Title:	Document Version:
D2.1 WiseGRID requirements, Use cases and pilot sites analysis	1.0

Project Number:	Project Acronym:	Project Title:
H2020-731205	WiseGRID	Wide scale demonstration of Integrated Solutions for European SmartGrid

Contractual Delivery Date:	Actual Delivery Date:	Deliverable Type*-Security*:
M9 (July 2017)	M9 (July 2017)	R-PU

*Type: P: Prototype; R: Report; D: Demonstrator; O: Other.

**Security Class: PU: Public; PP: Restricted to other programme participants (including the Commission); RE: Restricted to a group defined by the consortium (including the Commission); CO: Confidential, only for members of the consortium (including the Commission).

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Abstract:
This document reports the work performed within WP2 WiseGRID Use cases, requirements and KPIs definition. More specifically, following the presentation of the WiseGRID objectives and tools, the methodology for defining the Use Cases, for identifying the requirements and for formulating the Key Performance Indicators (KPIs) is presented. Furthermore, the core of the document comprises the Use Cases in itself, the requirements, scenarios and KPIs. Last but not least, the document includes the pilot site formal analysis where the Use Cases will be demonstrated.

Keywords:

Foundations, WiseGRID objectives, WiseGRID tools, methodology, requirements, Use Cases, Key Performance Indicators, scenarios, pilot sites.

Revision History

Revision	Date	Description	Author (Organisation)
V0.0	11.05.2017	New document	Georgia Asimakopoulou (ICCS)
V0.1	05.06.2017	Sections 1, 2 completed	Georgia Asimakopoulou (ICCS)
V0.2	12.07.2017	Sections 3-16 completed	All partners
V0.3	20.07.2017	Peer review	Ine Swennen (ECO), Vincent Dierickx (EID)
V0.4	21.07.2017	Peer review	Francesca Santori (ASM)
V0.5	24.07.2017	Version including partners comments	Georgia Asimakopoulou (ICCS)
V1.0	25.07.2017	Minor final changes	Ana María Arias (ETRA), Georgia Asimakopoulou (ICCS), Kostas Komninos (AEA), Benjamin Kraft (VS)

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EXECUTIVE SUMMARY

WiseGRID objectives

The WiseGRID project in its entirety is driven by four core strategic goals, to the achievement of which, the innovative solutions and technologies to be developed within the Project contribute directly. These goals are in line with the EU goals regarding:

- The development and demonstration of **innovative and advanced Demand Response (DR) mechanisms** that will facilitate the active participation, protection and empowerment of the European consumers and prosumers (households and businesses) in the energy grid and market, through flexible RES generation, self-consumption and storage, or through intermediaries such as aggregators and suppliers on behalf of the former.
- The **smartening of the distribution grid**, in order to achieve smooth operation of the grid through advanced techniques while actively integrating new assets such as VPPs and microgrids.
- The **integration of renewable energy storage systems in the network**, such as batteries or heat accumulators, the management of which will ensure the optimal operation of the network.
- The development of tools for planning the deployment of **electric mobility services**, as well as the management of charge and discharge of these vehicles – including the possible use of their batteries as storage systems or VPPs.

Methodology

In order to achieve the aforementioned goals, a specific methodology is followed regarding the definition of the requirements that should be met by the technologies to be developed and deployed; the definition of the Use Cases for testing the actual impact of the proposed solutions; the identification of Key Performance Indicators that enable the unbiased evaluation and quantification of the Project outcomes.

Requirement analysis

Through the requirement analysis it is possible to identify all necessary attributes, capabilities, characteristics, or qualities of a system that cover the needs of its users. To this end, each requirement describes measurable conditions the fulfillment of which is possible to be evaluated. The Volere methodology is being put to use, since it assists in the description, formalization and tracking of the Project requirements in an explicit and unambiguous manner. Additionally, it is not only useful in the initial phases of the Project, but also during the implementation phase and management in general.

For better organization of the work, ten classification groups are identified (one referring to the general architecture and one per WiseGRID product). Each requirement is characterized by its priority (5: high; 4-3: medium; 2-1: low). High priority is assigned to requirements that either realize a key innovation of the project or are needed to realize it and are, thus, necessary for achieving the goals of the Project.

A web tool is used to support the whole requirement definition process, which is performed iteratively: after a requirement is initially specified, the users of the tool validate the information and can identify any conflicts and dependencies and suggest specific changes or raise objections. A revision process follows, in order to improve each requirement, while at the same time new requirements can be added. By repeating the aforementioned process, the optimal set of requirements is produced.

Use Case definition

Even though the Use Case methodology defined in IEC 62559-2:2015 originally derives from the software engineering discipline, the straightforward manner it offers for describing the intended functionalities (static as well as dynamic) of the system under study renders it also appropriate for application in the smart grid. In fact, the Use Case Methodology is the basis upon which the Smart Grid Architecture Model (SGAM) framework builds. Within WiseGRID three levels of Use Cases are employed, each one with a different level of abstraction and – by extension – different level of granularity:

- High level use case (HL-UC): describes a general idea of a function;
- Primary use case (PUC): use case implemented in a specific system characterized by a defined boundary;
- Secondary use case (SUC): describes core functionalities that are used by multiple PUCs.

These Use Cases are formulated using a specific template that supports the process of mapping each characteristic of the Use Case to the SGAM layers.

One important part of the Use Cases is the identification of the actors involved in each one of them. In order to establish a common understanding and language regarding the actors involved in the Use Cases defined within WiseGRID, a list of 45 actors is defined. This list includes a definition commonly accepted by all partners, as well as the actor type (device, application, person, organization).

Key Performance Indicators

In order to evaluate the results of the solutions proposed and implemented within WiseGRID, it is necessary to quantify the tangible and measurable impacts which contribute to specific EU policy goals. To this end, the methodology proposed by GRID+ [1] for defining the Key Performance Indicators (KPIs) is followed. In order to ensure compliance with the methodology and produce *meaningful*, *understandable* and *quantifiable* indices, within WiseGRID, the KPIs are defined according to the identified needs of the PUCs and are categorized as "Specific" KPIs or "Project" KPIs. Consequently, each PUC could use more than one KPIs, while one KPI could be appropriate for more than one PUCs. Apart from the essential information of the description, the formula and the unit of measurement, each KPI is also mapped to the specific European energy policy goals (*Sustainability*, *Market competitiveness* and/or *Security of supply*) to the attainment of which the Project contributes.

WiseGRID tools

With the WiseGRID project, nine different products will be developed, each one targeting on a different aspect of the electricity distribution grid.

- WiseGRID Interoperable Platform (WG IOP): a scalable, secure and open ICT platform, with interoperable interfaces, for real-time monitoring and de-centralized control to support effective operation of the energy network.
- WiseHOME: application for individual domestic consumers and prosumers to become active energy players. Mutatis mutandis, this tool is an adapted version of WiseCORP mentioned below.
- WiseCORP: application for businesses, industries, Energy Services Companies (ESCOs) and public facilities consumers and prosumers to become active, smarter energy players by giving them more power and protection, while helping them to reduce energy costs and environmental impact.
- WiseCOOP: application for energy retailers, aggregators, local communities and cooperatives of consumers and prosumers (and other intermediary companies) to help domestic and small businesses, consumers and prosumers achieve better energy deals while relieving them from administrative procedures and cumbersome research.
- WG Cockpit: tool for Distribution System Operators (DSOs) or microgrids Operators in order to control, manage and monitor their own grid, improveflexibility, stability and security of their network, while considering an in-creasing share of distributed renewable resources.

- WiseEVP: WiseGRID Electric Vehicle Platform (WiseEVP) is a tool/platform to be used by vehicle-sharing companies or electric vehicle fleet managers and electric vehicles (EVs) fleet managers, in order to optimize the activities related to smart charging and discharging of the EVs including V2G (vehicle to grid, energy injection in the distribution network) and V2H (vehicle to home, energy injection in the household electric installation).
- WG FastV2G: WG FastV2G is a charging station, which will make possible to use EVs as dynamic distributed storage de-vices, injectingenergy stored in their batteries back into the system when needed (fast V2G supply).
- WG STaas/VPP: WiseGRID STorage as a Service/Virtual Power Plants (WG STaaS/VPP) is a technological solution targeting aggregators with a respective portfolio based on distributed generation and storage. The main goal of this solution is to help consumers and prosumers (be them households or corporate) to be aggregated and offer to the market their unused storage capacity as well as spare generation in the form of a VPP.
- WG RESCO: WiseGRID Renewable Energy Service Company (WG RESCO) is a tool that will enable the provision of energy from RES, usually PV, wind power or micro hydro to consumers (household/businesses) that do not own nor wish to maintain RES production facilities.

Requirements

Following the prescribed methodology, the requirements per WiseGRID product as well as the general requirements have been identified summing up to a total of 391 requirements that deal with various aspects of the project and its tools.

General requirements

The list of general requirements helps settling the high level objectives of the project, thus helping to spread a common understanding of the work to be developed. Several different perspectives of the energy field have been taken into account – cultural, legal, regulatory and technical. This list contains the requirements (57 in total) that will guide the first steps of the project, namely:

- Objectives of the project that need to be taken into account at the design of the technological solutions.
- Implications of the interoperability among the different technological solutions to be developed.
- Horizontal technical requirements affecting all the 9 interoperable WiseGRID products.

WiseGRID IOP (Interoperable Platform)

The 16 requirements identified cover different aspects of the WiseGRID IOP tool:

- Performance: assuring high performance and efficiency on data aggregation and filtering; following standards and interoperable technologies; assuring security.
- Expected features: authentication; access control mechanisms; management of heterogeneous data information according privacy policy.

WiseGRID Cockpit

The 58 requirements identified cover different aspects of the development and deployment of the WiseGRID Cockpit tool:

- Prerequisites: Communication channels and standard protocols available for interacting with field devices and existing systems (including Geographical Information System, Supervisory Control And Data Acquisition system, Enterprise Resource Planning system, etc.); availability of assets to demonstrate the expected features (Renewable Energy Sources, smart meters, etc.); availability of data to demonstrate the expected features (measurements, topology, etc.)

- Legal requirements (contractual agreements needed among different actors for the system to operate)
- Expected features: monitoring; increased observability; information to be displayed to the operator; enhanced maintenance, fault-detection and recovery of problems in the grid; enhanced operation of the grid by interoperating with services offered by other WiseGRID technological solutions.

WiseGRID STaaS/VPP

The 38 requirements identified cover different aspects of the development and deployment of the WiseGRID STaaS/VPP tool:

- Prerequisites: necessary infrastructure (including secure communication channels) available to access the required data.
- Legal requirements: explicit permission of final users' needs to exist in order to make use of their data; anonymization of prosumer data.
- Expected features: monitoring and data processing of aggregated units; market participation of aggregated units; efficient operation and scheduling of aggregated units triggered by smart algorithms; demand-response participation; billing and contracting; integration with tools to provide feedback to end-users; integration with tools to receive grid data and commands from DSO; cyber and physical security.

WiseCOOP

The 20 requirements identified cover different aspects of the development and deployment of the WiseCOOP tool:

- Prerequisites: necessary infrastructure available to access de required data.
- Legal requirements: explicit permission of final users' needs to exist in order to make use of their data.
- Expected features: monitoring; profiling; demand-response participation; billing; integration with tools to provide feedback to end-users.

WG RESCO

The 20 requirements identified cover different aspects of the development and deployment of the WG RESCO tool:

- Expected features: monitor energy produced by installed RES assets; monitor energy consumed by RESCO customers; showing data monitoring; provide information to its customers
- Operational requirements: portfolio management; user profiling; maintenance of provided equipment information.

WiseHOME

The 84 requirements identified cover different aspects of the development and deployment of the WiseHOME tool:

- Prerequisites: availability of assets to demonstrate the expected features (controllable loads, smart meters for consumption/generation metering, storage/EVs, etc.); availability of data to demonstrate the expected features (ambient conditions, consumption data, etc.).
- Legal requirements (contractual agreements needed among different actors for the system to operate).
- Expected features: user interfacing for energy monitoring and price-based DR; interaction with WiseCOOP to enable citizen participation in DR campaigns; comfort profiling.

WiseCORP

The 28 requirements identified cover different aspects of the development and deployment of the WiseCORP tool:

- Prerequisites: access to required data; availability of assets to demonstrate the expected features (RES, batteries, controllable load, etc.).
- Legal requirements: explicit permission of users to access and use their data in the application.
- Expected features: monitoring; advanced visualization; energy usage optimization towards different objectives; integration with other WiseGRID technological solutions for exploiting synergies among the corresponding actors.

WiseEVP

The 54 requirements identified cover different aspects of the development and deployment of the WiseEVP tool:

- EV fleet/infrastructure management: EV usage schedule; monitor deviations from schedule; EV & electric vehicle supply equipment (EVSE) maintenance; EV & EVSE booking.
- Interface with charging point: EV status information (SoC); charging process information (type, mode); charging process commands (start/stop, schedule); interface with grid (V2G); link to WG FastV2G.
- Interface with other WiseGRID products: WG Cockpit to provide flexibility products linked to regulation areas to help the distribution networks operation; WiseHOME to offer V2H and smart charging capabilities to be included in the household energy management.
- WiseEVP expected features: manage the EVSE and EV fleet monitoring database; manage EV user authentication in EVSE network; manage the charging session booking; manage the EVSE network model configuration; forecast EV load; estimate EV flexibility per regulation area; calculate the reference charging load profile; execute periodically the charging session schedule process (CSSP); execute the charging session reschedule process (CSRP) to follow grid requests or to maximise RES integration.

WiseGRID FastV2G

The 16 requirements identified cover different aspects of the development and deployment of the WiseGRID FastV2G tool:

- Prerequisites: available infrastructure to support deployment of WiseGRID FastV2G.
- Expected features: vehicle to grid energy transfer; supported charging modes; interaction with the user.

Use Cases

A first step towards achieving the project objectives is to define several Use Cases each one describing a distinctive operational situation expected to occur within the future distribution grid that is fundamentally different from the status quo due to integration of new types of resources.

Within WP2 of WiseGRID, the process of UC identification and definition has been performed following an analytical approach: starting from the project objectives, seven High-Level Use Cases are defined, each one considering the needs of the end-users and of the energy infrastructure in the presence of high penetration of Renewable Energy Sources (RES), DR programs, energy storage and electric vehicles:

- HL-UC 1 Distributed RES integration in the grid: Large-scale integration of intermittent decentralized RES, providing services to the grid (increased stability and security), while minimizing RES curtailment.
- HL-UC 2 Decentralized grid control automation: Intelligent distributed control facilitating the tasks of the Distribution System Operator (DSO) in ensuring the smooth and uninterrupted operation of the distribution grid (fault detection, self-healing, etc.)
- HL-UC 3 E-mobility integration in the grid with V2G: Integration of e-mobility and electric transport systems into the network with implementation of V2G technology, in order to provide services to the grid.
- HL-UC 4 Battery storage integration at substation and prosumer level: Integration of storage systems for providing flexibility to the grid and auxiliary power supply.
- HL-UC 5 Cogeneration integration in public buildings/housing: Integration of cogeneration in public buildings or collective housing and provision of services to the grid by exploiting the thermal storage capabilities.
- HL-UC 6 VPP technical and economic feasibility: Technical and economic feasibility of the aggregated management of distributed resources through the Virtual Power Plant (VPP) concept, in order to exploit the flexibility capabilities offered by the VPP.
- HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty: Participation of prosumers in energy management schemes for reducing energy costs and achieving improved market integration.

Figure 1 presents the mapping of the HL-UCs to the project objectives and the relevant WG tools per HL-UC.

Scenarios

Based on the UCs, four scenarios are defined, each one contributing to the project objectives as appearing in Figure 1.

- *Scenario 1: Innovative and advanced demand-response mechanisms*

  Relevant High-Level Use Cases to this scenario are HL-UC 6 VPP technical and economic feasibility and HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty. This scenario refers to the DR strategies for addressing all types of Distributed Energy Resources and the implementation of implicit and explicit DR campaigns by Aggregators, Suppliers and VPP Operators with a view to achieve enhanced user acceptance (less/non-intrusive DR, human comfort considerations) and increased model accuracy. At the same time, portfolio optimization and provision of services to the Grid and Market Operators is a key issue addressed within this scenario.

- *Scenario 2: Smartening of the distribution grid*

  Relevant High-Level Use Cases to this scenario are HL-UC 1 Distributed RES integration in the grid, HL-UC 2 Decentralized grid control automation and HL-UC 6 VPP technical and economic feasibility. This scenario addresses the seamless and reliable operation of the distribution grid in the presence of DERs, VPPs and increased penetration of RES (RESCO companies). This is achieved using existing (Energy Management Systems and Distribution Management Systems) as well as new tools (intelligent monitoring equipment, new data concentration structures, big data analysis, novel forecasting tools). Additionally, WG RESCO, WG Cockpit and WG STaaS/VPP allow the management of RES, the distribution grid and VPPs.

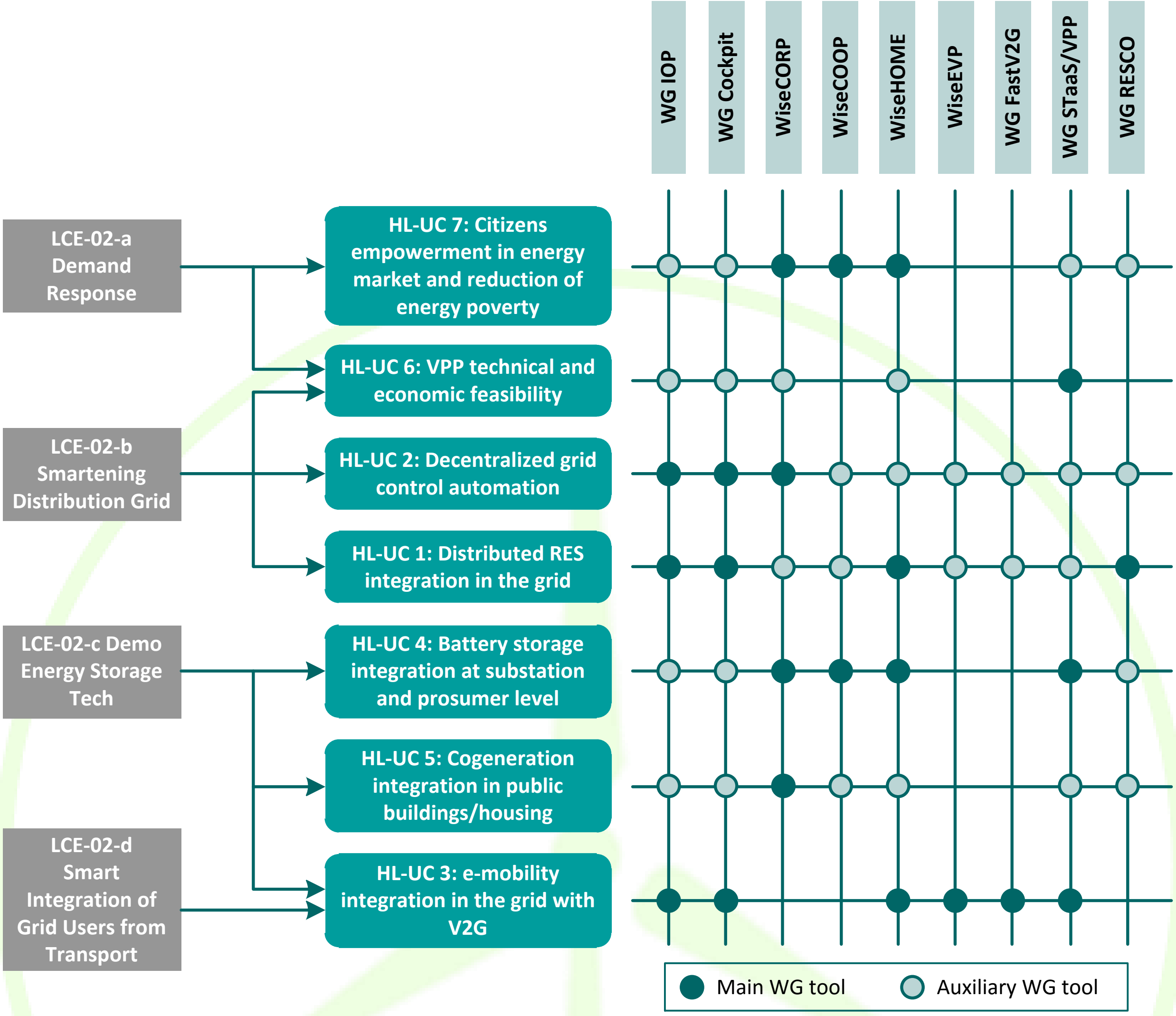


Figure 1 – HL-UCs mapping to project objectives and WiseGRID tools

- *Scenario 3: Integration of renewable energy storage systems in the network*

  Relevant High-Level Use Cases to this scenario are HL-UC 3 e-mobility integration in the grid with V2G, HL-UC 4 Battery storage integration at substation and prosumer level and HL-UC 5 Cogeneration integration in public buildings/housing. This scenario refers to the use of energy storage systems for managing and balancing optimally the network: batteries at substation and prosumer level allow the efficient management for providing services to the grid and for reducing energy cost and environmental impact; HVAC management and comfort-based demand flexibility models allow exploitation of the thermal inertia of the buildings; e-mobility provides flexibility to the grid through application of different charging methods. All these are achieved through the use of WG Fast V2G and WiseEVP for optimizing the activities related to G2V and V2G, WG STaaS/VPP for the management of storage units and WiseCORP for the energy management of buildings.

- *Scenario 4: Smart integration of electric mobility services*

  Relevant High-Level Use Cases to this scenario is HL-UC 3 e-mobility integration in the grid with V2G. This scenario addresses the smooth integration of EVs and the charging infrastructure in the network as well as the provision of flexibility while respecting user preferences. To this end, necessary functionalities are identified: user's authentication, EVSE booking and charging session scheduling, as well as the need to offer different types of charging (on user demand, smart, smart with V2G). Relevant WiseGRID tools are: WiseEVP facilitating the EVSE network configuration, EV load forecasting, EV flexibility estimation and reference load profile calculation; WGFastV2G: charging points enabling load shifting and V2G.

Pilot sites

The five pilot sites in Crevillent (Spain), Flanders (Belgium), Terni (Italy), Mesogia (Greece) and Kythnos (Greece), serve as real test bed for the solutions developed within WiseGRID. More specifically, the pilot site formal analysis comprises an outline of the current situation in terms of infrastructure as well as services offered to the end-users and applications that facilitate the management of each pilot site. The different needs of the end-users in each pilot, renders each one appropriate for testing and demonstrating a variety of UCs as well as for deploying several of the WiseGRID tools, thus ensuring that the proposed solutions and technologies within WiseGRID can be adapted to diverse environments, each one with its own peculiarities and comparative advantages. As a last step of the pilot site formal analysis, a preliminary deployment and demonstration plan is laid out, while potential barriers (regulatory, social, etc.) and the operational constraints due to the prevalent conditions in each pilot site are reported. Having in mind but not limited by the current situation, the potential of each pilot site to implement and test the defined UCs is also identified (Table 1) and reported in the UCs inventory using a scale 1-5, indicating not only the suitability of each pilot site but also reflecting the vision for the future operation of each pilot site (ANNEX B, section 13).

Table 1 – HL-UCs mapping to pilot sites

Pilot site / HL-UC	Crevillent	Flanders	Terni	Mesogia	Kythnos
HL-UC 1	✓	✓	✓	✓	✓
HL-UC 2	✓		✓	✓	✓
HL-UC 3	✓	✓	✓	✓	✓
HL-UC 4	✓	✓	✓	✓	✓
HL-UC 5				✓	
HL-UC 6		✓	✓	✓	✓
HL-UC 7	✓	✓	✓	✓	✓

KPIs

Following the GRID+ methodology, 52 KPIs are defined (Table 20 and ANNEX E). 16 of them belong in the "specific" category, while the rest of them are defined according to the WiseGRID project needs and are, therefore, categorized as "project" KPIs. Furthermore, the relevance of each KPI in quantifying the WiseGRID project impacts is identified either as direct or as indirect (i.e. the improvement observed in a KPI with direct relevance can be attributed directly to the solutions proposed within the Project), resulting in 34 KPIs that measure the direct impact of the WiseGRID solutions and 18 KPIs that measure the indirect impact. Last but not least, even though each KPIs is defined only once, there may be identified more than one PUCs to which a KPI is relevant.

Conclusions

The rigorous work within WP2 of WiseGRID has produced a significant amount of material that serves (along with WP1 and WP3) as a basis for the entire WiseGRID project. Keeping in mind the multidimensional challenges of the future and the strategic objectives to be met, the efforts are directed towards covering a wide range of issues by which the DSOs, the distribution network users and all relevant stakeholders will be (or, in some cases, are already) confronted. Using established and practically tested methodologies a set of 129 Use Cases (27 PUCs and 102 SUCs) has been defined, 385 requirements have been identified, four scenarios have been described, 52 KPIs have been formulated, while a realistic analysis of the five pilot sites, where the technologies and solutions developed within the WiseGRID project, will be tested, has been performed.

1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

WP2 (along WP1 and WP3) under SP1 lays the foundations for the technical aspects of the project. Since the ultimate goal is for the technological solutions proposed within the Project to be tested and studied in real applications, a set of tools is necessary for the systematic analysis of both the conditions under which the technological solutions are expected to operate as well as of the new environment formed and the new opportunities created by the widespread application of the proposed solutions. More specifically, the content of this document reflects the output produced by the close cooperation of the participating partners in order to serve as input for WP3 where the architecture will be analyzed and formulated. Consequently, and in view of the multidisciplinary nature of the project, the current document reports systematically the high quality, knowledge-intensive output produced during the previous months.

1.2 SCOPE OF THE DOCUMENT

This document records the accumulated collective knowledge produced through the cooperation of the partners within WP2 –each one contributing with his respective expertise – in order to define the requirements and use cases that serve as basis for forming the project architecture and for defining the demonstration scenarios and activities in the pilot sites. To the same end, the pilot site formal analysis is also documented. Furthermore, a set of Key Performance Indicators (KPIs) for assessing the impact of the project solutions is also produced.

Following the task break-down, a set of requirements have been defined (T2.1). These requirements are classified into appropriate categories, each one tackling a different technical aspect of the project, and are characterized by their priority. The procedure followed for recognizing the requirements is an iterative one, thus successfully identifying the needs of different end-users during the formulation of the Use Cases.

The Use Cases (UCs) defined consider the needs of the end-users and of the energy infrastructure in the presence of high penetration of Renewable Energy Sources (RES), Demand Response (DR) programs, energy storage and electric vehicles. To this end, the UCs are in line with the European SGAM framework. Based on the UCs, four scenarios are defined, each one contributing to the project objectives.

Accordingly, and in order to evaluate the success of the demonstration of the Use Cases, Key Performance Indicators (KPIs) are identified and formulated based on the GRID+ methodology. Based on these, the project impact of the integration and demonstration activities of SP7 as well as the replication and scaling-up of the project results within SP8 can be quantified and evaluated.

Testing all the above in realistic situations requires performing a formal analysis of the pilot sites, as well as the definitions of the preliminary WiseGRID requirements and use cases to be demonstrated at each pilot site, taking into consideration the potential barriers (regulatory, social, etc.) as well as the operational constraints due to the prevalent conditions in each pilot site. In fact, one of the fundamental principles of the project as well as the backbone of the proposed technological solutions is the constant consideration of the end-user needs: the seamless and smooth integration of the new technologies in the operation of the electricity grid should be ensured without exception.

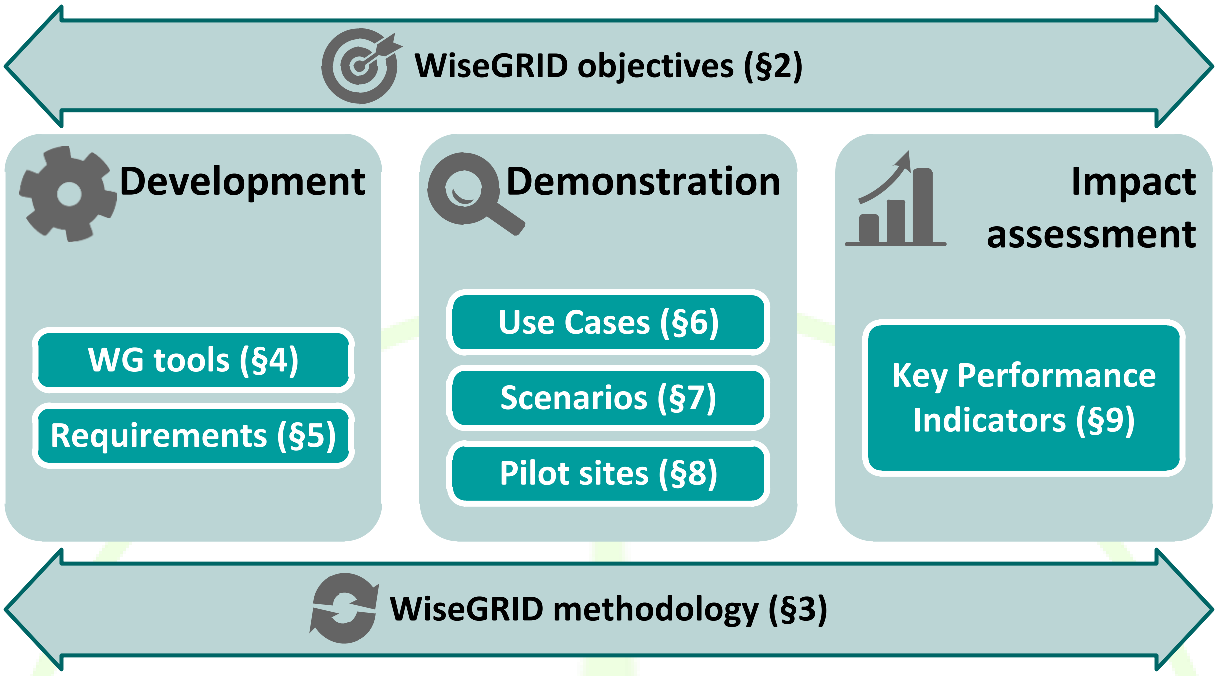


Figure 2 – WP2 overview

1.3 STRUCTURE OF THE DOCUMENT

The rest of the document is organized as follows. Section 2 documents the WiseGRID project objectives; Sections 3 outlines the methodology followed for the requirement analysis, the definition of the UCs, and the formulation of the KPIs; Section 4 presents the technological solutions proposed within the Project; Section 5 reports the requirements identified, which are categorized in 11 classification groups (one per WiseGRID product and one general category for the entire Project); Section 6 gives an overview of the seven High-Levels UCs (HL-UCs) defined within the Project; in Section 7 the scenarios formulated are presented; Section 8 contains the pilot site formal analysis performed for all 5 pilot sites; Section 9 reports the complete set of KPIs; Section 10 outlines the conclusions. The document concludes with Section 11 References and acronyms, and also contains three annexes presenting the complete set of WiseGRID requirements, the Use Cases inventory as well as the Primary and Secondary UCs.

2 WISEGRID OBJECTIVES

WiseGRID strategic goal is twofold with one aspect directed towards the environment outside the Project and another towards the WiseGRID ecosystem. More specifically, the Project will develop and put in the market, within a horizon of 24 months after project completion, a set of solutions and technologies which increase the smartness, stability and security of an open, consumer-centric European energy grid, with an enhanced use of storage technologies and a highly increased share of RES. Furthermore, the project intends to have a significant impact in the business and innovation activities of the consortium -with a planned ROI for the partners of less than 30 months after commercialisation of WiseGRID products and services starts- and the European sector at large, contributing to the creation of jobs, the access to new energy services of citizens and public/private organizations, the saving of CO_2, and the increase of RES penetration.

The four strategic goals to which the Project contributes are the following:

- WiseGRID will integrate and demonstrate **innovative and advanced DR mechanisms** that will facilitate the active participation, protection and empowerment of the European consumers and prosumers (households and businesses) in the energy grid and market, through flexible RES generation, self-consumption and storage, or through intermediaries such as aggregators and suppliers on behalf of the former. This will reduce the customers' electricity bill and their energy dependency but it will also will help DSOs in providing more balanced and stable distribution grids. The Project will also demonstrate the sustainable incentives schemes and business models, based on different technologies (smart metering, smart home appliances, batteries, electric vehicles – EVs, etc.) to the benefit of both the grid and the consumers. Moreover, the project will issue recommendations to overcome non-technical barriers for the proper integration of DR schemes into the network, such as legal, regulatory and social barriers.
- WiseGRID will address the **smartening of the distribution grid**, including both technologies and methods to gain advanced monitoring and awareness of variable generation and consumption loads, as well as the integration of VPPs and microgrids as active balancing assets.
- WiseGRID will address the **integration of renewable energy storage systems in the network**, such as batteries or heat accumulators. Technologies integrated and demonstrated during the project will help plan the market deployment of these storage systems, manage and balance the network optimally, responding better to changes in demand and reducing the losses in distribution grid at the same time. The project will evaluate the impact of the deployment of batteries and other storage systems (e.g. thermal), in any point of the distribution network, and also methods for managing these systems optimally once they are deployed.
- WiseGRID will integrate tools to plan the deployment of **electric mobility services**, as well as the management of charge and discharge of these vehicles -including the possible use of their batteries as storage systems or VPPs. This will be done both for individually owned vehicles and for vehicle fleets (public or private). Thus, similarly to other storage systems, it will be possible to answer better to demand variations, e.g. charging the vehicle when there is a RES energy surplus. In the same way, the Project will evaluate the impact of the deployment of charging points in the power grid and will provide information and services to the end-user, e.g. advising when and where it is most convenient or cost-effective to charge the vehicle.

3 METHODOLOGY

This section gives and overview of the methodological approach followed within WiseGRID, in order to specify the requirements needed for achieving the project objectives, to identify specific Use Cases and to define measurable indicators of the impact of the proposed innovative technological solutions.

3.1 REQUIREMENT ANALYSIS

The Volere methodology is not new to some of the project partners. It was first used by a number of the project partners in the NOBEL [2] and NOBELGRID [3] projects where it was used mainly because of its simplicity. It helped project partners to describe, formalize and track the project requirements in an explicit and unambiguous manner. Besides being a success in the above-mentioned previous projects, the Volere methodology was selected for the following three reasons:

1. It requires simple steps to identify and formalize the requirements in an unambiguous manner.
2. It provides an easy process to track and evaluate the progress of the project.
3. A number of the project partners have already experience with the Volere methodology. Hence, they did not need an extra learning effort.

The consequent application of the Volere methodology is not only useful in the initial phases of the project for specifying requirements but it is also helpful in specifying a reference point for the later stages. During the use case analysis, for example, it can be used to ensure that different use cases cover different aspects of the requirements and that all important requirements are covered by them. During the implementation and management, it can be used to track and evaluate the progress of the individual work packages and the overall project. Besides being efficient and easy to use, the Volere methodology provides a mechanism for all partners to specify the requirements in a standard format. Thereby, specifying additional context of a requirement such as the rationale and the acceptance criteria for every requirement helps to build a common understanding of the overall system. Furthermore, defining priorities helps to clarify the focus of the project.

3.1.1 Requirement Prioritization

In order to prioritize requirements, the project consortium has introduced five different classes of priorities. These classes range from one (lowest priority) to five (highest priority) and the consortium has defined them as follows:

- **5 - High**: Requirements in this class are either realizing a key innovation of the project or they are needed to realize it. These requirements are necessary to achieve the goals of the project.
- **4-3 Medium**: Requirements in this class are not necessary to realize a key innovation but they are necessary or very helpful to realize the application prototypes. These requirements are important to the application developer.
- **2-1 Low**: Requirements in this class are neither realizing a key innovation nor necessary for the application prototypes. However, in a broader context possibly beyond the scope of the project they may be important.

As a consequence, for the success of the project, it is essential to fulfil the requirements with high priority. With respect to providing thorough support for application developers, it is important to realize the requirements with medium priority as well. The requirements with low priority, however, are not of immediate relevance for the project. However, their realization may provide additional features or benefits for applications or users that should be considered after all requirements of the other two classes have been implemented successfully. In order to give all stake-holders and interested parties an insight into the prioritization process, the consortium has not only assigned categories to each requirement but also decided to include the main rationale for this classification in this document. Besides from being informative, this can be helpful in later stages of the project where unforeseeable issues may require the introduction of new requirements or changes to existing requirements.

3.1.2 Volere tool

Aiming at defining an optimum and complete list of requirements, a web tool based on the Volere methodology was developed originally by ETRA and used with successes in different projects ever since. This web tool has facilitated the definition, the validation and the prioritization of the NOBEL GRID requirements. For security reasons, the access to the web tool has been restricted to authorized users.

Access to the web tool is granted after a successful identification on the system. The application allows the administrator to control the status of the validation process from the initial definition to the final list of requirements passing through the required validation and revision status.

3.1.2.1 Specification process

The overall process of Volere as supported by the web tool is depicted in Figure 3. After an initial specification of requirements, the users can specify conflicts, dependencies and objections. After specifying them, they can iteratively revise the specification and identify additional issues until it is free of conflicts, dependencies and objections. The result will constitute the final list of requirements. The following subsections briefly outline the individual steps.

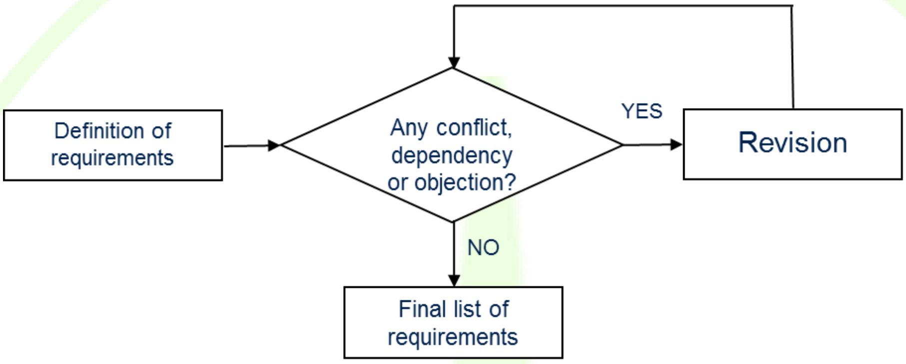


Figure 3 – Requirement Specification and Validation Process

3.1.2.2 Requirement definition

In this first stage all the requirements needed to accomplish the project objectives must be defined. These will be refined in future stages. The most useful information and the main functionalities at this stage available at the home page are (see Figure 4):

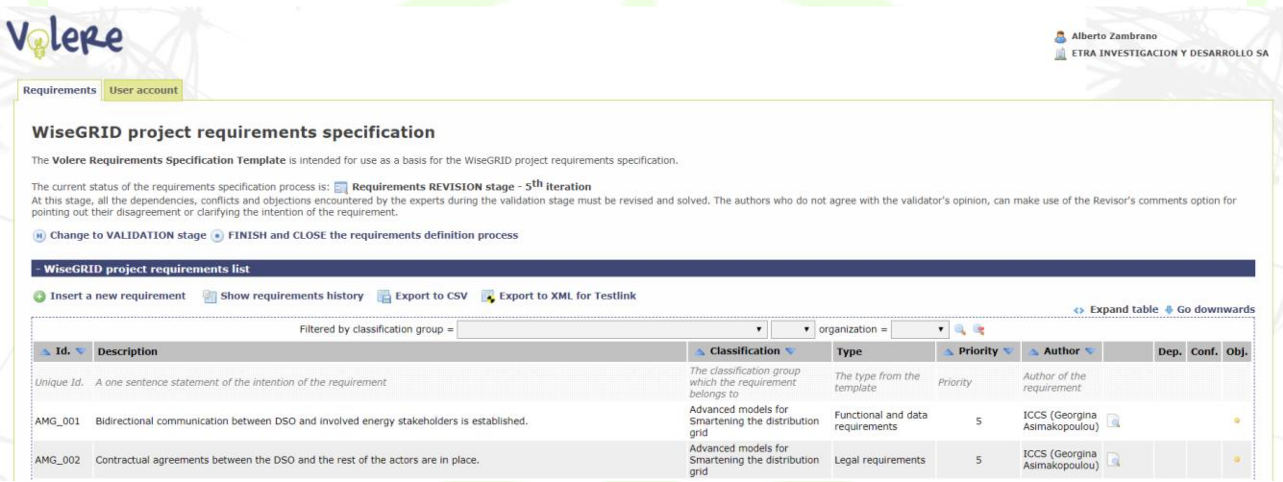


Figure 4 – Volere home page

- List of requirements: The list of requirements with some additional options.
    - Filtering options: The list of requirements filtered per id., type and/or filtered per author.
    - Expand table: Show/hide some columns, displaying more or less information about the requirement.

- Requirements management: Modification options for requirements.
    - View a requirement.
    - Edit a requirement (only available for the author).
    - Delete a requirement (only available for the author).
- Requirements tracing: After the first validation, a new service is made available for keeping track of all the requirements history.
- Insert a new requirement: Opens a new window (c.f. Figure 5) to allow adding a new requirement. All the fields are required except for the “Comments” field witch is optional. The required fields are:
    - ID: The scope of this requirement. Appended by an automatically generated sequential number, this ID uniquely identifies each requirement. This ID will be generated after the requirement has been added (c.f. Figure 6).
    - Description: A one sentence statement which describes the intention of the requirement.
    - Type: The type of the requirement as defined by Volere.
    - Rationale: A justification of the requirement.
    - Acceptance criteria: A measurement of the requirement for further verification that the solution matches the original requirement.
    - Priority: The importance for the customer of successfully implementing the requirement.

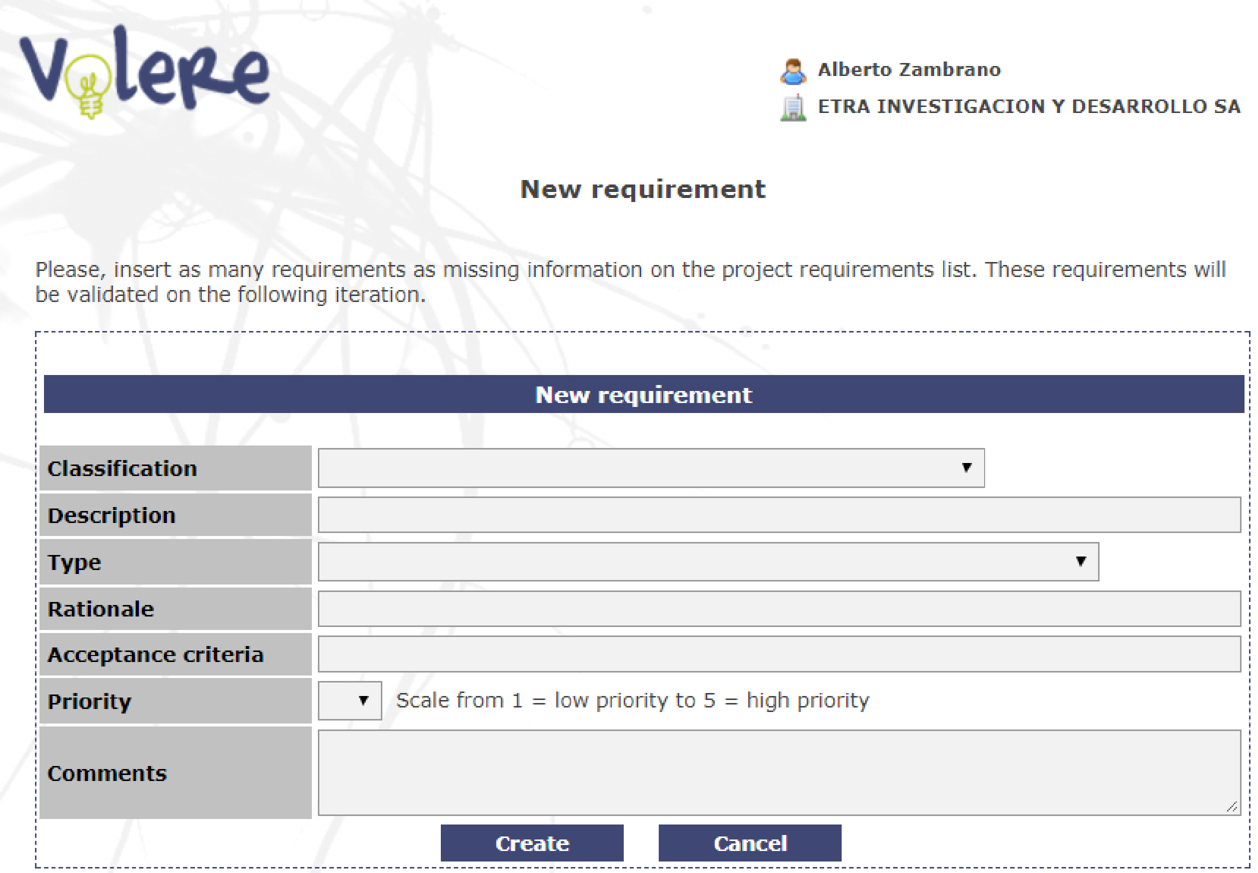


Figure 5 – Definition of new requirements

Alberto Zambrano
ETRA INVESTIGACION Y DESARROLLO SA

WiseGRID project requirement detail on 5th iteration

Id.	DRF_033
Classification	Consumer-centric demand response framework
Description	The outcomes of Advanced Flexibility Analysis engine may available for visualization or to a Decision Support System for Demand Response Strategies implementation at consumers level
Type	Functional requirements - Functional and data requirements
Author	HYP (k.tsatsakis)
Date	16/06/2017
Rationale	Analytics results to be exploited by different means
Acceptance criteria	Visualization of flex analysis outcomes in UI
Priority	5
Comments	

Close

Figure 6 – Requirement details

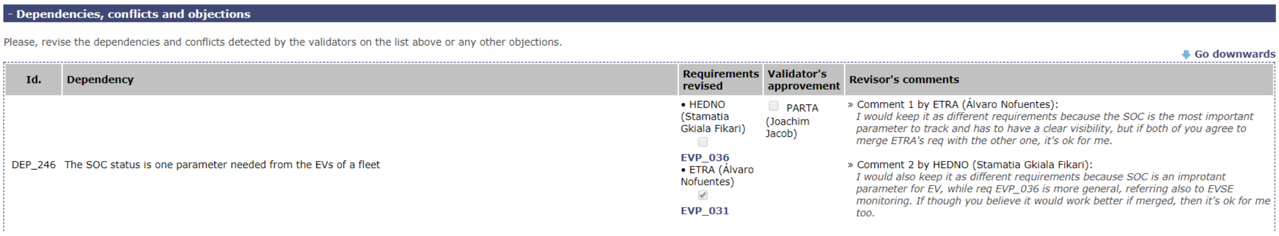
3.1.2.3 Validation

After the initial definition of requirements, the validation process begins. All the requirements should be approved by all the users. At this stage, conflicts and dependencies between requirements must be detected. Furthermore, any objection must be pointed out:

- **Dependency**: Requirements that have some dependency on other requirements.
- **Conflict**: Requirements that cannot be implemented if another requirement is implemented or a conflict due to an insufficient definition of the requirement.
- **Objection**: A reason or argument offered in disagreement, opposition, refusal or disapproval of the requirement.

3.1.2.4 Revision

All the dependencies, conflicts and objections highlighted by the experts during the validation stage must be revised and solved by the requirement's authors. However, if the authors do not agree with the validator's comments they can include their own view point in the "Revisor's comments" section for explanations and requirement clarifications. Note that only the authors of the requirements that have to be revised are able to add comments to the dependency, conflict or objection.



- Dependencies, conflicts and objections

Please, revise the dependencies and conflicts detected by the validators on the list above or any other objections.

