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 8_4	**Domain:** Customer Premises **Zone:** Enterprise	Micro Grid Customer Flexibility facilitated by a peer to peer market platform and enabled by Demand Side Response Programs	High level Use Case

63.2. Version Management

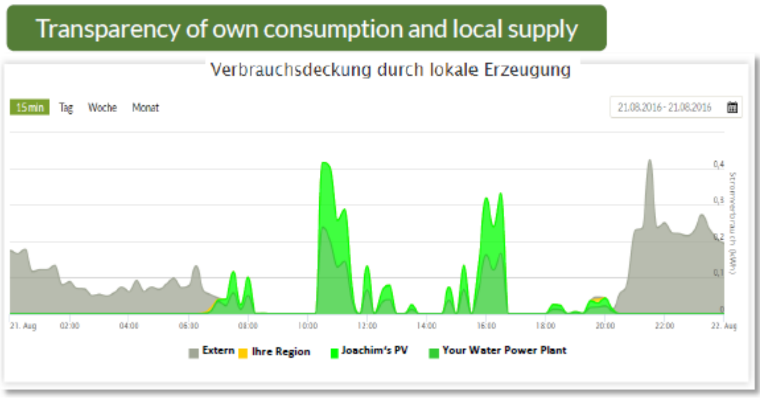
Version	Date	Name Author(s) or Committee	Changes
V0.1	15.04.17	Gaurav Chingale Thomas Fischer Hardik Balar	Document initiation
V1.0	01.05.17	Luis Hernández	Revision and completion
V1.1	28.07.17	Gaurav Chingale	Revised
V2.0	04.08.17	Luis Hernández	Final revision

63.3. Scope and objectives

Scope and Objectives of the Use Case 4	
Scope	Acquisition of a Local Energy Market Platform e.g. P2P, to allow customers to visualize their consumption, the operation and performance of their balancing technologies, their impact on the grid and the state of the overall local energy system (e.g. renewable surplus or deficit). The P2P platform will track retroactively the DSR activations executed and will perform the billing accordingly. The P2P platform will not allow customers to do active brokering with their available flexibility.
Objective	• Contact customers and start recruiting (E.ON). M3-M12 • Define Local Energy Market Platform concept (E.ON). Due on M9. • Select P2P platform supplier (E.ON). Due on M9 • Integrate selected P2P platform to the overall system architecture (E.ON). Due on M12-M15 • Track use and feedback from customers about the use of the P2P platform (E.ON). Due on M12-18 to 24-30 • Evaluate results and lessons learnt (E.ON). Due on M36 • Incentivize the load flexibility offered by the customer
Related Business Case	*P2P local energy market platform*

63.4. Narrative of Use Case

Short description – max 3 sentences
Development of Local Energy Market Platform, allowing customers to visualize their consumption, their contribution through balancing technologies installed in their house premises, their impact on the grid and the state of the system (e.g. renewable surplus or deficit)

Complete description
This UC will try to achieve following things: 1. Grid transparency via a visualization tool 2. Billing platform **1. Grid transparency via a visualization tool:** Customers will have the possibility to view via a User Interface i.e. visualization tool, the state of the energy system and the impact their technologies have on the overall system. This UI will be part of a Local Energy Market (P2P) platform, which will have also the possibility to calculate the incentives that customers will receive by allowing the system to utilize their flexibility. This platform aims at eliciting customer participation into the project and providing transparency in order to increase the energy awareness of the participants.    **2. Billing platform:** This visualization tool also proves instrumental in displaying the individual customer bills for the usage of electricity. It performs the billing process to track and calculate the incentives to be given to each customer participating based on their actual contribution to the system. This UC involves creating the IT platform which extends the functionality of the DSR platform and accumulates the data from the data aggregator and then analyses the data. This analyzed data will be then updated to each user via their UI/visualization tool. This UC aims to provide the customers awareness about the grid activities and their own contribution, which will be later measured through the customer surveys and interviews.

63.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
N5	Increase of renewable penetration	Evaluating how each one of the use cases contribute to the penetration of renewable energy.	UC 1, UC 2, UC 3, UC 4 & UC 5
N6	DSR technical availability	Maximize asset availability	UC 1, UC 3, UC 4
N9	Customer Energy Awareness	% of increase in the active participation in energy related activities. (measured at the start and close to the end of the trial)	UC 1, & UC 4
N10	Customer Satisfaction Index	Project to create an index based on relevant existing satisfaction surveys to measure customer satisfaction.	UC 1, & UC 4
N11	Recruitment		UC 1, & UC 4
N12	P2P platform participation	Internal KPI "Number of visits, number of actions per visit, time per visit"	UC 4

63.6. Use Case conditions

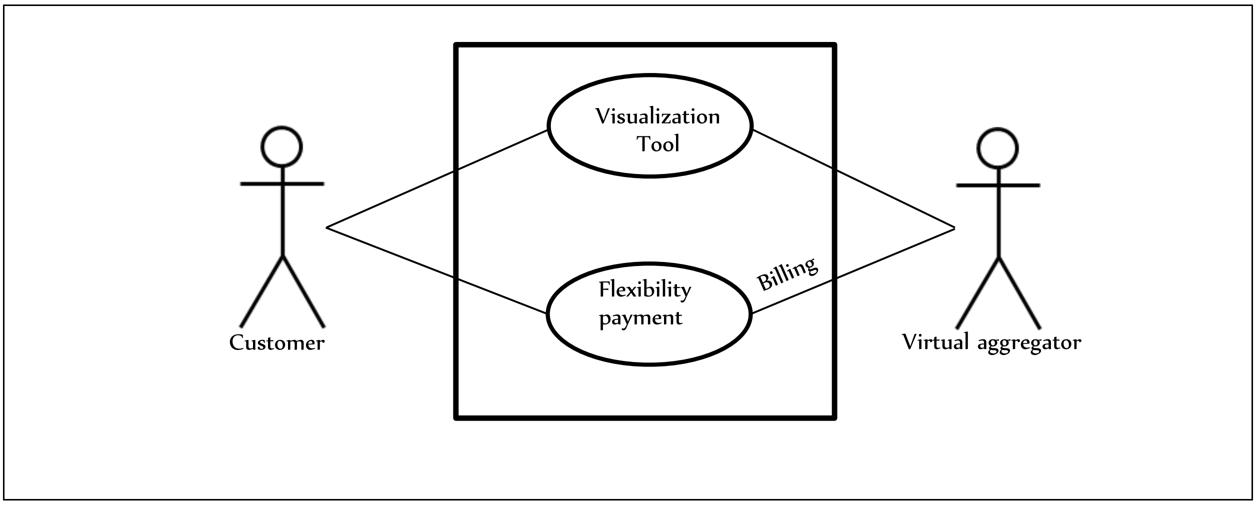
Actor	Triggering Event	Pre-conditions	Assumption
Utility, Customer	Visualization for the customers to increase the customer energy awareness and enable their participation	To have signed-in to participate in the project. To have a new smart meter installed at their premises.	Customer has internet access

63.7. Classification information

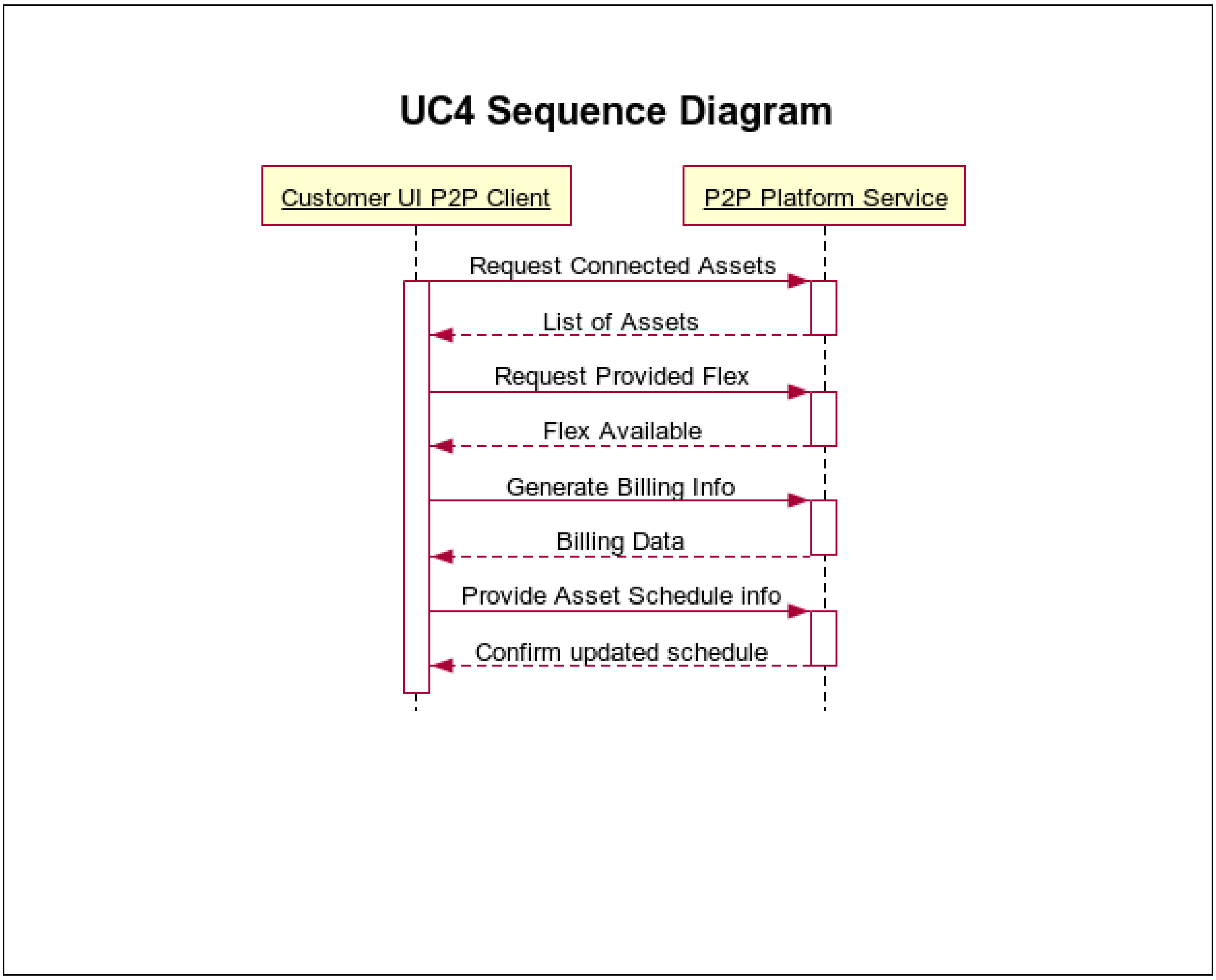
Relation to Other Use Cases in the same project or area
UC 3
Level of Depth - the degree of specialization of the Use Case
High Level Use Case
Prioritization
- obligatory
Generic, Regional or National Regional relation
Regional
Nature of the viewpoint- describes the viewpoint and field of attention
technical, business and market
Further Keywords for Classification
P2P platform, billing, visualization
Maturity of Use Case
realized in demonstration project

64. Diagrams of the Use Case

64.1. Diagram of the Use Case



64.2. Sequence diagram of the Use Case



65.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
P2P Platform	System	Interactive communication device	This platform interacts with the active-customer and visualizes the incentives earned			No	No
Communication	System	Communication infrastructure	the communication link between customer UI and the P2P platform			No	TBC

66.Step by Step Analysis of the Use Case

66.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS2	P2P	P2P platform correlates DSR activation periods with flexibility calculated values to calculate the compensation that customers will get for contributing to the integration of renewables with their balancing technologies.	P2P Platform	Billing signal	System connection enabled	Success: information correctly transmitted and each measured period can be allocated to a specific calculated value for flexibility.