Go downwards

Id.	Dependency	Requirements revised	Validator's approvement	Revisor's comments
DEP_246	The SOC status is one parameter needed from the EVs of a fleet	• HEDNO (Stamatia Gkiala Fikari) EVP_036 • ETRA (Álvaro Nofuentes) EVP_031	PARTA (Joachim Jacob)	» Comment 1 by ETRA (Álvaro Nofuentes): *I would keep it as different requirements because the SOC is the most important parameter to track and has to have a clear visibility, but if both of you agree to merge ETRA's req with the other one, it's ok for me.* » Comment 2 by HEDNO (Stamatia Gkiala Fikari): *I would also keep it as different requirements because SOC is an improtant parameter for EV, while req EVP_036 is more general, referring also to EVSE monitoring. If though you believe it would work better if merged, then it's ok for me too.*

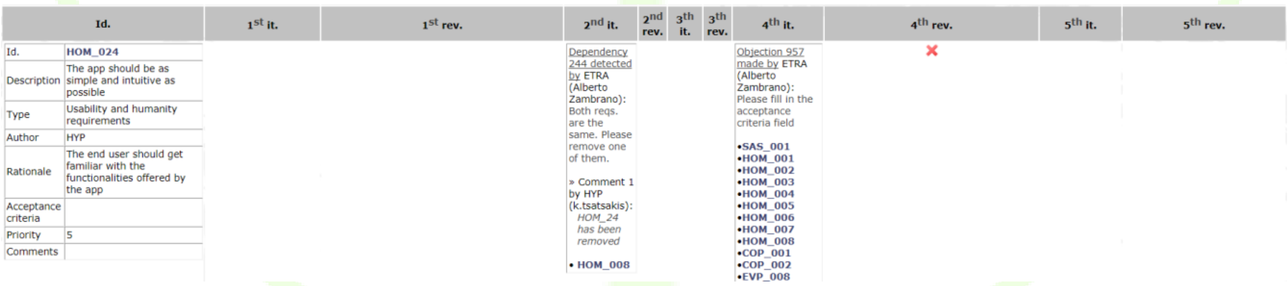
Figure 7 – Revision process

The checkboxes in the "Requirements revised" and "Validator's approval" columns, help the users to check the status of the revision and, together with the possibility of adding clarifying comments, facilitate the interaction and communication between the author and the validator. For security reasons, the checkboxes in the "Requirements revised" column are only enabled for the authors of the requirements who can also add new comments. Moreover, for the same reason, the checkboxes in the "Validator's approval" column are only enabled for the validator.

The revision process consists of four steps:

- First, the authors should identify which requirements have been objected to or are involved in any conflict or dependency.
- Second, and after analysing the validator's view point:
  - The author may agree with the validator and proceed to modify or delete the requirement or,
  - The author may disagree with the validator, therefore he/she should make appropriate comments trying to clarify the requirement with a better explanation or justify the intention of the requirement.
- Third, the author should mark the checkbox of the requirement as revised.
- Finally, the validator should be aware of the revised requirements and approve the actions taken by the author for resolving the dependency/conflict/objection.

The Volere tool allows every user to review the history of a requirement.



Id.	1st it.	1st rev.	2nd it.	2nd rev.	3th it.	3th rev.	4th it.	4th rev.	5th it.	5th rev.
Id.: HOM_024 Description: The app should be as simple and intuitive as possible Type: Usability and humanity requirements Author: HYP Rationale: The end user should get familiar with the functionalities offered by the app Acceptance criteria: Priority: 5 Comments:			Dependency 244 detected by ETRA (Alberto Zambrano): Both reqs. are the same. Please remove one of them. » Comment 1 by HYP (k.tsatsakis): *HOM_24 has been removed* • HOM_008				Objection 957 made by ETRA (Alberto Zambrano): Please fill in the acceptance criteria field •SAS_001 •HOM_001 •HOM_002 •HOM_003 •HOM_004 •HOM_005 •HOM_006 •HOM_007 •HOM_008 •COP_001 •COP_002 •EVP_008			

Figure 8 – Requirements revision history

3.2 USE CASE DEFINITION

The Use Case (UC) Methodology has been originally defined in IEC 62559-2:2015 [4] to cover the needs of the software engineering. However, its advantages render it also appropriate for application in the smart grid. More specifically [5]:

- It offers a systematical manner for gathering all necessary information regarding functionalities, processes and respective actors;

- It facilitates the coordination among various stakeholders as it ensures the common understanding of complex processes;
- It forms the basis for further development of the functionalities of the system under study.

The Use Case Methodology includes a template where all necessary information for a specific process is described: from high-level information, such as the name of the UC, to a detailed step-by-step analysis of the realization of the UC as well as the actors involved.

Depending on the amount of information and level of detail included in a Use Case, it can be classified under a different category. Out of the 13 different types of UCs defined in [5], three of them are put to use within WP2 of WiseGRID, each one with a different level of abstraction and – by extension – different level of granularity (Figure 9):

- High level use case (HL-UC): describes a general idea of a function;
- Primary use case (PUC): use case implemented in a specific system characterized by a defined boundary;
- Secondary use case (SUC): describes core functionalities that are used by multiple PUCs.

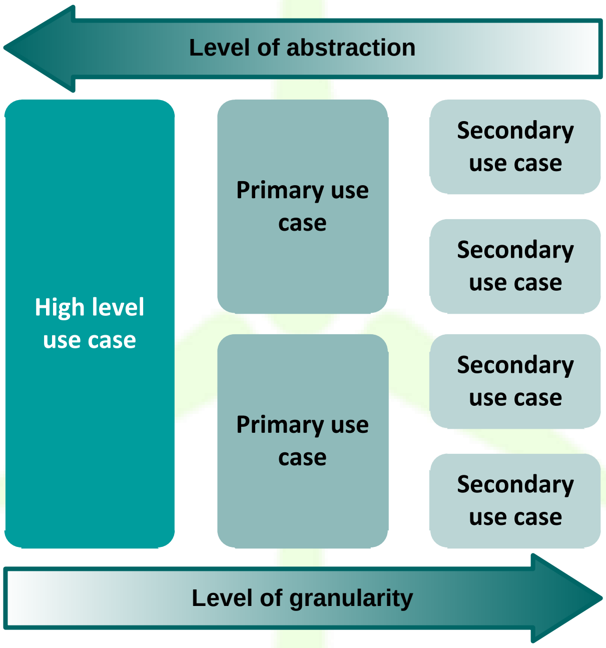


Figure 9 – Use case structure [5]

3.2.1 Overview of SGAM (Smart Grid Architecture Model)

The Smart Grids Architecture Model (SGAM) framework can be described as the architectural structure of a practical methodology where each particular Use Case (UC) can be modeled and analyzed from different aspects. The most important factor while modeling a UC is the coherency of the whole process, as well as the production of an analytic and easy to understand model. As far as the general presentation of a UC is concerned, three main categories interoperate between each other, while various cross-cutting issues (referring to relationships between the categories) need to be taken into account (Figure 10).

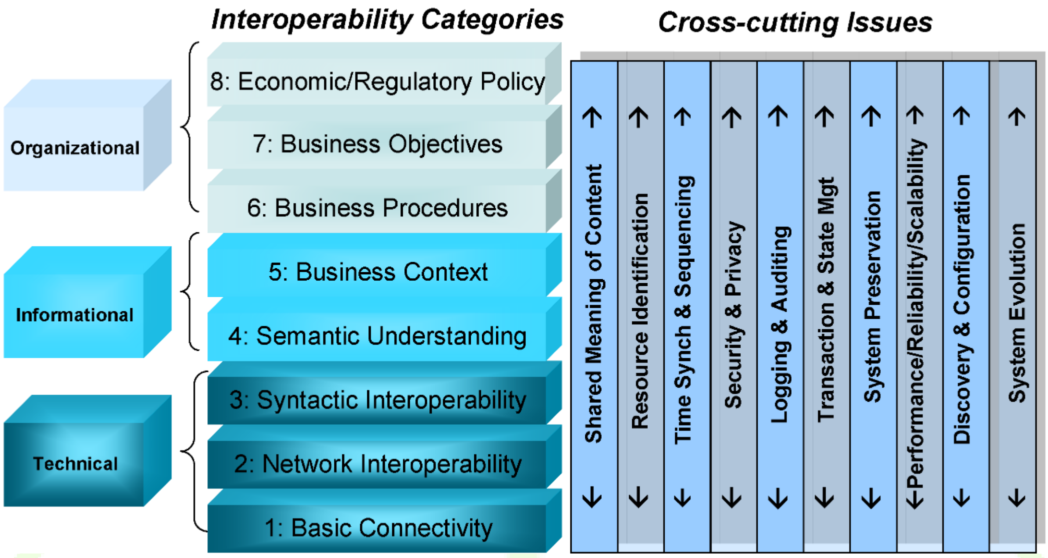


Figure 10 – Interoperability Categories and Cross-Cutting Issues. [6]

In the SGAM framework these interoperability categories are aggregated into five different levels, the SGAM layers (Figure 11). As can be seen, each layer refers to a different aspect of every UC, starting from the Business layer (referring to the business usage of the smart grid information exchanged, the involved market partners, business objectives, constraints etc.), moving step by step to the Component layer (physical layer, including all entities of smart grid, such as the system equipment, the network infrastructure and the protection devices). Between these two, lie the Function, the Information and the Communication layer. These layers refer to the functions implemented (functionality of UC), the information object and data models exchanged between functions or actors (devices, applications, persons, organizations) and the protocols/mechanisms used for the exchange of information, respectively.

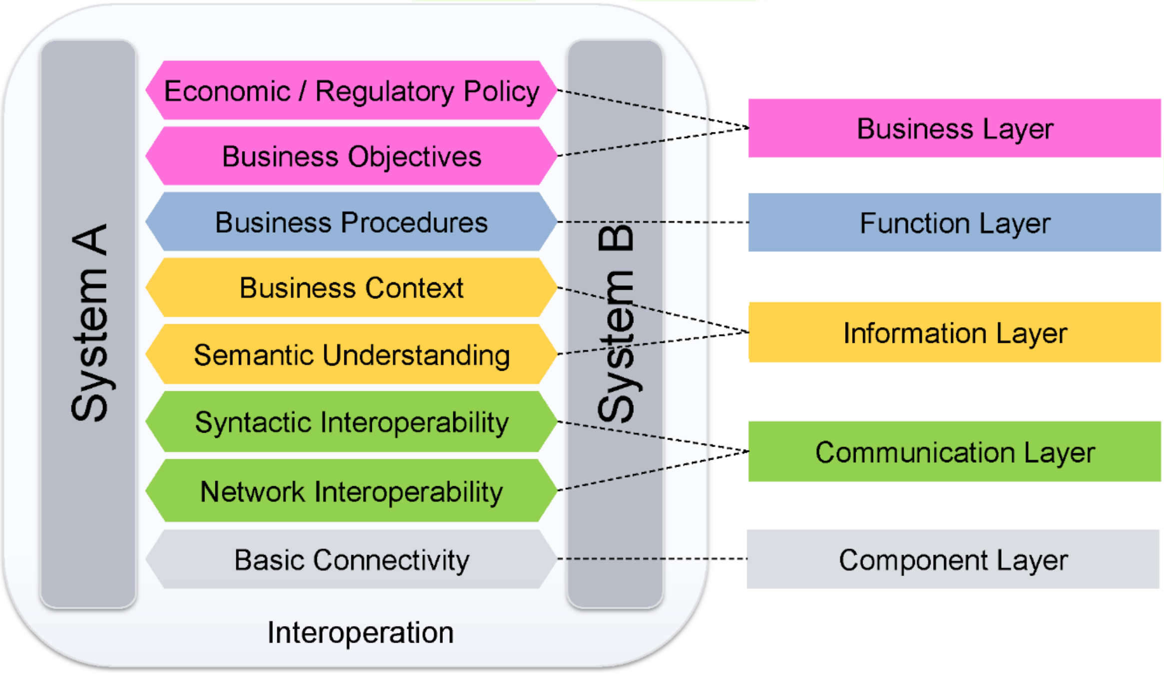


Figure 11 – Interoperability Categories and layers. [7]

In succession, the interoperability layers need to be merged with another concept, the smart grid plane, to compose the 3D SGAM framework. In the smart grid plane, an important distinction is made between the electrical processes (domains) and the information management viewpoints (zones) involved in every UC. The five SGAM domains contain the Bulk Generation domain (massive generation of electricity), the Transmission domain (infrastructure and organization for the transportation of energy), the Distribution domain, the Distributed Electrical Resources domain (DER connected to the public distribution grid ranging from 3kW~10.000 kW) and the Customer Premises domain (prosumers of electricity).

Moving on to the six SGAM zones, these are distinguished as follows. The Process zone (refers to the transformation of energy and the equipment involved) is followed by the Field zone (protection, control and monitor equipment) which, in turn, is succeeded by the Station zone (areal aggregation of previous level). Next comes the Operation zone (control operation systems such as DMS/EMS), followed by the Enterprise zone (commercial aspect/e.g. logistics, staff training etc) and finally the Market zone (commercialization of the produced energy).

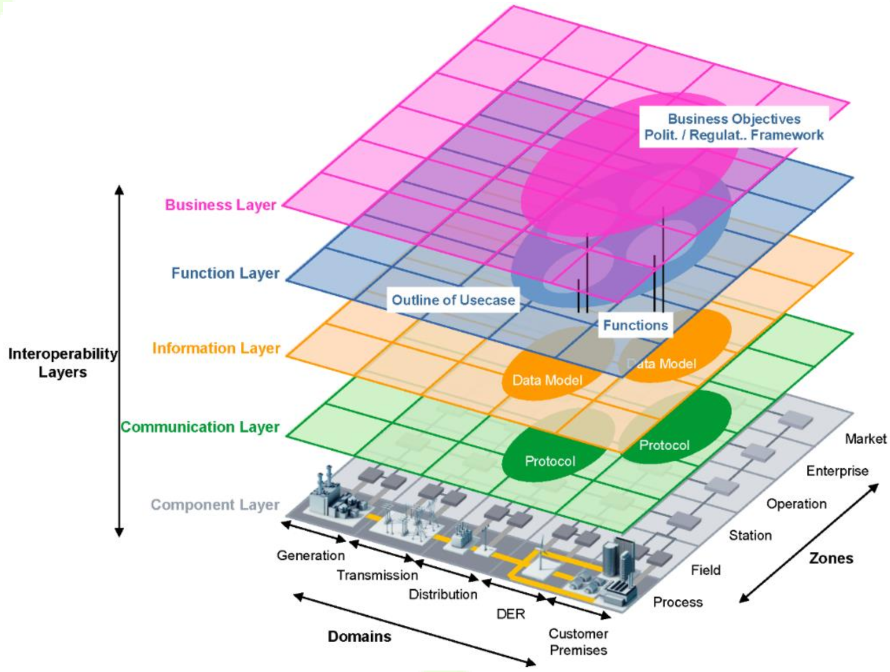


Figure 12 – SGAM framework. [7]

The basic principles on which the SGAM modeling framework is based upon are universality, localization, consistency, flexibility, scalability, extensibility and interoperability. So, as far as flexibility is concerned, a UC can be analyzed in multiple different ways while many functions or services can be placed in different zones/domains. This feature does not come at the expense of the consistency of the model, since all layers, domains and zones must be specified. In the end the coherency of the final extracted model is guaranteed, since the five SGAM layers are linked and able to interact with each other, as shown in the above figure.

Moving on, the mapping process of every UC, begins with the analysis phase in which needs to be confirmed that the UC description provides the necessary information (objective, UC diagram, actor name and type, precondition and assumptions, steps, information exchanged and requirements) (Figure 13). Once this phase is completed, one can proceed with the development of each SGAM layer, which is a work to be completed within WP3 of WiseGRID.

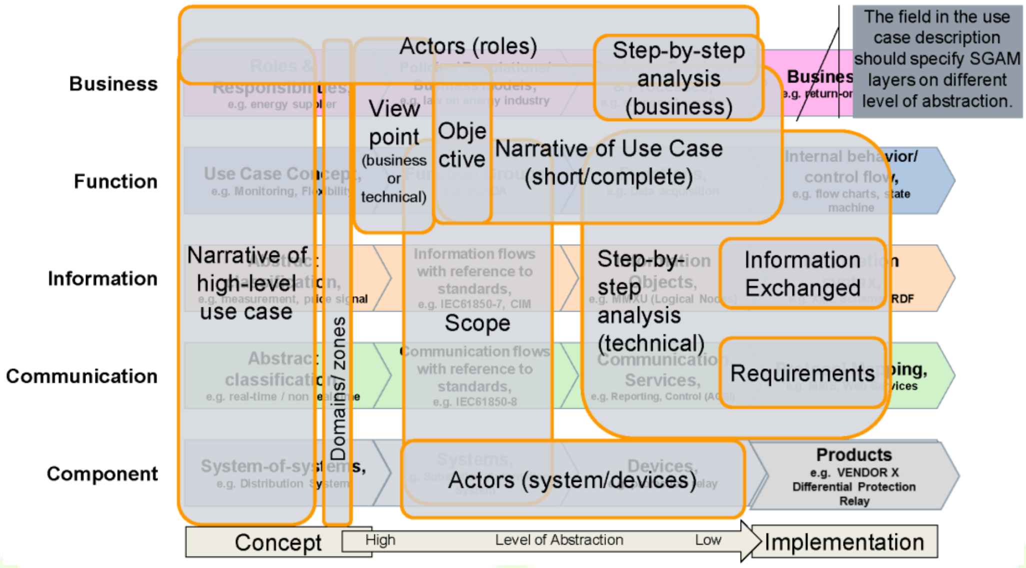


Figure 13 – Mapping of fields in the use case templates to SGAM analysis pattern [5]

3.2.2 Actors involved in the Use Cases

In order to establish a common understanding and language regarding the actors involved in the Use Cases defined within WiseGRID, a list of actors is defined (Table 2). Each one can belong to one of four types (device, application, person, organization) and can be implicated in the UC directly or indirectly.

Table 2 – Actors inventory

Actor name	Description	Actor type
Aggregator	Accumulates flexibility from Prosumers and Consumers and sells it to the Supplier, the DSO or the TSO.	Organization
AMI	*Advanced Metering Infrastructure*. A set of systems that monitor, collect and analyze electricity consumption, and have two-way communication capabilities.	System
Balance Responsible Party	A party that has a contract proving financial security and identifying balance responsibility with the Market Operator entitling the party to operate in the market. [The meaning of the word "balance" in this context signifies that the quantity contracted to provide or to consume must be equal to the quantity really provided or consumed.]	Organization
Battery Operator	An entity responsible for operating a set of Storage Units connected to the electricity grid.	Organization
Building Management System	An automated system that monitors and controls the equipment of a building (ventilation, lighting, electricity infrastructure, etc.)	System
CHP	*Combined Heat and Power*. A system that simultaneously generates electricity and useful thermal energy in one process from a single source of energy.	Device
Consumer	An entity connected to the grid, that consumes energy, i.e. a Prosumer without any production capabilities.	Person
Data Provider	Independent entity responsible for undertaking and coordinating the information exchange and translation of the data of various sources into a common data model.	Organization

Actor name	Description	Actor type
Distributed Energy Resource	Any type of generation units, storage units and load flexibility resources connected to the distribution network.	System
DMS	*Distribution Management System*. A system that monitors, controls and analyzes in real-time or near real-time the electricity distribution system.	System
DSO	*Distribution System Operator*. The entity responsible for: the distribution network planning and development; the safe and secure operation and management of the distribution system; for data management associated with the use of the distribution system; for procurement of flexibility services.	Organization
Electronic Meter	A physical device containing one or more registers.	Device
Energy Management System	A system that monitors, controls and optimizes the operation of the energy system under supervision.	System
ERP	*Enterprise Resource Planning*. A system that offers integrated management and automation of business processes. It is also used to refer to the Customer Relationship Management (CRM) system.	System
ESCO	*Energy Service COmpany*. Offers auxiliary energy-related services to Prosumers.	Organization
EV	*Electric Vehicle*. A vehicle that uses stored electricity as a source of energy.	Device
EV Fleet Manager	*Electric Vehicle Fleet Manager*. An organization that operates and controls an EV fleet.	Organization
EV User	*Electric Vehicle User*. The user of an EV.	Person
EVSE	*Electric Vehicle Supply Equipment*. The infrastructure external to the EV that provides connection to a power source for charging the EV.	Device
EVSE Operator	*Electric Vehicle Supply Equipment Operator*. The entity responsible for managing and operating the EV charging infrastructure.	Organization
Facility Manager	An entity responsible for the management of one or more buildings or other facilities in general.	Organization
Forecast Provider	The organization that provides, upon demand, forecasts regarding certain variables (e.g. electricity demand, RES production, weather conditions, etc.)	Organization
Gas Distribution Company	The organization responsible for the distribution of natural gas to final consumers.	Organization
Gas Meter	A device that measures and records the amount of gas (natural gas) consumed in residential, commercial, and industrial buildings.	Device
GIS	*Geographical Information System*.	System
Harbour Operator	An organization that manages and operates the harbour infrastructure.	Organization
HVAC	*Heating, ventilation and air conditioning*. An HVAC system maintains desired environmental conditions in a space.	System
Inverter	A power electronic device that converts DC electricity to AC and vice versa.	Device
Load Controller	A device that communicates with on-site electricity loads and has capabilities of sending control signals for increasing/descreasing the electricity demand.	Device
Market Operator	The unique power exchange of trades for the actual delivery of energy that receives the bids from the Balance Responsible Parties that have a contract to	Organization

Actor name	Description	Actor type
	bid. Determines the market energy price taking into account the technical constraints from the Transmission System Operator.	
P2G Unit	*Power to Gas Unit*. A unit that converts electrical power to a gas fuel.	Device
PDC	*Phasor Data Concentrator*. Receives and time-synchronizes phasor data from multiple phasor measurement units (PMUs) to produce a real-time, time-aligned output data stream.	Device
Producer	An entity connected to the grid that injects electricity to the grid.	Person
Prosumer	An entity that consumes and produces energy. There is no distinction between residential end-users, small and medium-sized enterprises or industrial users.	Person
Public Authority	Governmental organization that administrates the public life on the level of a municipality.	Organization
RES Unit	*Renewable Energy Source Unit*. A type of Producer that transforms energy from renewable energy sources (e.g. sun, wind, etc.) to electricity and injects it to the grid.	Device
RESCO	An ESCO that delivers energy to Consumers from renewable energy sources. (Not to be confused with WG RESCO)	Organization
SCADA	*Supervisory Control And Data Acquisition* system	Device
Sensor	A device that monitors and processes specific input from the physical environment (e.g. light, heat, motion, etc.).	Device
Smart Meter	An Electronic Meter with two-way communication capabilities.	Device
Storage Unit	A device that stores energy.	Device
Supplier	Supplies and invoices energy to its customers.	Organization
TSO	*Transmission System Operator*. A party that is responsible for a stable power system operation (including the organisation of physical balance) through a transmission grid in a geographical area. The System Operator will also determine and be responsible for cross border capacity and exchanges. If necessary, he may reduce allocated capacity to ensure operational stability.	Organization
VPP Component	*Virtual Power Plant Component*.	Device
VPP Operator	*Virtual Power Plant Operator*.	Organization

3.3 KEY PERFORMANCE INDICATORS

In order to evaluate the results of the solutions proposed and implemented within WiseGRID, it is necessary to quantify the tangible and measurable impacts which contribute to specific EU policy goals. To this end, the methodology proposed by GRID+ [1] for defining the Key Performance Indicators (KPIs) is followed. KPIs aim to highlight the added value of the solutions proposed in European projects and their alignment with EU ambitions and targets for future power grids. KPIs' role is to be used from active policy actors and energy market players to contribute in future decisions concerning network planning and operation. KPIs' main focus is to facilitate the monitoring of Research and Innovation (R&I) activities and link them with EU goals. Their use enables the exploitation of the experience gained from European R&I research activities and projects, without intention to compare or rank project results.

3.3.1 KPI design

The purpose of defining KPIs is to support the competent authorities (policy makers, regulators and network operators) in the decision making process regarding the large scale deployment of innovative solutions demonstrated within research activities. The design of KPIs in WiseGRID is in line with GRID+ guidelines, according to which a KPI should be:

- *meaningful*: it should relate with one or several expected innovation impacts, and therefore makes sense since contributing to reach the program goals;
- *understandable*: the KPI definition relates clearly with the expected impacts;
- *quantifiable*: experimental values coming from field testing at an appropriate scale are used to develop ad-hoc simulation tools able to estimate the expected innovation impacts.

The methodology describes the general framework for KPI definition and proposes their classification in two categories: "*Implementation Effectiveness KPI"* and "*Expected Impact KPIs"*. The first type of KPIs is used as a metric for the completion of R&I objectives of the European Electricity Grid Initiative (EEGI) roadmap, expressed as a percentage of the status of the activities (*not yet started, under proposal, ongoing* and *completed*). The second category refers to KPIs that measure the benefits achieved by European R&I projects and are split into the following three levels:

- Overarching KPIs

  A.1. Increased network capacity at affordable cost: Network capacity increase aims to ensure load demand coverage and can be achieved by adding new RES, network reinforcements, etc. Operating expenses (OPEX) and capital expenditure (CAPEX) should be considered when increasing network capacity.

  A.2. Increased system flexibility at affordable cost: System flexibility refers to the amount of electric power needed to be available to ensure the secure and robust operation of the network. Hence, flexibility requires the commitment of redundant units by implementing a cost minimization planning.

- Specific KPIs

  B.1. Increased RES and DER hosting capacity: Increase of RES/DER penetration in distribution systems characterizes active distribution networks. RES/DER connection requires their optimal integration, without endangering system's stability.

  B.2. Reduced energy curtailment of RES and DER: Energy curtailment is often proposed as a solution to operation problems raised by the connection of new RES/DER units. However, operation and control tools providing alternatives reducing the amount of green energy curtailed should be developed.

  B.3. Power quality and quality supply: High penetration of RES and DERs very often leads to stability problems and reliability issues, thus requiring the implementation of preventive actions to maintain high quality of power supply.

  B.4. Extended asset life time: The optimal usage and the maintenance of the equipment should be considered in operation planning in order to extend the life-time of assets.

  B.5. Increased flexibility from energy players: New energy control schemes, such as DR services, are exploited to provide further flexibility in network operation.

  B.6. Improved competitiveness of the electricity market: Energy and ancillary services for the management and control of active distribution networks calls for multiple energy players, thus improving the competitiveness of the electricity energy market.

  B.7. Increased hosting capacity for EVs and other new loads: The presence of new technologies, such as electric vehicles makes necessary the existence of infrastructure, ensuring their increased hosting capacity in the distribution system.

- Project KPIs, defined per project, based on specific project functionalities.

The relation between the first two KPI categories (*Overarching KPIs* and *Specific KPIs)* and EU energy policy goals can be depicted in Table 3.

Table 3 – Overarching and Specific KPIs compliance with EU energy policy goals

KPIs	Compliance with EU energy policy goals		
	Sustainability	**Market competitiveness**	**Security of supply**
A.1. Increased network capacity at affordable cost	✓	✓	✓
A.2. Increased system flexibility at affordable cost	✓	✓	✓
B.1. Increased RES and DER hosting capacity	✓	✓	✓
B.2. Reduced energy curtailment of RES and DER	✓	✓	✓
B.3. Power quality and quality supply	✓	✓	✓
B.4. Extended asset life time			✓
B.5. Increased flexibility from energy players		✓	✓
B.6. Improved competitiveness of the electricity market		✓	
B.7. Increased hosting capacity for EVs and other new loads	✓	✓	✓

As mentioned above, KPIs aim to present the added value of R&I results compared to the existing practices. The expected benefits (technical and/or economical) that could be provided by R&I versus the benefits already achieved by traditional solutions are quantified though KPIs, as depicted in the following figure.

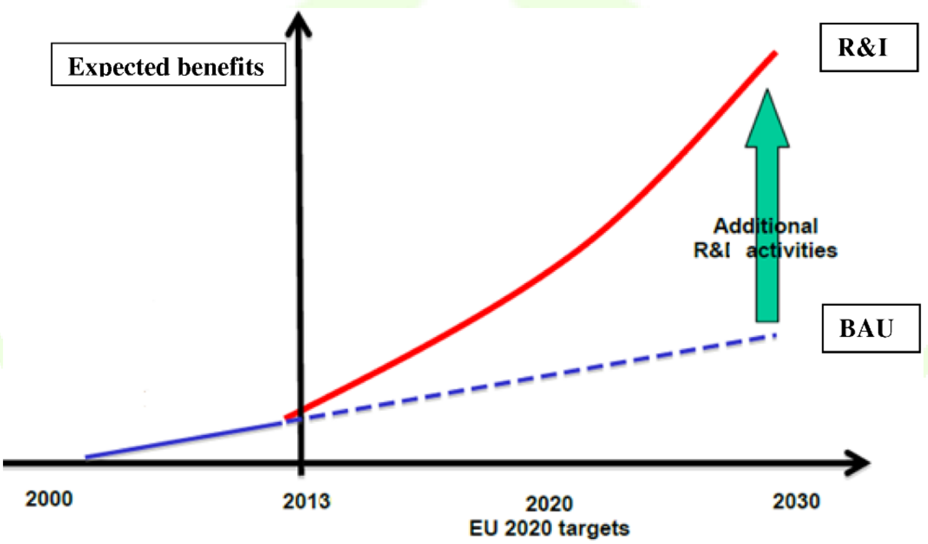


Figure 14 – Comparison of the expected benefits between R&I and BaU scenarios

The two following cases are compared and the corresponding values of the selected variables are used to calculate the KPIs.

- Business-As-Usual (BAU) scenario: values of the variables calculated by using traditional technologies.

- R&I case: values of the variables calculated by using the innovative results provided by R&I solutions.

It should be mentioned that in order to be able to make the comparison, a BaU solution should exist. The "*four step approach*" to value KPIs is as follows:

- Step 1: Identification of the problems needed to be solved or the situation that needs to be improved.

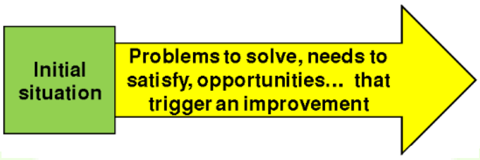


Figure 15 – Step 1 of the process for calculating the KPIs.

- Step 2: Selection of the already available tools to be used in the above described situation and other scenario cases of this in BaU and estimate the results and the progress made after applying this approach.

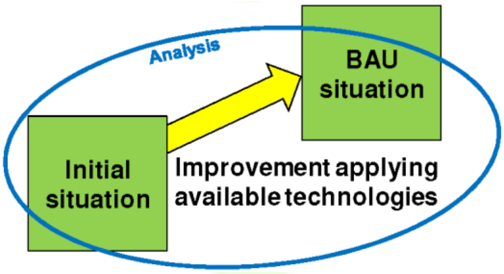


Figure 16 – Step 2 of the process for calculating the KPIs.

- Step 3: Implementation of the R&I developed solutions in order to deal with possible future situations and analysis of the estimated results.

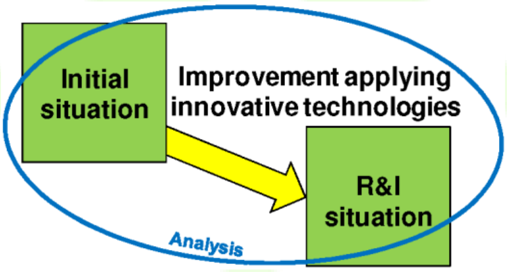


Figure 17 – Step 3 of the process for calculating the KPIs.

- Step 4: Calculation of KPIs in order to compare the R&I with the BaU approach, by applying the proposed formula for each KPI.

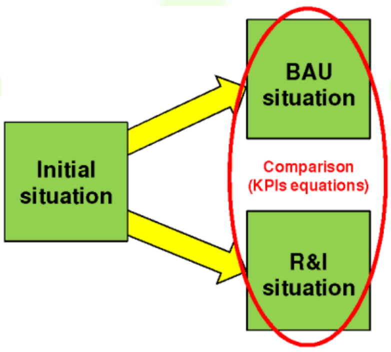


Figure 18 – Step 4 of the process for calculating the KPIs.

3.3.2 KPI definition

The first step towards the KPI definition is to clarify their applications. Hence, it should be determined what KPIs are impacted by the expected or achieved results of the R&I project. Therefore, a short analysis on how the project results contribute to each KPI and an estimation of the values of each affected KPI should be provided.

In WiseGRID, both *Specific KPIs* and *Project KPIs* are defined and selected in a way to measure the impact and evaluate the results of PUCs. Therefore, KPIs are associated at first level with PUCs and through them with HLUCs and SUCs. It should be mentioned that one KPI can be related to one or more PUCs and vice versa. Although the pairing of KPIs to more than one PUCs is performed individually per PUC, the proposed KPIs are reviewed by all partners and validated per pilot site. In order to facilitate this process, the information needed for the optimal definition of KPIs is categorized and presented as follows:

1. KPI ID;
2. Strategic Objective(s): the specific European energy policy goals (*Sustainability*, *Market competitiveness* and/or *Security of supply*) to the attainment of which the Project contributes; the success in attaining one or more of these goals can be measured through each KPI;
3. Project Objective(s): the project objectives to which the KPI is related;
4. Description: gives the purpose and the use of the KPI;
5. Formula: the analytical formula for the calculation of the KPI;
6. Unit of measurement;
7. Related PUC(s): the PUCs that could use the specific KPI;
8. Project relevance: the relevance of each KPI in quantifying the WiseGRID project impacts is identified either as direct or as indirect (i.e. the improvement observed in a KPI with direct relevance can be attributed directly to the solutions proposed within the Project);
9. General comments: any peculiarities in the calculation method, or specific details for facilitating and ensuring the correct usage of the KPI, such as risk factors for the quality of the data used as input for the KPI calculation, time delays, etc., are also included.

4 WISEGRID TOOLS

With the WiseGRID project, nine different products will be developed, each one targeting on a different aspect of the electricity distribution grid.

4.1 WG INTEROPERABLE PLATFORM (IOP)

The WiseGRID Interoperable Platform (WG IOP) is a scalable, secure and open ICT platform, with interoperable interfaces, for real-time monitoring and decentralized control to support effective operation of the energy network. The objective of the platform is to manage and process the heterogeneous and massive data streams coming from the distributed energy infrastructure deployed. This platform will enable new services and reduce ICT costs for prosumers and smaller players, whilst it will facilitate cross-network and cross-entity interoperability. In order to increase adoption and speed up deployment, this platform will have open interfaces to the relevant energy, IoT and Smart City standards.

4.2 WISEHOME

WiseHOME is an application for individual domestic consumers and prosumers to become active energy players. Mutatis mutandis, this tool is an adapted version of WiseCORP mentioned below. Some of the functionalities offered by the tool are: real-time monitoring of consumption and production, participation in DR programs, alerts, tips and price information to reduce energy costs for the consumer, remote control of the smart devices and distributed energy systems deployed at home such as PV panels, storage systems, EV charging points, power to heat solutions, etc.

4.3 WISECORP

WiseCORP is a corporate application for businesses, industries, ESCOs and public facilities consumers and prosumers to become active, smarter energy players by giving them more power and protection, and reducing their energy bill, supporting self-consumption by means of real-time data coming from all their energy devices and systems and by means of DR and load optimization schemes. Specialized versions are foreseen according to the type of end-user: ports, airports, trains, public lighting, public buildings and offices, water management, industries, etc. The functionalities offered by this app can be used and managed directly by the energy manager in charge of each organisation/facility or by means of ESCOs.

4.4 WISECOOP

WiseCOOP is an application for energy retailers, aggregators, local communities and cooperatives of consumers and prosumers (and other intermediary companies) to help domestic and small businesses, consumers and prosumers achieve better energy deals while relieving them from administrative procedures and cumbersome research. Through the aggregation and cooperation among citizens, better services and prices will be offered to the final consumers/prosumers. This includes aggregation models such as Virtual Power Plants (VPPs) where the energy aggregator (or other intermediary) gathers a portfolio of smaller generators and prosumers and operates them as a unified and flexible resource on the energy market or sells their power as system reserve.

4.5 WG COCKPIT

WG Cockpit is a tool for Distribution System Operators (DSOs) in order to control, manage and monitor their own grid, improve flexibility, stability and security of their network, while considering an increasing share of distributed renewable resources. By means of WG Cockpit, the DSO will be able to detect faults, self-protect and self-reconfigure the network in a robust way to restore the power system without the intervention of a central intelligence (self-healing). WG Cockpit will support DSOs by means of monitoring, decision support, control and optimized operation enabling grid-friendly integration of heterogeneous and distributed energy resources.

4.6 WISEEVP

WiseGRID Electric Vehicle Platform (WiseEVP) is a tool/platform to be used by vehicle-sharing companies and EVs fleet managers, in order to optimize the activities related with smart charging and discharging of the EVs and reduce energy billing. By means of this platform they will be able to plan and control the charging/discharging schedule of all EVs of the fleet. The platform will provide a reference load profile taking into consideration the renewable generation profile, the tariffs and the requirements from the driver(s) of the EV in question. EV fleet as VPP storage and geocharging optimization services will be included, considering the e-car fleet as an aggregation of moving batteries.

4.7 WG FASTV2G

WG FastV2G is a charging station, which will make it possible to use EVs as dynamic distributed storage devices, injecting energy stored in their batteries back into the system when needed (fast V2G supply). This can help reduce electricity system costs by providing a cost-effective means of providing regulation services, spinning reserves and peak shaving capacity.

4.8 WG STAAS/VPP

WiseGRID energy STorage as a Service/Virtual Power Plants (WG STaaS/VPP) is a tool that will make operational a service by which consumers/prosumers (be them households or corporate) can easily offer to the market (through a third party which operates the service) their unused storage capacity. Alternatively, a complementary service will allow consumers/prosumers to easily aggregate (again through a third party) their spare energy generation capacity and offer it to the market in the form of a VPP.

4.9 WG RESCO

WiseGRID Renewable Energy Service Company (WG RESCO) is a tool that will enable the provision of energy from RES, usually PV, wind power or micro hydro to consumers (household/businesses) that do not own RES production facilities. WG RESCO owns and operates such infrastructure and charges a fee to the consumer including any required capital replacement cost and all operating, maintenance and repair costs plus a profit for the operating organization.

5 REQUIREMENTS

5.1 GENERAL REQUIREMENTS

5.1.1 Overview

WiseGRID project aims at increasing the smartness, stability and security of an open, consumer-centric European energy grid, by helping all actors involved – DSOs, aggregators, retailers, prosumers, consumers, ESCOs, EV fleet operators, etc. to become more active and empowered players. Towards this objective, the project will develop a set of technological solutions packaged within 9 different interoperable products, each of them targeting a specific set of end-users.

The list of general requirements helps settling the high level objectives of the project, thus helping to spread a common understanding of the work to be developed. Several different perspectives of the energy field have been taken into account – cultural, legal, regulatory and technical. This list contains the requirements that will guide the first steps of the project, namely:

- Objectives of the project that need to be taken into account at the design of the technological solutions.
- Implications of the interoperability among the different technological solutions to be developed.
- Horizontal technical requirements affecting all the 9 interoperable WiseGRID products.

5.1.2 Detailed requirements

All partners of the WiseGRID project have participated – in parallel to the use cases definition – in the definition of the project general requirements list.

The list of requirements covers different aspects around the objectives of the project. A short summary of those includes:

- General requirements.
    - Project objectives.
    - Technological solutions horizontal requirements.
- Architectural requirements, focusing on the interoperability of the different solutions.
- Specific big data-related requirements, which is a horizontal aspect to all the solutions to be developed within the project.

An overview of all general requirements provided by the consortium can be found in Table 4.

Table 4 – WiseGRID general requirements

Requirement ID	Description	Type
ARC_001	The systems designed within WiseGRID must be based on open standards (as much as possible).	The scope of the product
ARC_002	Systems shall have appropriate interfaces for working with WiseGRID and securely exchange data with operational facilities.	The purpose of the product

Requirement ID	Description	Type
ARC_003	End Users should be grouped by consumption profiles and invited to interact in favour of more energy efficiency.	Usability and humanity requirements
ARC_004	WiseGRID System should be designed according principles of modularity, scalability and interoperability.	Operational requirements
ARC_005	Strong WiseEVP and WG FastV2G coordination due to the fact that they are using so much common data.	The scope of the work
ARC_006	WiseEVP has an EVSE management module and an EV fleet management module.	The scope of the product
BDP_001	The platform shall be able to work with several types of data.	Functional and data requirements
BDP_002	The platform shall be able to apply different algorithms on the data.	Functional and data requirements
BDP_003	The platform should provide enough storage capacity to deal with the storage of data managed within the project.	Operational requirements
BDP_004	Data quality assessment and substitution	Functional and data requirements
BDP_005	Temporal and spatial integration	Functional and data requirements
BDP_006	Clustering	Functional and data requirements
BDP_007	Periodic data analysis is supported.	Functional and data requirements
BDP_008	Data reduction	Functional and data requirements
BDP_009	The platform shall be able to apply privacy policies on different segments of data.	Functional and data requirements
BDP_010	The platform shall be able to communicate with a defined number of protocols.	Functional and data requirements
BDP_011	The platform will be able to work as a distributed system.	Functional and data requirements
BDP_012	The database(s) will store data based on CIM data model (extensions may be needed from standardized CIM).	Functional and data requirements
BDP_013	Where CIM is difficult to apply and data models have complex and hybrid structure, database(s) shall be able to store and retrieve JSON structures.	Functional and data requirements
BDP_014	The platform will be able to make data carving.	Functional and data requirements
BDP_015	The platform will have a real-time data section which will allow much higher number of transactions than on persistent database section.	Functional and data requirements
BDP_016	Access to different database information will be based on Role-Based Access Control (RBAC).	Functional and data requirements
BDP_017	The platform will support powerful scripts which will support data protection schemes according to GPDR requirements.	Functional and data requirements
BDP_018	The platform will support powerful data security features.	Functional and data requirements
BDP_019	The platform will need a concept if key management for the data security features.	Functional and data requirements

Requirement ID	Description	Type
BDP_020	The platform will allow micro transactions for different segmented markets. Block-chain solution will be considered.	Functional and data requirements
BDP_021	The platform will allow data anonymization by using anonymous labels in some data-bases and personal reference in other databases.	Functional and data requirements
BDP_022	The platform will allow data anonymization by using aggregation of personal data, where the applications allow and gives meaning for the aggregated data (e.g. aggre-gated active powers of a cluster of end-users).	Functional and data requirements
BDP_023	Triggered data analysis is supported.	Functional and data requirements
GEN_001	WiseGRID must advance the UN sustainable development goals (e.g., low carbon en-ergy security, energy efficiency over consumption).	Cultural and political requirements
GEN_002	WiseGRID must advance a low carbon based circular economy (cradle to grave pro-duction and waste management; renewables penetration).	Cultural and political requirements
GEN_003	WiseGRID must foster citizens' empowerment and decentralisation of the energy system (e.g., prosumers' markets, micro-generation, community energy)	Cultural and political requirements
GEN_004	WiseGRID must promote consumer-centric smart grid related data management sys-tems.	Security require-ments
GEN_005	WiseGRID must promote a 'level playing field' which does not discriminate between competitors (e.g., suppliers, aggregators) as well as flexibility solutions (e.g., storage, DR, EVs).	Operational require-ments
GEN_006	WiseGRID must make use of existing standards or standards under development to provide easier access to market and the dissemination of the resulting solutions worldwide.	Legal requirements
GEN_007	WiseGRID can promote new standards using the results of the project looking for a higher market penetration.	Legal requirements
GEN_008	The apps developed should be aligned and easy adaptable to the regulatory frame-work.	Legal requirements
GEN_009	Quality of historical data from pilot sites must be assured.	Operational require-ments
GEN_010	All product GUIs should be designed utilising user (stakeholder) feedback at the de-sign phase.	Look and feel re-quirements
GEN_011	The apps developed within WiseGRID should be compatible with different operating systems (Windows, Android, Linux, MacOS, iOS, etc.).	Functional and data requirements
GEN_012	A support system to the users should be created for the support of the tools deploy-ment in the pilot sites.	Users of the product
GEN_013	Maximize the implementation of local renewable production.	The scope of the work
GEN_014	The governance of the system needs to be collegial and include the end-users.	Usability and human-ity requirements
GEN_015	Standard Communication Protocols need to be used.	Naming conventions and definitions
GEN_017	WiseGRID must prioritize self-generation.	Cultural and political requirements
GEN_018	Feedback option of every WiseGRID final product	Usability and human-ity requirements

Requirement ID	Description	Type
GEN_019	Advertising to encourage users to use WiseGRID products	Cultural and political requirements
GEN_020	Implementation of algorithms that calculate forecast of renewable production according to meteorological data (solar irradiation, wind)	Functional and data requirements
GEN_021	WiseGRID products translation to different languages	Usability and humanity requirements
GEN_022	Granularity at the device level to identify and to isolate anomalous devices.	Operational requirements
GEN_023	Phasor Measurement Units (PMUs) in strategical places in order to monitor the quality of the grid	Operational requirements
GEN_024	Smart meters infrastructure should be deployed and integrated into the grid.	Functional and data requirements
GEN_025	Smart meter must have a network connection.	Functional and data requirements
GEN_026	Real data in real-time from smart meters, sensors, metering, etc. must be available.	Functional and data requirements
GEN_027	The WiseGRID app ecosystem should support coherent user management between apps.	Mandated constraints
GEN_028	Date time data will always be processed in UTC.	Mandated constraints
GEN_029	Data owners will decide for which purposes their data can be used.	Legal requirements

The complete set of requirements and their priority will be refined in next stages of the project, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.2 WISEGRID INTEROPERABLE PLATFORM

5.2.1 Overview

WG IOP inside WiseGRID project aims to provide a scalable, secure and open ICT platform, with interoperable interfaces, for real-time monitoring and decentralized control to support effective operation of the energy network.

The objective of the platform is to manage and process the heterogeneous and massive data stream coming from the distributed energy infrastructure deployed. This platform should enable new services and reduce ICT costs for prosumers and smaller players, whilst it will facilitate cross-network and cross-entity interoperability. It will enable the cooperation and synergies among the different actors targeted by the different WiseGRID technological solutions.

In order to increase adoption and speed up deployment, this platform will have open interfaces to the relevant energy, Internet of Things (IoT) and Smart City standards. In addition, proper data model standards will be considered for fostering the interoperability of energy field solutions.

5.2.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WG IOP tool. The list considers therefore several different perspectives of the product, according the partners background.

The list of requirements covers different aspects of the tool. A short summary of those includes:

- Performance:
  - Assuring high performance and efficiency on data aggregation and filtering
  - Following standards and interoperable technologies
  - Assuring security
- Expected features
  - Authentication
  - Access control mechanisms
  - Management of heterogeneous data information according privacy policy

An overview of all requirements for the WG IOP requirements provided by the consortium can be found in Table 5.

Table 5 – WG IOP requirements

Requirement ID	Description	Type
IOP_001	IOP must implement authentication mechanisms to identify its clients.	Functional and data requirements
IOP_002	IOP must implement access control mechanisms over the information exchanged.	Functional and data requirements
IOP_003	It collects and transfers heterogeneous and massive data stream coming from energy network.	Functional and data requirements
IOP_004	IOP manages heterogeneous data information.	Functional and data requirements
IOP_005	Guidelines to integrate the energy applications have to be identified.	Open issues
IOP_006	IOP must interface with different energy distributed resources of the smart grid and energy market actors.	Functional and data requirements
IOP_007	IOP is based on standards and interoperable technologies based on web services.	Performance requirements
IOP_008	IOP must manage data according privacy policy.	Functional and data requirements
IOP_009	IOP must follow a privacy-preserving data collection policy.	Functional and data requirements
IOP_010	IOP has to assure security.	Security requirements
IOP_011	IOP has to assure high performance and efficiency on data aggregation and filtering.	Performance requirements
IOP_012	WG IOP shall send and receive data through WG IOP components.	Functional and data requirements
IOP_013	A common framework shall be put in place for intercommunication among all modules and applications.	Operational requirements
IOP_014	It needs to support asynchronous communication.	Operational requirements
IOP_015	IOP should provide the centralised user authentication system.	The scope of the product
IOP_016	IOP has repository of communication modules readily accessible and installable by different Wise tools.	The scope of the work

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP4 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.3 WISEGRID COCKPIT

5.3.1 Overview

WiseGRID Cockpit is the WiseGRID technological solution targeting DSOs and microgrid operators, allowing them to control, manage and monitor their own grid, improving flexibility, stability and security of their network. Taking into account the goals of the project, the features to be implemented within WiseGRID cockpit consider a scenario of increasing share of distributed renewable resources and services provided by communities of prosumers (aggregated in the form of VPPs or cooperatives in order to achieve higher participation and environmental, social and economic benefits).

The main purpose of the WiseGRID Cockpit is to enable DSOs to manage the fundamental changes that distribution grids are facing nowadays, some remarkable ones of those being the transition towards a grid with high penetration of distributed renewable energy resources and the presence of additional significant loads coming from EVs among others. In addition, this particular outcome of the WiseGRID project aims at approaching the benefits that new technologies (such as big data or unbundled smart meters) and algorithms (such as state estimation or fault detection) bring to the operation of the grid. Finally, since one of the objectives of the project is the empowerment of the citizens in the energy field, the WiseGRID Cockpit will also demonstrate how that empowerment can be beneficial for several actors – including DSOs -, and how the whole ecosystem of actors can contribute to reach an environmentally and economically sustainable energy system.