66.2. Steps – Primary Scenario

Scenario Name : P2P									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Flexibility billing	DSR Platform sends a report to the P2P platform about the DSR activation periods and the activated assets.	DSR Platform	P2P Platform	Flexibility dispatch report				REST API

66.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1					ID or description	Get/Create/Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains	e.g. GPRS, Fibre, PLC	e.g. voice, GUI, protocol

67.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
			Select from Annex B/Introduce a new subcategory	

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider ...
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, ...
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP8_5 – Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints

Scope

This document describes the Use Case **WP8_5 - Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

68.Description of the Use Case WP8.5

68.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 8_5	**Domain:** DER, Customer Premises **Zone:** Station	Increased ability to observe and steer the operations of a micro-grid in response to distribution network constraints	High level Use Case

68.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
V0.1	15.04.17	Gaurav Chingale Thomas Fischer Hardik Balar	Document initiation
V1.0	01.05.17	Luis Hernández	Revision and completion
V1.1	28.07.17	Gaurav Chingale	Revised
V2.0	04.08.17	Luis Hernández	Final revision

68.3. Scope and objectives

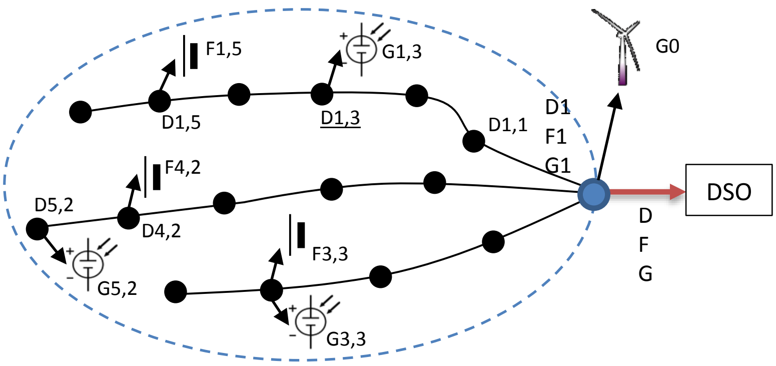
Scope and Objectives of the Use Case 5	
Scope	Create advanced algorithms that will support the automation of the grid and of the systems involved to: -minimize customer behavioral change. -maximize integration of renewables. -increase observability and controllability of the micro-grid.
Objective	Intelligent Algorithms for • Define potential use cases that would benefit from the creation of advanced algorithms (E.ON & RWTH). M6-M12 • Development of advanced algorithms (E.ON & RWTH). M6-M24 • Implementation and evaluation of the impact of the developed algorithms (E.ON & RWTH). M12-M30.
Related Business Case	*Advanced Control i.e. smart automation*

68.4. Narrative of Use Case

Short description – max 3 sentences
The system controls will enable the smooth steering of the customer balancing technologies. Artificial intelligence will be exploited, learning elements of the customer behavior and forecasting the feed-in of any local generation. This information will be used to maximize the renewable penetration in the Microgrid in a much more controlled manner and to enhance grid stability.
Complete description

A control system operating based on simple logic (such as little or no customer flexibility and basic persistence-forecasting of local generation) is likely to be functional but sub-optimal: additional customer flexibility could be used to time-shift operations and the system performance (measured in terms of renewables utilization and/or stability) could be improved. These advanced elements underpin activity within UC 5.

Advanced controls shall allow the DSR platform (introduced under UC 3) to improve the estimation accuracy of the available flexibility in the system (both in terms of magnitude and timing) and to improve forecasting and prediction of relevant quantities and events; these improvements will allow a better dispatch of the available resources. A number of different disaggregation levels will be relevant and will warrant independent forecasting activity within UC 5, depending on where the generation and flexibility resources are located within the network, what network properties are of interest and where the network constraints are relevant – in the below diagram, forecasting an individual customer's energy properties (represented as demand [Dn,m], generation [Gn,m] and flexibility [Fn,m]) may be relevant, as may the whole feeder's properties (Dn, Gn, Fn), as may the whole microgrid (D, G, F). UC 5 will explore forecasting methods for a number of aggregation levels and for a number of quantities.



Advanced algorithms implemented in this UC will aim to create a self-learning grid with minimal human-response requirement (including manual re-forecasting), increase the automation of the system and provide less reliance on human maneuvering of the grid. Consequently due to various monitoring devices, significant amount of data will be generated. This data will be instrumental for enriching the machine learning algorithms (either as self-learning or via offline modelling) and drawing/visualizing the patterns of energy management with Data-analytics.

Subsequently, as RES penetrations are increased, the grid inertia is substantially decreased which endangers the grid stability. Trying to implement synthetic inertia, amongst various approaches, will also be explored by this UC.

68.5. KPIs

ID	Name	Description	Reference to mentioned Use Case objectives
N3	DSR Dispatch Quality	Improving forecasting capabilities of residential DSR assets	UC 1, UC 2, UC 3, & UC 5
N4	Observability of the microgrid performance	Increase of observability of the Microgrid for better control	UC 5
N5	Increase of renewable penetration	Evaluating how each one of the use cases contribute to the penetration of renewable energy.	UC 1, UC 2, UC 3, UC 4 & UC 5

68.6. Use Case conditions

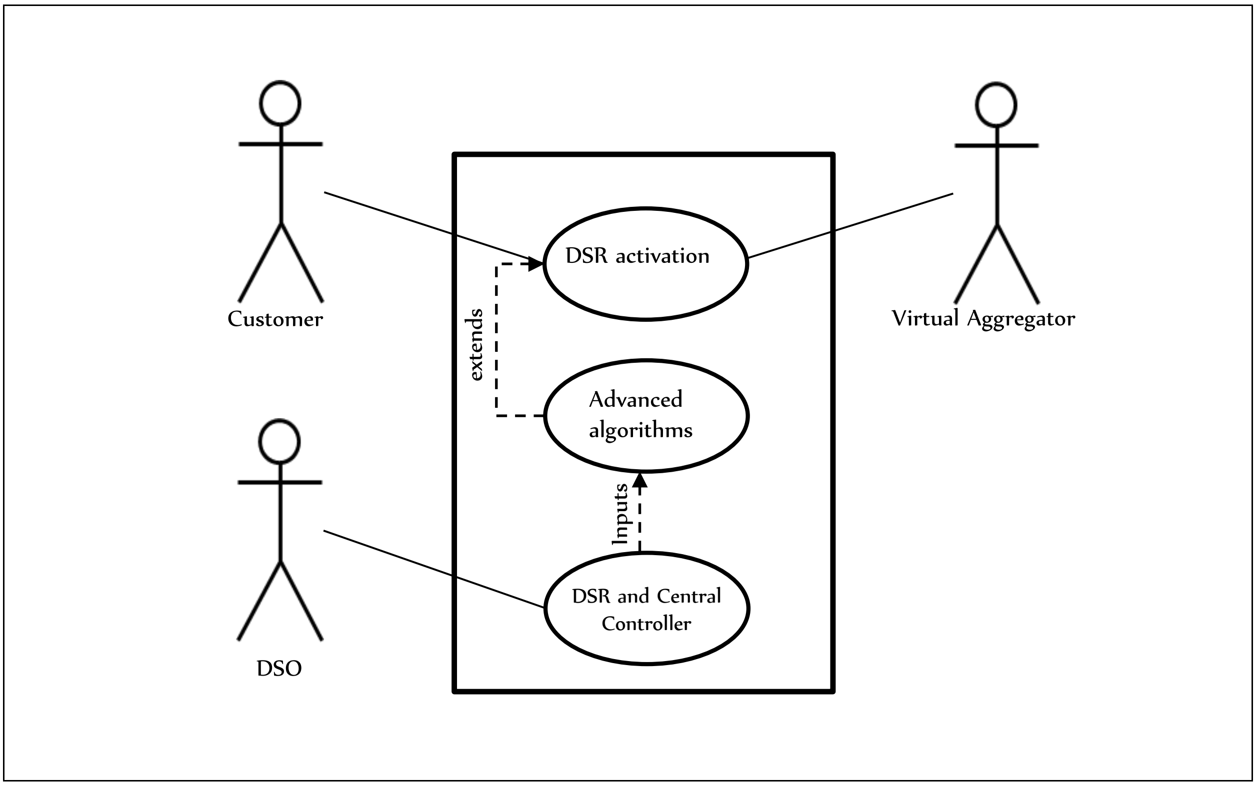
Actor	Triggering Event	Pre-conditions	Assumption
DSO	Islanded operation of the energy system requires enhanced operation.	Algorithms are created.	Input data (e.g. weather, grid measurements, device measurements, etc.) are available.

68.7. Classification information

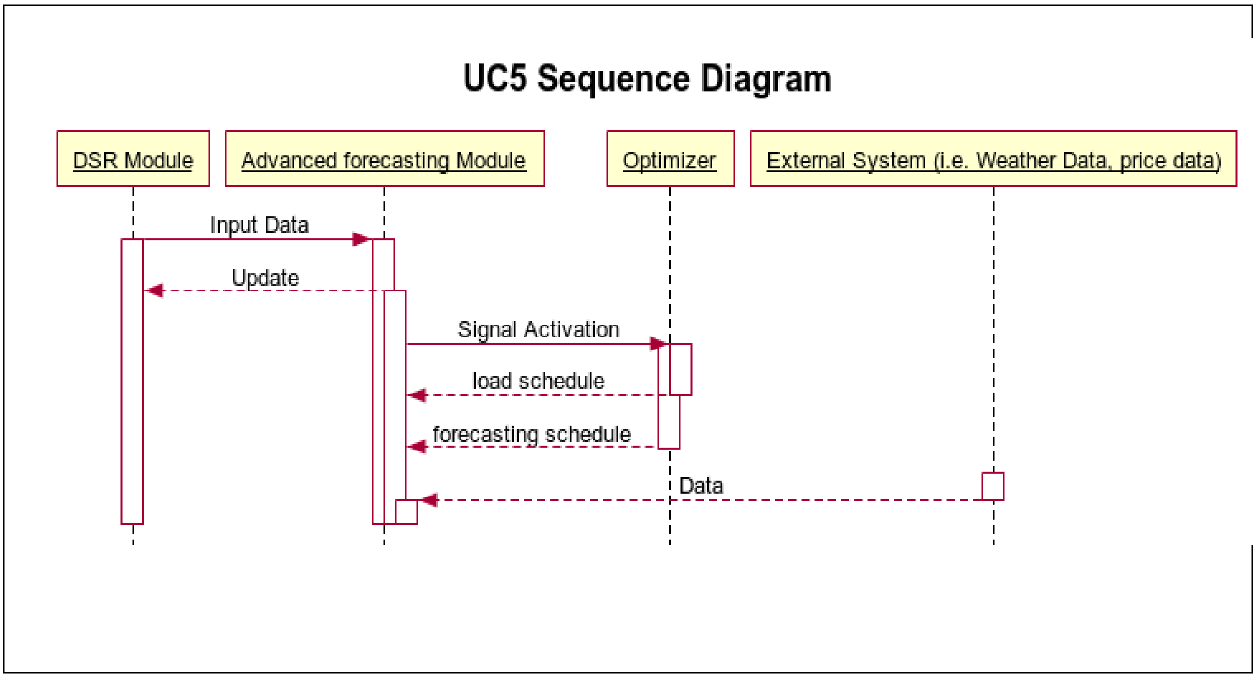
Relation to Other Use Cases in the same project or area
Related to UC3
Level of Depth - the degree of specialization of the Use Case
High Level Use Case
Prioritization
Nice-to-have
Generic, Regional or National Regional relation
Generic
Nature of the viewpoint- describes the viewpoint and field of attention
technical
Further Keywords for Classification
Machine Learning, Forecasting, Model Predictive Control
Maturity of Use Case
- *realized in demonstration project* - *realized in R&D* - *in preparation*

69. Diagrams of the Use Case

69.1. Diagram of the Use Case



69.2. Sequence diagram of the Use Case



70.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Advanced Control	System	IS IT	Responsible for advanced automation of the Microgrid		To be developed with RWTH Aachen	No	Tbc

71. Step by Step Analysis of the Use Case

71.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Advanced control	The DSR platform will process input date (e.g. weather, measurements) and run advanced algorithms to create alternative enhanced schedules for the balancing technologies.	DSR Platform	Control signal	Advanced algorithms are integrated into the DSR system	Success: advanced algorithms enhance the performance of the energy system in an automated way.

71.2. Steps – Primary Scenario

Scenario Name : Advanced Controls									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Flexibility estimation	External information is processed by algorithms to improve the creation of flexibility schedules.	Measurement devices, weather API, etc.	DSR Platform	External input data				

71.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means

Scenario Name :									
Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means

72.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
			Select from Annex B/Introduce a new subcategory	

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,...) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,...)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,...) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,...)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP9_1 – Islanding

Scope

This document describes the Use Case **WP9_1 - Islanding**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

73. Description of the Use Case WP9.1

73.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case[2]
WP 9_1	**Domains:** Distribution DER Customer Premises **Zones:** Process Field Station Operation Enterprise Market	Islanding automatically or remotely a district from the electrical grid	Detailed Use Case

73.2. Version Management

Version	Date	Name Author(s) or	Changes
0.1 – Document	1st April 2017	Thomas Drizard, Julien Bruschi, Romain Dosdat	Document initiation
0.2	12th May 2017	Thomas Drizard, Julien Bruschi, Romain Dosdat, Guillaume Lehec	Reviewing of the first draft version with new elements and modifications made by Engie
0.3	27th Sept 2017	Julien Bruschi	Some information have been changed depending on the use case progress

73.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	This use case aims at defining the solution of islanding to be tested in the French DEMO. It addresses the technical solutions and the interaction of the partners involved into the project.
Objective	Different objectives are the following: ► Determine the conditions to start islanding automatically and remotely and to minimize the duration of the blackout. ► Operate an islanding. ► Assess customers' contribution to support the islanding. ► Optimize the storage management accordingly to the contracted maximum duration and to the forecast loads and productions within the district. ► Determine the pricing structure for such product in order to maximize the value for the system. ► Manage faults during islanding.
Related Business Case	► Islanding grid operation ► Improving the quality of service of customers

73.4. Narrative of Use Case

Short description – max 3 sentences
This Use Case concerns the automatic and remotely activation of the islanding of a part of an MV feeder on which there are several MV/LV substations. The islanding insures the power supply of the subscribing customers of the LV area in case of problems on the upstream distribution grid. Islanding starts by disconnecting the islandable areas from the main distribution grid and insuring the power supply of the micro grid with local energy resources (storage assets, generation, etc.). In *Nice Smart Valley*, the islanding may be : ► Requested by the regional control room (DSO); ► [illegible]

Complete description
In the context of the *Nice Smart Valley* project, the islanding of an LV area consists in disconnecting it from the distribution grid for a limited period and insuring its power supply with the following local energy resources: ► Storage systems; ► Demand response on the area with customers' involvement; ► Local photovoltaic generation. The global storage system is made up of two components : ► The grid forming unit (GFU) owned by Enedis, which is responsible for the local grid frequency by controlling the balance generation = consumption. The system consists of a 620 kWh battery connected to four bidirectional power converters (250 kW) manufactured by SOCOMEC and connected in parallel. ► The grid supporting unit (GSU) owned by Engie, which can increase the islanding duration by injecting or consuming when the GFU requires help. Different modes of islanding will be tested: ► Automatic islanding: as soon as a blackout is detected, the GFU starts an islanding to supply the customers in the islanding area. ► Islanding required by the DSO: the DSO can remotely start an islanding from the regional control room. The duration of an islanding will depend on the grid outage duration, the amount of PV generation, the state of charge of the energy storage systems and the local consumption.

73.5. Use Case conditions

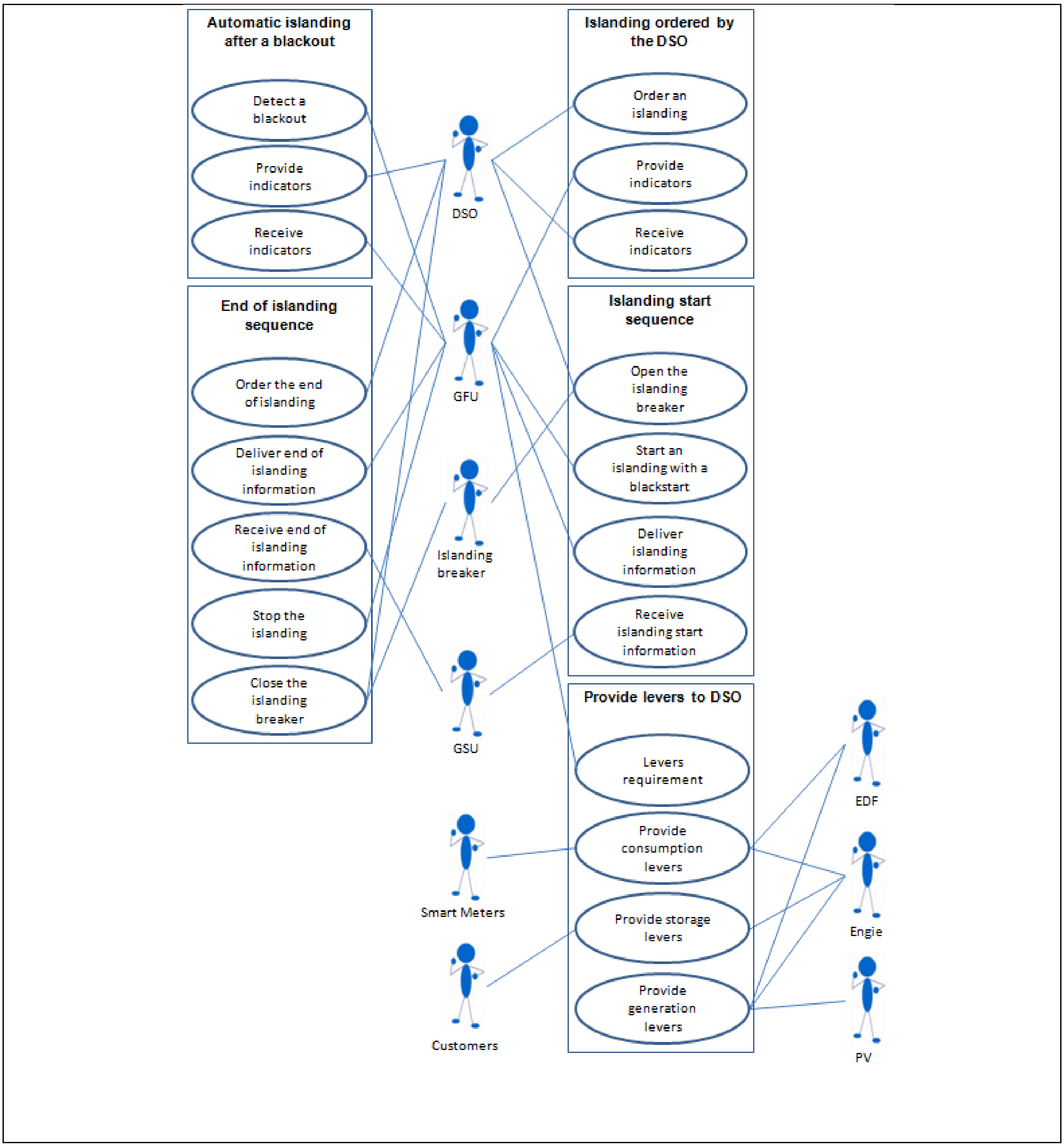
Actor	Triggering Event	Pre-conditions	Assumption
DSO	Blackout detected or anticipated	Storage system charged and able to operate the islanding	DSO has installed its GFU in the islanding grid
Regional control room (DSO)	The regional control room needs to disconnect the islandable area from the main grid	GFU's indicators are in the range	No fault in the islandable area
GFU	Start of an islanding	Islanding requirement (automatic or required by the regional control room)	GFU sufficiently charged and available for islanding purpose
GSU	The GFU requires help to maintain islanding stability	Islanding in progress	Agregator has an available storage asset in the islandable area
Levers agregators	The GFU requires help to maintain islanding stability	Islanding in progress	Agregators have recruited levers in the islandable area

73.6. Classification information

Relation to Other Use Cases in the same project or area
Relation to other use case: “multiservice approach for storage systems” is possible if and only if the same geographical area is selected for both use cases.
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Obligatory / mandatory
Generic, Regional or National Regional relation
Regional
Nature of the viewpoint- describes the viewpoint and field of attention
Technical, test.
Further Keywords for Classification
Distribution Network Operation.
Maturity of Use Case
In preparation.

74. Diagrams of the Use Case

74.1. Diagram of the Use Case



74.2. Sequence diagram of the Use Case

To be defined

75.Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enedis	Role	DSO	Enedis is the DSO and the operator of the GFU	Enedis can remotely activate islanding			
ENGIE	Role	Retailer	ENGIE will recruit customers' levers and install a storage system in the demonstration district.	Engie enslaves the grid supporting unit during islanding			
Customers	Role	Legal or physical client	They sell levers to the aggregator in order to increase the theoretical duration of the islanding.	They activate or allow levers for activation			
Regional control room interface	Role	IS IT	It can remotely activate the islanding.	Regional control room can check the main storage system			
Islanding breaker	System	Network device	Breaker controlled that can be controlled by: - The regional control room (DSO) - The main storage system				
Grid forming unit (GFU)	System	Storage system	Storage system that maintains the stability of the islanding area.	It includes sensors and function of regulation f(SoC)	Socomec		
Grid supporting unit (GSU)	System	Storage system	Storage system on the islandable area that can be controlled by the GFU to increase the islanding duration	It includes sensors and function of regulation P(f)			

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Telecommunication system	System	Communication infrastructure	Insures communication between storage system, sensors, breaker, the DERMS and the control room.				
Local photovoltaic generators	System	DER installation	Generate power to increase the maximum theoretical duration of	It includes sensors and a P(f) function of			

76.Step by Step Analysis of the Use Case

76.1. List of scenarios

Scenario No.	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1	Islanding required by the DSO	DSO needs to start an islanding in order to maintain the power supply of the area	DSO	Need to maintain the power supply		Smooth reconnection with no blackout
PS2	Automatic islanding to overcome a blackout	A blackout occurs upstream, the GFU assesses whether an islanding is possible. If yes, the islanding starts with a blackstart.	DSO	A blackout occurs upstream	- GFU's indicators are good - Regional control room authorizes the islanding - Failure comes from upstream	Smooth reconnection with no blackout
PS3	GFU's state of charge is too low	The islanding's life is in danger because the GFU does not have enough charge to last longer (consumption > generation)	DSO Storage agregator	Islanding in progress	Low state of charge of the GFU & overconsumption on the islanding area	Increase of islanding duration
PS4	GFU's state of charge is too high	The islanding is in danger because the GFU has no more space to charge the storage system (generation > consumption)	DSO Storage aggregator Local generation Local customers	Islanding in progress	High state of charge of the GFU & overgeneration on the islanding area	Increase of islanding duration
AS1	A fault appears into the islanding	The GFU detects a fault into the islanding area	GFU	Detection of a fault	Islanding in progress	End of islanding OR fault elimination

76.2. Steps – Primary Scenario

Scenario Name : DSO's control room starts islanding									
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
01	DSO needs to start islanding	DSO needs to start an islanding in order to maintain the power supply of the area	DSO Sensors	Regional control room (DSO)	Plan to make maintenance or forecast of an incident				
02	DSO checks the GFU indicators	DSO checks the storage system indicators to verify whether islanding could start. If every indicator is good, the islanding is required by the regional control room. If at least one indicator is outside the range, the islanding cannot start.	Storage system	Regional control room (DSO)	Storage indicators	GET			IT system between control room and the GFU
03	GFU indicators are good	The GFU can start finding the balance point: consumption = generation	GFU	Regional control room (DSO)	Blackstart enabled	EXECUTE			
04	Balance generation = consumption found	The GFU opens the islanding breaker and supplies the islanding area	GFU	Islanding breaker	Order to open	EXECUTE			IT system between the islanding breaker and the GFU
05	DSO requires a reconnection to the main grid	The GFU stops the islanding and opens the islanding breaker	Regional control room (DSO)	GFU	Order of reconnection	EXECUTE	Voltage detection upstream the islanding		IT system between the islanding breaker and the GFU
06	Islanding breaker is open	GFU requires the islanding breaker to close to let the islandable area to be supplied by the main distribution grid	GFU	Islanding breaker	Order to close	EXECUTE	Previous requirement		IT system between the islanding breaker and the GFU
07	Islanding breaker is closed.	The islandable area is supplied by the main distribution grid.							