Figure 19 – WiseGRID Cockpit

5.3.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WiseGRID Cockpit solution. The list considers therefore several different perspectives of the product, from whose DSO operation - and aspects that can be improved -, ICT requirements and pilot site expectations may be highlighted.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- Prerequisites
  - Communication channels and standard protocols available for interacting with field devices and existing systems (including GIS, SCADA, ERP, etc.)
  - Availability of assets to demonstrate the expected features (RES, smart meters, etc.)

- Availability of data to demonstrate the expected features (measurements, topology, etc.)
- Legal requirements (contractual agreements needed among different actors for the system to operate)
- Expected features
  - Monitoring
  - Increased observability
  - Information to be displayed to the operator
  - Enhanced maintenance, fault-detection and recovery of problems in the grid
  - Enhanced operation of the grid by interoperating with services offered by other WiseGRID technological solutions

An overview of all requirements for the WiseGRID cockpit requirements provided by the consortium can be found in Table 6.

Table 6 – WiseGRID Cockpit requirements

Requirement ID	Description	Type
AMG_001	Bidirectional communication between DSO and involved energy stakeholders is established.	Functional and data requirements
AMG_002	Contractual agreements between the DSO and the rest of the actors are in place.	Legal requirements
AMG_003	The proprietor of the unit (if different from the DSO) has signed a contract with the DSO that describes the conditions that apply regarding the load control actions.	Legal requirements
AMG_004	Reliable calculation of customer response to control signals.	Functional and data requirements
AMG_005	Characteristics of load control actions (timeframe, triggering events) should be well-established.	Legal requirements
AMG_006	The resource operator has signed a contract with the DSO that describes the conditions that apply regarding the load control actions.	Legal requirements
AMG_007	The Prosumers, EVs and other local energy resources have signed a contract with the resource operator for load control actions.	Legal requirements
AMG_008	Actors portfolio (characteristics) is known.	Functional and data requirements
AMG_009	The optimization algorithm is robust.	Functional and data requirements
AMG_010	The optimization algorithm produces reliable results.	Functional and data requirements
AMG_011	Adequate amount of pieces of equipment for monitoring the distribution network is installed.	Functional and data requirements
AMG_012	Regulation allows islanded operation of part of the distribution network.	Legal requirements
WCP_001	Smart meters shall be installed in enough ratio to allow proper measurements of the grid buses.	Operational requirements
WCP_002	Smart meters shall be installed in participant prosumers to allow proper consumption/production/power quality measurements.	Operational requirements
WCP_003	WiseGRID Cockpit must visualize all collected measurements of the grid.	Functional and data requirements
WCP_004	WiseGRID Cockpit must visualize KPIs of Power Quality-related metrics.	Functional and data requirements

Requirement ID	Description	Type
WCP_005	DER attached to the grid must include control interfaces.	Operational requirements
WCP_006	Flexibility market must offer an open interface to post requests.	Operational requirements
WCP_007	VPPs and Storage aaS (including DR, RES, VE and batteries) must offer an open interface to post requests.	Operational requirements
WCP_008	WG Cockpit must provide an interface to inform fault detections to operators.	Functional and data requirements
WCP_009	WG Cockpit must provide operators with grid reconfiguration proposals in the event of (expected) faults.	Functional and data requirements
WCP_010	WG Cockpit must be able to automatically apply optimized grid reconfiguration.	Functional and data requirements
WCP_011	Switches available in the feeders must be controllable.	Operational requirements
WCP_012	The platform will be able to manage grid imbalance.	Functional and data requirements
WCP_013	WG Cockpit must perform grid state estimation.	Functional and data requirements
WCP_014	WG Cockpit will monitor the distribution network.	The scope of the product
WCP_015	WG Cockpit will improve the flexibility of the distribution network.	The scope of the product
WCP_016	WG Cockpit will enhance RES integration in the distribution network.	The scope of the product
WCP_017	WG Cockpit will detect faults in the distribution network.	The scope of the product
WCP_018	WG Cockpit will self-configure the distribution network.	The scope of the product
WCP_019	WG Cockpit will manage remotely the switching elements in the distribution network.	The scope of the product
WCP_020	WiseGRID should use open standards, if possible and define interfaces for all interconnected systems under WiseGRID Cockpit app.	The scope of the product
WCP_021	WG Cockpit will enable a connection bus between different various operational facilities and applications of the DSOs.	The scope of the product
WCP_022	WG Cockpit should be able to provide suggested solutions as best practises to faults in case of repetition, or in cases of grid reconfiguration.	Functional and data requirements
WCP_023	The topology of the grid at pilot sites must be known in advance.	Operational requirements
WCP_024	The developed fault location algorithms should work effectively on both underground and overhead networks.	Functional and data requirements
WCP_025	Real-Time or near Real-Time update of asset database/GIS.	Functional and data requirements
WCP_026	Bidirectional communication between installed devices and central control unit.	Functional and data requirements
WCP_027	Data transfer between different applications based on a common data model.	The scope of the product

Requirement ID	Description	Type
WCP_028	It should perform/provide the results of load flow analysis.	Operational require-ments
WCP_029	It should provide information on the status of the asset and their maintenance to the DSO.	Functional and data requirements
WCP_030	WG Cockpit shall provide clear and effective visualization of the topology, so that the DSO can easily spot the whole affected area in case a fault happens at the grid.	Functional and data requirements
WCP_031	WG Cockpit must have an open interface with GIS (through IOP).	Functional and data requirements
WCP_032	WG Cockpit must support communication with DMS, through IOP.	Functional and data requirements
WCP_033	WG Cockpit should allow DSOs to generate curtailment warnings.	Functional and data requirements
WCP_034	WG Cockpit allows the active voltage control and the management of switching com-ponents in the network.	The scope of the product
WCP_035	WG Cockpit provides support for grid automation based on Unbundled Smart Meters measurements.	The scope of the product
WCP_036	WG Cockpit has to support grid operators to better manage and control the energy network.	The scope of the product
WCP_037	WG Cockpit provides SCADA support and DER dispatch services, for Smart Grid using real-time data (at the consumer level) and direct control of DERs.	The scope of the product
WCP_038	WG Cockpit provides energy quality monitoring service (e.g. voltage levels and volt-age asymmetries, current asymmetries in low voltage, time of voltage, failures at customer levels).	The scope of the product
WCP_039	WG Cockpit shows energy grid load, RES forecast, state estimation and load flow.	Functional and data requirements
WCP_040	WG Cockpit will support grid energy storage system (g-ESS) optimisation for grid ca-pacity management. In this context, g-ESS will be DSO asset and shall be combined with SaaS (Storage as a Service) offered by market aggregators.	Functional and data requirements
WCP_041	WG Cockpit will support grid survey and will highlight critical nodes in terms of volt-age and critical sections in terms of power flow.	Functional and data requirements
WCP_042	WG Cockpit will have suitable interface to energy market platform.	Functional and data requirements
WCP_043	WG Cockpit will have suitable interface to balancing market platform.	Functional and data requirements
WCP_044	WG Cockpit should perform/provide the results of short circuit calculations.	Functional and data requirements
WCP_045	WG Cockpit shall provide zoning of the grid with clear allocation of each RES, storage and/or dispatchable consumer. This would manage also the visualization of the to-pology, so that the DSO can easily evaluate actors implication within various operat-ing	Functional and data requirements
WCP_046	WG Cockpit will have a refreshing period for data update to suit various functions availability.	Functional and data requirements

5.4 WISEGRID STORAGE AS A SERVICE/VIRTUAL POWER PLANT

5.4.1 Overview

WG StaaS/VPP is the WiseGRID technological solution targeting aggregators with a respective portfolio based on distributed generation and storage. The main goal of this solution is helping consumers and prosumers (be them households or corporate) to be aggregated and offer to the market their unused storage capacity as well as spare generation in the form of a VPP. The objective of the tool is the provision of services to different actors:

- Services to prosumers
  - Benefit from participation in flexibility markets
  - Avoid curtailment of RES (if storage is in place)
- Services to Balance Responsible Party
  - Day-ahead/Intraday portfolio optimization
  - Self-balancing
  - Generation optimization
- Services to DSOs
  - Load frequency control
  - Grid capacity management
    - Deliver peak load electricity
    - Load-following power generation at short notice (DRES + batteries combined)
  - Voltage support
  - Power quality support

Figure 20 – WG StaaS/VPP

5.4.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WG StaaS/VPP solution.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- Prerequisites

- Necessary infrastructure (including secure communication channels) available to access de required data
- Legal requirements
    - Explicit permission of final users' needs to exist in order to make use of their data
    - Anonymization of prosumer data
- Expected features
    - Monitoring and data processing of aggregated units
    - Market participation of aggregated units
    - Efficient operation and scheduling of aggregated units triggered by smart algorithms
    - Demand-response participation
    - Billing and Contracting
    - Integration with tools to provide feedback to end-users
    - Integration with tools to receive grid data and commands from DSO
    - Cyber and physical security

An overview of all requirements for the StaaS/VPP requirements provided by the consortium can be found in Table 7.

Table 7 – WiseGRID StaaS/VPP requirements

Requirement ID	Description	Type
SAS_002	Algorithms should strive for maximal lifespan of battery.	Functional and data requirements
SAS_003	Algorithms for selection of best suited combinations of storage units have to consider type of storage, availability of storage system, power capability, remaining energy content, current aging status, efficiency, demand and production forecasts.	Functional and data requirements
SAS_004	WG StaaS/VPP must collect and process data from storage systems.	Functional and data requirements
SAS_005	WG StaaS/VPP must be linked to energy market.	Functional and data requirements
SAS_006	Algorithms have to define if participation of storage systems in energy market/energy transfer is beneficial or not. (Aging of system + loss of energy + unavailability during period vs. income)	Functional and data requirements
SAS_007	Not only energy transfer to/from energy market but also to/from other storage systems should be considered.	Functional and data requirements
SAS_008	Communication structure/protocols used for data transfer between storage systems and platform should be secure and in-line with current standards.	Functional and data requirements
SAS_009	Aggregated data from storage systems should be anonymised.	Legal requirements
SAS_010	WG StaaS/VPP must include billing function. If necessary data transfer with smart meters has to be established as well.	Functional and data requirements
SAS_011	Grid status should be included in selection algorithms as well.	Functional and data requirements
SAS_012	Tool calculates how the overall VPP-power is distributed to the different storage systems according to ranking. Selection criteria are mentioned in SAS_003.	Functional and data requirements
SAS_013	WG StaaS/VPP should integrate renewable energy generation.	The scope of the product

Requirement ID	Description	Type
SAS_014	WG StaaS/VPP should notify the user for the uses.	Usability and humanity requirements
SAS_015	WG StaaS/VPP needs to take into account the needs from the DR module.	Functional and data requirements
SAS_016	Platform shall allow both short-term and long-term contracts.	Operational requirements
SAS_017	The system must calculate the optimal bid to be placed in the market.	Functional and data requirements
SAS_018	Command verification	Functional and data requirements
SAS_019	WG StaaS/VPP must be able to manage all VPP participants' contracts	The scope of the product
SAS_020	System scalability	Performance requirements
SAS_021	VPP cyber/physical protection	Security requirements
SAS_022	VPPu management	Security requirements
SAS_023	Tool's downtime during upgrade operations	Maintainability and support requirements
SAS_025	VPP participants as well as their meters and sensors must have an internet connection and be operative.	Functional and data requirements
SAS_026	The VPP energy grid status of important components must be available (voltage, frequency, etc.).	Functional and data requirements
SAS_027	Decentralized energy generators and/or energy consumers portfolio (including their characteristics)	Functional and data requirements
SAS_028	Receiving notifications and requests by WG cockpit (DSO) about status of the distribution grid.	Functional and data requirements
SAS_029	Nominal battery characteristics	Functional and data requirements
SAS_030	Power and energy capability of the storage system in order to meet the black start requirements	Operational requirements
SAS_031	Implementation of an algorithm that calculates the best option to manage an energy production surplus	Functional and data requirements
SAS_032	WG StaaS/VPP should provide islanding mode in case of a power outage.	Functional and data requirements
SAS_033	The GUI of the aggregator app version should assist in prosumer portfolio management, with the list of the related prosumers, their assets and their location in grid topology.	Functional and data requirements
SAS_034	WG StaaS/VPP should provide information on the overall status of VPP, regarding current production, SoC, and forecasting.	Functional and data requirements
SAS_035	WG StaaS/VPP should support ADR.	Functional and data requirements
SAS_036	It should provide VPP flexibility forecast	Functional and data requirements

Requirement ID	Description	Type
SAS_037	StaaS/VPP must facilitate selling the energy managed by VPP in the corresponding wholesale market.	The scope of the work
SAS_038	VPP will only aggregate controllable assets.	Mandated constraints
SAS_039	An information channel from VPP operator to portfolio members will be available.	The scope of the work
SAS_040	StaaS/VPP should be able to integrate multiple stationary storage systems as a type of controllable distributed energy production in the virtual power plant.	Functional and data requirements

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP7 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.5 WISECOOP

5.5.1 Overview

WiseCOOP is the WiseGRID technological solution targeting aggregators of consumers and prosumers - particularly focused on domestic and small businesses -, supporting them in their roles of energy retailers, local communities and cooperatives – which may have different objectives.

The main goal of the solution is helping consumers and prosumers to work together in order to achieve better energy deals while relieving them from administrative procedures and cumbersome research. In the particular scenario of increasing share of distributed renewable resources, this goal can be achieved by pursuing several objectives:

- Net metering: supporting the operation of communities of prosumers that invest in renewable energy sources aiming at reducing their environmental impact
- Member profiling: clusters of consumers and prosumers with common energy usage patterns may be identified, allowing the aggregator to negotiate special terms (as for instance energy tariffs) particularly beneficial for those groups
- Demand forecasting: by allowing aggregator (in its retailer role) to forecast the demand of its customers, optimized purchase of energy at the wholesale market is enabled
- Tariff comparison: by offering members a tool for comparing their particular consumption with different available tariffs, those will have access to very valuable information to reduce their energy bills
- Implicit price-based DR towards modulating the overall demand of the group to achieve a common objective (as, for instance, maximize usage of renewable energy sources produced within the group)
- Providing clear information to members to raise awareness on efficient energy usage and environmental awareness

Figure 21 – WiseCOOP

5.5.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WiseCOOP solution.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- Prerequisites
  - Necessary infrastructure available to access de required data
- Legal requirements
  - Explicit permission of final users' needs to exist in order to make use of their data
- Expected features
  - Monitoring
  - Profiling
  - Demand-response participation
  - Billing
  - Integration with tools to provide feedback to end-users

An overview of all requirements for the WiseCOOP requirements provided by the consortium can be found in Table 8.

Table 8 – WiseCOOP requirements

Requirement ID	Description	Type
COP_002	Intelligent decision algorithms to solve local imbalance between local production and local consumption	Functional and data requirements
COP_003	Users of the platform will have access to consumption measurements of the aggregated prosumers.	Functional and data requirements
COP_004	Users of the platform will have access to production measurements of the aggregated prosumers.	Functional and data requirements
COP_005	Users of the platform will have access to battery status of the aggregated prosumers.	Functional and data requirements
COP_006	WiseCOOP shall be able to cluster prosumers accordingly to their consumption pattern.	Functional and data requirements
COP_007	WiseCOOP shall be able to cluster prosumers accordingly to their production pattern.	Functional and data requirements

Requirement ID	Description	Type
COP_008	WiseCOOP shall be able to assist the selection of the proper tariffs for each cluster.	Functional and data requirements
COP_009	WiseCOOP shall be able to aggregate the cooperatives' partners available flexibility.	Functional and data requirements
COP_011	RES generation should never be limited (full priority) in times of potential grid congestion or local imbalance. Appropriate scenarios should be evoked to avoid grid problems.	Operational requirements
COP_013	Users of the platform shall be able to participate in DR programs as a whole.	Functional and data requirements
COP_014	WiseCOOP shall offer billing functionalities for cooperatives with a retailer role.	Functional and data requirements
COP_015	WiseCOOP shall be able to geographically map the clustered consumers to grid lines.	Functional and data requirements
COP_015	WiseCOOP shall be able to geographically map the clustered pronsumers to grid lines.	Functional and data requirements
COP_017	WiseCOOP shall be able to have access to measurements of the interconnected entities and transform them accordingly.	Functional and data requirements
COP_018	Platform will require permission from prosumers to access and operate with their data.	Legal requirements
COP_020	Permission from domestic battery owners will be required in order to aggregate those batteries under Storage as a Service services.	Legal requirements
COP_021	WiseCOOP app could support gamification initiatives among the cooperatives members.	Functional and data requirements
COP_022	WiseCOOP app should provide visualization of the KPIs of the energy management strategies and DR campaigns of the cooperative.	Functional and data requirements
COP_023	WiseCOOP demand shifting mechanisms will focus in implicit (price-based) demand-response.	The scope of the work
COP_024	An information channel from aggregator to portfolio members will be available.	The scope of the work

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP7 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.6 WG RESCO

5.6.1 Overview

The WiseGRID RESCO is a solution addressed for RESCOs – Renewable Energy Sources Companies - and ESCOs which want to provide RES services to end-users (both households and businesses) that do not own nor wish to maintain the necessary equipment. In this perspective, three potential scenarios are envisaged:

- RESCO pays a fee to end-users using their premises (e.g. for installing PVs on their roof), installs and maintains the RES assets and markets all produced energy;
- RESCO provides to customers the supply of energy coming from RES owned by the RESCO (i.e. allowing self-consumption) and markets the production surplus;

* RESCO provides to customers the installation of RES equipment (e.g. PV panels) which are owned and maintained by the RESCO but fully exploited by the end customers (renting business model).

According to that, this tool aims at supporting the RESCOs to manage the relationship with their customers and the provision of energy to the consumers from renewable energy sources, usually PV, wind power or micro hydro enabling that the household/businesses serviced do not own nor maintain. Since the generation equipment will be owned, serviced and operated by the RESCO itself, the tool will also support the maintenance management of those assets and the market operation of the produced energy. Final goal is improving the share of renewable distributed resources by supporting a business model that will encourage the wide adoption of those technologies.

Figure 22 – WiseGRID RESCO

5.6.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the RESCO services. The list considers therefore several different perspectives of the product and aspects that can be improved.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

* The following expected features:
  * Monitor energy produced by installed RES assets
  * Monitor energy consumed by RESCO customers
  * Showing data monitoring
  * Provide information to its customers
* The following operational requirements:
  * Portfolio management
  * User profiling
  * Maintenance of provided equipment information

An overview of all requirements for the RESCO services requirements provided by the consortium can be found in Table 9.

Table 9 – RESCO services requirements

Requirement ID	Description	Type
RSC_002	WG RESCO shows data monitoring from Unbundled Smart Meters in real-time (max 10 seconds).	Functional and data requirements

Requirement ID	Description	Type
RSC_007	WG RESCO receives real-time inputs from Unbundled Smart Meters.	Functional and data requirements
RSC_009	WG RESCO sends signals for reducing/increasing power consumption to selected consumers.	Functional and data requirements
RSC_010	WG RESCO aims at improving the grid and support grid operators to better manage the energy network which including distributed renewables and other new energy resources, such as EV and batteries.	The purpose of the product
RSC_011	Portfolio management (list of equipment deployed, lists of clients, billing)	Operational requirements
RSC_012	Maintenance of provided equipment information (solar panels, batteries) including information of the current status	Operational requirements
RSC_013	User profiling (which business scenario suits better to each end-user)	Operational requirements
RSC_014	Owner and end-user direct communication	Operational requirements
RSC_015	List of RESCO companies that provide services (including price and location information)	Functional and data requirements
RSC_016	Implementation of a payment platform	Operational requirements
RSC_017	RESCOs should receive signals from the DSO about curtailment danger.	Functional and data requirements
RSC_018	WG RESCO should provide RES production forecasting.	Functional and data requirements
RSC_019	WG RESCO must facilitate selling the energy managed by RESCO in the corresponding wholesale market.	The scope of the work
RSC_020	Monitor energy produced by installed RES assets	Functional and data requirements
RSC_021	Monitor energy consumed by customers	Functional and data requirements
RSC_022	WG RESCO must provide information to its customers.	The scope of the work

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP12 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.7 WISEHOME APP

5.7.1 Overview

The WiseHOME app is the tool of the WiseGRID tool chain that serves as the interface with the residential electricity consumer or prosumer. Its initial goal is to provide a deep and comprehensive understanding of the energy consumption of the household to the user, in order to raise awareness about how energy is consumed, e.g. by which devices, when, what is the impact on total electricity intake from the grid. In addition, WiseHOME will also inform the user about the state and performance of other assets he may have in the home, such as local generation, stationary batteries or EVs. Finally the WiseHOME tool will also serve as the interface toward the user for the deployment of price-based DR campaigns by the supplier and/or cooperative within the context of the WiseGRID project. The main novelty of WiseHOME is the enabling, development and delivery of consumer-centric DR services in order to lower – or even eradicate – the consumer acceptance barrier that is typically observed in the deployment of price-based DR schemes. The preservation of consumer comfort preferences in terms of indoor conditions ensures that no comfort degradation will be observed due to participation in DR campaigns.

WiseHOME is a key component in order to achieve one of the main goals of the project, namely to empower citizens to become active participants in the energy system. The first prerequisite for this empowerment is the availability of tools that enable citizens to have a profound understanding of their energy related behaviours and consumption/generation patterns. This understanding, achieved using an energy monitoring tool via visual analytics, enables residential users to adapt their patterns to achieve their own objectives, e.g. energy cost reduction or maximization of self-consumption. By offering a direct link with the supplier/cooperative, WiseHOME opens up a new world of opportunities, including the communication and achievement of energy-related goals at the level of a neighbourhood or a cooperative, which can be facilitated using price-based DR schemes. Dynamic prices can serve as a proxy either for actual cost of energy in the wholesale market or for availability of renewable energy in the supplier generation portfolio – or any other metric that the supplier/cooperative wishes to communicate – and can be used as a tool to urge consumers to alter their consumption patterns in response to their increase or decrease. As a result, WiseHOME becomes a valuable tool in the hands of the residential con/prosumer and the supplier/cooperative in order to actively engage citizens in the energy system and empower them to take their energy fate in their own hands.

Figure 23 – WiseHOME

5.7.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WiseHOME application. As a result, the list encompasses several different perspectives of the product.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- Prerequisites
    - Availability of assets to demonstrate the expected features (controllable loads, smart meters for consumption/generation metering, storage/EVs, etc.)
    - Availability of data to demonstrate the expected features (ambient conditions, consumption data, etc.)
- Legal requirements (contractual agreements needed among different actors for the system to operate)
- Expected features

- User interfacing for energy monitoring and price-based DR
- Interaction with WiseCOOP to enable citizen participation in DR campaigns
- Comfort profiling

An overview of all requirements for the WiseHOME requirements provided by the consortium can be found in Table 10.

Table 10 – WiseHOME requirements

Requirement ID	Description	Type
DRF_003	The user needs to be able to configure the electricity tariff, or connect it with some public API in case of real-time pricing.	Usability and humanity requirements
DRF_004	Energy storage should be used in order to provide flexibility to the DR.	The scope of the product
DRF_005	The system should be compatible with others at the project in order to be able to share information.	Naming conventions and definitions
DRF_006	Different types of demand flexibility profiles will be defined as part of the consumer-centric DR profiling addressing the objectives of the project.	The scope of the product
DRF_007	The comfort-based demand flexibility profiles should be designed taking into account remote monitoring (and controllable) of building loads examined in the project.	The scope of the work
DRF_008	As part of comfort-based demand flexibility, we should address comfort profiles associated with the operation of energy-hungry HVAC devices.	The scope of the product
DRF_010	Towards the extraction of thermal comfort profiles, information about thermal context (temperature & humidity sensors) under different operational conditions (HVAC device status) is required.	Functional and data requirements
DRF_011	Towards the extraction of HVAC demand flexibility profiles, information about operational conditions (HVAC device status) and HVAC energy consumption is required	Functional and data requirements
DRF_013	The potential of defining comfort-based flexibility profiles for DHW devices should be also examined.	The scope of the product
DRF_014	The extraction of comfort-based flexibility profiles should be based on accurate DER models.	The scope of the product
DRF_015	Towards the extraction of comfort-based demand flexibility profiles, information about energy cost (retailer tariffs) is required.	Functional and data requirements
DRF_016	Comfort-based demand flexibility profiles shall support the implementation of demand shifting strategies (P2H flexibility profiling extraction).	The scope of the product
DRF_017	Comfort-based flexibility profiles should ensure the minimum of occupants' disturbance on building environment.	Functional and data requirements
DRF_018	Comfort based flexibility profiles should be exploited towards the implementation of automated DR strategies.	The scope of the product
DRF_019	Price based flexibility profiles should be defined, reflecting the enrolment of prosumers on price based DR scenarios.	The scope of the product
DRF_020	High-level demand elasticity profiles should be provided in lack of low level information (device level) information.	Functional and data requirements
DRF_021	Towards the extraction of price based flexibility profiles, information about market prices (real-time hourly prices, day-ahead hourly prices, pricing schemes) is required.	Functional and data requirements
DRF_022	Towards the extraction of price based flexibility profiles, information about external weather conditions should be available.	Functional and data requirements
DRF_023	Towards the extraction of price based flexibility profiles, information about individual consumer consumption is required.	Functional and data requirements

Requirement ID	Description	Type
DRF_025	A central data management unit should be responsible for capturing real-time and historical information required for the extraction of the different profiling types.	Functional and data requirements
DRF_026	Real-time information required for the extraction of (comfort-based, price based and EV based) demand flexibility profiles, should be available in real-time through an automated way.	Functional and data requirements
DRF_027	The consumer-centric DR profiling is running as a standalone service calculating the amount of potential flexibility at each demand side end point.	Performance requirements
DRF_031	Input values (capacity, response capability, location, time) will set the configuration parameters for the analytics process.	Functional and data requirements
GEN_003	WiseGRID must foster citizen empowerment and decentralisation of the energy system (e.g., prosumers markets, micro-generation, community energy).	Cultural and political requirements
GEN_004	WiseGRID must promote consumer-centric smart grid related data management systems.	Security requirements
GEN_006	WiseGRID must make use of existing standards or standards under development to provide easier access to market and the dissemination of the resulting solutions worldwide.	Legal requirements
GEN_007	WiseGRID can promote new standards using the results of the project looking for a higher market penetration.	Legal requirements
GEN_008	The apps developed should be aligned and easy adaptable to the regulatory framework.	Legal requirements
GEN_009	Quality of historical data from pilot sites must be assured.	Operational requirements
GEN_010	All product GUIs should be designed utilising user (stakeholder) feedback at the design phase.	Look and feel requirements
GEN_011	The apps developed within WiseGRID should be compatible with different operating systems (Windows, Android, Linux, MacOS, iOS, etc.).	Functional and data requirements
GEN_012	A support system to the users should be created for the support of the tools deployment in the pilot sites.	Users of the product
GEN_014	The governance of the system needs to be collegial and include the end-users.	Usability and humanity requirements
GEN_015	Standard communication protocols need to be used.	Naming conventions and definitions
GEN_017	WiseGRID must prioritize self-generation.	Cultural and political requirements
GEN_018	Feedback option of every WiseGRID final product	Usability and humanity requirements
GEN_019	Advertising to encourage users to use WiseGRID products	Cultural and political requirements
GEN_021	WiseGRID products translation to different languages	Usability and humanity requirements
GEN_023	Phasor Measurement Units (PMUs) in strategical places in order to monitor the quality of the grid.	Operational requirements
GEN_024	Smart meters infrastructure should be deployed and integrated into the grid.	Functional and data requirements
GEN_025	Smart meter must have a network connection.	Functional and data requirements

Requirement ID	Description	Type
GEN_026	Real data in real-time from smart meters, sensors, metering, etc. must to be available.	Functional and data requirements
GEN_027	The WiseGRID app ecosystem should support coherent user management between apps.	Mandated constraints
GEN_028	Date/time data will always be processed in UTC.	Mandated constraints
HOM_001	End-users should get access to energy consumption, local generation (if any) and storage (if any) information (real-time and historical) in a personalized way.	Functional and data requirements
HOM_002	End-users should get access to energy cost & CO_2 intensity information (real-time and historical data) in a personalized way.	Functional and data requirements
HOM_003	End-users should get informed about retailer prices and available tariff schemes.	Functional and data requirements
HOM_004	Along with real-time information end-users will receive information about short term consumption and generation forecast.	Functional and data requirements
HOM_005	Advices and recommendations about efficient energy usage should be triggered to the end-users.	Functional and data requirements
HOM_006	Notifications about activation of manual driven DR strategies should be available via WiseHOME app.	Functional and data requirements
HOM_007	The end-users should get informed about incentives (for DR participation) or penalization (for non DR participation).	Functional and data requirements
HOM_008	The app should be as user-friendly as possible.	Usability and humanity requirements
HOM_009	Consumer or prosumers need to have an opt-out option for DR/ADR programs (if ADR is exploited in the project).	Functional and data requirements
HOM_010	The application GUI should be designed in a user-centric way i.e. involving the feedback of the end-user at the design phase	Look and feel requirements
HOM_011	The granularity of consumption and generation information presented to the consumers/prosumers should be at least (min) at an hourly level	Functional and data requirements
HOM_012	WiseHOME app should include remote control of smart devices for end-users.	Functional and data requirements
HOM_013	WiseHOME app should illustrate cost savings.	Functional and data requirements
HOM_014	WiseHOME shall allow its users to set constraints to the remote control of the smart appliances.	Operational requirements
HOM_015	Notifications about activation of ADR strategies should be available via WiseHOME app.	Functional and data requirements
HOM_016	End-users should get informed about active DR contracts in a personalised way.	Functional and data requirements
HOM_017	End-users should get informed about the best practices towards optimally participating in active DR contracts.	Functional and data requirements
HOM_018	Simple analytics over historical data (consumption, generation, cost, etc.) will be provided by the tool.	Functional and data requirements
HOM_019	End-users (prosumers) should get access to local generation data, if any.	Functional and data requirements
HOM_020	End-users (prosumers) should get access to local storage data, if any.	Functional and data requirements

Requirement ID	Description	Type
HOM_021	Apart from DR strategies, ESCOs and Aggregators may trigger additional messages to the portfolio users via the app.	Functional and data requirements
HOM_022	The application will support social networks integration, to allow that way comparison with similar peers.	Functional and data requirements
HOM_023	The end-users will be able to configure the WiseHOME app settings (username, password, social media connection).	Functional and data requirements
HOM_025	Data must be presented in an accessible, understandable and flexible format.	Usability and humanity requirements
HOM_027	End user credentials are required for accessing the app.	Security requirements
HOM_028	Data should be consistent ensuring that way the reliability of the app.	Performance requirements
HOM_029	The structure of the app should address scalability requirements.	Performance requirements
HOM_030	Access on the WiseHOME should not be dependent on the connecting device.	Operational requirements
HOM_031	Under automated DR, cleanest energy sources must always be prioritized against fossil-fuel based ones.	Operational requirements
HOM_032	Remotely controllable loads	Operational requirements
HOM_033	Real-time monitoring information about indoor/exterior conditions in buildings	Functional and data requirements
HOM_034	Maintenance of devices information (solar panels, boilers, air conditioning, etc.)	Operational requirements
HOM_035	Calculation of the optimal power term for each prosumer	Operational requirements
HOM_036	Market information availability	Functional and data requirements
HOM_037	Anonymizing data from private EVs	Security requirements
HOM_038	WiseHOME app should include a user support section.	Usability and humanity requirements
HOM_039	Private EV owners end-users should get access to EV management for domestic charging.	Functional and data requirements
HOM_040	WiseHOME app shall allow its users to set constraints on the use of their data.	Usability and humanity requirements
HOM_041	WiseHOME will be able to execute the home EVSE's flexibility offers (V2H and/or smart charging capabilities).	The scope of the product
HOM_042	WiseHOME must have access to assets-to-be-controlled or their load controller via remotely accessible APIs (preferably over IP, e.g. ReST interfaces).	Operational requirements

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP13 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.8 WISECORP APP

5.8.1 Overview

WiseCORP is the WiseGRID technological solution targeting businesses, industries, ESCOs and public facility consumers and prosumers, with the objective of providing to them the necessary mechanisms to become smarter energy players. By means of energy usage monitoring and analysis, proper information can be given to facility managers helping them to reduce energy costs and environmental impact.

A key factor towards achieving these objectives is a proper retrieval and analysis of energy usage data, and visualization of meaningful information extracted from it. This information may include:

- detailed visualization of energy demand at different areas of the building, helping facility managers to identify opportunities for enhancing energy efficiency;
- energy tariff comparison, enabling a direct economic cost reduction by shifting to a more adequate tariff;
- energy demand forecast, enabling medium to long term cost estimations and supporting operative decisions about the usage of the facilities;
- demand flexibility estimation, allowing the execution of optimization algorithms that will – either automatically or by providing advices – shift demand in order to minimize economic costs – by maximizing self-consumption or moving demand to off-peak periods – or minimize environmental impact – by shifting demand to periods where green energy is available.

Figure 24 – WiseCORP

5.8.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WiseCORP solution.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- Prerequisites
    - Access to required data
    - Availability of assets to demonstrate the expected features (RES, batteries, controllable loads, etc.)
- Legal requirements
    - Explicit permission of users to access and use their data in the application

- Expected features
    - Monitoring
    - Advanced visualization
    - Energy usage optimization towards different objectives
    - Integration with other WiseGRID technological solutions for exploiting synergies among the corresponding actors

An overview of all requirements for the WiseCORP requirements provided by the consortium can be found in Table 11.

Table 11 – WiseCORP requirements

Requirement ID	Description	Type
CRP_001	Platform users' shall have access to measured data of their related facilities.	Functional and data requirements
CRP_002	Manageable loads must include a control interface.	Functional and data requirements
CRP_003	Energy tariffs must be available.	Functional and data requirements
CRP_004	Energy price at wholesale electricity market must be available.	Functional and data requirements
CRP_005	Platform will have access to energy measurements (consumption and production) of the platform users' related facilities.	Functional and data requirements
CRP_006	WiseCORP shall show consumption and production evolution charts.	Functional and data requirements
CRP_007	WiseCORP shall show consumption and production KPIs.	Functional and data requirements
CRP_008	Platform users should get informed about the economic cost of the energy consumed in their facilities.	Functional and data requirements
CRP_009	Platform users' shall be able to watch the energy mix and CO_2 emissions associated to their consumption.	Functional and data requirements
CRP_010	WiseCORP will be able to control smart devices (HVAC, lighting, industrial processes) for energy optimization purposes.	Functional and data requirements
CRP_011	WiseCORP will be able to minimize economic costs by using flexibility.	Functional and data requirements
CRP_012	WiseCORP will be able to minimize CO_2 emissions by using flexibility.	Functional and data requirements
CRP_013	WiseCORP will be able to trade flexibility in the market.	Functional and data requirements
CRP_014	WiseCORP will allow end-users to choose usage of their flexibility (optimize energy demand, costs or CO_2 emissions, or offer it in the flexibility market).	Functional and data requirements
CRP_015	WiseCORP will exchange data with operational facilities.	Functional and data requirements
CRP_016	WiseCORP will need communication networks to incorporate various entities in data exchange.	Relevant facts and assumptions
CRP_017	WiseCORP will need synchronization mechanism.	Functional and data requirements

Requirement ID	Description	Type
CRP_018	WiseCORP app users shall have a secure protocol for data exchange and defined security rules for operational facilities integration to platform.	Functional and data requirements
CRP_019	One user of WiseCORP (i.e. a company or organisation) may be able to monitor and control several facilities from the platform.	The scope of the product
CRP_020	WiseCORP shall calculate demand and generation forecasts.	The scope of the product
CRP_021	WiseCORP will facilitate the participation of companies in demand-response programmes.	The scope of the product
CRP_022	WiseCORP shall allow its users to set constraints to the remote control of the smart appliances.	Operational requirements
CRP_023	Users of the platform (companies, municipalities, etc.) will explicitly be informed (upon registration) about the data required and how it will be managed.	Legal requirements
CRP_024	End-users of the platform (organisations, municipalities, etc.) will grant permissions to the platform to access and operate with their data.	Legal requirements
CRP_025	WiseCORP app should provide information on energy production and storage equipment status and their maintenance details.	Functional and data requirements
CRP_026	WiseCORP app should offer access to historical data of consumption, production of the facilities and KPIs of different management strategies in them.	Functional and data requirements
CRP_027	WiseCORP app could include a map with all the facilities and the relevant assets for better visualization to facilitate the managers/users.	Operational requirements
CRP_028	WiseCORP app shall provide visualization of the energy transferred to and from the EV fleet of the company, if it exists and uses its infrastructure as charging station.	Functional and data requirements

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP7 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.9 WISEEVP

5.9.1 Overview

WiseEVP is the WiseGRID technological solution for

- vehicle-sharing companies or EV fleet managers and
- EV infrastructure operators

in order to optimize the activities related with smart charging and discharging of the EVs including V2G (vehicle to grid, energy injection in the distribution network) and V2H (vehicle to home, energy injection in the household electric installation).

The management of the EVSEs charging and discharging processes will meet the following objectives:

- Reduce the EV charging energy bill.
- Follow flexibility requests from DSO to help the electric distribution network operation in exchange for an economic consideration.
- Follow flexibility requests to increase injection of RES production reducing curtailment in exchange for an economic consideration.
- Contribute in the household energy management system with the main objectives of reducing the energy bill and maximize local RES production.

All the aforementioned objectives will be subordinated to the EV user preferences: desired state of charge (SoC) at the time of unplugging the EV.

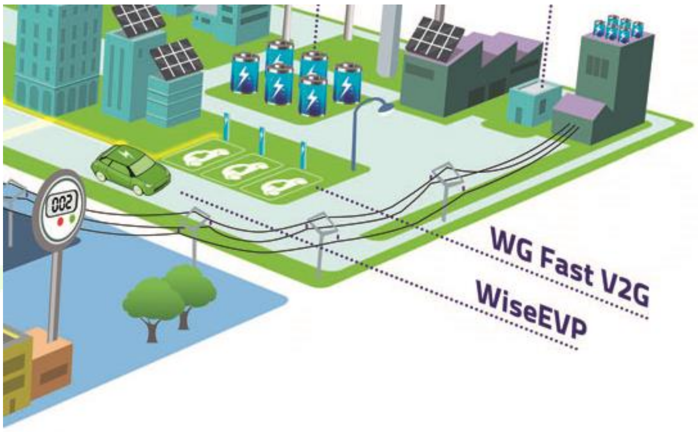


Figure 25 – WiseEVP

5.9.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WiseEVP solution.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- EV fleet/infrastructure management
  - EV usage schedule
  - Monitor deviations from schedule
  - EV & EVSE maintenance
  - EV & EVSE booking
- Interface with charging point
  - EV status information (SoC)
  - Charging process information (type, mode)
  - Charging process commands (start/stop, schedule)
  - Interface with grid (V2G)
  - Link to WG FastV2G
- Interface with other WiseGRID products
  - WG Cockpit to provide flexibility products linked to regulation areas to help the distribution networks operation.
  - WiseHOME to offer V2H and smart charging capabilities to be included in the household energy management.
- WiseEVP expected features
  - Manage the EVSE and EV fleet monitoring database
  - Manage EV user authentication in EVSE network
  - Manage the charging session booking

- Manage the EVSE network model configuration
- Forecast EV load
- Estimate EV flexibility per regulation area
- Calculate the reference charging load profile
- Execute periodically the charging session schedule process (CSSP)
- Execute the charging session reschedule process (CSRP) to follow grid requests or to maximise RES integration.

An overview of all requirements for the WiseEVP requirements provided by the consortium can be found in Table 12.

Table 12 – WiseEVP requirements

Requirement ID	Description	Type
EVP_001	Different models of EV's should easily be integrated in WiseEVP.	Functional and data requirements
EVP_002	Charging speed of charging station can be manually set.	Usability and humanity requirements
EVP_003	WiseEVP must provide API's to allow integration in other fleet management tools.	Functional and data requirements
EVP_004	WiseEVP collects data from vehicles and charging stations on one platform.	The scope of the product
EVP_005	Different models of charging stations should easily be integrated in WiseEVP.	The scope of the product
EVP_006	WiseEVP should provide basic fleet management functionalities: maintenance, documents administration, damage reporting, etc.	Usability and humanity requirements
EVP_007	WiseEVP should have a simple mechanism to link the availability / calendar of each car to the charging control engine.	Usability and humanity requirements
EVP_008	WiseEVP should perhaps also include access to a buffer of energy, such as a collection of standalone fixed batteries.	Operational requirements
EVP_010	WiseEVP will receive the state of the distribution network from the WiseGRID Cockpit.	Functional and data requirements
EVP_014	WiseEVP will receive the DSO flexibility needs through the WiseGRID Cockpit.	The scope of the product
EVP_015	WiseEVP will calculate the aggregated flexibility capabilities of the EVSEs under its management.	The scope of the product
EVP_017	WiseEVP will reschedule the EVSE charging sessions to meet DSO needs.	The scope of the product
EVP_018	WiseEVP will allow EVSE booking.	The scope of the product
EVP_019	WiseEVP will establish a two way communication with DSOs.	The scope of the product
EVP_020	WiseEVP should have a link to energy markets (energy exchange, balancing and ancillary services markets).	Functional and data requirements
EVP_021	The platform will share data in order to provide information to the demand forecasting module.	Functional and data requirements
EVP_022	WiseEVP could merge data from owned EVSE and from publicly available EVSE.	The scope of the product

Requirement ID	Description	Type
EVP_024	EVSE unique identifier	Functional and data requirements
EVP_025	Smart card or unique digital token per user	Functional and data requirements
EVP_026	The users have to provide their personal data, EV data and preferences in the context of EV.	Usability and humanity requirements
EVP_027	Clear identification of the EVSE on its casing	Usability and humanity requirements
EVP_028	The end-user should be registered and authorised in order to charge and/or book an EV in the system.	Usability and humanity requirements
EVP_029	List of available charging stations with booking possibilities	Operational requirements
EVP_031	EV status available (SoC)	Functional and data requirements
EVP_032	Notification of near charging stations	Usability and humanity requirements
EVP_033	WiseEVP should perform and make use of grouping of EVSE in regulation areas.	Operational requirements
EVP_034	It must facilitate the management of EV fleet of industries/companies, etc.	The scope of the product
EVP_035	WiseEVP should support the end-user's ability to choose the preferable type of EV charging (among the ones described in HL-UC 3).	Functional and data requirements
EVP_036	WiseEVP must provide real or near real-time monitoring of the EVSE equipment (and the EV fleet) to the EVSE manager (and EV fleet manager).	Functional and data requirements
EVP_037	Anonymising charging data to assure data privacy in case of private EVs.	Legal requirements
EVP_038	In case of EV fleets, WiseEVP shall provide to the EV fleet manager (owner) information on the EVs usage and position.	Functional and data requirements
EVP_040	WiseEVP shall provide historical consumption and charging session data from each EVSE.	Functional and data requirements
EVP_041	WiseEVP should contain a pricing mechanism for rewarding the performed balancing.	Functional and data requirements
EVP_042	WiseEVP should provide information about the energy price curves to the users.	Functional and data requirements
EVP_043	WiseEVP communicates with charging stations through open smart charging protocol of the Open Charge Alliance (OSCP).	Functional and data requirements
EVP_044	The status of EVSE can be changed easily from public, private, out-of-order, etc. by the manager, or by the EVSE itself.	Functional and data requirements
EVP_045	WiseEVP gathers data from EVs (location, SoC, status of the car, etc.) via API.	Functional and data requirements
EVP_046	The EVSE operator or the fleet manager has an updated list of known users (for authentication process).	The scope of the product
EVP_047	The EV user has a valid account in the WiseEVP for the authentication process.	The scope of the product
EVP_048	The EV user only will provide flexibility to the system allowing the system to module his charging session if he wants (charging types 2 and 3). If not, his car will be charged asap (charging type 1).	Users of the product

Requirement ID	Description	Type
EVP_049	The EVSE Operator or the EV Fleet manager will be able to configure the EVSE network through the WiseEVP (EVSE location, number of sockets, maximum and minimum power, etc.).	The scope of the product
EVP_050	WiseEVP will calculate the EV load forecasting per regulation area and/or for the whole system.	The scope of the product
EVP_051	WiseEVP will calculate the reference load profile per regulation area.	The scope of the product
EVP_052	WiseEVP will schedule the type 2-3 charging sessions of the EVSE network following an economic criterion if no other grid or RES requests are triggered.	The scope of the product
EVP_053	The EVSE Operator needs to know the regulation areas division based on coordinates or based on network topology (this information may be retrieved from the DSO outside the system).	Functional and data requirements
EVP_054	Before starting with the charging session schedule processes, the data collection from EVSE should be performed to have historical data and to know the status of the EVSEs.	Functional and data requirements
EVP_055	WiseEVP will modulate the power output of his EVSE network to help the DSO with the grid operation.	The scope of the work
EVP_056	WiseEVP will modulate the power output of his EVSE network to maximize the RES integration answering the flexibility requests performed by the RESCOs or Aggregators through the WG StaaS/VPP.	The scope of the product
EVP_057	WiseEVP allows setting a pricing model for booking an EVSE: reservation cost, cancellation cost, extending booking cost, etc.	Functional and data requirements
EVP_058	WiseEVP has a console at an EVSE or a hub of EVSEs.	Functional and data requirements
EVP_060	WiseEVP should allow grouping EVSEs in one hub, sharing the same location.	Functional and data requirements

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP9 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

5.10 WISEGRID FASTV2G

5.10.1 Overview

WiseGRID FastV2G is the EV charging station solution within WiseGRID making possible to use EV as dynamic distributed storage devices, feeding electricity stored in their batteries back into the system when needed (fast V2G supply). This feature brings up a number of possibilities that may be beneficial not only for the EV owners but for other actors of the energy field:

- By taking advantage of V2G, fleet managers and domestic EV owners can use their vehicles also as a battery, giving them the flexibility needed to shift their demand from the supplier, reduce peak power demand and minimize costs.
- In a scenario of increasing share of EVs, EVSE managers can, on one hand, take advantage of this flexibility for developing smarter charging strategies and optimize costs and, on the other hand, provide ancillary services to other actors such as the DSO and the BRP (for instance, supporting voltage control or balancing the demand in the system).

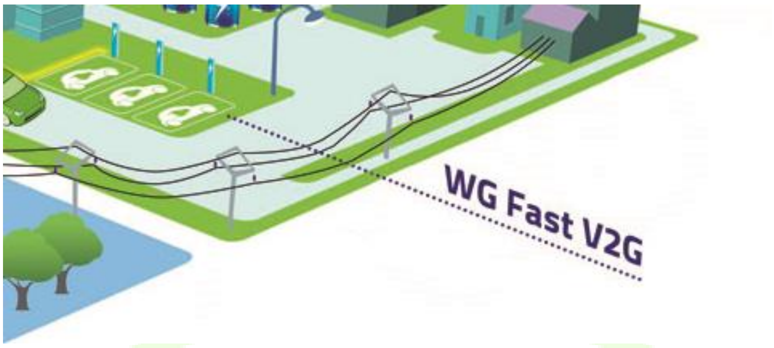


Figure 26 – WiseGRID FastV2G

5.10.2 Detailed requirements

All partners of WiseGRID project have participated – in parallel to the use cases definition – in the elaboration of the requirements list for the WiseGRID FastV2G solution.

The list of requirements covers different aspects around the development and deployment of the tool. A short summary of those includes:

- Prerequisites
    - Available infrastructure to support deployment of WiseGRID FastV2G
- Expected features
    - Vehicle to grid energy transfer
    - Supported charging modes
    - Interaction with the user

An overview of all requirements for the WiseGRID FastV2G requirements provided by the consortium can be found in Table 13.