Scenario Name : Automatic islanding to overcome a blackout									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
01	A blackout occurs on the islandable area	The GFU checks its indicators					Blackout		
02	GFU's indicators are good	The GFU checks whether the failure is provoked by the LV grid					Previous requirement		
03	Failure comes from upstream (MV or HV)	The GFU asks the regional control room if an islanding is possible	GFU	Regional control room (DSO)	Blackstart enabled	CREATE	Previous requirement		IT system between control room and the GFU
04	Islanding authorized by the regional control room	The GFU opens the islanding breaker	GFU	Islanding breaker	Order to open	EXECUTE	Three previous requirements		IT system between the islanding breaker and the GFU
05	Islanding breaker open	The GFU starts a blackstart				EXECUTE	Islanding breaker is effectively opened		
06	All customers are supplied	The GFU holds voltage magnitude and frequency in the range	GFU	Islanding breaker	Order to close	EXECUTE	Previous requirement		
07	Power supply from the main grid upstream is	The GFU proposes the end of islanding to the regional control room	GFU	Regional control room (DSO)	Validation	CREATE	Previous requirement		
08	Regional control room validates the end of the islanding	The GFU opens the islanding breaker.		Regional control room (DSO)	Order to open	EXECUTE	Previous requirement		
09	Islanding breaker is open	GFU requires the islanding breaker to close	GFU	Islanding breaker	Order to close	EXECUTE	Previous requirement		IT system between the islanding breaker and the GFU
10	Islanding breaker is closed.	The islandable area is supplied by the main distribution grid.							

Scenario Name : GFU's state of charge is too low

Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
01	The GFU's capacity is too low	The islanding's life is in danger because the GFU does not have enough charge to last longer (consumption > generation)					The GFU's capacity is too low		
02	The GFU requires help from the local customers and the GSU	The GFU injects a voltage with a low frequency to let the customers and the GSU know that they can help the islanding to last longer	GFU	- GSU - Local customers	Frequency measure	EXECUTE	GFU with a SoC(f)		Voltage signal through the grid
03	GSU injects power	After receiving the frequency signal, GSU injects power depending on the frequency measurement				EXECUTE	GSU with a P(f) function of regulation		
04	Local customers decrease their consumption	*To be defined*				EXECUTE	*To be defined*		

Scenario Name : GFU's state of charge is too high

Step No.	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
01	The GFU's capacity is too high	The islanding is in danger because the GFU has no more space to charge the storage system (generation > consumption)					The GFU's capacity is too high	?	?
02	The GFU requires help from the local generation and the GSU	The GSU injects a voltage with a low frequency to let the generators and the GSU know that they must help the islanding to last longer	GFU	- GSU - Local generation	Frequency measure	EXECUTE	GFU with a SoC(f) function of regulation	?	?

Scenario Name : GFU's state of charge is too high									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
03	GSU charges	GSU charges depending on the frequency measurement				EXECUTE	GSU with a P(f) function of regulation	?	?
04	Local producers decrease their generation	Local producers decrease their generation depending on the frequency measurement				EXECUTE	Local generation with a P(f) function of regulation	?	?
05	Islanding lasts longer	Islanding duration increases as the levers into the islanding help the GFU to maintain stability				EXECUTE	Both previous requirements	?	?

76.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name : A fault appears into the islanding area									
Step No	Event	Description of Process/Activity	Information Producer	Information Receiver	Information Exchanged	Service	Requirements	Communication Media	Communication Means
1	Detection of a fault in the islanding area	The islanding must be stopped for safety reasons					Islanding in progress	?	?
2	Fault elimination attempt	The GSU tries to eliminate the fault. If it works, islanding remains. If it is impossible, GFU must stop the islanding				EXECUTE		?	?

77.Information exchanged

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
1	GFU indicators to the regional control room	Temperature, state of charge, etc.	Information exchanged between IS or sent to device	IT solution between the GFU and the control room
2	State of islanding from GFU to control room	Integer (0=no islanding, 1=islanding)	Information exchanged between IS or sent to device	IT solution between the GFU and the control room
3	State of charge of the GFU	Function of regulation SoC(f) through the voltage sinusoid	Network state	GSU and customers must be able to measure the frequency
4	Enable islanding from the control room to the islanding breaker or the GFU	Integer (0=disable, 1=enable)	Information exchanged between IS or sent to device	IT solution between the control room and the switch or the storage system
5	State of the islanding breaker	Integer (0=off, 1=on)	Information exchanged between IS or sent to device	IT solution between the control room and the islanding breaker

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO

Category	Type	Subcategory	Definition	Example
Data	Facility data	Customer's meter state and output	All the information concerning customer's meter state and outputs information	- Customer's consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract's data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request

Use Case Description

UC WP9_2 – Multiservice approach for storage systems

Scope

This document describes the Use Case **WP9_2 - Storage**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case
- Information exchanged

78. Description of the Use Case WP9.2

78.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use
WP 9_2	**Domains:** Distribution DER **Zones:** Process Field Station Operation Enterprise Market	Use of storage systems in a multiservice approach	Detailed Use Case

78.2. Scope and objectives

Scope and Objectives of the Use Case	
Scope	This use case aims at using storage systems in a multiservice approach
Objective	The use case will allow for dispatching storage systems delivering the following services: - "Cloud storage": using community energy storage assets to increase self consumption for customers - Ancillary services and services on the national level (e.g. capacity and reserve mechanisms) - Mitigating simulated grid constraints for the distribution grid on the MV and LV levels - Islanding - Optimization of power sourcing for end customer, including load report from peak to offpeak period and reduction of subscribed power
Related Business Case	► Use case WP9 automatic islanding ► Use case WP9 local flexibility system

78.3. Narrative of Use Case

Short description
This use case consists in dispatching a set of storage systems on multiple services. Some storage
Complete description

In this use case, storage systems will be used on a multiservice approach. Some storage systems will be operated by ENGIE as an aggregator and some of them by Enedis as a DSO. The storage systems from ENGIE could deliver the following services: - "Cloud storage": using community energy storage assets to increase self consumption for customers - Ancillary services and services on the national level (e.g. capacity and reserve mechanisms) - Mitigating simulated grid constraints for the distribution grid on the MV and LV levels - Islanding as grid supporting unit - Optimization of power sourcing for end customer, including load report from peak to offpeak period and reduction of subscribed power The storage systems from Enedis could deliver the following services: - Mitigating simulated grid constraints for the distribution grid on the MV and LV levels - Islanding as grid forming unit

78.4. KPI

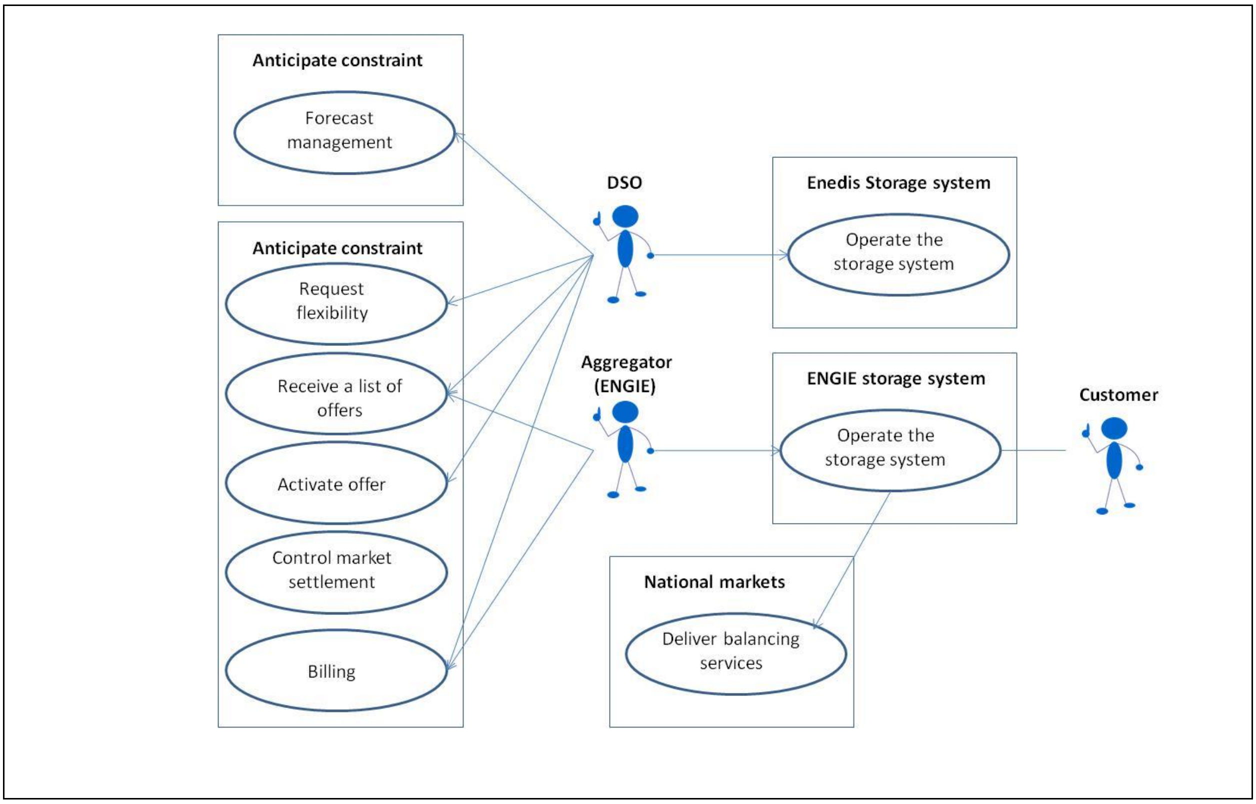
Abbreviation	*Name*	*Description*
KPI1a1	The storage system availability	To be definied
KPI1a2	Contribution of the battery	Battery power/ Power called(Cf market settlement)
KPI1a3	Response time of the storage system	Time between the order and the execution of the operation
KPI1a4	Adequacy between the response need and capacity of the storage system.	Response capacity : Power, Energy, Duration

78.5. Classification information

Relation to Other Use Cases in the same project or area
Islanding, flexibility
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Obligatory / mandatory
Generic, Regional or National Regional relation
Regional
Nature of the viewpoint- describes the viewpoint and field of attention
Technical, test.
Further Keywords for Classification
Distribution Network Operation.
Maturity of Use Case
In preparation.

79. Diagrams of the Use Case

79.1. Diagram of the Use Cass



80. Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enedis	Role	DSO	Enedis is managing the distribution grid and using flexibility	Enedis is operating storage systems for the use of the distribution grid only Enedis storage systems are controlled by the Regional Control Agency	Socomec SAFT	N/A	N/A
ENGIE	Role	Aggregator	ENGIE manages a flexibility portfolio ENGIE installs and operates storage assets	ENGIE connects to the aggregator portal and submits its offers. It specifies all the characteristics relative to the offer	Confidential	Classical connection for end customers Dedicated grid connection for storage systems	

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Aggregator portal	System	Interactive communication device	An interfacing tool that ENEDIS and the aggregators use to exchange data. It provides all the necessary features that both parties need in order to submit and activate flexibility offers	It Hosts the flexibility offers submitted by the aggregators and serves as a medium of communication between ENEDIS and the aggregators.	Enedis	N/A	CIM Market
Forecast management tool	System	IS IT	It helps grid control and operation to manage the changing uses of the grid. ENEDIS control room is in charge of supervising the system and analyzing the information the	It anticipates grid constraints for ENEDIS	Enedis	N/A	
ENGIE Aggregation platform	System	IS IT	Used by the aggregators in order to manage their flexibilities assets	The aggregators are responsible for creating and managing their own platforms	ENGIE	N/A	

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enedis storage management platform	System	IS IT	Used by Enedis in order to manage its storage systems	Deployed at control room level			
Storage systems	System	Device	System consisting of a battery, a power conversion system and auxiliary systems, capable of absorbing power and reinjecting it back later	Connected at LV level			

81. Step by Step Analysis of the Use Case

81.1. List of scenarios

There are the main scenarios for the use of the storage systems:
- Storage systems managed by Enedis
- Storage systems managed by ENGIE

81.2. Storage systems managed by Enedis

Distribution grid constraints management

The objectives of the use case are:
- Solve constraints on the public distribution grid (MV and LV) ,
- Improve the supply quality,
- Increase the integration/connection capacity of the renewable energies,
- Postpone investments.

To do so, the Enedis storage management platform is connected to the control room. In case of constraints on the distribution grid, the storage management platform sends setpoints to the storage system.

Step by step :

1. The operator in the control room detect a grid constraint
2. The operator report this constraint to the storage manager
3. The storage system manager modulates the battery charge depending on the constraint type.
4. The storage system manager adapts the battery charge to its nominal level.
5. The nominal charge level is to be determined by the storage system manager according to the identified constraints on the grid

Use case conditions
- The charge /discharge operations are not part of the market operations : the DSO does not buy/ sell the stored energy
- The DSO can operate a storage system for the needs of the public distribution grid only, it does not position itself as a storage operator on the market
- Losses related to battery performance are considered technical losses of the grid

Islanding

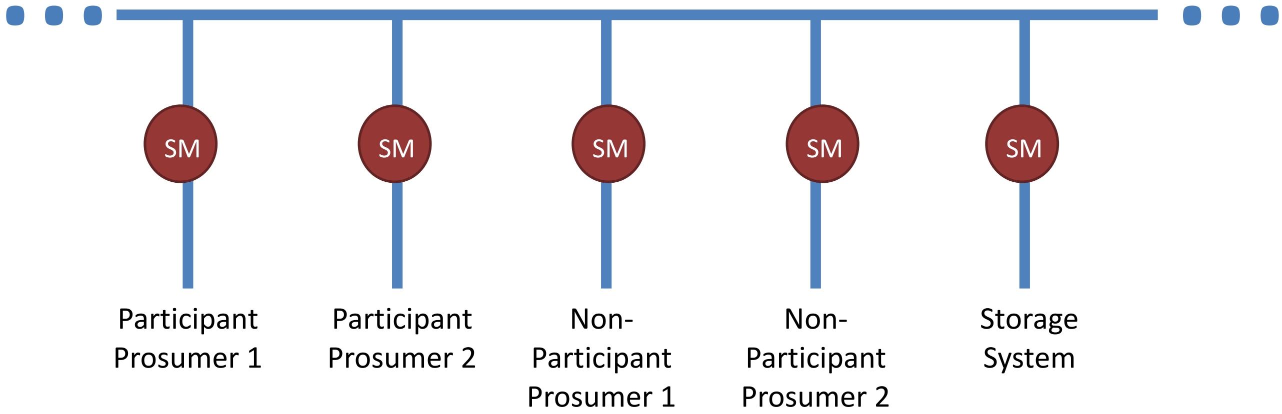
See UC1 – Islanding.

4.3 Storage systems managed by ENGIE

The storage systems from ENGIE could deliver the following services:
- "Cloud storage": using community energy storage assets to increase self consumption for customers
- Ancillary services and services on the national level (e.g. capacity and reserve mechanisms)
- Mitigating simulated grid constraints for the distribution grid on the MV and LV levels
- Islanding as grid supporting unit
- Optimization of power sourcing for end customer, including load report from peak to offpeak period and reduction of subscribed power

Focus on the cloud storage

The “cloud storage” solution proposed by this document will encompass several prosumers that are connected to the distribution grid. In this Use Case, some prosumers could have PV panels even before recruitment takes place, and the target area for the demonstrator will be chosen among the areas with the highest numbers of PV producers already installed. In addition, Enedis expects that some, if not most, of them already have smart meters measuring both the energy produced and consumed. The storage system is thus a layer to be added to an already existing and functioning system, and it must also take into consideration that not all consumers connected to the same feeder will agree to participate. A possible structure is shown below, where the storage system is integrated into an existent feeder. Each prosumer, as well as the storage system, is equipped with a smart meter, marked “SM” in the diagram.



We measure the interest of cloud storage by comparing it to the current solution relying on distributed storage installed down each prosumer’ head meter with no exchanges between prosumers. The created value comes from: installation and maintenance costs pooling, sizing optimization and land use optimization.

It is necessary to determine the rules guiding the power exchanges between the prosumers, the DSO and the storage system. An important limit is the maximum storage capacity of the storage asset, since the storage system cannot indefinitely receive the energy produced by the prosumers.

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Use Case Description

UC WP9_3 – Flexibility mechanism

Scope

This document describes the Use Case **WP9_3 - Flexibility**

The Use Case description within is divided in to five areas:

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

82. Description of the Use Case WP9.3

82.1. Use Case Identification

ID	Domains/Zones[1]	Name of Use Case	Level of Use Case
WP 9_3	**Domains:** Distribution DER Customer Premises **Zones:** Process Field Station Operation Enterprise Market	Use of flexibility delivered by aggregators for the distribution grid, through an "aggregator portal"	Detailed Use Case

82.2. Scope and objectives

Scope and Objectives of the Use Case	
Scope	This use case aims at using flexibility delivered by aggregators to manage local constraints on the distribution grid
Objective	Different objectives are the following: ▪ Test client behavior and responsiveness for aggregators ▪ Test the reliability of the use of flexibilities by the distribution system operator ▪ Test the entire chain of flexibility activation, from Enedis to the flexibilities (customers or storage assets) ▪ Test the forecasting method (predictions and constraint simulations) at an operational level (e.g. control room) for Enedis ▪ Understand the addition or cannibalization between two flexibility uses for the distribution grid and other services in competition (e.g. ancillary services) ▪ Understand the cost of flexibilities for the aggregators ▪ Test the ability to take advantage of the gas grid to make electrical flexibility available, through innovative gas appliances (gas/electric flexibility)
Related Business Case	► Multiservice approach for storage systems

82.3. Narrative of Use Case

Short description
This use case describes the scenarios- step by step- in which the DSO requires flexibility, in both preventive and emergency situation. It also details the steps a flexibility operator must follow to connect to the aggregator portal and to submit flexibility offers.
Complete description

The incidents and constraints that appear on the grid are important challenge that the DSO faces. Flexibilities could enable the DSO to manage and resolve those constraints and thus defer investments in the grid
In this context comes the aggregator portal, a digital platform that hosts the flexibility offers submitted by the aggregators and serves as a medium of communication between the DSO and the aggregators. This use case explains the process followed by both the aggregator and the DSO in order to request and offer flexibilities. The different steps can be summarized as follows:

1. Register market participants (aggregators)
2. Register flexibilities
3. Submit flexibility offers
4. Research available flexibility offers
5. Anticipate grid constraints
    a. Generation and consumption forecast
    b. Proceed power flow computations
6. Request offers (case of emergency)
7. Analyze offers
    a. Proceed a merit order
    b. Proceed power flow computations
8. Activate flexibilities
9. Settle the market
10. Bill the transaction

82.4. KPIs

ID	Name	Description
WP2.2_KPI_	Flexibility	The available power flexibility in a defined period (eg. per day) that can be allocated by the DSO at a specific grid segment. Measured in MW. This in relation with the total amount of power in the specific grid segment in the same period.
WP2.2_KPI_4	Customer recruitment rate	Customer engagement is a heuristic for the new energy system. This KPI measures if customers are prone to be more active in the new system and this will have an impact on how new solutions will be designed in a commercialization phase. A prerequisite for this is that they are willing to take part, in the first place.
WP2.2_KPI_5	Active participation of all kinds of flexibility	The DEMOs aspire to make use of flexibility from different technologies. If and how different types of technologies can actually be accessed and utilized during the DEMO phase depends on the number of different technologies that are available in the region of the DEMO as well as on the general capabilities of the DEMO. DEMOs have declared a number and types of technologies they are targeting during DEMO phase and will be measured against their initial aspirations.

82.5. Use Case conditions

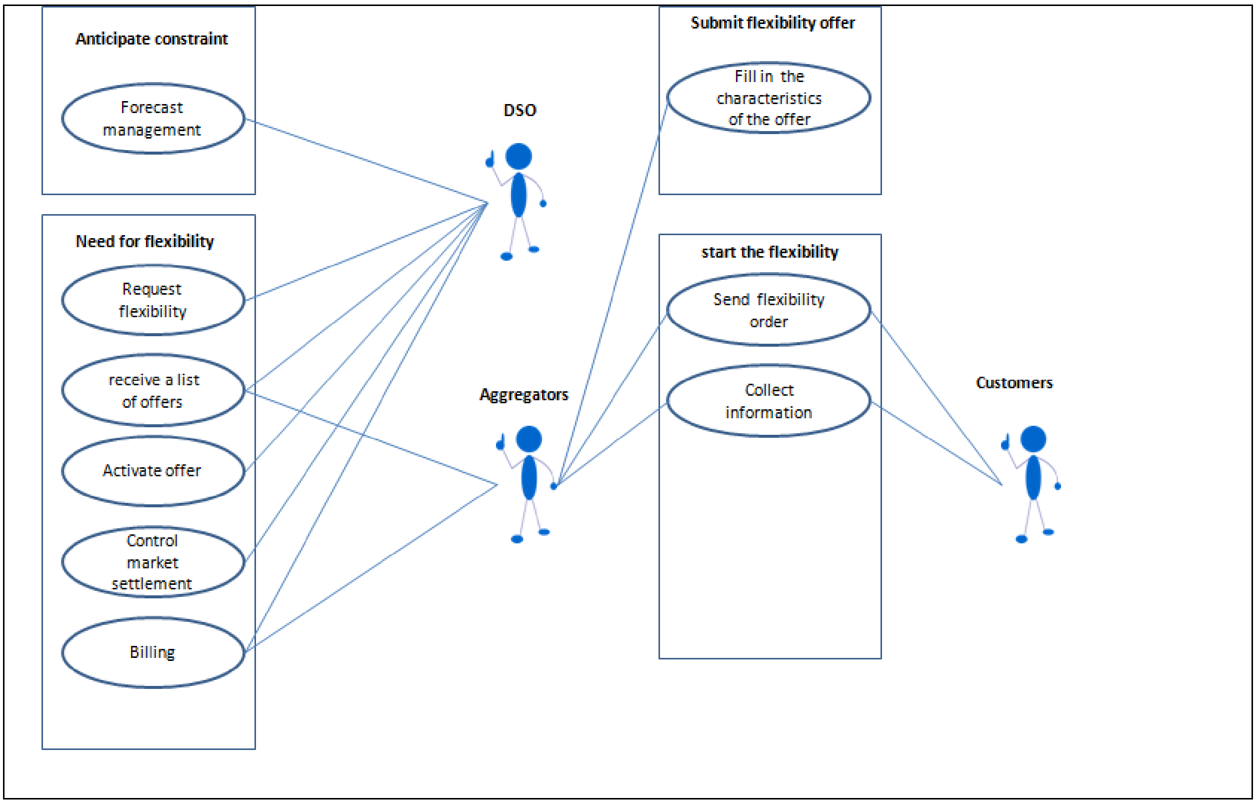
Actor	Triggering Event	Pre-conditions	Assumption
DSO	Anticipated grid constraint: request flexibility	DSO already anticipated the constraint	Forecast tools operational
Aggregator	DSO requests flexibility offers	Aggregator already registered in the aggregator portal	Aggregator successfully registered in the portal with valid information.
Customers	Aggregator sends flexibility order	Customers agreed to participate in the flexibility program	The customers have an operational control system for the flexibility.