Table 13 – WiseGRID FastV2G requirements

Requirement ID	Description	Type
FVG_001	WG FastV2G should be able to inject energy in the distribution network in a controlled manner (bidirectional power flow (from EV to Grid), depending on the capabilities of the EV).	The scope of the product
FVG_002	The user should be able to introduce his/her charging preferences through WG FastV2G (SoC objective, time limit, price, etc.).	Functional and data requirements
FVG_003	WG FastV2G should be able to perform a fast charging in less than 30 minutes.	The scope of the product
FVG_004	WG FastV2G should be able to perform Mode 3 charging (slow charging) following a charging pattern received from the WiseEVP.	The scope of the product
FVG_005	WG FastV2G will have two different connectors: Chademo and Combo connectors.	The scope of the product
FVG_006	WG FastV2G should be able to authenticate users.	The scope of the product
FVG_007	The characteristics of the grid need to allow implementation of the charging stations.	Operational requirements
FVG_008	The users should be matched to predefined templates based on DSO needs through WG FastV2G.	Functional and data requirements

Requirement ID	Description	Type
FVG_009	WG FastV2G should be able to manage and monitor the consumption of electric energy.	Functional and data requirements
FVG_011	EVSE to provide info to the user about charging capabilities (power output) and about optimizing the energy usage and reduction CO_2 footprint of the EV.	Usability and humanity requirements
FVG_012	EV charging constraints	Functional and data requirements
FVG_013	EVSE capable of communicating status (free, reserved, in use, out of order), as well to user as to WG IOP.	Operational requirements
FVG_014	EV minimum desired SoC at the end of the process is well known	Functional and data requirements
FVG_015	Identification method available on EVSE for users (smart card reader or smartphone /web-app, etc.)	The scope of the product
FVG_016	The EVSEs installed in a home environment will participate in the house energy management process modulating the power consumption and even injecting power to the household electric installation (V2H).	The scope of the product
FVG_017	Home EVSEs will be able to calculate its V2H and smart charging capabilities.	The scope of the product

The complete set of requirements and their priority will be refined in next stages of the project, especially in the WP8 activity, with inputs from demonstrators and from the development of the applications, thus some requirements will be enhanced, discarded or adapted.

6 USE CASES

A first step towards achieving the project objectives is to define several Use Cases each one describing a distinctive operational situation expected to occur within the future distribution grid that is fundamentally different from the status quo due to integration of new types of resources.

Within WP2 of WiseGRID, the process of UC identification and definition has been performed following an analytical approach: starting from the project objectives, seven High-Level Use Cases are defined, each one considering the needs of the end-users and of the energy infrastructure in the presence of high penetration of RES, DR programs, energy storage and EVs:

- HL-UC 1: Distributed RES integration in the grid

  Large-scale integration of intermittent decentralized RES, providing services to the grid (increased stability and security), while minimizing RES curtailment.

- HL-UC 2: Decentralized grid control automation

  Intelligent distributed control facilitating the tasks of the Distribution System Operator (DSO) in ensuring the smooth and uninterrupted operation of the distribution grid (fault detection, self-healing, etc.)

- HL-UC 3: e-mobility integration in the grid with V2G

  Integration of e-mobility and electric transport systems into the network with implementation of V2G technology, in order to provide services to the grid.

- HL-UC 4: Battery storage integration at substation and prosumer level

  Integration of storage systems for providing flexibility to the grid and auxiliary power supply.

- HL-UC 5: Cogeneration integration in public buildings/housing

  Integration of cogeneration in public buildings or collective housing and provision of services to the grid by exploiting the thermal storage capabilities.

- HL-UC 6: VPP technical and economic feasibility

  Technical and economic feasibility of the aggregated management of distributed resources through the Virtual Power Plant (VPP) concept, in order to exploit the flexibility capabilities offered by the VPP.

- HL-UC 7: Citizens empowerment in energy market and reduction of energy poverty

  Participation of prosumers in energy management schemes for reducing energy costs and achieving improved market integration.

Figure 27 presents the mapping of the HL-UCs to the project objectives and the relevant WG tools per HL-UC.

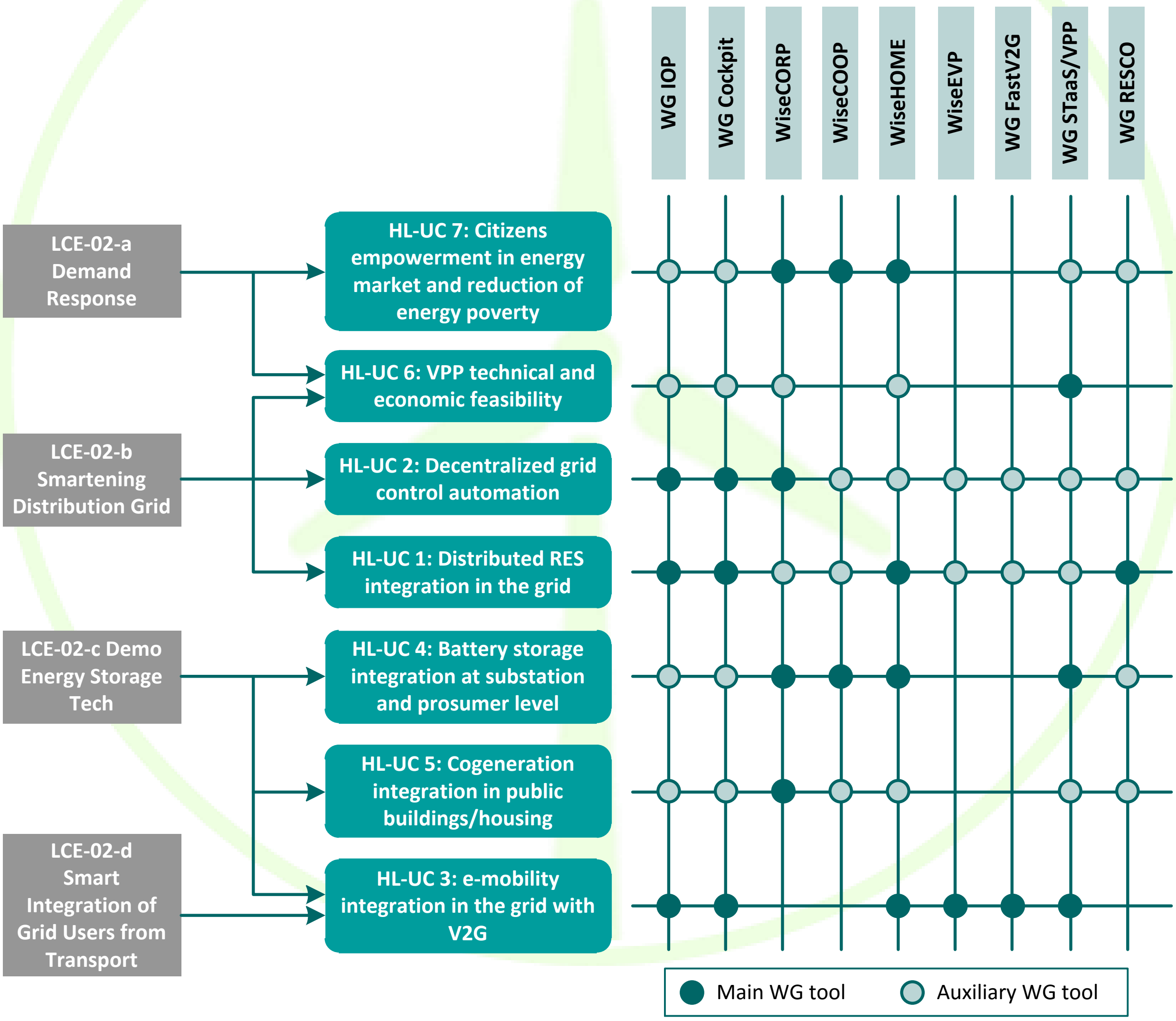


Figure 27 – HL-UCs mapping to project objectives and WiseGRID tools

These HL-UCs are further analysed through separate PUCs and SUCs, thus achieving detailed descriptions of the interactions among the various actors down to the level of systems and devices. For each PUC and SUC, the Full Templates appearing in ANNEX C and ANNEX D (sections 14 and 15, respectively) are created. These contain all useful information that defines each UC. The relevant fields are as follows:

1. Use Case ID: indicates the ID and the name of the UC.
2. Cluster: includes the target(s) to which the UC contributes according to the mapping appearing in Figure 27.
3. Classification: the type of the UC (PUC or SUC).
4. Description: contains a description of the UC.
5. Actors involved: the actors involved in the specific UC are included and separated into two categories: main actors take a leading role within the UC, while contributing actors have a secondary role.
6. Triggering event: describes what sets off (triggers) the UC. Note that some UCs may run periodically.
7. Pre-condition: describes the necessary conditions that should be true prior to the initiation of the UC in order for the UC execution to begin.
8. WiseGRID systems involved: these are distinguished into two categories: the main WG tool is the one undertaking the basic functionalities within each UC; the auxiliary WG tool plays a secondary role and assists in the implementation of the specific UC.
9. Post-condition: describes the status of the system under study after the UC finalization.
10. Typical steps: describes the course of events (steps) occurring sequentially under normal conditions in the framework of the specific UC.
    a. Step No.: 1, 2, 3, etc.
    b. Event: event name.
    c. Description of process/Activity: interactions between actors or processes performed by a single actor in the framework of the specific UC.
    d. Info. exchanged: information exchanged among the involved actors.
    e. Actor(s) producing the information.
    f. Actor(s) receiving the information.
11. Exception path: describes the course of events (steps) occurring sequentially under abnormal conditions in the framework of the specific UC (alternative, error management, backup scenario). There might be none, one or more than one exception paths.
12. Main responsible partner(s) (Author): the author of the UC.
13. Contributing partner(s): includes the partners that should be involved in the implementation of the UC including also pilot sites in which the UC will be demonstrated.
14. Priority: the priority of the UC with respect to the project. This can be low, medium or high and depends on the alignment of each UC to the project objectives.

6.1 HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID

The HL-UC 1 entitled "Distributed RES integration in the grid", aims to handle and demonstrate the network operation with the largest possible penetration of intermittent decentralized RES. One of the goals is to show the services that will render the grid operation stable and secure under these circumstances, while avoiding RES curtailment. WiseGRID solutions to be mapped within cases from HL-UC 1 are: WG IOP, WG Cockpit, WiseCORP, WiseCOOP, WiseHOME, WG STaaS/VPP and WG RESCO.

This HL-UC mainly describes the actions of RESCOs where different triggering events would be in place focusing on RES integration. The main objectives of HL-UC 1 are related to identifying solutions to accommodate an increasing amount of RES production, while advanced methodologies and tools will be available to the DSOs, to enhance the control, management, automation and maintenance of the grid, reducing losses and providing more stable and secure energy networks.

HL-UC 1 is based on PUCs and subsequent SUCs presenting possible cases that could facilitate a larger RES connection to the grid and operation, from various perspectives like: network monitoring; strategies to avoid

RES curtailment; voltage support and congestion management available from RES; grid planning analysis; and promoting RES via RESCO companies.

The Use Cases are further analysed (in more depth) by defining suitable SUCs that are presenting triggering events and subsequent steps for dedicated solutions. The HL-UC is a large and comprehensive set of tools providing possible applications that would help the RES integration within the distribution grid.

6.2 HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION

Within HL-UC 2, focus is placed on the functionalities pertaining to the control of the distribution grid with a view to address the challenges faced by the Distribution System Operator (DSO) in operating and managing the distribution grid in a reliable and economic manner under normal and abnormal conditions in the presence of new types of resources (variable generation, controllable loads, microgrids, etc.). More specifically, fault-detection, self-reconfiguration and self-healing are fundamental operations, which the DSO is expected to be able to offer in a decentralized manner. Accomplishing these goals requires: continuous monitoring of the prevailing conditions in the MV/LV distribution network, in order to determine the status of the grid and detect faults (HL-UC 2_PUC_1); identification of the operating state of the distribution network (HL-UC 2_PUC_2); and optimal real-time grid control for taking the necessary preventive actions (direct and indirect control, adjustments in the network topology including islanding of the local grid) (HL-UC 2_PUC_3).

To this end, an appropriate tool – WG Cockpit – is employed in order to facilitate the tasks of DSOs and microgrids Operators in monitoring, controlling and managing the grid under their responsibility as well as the decision-making process regarding the optimal operation of the distribution grid. Through the communication of WG Cockpit with the other components of the distribution grid, enabled by WG IOP, advanced methodologies are made available to the DSOs, thus allowing to achieve smooth integration of heterogeneous and distributed energy resources and to operate their grid in a robust way.

6.3 HL-UC 3 E-MOBILITY INTEGRATION IN THE GRID WITH V2G

One of the main objectives of the WiseGRID project is the smooth integration of (battery) EV and its charging infrastructure, referred to as EVSE or "electric supply equipment", in the local electric grid. The EVSE and the charging session it performs will be managed by the tool WiseEVP. To achieve this, WiseEVP takes into account the user needs and the local electricity grid requests. WiseEVP will adjust the profile of the charging sessions as required, and create in this way flexibility to the operation of the distribution network, within the limits set by end-user requests. This flexibility provided and managed by WiseEVP, helps to maximise the local RES integration by avoid curtailment of RES production and even letting the charging process participate in the household energy management processes (V2H) through the WiseHOME.

These processes will be supported by the WiseGRID FastV2G charging station, which will be developed within the project. FastV2G is managed by WiseEVP to the full extent and will enable load shifting and even supplying power to the grid (vehicle to grid, V2G).

The basis of these functionalities is a reliable and intends network monitoring that gathers data from the EVSEs and the EVs, making use of the WG IOP communication modules. In the end, smart managing of the network of EVSEs will provide extra network services while respecting the EV end-user preferences, which always have the highest priority in the scheduling of the charging sessions.

6.4 HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL

This HL-UC addresses energy storage systems' integration at different levels. On a prosumer level, storage units can increase self-consumption and self-sufficiency making the prosumer less dependent on utilities and energy prices. Moreover, energy cost can be reduced by applying time-of-use management, e.g. charging the storage unit when energy prices are low and discharging when energy prices are high. Last but not least, peak shaving is also achieved, since prices also depend on the highest peak power. In each of those cases, the storage unit provides power according to either a signal received through a sensor respectively a smart meter which reflects the current residual load, or according to price signals resulting from variable rate energy tariffs or energy market data. The monitoring and configuration of the storage units at prosumer level will be mainly supported by the WiseHOME and WiseCORP tools.

On an aggregator level, storage units provide services that are important for the smooth operation of the network, such as frequency control, reactive power and voltage control as well as DR. In order to provide such services, efficient batteries dispatch management as well as market scheduling need to be implemented on the level of an aggregator or VPP. As a basis for the market participation, storage units in the VPP are constantly monitored. The collected data serve as the input for intelligent algorithms that calculate the optimal dispatch for a set of storage units which will be providing services to the market. In that context, the combination of applications/services in a single storage unit is of interest as well. The operation of the storage units is triggered by means of command signals that are sent via defined communication channels. The most important tool for data collection, market scheduling and storage unit management will be WG STaaS.

HL-UC 4 mainly contributes to the deployment, integration and demonstration of energy storage systems in the distribution grid. Furthermore, techniques for a smarter distribution grid as well as innovative and advanced demand-response mechanisms are tackled.

This HL-UC is strongly linked to HL-UC 6, since storage units are aggregated and managed via a VPP. Since EVs can be used as storage units on both prosumer and aggregator level, this HL-UC is to some extent linked to HL-UC 3.

6.5 HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING

HL-UC 5 refers to the integration of cogeneration in households, commercial and industrial buildings and the use of the HVAC systems in such buildings, in order to exploit the synergies between the thermal and electrical needs of the buildings. The management of the available thermal potential of the buildings allows using them as a form of thermal storage in order to take advantage of their flexibility and contribute to the smooth operation of the distribution grid.

Achieving this goal requires modules for thermal monitoring (HL-UC 5_PUC_1) as well as for managing and controlling the devices that are part of the building's ecosystem (HL-UC 5_PUC_2). Maintaining an optimal level of services offered to the occupants of the buildings, requires models for simulating the thermal behavior of households and buildings in general, taking also into account the usage and occupancy patterns (HL-UC 5_PUC_3). Since the ultimate goal is to integrate the flexibility on the part of the thermal needs of buildings into the operation of the distribution grid, the optimal operation of the cogeneration and HVAC systems is also considered (HL-UC 5_PUC_4).

The WG tool appropriate for handling the aforementioned transactions is WiseCORP. This tool facilitates the handling of data pertaining to the energy management of the facilities under its supervision and also offers functionalities for optimizing the use of energy and promoting the application of energy management schemes that enable services to be offered to the distribution grid.

6.6 HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY

The Virtual Power Plant (VPP) represents a basic component of Active Distribution Network. VPP specifically is a system that integrates many resources, such as: Distributed Generation Units, energy storage systems and flexible/controllable loads with the aim to provide security of supply in a reliable way. The inclusion of VPPs in the energy grid becomes necessary due mainly to the increased needs for flexibility and its management in a context where the penetration of Renewable Energy Resources is growing. In fact, in case of excessive generation, the curtailment of Renewable Energy Resources can be avoided by taking advantage of the flexibility of the Virtual Power Plant, which comes from demand-responsive loads and storage technologies.

The VPP also represents an intermediary between the Distributed Energy Resources owners and the Energy wholesale market. The capacity of these heterogeneous resources can be aggregated and the energy surplus can be sold to the energy market. The VPP can participate in the day-ahead and intraday market for selling energy and in the ancillary services market to offer ancillary services. The VPP can otherwise decide to store the surplus for future use. Additionally, it is possible to use DR mechanisms to suitably shift the consumption of VPP members. In this framework the PUCs identified are about: VPP monitoring and management, in order to monitor the VPP resources and provide forecasting for defining the optimal strategy for managing the VPP (HL-UC 6_PUC_1); VPP market participation, in order to support the VPP in participating in the energy and ancillary services market (HL-UC 6_PUC_2); VPP real-time control, in order to provide a real-time control of the VPP (HL-UC 6_PUC_3) and VPP RES promotion and prosumer relationship management, in order to support the VPP in the relationship with energy consumers/prosumers, involving them in DR campaign and RES purchasing (HL-UC 6_PUC_4).

6.7 HL-UC 7 CITIZENS EMPOWERMENT IN ENERGY MARKET AND REDUCTION OF ENERGY POVERTY

The High Level Use Case 7 (entitled "Citizens Empowerment in Energy Market and Reduction of Energy Poverty") aims to bring the energy prosumers – residential and tertiary – closer to the energy markets in order to reduce their energy costs and improve market integration. DR is a critical tool in this endeavour, since it enables consumers to monetise their flexibility of energy consumption and production. Other enablers that help reduce energy poverty include self-consumption and net metering. The present HL-UC lays down the required processes and tools that can materialise these enablers through three distinct ICT tools for the three main actors involved downstream from the DR requestor, namely the residential prosumer, the tertiary building facility manager and the DR campaign coordinator (aggregator or supplier).

Energy management of tertiary buildings – and especially participation in DR campaigns – can bring significant financial benefits for the Facility Manager as well as environmental benefits. Support from ICT tools (WiseCORP) is necessary to optimise this process. "HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector" outlines the necessary functionalities and processes.

One of the main actors in the DR value chain is the Cooperative or the Retailer, the actor who manages end-to-end the DR campaigns, from design and participant recruitment to execution and reconciliation. "HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market" encapsulates the necessary ICT tool functionalities (WiseCOOP) to facilitate the process.

The necessary ICT tools (WiseHOME) to enable residential energy consumers to manage and optimise their electricity consumption as well as participate in DR campaigns of the Supplier or the Aggregator are described in "HL-UC 7_PUC_3_Clients engagement for active market participation".

7 SCENARIOS

Based on the UCs, four scenarios are defined, each one contributing to the project objectives. Apart from the scenario description, in this section the following information per scenario is presented: the actors involved, the WG tools employed, the relevant UCs per scenario, as well as the pilot sites for testing each scenario. Furthermore, each scenario is supported by at least two relevant HL-UCs according to the mapping appearing in Figure 27. The aforementioned diagram presents the relation of each HL-UC to at least one of the project objectives, which has been produced as a refined version of the relevant diagram appearing in the WiseGRID Description of Action after the laborious interactions among the project partners.

7.1 INNOVATIVE AND ADVANCED DEMAND-RESPONSE MECHANISMS

7.1.1 Scenario Description

The WiseGRID framework addresses the "structural inertia" of existing DR programmes by introducing more active elements combined with the necessary control and distributed coordination mechanisms. DR will be holistic, in the sense that they should cooperatively address all types of DERs (local generation, storage along with consumption and on-site EVs) and also in conjunction with local prosumer related and environmental parameters underlying the operation and affecting the flexibility and performance of these loads. Special emphasis will be given to the enhancement of user acceptance of DR mechanisms. On the technical side this will be achieved by introducing human comfort considerations in all related optimizations in order to preserve user preferences and comfort settings at all time, making DR a less (possibly even non-) intrusive proposition for the average citizen and eliminating main critical barriers. To this end, accurate, realistic and robust consumer profiles and comfort-aware DER flexibility models will be defined and utilized to facilitate the successful wide scale application of DR.

DR campaigns, as considered within the project, will be triggered targeting different objectives, depending on the context:

- Fostering in-home self-consumption and minimizing economic and environmental impact;
- Fostering self-consumption and minimizing economic and environmental impact among an aggregated group (e.g. cooperative) of prosumers;
- Offering ancillary services (e.g. peak shaving) to other actors of the smart grid.

The loads to be modelled need to have an appropriate capacity to provide demand flexibility; hence WiseGRID will focus on HVAC devices as the most appropriate and favourable with respect to automated DR capacity. Other loads – that do not contribute to occupant comfort – will also be utilised in order to maximise self-consumption at the building or group level. In addition, the project will also investigate the role that domestic batteries and EVs play in the modulation of the demand flexibility. Innovative and well proven learning techniques will be utilized to improve model accuracy taking into account information related to events from user behaviour and respective comfort preferences, towards defining robust and dynamic demand profiles. The latter will lead to the delivery of context-aware load flexibility profiles, reflecting real-time demand flexibility as a function of multiple parameters, such as time, device operational characteristics, environmental context/ conditions, energy costs and comfort preferences.

These models will further support the aggregator to implement more accurate incentive and price-based DR strategies, towards the exploitation of demand flexibility on different business scenarios. Prices will most likely be quantised depending on the source of electricity (e.g. own generation, generation within substation are, generation within cooperative, energy purchased in wholesale market) in order to provide citizens a simple and easy-to-grasp metric which encapsulates more than pure cost of electricity, but include environmental aspects as well. Aggregators and suppliers will gain access to an innovative DR framework that will allow for demand portfolio optimization by achieving high response reliability levels for the provision of services to grid and market operators during peak load events or other instability incidents.

During the WiseGRID pilot demonstrations, the entire end-to-end information flow required to support successful explicit & implicit DR campaigns will be showcased, including interfaces for all involved users (citizens, facility managers and aggregators/suppliers) to stimulate their involvement and provide easy-to-use and informative insights on building/system operations. For explicit DR, appropriate signals will be generated by the grid operator to indicate problems that can be resolved through demand modulation and sent to the aggregator, who will activate (automatically or via the manual intervention of users) the necessary loads at tertiary building premises to respond to the grid contingency. For implicit DR, on the other hand, the supplier will send the appropriate price signal to the energy consumers so that they can adapt their demand based on the actual market dynamics. Implicit DR will be tested in residential and tertiary buildings, while explicit DR will be showcased only in tertiary buildings which are typically better equipped with automation and remote control capabilities. As a result, Automated Demand Response (ADR) mechanisms will be developed and tested, where tertiary pilot buildings provide the necessary load controllability from the BMS level. In residential buildings, automation will be investigated based on the availability of remotely controllable loads through the internet. Manual DR schemes will be extensively tested in both building typologies, as they seem to involve acceptance barriers from prosumers and facility managers.

7.1.2 Actors and technologies involved

Actors

- Prosumer
- Facility Manager
- ESCO
- RESCO
- Aggregator
- Supplier
- Consumer
- Sensor
- Load Controller
- Forecast Provider
- Smart Meter
- Market Operator
- EVSE Operator
- VPP Operator
- Battery Operator
- DSO
- TSO
- BRP
- BMS

WiseGRID tools

Within the WiseGRID project, different solutions will be developed implementing the aspects previously described and targeting the particularities of different groups of users:

- WiseCORP, targeting businesses, industries, ESCOs and public facilities consumers and prosumers;
- WiseCOOP, targeting energy retailers, aggregators, local communities and cooperatives of consumers and prosumers;
- WiseHOME, targeting individual domestic consumers and prosumers.

A direct link from WiseCORP will also be established toward the STaaS/VPP tool, which includes all the functionalities required for aggregators to manage and operate explicit DR campaigns.

7.1.3 UC identification

PUCs

- HL-UC 6_PUC_1_VPP monitoring and management
- HL-UC 6_PUC_2_VPP market participation
- HL-UC 6_PUC_3_VPP real-time control
- HL-UC 6_PUC_4_VPP users relationship management

- HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector
- HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market
- HL-UC 7_PUC_3_Clients engagement for active market participation

SUCs

- HL-UC 6_SUC_1.1_Resource metering
- HL-UC 6_SUC_1.2_VPP RES forecast
- HL-UC 6_SUC_1.3_VPP flexibility forecast
- HL-UC 6_SUC_1.4_Strategies definition
- HL-UC 6_SUC_2.1_VPP market participation and bid calculation
- HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation
- HL-UC 6_SUC_2.3_VPP unit scheduling
- HL-UC 6_SUC_3.1_Real-time flexibility calculation
- HL-UC 6_SUC_3.2_VPP implementation of ancillary services
- HL-UC 6_SUC_3.3_Real-time decision making
- HL-UC 6_SUC_4.1_Manage contractual issues
- HL-UC 6_SUC_4.2_Define and manage member compensation
- HL-UC 6_SUC_4.3_DSM and DR mechanisms
- HL-UC 7_SUC_1.1_Monitor energy demand
- HL-UC 7_SUC_1.2_Enriched information visualization
- HL-UC 7_SUC_1.3_Integration with DR mechanisms
- HL-UC 7_SUC_1.4_Net metering & self-consumption
- HL-UC 7_SUC_1.5_Energy cost management for large infrastructures
- HL-UC 7_SUC_2.1_Enriched information visualization
- HL-UC 7_SUC_2.2_Portfolio profiling & analytics
- HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading
- HL-UC 7_SUC_2.4_Billing services
- HL-UC 7_SUC_2.5_Energy cost management and optimization
- HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control
- HL-UC 7_SUC_2.7_Manual DSM strategies activation
- HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring
- HL-UC 7_SUC_3.2_Social network collaboration and comparison with similar peers
- HL-UC 7_SUC_3.3_Participation in DR programs
- HL-UC 7_SUC_3.4_Residential net metering & self-consumption

Pilot sites

- Crevillent (ENER)
- Flanders (ECO-EID)
- Terni (ASM)
- Mesogia (HEDNO)
- Kythnos (AEA)

7.2 SMARTENING OF THE DISTRIBUTION GRID

7.2.1 Scenario Description

The evolution from Passive to the so-called Active Distribution Networks has resulted in bidirectional power flows, massive penetration of Distributed Energy Resources, limited amount of controllable resources and frequent violation of operational constraints of the grid.

The need to deliver electricity to all points of consumption in a seamless and reliable way has remained the main request for the Transmission System and Distribution Network Operators. In this framework, it has been necessary to design suitable Energy Management Systems and Distribution Management Systems, in order to achieve optimal power and voltage/congestion control, updated protection schemes, losses minimization, improvement of the network reliability, etc. The aforementioned functionalities are significantly improved, if the system state is monitored with the highest possible accuracy and refresh rate, and the minimum time latency.

To this direction, the development of new intelligent monitoring equipment, such as smart meters, Phasor Measurement Units, modern fault detectors as well as the design of new data concentration structures that operate in a coordinated way with the existing SCADA systems, enable the smooth transition to the Active Distribution Networks by assisting in their real-time monitoring and situational awareness. Additionally, the deployment of big data analysis and novel forecasting tools makes it possible to deal with the large amount of information existing in modern electrical grids and replace missing or erroneous measurements.

One basic component of Active Distribution Networks is the so-called Virtual Power Plant, which represents a system that integrates a large number of sources, such as Distributed Generation Units, energy storage systems, and controllable loads with the aim to increase flexibility and provide security of supply. However, the continuously increasing penetration of Renewable Energy Sources results in increased needs for flexibility. In case of overgeneration, the curtailment of Renewable Energy Sources can be avoided by taking advantage of the flexibility of the Virtual Power Plant.

In this framework, the project will also work on enabling the business model of RESCO companies. These companies can boost the presence of Distributed Energy Sources by investing on installation of domestic sources on some of its customers' premises and retailing the energy surplus produced by them.

7.2.2 Actors and technologies involved

Actors

- DSO
- DMS
- GIS
- SCADA
- PDC
- AMI

- Sensor
- Electronic meter
- Smart meter
- TSO
- EMS
- ESCO
- RESCO
- RES Unit
- Distributed Energy Resource
- Aggregator
- Supplier
- EV
- EVSE
- EVSE Operator
- EV fleet Manager
- Storage Unit
- Battery Operator
- Public authority
- Producer
- Prosumer
- Consumer
- VPP Operator
- VPP Component
- Load Controller
- Forecast Provider
- Market Operator
- ERP
- BRP
- Harbour Operator

WiseGRID tools

Within the WiseGRID project, different solutions will be developed focusing on the functionalities required by the scenario:

- WiseGRID Cockpit, a tool for DSOs or microgrid operators in order to control, manage and monitor their grid improving flexibility, stability and security;

- WiseGRID STaaS/VPP (STorage as a Service/Virtual Power Plant), a service by which consumers and prosumers can easily be aggregated and offer to the market their unused storage capacity and spare generation;
- WiseGRID RESCO (Renewable Energy Service COmpany), a tool enabling the provision of energy to consumers from renewable energy sources making possible that the serviced household and businesses do not own and maintain the generation and/or storage equipment.

7.2.3 UC identification

PUCs

- HL-UC 1_PUC_1_Network monitoring
- HL-UC 1_PUC_2_Control strategies for reducing RES curtailment
- HL-UC 1_PUC_3_Voltage support and congestion management
- HL-UC 1_PUC_4_Grid planning analysis
- HL-UC 1_PUC_5_Promote RES via RESCO companies
- HL-UC 2_PUC_1_Distribution network real-time monitoring
- HL-UC 2_PUC_2_Real-time distribution system awareness
- HL-UC 2_PUC_3_Grid control
- HL-UC 6_PUC_1_VPP monitoring and management
- HL-UC 6_PUC_2_VPP market participation
- HL-UC 6_PUC_3_VPP real-time control
- HL-UC 6_PUC_4_VPP users relationship management

SUCs

- HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections
- HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections
- HL-UC 1_SUC_1.3_KPI management
- HL-UC 1_SUC_1.4_Big data storage analysis
- HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption
- HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means
- HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies
- HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode
- HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)
- HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)
- HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases
- HL-UC 1_SUC_4.1_EV charge points planning analysis
- HL-UC 1_SUC_4.2_Grid storage planning analysis

- HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance
- HL-UC 1_SUC_5.2_Monitor domestic RES production
- HL-UC 1_SUC_5.3_Monitor domestic clients consumption
- HL-UC 1_SUC_5.4_Manage energy selling
- HL-UC 1_SUC_5.5_Energy cost management
- HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters
- HL-UC 2_SUC_1.2_Data concentration
- HL-UC 2_SUC_1.3_Monitoring power quality in the grid
- HL-UC 2_SUC_1.4_Fault detection and identification
- HL-UC 2_SUC_1.5_Asset management
- HL-UC 2_SUC_2.1_RES and load forecasting
- HL-UC 2_SUC_2.2_Topology processor
- HL-UC 2_SUC_2.3_Network observability analysis
- HL-UC 2_SUC_2.4_Load flow calculation
- HL-UC 2_SUC_2.5_State estimation
- HL-UC 2_SUC_2.6_Bad data detection, identification and replacement
- HL-UC 2_SUC_3.1_Load control
- HL-UC 2_SUC_3.2_DR as a service to the grid
- HL-UC 2_SUC_3.3_Optimization algorithm
- HL-UC 2_SUC_3.4_Reconfiguration
- HL-UC 2_SUC_3.5_Islanding procedures for the local grid
- HL-UC 2_SUC_3.6_Cold ironing
- HL-UC 6_SUC_1.1_Resource metering
- HL-UC 6_SUC_1.2_VPP RES forecast
- HL-UC 6_SUC_1.3_VPP flexibility forecast
- HL-UC 6_SUC_1.4_Strategies definition
- HL-UC 6_SUC_2.1_VPP market participation and bid calculation
- HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation
- HL-UC 6_SUC_2.3_VPP unit scheduling
- HL-UC 6_SUC_3.1_Real-time flexibility calculation
- HL-UC 6_SUC_3.2_VPP implementation of ancillary services
- HL-UC 6_SUC_3.3_Real-time decision making
- HL-UC 6_SUC_4.1_Manage contractual issues
- HL-UC 6_SUC_4.2_Define and manage member compensation
- HL-UC 6_SUC_4.3_DSM and DR mechanisms

Pilot sites

- Crevillent (ENER)
- Flanders (ECO-EID)
- Terni (ASM)
- Mesogia (HEDNO)
- Kythnos (AEA)

7.3 INTEGRATION OF RENEWABLE ENERGY STORAGE SYSTEMS IN THE NETWORK

7.3.1 Scenario Description

One of the main objectives of the WiseGRID project is the integration of renewable energy storage systems in the network in order to help the market deployment of energy storage systems, such as batteries, heat accumulators and even plugged EVs. The latter will allow to manage and balance the network optimally, responding, thus, better to changes in demand and reducing, at the same time, losses at distribution level. To achieve this goal, the following actions have been proposed.

Demand curve in current electric systems usually shows off-peak hours with lower consumption (usually at night) and peak hours during the times of high activity. With a more and more increasing ratio of distributed RES, whose production is volatile and hardly controllable, imbalance between demand and production becomes an important issue that negatively affects the basic objectives of the smart grid: an efficient, economic and safe supply. Energy storage systems enable new features towards meeting this imbalance, by charging and discharging the elements according to the deviation between production and demand.

First of all, the Battery Storage Integration at substation and prosumer level is addressed within this scenario. By deploying energy storage units, RES integration can be optimized and a more efficient distribution system can be realized. With storage units prosumers can enhance their self-consumption reduce energy costs and lower environmental impact by applying time-of-use management. Moreover, Energy storage systems can provide services that are important for a satisfactory operation of the network, such as reactive power support, load following, back-up service, peak shaving and power quality. In order to provide such services, an efficient batteries dispatch management as well as a market scheduling needs to be implemented at battery operator, aggregator or VPP level.

Secondly, the Cogeneration as well as heating storage integration in Public Building Housing is addressed. Here, thermal inertia of buildings will be exploited by managing building properties together with monitoring and control devices, such as gas meters, CHP units and HVAC systems. By applying forecasting methods for thermal needs, the thermal flexibility is estimated.

Specific algorithms will provide real-time set-points to the various devices and via communication interfaces control signals will be transmitted. HVAC management is completed by implementing an alarm management. The main priority of the management is the satisfaction of the local needs in a secure and efficient approach. However, additional monetary gains may be derived by the participation in a VPP or the provision of Ancillary Services to the distribution network. Therefore, optimisation algorithms that focus on market and business decisions will be implemented. The management is supported by comfort-based demand flexibility models that are parameterized by available information (measurements, building properties, meteorological information) in order to estimate thermal flexibility and the amount of thermal energy (among others) that can be shifted.

Last but not least, the e-mobility integration in the grid, along with V2G Integration of e-mobility and electric transport systems into the network in order to provide services to the grid, such as storage capacity, are part of this scenario. Here, the data collection process from the EVSEs and the EVs to the various tools builds the foundation. By applying different charging options such as charging on user demand, smart charging (V2H) or smart charging with V2G the EVs, storage capacity can be used in order to cover users' as well as grid's needs (also at the same time). In order to provide flexibility to the grid, to maximize the RES integration and to participate in the house energy management process (V2H), a charging reschedule as well as a participation in a house energy management system is envisaged. The e-mobility integration is linked to scenario 4.

7.3.2 Actors and technologies involved

Actors

- Storage Unit
- Prosumer
- Consumer
- Producer
- Forecast Provider
- Battery Operator
- Market Information Aggregator
- Market Operator
- Retailer
- DSO
- Aggregator
- VPP Operator
- RESCO
- ESCO
- CHP
- Building Management System (BMS)
- HVAC
- Gas Meter
- Gas Distribution Company
- AMR
- EV
- EVSE
- EV Fleet Manager
- EVSE Operator
- EV user
- Public Authority

WiseGRID tools

Within the WiseGRID project, different solutions will be developed focusing on the functionalities required by the scenario:

- WiseGRID STaaS/VPP (STorage as a Service/Virtual Power Plant): a service by which consumers and prosumers can easily be aggregated and offer to the market their unused storage capacity and spare generation;
- WiseCORP: application for businesses, industries, ESCOs and public facilities consumers and prosumers to become active, smarter energy players. In this scenario the tool can be used for the monitoring and remote configuration of storage units in order to support self-consumption, time-of-use management, peak shaving and DR;
- WiseHOME: application targeting individual domestic consumers and prosumers to become active energy players. In this scenario the tool can be used for the monitoring and remote configuration of storage units in order to support self-consumption, time-of-use management, peak shaving and DR;
- WiseCOOP: targeting energy retailers, aggregators, local communities and cooperatives of consumers and prosumers; the tool can be used for configuration purposes or for initiating DR programs in combination with storage unit;
- WiseGRID FastV2G, and EV charging station that will make possible to use EVs as dynamic distributed storage devices;
- WiseEVP (Electric Vehicle Platform), a tool for vehicle-sharing companies and EV fleet managers to optimize activities related to G2V and V2G.

7.3.3 UC identification

PUCs

- HL-UC 3_PUC_1_EVSE and EV fleet monitoring
- HL-UC 3_PUC_2_Interaction of the user with EVSE
- HL-UC 3_PUC_3_EV charging management
- HL-UC 3_PUC_4_Interaction with the energy infrastructure
- HL-UC 4_PUC_1_Batteries management at prosumer level
- HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)
- HL-UC 4_PUC_3_Ancillary services
- HL-UC 4_PUC_4_Combination of battery storage systems
- HL-UC 5_PUC_1_Thermal monitoring
- HL-UC 5_PUC_2_Cogeneration and HVAC management
- HL-UC 5_PUC_3_Comfort-based demand flexibility models
- HL-UC 5_PUC_4_Cogeneration and HVAC optimisation

SUCs

- HL-UC 3_SUC_1.1_Data collection from EVSE
- HL-UC 3_SUC_1.2_Data collection from EVs
- HL-UC 3_SUC_2.1_Users' authentication
- HL-UC 3_SUC_2.2_Charging session request
- HL-UC 3_SUC_2.3_Charging session booking
- HL-UC 3_SUC_3.1_EVSE network configuration

- HL-UC 3_SUC_3.2_EV load forecasting
- HL-UC 3_SUC_3.3_EV flexibility estimation
- HL-UC 3_SUC_3.4_Reference charging load profile calculation
- HL-UC 3_SUC_3.5_Charging session schedule
- HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests
- HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration
- HL-UC 3_SUC_4.3_EV providing V2H services
- HL-UC 4_SUC_1.1_Increase of self-consumption
- HL-UC 4_SUC_1.2_Time-of-use management
- HL-UC 4_SUC_1.3_Peak shaving
- HL-UC 4_SUC_2.1_Batteries dispatch management
- HL-UC 4_SUC_2.2_Black start capabilities
- HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonization
- HL-UC 4_SUC_2.4_Backup power for residential area
- HL-UC 4_SUC_3.1_Market scheduling
- HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system
- HL-UC 4_SUC_3.3_Batteries automatic dispatch
- HL-UC 4_SUC_4.1_Parameter configuration of storage systems
- HL-UC 4_SUC_4.2_Priority list of units running
- HL-UC 5_SUC_1.1_Monitoring gas meters
- HL-UC 5_SUC_1.2_Monitoring CHP
- HL-UC 5_SUC_1.3_Monitoring buildings
- HL-UC 5_SUC_2.1_Forecasting thermal needs
- HL-UC 5_SUC_2.2_Real-time control set-points
- HL-UC 5_SUC_2.3_Control devices
- HL-UC 5_SUC_2.4_Alarm management
- HL-UC 5_SUC_3.1_Thermal model of households
- HL-UC 5_SUC_3.2_Thermal model of building
- HL-UC 5_SUC_3.3_Thermal flexibility modeling
- HL-UC 5_SUC_4.1_VPP participation
- HL-UC 5_SUC_4.2_Provision of ancillary services
- HL-UC 5_SUC_4.3_System optimisation

Pilot sites

- Crevillent (ENER)
- Flanders (ECO-EID)

- Terni (ASM)
- Mesogia (HEDNO)
- Kythnos (AEA)

7.4 SMART INTEGRATION OF ELECTRIC MOBILITY SERVICES

7.4.1 Scenario Description

One of the main objectives of the WiseGRID project is to develop the technology needed to guarantee a smooth integration of the EV and its charging infrastructure in electric networks. Furthermore, WiseGRID also aspires to use the EVSE to provide flexibility to the distribution network operation and to maximise the local RES integration avoiding curtailment and even participating in the household energy management processes (V2H).

The aforementioned functionalities will be based on a reliable network monitoring to gather data from the EVSEs and from the EVs through the WG IOP to be used in WiseEVP energy management processes. The data gathered from EVSEs will be mainly the energy parameters that are provided by a smart meter per socket (power, current, etc.) and also EVSE status information (out of service, sockets being used, etc.). The information gathered from the EVs will be related to their state of charge (SoC) and their charging capabilities.

All the extra functionalities that the EVSEs will provide to the electric network will respect the EV user preferences, meaning that user constraints (e.g. charge required to be completed within a certain time frame) will be prioritised in the charging sessions scheduling process. In order to maximise the flexibility provided by the EVSEs, respect the user preferences regarding his charging and enable the operation, the WiseGRID products will include a set of user functionalities, such us user's authentication, EVSE booking and charging session start as EVSEs considering three different types of charging:

- Type 1: Charging on user demand. Once the user plugs the EV and selects the desired final SoC, the EVSE uses all the available power to charge the EV as soon as possible to the required level.
- Type 2: Smart charging. Once the user plugs the EV and selects the desired final SoC and the time to disconnect the EV, the EVSE manages a smart charging session lowering and increasing the power output to follow energy prices, to avoid network congestion, to maximise the RES integration, etc.
- Type 3: Smart charging with V2G. The principle is exactly the same as type 2, but with inclusion of the possibility of power injection in the electrical network (V2G) coming from the vehicle's battery. In this way, enhanced electricity network services can be provided.

The EVSE's will be managed by the tool WiseEVP, and will decide on the load/output profile of the charging sessions providing flexibility to the network. For this purpose, some preparatory processes will occur in WiseEVP using the information and preferences provided by the EV user but also the EVSE and EV monitoring (EVSE network configuration, EV load forecasting, EV flexibility estimation and reference charging load profile calculation).

In particular, all the required capabilities will be provided by the WiseGRID FastV2G charging points, which will be developed within the project and will enable load shifting (following the directives of WiseEVP as stated above) and supplying power to the grid (V2G).

Finally, WiseEVP will also manage the EVSE network via the charging session schedule process (CSSP) with the aim to minimize the cost of charging. In addition, the EV charging infrastructure will be able to modulate its power output to provide flexibility to the grid, to maximise the RES integration and to participate in the house energy management process (V2H). The WiseEVP will execute the charging session reschedule process (CSRP) to respond to the flexibility requests from other WiseGRID products.

7.4.2 Actors and technologies involved

Actors

- EV
- EVSE
- EV Fleet Manager
- EVSE Operator
- EV user
- DSO
- Market Operator
- RESCO
- Aggregator (VPP Operator)
- Prosumers

WiseGRID tools

- WG IOP
- WiseHOME
- WiseEVP
- WG FastV2G (and other EVSEs)
- WG Cockpit
- WG STaaS/VPP

7.4.3 UC identification

PUCs

- HL-UC 3_PUC_1_EVSE and EV fleet monitoring
- HL-UC 3_PUC_2_Interaction of the user with EVSE
- HL-UC 3_PUC_3_EV charging management
- HL-UC 3_PUC_4_Interaction with the energy infrastructure

SUCs

- HL-UC 3_SUC_1.1_Data collection from EVSE
- HL-UC 3_SUC_1.2_Data collection from EVs
- HL-UC 3_SUC_2.1_Users' authentication
- HL-UC 3_SUC_2.2_Charging session request
- HL-UC 3_SUC_2.3_Charging session booking
- HL-UC 3_SUC_3.1_EVSE network configuration
- HL-UC 3_SUC_3.2_EV load forecasting
- HL-UC 3_SUC_3.3_EV flexibility estimation

- HL-UC 3_SUC_3.4_Reference charging load profile calculation
- HL-UC 3_SUC_3.5_Charging session schedule
- HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests
- HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration
- HL-UC 3_SUC_4.3_EV providing V2H services

Pilot sites

- Crevillent (ENER)
- Flanders (ECO-EID)
- Terni (ASM)
- Mesogia (HEDNO)
- Kythnos (AEA)

8 PILOT SITES

This paragraph is dedicated to the detailed description of the five pilot sites, which serve as real test bed for the solutions proposed within WiseGRID. More specifically, the pilot site formal analysis comprises an outline of the current situation in terms of infrastructure as well as services offered to the end-users and applications that facilitate the management of each pilot site. The different needs of the end-users in each pilot, renders each one appropriate for testing and demonstrating a variety of UCs as well as for deploying several of the WiseGRID tools, thus ensuring that the proposed solutions and technologies within WiseGRID can be adapted to diverse environments, each one with each own peculiarities and comparative advantages. As a last step of the pilot site formal analysis, a preliminary deployment and demonstration plan is laid out, while potential barriers (regulatory, social, etc.) and the operational constraints due to the prevalent conditions in each pilot site are reported. Having in mind but not limited by the current situation, the potential of each pilot site to implement and test the defined UCs is also identified (Table 14) and reported in the UCs inventory using a scale 1-5, indicating not only the suitability of each pilot site but also reflecting the vision for the future operation of each pilot site (ANNEX B, section 13).

Table 14 – HL-UCs mapping to pilot sites

Pilot site / HL-UC	Crevillent	Flanders	Terni	Mesogia	Kythnos
HL-UC 1	✓	✓	✓	✓	✓
HL-UC 2	✓		✓	✓	✓
HL-UC 3	✓	✓	✓	✓	✓
HL-UC 4	✓	✓	✓	✓	✓
HL-UC 5				✓	
HL-UC 6		✓	✓	✓	✓
HL-UC 7	✓	✓	✓	✓	✓

8.1 CREVILLENT

8.1.1 Pilot site description

Crevillent is a municipality of the Valencian Region, Spain. It is located in the Range of Crevillent in the province of Alicante (Bajo Vinalopó region). Crevillent has 28,465 inhabitants (INE2015).

The electric Cooperative Crevillent, subsidiary of the Enercoop Group, was founded in 1925 with the firm objective to bring power to all households in the village in a fair way while respecting the environment.

From its beginning, the entity promotes a type of energy that respects nature, a feature that has been maintained and strengthened during its nine decades of operation, and which has made it one of the most important energy cooperatives of the country. The entity received from the hands of the Head of State the title of Exemplary Cooperative in 1970, enjoying from this moment on an outstanding international prestige.

The cooperative was born in a town with great expectations of industrial development, especially in the textile sector. By that time, Crevillent was a small municipality that lacked the interest of the great electrical companies, but Enercoop bet on the courage and the entrepreneurial character of its citizens. Over the years, the manufacturing of carpets reached a great boom, radically changing the tables. This fact significantly stimulated the development of the energy company, which was compensated for its initial effort.

The Cooperative bears the name of "Charitable" because the founders of the Cooperative wished that the net profits that were obtained in the future would result in social work. They were young industrial engineers with social concerns. Ideas of renewal and progress were boiling in their minds. The key to success was to take a product, the electric energy, indispensable for the development of the town, and to distribute it in a fair and efficient way.

Currently, the Electric Cooperative of Crevillent is a DSO and retailer that provides electricity to 14.315 consumers (13.047 households and 1.268 companies) in low voltage network and 30 consumers in medium voltage network (mainly industrial and service sector companies).

The entire energy production of the entity has zero emissions and is working hard to get all the generated and distributed energy 100% clean. The experience and background has led the company to become one of the most important cooperatives in Spain having a great international prestige. They have installed and integrated into their grid more than 75,000 PV panels in solar plants and 2,000 modules of PV panels in solar roofs.