82.6. Classification information

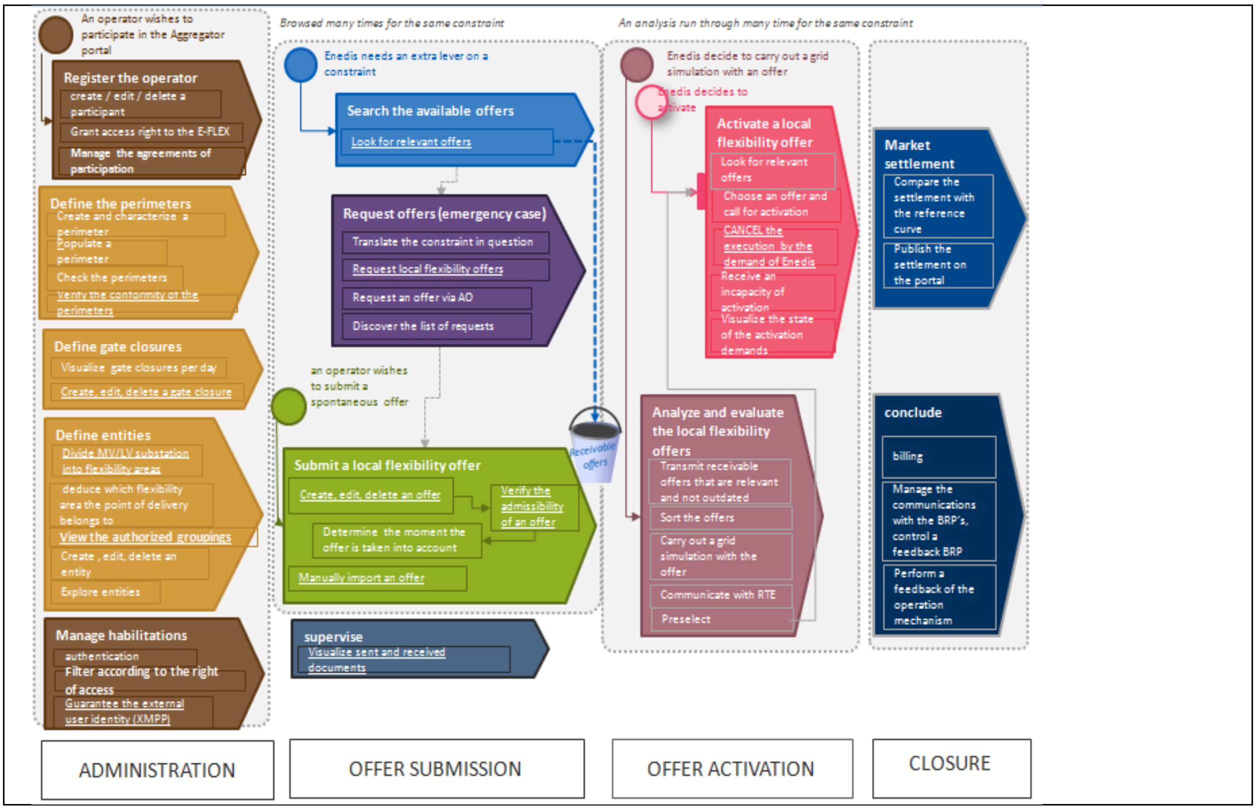
Relation to Other Use Cases in the same project or area
Storage
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case
Prioritization
Obligatory / mandatory
Generic, Regional or National Regional relation
Regional
Nature of the viewpoint- describes the viewpoint and field of attention
Technical, test.
Further Keywords for Classification
Distribution Network Operation.
Maturity of Use Case
In preparation.

83. Diagrams of the Use Case

83.1. Diagram of the Use Cass



Sequence diagram of the Use Case



84. Technical details of the Use Case - Actors

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Enedis	Role	DSO	Enedis is managing the distribution grid and using flexibility	Enedis is operating the aggregator portal and the forecast management tool from the control room	N/A	N/A	
ENGIE	Role	Aggregator	ENGIE manages a flexibility portfolio ENGIE contracts with the customers ENGIE installs the equipment necessary for the flexibility control ENGIE installs and operates storage assets ENGIE manages gas/electric flexibility on the residential	ENGIE connects to the aggregator portal and submits its offers. It specifies all the characteristics relative to the offer ENGIE aggregation platform connects to the GRDF	Confidential	Classical connection for end customers Dedicated grid connection for storage systems	

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
EDF	Role	Aggregator	EDF manages a flexibility portfolio EDF contracts with the clients EDF installs the equipment necessary for the flexibility control EDF manages gas/electric flexibility on the business level	EDF connects to the aggregator portal and submits its offers. It specifies all the characteristics relative to the offer EDF aggregation platform connects to the	Confidential	Classical connection for end customers	
GRDF	Role	Gas DNO	GRDF installs gas/electric appliances at customer premises GRDF deploys communication infrastructure between gas/electric flexibility and its	GRDF deploys a gas/electric flexibility supervision system	WIT SUEZ Smart Solutions AREAL	Classical connection for end customers	
Customers	Role	Legal or physical client	They modify their consumption in order to deliver flexibilities to the grid	They sign contracts with the aggregators	N/A	Classical connection for end customers	

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Aggregator portal	System	Interactive communication device	It serves as an interfacing tool that ENEDIS uses to request/activate flexibility offered by the aggregators	It Hosts the flexibility offers submitted by the aggregators and serves as a medium of communication between ENEDIS and the aggregators.	Enedis	N/A	CIM Market
Forecast management IS	System	IS IT	It helps grid control and operation to manage the changing uses of the grid. ENEDIS control room (ACR) is in charge of supervising the system and analyzing the information obtained	It anticipates grid constraints for the ENEDIS	Enedis	N/A	
Aggregation platform	System	IS IT	Used by the aggregators in order to manage their flexibilities assets	The aggregators are responsible for creating and managing their own platforms	EDF/ENGIE	N/A	

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Gas/electric appliances	System	In house device	High efficiency gas products that will give a smooth gas/electricity flexibility to the power grid without any impact on end user comfort	It is based on technologies such as : cogeneration and hybrid heating	GRDF	N/A	
ENGIE flexibility control infrastructure	System	Communication infrastructure	It enables ENGIE to control and communicate with its flexibility infrastructure		Confidential		
EDF flexibility control infrastructure	System	Communication infrastructure	It enables EDF to control and communicate with its flexibility		Confidential		
GRDF gas/electric flexibility supervision system	System	Communication infrastructure	It enables GRDF to control and communicate with gas/electric flexibility		WIT SUEZ Smart Solutions AREAL		
Smart meter	System	In house device	It can send information and transfer control orders to the residential equipment. Linky is the smart meter deployed in FRANCE		Itran Sagem …		

Actor Name	Actor Type	Actor Subcategories	Actor description	Further information specific to this UC	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
MV sensors and switchers	System	Network devices	Equipment installed on the MV grid that gives information about the MV electrical system parameters	The information obtained by the sensors help observe the grid and anticipate constraints			

85. Step by Step Analysis of the Use Case

85.1. List of scenarios

There are two main scenarii for the use of the flexibility:

- A preventive scenario, in which the DSO can request flexibility on the day before
- An emergency scenario, in which the DSO requires flexibility in real time

A registration is necessary first, in order for the aggregator to connect to the portal and the flexibilities to be recorded in the aggregator portal

85.2. Steps – primary scenario

- Preliminary step: registration

The aggregator has to fill in its **administrative information** when connecting to the portal for the first time, or when adding new flexibility assets to its portfolio. For that, it needs to define three key elements of his flexibility assets:

- point of delivery (connection) of the flexibility. This number is unique for each customer of storage asset
- related flexibility entity
- related flexibility perimeter

Preventive scenario

The first scenario is a preventive scenario, i.e. a **preventive activation of flexibility** to anticipate works on the grid or a predictable incident on the distribution grid. Within this approach, the flexibilities can be offered the day before.

Scenario Name : Preventive scenario							
Step No.	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**
1	The DSO detects a constraint on the grid	The DSO foresees a future constraint on the grid according to the forecast management tool.	DSO	DSO	Grid simulation computation results	EXECUTE	The DSO must have all the necessary sensors on the grid
2	DSO requests flexibility offers	The DSO requests via the aggregator portal local flexibility offers from the aggregators	DSO	Aggregators	A flexibility request	CREATE	Aggregators and flexibility are registered
3	Aggregators submitted flexibility offers	Aggregators send flexibility offers to the DSO. DSO can visualize a list of offers on the portal submitted by the aggregators.	Aggregators	DSO	Flexibility offers	GET	The aggregators must fill in all the characteristics of their offers.
4	DSO decides to carry out a grid simulation with flexibility offers	The DSO needs to ensure that the offer resolves the constraint in question	DSO	DSO	A grid simulation results	EXECUTE	The aggregator must have gone through the process described in the pre-requisite

5	DSO analyzes and evaluates the flexibility offers	The DSO ranks/sorts the flexibility offers based on a merit order	DSO	DSO		CREATE	The simulation /study described in the previous step must be verified
6	The DSO reserves the offers	After proceeding the merit order and selecting the suitable offers, the DSO reserves the offers in question, before calling for their activation.	DSO	Aggregators		REPORT	
7	The DSO activates flexibility offers	The DSO informs the Aggregator of the activation of his offer. The activation order contains : • The reference N° of the activation order • The Identification N° of the flexibility offer • The power requested • Time of beginning and end of the activation	DSO	Aggregators	An order of activation	EXECUTE	
8	Market settlement	The DSO compares the flexibility activation with the offer conditions to check whether the flexibility correctly worked and complied with the requirements.	DSO	DSO	Load curves	GET	
9	Billing	The DSO proceeds the calculation of the bills : • Charge the aggregator the sum of all the positive increases and decreases of the activation • Pay the aggregator the sum of all the negative increases and decreases of the activation It monthly publishes the necessary data for establishing and controlling the bills	DSO	Aggregators	Billing information	REPORT	

Emergency Scenario

The **emergency scenario**, in case of unforeseen incident on the grid, will be different of the preventive scenario described above, because **the flexibility has to be involved in the very short term, near real time**. **This scenario is still under discussion between aggregators and the DSO**. The last steps (7-9) of the preventive scenario **should remain unchanged** for the emergency scenario. The first step need to take into account the **emergency of the situation**, the **processing time at the regional control room**, and the **communication time between DSO and aggregators**.

- - * - -

ANNEX 3

Guideline to Use Case description within InterFlex project

Content

Scope

This document describes the way of Use Cases description within InterFlex project.

It provides the following information:

- it explains the template which will be used within InterFlex project. The Use Case template is based on IEC PAS 62559.
- it provides a template for a structured description of Use Cases.

The Use Case description within InterFlex is divided in to five areas

- Description of the Use Case
- Diagrams of the Use Case
- Technical data - Actors
- Step by Step Analysis of Use Case (can be extended by detailed info on “information exchanged”)
- Information exchanged

1. Description of the Use Case

1.1. Use Case Identification

A Use Case is a list of actions or event steps, defining the interactions between an Actor and a system, to achieve a goal.

ID	Domais/Zones[1]	Name of Use Case	Level of Use Case[2]
WPX_1	Enter a name from the Domain/Zone list	Enter a short name that refers to the activity of the Use Case itself. Example: "Determine energy balance on substation level"	Cluster, High Level Use Case, Detailed Use Case

[1] **Domains and Zones**
Power system management distinguishes between electrical process and information management. These viewpoints can be partitioned into the physical domains of the electrical energy conversion chain and the hierarchical zones for management of the electrical process. The *Smart Grid Plane* spans in one dimension the complete electrical energy conversion chain, partitioned into five domains: (Bulk) Generation, Transmission, Distribution, DER and Customer Premises. And in the other dimension the hierarchical levels of power system management, partitioned into six zones: Process, Field, Station, Operation, Enterprise and Market. (*SG-CG/ M490/F_ Overview of SG-CG Methodologies, Version 3, CEN-CENELEC-ETSI Smart Grid Coordination Group)*

1.1.1. Table of domains

Domain	Description
(BULK) GENERATION	Representing generation of electrical energy in bulk quantities typically connected to the transmission system, such as by fossil, nuclear and hydro power plants, off-shore wind farms, large scale solar power plant (i.e. PV, CSP).
TRANSMISSION	Representing the infrastructure which transports electricity over long distances.
DISTRIBUTION	Representing the infrastructure which distributes electricity to customers.
DER	Representing distributed electrical resources directly connected to the public distribution grid, applying small-scale power generation and consumption technologies (typically in the range of 3 kW to 10,000 kW). These distributed electrical resources may be directly controlled by e.g. a TSO, DSO, an aggregator or Balance Responsible Party (BRP).
CUSTOMER PREMISES	Hosting both end users of electricity and also local producers of electricity. The premises include industrial, commercial and home facilities (e.g. chemical plants, airports, harbors, shopping centers, homes). Also generation in form of e.g. photovoltaic generation, electric vehicles storage, batteries, micro turbines.

1.1.2. Table of zones

Zone	Description
PROCESS	Including the physical, chemical or spatial transformations of energy (electricity, solar, heat, water, wind,…) and the physical equipment directly involved (e.g. generators, transformers, circuit breakers, overhead lines, cables, electrical loads, any kind of sensors and actuators which are part or directly connected to the process,…).
FIELD	Including equipment to protect, control and monitor the process of the power system, e. g. protection relays, bay controller, any kind of intelligent electronic devices which acquire and use process data from the power system.
STATION	Representing the areal aggregation level for field level, e.g. for data concentration, functional aggregation, substation automation, local SCADA systems, plant supervision…
OPERATION	Hosting power system control operation in the respective domain, e.g. distribution management systems (DMS), energy management systems (EMS) in generation and transmission systems, microgrid management systems, virtual power plant management systems (aggregating several DER), electric vehicle (EV) fleet charging management systems.

Zone	Description
ENTERPRISE	Including commercial and organizational processes, services and infrastructures for enterprises (utilities, service providers, energy traders …), e.g. asset management, logistics, work force management, staff training, customer relation management, billing and procurement…
MARKET	Reflecting the market operations possible along the energy conversion chain, e.g. energy trading, retail market.

1.1.3. [2] Levels of Use Cases

Use Cases can be defined on various levels. They can be either defined on a high level close to a business process (for example "A consumer change supplier" or "Manage the EV charging process") or on a much lower level (for example "On-demand meter read" or "Start charging"). In order to identify the level of detail, the following levels are defined:
Level 1 – Cluster
Level 2 – High level Use Case
Level 3 – Detailed Use Case

Types of Use Cases	Description
Use Case cluster	A Use Case cluster represents a group of high level Use Cases. Cluster may span several domains. EXAMPLE: Smart Charging
High level Use Case	A high-level Use Case (HL-UC) describes the general idea of a function together with generic actors. The HL-UC can be realized in different ways, so the HL-UC cannot be mapped to a specific system or architecture. HL-UC is a generic and abstract and can be detailed by other Use Cases. EXAMPLE: Fault Location, Isolation, Restoration (FLIR) in general.
Detailed Use Case.	A Use Case is a list of actions or event steps, defining the interactions between an Actor and a system, to achieve a goal. Use case should be assigned to one domain.

1.2. Version Management

Version	Date	Name Author(s) or Committee	Changes
e. g. V0.1 – Document initiation		Person or e.g. standardization committee	Describe the changes made

1.3. Scope and objectives

Scope and Objectives of the Use Case	
Scope	The scope describes the aims and boundaries of the Use Case in a short, precise text. The scope draws the boundary between what's in and what's out for the project.
Objective	The objectives are itemized in form of bullet points and a small headline. Goals the Use Case is expected to achieve for the Actor using the system. Objectives should be SMART3
Related Business Case	*E. g. Distribution grid operation*

[3]Objectives should be SMART:
- *Specific* – target a specific area for improvement.
- *Measurable* – quantify or at least suggest an indicator of progress – KPI.
- *Assignable* – specify who will do it.
- *Realistic* – state what results can realistically be achieved, given available resources.
- *Time-related* – specify when the result(s) can be achieved

1.4. Narrative of Use Case

Short description – max 3 sentences
Short description – not more than ten lines/three sentences - as service for the reader searching for a Use Case or looking for an overview.
Complete description
Full description of the Use Case, a complete narrative of the function from a domain expert user's point of view, describing what occurs when, why, with what expectation, and under what conditions. It has to be written in a way that it can also be understood by non-experts.

1.5. KPIs

Key performance indicators (KPI) have a unique ID and name, a description in form of a few sentences and, usually, they are associated to one of the above-listed Use Case objectives, which is stored in the field reference to mentioned Use Case objective.

ID	Name	Description	Reference to mentioned Use Case objectives

1.6. Use Case conditions

Describe conditions that must exist prior to the initiation of the Function, such as prior state of the Actors and activities. Identify any assumptions, such as what systems already exist, what contractual relations exist, and what configurations of systems are probably in place.

Actor	Triggering Event	Pre-conditions	Assumption
Describe which Actor(s) trigger(s) this Use Case	Describe what event(s) trigger(s) this Use Case	Describe what condition(s) should have been met before this Use Case happens	Describe the assumptions about conditions or system configurations.

1.7. Classification information

Relation to Other Use Cases in the same project or area
Is there a relation (*include*, *extend*, *invoke*, or *associate)* to the other Use Cases?
Level of Depth - the degree of specialization of the Use Case
Detailed Use Case/High Level Use Case/Cluster
Prioritization
Prioritization helps to rate the Use Cases in a project from very important to nice-to-have. *- e.g. obligatory / mandatory, optional, nice to have*
Generic, Regional or National Regional relation
Choose from *Generic, Regional or National Regional*
Nature of the viewpoint- describes the viewpoint and field of attention
- *e.g technical*, *political*, *business/market*, *test…*
Further Keywords for Classification

- *e.g State Estimation/Distribution Management System/Distribution Network Operation/…*
Maturity of Use Case
- *e.g* - *in business operation* - *realized in demonstration project* - *realized in R&D* - *in preparation* - *visionary*

2. Diagrams of the Use Case

Diagram of Use Case is a visual representation of a Use Case. There are two basic ways how to draw a Use Case diagram: context or sequence diagram. Within the InterFlex project we will use both types of diagrams.
Context diagram represents the relationships between Actors and Use Cases and documents the system's intended behavior. A simple Use Case diagram is shown below in Figure 3. Use Case diagram consists of Actors, Use Case and system.
Sequence diagram shows the steps of the Use Case scenarios.

2.1. Use Case

A Use Case is a list of actions or event steps, defining the interactions between an Actor and a system, to achieve a goal.
The Use Case will be in context diagram depicted as:

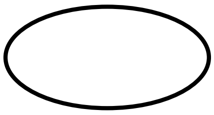


Figure 1: The UML symbol for a Use Case

2.2. Actors

An Actor is an entity that interacts with the system and/or needs to exchange information with the system. The Actor is not part of the system itself and should be included to represent anyone or anything that interacts with the system. (For more details, please see chapter 3. Technical details – Actors.
The Actor will be in context diagram depicted as:

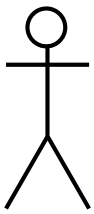


Figure 2: The UML symbol for an Actor

2.3. System boundary

Things inside the boundary of the system are things you need to worry about creating. In a UML Use Case diagram, the *system boundary* is denoted by a rectangle:

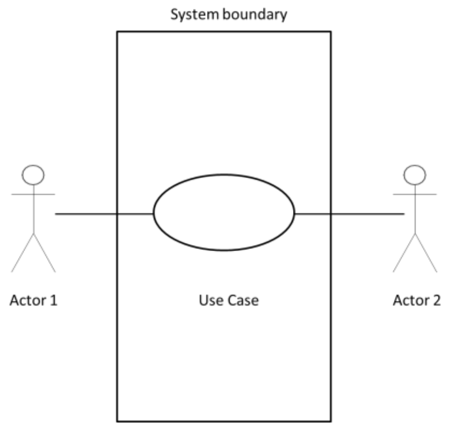
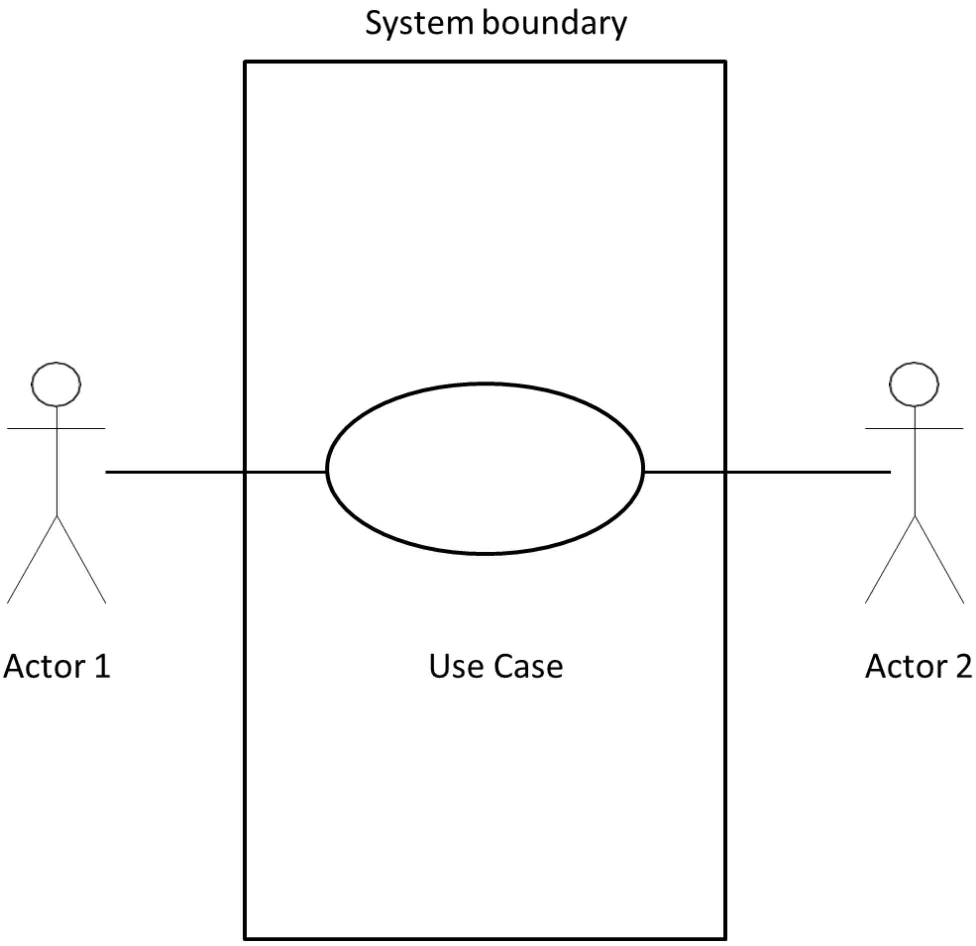
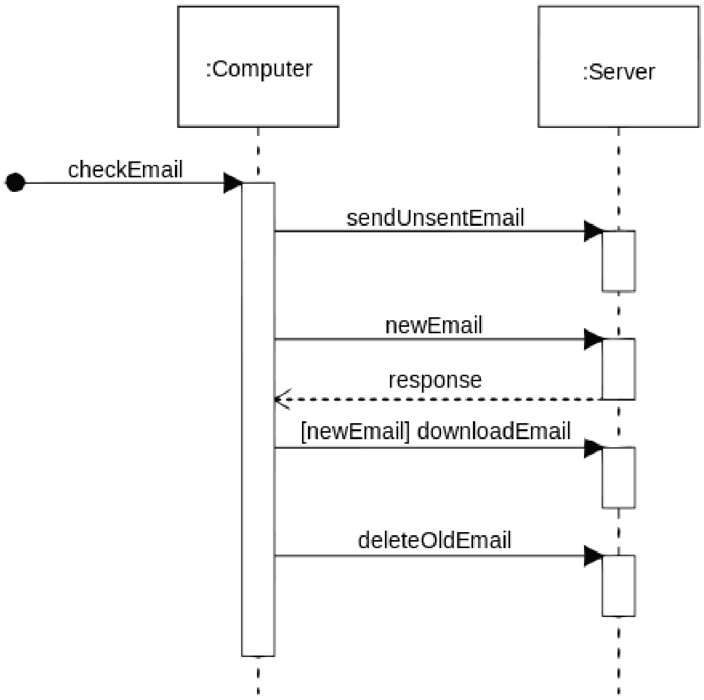


Figure 3: System boundary symbol

2.5. Drawing or Diagram of Use Case

Provide context and sequence diagram for the Use Case.