8.1.1.1 Infrastructure

The network of the Crevillent field test is composed of:

- One primary substation (132kV/20kV) with a nominal power equal to 40 MVA that provides electricity to 14.129 consumers in Low Voltage Network and 30 consumers in Medium Voltage Network (mainly industrial and service sector companies).
- **The medium voltage distribution grid,** composed of **11 general branches** with **a total length of conductors equal to 122.474 m**. This distribution grid is composed of both overhead and underground lines. Figure 32 refers to the single-line diagram of this medium voltage network (20kV).

Figure 28 – Crevillent substation 132/20kV

Figure 29 – GIS technology

Figure 30 – 132kV/20kV 40MVA power transformer

Figure 31 – 20kV protection cubicles

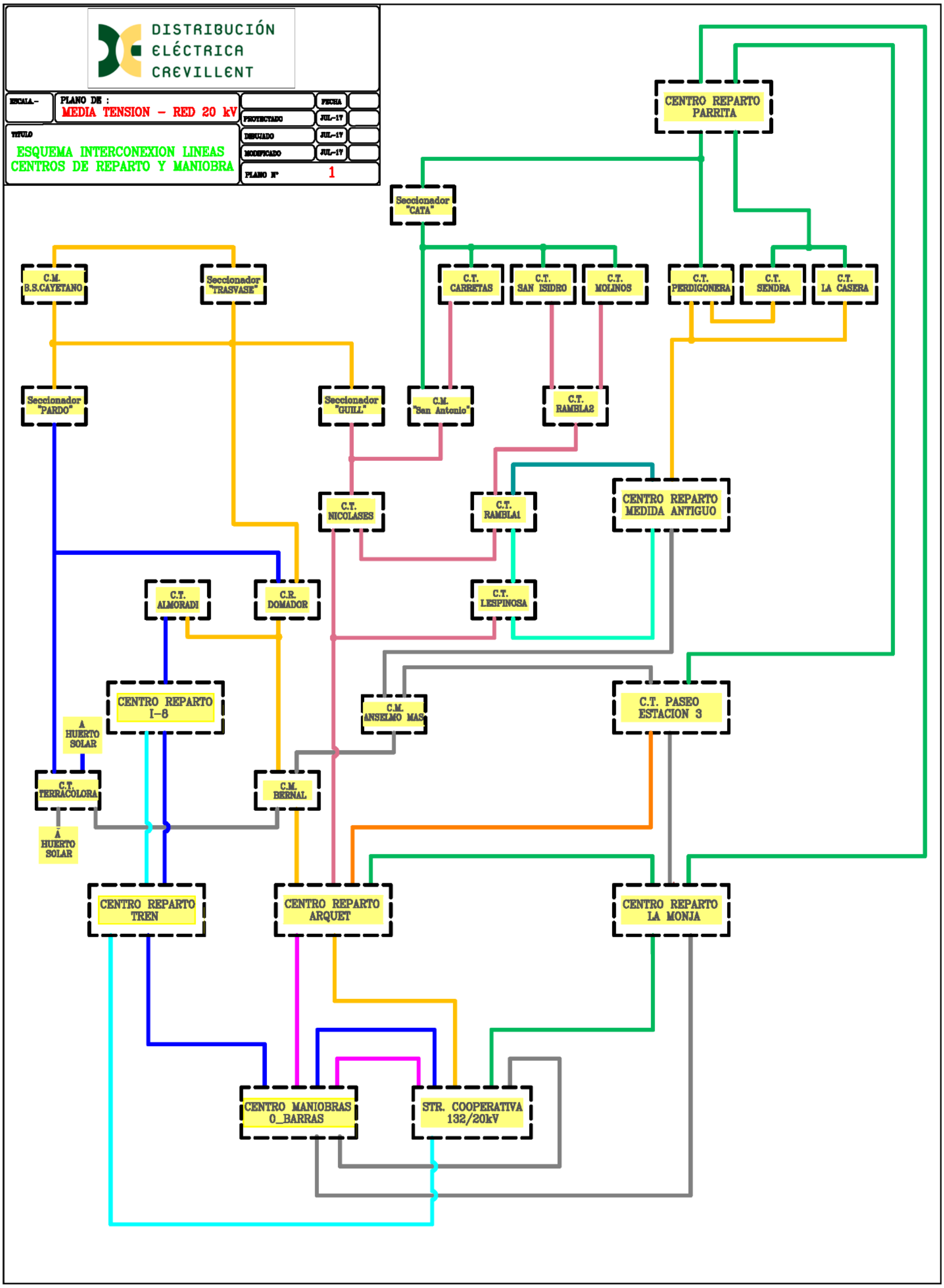


Figure 32 – Single-line diagram of the Medium Voltage network

The network has a total of 143 secondary substations to directly supply end-users and 24 secondary substations to redistribute the energy in the MV network (distribution station). Their total rated power is 89.220 kVA.

Figure 33 – Power transformer for the redistribution of energy

Figure 34 – Distribution and transformation centers

Photovoltaic plants connected to the Cooperative Network produce a total power of 13,4 MW, of which 13 MW are located in the solar farm of "El Realengo".

This solar farm is divided into solar plants of 100, 50 and 25 kW, which are connected to the LV Cooperative Network. The rest of the plants are located on rooftops.

Figure 35 – Solar farm "El Realengo"

Figure 36 – Solar panels on rooftops

Figure 37 – Inverters

8.1.1.2 Services and applications

The technical department has different systems for the management of the entire Cooperative Distribution Network differentiating which subsystem of the network has to be managed.

Medium Voltage network

SCADA is available in dispatch and remote control equipment is available in the centers of transformation, distribution and maneuver, as well as the automation of them. These elements use the Ormazabal System, Sitel, for their operation. There is also an Optical Fiber Network that connects the Transformation and Distribution Centers with the Control Center. In this system, there is a connection via PLC in Medium Voltage (using Ormazabal technology) in order to connect the centers that cannot use Fiber Optic cables. The Transformation Centers of the periphery are connected through a Wimax system.

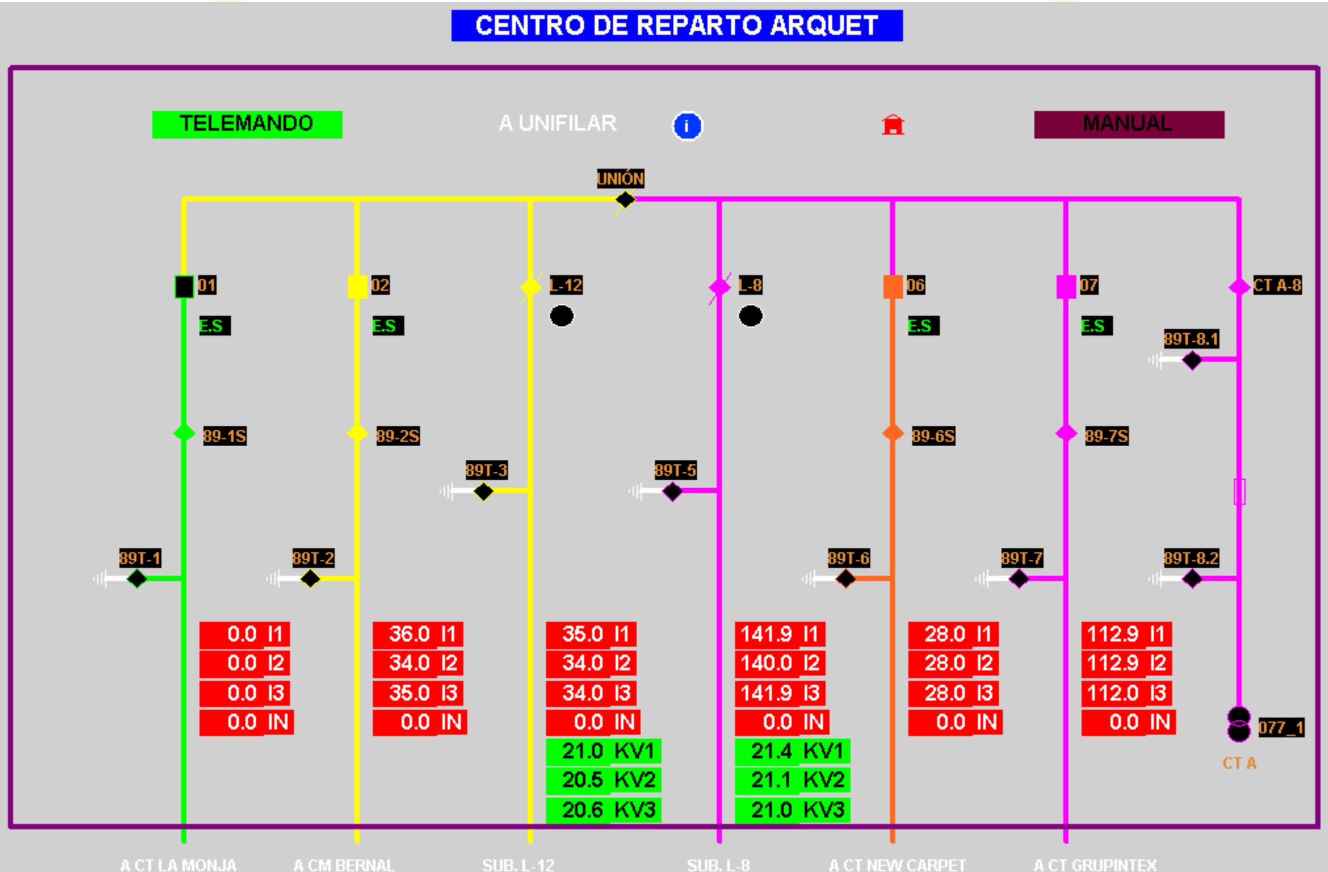


Figure 38 – SCADA

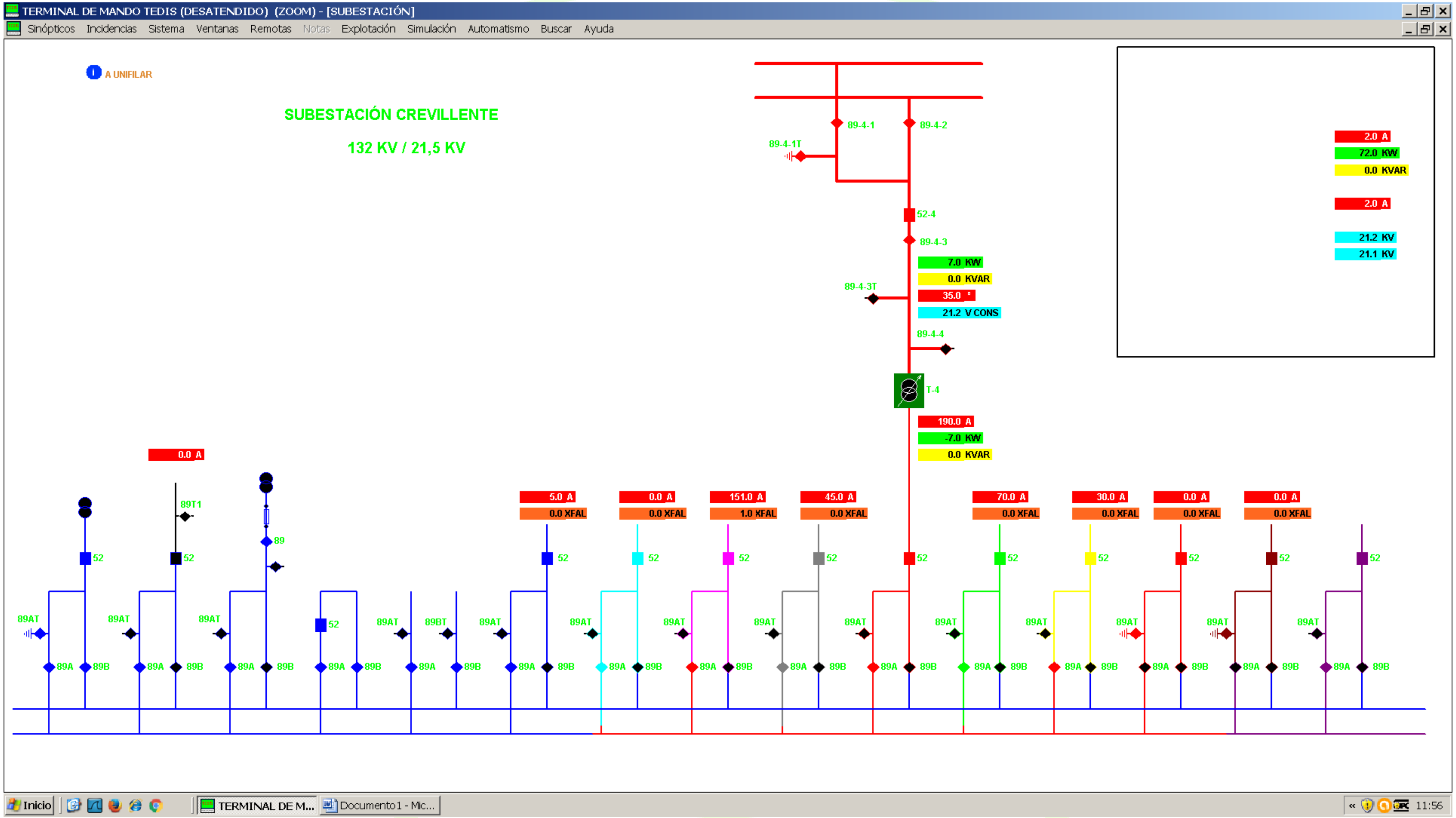


Figure 39 – Remote control

Figure 40 – Automated centers

Figure 41 – Communication devices

Low Voltage network

Concentrators and network analyzers are available in the transformation centers and they are managed in an office with a GIS system, and an ERP application; which allows to obtain information from those clients.

Figure 42 – PRIME concentrator installed

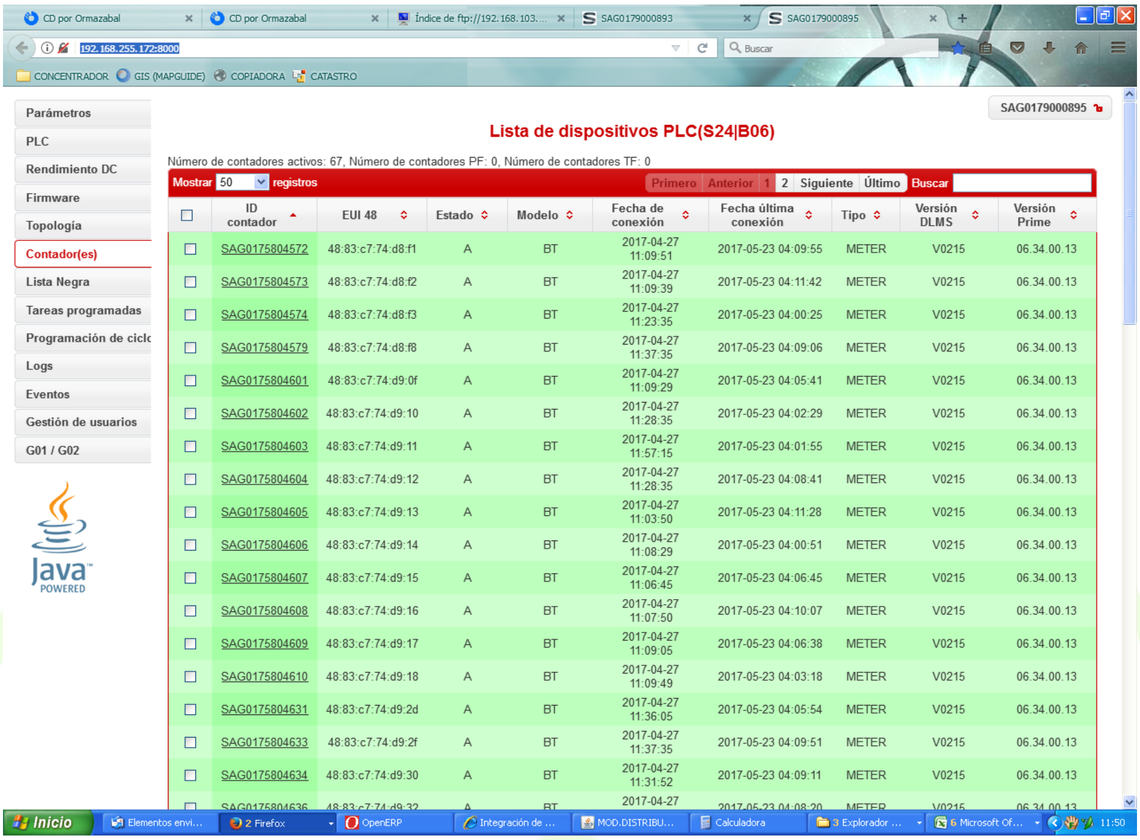


Figure 43 – PRIME concentrator

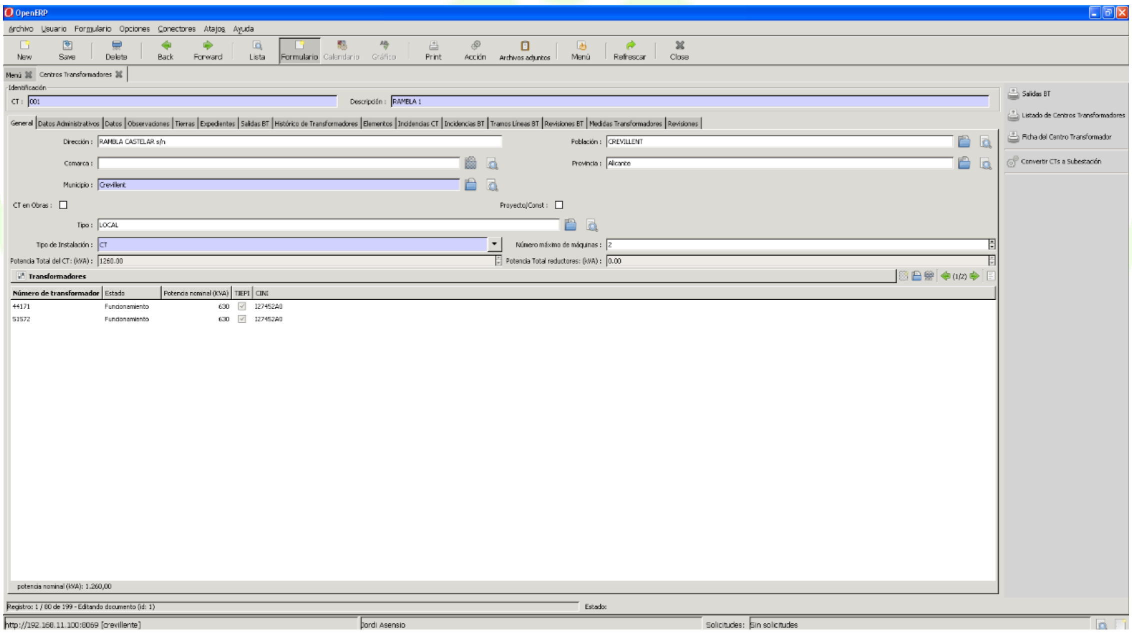


Figure 44 – ERP

Meters

The electronic meters of the PRIME system that are being implemented, are managed by the concentrators located at each transformation center and handled from the office by a FTP server. Currently, 75% of the new equipment has already been installed. The installation plan will be finished in 2018.

Figure 45 – Centralized meters

Customer service

One of the objectives of the Cooperative is to provide good quality electric service, at the best possible price through an efficient and secure Distribution Network.

Enercoop also offers a 24 hour totally free service for the users in order to advise them and to solve any problem that they may have.

The profits of the Cooperative are used to invest in the Distribution Network, to improve its technology and to give back to the society. Some of their contributions to the city are: a nursing home, schools for the disabled, and a free mortuary for all the citizens of Crevillent.

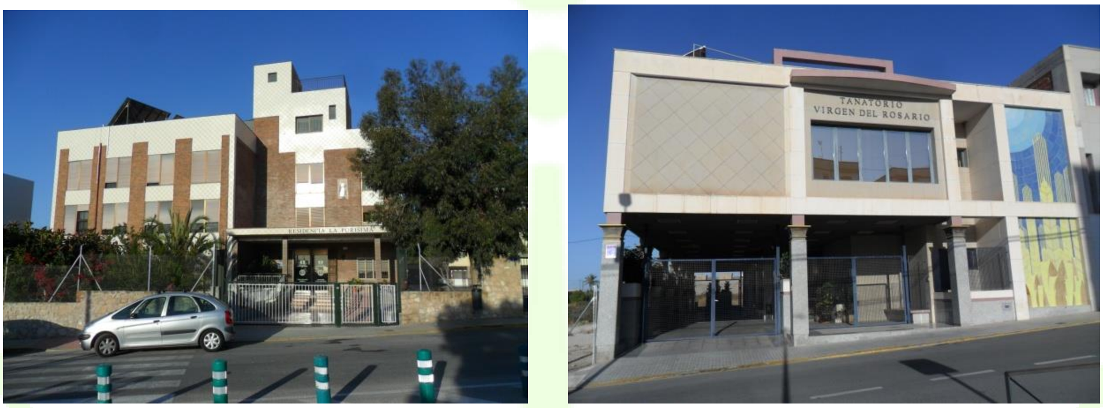


Figure 46 – Nursing home and mortuary

8.1.2 WiseGRID in Crevillent

8.1.2.1 WiseGRID tools and technologies

This section provides an overview of the different WiseGRID tools that will be deployed and tested in Crevillent.

- WG IOP (WiseGRID InterOperable Platform)

  As WG IOP is a tool intended to interconnect and support the rest of WG products, this product will not be directly used by Enercoop members but its general performance will be demonstrated. Moreover, all the necessary logistics for the well-functioning of WG IOP (smart meters, sensors…) will be deployed in strategic places of the Enercoop infrastructure.

- WG Cockpit

This product will be one of the most important for the Enercoop managers. As Enercoop has DSO functions, WG cockpit will help operators to manage its medium voltage and low voltage networks and also the substations owned by Enercoop. Some of the WG Cockpit functionalities that will be more useful for Enercoop workers are: overload management, voltage control, fault detections, definition of the most appropriated topology, and automatic configuration of the network and isolating failures in order not to affect consumers.

- WiseCORP

Although WiseCORP is not designed to control and manage the most important facilities of Enercoop (transformers, solar panels…), this tool can be useful to manage other parts of the company, such as the headquarters or the warehouse. Agreements with some companies of Crevillent are also possible in order to test WiseCORP.

- WiseCOOP

The implementation of WiseCOOP will be very useful to the cooperative due to the fact that Enercoop has retailer functions. This product will help Enercoop workers to handle their portfolio of clients, operate DR campaigns, manage flexibility strategies and improve the company's customer relationships.

- WiseHOME

Keeping in mind that WiseHOME is a tool destined for domestic users (non-technical users), some consumers/prosumers of the cooperative will use the application in order to provide feedback to know if the product reaches the necessary quality levels. The WiseHOME app will be available for all cooperative members to help them make a more efficient use of the energy and become empowered actors. A great use of this tool is expected and it will be demonstrated to consumers/prosumers in order to convince them of the suitability of the application and thus, encourage its use.

- WG FastV2G

One WG FastV2G is already deployed in the central building of Enercoop, while 2 other WG FastV2G will be deployed in the warehouse. There will be also another EVSE in a Hotel/Restaurant in Crevillent.
In addition, there are some EVSE in Crevillent and reaching agreements with their owners would be suitable in order to study the implementation of more EVSEs in the city.

- WiseEVP (WiseGRID Electric Vehicle Platform)

Some Enercoop operators can function as EVSE Operators (from the EVSE installed in Enercoop facilities) in order to manage and visualize WiseEVP possibilities. If finally other EVSE owners are involved in the implementation of WiseGRID, they can also test WiseEVP.

- WG RESCO (WiseGRID Renewable Energy Service Company)

To deploy WG RESCO, Enercoop has to reach agreements with some RESCOs and, in the same way, these RESCOs have to reach agreements with some Enercoop clients. Thus, testing all the functionalities from WG RESCO will be possible.

8.1.2.2 WiseGRID Use Cases

Five HL-UCs will be implemented and tested in Crevillent:

- HL-UC 1 Distributed RES integration in the grid
- HL-UC 2 Decentralized grid control automation

- HL-UC 3 E-mobility integration in the grid with v2g
- HL-UC 4 Battery storage integration at substation and prosumer level
- HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty

To be able to test the aforementioned HL-UCs, a set of PUCs and SUCs will be also implemented and tested. The following list presents those PUCs and SUCs:

PUCs

- HL-UC 1_PUC_1_Network monitoring
- HL-UC 1_PUC_2_Control strategies for reducing RES curtailment
- HL-UC 1_PUC_3_Voltage support and congestion management
- HL-UC 1_PUC_4_Grid planning analysis
- HL-UC 1_PUC_5_Promote RES via RESCO companies
- HL-UC 2_PUC_1_Distribution network real-time monitoring
- HL-UC 2_PUC_2_Real-time distribution system awareness
- HL-UC 2_PUC_3_Grid control
- HL-UC 3_PUC_1_EVSE and EV fleet monitoring
- HL-UC 3_PUC_2_Interaction of the user with EVSE
- HL-UC 3_PUC_3_EV charging management
- HL-UC 3_PUC_4_Interaction with the energy infrastructure
- HL-UC 4_PUC_1_Batteries management at prosumer level
- HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector
- HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market
- HL-UC 7_PUC_3_Clients engagement for active market participation

SUCs

- HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections
- HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections
- HL-UC 1_SUC_1.3_KPI management
- HL-UC 1_SUC_1.4_Big data storage analysis
- HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption
- HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means
- HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies
- HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode

- HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)
- HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)
- HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases
- HL-UC 1_SUC_4.1_EV charge points planning analysis
- HL-UC 1_SUC_4.2_Grid storage planning analysis
- HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance
- HL-UC 1_SUC_5.2_Monitor domestic RES production
- HL-UC 1_SUC_5.3_Monitor domestic clients consumption
- HL-UC 1_SUC_5.4_Manage energy selling
- HL-UC 1_SUC_5.5_Energy cost management
- HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters
- HL-UC 2_SUC_1.2_Data concentration
- HL-UC 2_SUC_1.3_Monitoring power quality in the grid
- HL-UC 2_SUC_1.4_Fault detection and identification
- HL-UC 2_SUC_1.5_Asset management
- HL-UC 2_SUC_2.1_RES and load forecasting
- HL-UC 2_SUC_2.2_Topology processor
- HL-UC 2_SUC_2.3_Network observability analysis
- HL-UC 2_SUC_2.4_Load flow calculation
- HL-UC 2_SUC_2.5_State estimation
- HL-UC 2_SUC_2.6_Bad data detection, identification and replacement
- HL-UC 2_SUC_3.1_Load control
- HL-UC 2_SUC_3.2_DR as a service to the grid
- HL-UC 2_SUC_3.3_Optimization algorithm
- HL-UC 2_SUC_3.4_Reconfiguration
- HL-UC 2_SUC_3.5_Islanding procedures for the local grid
- HL-UC 3_SUC_1.1_Data collection from EVSE
- HL-UC 3_SUC_1.2_Data collection from EVs
- HL-UC 3_SUC_2.1_Users' authentication
- HL-UC 3_SUC_2.2_Charging session request
- HL-UC 3_SUC_2.3_Charging session booking
- HL-UC 3_SUC_3.1_EVSE network configuration
- HL-UC 3_SUC_3.2_EV load forecasting
- HL-UC 3_SUC_3.3_EV flexibility estimation

- HL-UC 3_SUC_3.4_Reference charging load profile calculation
- HL-UC 3_SUC_3.5_Charging session schedule
- HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests
- HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration
- HL-UC 3_SUC_4.3_EV providing V2H services
- HL-UC 4_SUC_1.1_Increase of self-consumption
- HL-UC 4_SUC_1.2_Time-of-use management
- HL-UC 4_SUC_1.3_Peak shaving
- HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonization
- HL-UC 4_SUC_2.4_Backup power for residential area
- HL-UC 7_SUC_1.1_Monitor energy demand
- HL-UC 7_SUC_1.2_Enriched information visualization
- HL-UC 7_SUC_1.3_Integration with DR mechanisms
- HL-UC 7_SUC_1.4_Net metering & self-consumption
- HL-UC 7_SUC_1.5_Energy cost management for large infrastructures
- HL-UC 7_SUC_2.1_Enriched information visualization
- HL-UC 7_SUC_2.2_Portfolio profiling & analytics
- HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading
- HL-UC 7_SUC_2.4_Billing services
- HL-UC 7_SUC_2.5_Energy cost management and optimization
- HL-UC 7_SUC_2.7_Manual DSM strategies activation
- HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring
- HL-UC 7_SUC_3.2_Social network collaboration and comparison with peers
- HL-UC 7_SUC_3.3_Participation in DR programs
- HL-UC 7_SUC_3.4_Residential net metering & self-consumption

8.1.3 Preliminary deployment and demonstration plan

- Month 14 – Month 19: in-depth analysis of all the technical data, systems and components involved in the demonstration. It also includes the implementation of the required adaptations and the activities to engage and train the different type of final users (DSO, retailer and end-users including domestic and corporate consumers).
- Month 20 – Month 25: definition of a complete plan and timeline of the specific and detailed demonstration activities. It is an ex-ante analysis of the Crevillent pilot site that will screen the landscape before the deployment and demonstration of the WiseGRID tools.
- Month 19 – Month 24: test of the WiseGRID solutions in an integrated environment (laboratory conditions or simulation).

- Month 22 – Month 26: preliminary deployment of the first version of the WiseGRID tools (to be demonstrated in Crevillent) including the test of its critical functionalities and the data gathering for evaluation.
- Month 27 – Month 30: local deployment of the final version of the WiseGRID tools (to be demonstrated in Crevillent), including the test of the full set of functionalities in real environments and the data gathering for evaluation.
- Month 30 – Month 40: Large scale demonstration of the WiseGRID complete and integrated solutions, including the data gathering for evaluation.

Recruitment and involvement plan of end-users in the demonstration

For the first contact, the following possibilities are available:

- Contact by mail: the database of ENERCOOP collects personal data of the 14,315 cooperative members. This includes the postal addresses of all members and telephone numbers & e-mail addresses of most of them.
- ENERCOOP has also the possibility to publish an article or a presentation of the project in the local media TeleCrevillent or in the Cooperative webpage, with a call to citizens to get involved in this demonstration.
- A specific recruitment workshop will be organized in the second half of 2017 aiming at creating and maximizing public awareness of the project among the citizens and also at starting an open recruitment process.
- Presentations of the project addressed to different collectives to involve them as WiseGRID tool users will also take place.

8.1.4 Potential barriers

- Communication infrastructures: Depending on the needs, Enercoop will have to install new elements (Wimax, GPRS, etc.) to be able to correctly manage the communications.
- The Cooperative must be very careful in the demonstration of the WG Cockpit in order to avoid causing network failures and curtailments that affect the users.
- A low number of users will hinder a correct demonstration of the tool.
- The installation of the EVSEs must be done within the legality of the Regional Government.
- Privacy and security of users' data must be kept in accordance to the Data Protection Law.
- Permission and engagement of end-users. As mitigation, we will launch different campaigns to engage the potential users and make them aware of the WiseGRID benefits.

8.2 FLANDERS

8.2.1 Pilot site description

The main coordinator of the Flanders pilot site is Ecopower cvba. Ecopower was founded in 1992 as a cooperative under Belgian law. The organisation has three main goals: investing in renewable energy; supplying 100% green electricity to our cooperative members and promoting a rational use of energy (and renewable energy and the cooperative business model in general). By the end of 2015 Ecopower was a cooperative with 50.393 cooperative members, 199.524 shares and 41.586 customers. The latter corresponds to about 1,44% of the Flemish household market. Ecopower has a private equity (capital) of 49,8 million euro (31/12/2016) and a balance total (assets) of 83,9 million euro (31/12/2016). The annual turnover was 37,1 million euro (31/12/2016) and the staff is composed of 33 FTE (31/12/2016).

To invest in renewable energy, Ecopower gathers financial resources from as many cooperative members (shareholders) as possible and uses these funds to invest in renewable energy projects. By the end of 2016 Ecopower has in use 19 wind turbines, 3 Hydro power installations, 1 cogeneration installation and 320 decentralised PV installations on the roofs of schools and houses scattered across Flanders. The total production of these installations was about 56 million kWh. Ecopower also has a factory that produces wood pellets for residential heating (production capacity: 20.000 tonnes/year).

To supply 100% green electricity to its cooperative members, in 2006 Ecopower received a permit to sell electricity on the Flemish market. In order to become a client, citizens can buy at least one share in the cooperative. Ecopower does not have its own grid so we need external Distribution Service Organisations (DSO) to distribute our electricity.

For the integration of EVs, partnership was formed with Partago cvba. Partago was founded in 2015 as a cooperative under Belgian law. The organisation is active solely in Ghent, and has two main goals: to provide access to 100% electric cars to the cooperative members; and promote a transition towards a healthy and sustainable city. By providing electric car sharing in a cooperative model, Partago aims to lower the dependency on fossil fuels, help countering global warming, achieve extremely efficient use of energy and materials, and freeing up space in our overcrowded cities, in which one third of the space is occupied by non-utilised vehicles.

Partago is a young multistakeholder cooperative enterprise with 209 members (both natural persons as well as corporate members, May 2017). To invest in clean car mobility, Partago gathers financial resources from as many cooperative members (shareholders) as possible and uses these funds to invest in the development of the mobile car sharing platform and the acquisition of electric cars.

Partago has currently 16 EVs with a total battery capacity of 504 kWh and 3 charging stations (EVSE).

8.2.1.1 Infrastructure

The WiseGRID pilot site in Flanders, Belgium consists of 1 main pilot area in the City of Ghent and some smaller complementary test sites. The smaller project sites are particularly being investigated as they are potentially capable of combining PV, batteries, charging stations and EVs on a small but manageable scale. In this list there are 3 sites already involved in the H2020 Nobel Grid project: the Water Mill of Rotselaar, the City Office site in Eeklo and the Ecopower office.

Note: communication with all following smaller sites is still ongoing, and thus they cannot be considered as definitive project sites. This depends on the agreement between the partners of the project and the owner of the site.

Figure 47 gives an overview of the test sites in Flanders:

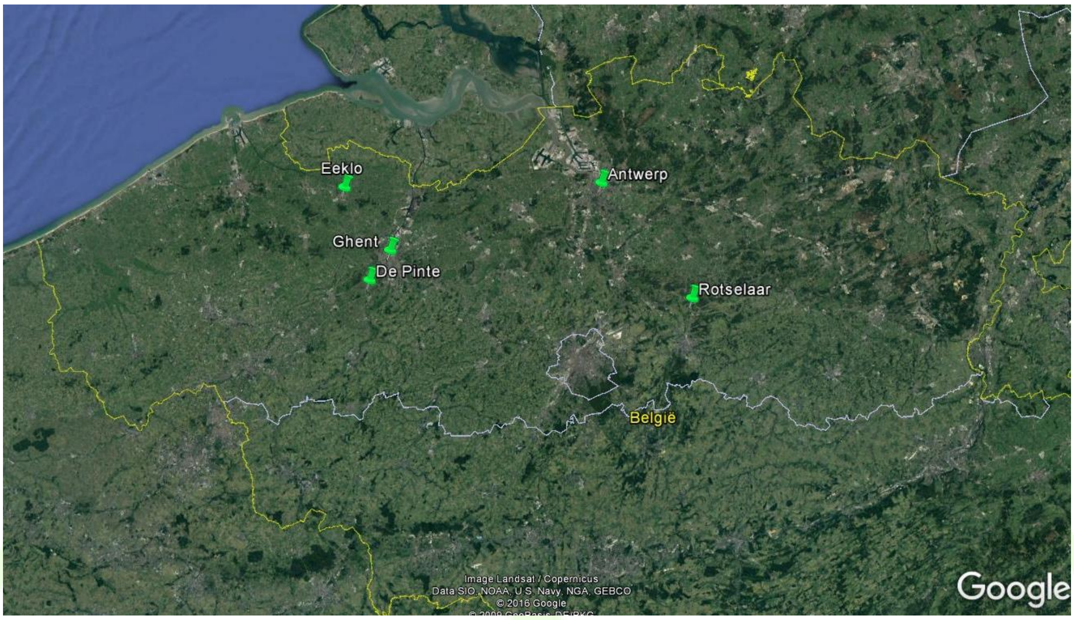


Figure 47 – Locations Flanders test site on Google Earth map

Main site - Sint-Amandsberg, Ghent

The main pilot site is situated in Sint-Amandsberg, a municipal district of the city of Ghent. It consists of 2 areas. The red center area and the blue extended area. Within the red area there are 2.452 residents (448 multi-dwelling buildings, 1.545 family homes and 360 SME sites). 40% of the 2.452 residents are the owner of their home. The area of pilot site is well known for its heterogeneous typology of inhabitants: transit inhabitants (young families moving after a couple of years), families with migration background, elderly people and vulnerable social groups with a limited income.

Figure 48 – Overview area pilot site Ghent

Infrastructure in place:

- DSO Eandis is planning to install 200 smart meters in the area within the local city project 'Buurzame Stroom'. We are involved in this project and will together with Eandis look for the best places to install them. Unfortunately, we will not be able to read them out in high time resolution. In the best case scenario we will have (with consent of the end-user) 15-min consumption data the day-after and have a general overview of the energy flows in the neighborhood;

- We envision to reuse all SLAMs of the Nobel Grid project in the area;
- We will place as much as possible SMXs from Nobel Grid, coming from other sites in the Nobel Grid project;
- Local co-operative Energent cvba invests in renewable energy and is currently looking for homes in the test site to install co-operative PV systems. This is an ideal scenario for the WG RESCO tool. The goal is to obtain as fast as possible 750 kWp in the area. We are discussing to have all sites monitored compatible with the WiseGRID specs;
- 5 household battery sets (7-13 kWh) are planned to be deployed in the neighbourhood.

Oxfam wereldwinkels vzw – Ghent

The headquarters of Oxfam Wereldwinkels vzw is a site of interest in the extended main project area. It has a co-operative roof PV plant of 82,6 kWp with the potential to include batteries and at least one EVSE.

Figure 49 – Headquarters of Oxfam – Ghent

Coworking site The Watt Factory – Ghent

This newly renovated industrial building in a densely populated area in Ghent opened in June 2017 with the purpose of hosting facilities and office space for companies focusing on Smart Cities and Smart Mobility. We will investigate the technical feasibility to invest on this site PV production installations and EVSE. The inhabiting companies at the Co-working site will make use of shared EVs, so we can acquire sufficient useful data. The shared EVs are being used also outside office hours and in the weekend by the neighbors of the Watt Factory.

Infrastructure in place:

- 25 small to mid-sized companies;
- 15 parking spots.

Characteristics:

- Maximal rooftop area PV: 800 m²;

- Publicly accessible charging infrastructure on parking spot;
- Parking spot and guaranteed use of shared electric cars;
- Space to install fixed batteries;
- New electricity infrastructure;
- High concentration of interested end-users (companies on smart mobility).

Figure 50 – Coworking site The Watt Factory – Ghent

Technologypark Zwijnaarde – Ghent

The Technologypark Zwijnaarde is an industry zone of 50 hectares just outside Ghent, focusing on technology and biotechnology companies. At least one interested company at the site exemplifies the potential and matches the goals of WiseGRID. The specific situation of this setting (companies are end-users on this site) will teach us how the WiseGRID tools can be designed to meet their needs, in order to maximize RES production, while guaranteeing grid stability and ensuring access to electric mobility. The site offers also the possibility to reach end-users for the shared EVs, so we are able to receive enough relevant data on real life situations.

Infrastructure in place:

- 2 charging stations with 4 connection points.

Characteristics of one typical company at the Technologypark Zwijnaarde:

- Maximal rooftop area PV: 1.000 m², estimated 100 kWp;
- Yearly energy usage: 350.000 kWh;
- Continuous energy usage: 100A per phase.

Figure 51 – Technologypark Zwijnaarde – Ghent

Cluster of schools - De Pinte

This cluster of schools in De Pinte, a municipality located at 10 km of Ghent, is situated on a very big area of 3 ha. The buildings (10+) on the area consist of a childcare provision center, sport infrastructure, a refectory, and buildings to host all stages of education up to high school. The area is surrounded by a typical suburban sprawl neighborhood, hence not so densely populated area. A lot of possibilities to deploy the WiseGRID tools exists in this setting, including citizen involvement via the many activities hosted at the school buildings, so that end-users can be easily reached.

Characteristics of this cluster of schools:

- Maximal rooftop area: estimated 5.800 m²;
- Yearly energy usage: 110.000 kWh;
- Currently available infrastructure: 1.400 m² roof area covered with PV;
- Publicly accessible parking space present to install publicly accessible charging stations.

Water mill site - Rotselaar

The water mill site in Rotselaar is a versatile and sustainable project situated on a historical site. It is one of the testsites of the Nobel Grid currently in development. It houses a hydroelectric power station, owned by Ecopower, that generates almost permanently 75 kW of green power. The site is also a cohousing project of nine units.

Figure 52 – Water mill site – Rotselaar

Infrastructure in place:

- 9 households;
- 1 hydro power plant;
- 1 EV;
- 1 EVSE;
- 4 or 5 SMX installed in Nobel Grid.

The city office site - Eeklo

The main administrative center of the City of Eeklo, a city close to Ghent, together with its neighboring site 'Kringwinkel Meetjesland', forms a longstanding pilot site for Ecopower. On the city office site in Eeklo, a CHP on PPO (pure plant oil), a small heating network and 2 photovoltaic installations (one of them being a 35 kWp on the Kringwinkel) are present. The current oil prices force the CHP to stand still most of the time. We are currently investigating if the WiseGRID tools could help improving the profitability of the installation.

Figure 53 – City office site – Eeklo

Figure 54 – Ecopower's CHP on pure plant oil of Ecopower – Eeklo

Infrastructure in place:

- 1 administrative building;
- 1 large second hand shop with office;
- 2 PV installations;
- 1 CHP 250 kWe and 300 kWth on PPO;
- 1 or 2 SMX installed from Nobel Grid.

Ecopower office – Antwerp

Figure 55 – Ecopower office - Antwerp

Infrastructure in place:

- 1 office of 750 m²;
- 1 small PV installation of approximately 3 kWp;
- 1 battery system, reused from Nobel Grid;
- 1 SMX installed from Nobel Grid;
- 2 ADR functions: PV inverter (Nobel Grid) and lighting (Dali).

8.2.1.2 Services and applications

Currently Ecopower is deploying the Nobel Grid tools and services: the DRFM-cockpit and the Ema-app. In Nobel Grid, 200 USM (100 SLAM and 100 SMX) will form a co-operative powerplant, organized through the DRFM cockpit.

8.2.2 WiseGRID in Flanders

8.2.2.1 WiseGRID tools and technologies

WiseGRID tools and technologies to be deployed in Flanders:

- WiseHOME: The WiseHOME tool will be provided to domestic consumers and prosumers that are members of the WiseGRID test group.
- WiseCORP: The WiseCORP tool will be provided to facility managers of SME’s (consumers or prosumers) that are member of the WiseGRID test group.
- WiseCOOP: The WiseCOOP tool aims to help members of the WiseGRID test group (both owner and not-owner of production installation on their roof) get better energy deals without entangling them in comprehensive administrative procedures and research. Some examples can be reduction of energy bill after analysis of consumption profiles and/or tariff advisor. There will also be a focus on encouraging the members of the WiseGRID test group to maximize their self-consumption by means of local load shifting. Participation in flexibility market will also be incorporated by means of DR schemes that will be available for the WiseGRID test group.

- WG RESCO: Energent (local cooperative in Ghent) will use the WS RESCO to monitor both production and forecast of production in ownership of PV-installations.
- WG Cockpit: We are currently in discussion with DSO Eandis to test the WG Cockpit. This is not planned for the moment being.
- WiseEVP: Partago (PARTA) will use this platform to manage the charging and/or discharging of EVs. This enables the flexibility of charging, depending on the level of renewable energy production and the user-demand of the EV fleet.
- Partago (PARTA) will monitor continuously their EVs through WiseEVP.
- WG Fast V2G: The currently operational EVs of Partago will not be able to charge with WG Fast V2G based on its current specifications (connector type, charging current). Partago (PARTA) will invest in own charging infrastructure that is technically capable of being managed by WiseEVP, in order to collect data from the EVs and charging infrastructure. In case the technical specifications of WG Fast V2G evolve in such a way that charging the EVs of Partago becomes possible, the option of installing WG Fast V2G in the project zone, if all practical conditions to do so are met, will be investigated.
- WG StaaS/VPP: Ecopower (ECO) will use the WG StaaS/VPP-tool to aggregate available capacity of renewable energy production and storage collected from members of the WiseGRID test group (consumers, prosumers, SME's, etc.) as available flexibility in the market. Individual available capacity will thus be bundled into a collective available capacity. This tool will visualize the status of all the individual components (local production, aggregated charging status of batteries, overall forecasts).

8.2.2.2 WiseGRID Use Cases

Five High Level Use cases will be implemented and tested in Flanders:

- HL-UC 1 Distributed RES integration in the grid
- HL-UC 3 E-mobility integration in the grid with V2G
- HL-UC 4 Battery storage integration at substation and prosumer level
- HL-UC 6 VPP technical and economic feasibility
- HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty

If the CHP site of Eeklo enables this, a sixth HL-UC, being HL-UC 5 Cogeneration integration in public buildings/housing could be added.

The detailed list of the PUCs and SUCs to be tested in Flanders is included in ANNEX B – UC INVENTORY.

8.2.3 Preliminary deployment and demonstration plan

- Month 14 – Month 19: in-depth analysis of all the technical data, systems and components involved in the demonstration. It also includes the implementation of the required adaptations and the activities to engage and train the different type of final users (DSO, retailer and end-users including domestic and corporate consumers).
- Month 20 – Month 25: definition of a complete plan and timeline of the specific and detailed demonstration activities. It is an ex-ante analysis of the Flanders pilot site that will screen the landscape before the deployment and demonstration of the WiseGRID tools.
- Month 19 – Month 24: test of the WiseGRID solutions in an integrated environment (laboratory conditions or simulation).

- Month 22 – Month 26: preliminary deployment of the first version of the WiseGRID tools (to be demonstrated in Flanders) including the test of its critical functionalities and the data gathering for evaluation.
- Month 27 – Month 30: local deployment of the final versions of the WiseGRID tools (to be demonstrated in Flanders), including the test of the full sets of functionalities in real environments and the data gathering for evaluation.
- Month 30 – Month 40: Large scale demonstration of the WiseGRID complete and integrated solutions including the data gathering for evaluation.

8.2.4 Potential barriers

- It is our intention to test as many UC's as possible. However, in this early project stage, it is not possible to say if the demonstration of every UC will be feasible in the end. We will actualize the list further during the project.
- The following interesting test scenarios are currently not feasible because of regulatory barriers:
    - Aggregate the small co-operative PV-installations as one bigger virtual production site. In that way, better Green Certificate conditions could be obtained.
    - Net metering between different grid connections: the one of the PV-site and the one of an investor: in that way, investors could benefit from the production gains.
    - Dynamic grid tariffs depending on the origin of the green electricity that a user is consuming. If electricity is produced within a multi-tenant building or within a substation, cheaper grid tariffs could be applied.
- The installation of the EVSEs must be done within the legality of the Regional Government. Public locations for installing charging stations are very limited.
- DSO Eandis will install 200 smart meters with limited data collection possibility. Consent of users is needed. Data will be of limited use due to limited resolution (15 min).
- DSO Eandis is not keen on providing high resolution data of substations. We can mitigate this by having enough smart meters per feeder at different places within a feeder.
- Charging infrastructure of parties other than the Partners interfere with measurements.
- Data of charging infrastructure of parties other than the Partners do not share information.
- Privacy and security of users' data must be kept in accordance to the Data Protection Law. The new EU Regulation 2016/679 and Directive 2016/680 due for implementation in 2018 are specifically important in this regard.
- Permission and engagement of end-users. As mitigation, we will launch different campaigns to engage the potential users and make them aware of the WiseGRID benefits. A low number of users will hinder a correct demonstration of the tool.

8.3 TERNI

8.3.1 Pilot site description

8.3.1.1 Infrastructure

ASM TERNI S.p.A. is an Italian multi utility company, established in 1960 and fully owned by the Terni municipality, specializing in water, gas, electricity and environmental services. It owns and operates the local power distribution network, covering a surface of 211 km^2 and delivering about 400 GWh to 65.100 customers annually. The ASM distribution network acquires electricity at High Voltage (HV) through 3 primary substations and supplies electricity to residential and business customers through 60 Medium Voltage (MV) lines (10kV to 20kV) and 700 secondary substations. The peak power is about 70 MW and the total length of the power lines in the grid is about 2.350 kilometres (587 km MV and 1.762 km Low Voltage - LV).

Nowadays the ASM electric grid is characterized by a large number of distributed renewable energy sources embedded in the medium and low voltage distribution networks: 1 biomass plant, 5 hydro power generators and 1,234 photovoltaic (PV) units are currently connected directly to the MV and LV distribution networks, respectively, reaching the total installed capacity of around 70 MW. In this regard, it is worth pointing out that, based on this energy mix shown in Figure 56, **200 GWh** of the **400 GWh** absorbed yearly, are produced by DER systems connected to the MV/LV grid of ASM, **70 GWh** of which are from intermittent RES.

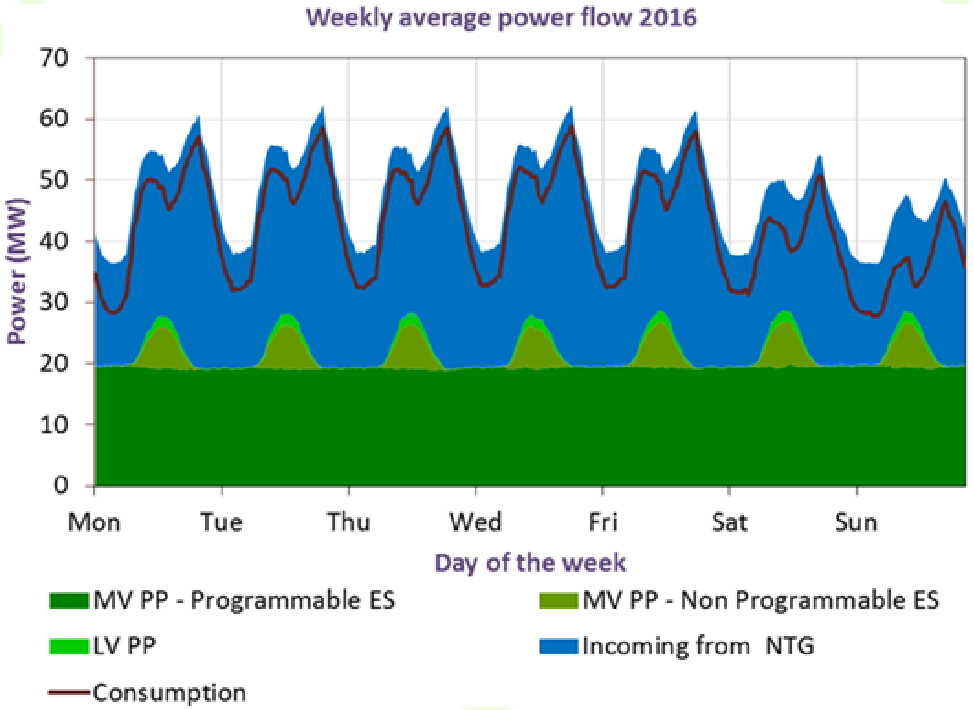


Figure 56 – Average weekly profile of consumption and production in the ASM power network

In 2010 the deployment throughout the power network of smart meters with four data acquisitions per hour (each 15 minutes) was completed, reaching all the 65.100 end-users. Moreover, both secondary substations and RES generators have been equipped with real-time power automation devices (compliant to the IEC 61850 protocol), allowing the real-time measurements of at least active and reactive power, frequency, voltage and current.

Basically, ASM TERNI will run the WiseGRID trial at its own headquarters, located in a suburb of the city of Terni. It comprises five blocks of energy units (BoEU), namely:

- Two PV arrays (180 kWp and 60 kWp), connected to the LV network.
- 96 kWh 2nd life Li-ion battery energy storage. The battery storage is the BoEU providing the service of electric power storage and supply. It is the BoEU that plays an important role in providing to the district the flexibility necessary to implement different services, especially ancillary services like Primary reserve, Dynamic reactive Power control and Reactive Power Compensation. This block can be

seen as an energy generation unit, from one side, and as a flexible load during the charging phase with the possibility to control the demand profile (H2020 ELSA project [8]).

- ASM Terni buildings comprising i) a 4.050 m^2 three-storey office building; ii) a 2.790 m^2 single-storey building consisting of technical offices, a computer centre and an operation control centre and iii) a 1.350 m^2 warehouse; usually the base load varies between 50 kW and 90 kW and peak load is between 120 kW and 170 kW, depending on seasonal factors.
- Four EV charging stations and six EVs. A Renault Zoe R240 featuring a 22 kWh lithium-ion battery is already in use in ASM TERNI headquarters, fed by a SPOTLINK - EVO filling station. The other units will be put in operation over the WISEGRID project by the EMOTION partner. SPOTLINK, the intelligent charging station, charge AC up to 32 A three phases and will be able to modulate power in such a way as to avoid voltage and frequency peaks. Each EVs will be equipped with an OBD device, which can be retrieved remotely to know in real-time the state of the vehicle, battery, geolocation and battery charging times.

All the aforementioned Units are connected to the secondary substation "ASM" as shown in the figures below (Figure 57 and Figure 58).

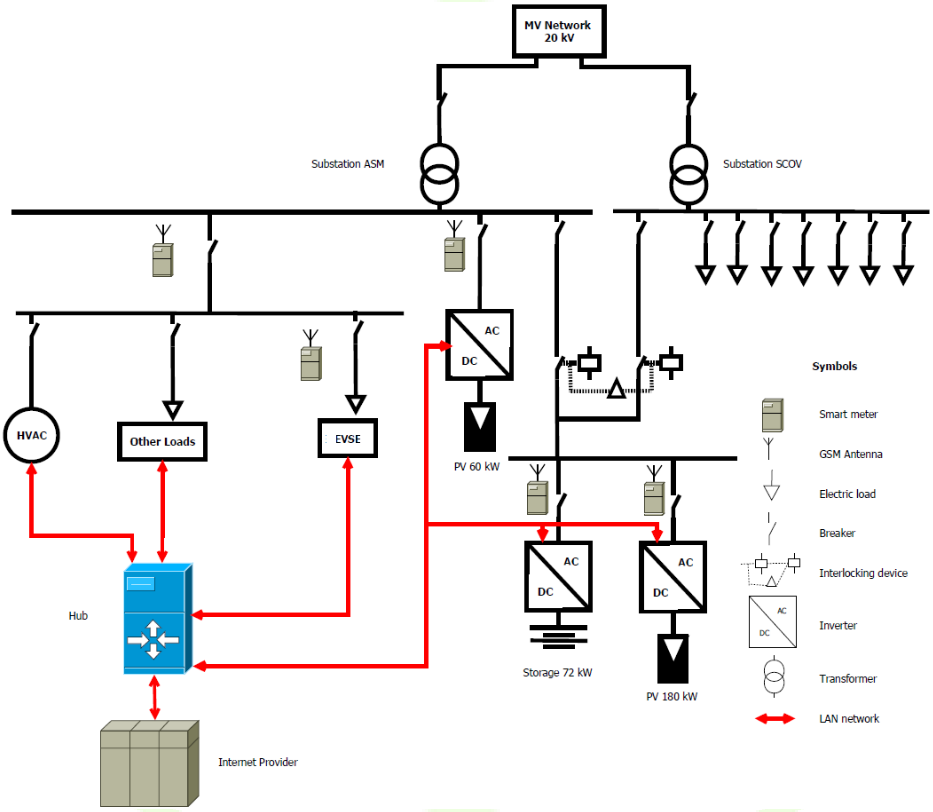


Figure 57 – Terni pilot site configuration

= Electric Vehicle Supply Equipments;

= Storage System;

= PV Array 60 kWp;

= PV Array 180 kWp;

= ASM Terni buildings.

Figure 58 – Italy, Terni trial site (current situation)

Smart meters - The smart meters installed at the Terni pilot site are 3-phase ZMD meters (Landys+Gyr) or new generation smart meters able to get real-time measurements and support real-time operations in a Smart Grid (class A power quality analyser WALLY A-RTU, manufactured by TeamWare - a 3-phase high-precision analyser and recorder, power quality, power meter, fault recorder and energy meter). To develop new services and business model in the Smart Grid, the Unbundled Smart Meter concept has been developed under the H2020 **Nobel Grid** project [3] and applied to the existing smart meters.

The *Unbundled Smart Meter* (USM) is a systematisation where smart meter functionalities are adequately grouped in two separate (unbundled) components: - A smart metrology meter (SMM), for metrological and hard real-time functions, which is intelligent but has fixed (frozen) functionality and high security of recorded data (black boxlike standard) and - A smart meter eXtension (SMX) that comes with the high flexibility that is needed for new functionalities, to be deployed during the meter's lifetime and support the future evolution of the smart grid and energy services. Figure 59 shows the general architecture of the USM.

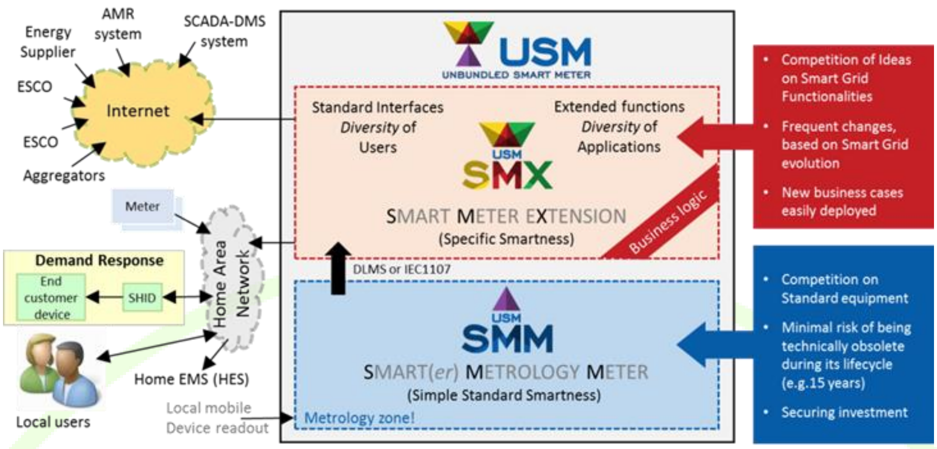


Figure 59 – Unbundled Smart Meter architecture

Based on this concept, SMXs are being developed and the first devices are going to be installed at the Terni pilot site making new functionalities possible, such as DR. As shown in Figure 59, SMX is responsible for all communication, to both local network (HAN) and public IP-network (internet) as well as for running necessary basic applications and also third party applications, in this way addressing the need for evolution in functionality, based on the evolution of Smart Grid and of the markets. It is worth pointing out that ASM TERNI will deploy about 100 SMX in different parts of its power network as well as about 100 Smart Low-cost Advanced Meter (SLAM), based on the Unbundled Smart Meter (USM) architecture. The new SLAM will be a compact meter having both SMM (metrology part) and SMX (communication and advanced services part) in the same case and having improved characteristics of SMM as well as an overall ergonomic solution, targeting a flexible and improved new generation of smart meters, serving all energy actors, such as the DSO, the supplier, the aggregators or ESCOs as well as the end customer, either consumer or prosumer, also being an alternative to today's smart meters generation (reference Nobel Grid project).

In this respect, ASM Terni is also involved in the H2020 **SUCCESS** project [9] as trial site for validating a novel holistic adaptable security framework which is able to significantly reduce the risks of additional potential cyber threats and attacks when next generation real-time scalable unbundled smart meters (NORM) are deployed along smart electricity grid, which will enable innovative application and added value services within the emerging smart decentralized energy system paradigm. NORM configuration is depicted in Figure 60.

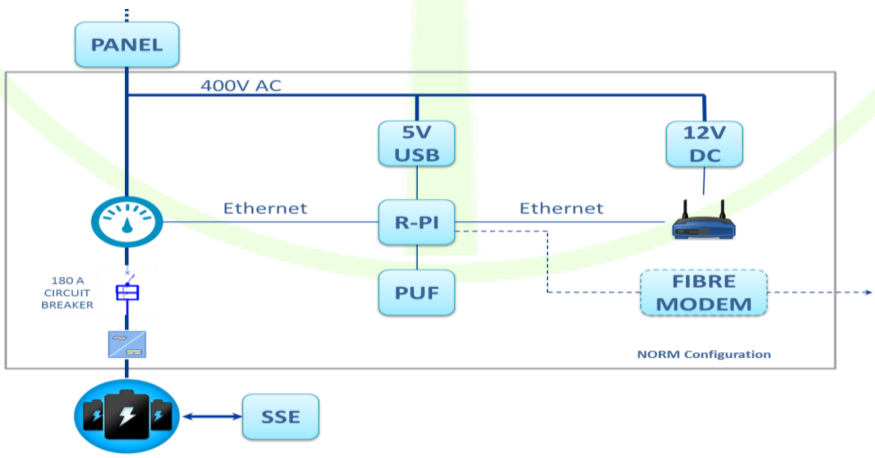


Figure 60 – Smart Meter Configuration in SUCCESS

Advanced Metering Infrastructure (AMI) - In order to manage time-based data from smart meters, an AMI has been put in place, allowing to remotely turn power on or off to a customer, read usage information from a meter, detect a service outage, change the maximum amount of electricity that a customer may demand at any time, detect "unauthorized" use of electricity and remotely shut it off, and remotely change the meter's billing plan. ASM is currently using two different channels for the collection of data from the installed meters; one is exclusively used for the Point of Delivery (PoD) for customers with power installation up to 30 kW and the other for power consumption greater than 30 kW. Data related to first channel are addressed via PLC; these are temporarily stored in Electric energy meter concentrator (one for each 400 meters), extracted and transmitted via GPRS network towards ASM Terni servers. Data related to the second channel is extracted and transmitted via GSM/GPRS. The current AMI system adopted for customers with power installation up to 30 kW is shown in Figure 61.

Figure 61 – AMI configuration

SCADA system- The whole Medium Voltage (MV) network is under the control of a cutting-edge SCADA system, able to:

- communicate with the calculation platform which hosts all algorithms for status analysis, power flow calculation and voltage regulation;
- receive and send information from/to Main Station equipment;
- receive and send information from/to Substation equipment;
- carry out the anti-islanding function and, when needed, send disconnection requests to the Main Station equipment.

Remote Control System staff is using the Operator Terminals to display the grid (status and measurements), interact with it (controls and commands) and manage abnormal situations (alarms) by means of a Human-Machine Interface (HMI).

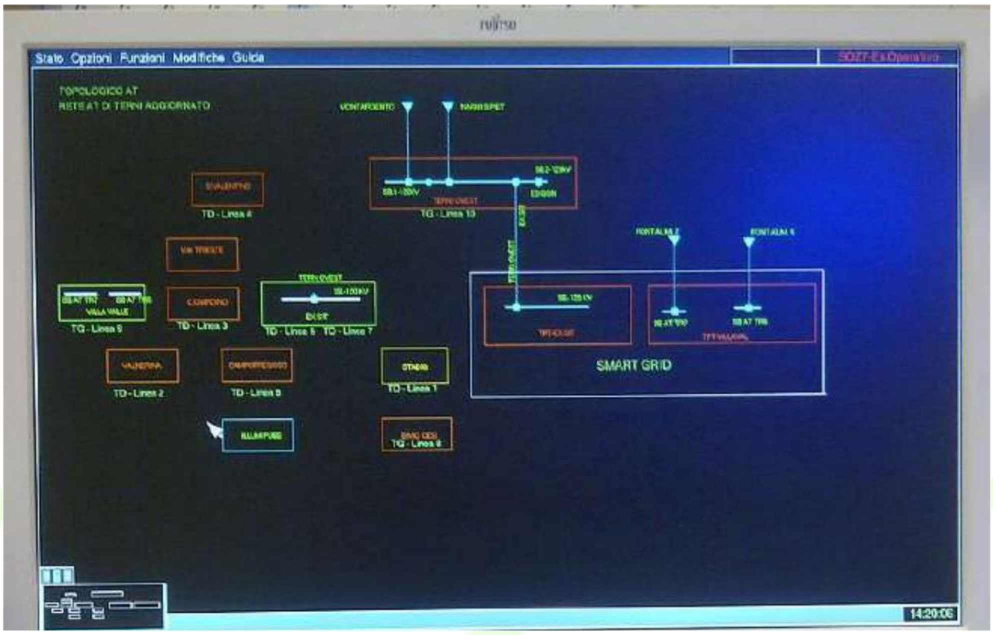


Figure 62 – ASM Terni SCADA system

Figure 63 – ASM Terni SCADA system screenshot

Communication Network - The nodes of the distribution grid are physically interconnected with one another by the electrical grid itself according to typical topologies. The controlling devices are deployed next to the respective electric nodes, and they must be able to communicate with the other nodes. The communication topology network can be different from the one of the controlled electrical grid.

The figure below is an example of the information flows needed to manage the main elements of the control chain of the electrical distribution grid for ASM Terni S.p.A. In the figure, the tags PS (Primary Substation), SS (secondary Substation) and User (U) units generally indicate the type of stations (HV/MV and MV/LV, generator or active user) and the corresponding type of Remote Control System unit installed.

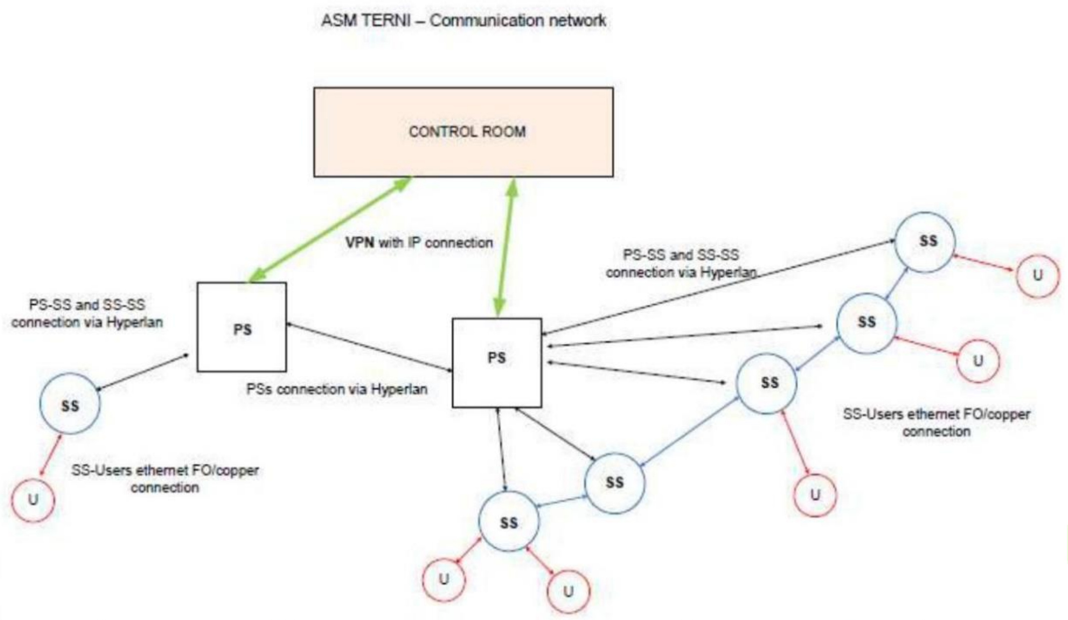


Figure 64 – Communication system architecture for ASM Terni smart grid

8.3.1.2 Services and applications

In addition to the forefront SCADA system (SIMENS) and the Advanced Metering Infrastructure (AMI), ASM TERNI is going to provide energy actors with advanced services and applications developed over H2020 Nobel Grid and ELSA projects.

DRFM (Demand Response Flexible Market) Cockpit: *This application will bridge Demand-Side Resources and their flexibility with the distribution grid actors to improve the operation of the processes under their control and more specifically to maximize profit and manage deviations' for Aggregators and Retailers, while supporting grid operators to ensure network stability and security. The tool will allow for the optimization of Aggregators', Retailers' and ESCOs' consumers portfolios performance and will facilitate demand response strategies optimization in technical/ operational and financial terms*. [3]

DRFM cockpit using the DR Components as well as the other components and tools of the Nobel Grid, will provide to the ASM Terni the following functionalities:

- identification of different prosumer clusters to be involved in the resolution of critical issues in the network;
- identification of appropriate actions to be performed on selected clusters (DR dispatch signal, action on network);
- to show in real-time to both the prosumer and the DSO the availability of green energy with the purpose to foster the provision of flexibility and to encourage environmental awareness and on save CO_2 emissions;
- to show the forecast of green energy availability (i.e. excess of renewable production) in the network;
- to provide flexibility to the DSO to support the stability of the network accordingly to maintenance work or fault restoration;
- to provide periodic report and statistical analysis on the prosumer enrolling in DR campaign.

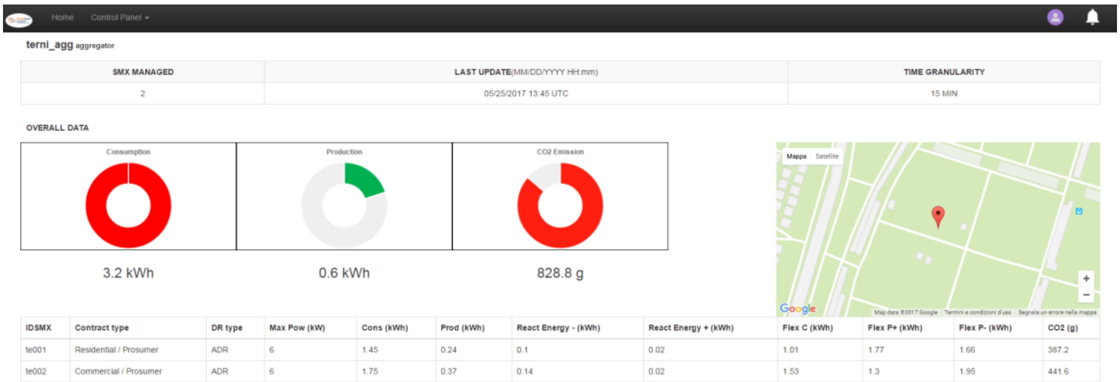


Figure 65 – DRFM Cockpit example

EMA app: The application will be the customer interface and the communication tool between ASM Terni and the end-users. Consumers using EMA app will know how much green energy is available in the grid. Moreover, EMA app will show a forecast of available green energy in the next 72 hours. Another functionality of the EMA app will be to provide customer with their real-time data and their historical data about energy consumption. Finally EMA app will provide notifications of energy disruptions and information about service restoration.

Figure 66 – EMA app example

G3M: G3M framework tool will help ASM Terni as DSO to manage the distribution grid by detecting grid instability and security problems. In more detail, the G3M toolset will allow the DSO to monitor and evaluate in real-time the operation and status of the distribution grid, under mass presence of Intermittent Distributed Generation, characterized by variable and unstable output. ASM Terni is going to use the following G3M functionalities:

- to visualize the real-time data of the Smart Grid. The monitored data will be data directly obtained from the grid (MV/LV readings), parameters of the electrical network model and added-value information generated from the raw observations like heat map, incidents, states, anomalies, etc.;

- to visualize the future state of the grid based on current measurements, trends and forecasts;
- to visualize the future state of the grid in order to assess the impact of specific control commands or configuration changes;
- to use the incident manager to deal with future problems before they happen;
- to visualize and to control the voltage level in some specific points of the network;
- to avoid congestion during the peak period or during the fault management;
- to use workforce management tool for solving outages and incidents in general;
- to use incident management tool to solve outages and incidents;
- to use existing MV mathematical network model in the offline simulation of network reconfiguration tool to analyse impact of new RESs in the network and to simulate of N-1, N-2 contingencies;
- to assess the impact of different grid topology configurations through the simulation tool.

ESMS - 2nd life battery ELSA storage management system: ASM Terni is going to use the battery system to provide fast ancillary services directly to the grid. Two main kinds of ancillary services will be provided, the services controlled directly by DSO and the services operated by battery system in an autonomous way. The first set includes: Power balance, Primary reserve and Reactive power compensation. The latter is represented by reactive power compensation, which is activated by DSO in on/off modality; the actual service provision is implemented by the battery system autonomously. The Terni pilot site is experimenting with ancillary services via a direct communication between the DSO infrastructure and the battery system. In this case the battery system is uniquely serving the DSO for services provision and is controlled via direct SCADA connection with DSO environment. The infrastructure will rely on a SCADA connection on private network.

8.3.2 WiseGRID in Terni

8.3.2.1 WiseGRID tools and technologies

WG IOP: WiseGRID InterOperable Platform will be used in Terni to manage and process big data stream coming from the deployed distributed energy infrastructure (SMX/SLAM/Wally).

WG Cockpit: WiseGRID Cockpit will be used in Terni to control, manage and monitor the grid, improving flexibility, stability and security of the network, considering an increasing share of distributed renewable resources. Furthermore, ASM will be able to detect faults, self-protect and self-reconfigure the network in a robust way to restore the power system without the intervention of a central intelligence (self-healing). In conclusion, WiseGRID Cockpit will support ASM by means of monitoring, decision support, control and optimized operation enabling grid-friendly integration of heterogeneous and distributed energy resources.

WiseCORP: Since this application will be developed for businesses, industries, ESCOs and public facilities of consumers and prosumers, ASM will be a suitable candidate for testing this tool in its district. In actual fact, WiseCORP will give more power and protection, and reduce the energy bill, supporting self-consumption by means of real-time data coming from all the energy devices and systems and by means of DR and load optimization schemes.

WiseCOOP: This application will be developed for energy retailers, aggregators, local communities and cooperatives of consumers and prosumers (and other intermediary companies) to help domestic and small businesses, consumers and prosumers achieve better energy deals while relieving them from administrative procedures and cumbersome research; in this regard, ASM could test this tool playing the role of the aggregator. By means of aggregation and cooperation among citizens, better services and prices will be offered to the final consumers/prosumers. This includes aggregation models such as VPP where the energy aggregator (or other intermediate) gathers a portfolio of smaller generators and operates them as a unified and flexible resource on the energy market or sells their power as system reserve.

WiseEVP (WiseGRID Electric Vehicle Platform): This tool/platform will be put in operation in the Terni pilot site for optimizing the activities related to smart charging and discharging of the EVs and for reducing energy billing. By means of this platform it will be possible to plan and control the charging/discharging schedule of all EVs of the fleet. The platform will provide a reference load profile taking into consideration the renewable generation profile, the tariffs and the requirements from the driver(s) of the EV in question. EV fleet as VPP storage and geo-charging optimization services will be included, considering the e-car fleet as an aggregation of moving batteries.

WG FastV2G: V2G Fast EV charging station will be made available at the Terni pilot site thanks to the six EVs and four EVSEs available locally. This tool will allow using of EV as dynamic distributed storage devices, feeding electricity stored in their batteries back into the system when needed (fast V2G supply). This can help reducing electricity system costs by providing cost-effective means of providing regulation services, spinning reserves and peak shaving capacity.

WG STaaS/VPP (WiseGRID energy STorage as a Service/Virtual Power Plants): Since the Terni pilot site is equipped with a 96 kWh 2nd life Li-ion battery energy storage, this tool will be tested with the aim to give additional flexibility as a service for the district.

8.3.2.2 WiseGRID Use Cases

The HL-UCs that will be implemented in Terni trial site are as follows:

- HL-UC 1 Distributed RES integration in the grid
- HL-UC 2 Decentralized grid control automation
- HL-UC 3 E-mobility integration in the grid with V2G
- HL-UC 4 Battery storage integration at substation and prosumer level
- HL-UC 6 VPP technical and economic feasibility

The PUCs that will be implemented in Terni trial site are as follows:

- HL-UC 1_PUC_1_Network monitoring
- HL-UC 1_PUC_2_Control strategies for reducing RES curtailment
- HL-UC 1_PUC_3_Voltage support and congestion management
- HL-UC 1_PUC_4_Grid planning analysis
- HL-UC 1_PUC_5_Promote RES via RESCO companies
- HL-UC 2_PUC_1_Distribution network real-time monitoring
- HL-UC 2_PUC_2_Real-time distribution system awareness
- HL-UC 2_PUC_3_Grid control
- HL-UC 3_PUC_1_EVSE and EV fleet monitoring
- HL-UC 3_PUC_2_Interaction of the user with EVSE
- HL-UC 3_PUC_3_EV charging management
- HL-UC 3_PUC_4_Interaction with the energy infrastructure
- HL-UC 4_PUC_1_Batteries management at prosumer level

- HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)
- HL-UC 4_PUC_3_Ancillary services
- HL-UC 4_PUC_4_Combination of battery storage systems
- HL-UC 6_PUC_1_VPP monitoring and management
- HL-UC 6_PUC_2_VPP market participation
- HL-UC 6_PUC_3_VPP real-time control
- HL-UC 6_PUC_4_VPP users relationship management

The SUCs that will be implemented in Terni trial site are as follows:

- HL-UC 1_SUC_1.1_Data collection from RES and critical network sections
- HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections
- HL-UC 1_SUC_1.3_KPI management
- HL-UC 1_SUC_1.4_Big data storage analysis
- HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighborhood transactions and real-time consumption
- HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means
- HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies
- HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode
- HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)
- HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)
- HL-UC 1_SUC_3.4_Improve voltage symmetry between the phases
- HL-UC 1_SUC_4.1_EV charge points planning analysis
- HL-UC 1_SUC_4.2_Grid storage planning analysis
- HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance
- HL-UC 1_SUC_5.2_Monitor domestic RES production
- HL-UC 1_SUC_5.3_Monitor domestic clients consumption
- HL-UC 1_SUC_5.4_Manage energy selling
- HL-UC 1_SUC_5.5_Energy cost management
- HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters
- HL-UC 2_SUC_1.2_Data concentration
- HL-UC 2_SUC_1.3_Monitoring power quality in the grid
- HL-UC 2_SUC_1.4_Fault detection and identification
- HL-UC 2_SUC_1.5_Asset management

- HL-UC 2_SUC_2.1_RES and load forecasting
- HL-UC 2_SUC_2.2_Topology processor
- HL-UC 2_SUC_2.3_Network observability analysis
- HL-UC 2_SUC_2.4_Load flow calculation
- HL-UC 2_SUC_2.5_State estimation
- HL-UC 2_SUC_2.6_Bad data detection, identification and replacement
- HL-UC 2_SUC_3.1_Load control
- HL-UC 2_SUC_3.2_DR as a service to the grid
- HL-UC 2_SUC_3.3_Optimization algorithm
- HL-UC 2_SUC_3.4_Reconfiguration
- HL-UC 2_SUC_3.5_Islanding procedures for the local grid
- HL-UC 2_SUC_3.6_Cold ironing
- HL-UC 3_SUC_1.1_Data collection from EVSE
- HL-UC 3_SUC_1.2_Data collection from EVs
- HL-UC 3_SUC_2.1_Users' authentication
- HL-UC 3_SUC_2.2_Charging session request
- HL-UC 3_SUC_2.3_Charging session booking
- HL-UC 3_SUC_3.1_EVSE network configuration
- HL-UC 3_SUC_3.2_EV load forecasting
- HL-UC 3_SUC_3.3_EV flexibility estimation
- HL-UC 3_SUC_3.4_Reference charging load profile calculation
- HL-UC 3_SUC_3.5_Charging session schedule
- HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests
- HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration
- HL-UC 3_SUC_4.3_EV providing V2H services
- HL-UC 4_SUC_1.1_Increase of self-consumption
- HL-UC 4_SUC_1.2_Time-of-use management
- HL-UC 4_SUC_1.3_Peak shaving
- HL-UC 4_SUC_2.1_Batteries dispatch management
- HL-UC 4_SUC_2.2_Black start capabilities
- HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonization
- HL-UC 4_SUC_2.4_Backup power for residential area
- HL-UC 4_SUC_3.1_Market scheduling
- HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system

- HL-UC 4_SUC_3.3_Batteries automatic dispatch
- HL-UC 4_SUC_4.1_Parameter configuration of storage systems
- HL-UC 4_SUC_4.2_Priority list of units running
- HL-UC 6_SUC_1.1_Resource metering
- HL-UC 6_SUC_1.2_VPP RES forecast
- HL-UC 6_SUC_1.3_VPP flexibility forecast
- HL-UC 6_SUC_1.4_Strategies definition
- HL-UC 6_SUC_2.1_VPP market participation and bid calculation
- HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation
- HL-UC 6_SUC_2.3_VPP unit scheduling
- HL-UC 6_SUC_3.1_Real-time flexibility calculation
- HL-UC 6_SUC_3.2_VPP implementation of ancillary services
- HL-UC 6_SUC_3.3_Real-time decision making
- HL-UC 6_SUC_4.1_Manage contractual issues
- HL-UC 6_SUC_4.3_Define and manage member compensation
- HL-UC 6_SUC_4.4_DSM and DR mechanisms

8.3.3 Preliminary deployment and demonstration plan

- Month 14 – Month 19: a thorough analysis of the Terni demo site will be carried out in terms of technologies and facilities available locally. Particular emphasis will be placed on the integration of the innovative solutions developed under Nobel Grid, ELSA and SUCCESS projects with WISEGRID tools.
- Month 19 – Month 24: The Terni demo site will support technical developments in lab testing in an integrated environment, eventually through simulation.
- Month 22 – Month 30: preliminary deployment of the first version of the WiseGRID tools (to be demonstrated in Terni demo site) including the test of its critical functionalities and the data gathering for evaluation.
- Month 30 – Month 40: local deployment and testing of the final version of the WiseGRID tools (to be demonstrated in Terni Demo site), including the test of the full sets of functionalities in real environments and the data gathering for evaluation.

8.3.4 Potential barriers

In this section, we identify a number of regulatory, technical, social and economic obstacles that could reduce the impact of the WiseGRID in the European smart grid landscape and provide recommendations to efficiently and collectively overcome them:

- Lack or limited adoption of open and interoperable standards: Member States and the EC should ensure that internationally accepted open and interoperable standards for interfaces are adopted in order to efficiently deploy and operate Smart Grid services via competitively-neutral incentives and a clear roadmap. Furthermore, CEN, CENELEC and ETSI should orchestrate a more thorough gap analysis in order to identify and, later, develop any missing standards. Moreover AENOR, as partner in the project, will support us into considering and contributing to the Smart Grid standardization.

- Inadequate energy market design and rules: The revision of the Third Internal Energy Market Package needs to comprise market rules that ensure a fair, democratic, non-discriminatory and competitive environment, with clear roles for all energy players, including policy groups such as the Agency for the Cooperation of the Energy Regulators (ACER). For example, controllers of smart metering data should provide access to all rightful data recipients on a timely manner via appropriate market facilitation services. Similarly, fair competition between different storage solutions should be facilitated. Furthermore, short-term balancing market development, equal access to electricity storage, aggregated flexibility and dynamic pricing are considered as mature options for enhancing the competitiveness and efficiency of the single European energy market, as well as, validating the key role of aggregators. Last, but not least, DSOs and TSOs should be encouraged to exchange relevant operational data with each other and allow flexible capacity management in order to ensure safe, secure and cost efficient distribution and transmission network operation and development. Policy makers need to take these into consideration.
- Absence of efficient and fair legal/regulatory framework: Regulation needs to make sure that the five principles of data management (privacy and security, transparency, accuracy, accessibility and non-discrimination) are met in order for consumers to be protected and agree to actively participate in DR schemes. Furthermore, contractual arrangements should be simple, transparent and fair and allow consumers to access any service provider of their choosing, and protect them from multiple conflicting contracts for flexibility.
- Limited adoption of smart appliances and distributed energy resources by consumers: Enablers of active demand and supply side participation, such as smart appliances, storage systems and EVs, could be subsidised in order to reduce the initial acquisition cost for end-users. Additional concerns for the latter, such as the slow charging rate, range anxiety, etc., can be mitigated by further incentives (e.g. attractive access to parking in congested urban area) and roll-out of infrastructure, like charging stations.
- Privacy concerns, fear of losing control and excessive charges: These barriers may be reduced by stimulating public awareness for smart energy solutions, communicating the non-compulsory nature of DR schemes and providing fair behavioural incentives in order to effectively deal with inertia.
- Economic attractiveness: A forward-looking and stable regulatory framework, can provide the right economic incentives to newcomers for implementing innovative business models. Furthermore, Grid operators should be discouraged from performing short-term optimisation in order to make sustainable, long-term investments that will support the EU's Energy and Climate targets for 2030.

8.4 MESOGIA

HEDNO (Hellenic Electricity Distribution Network Operator S.A.) was established in April 2012 with the secession of the Distribution sector of PPC S.A. in accordance with Law 4001/2011 and in compliance with EU Directive 2009/72/EC. It is a 100% subsidiary of PPC S.A., however it is functionally and administratively independent, in compliance with all the requirements of independence incorporated in the above legal framework.

HEDNO is the only DSO in Greece (except the airport network) and one of the largest in Europe and is responsible for the operation, maintenance and exploitation of the distribution network in the whole country, including the mainland and the non-interconnected islands.

HEDNO's tasks comprise the operation, maintenance and development of the electricity distribution network in Greece in order to ensure transparent and non-discriminatory access of all consumers and more generally of all users of the network. In order to improve service quality as expressed by energy quality indices (number of failures, time of restoration, quality of voltage waveforms, etc.) along with the reduction of the operating cost and the increase of productivity, important investments in the network have been made in order to:

- Supply the continuously increasing demand;
- Enhance network reliability and decrease losses by construction of new lines and substations and upgrade of existing ones;
- Introduce operation automation (installation of remote metering and remote control systems);
- Construct networks compatible to societal requirements (taking care of the harmonization of new constructions with the natural and built environment).

The total length of MV/LV Network is 233.038 km, of which the Medium Voltage (MV) Network is 111.139 km and the Low Voltage (LV) Network is 125.164 km. The high-voltage (HV) grid is 945 km, of which 200 km are in Attica and 745 km in non-interconnected Islands. The network includes 161.182 MV/LV Substations and 225 HV/MV Substations including 19 GIS substations, 199 in the mainland system and 26 in non-interconnected Islands. HEDNO serves 7.438.455 customers (11.444 at MV and 7.427.011 at LV).

In addition, in order to compare the evolution of the distribution network during the last two years, the basic figures of the Electricity Distribution network for the year 2014 are provided in Figure 67.

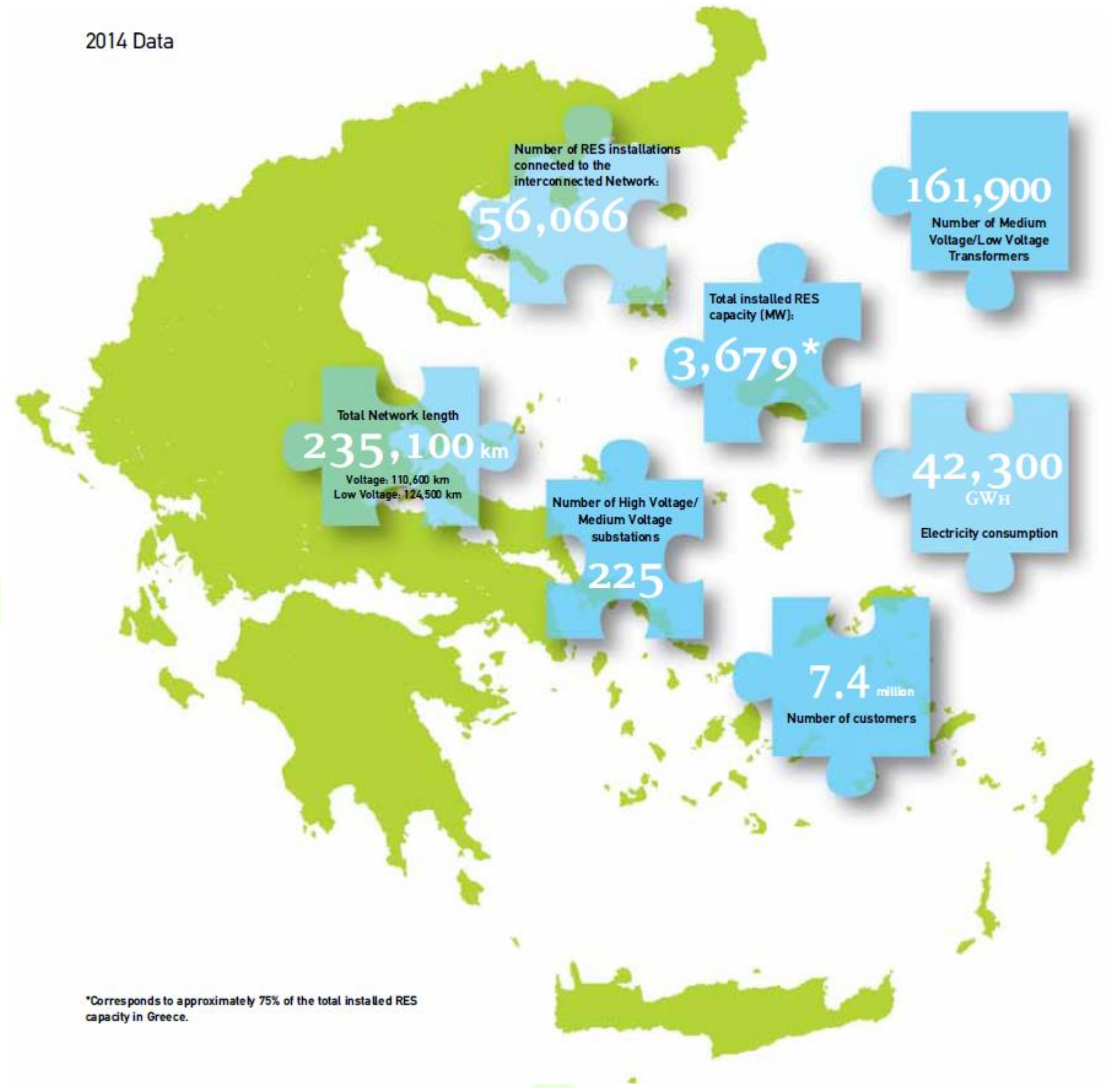


Figure 67 – Basic figure of the Hellenic Electricity Distribution Network

Irrespective of the choice regarding the current or future electricity retailer, each new or existing consumer should address HEDNO for topics related to the connection to the Distribution Network.

HEDNO ensures the implementation of the relevant works based on the applicable terms, conditions, and bills. The most important works include:

- new electricity supply connection,
- increase/decrease in the contracted capacity of electricity supply,
- supply relocation,
- unification/separation of supply connection points,
- removal of electricity supply and
- other technical issues regarding connections.

HEDNO is responsible for examining the possibility of connecting Renewable Energy (RES) Generation Units and Combined Heat and Power (CHP) Generation Units to the Distribution Network. For the cases where this possibility exists, HEDNO looks after the implementation of the works relevant to the connection of the interested producers.

As Operator of the non-interconnected islands, HEDNO ensures the reliable, efficient and secure operation of each individual electricity system. Furthermore, HEDNO takes all necessary measures in order to mitigate the environmental impact and to ensure the optimal participation of RES and CHP production units.

Figure 68 – Instance from one of HEDNO's Control Centre

HEDNO has under close observation the status of the infrastructure and takes all necessary actions in order to ensure compliance with specific technical specifications for the Network, with a view to achieve smooth and secure operation and to provide customers with the best possible power quality. In order to offer optimal supply of electricity in terms of quality, every effort is made to reduce the number and duration of supply interruptions. To this end, Network maintenance and reinforcement is systematic, while all fault incidents are rectified as soon as possible.

Radical modernization of the existing Network and its transformation to a "Smart System" that continually optimizes management of the connected consumers and producers, constitute the fundamental pursuits of HEDNO.

Compared to the existing, the new smart network will be superior in terms of performance and reliability, while being more customer-centric and at the same time more economical for the electricity sector in total. HEDNO is committed to implement in the course of the following years all necessary works, through which "smart grids" will transform from vision to reality.

These include automation and control projects, the computerized Geographical Information System (GIS) of the electricity Distribution Network, management and operation infrastructure of the non-interconnected systems, with a view to achieve greater Renewable Energy penetration and expansion of the use of smart meters and relevant technological equipment.

Regarding its commitment to improve power quality, the most commonly used index internationally is SAIDI (System Average Interruption Duration Index), which reflects the average interruption duration per customer on a yearly basis. HEDNO systematically strives to achieve constant improvement in the specific index, while further reduction of the duration of interruptions constitutes part of the Company's mid-term planning.

Improving power quality and enhancing HEDNO's services being part of the general framework of its efforts, the Company realizes investments of over €250 million per year with a view to reinforce and modernize the Distribution Network and offer faster and more effective services to consumers throughout the country.

Direct and bidirectional communication with the customers is achieved by developing modern call centers, such as customer service information center.

8.4.1 Pilot site description

The Hellenic Distribution Network Operator in order to operate, maintain and evolve the Distribution Grid, ensuring the optimal operation, is divided in 5 Regional Departments with defined areas of jurisdiction. The five regional departments are also related to geographical areas in Greece, namely:

- Department of Attica Region,
- Department of Macedonia – Thrace Region,
- Department of Peloponnese-Epirus Region,
- Department of Central Greece and
- Department of Islands Region.

Each of these regions is further divided in smaller areas (consisting of several municipalities) responsible for the development and maintenance of the local grid and customers' service. More specifically, as an indicative example Attica region (shown in Figure 69) comprises of 7 areas which are: Athens, Piraeus, Kallithea, Philothei-Kifisia, Peristeri, Mesogia and Elefsina.

Figure 69 – Attica region with the main Control Centre located at Athens

The pilot site "Mesogia" is located in the area of Mesogia at the south-eastern part of Attica, near Athens. Mesogia area includes the municipalities of Koropi, Lavrio, N. Makri and the interconnected islands of Kea, Andros and Tinos. The area of jurisdiction is depicted in Figure 70 and in Figure 71.

Further information regarding the structure of HEDNO is available in HEDNO's website, where all the relevant information for the company and customer services is given. The following link is provided for easy access: (https://www.deddie.gr/en/upiresies/simeia-eksupiretisis/diktuo-eksupiretisis). The area of Mesogia can be found by selecting the Prefecture: Attica and the Area of: Mesogia.

Mesogia has been used by HEDNO for the implementation of innovative pilot projects (e.g. Geographic Information System), which are expected to be expanded in the future to the rest of Greece after their successful completion there. Thus, it contains more advanced equipment which could be integrated with WiseGRID products for further development of smart grids solutions, and human resources eager to support these kinds of projects. In addition, the Mesogia area is considered as ideal for demonstration purposes since: a) it combines parts of mainland and interconnected islands, which is an interesting mixture of locations, systems and infrastructure to be studied, b) provides a mix of rural, urban and suburban areas, c) consists of a customer mix including: households, small, medium and large industries, d) has good RES penetration of various types and e) is close to the capital.

Also, another point mentioned above that should be stressed is the fact that the area combines mainland and interconnected islands and the experience to be acquired will be valuable for HEDNO, since more islands are expected to get interconnected with the Mainland Network increasing its complexity.