Context diagram
Example 

Sequence diagram
Example: diagram of email message sequence 

3. Technical details of the Use Case - Actors

An Actor is an entity that interacts with the system and/or needs to exchange information with the system. The Actor is not part of the system itself and should be included to represent anyone or anything that interacts with the system in the following ways:

- supplies input information to the system
- receives information from the system
- both supplies input information to and receives information from the system

Actor Name	Actor Type[4]	Actor Subcategories[4]	Actor description	Further information specific to this Use Case	Equipment Manufacturer	Grid Connection Requirements	IEC Standards
Every actor needs a unique actor name. E. g. Voltage sensor/ switch/IED/Scada/ DMS/operator	System/Role	To be used for the classification of data protection/confidentiality related aspects (WP2.3)		Describe specific role of an Actor within this Use Case.		e.g. Requirements from grid code YES (if yes, please provide the reference)/NO	YES (please provide the reference)/NO

[4]The Actor list comprises both types: an Actor might be a role (organization, roles that people fill, other stakeholders) or it might be a system type (application, function, database, the power system).
Select from the Subcategories listed in Annex A or in case of a new subcategory, please introduce it in the structure given in Annex A (insertion of new row in the Annex A).

How to identify Actors?

- *Who uses the system?*
- *Who installs the system?*
- *Who starts up the system?*
- *Who maintains the system?*
- *Who shuts down the system?*
- *What other systems use this system?*
- *Who gets information from this system?*
- *Who provides information to the system?*

4. Step by Step Analysis of the Use Case

This section describes the possible scenarios of the Use Case with a distinct association to the Use Case narrative.
Primary Scenarios are named PS1, PS2, PS3 and so on in column S.No; alternative scenarios are named AS1, AS2, AS3 and so on (S.No).
The scenarios should comply with the sequence diagrams, so that every step describes one part of a communication or action. Apart from a normal success scenario, different failure scenarios or alternatives can be included to describe situations where preconditions are not satisfied or unwanted states are attained.
Start with the normal scenario (success). In case pre-condition or post-condition provides not the expected output (no success = failure) alternative scenarios have to be defined. Trigger for alternative routes.

Steps within each scenario are numbered sequentially. The table below provides an overview of all scenarios.

4.1. List of scenarios

S.No	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
PS1			The primary actor is the first actor appearing in the scenario at the incident causing the scenario to begin, called triggering event. Describe which Actor(s) trigger(s) this scenario	Describe what event(s) trigger(s) this scenario	Describe what condition(s) should have been met before this scenario happens.	Describe what condition(s) should prevail after this scenario happens. The post conditions may also define “success” or “failure” conditions for each Use Case.

S.No	Scenario Name	Scenario Description	Primary Actor	Triggering Event	Pre-Condition	Post-Condition
AS1			Describe which Actor(s) trigger(s) this scenario	Describe what event(s) trigger(s) this scenario	Describe what condition(s) should have been met before this scenario happens.	Describe what condition(s) should prevail after this scenario happens. The post conditions may also define "success" or "failure" conditions for each Use Case.

4.2. Steps – Primary Scenario

List the steps of the scenario in consecutive execution order with their step number and a triggering event. The event often just states that the last step has been performed successfully. Each step represents a process or activity which gets a unique name and a brief explanation of the procedure taking place in its description. The second half of the columns of this table deals with the information which is exchanged in the respective step. The Service addresses the nature of the information flow with the following possibilities:

- GET (default): The information receiver obtains information from the information producer after an implicit request.
- CREATE: The information producer creates an information object.
- CHANGE: The information producer performs an update of the information at the information receiver's.
- DELETE: The information producer deletes information of the receiver.
- CANCEL/CLOSE: A process is terminated.
- EXECUTE: An action or service is performed.
- REPORT: The information producer supplies information of its own account.
- TIMER: The actor which represents both information producer and receiver has to enforce a waiting period.
- REPEAT: A number of steps has to be repeated until a break condition (stated in the field Event) is satisfied. The contemplated steps have to be added in parentheses

-

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1					ID or description	Get/Create/Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains or other issues	e.g. GPRS, Fibre, PLC	e.g. voice, GUI, protocol

4.3. Steps – Alternative, Error Management, and/or Maintenance/Backup Scenario

Scenario Name :									
Step No	**Event**	**Description of Process/Activity**	**Information Producer**	**Information Receiver**	**Information Exchanged**	**Service**	**Requirements**	**Communication Media**	**Communication Means**
1					ID or description	Get/Create/Change/Delete/Cancel(Close/Execute/Report/Timer/Repeat	Configuration, Quality service, Security, Privacy, Data Management, Constrains or other issues	e.g. GPRS, Fibre, PLC	e.g. voice, GUI, protocol

5. Information exchanged

This section provides detail information about the information exchanged within the Use case (in the scenario steps)

Inf. ID	Name of information exchanged	Description of information exchanged	Information Subcategories[5]	Requirements
			To be used for the classification of data protection/confidentiality related aspects (WP2.3)	

[5] Select from the Subcategories listed in Annex B or in case of a new subcategory, please introduce it in the structure given in Annex B (insertion of new row in the Annex B).

Annex A – List of Actor Subcategories

Category	Type	Subcategory	Definition	Example
Actors	Role	DSO	Responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area	Avacon, CEZ, E.ON, Enexis, Enedis
Actors	Role	Industrial partner	All industrial partners involved in InterFlex project at a DEMO level	- GE - Siemens - Schneider …
Actors	Role	University and research partner	All university or research partners involved in InterFlex project at a DEMO level	- RWTH - AIT etc
Actors	Role	Retailer	Licensed supplier of electricity to an end-user	- EDF - Engie...

Category	Type	Subcategory	Definition	Example
Actors	Role	Legal Client	A legal client of a DSO that is involved at Demo scale	- Company producer - Municipalities - Tertiary service providers
Actors	Role	Physical client	A physical client of a DSO that is involved at Demo scale	- Residential client
Actors	System	Charging facilities	Facilities to charge electrical vehicles	- Charging facilities
Actors	System	DER installation	Power plant that use renewable technology and are owned by a legal person	- Photovoltaics panels - Biomass farm - Wind power, …
Actors	System	In house device	All devices working on electricity that can be find in a customer's dwelling.	- Heater - Meter - Local display - Customer's battery
Actors	System	Communication infrastructure	All the infrastructure that are used for communication at all level (from customer's place to power command)	- Modem - Routers
Actors	System	Network device	All devices placed on MV/LV network for monitoring or gathering information on grid's situation or electrical parameters values. It also include the IS associated	- Secondary Substation control infrastructure - RTU : Remote terminal units - Circuits breakers - sensors
Actors	System	IS IT	All the hardware and software associated, used at power command to control and monitor the network	- SCADA - Central database - Control operation center
Actors	System	Interactive communication device	All device used to interact with customers in order to involved him in the Demo	- Web portal - Display used for communication

InterFLEX

Annex B – List of Information Subcategories

Category	Type	Subcategory	Definition	Example
Data	Document	Internal document	All the documentation made by Demo to run operation, to monitor and conduct the project's good development	- Meeting minutes - Report on the cost's impact of selected flexibility plans
Data	Document	InterFlex deliverable	All the deliverables that Demo have to produce during the project's time as agreed in the DOW	- Risk analysis - Documentation on KPI - Detailed Use Case - Report on technical experimentation, market research, …
Data	Document	Communication material	All the documentation that describe the project to the public and can be put on the future website	- Purpose of the DEMO (leaflet) - Brief description of Use Case - Location of Use Case
Data	Financial data	Project financial data	All the financial data that are produced during the project and that are used to make financial report for European Commission and internal report	- Invoices - Cost and time imputation
Data	Financial data	Solution cost and selling price	All the financial data that can be made concerning estimation prices of solution for replication	- Unit product cost of hardware developed by Demo - Sell price of the solution develop (software,…)
Data	Parameter	Condition parameter	All the external parameters that may influence the success of the Use Case	- Weather - Time of day - Day of week …
Data	Parameter	Scenario assumption	All the stated parameters that are necessary to determinate a scenario for the Use Case	- Location of islanding - Experiment's location
Data	Parameter	Electrical parameter	All the electrical parameters that are used to supervise the network and its good state	- Intensity - Voltage - Frequency - Quality
Data	Parameter	Algorithm, formula, rule, specific model	All the intellectual data that are created during the project to made software's contents	- Algorithm to optimize flexibility plan - Simulation to determine location of circuit breaker - Voltage regulation algorithm
Data	Parameter	Optimized value	Values of parameters that optimized the Use Case or the demo's performance	- Optimization time of islanding
Data	Parameter	Forecast data	All the data used to forecast consumption or production of customer	- Forecast customer's consumption - Forecast photovoltaic panels' production
Data	Facility data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Facility data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation

Category	Type	Subcategory	Definition	Example
				- Location of constraint - Flexibility needs of DSO
Data	Facility data	Customer's meter state and output	All the information concerning customer’s meter state and outputs information	- Customer’s consumption or production
Data	Facility data	Other device state and output	All the information concerning device's state and outputs information	- State of charge of batteries - Consumption data coming from meter - Production data coming from meter - State of charge of storage components
Data	Parameter	Information exchanged between IS or sent to device	All automated information sent between facilities in order to send information or order for monitoring	- Order sent to breaker devices (open, close,…) - Information on local network status coming from sensors - Order and roadmap sent to network devices (batteries, aggregator,…)
Data	Parameter	Detailed specification on devices	All detailed information (reference components, specification, process,…) useful to build the devices	- Detailed specification of the telecommunication infrastructure - Detailed specification of interactive sensor network
Data	Network data	Network topology	All information on network devices and their location and interaction, mainly coming from GIS (Geographic Information System)	- Map of the network - Substations location - All the other data found in the GIS (Geographical Information System)
Data	Network data	Network state	All information concerning the network's status (global or local) at a precise moment useful to monitor the network	- Feeding situation in a distribution area - State of network regarding Limit value violation - Location of constraint - Flexibility needs of DSO
Data	KPI	Data for KPI (input raw data)	All raw data that are used to calculate the final KPI	- Duration of experiment - Customer response to DSO's demand - Electrical parameter used for KPI
Data	KPI	KPI (KPI values)	All the KPI values and the way to calculate them	- Economic KPI - System Efficiency KPI
Data	Customer data	Customer contract’s data	All the data in customer's contact that are used for contact or make payment	- Address - Phone number - Bank account details
Data	Customer data	Information sent to /received from customer	All the information and data that are exchanged between the DEMO and the customer in order to involve customer in the experiment	- Customer's response to DSO's request to reduce consumption - Information and data available to customer in order to visualize its consumption - Advices and encouragement sent to encourage a smart consumption
Data	Customer data	Customer analysis (profile analysis, studies on client reactivity,…)	All the data that are produced in order to better understand the customer's behaviour regarding the possibility to adopt smarter habits in their electricity consumption	- Customer's typology and behaviour patterns - Analysis on customer's response to DSO's request