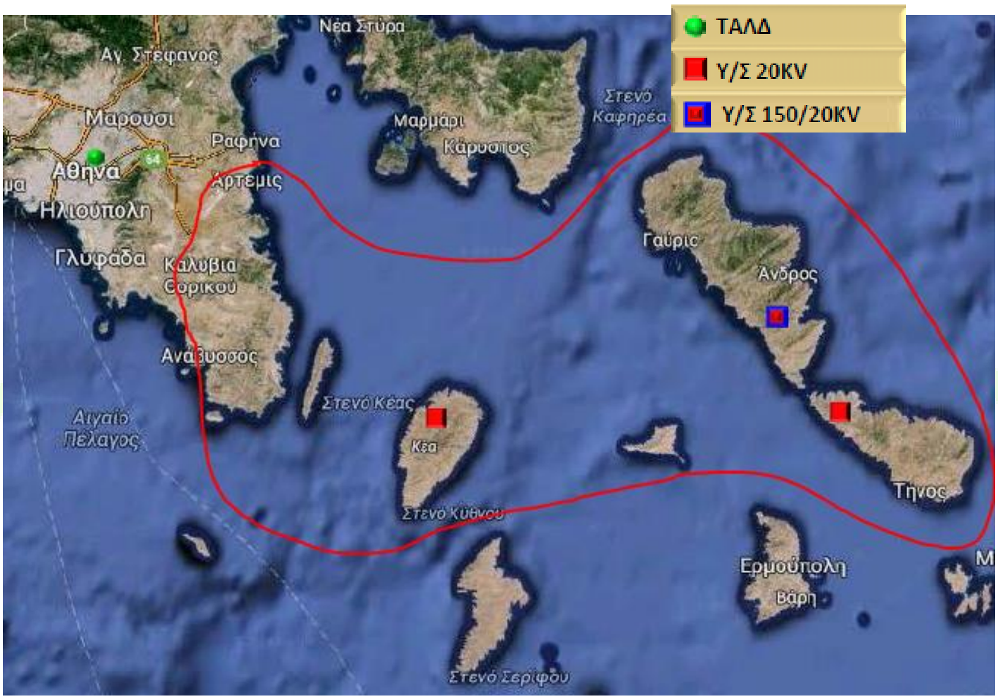


Figure 70 – Mesogia area with indication of the substations at the interconnected islands

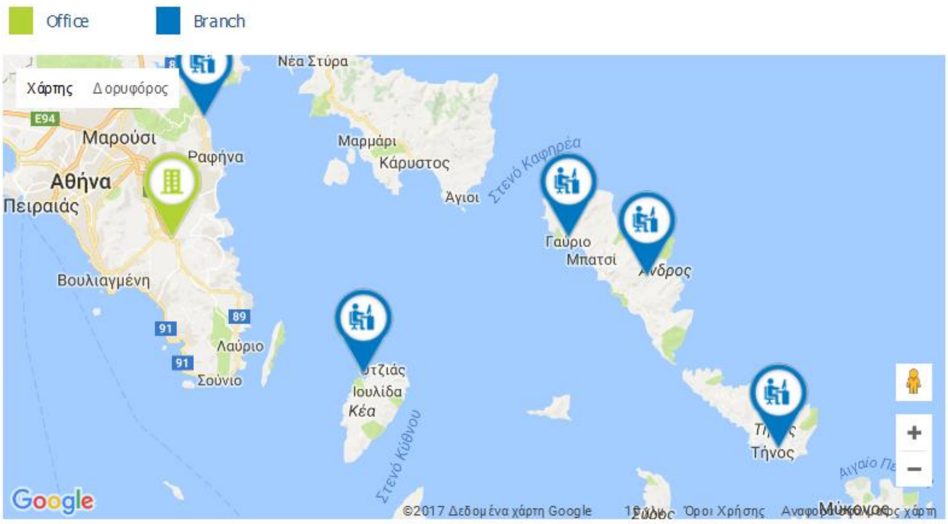


Figure 71 – South-eastern part of Attica with indication of customer service points

Mesogia pilot site includes also the Meltemi seaside camping in Rafina, which has been used as a test bed for several other projects, including Nobelgrid. Meltemi consists of 170 cottages used mostly for summer holidays. Due to the small size of each cottage, its electrical consumption is lower than an ordinary house in Greece. The ecological awareness of its habitants and the electrical structure (all houses connected to the same MV/LV transformer) of the settlement make it ideal for use as a test bed, for functions related to emergency and critical grid situations. A number of Distributed Generators (DGs) are installed that can partially support the Meltemi camping load in islanded Microgrid operation.

8.4.1.1 Infrastructure

In this section, the infrastructure of the distribution grid and HEDNO in Mesogia (as registered at the end of 2016) will be briefly described in terms of customers, network lines and substations.

In 2016, HEDNO provided in the area of Mesogia electricity to 482 consumers connected to the medium voltage network and 226.076 consumers connected to the low voltage network. More specifically, Table 15 presents the number of consumers per zone and for medium and low voltage networks, respectively. There are three zones: A, B and C.

- Zone A refers to urban consumers.
- Zone B refers to suburban consumers.
- Zone C refers to rural consumers.

Table 15 – Consumers in Mesogia

Consumers in medium voltage network			Consumers in low voltage network			Total consumers		
Zone A	Zone B	Zone C	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
160	313	9	20.347	176.339	29.390	**20.507**	**17.652**	**29.399**

Furthermore, in 2016, the overall energy demand was 414.364 kVA in the medium voltage network and 3.689.733 kVA in the low voltage network. In particular, Table 16 and Table 17 present the consumption per usage for the low and medium voltage networks respectively.

Table 16 – Consumption per usage in low voltage network in Mesogia (MWh)

Usage	Residential	Industrial	Commercial	Agricultural	Streetlight	Public Buildings	Total
Consumed Energy (MWh)	586.566	31.596	267.221	20.696	30.572	19.954	**956.604**

Table 17 – Consumption per usage in medium voltage network in Mesogia (MWh)

Usage	Industrial	Commercial	Public Buildings	Total
Consumed Energy (MWh)	241.326	217.314	21.467	**480.107**

The main components of the equipment already installed in Mesogia pilot site for the year 2016 are:

- MV/LV Substations.

  Table 18 presents the number of overhead and other MV/LV substations and the total installed power in medium and low voltage networks.

Table 18 – MV/LV Substations in distribution network in Mesogia

Overhead substations		Other substations		Total substations	
Number	Installed power (kVA)	Number	Installed power (kVA)	Number	Installed power (kVA)
3.182	734.645	113	73.590	**3.295**	**808.235**

- Transformers in MV/LV substations.

  Table 19 presents the number of transformers in overhead and other substations and their nominal power.

Table 19 – Transformers in MV/LV substations in Mesogia

20kV		15kV		Total	
Number	kVA	Number	kVA	Number	kVA
3.114	790.835	181	17.400	**3.295**	**808.235**

- Voltage regulators: 5 in substations of 20kV with nominal power equal to 50MVA.
- Power lines in medium and low voltage networks.

  The following Table 20 presents the length of MV and LV power lines per type of line for the medium and low voltage networks in Mesogia. There are three types of line in the distribution network: overhead, underground and underwater.

Table 20 – Length (km) of MV and LV lines in Mesogia

Medium voltage network			Low voltage network		Total		
Overhead	Underground	Submarine	Overhead	Underground	Overhead	Underground	Submarine
1.992	303	56	4.622	229	**6.615**	**532**	**56**

- Installed Renewable Energy Sources.

  The following Table 21 presents the installed nominal power of Renewable Energy Sources, consisting of wind farms, PVs, PVs net metering and rooftop PVs in Mesogia.

Table 21 – Installed RES technologies in Mesogia

RES Technology	Number	Power (kW)
Wind Farm	5	5.150,00
PV	280	48.822,88
PV Net Metering	40	545,84
Rooftop PV	1457	12.442,68
Total	1782	66.961,40

- Network infrastructure in connection with TSO.

  Network infrastructure at the edges of the distribution network, particularly in connection with the Transmission System, consisting of substations, power transformers, power switches and capacitors (Table 22).

Table 22 – Network infrastructure in connection with TSO in Mesogia

Number of Substations	Power Transformers		Power Switches	Capacitors	
150kV	150kV		150kV	Number	MVAR
	Number	MVA	Number		
6	16	750	16	33	132

Meltemi Test Site

Figure 72 presents the LV network of Meltemi, which is a radial network fed by a single 400kVA MV/LV transformer. This is ideal for testing new tools since all houses are connected to a single transformer.

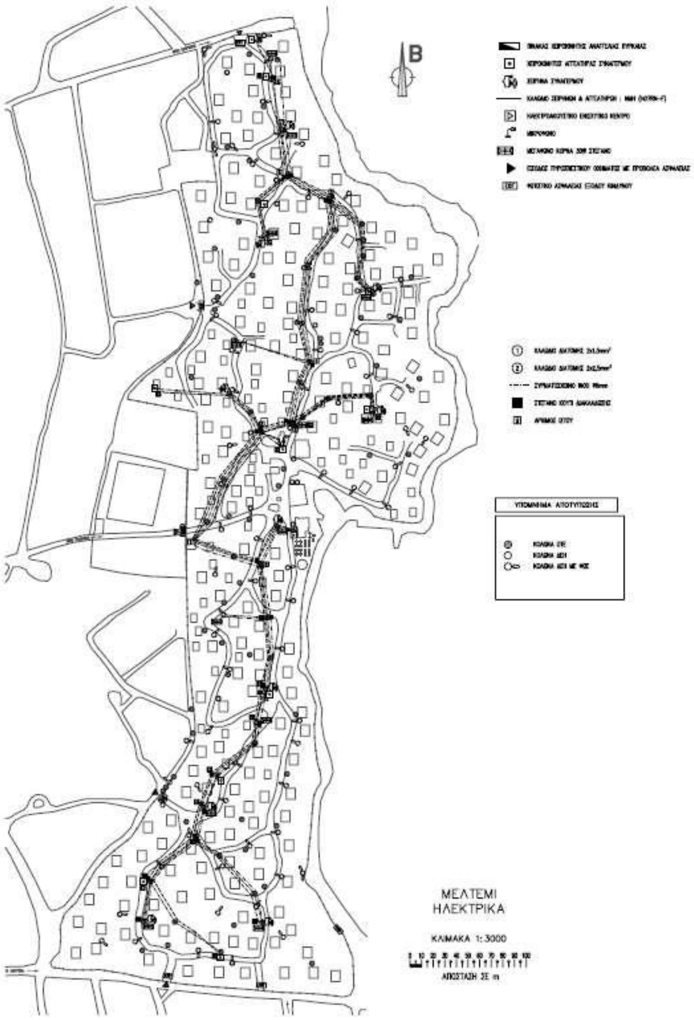


Figure 72 – Topographic and network configuration in Meltemi

Equipment that is already installed in Meltemi includes the following main components:

- existing RES 4,5 kW photovoltaic panels and small residential wind turbines (2-3 Wind Turbines ~1kW);
- existing Home Energy Management System (10-20 pieces) and
- diesel generator 40kVA (metering equipment in the main substation with available online connection).

8.4.1.2 Services and applications

In order to achieve the objectives of offering high quality services to the users of the network, HEDNO equips and enhances the network with advanced equipment and applications. In case of Mesogia region, the following applications are in place or are being gradually implemented and could be considered in the framework of WiseGRID project (where applicable), taking into account their possible integration capabilities via test servers.

Distribution Management System (DMS): At Attica Region, a new Regional SCADA-DMS system is in the phase of installation and commissioning, replacing the older Regional SCADA system. Currently the main functionality of the system is the supervision of the HV/MV substations. For instance, critical data are aggregated for the sustainable operation of the HV/MV substations such as event, fault alarms and metering data. Moreover, the system has the ability to supervise the protection relays of the MV subsystems by the use of the communication protocol IEC 870-5-103.

The current telecommunication infrastructure is used by SCADA systems for the transfer of tele-control signals, metering data, event signals and alarm signals. The current telecommunication connections that are used between the components of the SCADA systems are briefly presented below:

- Connection between the Central Control Systems (CCS) and the Remote Terminal Units (RTUs, which are installed into HV substations. This connection is realized with the use of the telecommunication grid E-NET, which belongs to Hellenic Public Power Corporation, or using ADSL connection.
- Connection between the CCS and the tele-control switching components that are installed on the overhead MV lines. GSM modems and the communication protocol Telegyr TG800 are used for the tele-control of the switching elements on the overhead lines.
- Connection between the CCS and the RTUs, which are installed for tele-control of urban MV substations.
- Connection between the CCS and the Fault Passage Indicators (FPI). In many regions, FPIs have appropriate RTUs which relay the fault signals with the use of SMS messages via an integrated GSM modem.

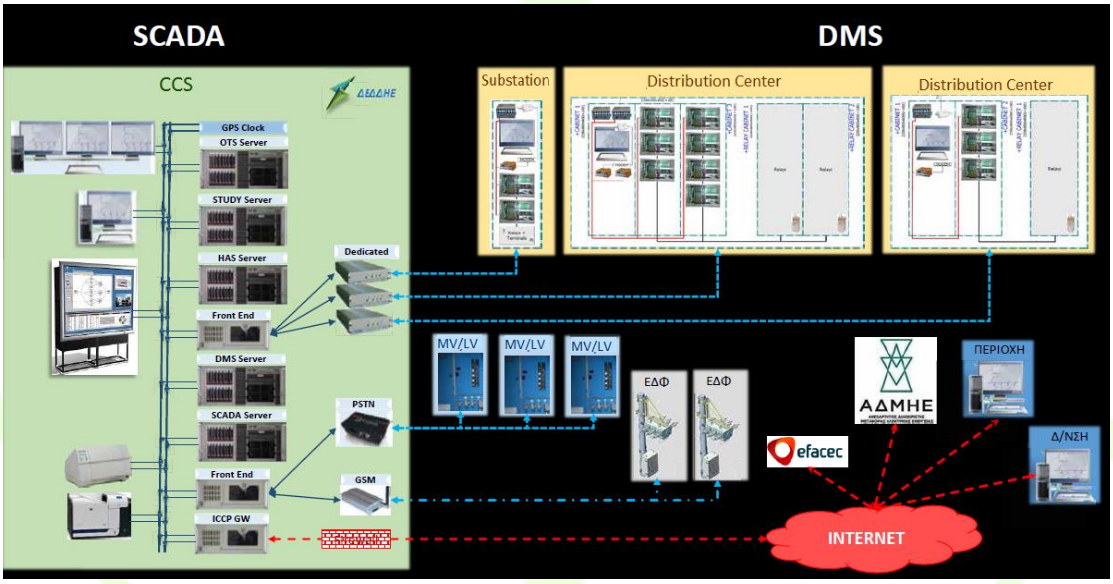


Figure 73 – Schematic description of the architecture of the installed SCADA/DMS system, its function and communication with the other actors

Figure 74 – EFACEC Remote Control System

The expected options and services to be provided by DMS (upon complete installation) include among others, alarm management, topology information (with feeder traces and schematics), fault management, power flow and local allocators, outage management, quality indices monitoring and extraction, load shed, asset management, short-circuit analysis and a virtual environment fed with real grid details, such as study environment for investigating distribution feeder optimization, protection coordination and operator training simulation.

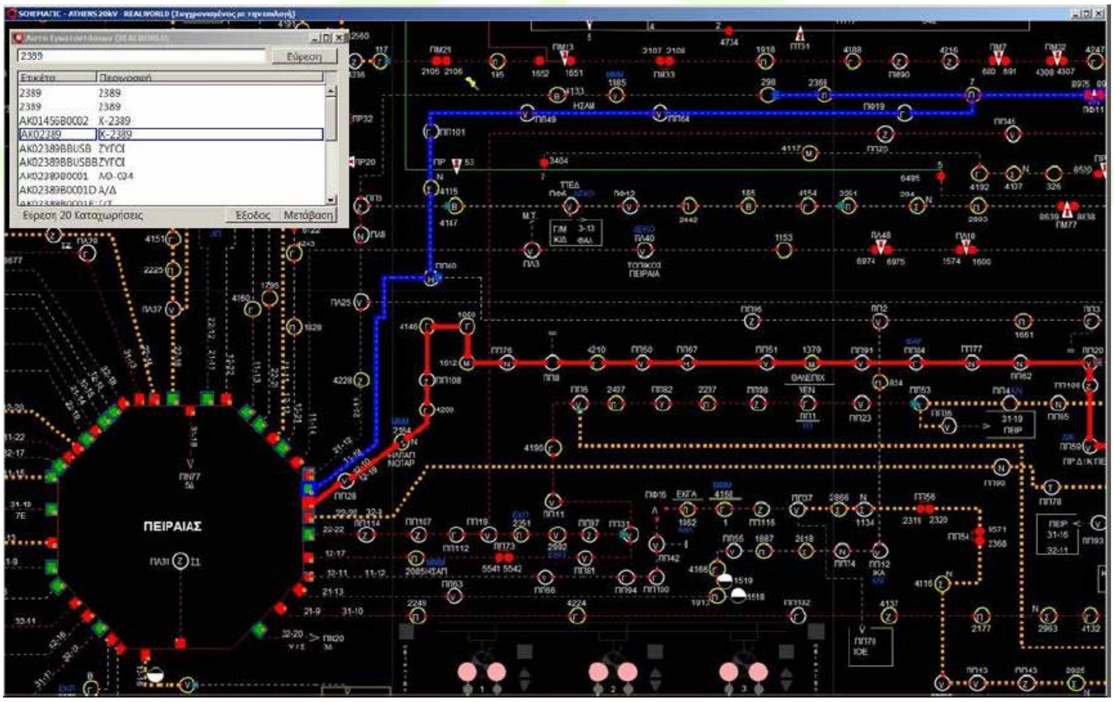


Figure 75 – Attica Region's network topology as depicted in SCADA.

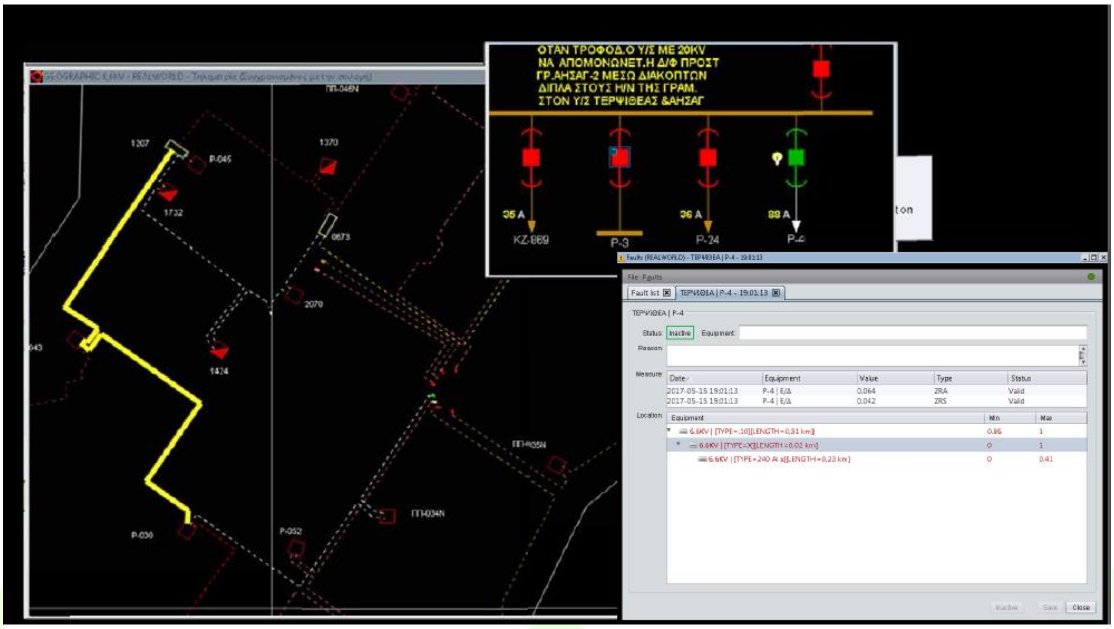


Figure 76 – Fault locator as depicted in SCADA

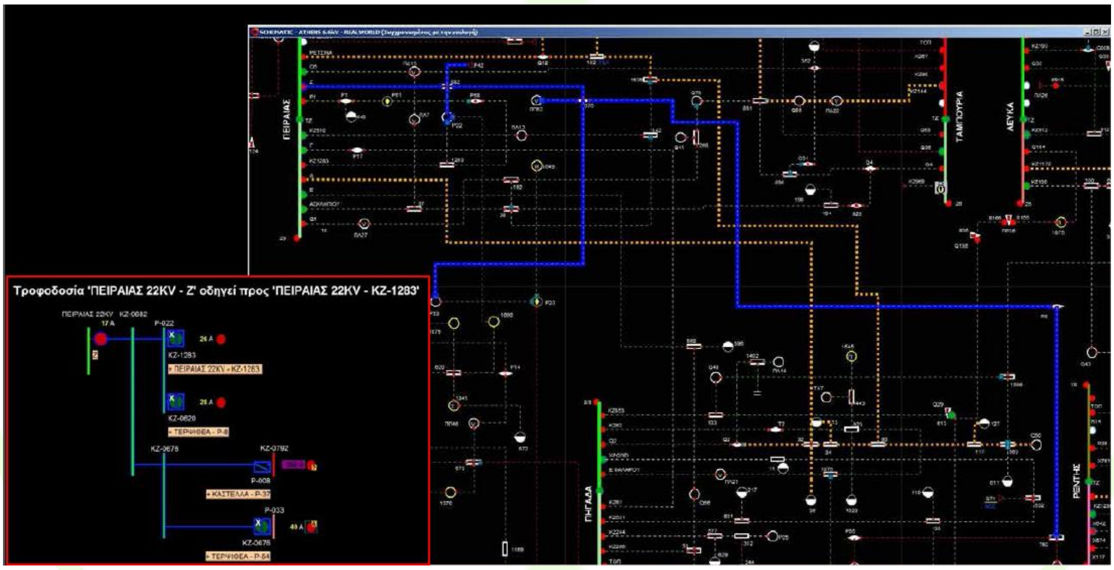


Figure 77 – Feeder schematic as depicted in SCADA

Automatic Meter Reading (AMR)/Advanced Metering Infrastructure (AMI): HEDNO is responsible for installing, operating and maintaining the metering equipment necessary for the operation of the Distribution Network. To this end, HEDNO collects and validates meter data and provides the respective electricity retailers with the measured consumption data necessary for customer billing.

Smart electronic meters are installed on some distribution grid buses, extensively in the MV systems and limited in LV systems, and are responsible for monitoring the transferred energy of these buses every 15 minutes. Currently, the AMR communicates with each Smart Meter once every 24 hours using GPRS to collect metering data and meter log files. Up till now, all MV customers are equipped with Electronic Telemetering Meters, but most LV customers are equipped with electromechanical meters which measure active and in certain cases reactive energy consumption. For electromechanical meters, metering data are manually logged by DSO technical personnel. However, approximately 200.000 smart electricity meters with either GSM/GPRS/3G communications or PLC through substation concentrators communications, are expected to be supplied for a pilot rollout to commercial, industrial and residential LV customers. This pilot rollout faces certain delays due to some legal issues related to tendering procedures. The integration of smart meters with telemetry software will provide an advanced metering infrastructure solution, eliminating the need for onsite meter reading visits, increasing power network's quality, monitoring load conditions, but is not expected to support the need of WiseGRID apps for real-time monitoring.

Meter Data Management System (MDMS): System for validating, storing, processing and analyzing large quantities of metering data. Particularly, MDMS provides infrastructure for data receipt on metered consumption from the implemented AMI system within one electric utility, it potentially calculates consumed electricity (i.e. provides data necessary to the system for calculation and collection of electricity), preserves and manages data, and also provides access to data to all interested parties if it is compliant with the current legislation.

Customer Information System (CIS): Customer information system covers the functionalities related to customers and the collection of the basic identifying information such as contracts and requests for types of energy products. In addition to this, basic functionalities are related to information offering, as well as receiving fault complaints from customers. Customer information system deals with the processes related to accounting complaints, customer disconnection due to non-payment, and reconnection after the settlement of financial liabilities and change of tariff packages. Now, CIS is a DSO's asset who is responsible for the complaints, disconnections, etc. Of course, a CIS could become in the future a VPP's asset and could realize the aforementioned functionalities between the customers and the VPP operator.

Outage Management System (OMS): OMS is used by the distribution system operator for the purpose of detecting outages within the electric distribution network, as well as outage verification and/or supply restoration. OMS is a system considering that it is functionally connected with different domains and their business sub-functions. The most important of all domains and business sub-functions are: fault management under the network management, work management and supervision under maintenance and construction.

GIS: Geographic information system is originally designed to capture, analyze, manage and present the spatial or geographical network data. Moreover, it is a quite flexible system that can collaborate with other systems and technologies concerning the network functions and management operations, such as DMS-SCADA, SAP, CIS, etc. The visualized network status will be directly displayed to the operators so that it is helpful for the operating efficiency, as show in Figure 78. Last but not least, the geographic information system is valuable for grid planning, optimizing, repairing and maintaining strategies. The regions of Mesogia and West Thessaloniki are the first to be equipped with GIS, as the first stage of the system's roll-out in the Greek Distribution Network. The GIS pilot in Mesogia started in April 2017.

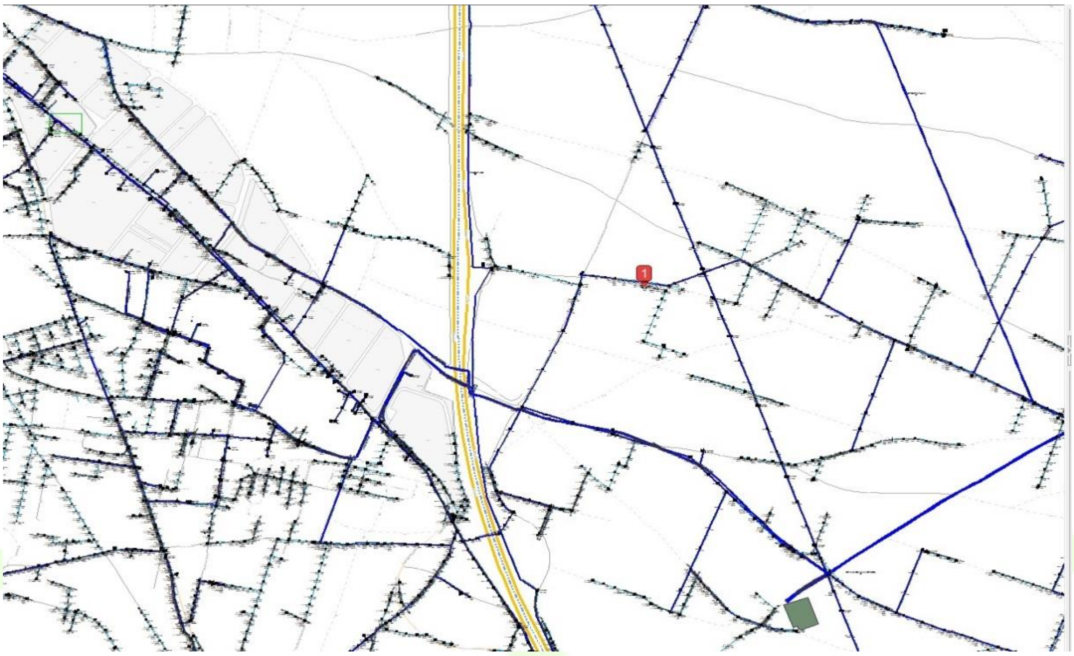


Figure 78 – Grid's depiction in GIS

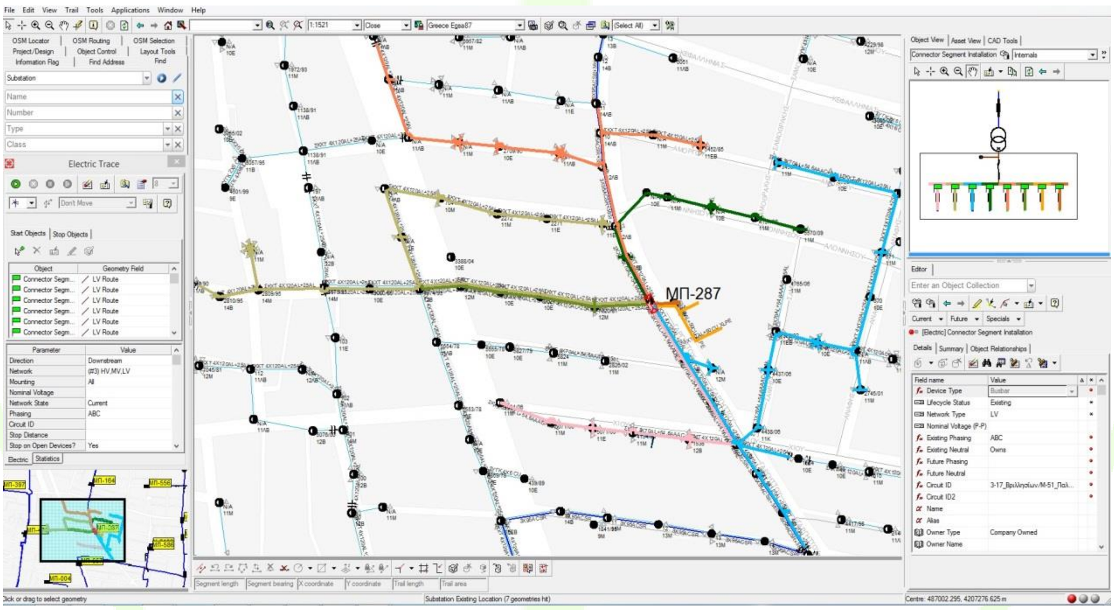


Figure 79 – Closer depiction of the grid in GIS, while used for grid planning studies

Distribution Grid Components:

- Smart Meter (SM)
- DER Controller: In this case, DER controller is able to receive setpoint signals in order to adjust its production, as well as to send acknowledgement information and implement the respective set-points.
- Concentrators: Concentrators are autonomous devices executing automatically or on request metering data reading and parameterization and delivery of read data to AMI. In general case, many

levels concentrators could be implemented depending on how the data are transferred and manipulated. Now, concentrators transfer metering data to DMS every 24 hours via GPRS communication.

8.4.2 WiseGRID in Mesogia

In general, WiseGRID project will assist HEDNO in improving the services provided to the customers (WiseHOME app), as well as in developing new services, by means of the WiseGRID IOP and the WiseGRID Cockpit.

The increased RES/DG penetration creates new challenges to the management distribution network and HEDNO already searches for solutions to efficiently control and integrate them, cope with voltage problems and increase the hosting capacity.

HEDNO needs intelligent automation in order to improve the power quality and efficiency. The demonstration site will provide the opportunity to test new functionalities and investigate the replicability in other sections of the distribution network. Furthermore, taking into account the ongoing tender for smart meters, the demonstration in the WiseGRID will allow HEDNO to gain valuable experiences.

Furthermore, a critical role of HEDNO is to become a market facilitator in the distribution network, and ICT tools developed in the WiseGRID are recognised as a significant step to fulfill this objective.

More specifically, the goals of the tests implemented in Mesogia are the following:

- Increase of power quality and RES penetration: The selection of a congested substation is ideal for testing new advanced application for grid management and DR. The goal is to achieve the increase in RES penetration using grid management tools and DR.
- Active demand management for ancillary services and market participation: The goal is to demonstrate the role of DSO as market facilitator. Namely, combining the DR capabilities and the grid management tools, HEDNO will demonstrate the provision of ancillary services (voltage support).
- Collaboration with other energy actors: The goal is to investigate policies that will allow the further increase in the system efficiency through a more holistic view, thus integrating other energy actors.

8.4.2.1 WiseGRID tools and technologies

For these to be achieved, the following WiseGRID tools will be mainly deployed and tested:

- WG IOP (WiseGRID InterOperable Platform)

  WG IOP, as a scalable, secure and open interoperable platform will interconnect the different WiseGRID products/tools, managing the massive heterogeneous data streams and ensuring an efficient and harmonized function of the WiseGRID integrated solution. Its role is important for a DSO, since the combination and co-ordination of the different used systems and the efficient data retrieval affect the effectiveness of its operation.

- WG Cockpit

  WG Cockpit tool, as the tool focusing on the operation, monitoring and decentralized automatic control of the distribution network, is one of the most significant tools for HEDNO in the WG palette. The offered possibilities of real-time grid monitoring, load and production forecasting, DR campaigns triggering and decentralized fast control could assist in reaching the goal of increased RES penetration with high power quality.

In addition to the above products, the following WiseGRID tools will be also considered at Mesogia pilot site:

- WiseCORP

  WiseCORP tool as a corporate application is not a tool destined for DSO and its central activities.

However, it could be useful both for a DSO company for better energy management in its premises and for DSO's customers, mainly the industrial ones. By incorporating WiseCORP, they would optimize their energy use, increase their self-consumption, and participate in DR campaigns finally offering services also to the DSO, contributing to a more efficient operation of the network. In this case, it could be utilized in order to test the interoperability between the interfaces of similar applications potentially used by businesses in the future and the interface of HEDNO's systems, providing that there is the necessary technical infrastructure.

- WiseCOOP

  WiseCOOP tool, as WiseCORP too, does not directly address DSO's activities and needs. Moreover, in Greece, there is not a regulatory framework for the Aggregator activity yet. Nevertheless, since cooperatives have started arising and there are active retailers in Greece, WiseCOOP could play a significant role in better management of their portfolio (customers and assets) and in fast and reliable response to DSO's requests or DR campaigns.

- WiseHOME

  WiseHOME app is the tool to make the residential customers active players able to monitor and control their energy consumption, participate in the market, thus also affecting their energy costs. In this way, it could be a means to improve the services provided to HEDNO's customers and check the parameters or the interoperability between the interfaces of the customer apps with DSO's systems and how this can be most effectively used to activate customer's response. In this case, WiseHOME tool could be used as an incentive for the residents accepting to participate in the pilot project in order to provide to them an overview of their energy consumption and the possibility to monitor and manage it.

- WG RESCO

  WG RESCO app could facilitate the operation of RESCOs and help them to increase their portfolio allowing more citizens to have access to renewable energy. This would be in line with the HEDNO's objective for increasing RES penetration.

- WG STaaS/VPP

  WG STaaS/VPP app as a tool of specialized aggregators with focus on services to DSO and energy selling could be of interest to HEDNO and contribute to a reliable and stable grid operation. In Mesogia pilot site, WG STaaS/VPP participates as auxiliary system in the implementation of HL-UC 5 related with Cogeneration.

- WG FastV2G
- WiseEVP

The infrastructure to be deployed includes:

- 400 smart meters, as they were developed in previous project, following the architecture of Unbundled Smart Meters (USM) to aggregate functionalities which allow flexible support for billing, for energy and ancillary services markets. The smart meter functionalities are adequately grouped in two separate (unbundled) components, the Smart Metrology Meter (SMM) and the Smart Meter eXtension (SMX). The Metrology Meter is responsible to record the metrological data in highly secured manner, but has limited functionalities. The Extension overcomes this functional limitation by providing advanced functionalities that support the future evolution of the smart grid and energy services. These smart meters will be deployed to satisfy the necessary requirements and functions of the WiseGRID applications.

- CHP at Gas Company

  2 CHP units (10-20kWe) will be installed in the area in order to demonstrate the corresponding functionalities of WiseCORP. Advanced management of the CHP will allow the provision of ancillary services and the participation in VPP schemes without affecting the comfort level in the buildings.

8.4.2.2 WiseGRID Use Cases

7 HL-UCs, 26 PUCs and 99 SUCs are planned to be implemented and tested in the Mesogia pilot site. It should be mentioned that each UC will be implemented with a different priority value as presented in the WiseGRID UCs Inventory (Table 31).

HL-UCs

- HL-UC 1 Distributed RES integration in the grid
- HL-UC 2 Decentralized grid control automation
- HL-UC 3 E-mobility integration in the grid with V2G
- HL-UC 4 Battery storage integration at substation and prosumer level
- HL-UC 5 Cogeneration integration in public buildings/housing
- HL-UC 6 VPP technical and economic feasibility
- HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty

PUCs

- HL-UC 1_PUC_1_Network monitoring
- HL-UC 1_PUC_2_Control strategies for reducing RES curtailment
- HL-UC 1_PUC_3_Voltage support and congestion management
- HL-UC 1_PUC_5_Promote RES via RESCO companies
- HL-UC 2_PUC_1_Distribution network real-time monitoring
- HL-UC 2_PUC_2_Real-time distribution system awareness
- HL-UC 2_PUC_3_Grid control
- HL-UC 3_PUC_1_EVSE and EV fleet monitoring
- HL-UC 3_PUC_2_Interaction of the user with EVSE
- HL-UC 3_PUC_3_EV charging management
- HL-UC 3_PUC_4_Interaction with the energy infrastructure
- HL-UC 4_PUC_1_Batteries management at prosumer level
- HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)
- HL-UC 4_PUC_3_Ancillary services
- HL-UC 4_PUC_4_Combination of battery storage systems

- HL-UC 5_PUC_1_Thermal monitoring
- HL-UC 5_PUC_2_Cogeneration and HVAC management
- HL-UC 5_PUC_3_Comfort-based demand flexibility models
- HL-UC 5_PUC_4_Cogeneration and HVAC optimisation
- HL-UC 6_PUC_1_VPP monitoring and management
- HL-UC 6_PUC_2_VPP market participation
- HL-UC 6_PUC_3_VPP real-time control
- HL-UC 6_PUC_4_VPP users relationship management
- HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector
- HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market
- HL-UC 7_PUC_3_Clients engagement for active market participation

SUCs

- HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections
- HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections
- HL-UC 1_SUC_1.3_KPI management
- HL-UC 1_SUC_1.4_Big data storage analysis
- HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption
- HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means
- HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies
- HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode
- HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)
- HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)
- HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases
- HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance
- HL-UC 1_SUC_5.2_Monitor domestic RES production
- HL-UC 1_SUC_5.3_Monitor domestic clients consumption
- HL-UC 1_SUC_5.4_Manage energy selling
- HL-UC 1_SUC_5.5_Energy cost management
- HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters
- HL-UC 2_SUC_1.2_Data concentration
- HL-UC 2_SUC_1.3_Monitoring power quality in the grid

- HL-UC 2_SUC_1.4_Fault detection and identification
- HL-UC 2_SUC_1.5_Asset management
- HL-UC 2_SUC_2.1_RES and load forecasting
- HL-UC 2_SUC_2.2_Topology processor
- HL-UC 2_SUC_2.3_Network observability analysis
- HL-UC 2_SUC_2.4_Load flow calculation
- HL-UC 2_SUC_2.5_State estimation
- HL-UC 2_SUC_2.6_Bad data detection, identification and replacement
- HL-UC 2_SUC_3.1_Load control
- HL-UC 2_SUC_3.2_DR as a service to the grid
- HL-UC 2_SUC_3.3_Optimization algorithm
- HL-UC 2_SUC_3.4_Reconfiguration
- HL-UC 2_SUC_3.5_Islanding procedures for the local grid
- HL-UC 3_SUC_1.1_Data collection from EVSE
- HL-UC 3_SUC_1.2_Data collection from EVs
- HL-UC 3_SUC_2.1_Users' authentication
- HL-UC 3_SUC_2.2_Charging session request
- HL-UC 3_SUC_2.3_Charging session booking
- HL-UC 3_SUC_3.1_EVSE network configuration
- HL-UC 3_SUC_3.2_EV load forecasting
- HL-UC 3_SUC_3.3_EV flexibility estimation
- HL-UC 3_SUC_3.4_Reference charging load profile calculation
- HL-UC 3_SUC_3.5_Charging session schedule
- HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests
- HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration
- HL-UC 3_SUC_4.3_EV providing V2H services
- HL-UC 4_SUC_1.1_Increase of self-consumption
- HL-UC 4_SUC_1.2_Time-of-use management
- HL-UC 4_SUC_1.3_Peak shaving
- HL-UC 4_SUC_2.1_Batteries dispatch management
- HL-UC 4_SUC_2.2_Black start capabilities
- HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonization
- HL-UC 4_SUC_2.4_Backup power for residential area
- HL-UC 4_SUC_3.1_Market scheduling

- HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system
- HL-UC 4_SUC_3.3_Batteries automatic dispatch
- HL-UC 4_SUC_4.1_Parameter configuration of storage systems
- HL-UC 4_SUC_4.2_Priority list of units running
- HL-UC 5_SUC_1.1_Monitoring gas meters
- HL-UC 5_SUC_1.2_Monitoring CHP
- HL-UC 5_SUC_1.3_Monitoring buildings
- HL-UC 5_SUC_2.1_Forecasting thermal needs
- HL-UC 5_SUC_2.2_Real-time control set-points
- HL-UC 5_SUC_2.3_Control devices
- HL-UC 5_SUC_2.4_Alarm management
- HL-UC 5_SUC_3.1_Thermal model of households
- HL-UC 5_SUC_3.2_Thermal model of building
- HL-UC 5_SUC_3.3_Thermal flexibility modelling
- HL-UC 5_SUC_4.1_VPP participation
- HL-UC 5_SUC_4.2_Provision of ancillary services
- HL-UC 5_SUC_4.3_System optimisation
- HL-UC 6_SUC_1.1_Resource metering
- HL-UC 6_SUC_1.2_VPP RES forecast
- HL-UC 6_SUC_1.3_VPP flexibility forecast
- HL-UC 6_SUC_1.4_Strategies definition
- HL-UC 6_SUC_2.1_VPP market participation and bid calculation
- HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation
- HL-UC 6_SUC_2.3_VPP unit scheduling
- HL-UC 6_SUC_3.1_Real-time flexibility calculation
- HL-UC 6_SUC_3.2_VPP implementation of ancillary services
- HL-UC 6_SUC_3.3_Real-time decision making
- HL-UC 6_SUC_4.1_Manage contractual issues
- HL-UC 6_SUC_4.2_Define and manage member compensation
- HL-UC 6_SUC_4.3_DSM and DR mechanisms
- HL-UC 7_SUC_1.1_Monitor energy demand
- HL-UC 7_SUC_1.2_Enriched information visualization
- HL-UC 7_SUC_1.3_Integration with DR mechanisms
- HL-UC 7_SUC_1.4_Net metering & self-consumption

- HL-UC 7_SUC_1.5_Energy cost management for large infrastructures
- HL-UC 7_SUC_2.1_Enriched information visualization
- HL-UC 7_SUC_2.2_Portfolio profiling & analytics
- HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading
- HL-UC 7_SUC_2.4_Billing services
- HL-UC 7_SUC_2.5_Energy cost management and optimization
- HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control
- HL-UC 7_SUC_2.7_Manual DSM strategies activation
- HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring
- HL-UC 7_SUC_3.2_Social network collaboration and comparison with peers
- HL-UC 7_SUC_3.3_Participation in DR programs
- HL-UC 7_SUC_3.4_Residential net metering & self-consumption

8.4.3 Preliminary deployment and demonstration plan

- Month 14 – Month 19: analysis of the necessary technical data, existing systems and components involved in the demonstration. Additionally, the required adaptation for the efficient demonstration of the project solutions will be identified and a planning of the integration and deployment activities will be provided.
- Month 19 – Month 24: lab testing of the WiseGRID ecosystem in an integrated environment in laboratory conditions, as well as through simulations.
- Month 20 – Month 25: complete plan and timeline of the specific and detailed demonstration activities considering on one hand the technical analysis done in WP14 and on the other the use cases, business models and legal, social and ethics aspects analyzed in SP1 for the pilot site "Mesogia".
- Month 22 – Month 26: preliminary deployment of the WiseGRID integrated ecosystem demonstrated in Mesogia including a core set of critical functionalities in real environment and data gathering during the demonstration activities.
- Month 26 – Month 30: preliminary demonstration of the WiseGRID complete and integrated solutions in the real environment of the Mesogia pilot site including the data gathering during the demonstration activities.
- Month 27 – Month 30: final deployment of the WiseGRID integrated ecosystem demonstrated in Mesogia including the full set of functionalities in real environment and data gathering during the demonstration activities.
- Month 30 – Month 40: final large scale demonstration of the WiseGRID complete and integrated solutions in the real environment of the Mesogia pilot site including the data gathering during the demonstration activities.

8.4.4 Potential barriers

Potential barrier in the deployment of WiseGRID tools and the implementation of the Use Cases are the following:

- Certifications:

Any equipment installed by HEDNO should follow specific standards (not only CE certification). If the equipment is installed after the electricity meter (towards the user's installation), the only certification needed is CE.

- Smart meters:

  The smart meters tender has not been completed yet, so the initially considered smart meters are not in place. However, this is going to be mitigated by using smart meters already developed in previous pilot projects and installing them in Mesogia pilot site.

- The safety and operation of the Distribution Grid can not be hindered during or by the demonstration of the WG Cockpit.

- Data privacy and security for the participants:

  It is mandatory to anonymize all data. The user's name should not be known to the partners.

- Participation and engagement of end-users:

  In order to extract reliable results and a representative outcome from the deployment and demonstation of WG tools, a significant number of users should not only aggree to participate, but also to engage with the project, actively use the proposed tools and give feedback on them. In order to mitigate this, adequate incentives should be found, which will make it easier, more interesting and profitable for the users to participate.

- Lack of regulatory framework regarding storage technologies:

  This can be mitigated, since this is a pilot project through which several storage technologies and their integration in grid operations could be tested and used for further development of the framework.

- Lack of aggregators or cooperatives in Mesogia area, which is the main customer segment targeted by WiseCOOP.

- System Communications: In 2015, there was no ability of data exchange between DMS and AMI. The existence of such a communication system will facilitate the integration of smart grid functionalities in Greece as it will enable DMS to implement various controls to grid's components and have knowledge of the whole system's operation. For example, it is obvious, that in order for a VPP to provide ancillary services to the DSO knowledge of metering data by DMS is required.

8.5 KYTHNOS

8.5.1 Pilot site description

The demonstration area of the current pilot site corresponds to the electrical system of Kythnos, a Greek island and municipality in the Western Cyclades with a population of 1,632 people. Kythnos is not interconnected either to the mainland grid or to any other neighboring islands' electricity grids; hence Kythnos Island's electrical system constitutes a single-island insular system.

8.5.1.1 Infrastructure

The electricity mix of Kythnos Island is dominated by diesel and fuel oil. More specifically, regarding the conventional electricity generation on Kythnos Island, there is the local power station, constructed by Public Power Corporation S.A. in 1964. It is located in the area between Chora and Loutra, and at a distance of 2 km from Chora (Figure 80). The power station consists of four (4) MWM generating sets of 0,53 MW rated power each, two (2) MITSUBISHI generating sets of 1.275 MW rated power each and one (1) MITSUBISHI generating set of 1.250 MW rated power. The technical characteristics of the power station are given in more detail in Table 23.

The electricity generated by the available conventional power station, as described above, is distributed through medium voltage lines of 15kV; namely lines P-21, P-22, P-23. Figure 81 shows an overview of Kythnos' medium voltage transmission grid. Line P-22 powers the regions of Chora and Loutra, line P-21 powers the regions of Dryopida and Merichas, and line P-23 powers the region of Kanala and other coastal settlements. Table 24 gives some of the grid characteristics. The electricity is delivered to the consumers (Kythnos Island's population) via low voltage distribution lines. This electrical grid is used for covering the island's electricity demand.

Figure 80 – Conventional power station location

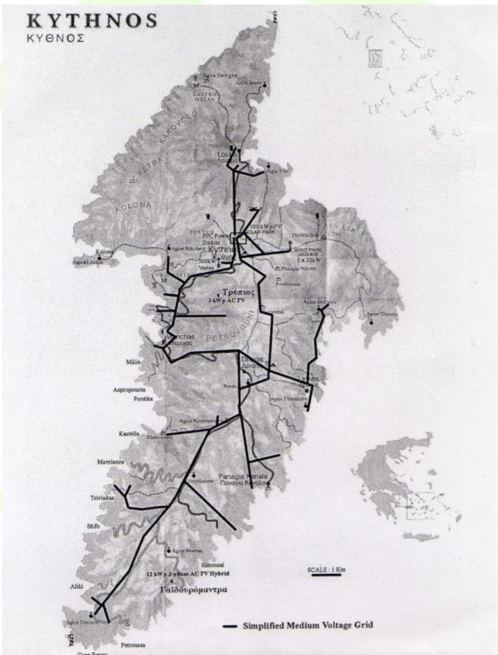


Figure 81 – Kythnos Island MV distribution grid

Table 23 – Conventional power station technical characteristics

UNIT	FUEL	VOLTAGE (kV)	CONVENTIONAL UNITS CAPACITY (kW)					
			RATED POWER	MAXIMUM GENERATED (gross)	MAXIMUM GENERATED IN SUMMER (gross)	MAXIMUM GENERATED IN SUMMER (net)	Tech. Min (MW)	Merit Order
MWM TBD603V12	DIESEL	0,4	530	400	400	386	0,265	3A
MWM TBD603V12	DIESEL	0,4	530	400	400	386	0,265	3B
MWM TBD603V12	DIESEL	0,4	530	400	400	386	0,265	3C
MWM TBD603V12	DIESEL	0,4	530	400	400	386	0,265	3D
MITSUBISHI S16R-PTA	DIESEL	0,4	1.275	1.275	1.122	1.083	0,600	1A
MITSUBISHI S16R-PTA	DIESEL	0,4	1.275	1.275	1.122	1.083	0,600	1B
MITSUBISHI	DIESEL	0,4	1.250	1.250	1.122	1.083	0,600	2

Table 24 – Characteristics of medium voltage distribution grid

LINE	MAXIMUM LOAD IN 2011 (A)	MINIMUM LOAD IN 2011 (A)	NUMBER OF SUBSTATIONS MEDIUM VOLTAGE/LOW VOLTAGE	TOTAL INSTALLED CAPACITY (kVA)	LINES LENGTH (km)	UNDERGROUND LINES LENGTH (km)	TOTAL GRID LINES LENGTH (km)	WIND STATION INSTALLED CAPACITY (kW)	PV STATION INSTALLED CAPACITY (kW)	PV CONNECTED TO THE GRID (kW)	TOTAL RES CAPACITY INSTALLED (kW)
P-21	58	7	24	3.825	17.6	0,4	18	500	170	0	670
P-22	39	4	23	2.710	15.2	0	15,2	0	100	70	170
P-23	33	2		3.270	44.3	0	44,3	0	70	70	140

In general, the Kythnos power system can be characterized as a small one, since its average peak demand is lower than 5 MW. Figure 82 shows the yearly peak and base load in the last 11 years.

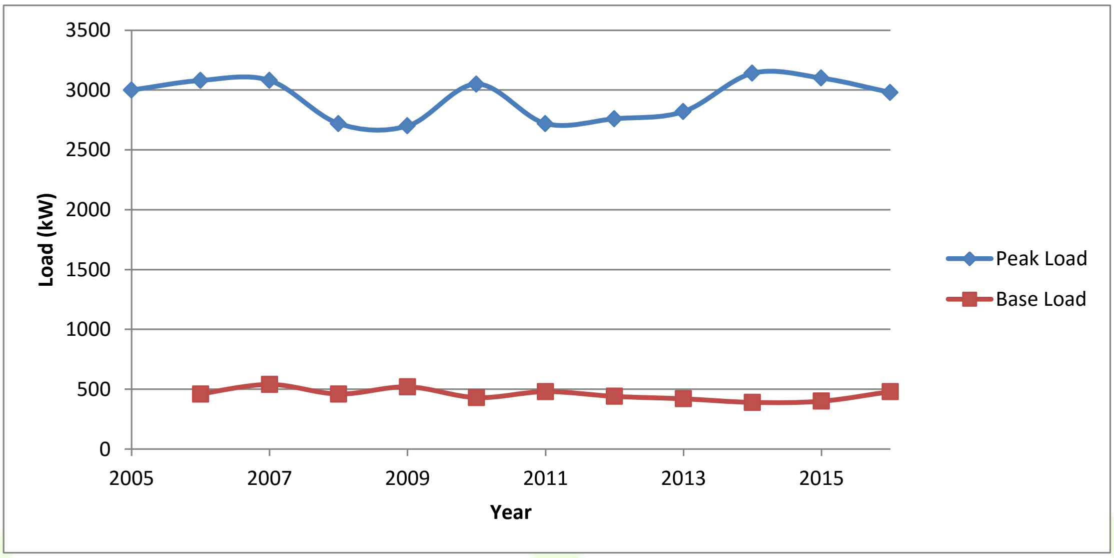


Figure 82 – Peak and base load from 2005 to 2016

Figure 83 presenting the load factor for each year, from 2006 to 2016, gives values of about 30% - 35%. Such low values of the load factor indicate a highly variable load throughout the year – seasonal load variability, which results from the increased electricity demand during the summertime, as it becomes apparent below (Figure 89 and Figure 90).

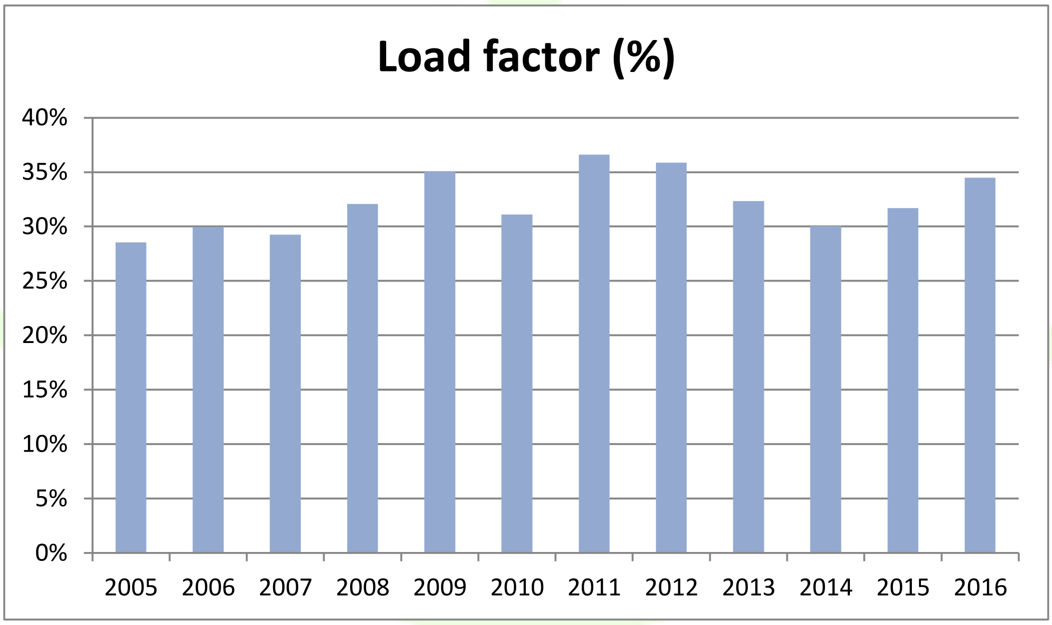


Figure 83 – Annual load factor

The yearly electricity generation is depicted in Figure 84. In the last 3 years, there is a trend of increasing electricity demand.

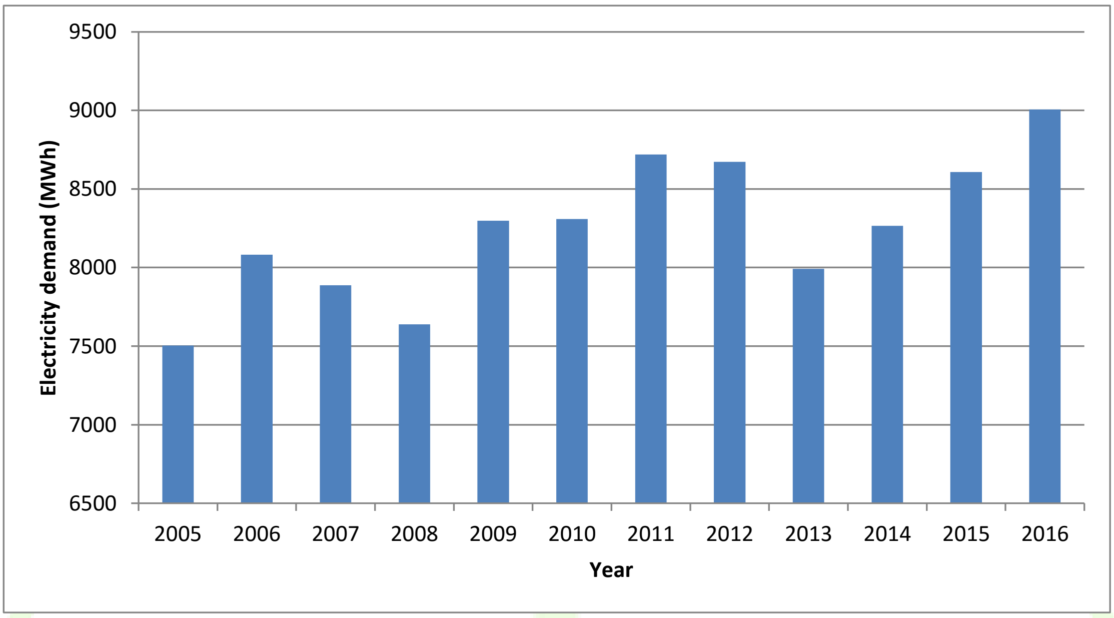


Figure 84 – Electricity demand in the last 11 years

Figure 85, Figure 86, Figure 87 and Figure 88 present the daily energy curve during each season in 2016 for working days and weekends/holidays. During autumn and springtime, contrary to winter and summer time, the electricity demand has higher values during weekends/holidays than during working days. This difference occurs because of two facts; firstly, on Kythnos Island there are not any industries, department stores or many public services, which could increase the demand during working days, and secondly, touristic activity is higher during weekends especially in autumn and spring time, since Kythnos Island is close to Athens and many tourists visit the island for a weekend at that time of the year.

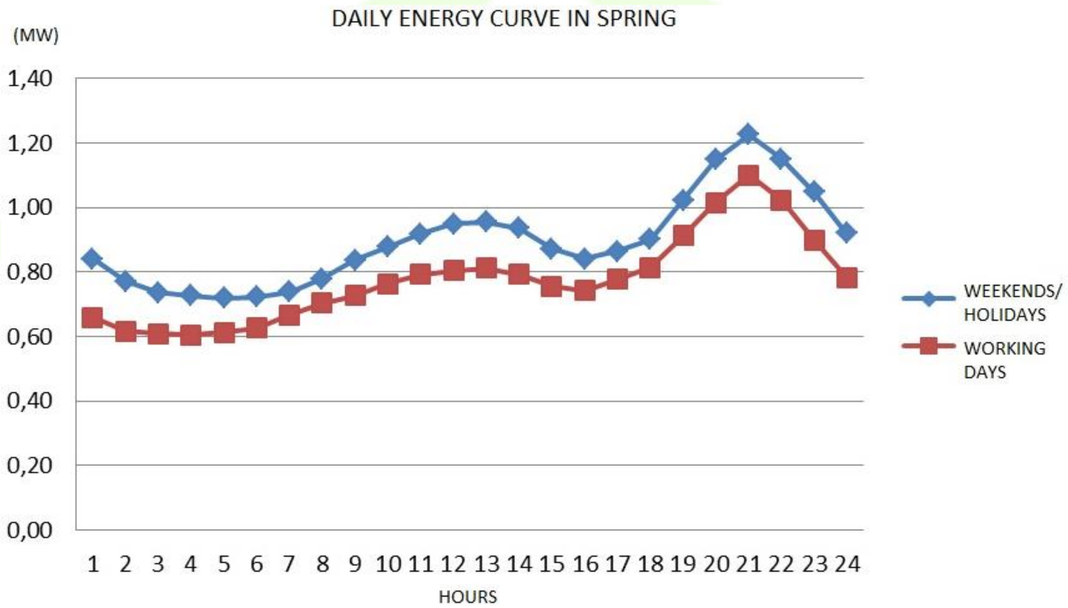


Figure 85 – Daily energy curve in spring

Furthermore, one can notice that in winter and summertime, contrary to autumn and springtime, the daily energy demand curves of working days and weekends/holidays are almost identical. This can be justified because during the winter touristic activity is too low, and in summertime touristic activity is not influenced by working days or weekends/holidays.

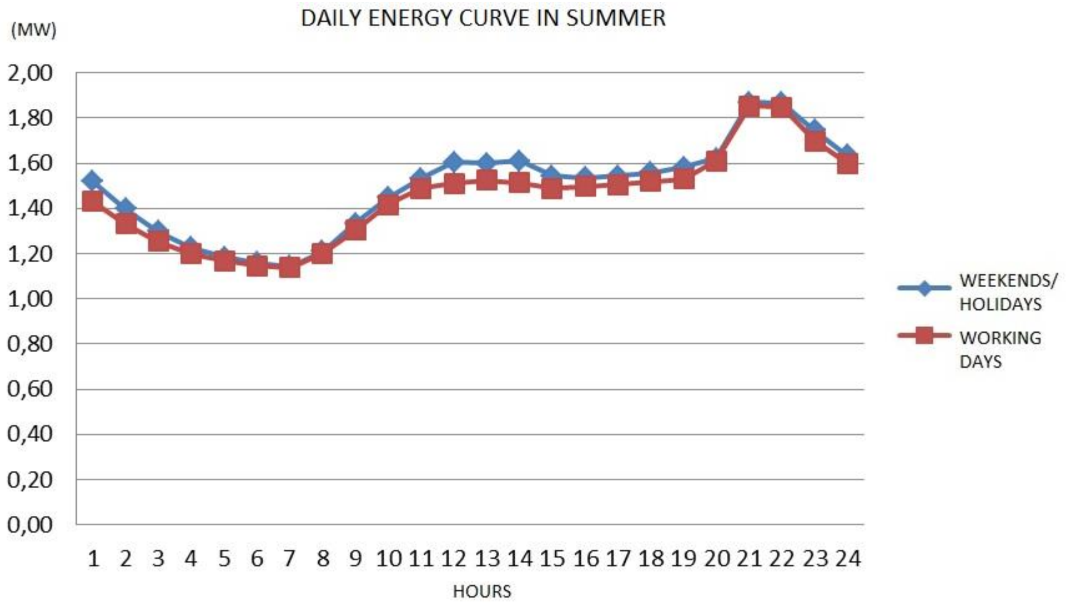


Figure 86 – Daily energy curve in summer

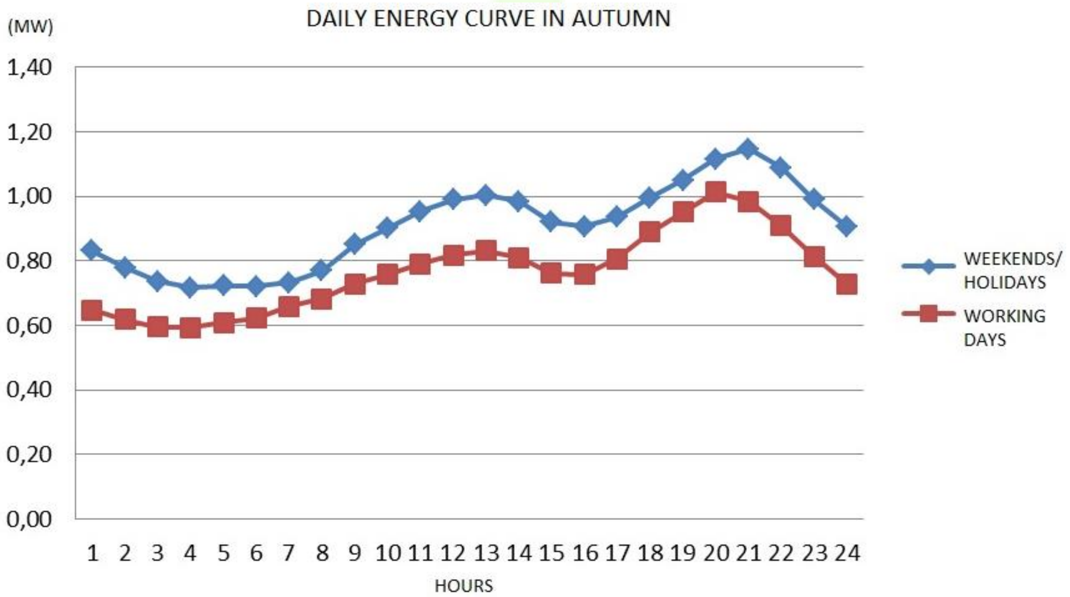


Figure 87 – Daily energy curve in autumn

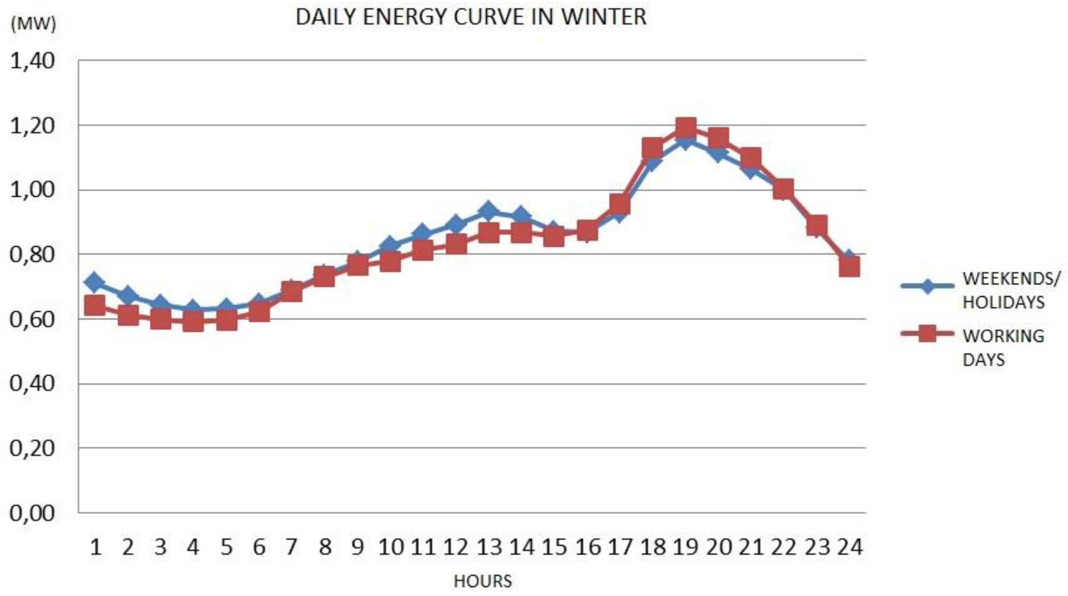


Figure 88 – Daily energy curve in winter

Finally, by grouping curves of Figure 85, Figure 86, Figure 87 and Figure 88 per weekends/holidays (Figure 89) and working days (Figure 90), one can see that the summer touristic activity constitutes the main reason why electricity demand increases on working days as well as during weekends/holidays.

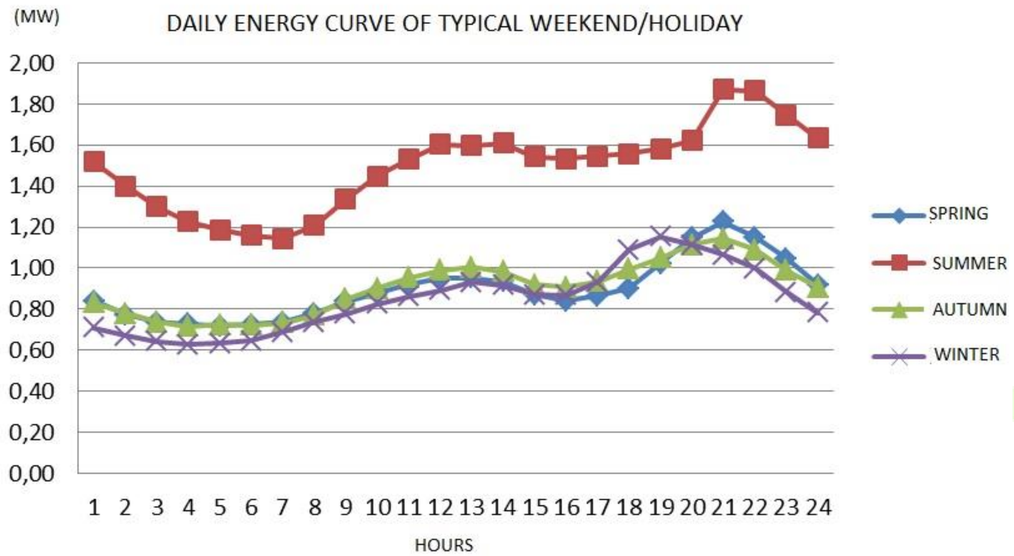


Figure 89 – Daily energy curves of a typical weekend/holiday

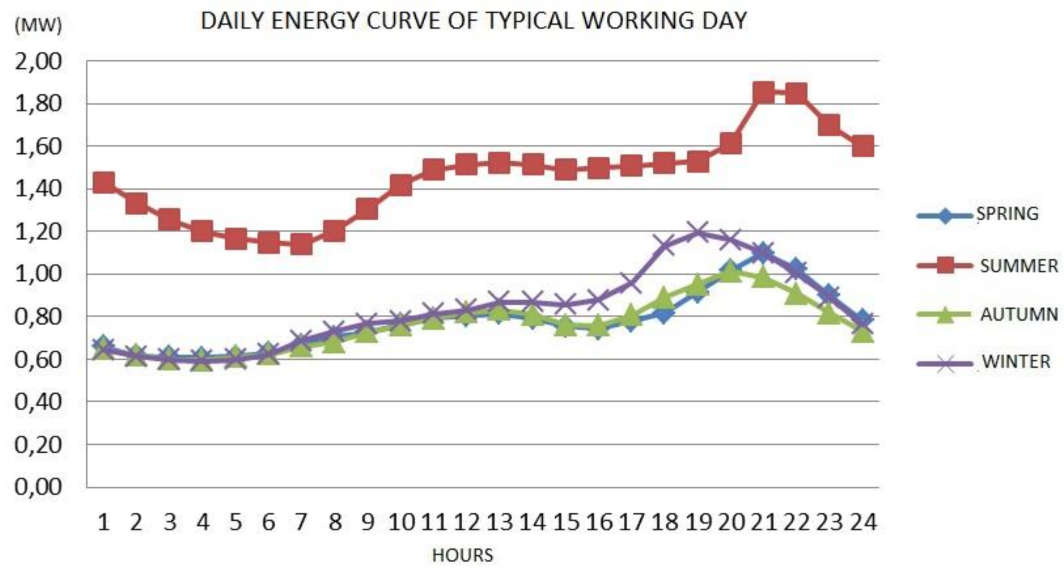


Figure 90 – Daily energy curves of a typical working day

The higher electricity demand during summer is obvious in the typical yearly load profile (Figure 91) as well. There is also a single maximum in April, which represents the touristic activity during Easter. This seasonal load variability and any variability due to non-dispatchable renewable energy should always be balanced out.

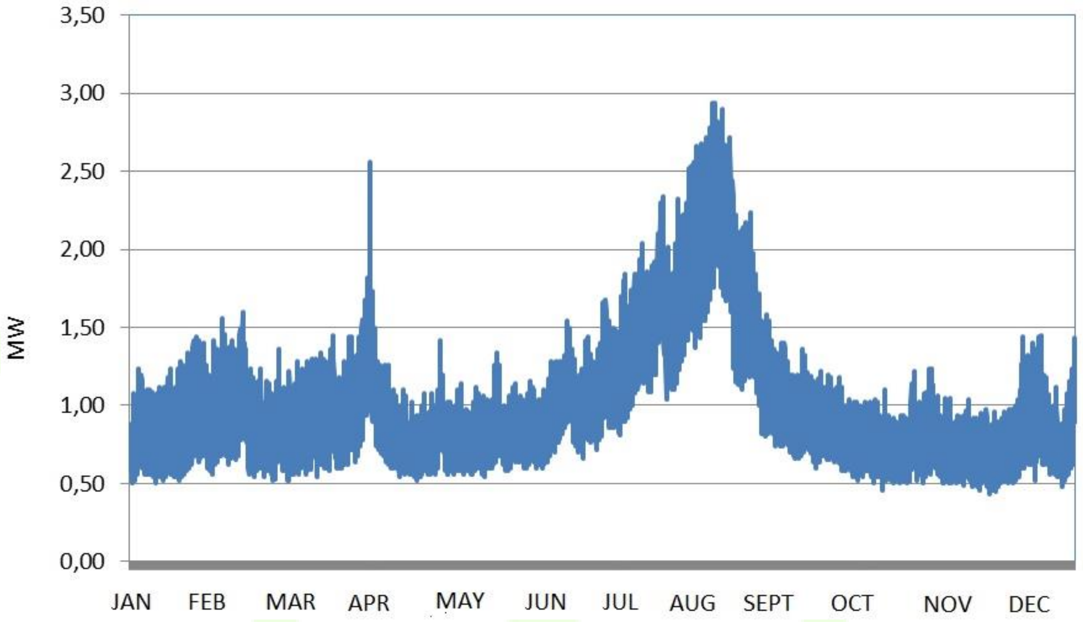


Figure 91 – Typical yearly load profile

The management and operation of Kythnos Island power system as well as the island's electricity market is under the responsibility of Hellenic Electricity Distribution Network Operator (HEDNO). Hence, in addition to its default role as distribution network operator, HEDNO is the island's generation and transmission system operator as well as market operator. HEDNO objective is to ensure security of supply, quality of service, generation cost minimization and maximum RES penetration. Nowadays, there is priority dispatch for the existing solar photovoltaic stations, which are followed by the conventional power station.

Renewables in Kythnos

Thanks to Kythnos Island excellent wind and solar potential, development of RES generation on the island has started since the 80s. Nevertheless, the penetration rate has not shown the same intensity during the years, which justifies the low installed and operating RES capacity on the island nowadays. In particular, regarding the wind stations investments on Kythnos Island, Public Power Corporation Renewables S.A. holds two operation licences of 0,67MW wind stations. In the following table and figure, further details about the licences as well as wind stations locations are provided. Unfortunately, all the wind turbines are currently out of order. The company though is investigating a horizontal repower project for its small wind farms.

Table 25 – Wind stations operation licences

Application Submission Date	Company	RAE Licence Registry	Production Licence Issue Date	Location	Capacity (MW)
05/03/08	Public Power Corporation Renewables S.A.	LN-01144	27/10/08	CHORA	0,165
05/03/08	Public Power Corporation Renewables S.A.	LN-01145	27/10/08	KOUKOUVAGIA	0,50

AΔ-01144 AΔ-01145

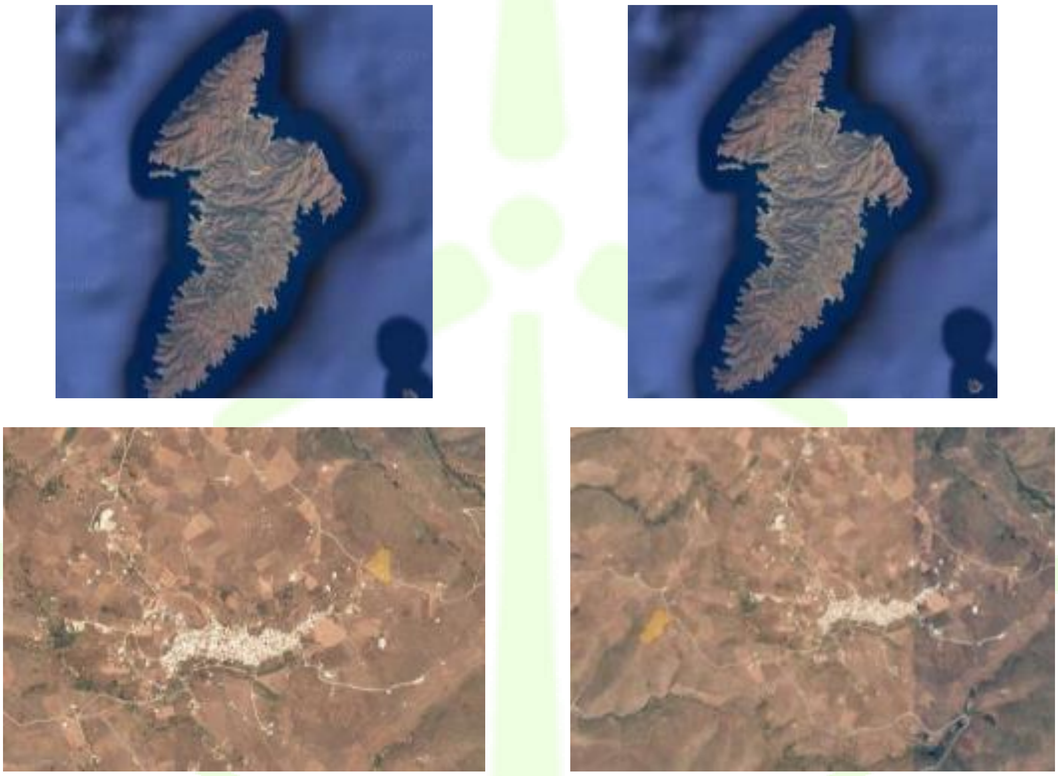


Figure 92 – Wind stations locations

Furthermore, Public Power Corporation Renewables S.A. has submitted an application to obtain a generation licence for wind stations of 1.047 MW total capacity. This investment constitutes a project proposing the installation of 349 Enercon E82 wind turbines in 10 different islands (Table 26 & Figure 93). One of the islands is Kythnos, where 26 of these wind turbines will be installed. The project proposal plans the development of a new separate interconnection to the mainland grid. However, the application has not been evaluated by the Greek Regulatory Authority of Energy (RAE) and does not appear in Public Power Corporation Renewables

S.A. list of future projects.

Table 26 – Application for 1,047 MW wind stations generation licence

Application Submission Date	Company	RAE Licence Registry	Production Licence Issue Date	Location	Capacity (MW)
10/09/13	Public Power Corporation Renewables S.A.	-	-	North-Western peninsula	78 (on Kythnos)

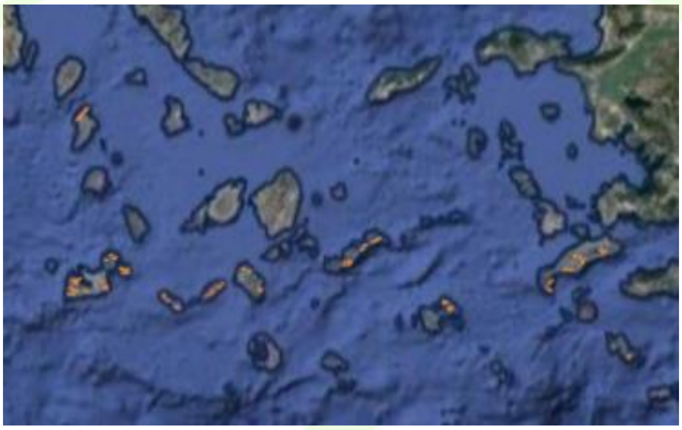


Figure 93 – Locations of 1.047 MW wind stations

Another wind station, owned by Aiolos Kritis S.A., has obtained a generation licence for installing 50MW wind turbines, provided that the licence's owner will develop an interconnection to the mainland grid. Licence's details as well as wind station's location are presented below. Nevertheless, the project has not acquired environmental licences yet and has been through two modifications of the shareholders scheme.

Table 27 – 50MW wind station's licence

Application Submission Date	Company	RAE Licence Registry	Production Licence Issue Date	Location	Capacity (MW)
10/04/09	AIOLOS KRITIS S.A.	ΑΔ-03306	05/12/12	ΑΓ.ΚΩΝΣΤΑΝΤΙΝΟΣ-ΚΑΣΤΕΛΛΑ-ΣΤΥΦΟ	50

Figure 94 – Wind station's location

As far as the solar photovoltaic capacity is concerned, there are three stations of 238,25 kWp installed and fully operating on Kythnos Island (Figure 95). Public Power Corporation Renewables S.A. is the owner of the 98,25 kWp station, while two installations of 70kWp each are owned by other private investors (1. ΓΟΝΙΔΗ Ι. & ΣΙΑ ΕΕ ΜΕ Δ.Τ ΚΥΝΘΙΑΚΗ ΔΥΝΑΜΙΚΗ and 2. TREND ΕΝΕΡΓΕΙΑΚΗ ΜΟΝΟΠΡΟΣΩΠΗ ΕΤΑΙΡΕΙΑ ΠΕΡΙΟΡΙΣΜΕΝΗΣ ΕΥΘΥΝΗΣ). The locations of these solar photovoltaic stations are shown in the following pictures. Despite that the total installed solar photovoltaic capacity is considerable, on Kythnos Island the total available electrical space for photovoltaic installations is 297 kWp, meaning that there is 58,75 kWp remaining capacity for further installations.

Table 28 – Solar photovoltaic stations per programme

PV stations on roofs		PV stations with exemption for production licence		PV stations under net metering compensation	
Applications	Capacity (kW)	In operation	Capacity (kW)	Applications	Capacity (kW)
3	14.735	3	238,25	1	10

PV station PPCR

PV station Other investor 1

PV station Other investor 2

Figure 95 – Solar photovoltaic stations locations

8.5.1.2 Services and applications

HEDNO has launched projects in order to feature technologically advanced infrastructure, improve management capabilities and examine state-of-the-art concepts and technologies. These projects include introduction of automated metering infrastructure for consumers and generators, establishment of Energy Control Centres (ECC), development of IT systems and applications, test-beds for innovative technologies, and management for increased RES integration. These projects go hand in hand with reshaping the generation management, which will consist of optimal units' commitment scheduling in real-time economic dispatch of dispatchable units (conventional units and RES such as hydro, biomass, etc.) and in output curtailments for non-dispatchable units (RES such as wind and PV) with upper-level dispatch command receiving capabilities.

More specifically, a central ECC in Athens and a local ECC on the island are to be established. The central ECC executes the Rolling Day Ahead Scheduling (RDAS). RDAS includes submission of declarations by load representatives and dispatchable generators as well as forecasts about non-dispatchable RES power by HEDNO (system operator) on one day in advance. On the same day, updated forecasts giving the total quantity of available RES energy to be dispatched or hourly generation schedules are submitted. In this way, an initial commitment schedule for the system's dispatchable generating units is determined while RES power units enjoy priority dispatch. These results are to be sent to local ECC and market participants.

Besides executing RDAS, the central ECC has the responsibility of billing functions taking place on monthly or annual cycle, data transferring between metering collection/validation system and IT system, and analysis and application tools, such as load flow, contingency analysis, etc.

The local ECC conducts the Dispatch Scheduling (DS) and Real Time Dispatch (RTD). Inputs of DS include RDAS results, short-term results, SCADA data, actual availability and operating status of all generation units as well as reserve requirements. This results in DS determining the final conventional units' commitment and initial output at a time closer to actual operation. Then, the latest DS results, or in other words the most recent generation units' commitment schedules are used as input for the RTD execution. RTD optimizes load dispatch taking into consideration the actual commitment status of generation units and existing system conditions, while meeting operating reserve requirements.

The local ECC on the island is also responsible for the AGC (Automatic Generation Control) system and SCADA functionality, which feed DS and RTD inputs.

The above described generation management aims to operation security, maximization of RES energy absorption, minimization of conventional units operating costs, as well as objectivity and transparency for the final customers.

8.5.2 WiseGRID in Kythnos

In Kythnos, an integrated management system that combines EVs, DR (public buildings), critical infrastructure (port, desalination unit) and grid management will be demonstrated. The goal is to demonstrate that the combination of these systems leads to a more efficient and economic operation of the system with minimised RES curtailment.

The scenarios that will be demonstrated are:

- Increase RES penetration: the operation of a non-interconnected system with high RES penetration is very complicated since it is a weak system. Usually, this leads to significant RES curtailment. In Kythnos, when the wind turbine was operating, a significant portion of the produced energy was curtailed. In view of repowering the wind station, the decrease of this curtailment can provide additional motives to the RES producer to invest. The goal is to demonstrate that WiseGRID tools may contribute in the reduction of curtailment and the increase of RES penetration in the electrical system.

- Energy efficiency: The thermal production is based on units powered by light diesel, thus the variable cost of the island is very high. The goal is to test innovative services, solutions and policies that will allow the reduction of production cost and increase the electrical system's energy efficiency.
- Integration of critical infrastructure: The desalination unit and the port (the ability to provide electricity to docked ships will be simulated) are critical infrastructure for the island and they have special characteristics and power requirements. The goal is to demonstrate the integration of such infrastructure in the system management.

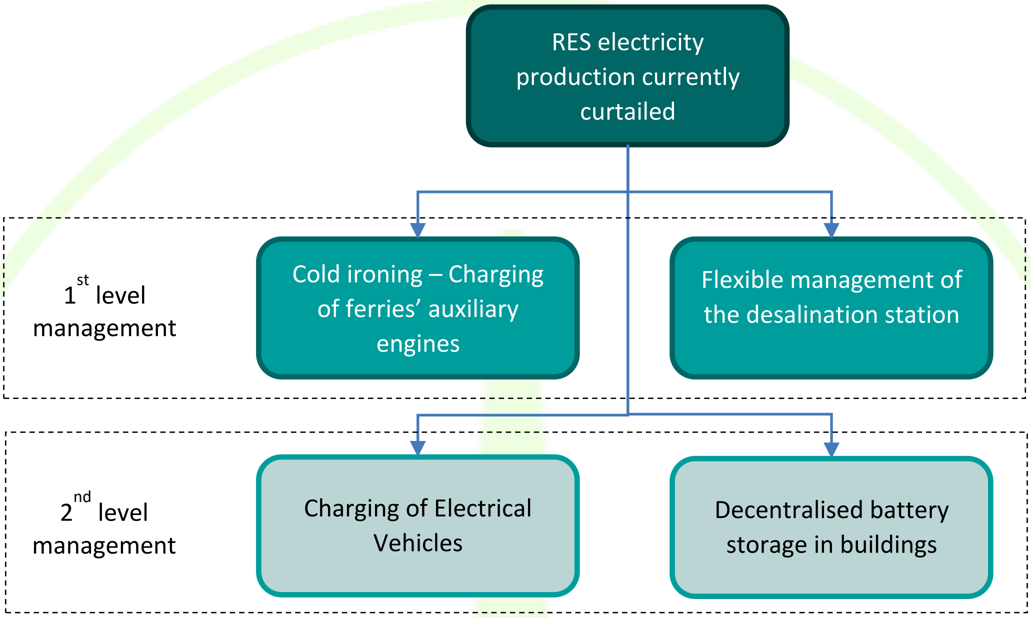


Figure 96 – Demonstration scenarios for reducing RES production curtailment in the pilot site of Kythnos

8.5.2.1 WiseGRID tools and technologies

The use of the different WiseGRID tools and technologies for the specific conditions of the Kythnos pilot site are presented.

- WG Cockpit

  WG Cockpit tool will be the main backbone tool to allow HEDNO manage the Kythnos electrical system with more flexibility which will potentially lead to a more efficient and economic operation of the system with minimised RES curtailment. More specifically it will allow the management and forecasting of the different critical infrastructure loads (desalination and cold ironing) and RES production but also the communication and management of decentralised storage and loads (EVs and battery storage in buildings). Furthermore, it will enable the more efficient grid operation through real-time distribution system awareness and monitoring and integration of grid control services.

- WiseCORP

  WiseCORP tool will be marginally used in the Kythnos pilot site mainly for providing the building managers with the essential information to support the efficient and smart operation of decentralised battery storage in public buildings. In addition to that it will be used while modelling the potential future operation of cold ironing infrastructure at the port of Kythnos but also as an auxiliary tool when implementing grid operation strategies which require the communication and collaboration between the DSO and load operators.

- WG RESCO

  WG RESCO tool will be used to analyse the potential operation and management of decentralised RES production, potentially coupled with the new storage equipment, by a RESCO which in the pilot phase will be assumed to be the Aegean Energy and Environment Agency.

- WG FastV2G

  WG FastV2G tool is one of the most significant tools for the Kythnos pilot site since it will be used to enable and facilitate the supply of electricity from EVs' batteries to the grid upon demand of the DSO. The V2G technology combined with the electrification of Kythnos' vehicles is expected to be one of the main solutions to reduce RES curtailment in the island's non-interconnected electrical system.

- WG IOP

  WG IOP tool will be used by HEDNO to integrate the rest of the WG tools ensuring the open and interoperable data collection and management of the different loads and RES stations in order to enhance the efficiency of the Kythnos electrical system.

- WG STaaS

  WG STaaS tool will be used as one of the main tools to support the integration and management of decentralised small-scale battery storage in public buildings but also as an auxiliary tool for HL-UC related both to the integration of distributed RES in the grid and to decentralised grid control automation.

In Table 29 the correspondence between the WiseGRID tools and technologies that are expected to be used with the respective PUCs are summarised.

Table 29 – Correspondence of PUCs to WiseGRID tools

PUCs	WG tools and technologies
HL-UC 1_PUC_1_Network monitoring HL-UC 1_PUC_2_Control strategies for reducing RES curtailment HL-UC 1_PUC_3_Voltage support and congestion management HL-UC 1_PUC_4_Grid planning analysis HL-UC 2_PUC_1_Distribution network real-time monitoring HL-UC 2_PUC_2_Real-time distribution system awareness	WG Cockpit
HL-UC 1_PUC_4_Optimize business/industrial facilities energy usage	WiseCORP
HL-UC 1_PUC_5_Promote RES via RESCO companies	WG RESCO
HL-UC 3_PUC_1_EVSE and EV fleet monitoring HL-UC 3_PUC_2_Interaction of the user with EVSE HL-UC 3_PUC_3_EV charging management HL-UC 3_PUC_4_Interaction with the energy infrastructure	WG FastV2G
HL-UC 3_PUC_2_Interaction of the user with EVSE HL-UC 3_PUC_3_EV charging management HL-UC 3_PUC_4_Interaction with the energy infrastructure	WG IOP
HL-UC 4_PUC_1_Batteries management at prosumer level HL-UC 4_PUC_2_Batteries management at aggregator level (grid support) HL-UC 4_PUC_3_Ancillary services HL-UC 4_PUC_4_Combination of battery storage systems	WG STaaS

8.5.2.2 WiseGRID Use Cases

HL-UCs

The Kythnos demo site relates to six (6) out of the seven (7) HL-UC of which the four (4) are highly related to the specific challenges.

<u>High relevance</u>

- HL-UC 1 Distributed res integration in the grid
- HL-UC 2 Decentralized grid control automation
- HL-UC 3 E-mobility integration in the grid with V2G
- HL-UC 4 Battery storage integration at substation and prosumer level

<u>Low relevance</u>

- HL-UC 6 VPP technical and economic feasibility
- HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty

PUCs

The Kythnos demo site relates to twenty three (23) out of the twenty eight (28) PUC, of which the sixteen (16) are highly related to the specific challenges.

<u>High relevance</u>

- HL-UC 1_PUC_1_Network monitoring
- HL-UC 1_PUC_2_Control strategies for reducing RES curtailment
- HL-UC 1_PUC_3_Voltage support and congestion management
- HL-UC 1_PUC_5_Promote RES via RESCO companies
- HL-UC 2_PUC_1_Distribution network real-time monitoring
- HL-UC 2_PUC_2_Real-time distribution system awareness
- HL-UC 2_PUC_3_Grid control
- HL-UC 3_PUC_1_EVSE and EV fleet monitoring
- HL-UC 3_PUC_2_Interaction of the user with EVSE
- HL-UC 3_PUC_3_EV charging management
- HL-UC 3_PUC_4_Interaction with the energy infrastructure
- HL-UC 4_PUC_1_Batteries management at prosumer level
- HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)
- HL-UC 4_PUC_3_Ancillary services
- HL-UC 4_PUC_4_Combination of battery storage systems

<u>Low relevance</u>

- HL-UC 6_PUC_1_VPP monitoring and management
- HL-UC 6_PUC_2_VPP market participation

- HL-UC 6_PUC_3_VPP real-time control
- HL-UC 6_PUC_4_VPP users relationship management
- HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector
- HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market
- HL-UC 7_PUC_3_Clients engagement for active market participation

SUCs

The Kythnos demo site relates to ninety (90) out of the one hundred eight (108) SUC, of which the thirty six (36) are highly and twenty four (24) averagely related to the specific challenges.

High relevance

- HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections
- HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections
- HL-UC 1_SUC_1.3_KPI management
- HL-UC 2_SUC_1.2_Data concentration
- HL-UC 2_SUC_1.3_Monitoring power quality in the grid
- HL-UC 2_SUC_1.5_Asset management
- HL-UC 2_SUC_2.1_RES and load forecasting
- HL-UC 2_SUC_2.4_Load flow calculation
- HL-UC 2_SUC_2.6_Bad data detection, identification and replacement
- HL-UC 2_SUC_3.3_Optimization algorithm
- HL-UC 3_SUC_1.1_Data collection from EVSE
- HL-UC 3_SUC_1.2_Data collection from EVs
- HL-UC 3_SUC_2.1_Users' authentication
- HL-UC 3_SUC_2.2_Charging session request
- HL-UC 3_SUC_2.4_Charging session booking
- HL-UC 3_SUC_3.1_EVSE network configuration
- HL-UC 3_SUC_3.2_EV load forecasting
- HL-UC 3_SUC_3.3_EV flexibility estimation
- HL-UC 3_SUC_3.4_Reference charging load profile calculation
- HL-UC 3_SUC_3.5_Charging session schedule
- HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests
- HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration
- HL-UC 3_SUC_4.3_EV providing V2H services
- HL-UC 4_SUC_1.1_Increase of self-consumption

- HL-UC 4_SUC_1.2_Time-of-use management
- HL-UC 4_SUC_2.1_Batteries dispatch management
- HL-UC 4_SUC_2.2_Black start capabilities
- HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonisation
- HL-UC 4_SUC_2.4_Backup power for residential area
- HL-UC 4_SUC_3.1_Market scheduling
- HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system
- HL-UC 4_SUC_3.3_Batteries automatic dispatch
- HL-UC 4_SUC_4.2_Parameter identification of storage systems
- HL-UC 4_SUC_4.3_Priority list of units running

Average relevance

- HL-UC 1_SUC_1.4_Big data storage analysis
- HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption
- HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means
- HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies
- HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode
- HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)
- HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)
- HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases
- HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance
- HL-UC 1_SUC_5.2_Monitor domestic RES production
- HL-UC 1_SUC_5.3_Monitor domestic clients consumption
- HL-UC 1_SUC_5.4_Manage energy selling
- HL-UC 1_SUC_5.5_Energy cost management
- HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters
- HL-UC 2_SUC_2.2_Topology processor
- HL-UC 2_SUC_2.3_Network observability analysis
- HL-UC 2_SUC_2.5_State estimation
- HL-UC 2_SUC_3.1_Load control
- HL-UC 2_SUC_3.2_DR as a service to the grid
- HL-UC 2_SUC_3.4_Reconfiguration

Low relevance

- HL-UC 6_SUC_1.1_Resource metering
- HL-UC 6_SUC_1.2_VPP RES forecast
- HL-UC 6_SUC_1.3_VPP flexibility forecast

- HL-UC 6_SUC_1.4_Strategies definition
- HL-UC 6_SUC_2.1_VPP market participation and bid calculation
- HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation
- HL-UC 6_SUC_2.3_VPP unit scheduling
- HL-UC 6_SUC_3.1_Real-time flexibility calculation
- HL-UC 6_SUC_3.2_VPP implementation of ancillary services
- HL-UC 6_SUC_3.3_Real-time decision making
- HL-UC 6_SUC_4.1_Manage contractual issues
- HL-UC 6_SUC_4.2_Define and manage member compensation
- HL-UC 6_SUC_4.3_DSM and DR mechanisms
- HL-UC 7_SUC_1.2_Enriched information visualization
- HL-UC 7_SUC_1.3_Integration with DR mechanisms
- HL-UC 7_SUC_1.4_Net metering & self-consumption
- HL-UC 7_SUC_1.5_Energy cost management for large infrastructures
- HL-UC 7_SUC_2.1_Enriched information visualization
- HL-UC 7_SUC_2.2_Portfolio profiling & analytics
- HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading
- HL-UC 7_SUC_2.4_Billing services
- HL-UC 7_SUC_2.5_Energy cost management and optimization
- HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control
- HL-UC 7_SUC_2.7_Manual DSM strategies activation
- HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring
- HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers
- HL-UC 7_SUC_3.3_Participation in DR programs
- HL-UC 7_SUC_3.4_Residential net metering & self-consumption

8.5.3 Preliminary deployment and demonstration plan

- Month 14 – Month 19: analysis of the necessary technical data, existing systems and components involved in the demonstration. Additionally, the required adaptations for the efficient demonstration of the project solutions will be identified and a planning of the integration and deployment activities will be provided.
- Month 19 – Month 24: lab testing of the WiseGRID ecosystem in an integrated environment in laboratory conditions, as well as through simulations.
- Month 20 – Month 25: complete plan and timeline of the specific and detailed demonstration activities considering on one hand the technical analysis done in WP14 and on the other the use cases, business models and legal, social and ethics aspects analyzed in SP1 for the pilot site “Kythnos”.
- Month 22 – Month 26: preliminary deployment of the WiseGRID integrated ecosystem demonstrated in Kythnos including a core set of critical functionalities in real environment and data gathering during the demonstration activities.

* Month 26 – Month 30: preliminary demonstration of the WiseGRID complete and integrated solutions in the real environment of the Kythnos pilot site including the data gathering during the demonstration activities.
* Month 27 – Month 30: final deployment of the WiseGRID integrated ecosystem demonstrated in Kythnos including the full set of functionalities in real environment and data gathering during the demonstration activities.
* Month 30 – Month 40: final large scale demonstration of the WiseGRID complete and integrated solutions in the real environment of the Kythnos pilot site including the data gathering during the demonstration activities.

8.5.4 Potential barriers

* The intermittent RES stations (625 kW wind stations) are currently not in operation. However, there is an ongoing significant effort for repowering, which is expected to be carried out within the next 1-2 years.
* Any equipment installed by HEDNO should follow specific standards (not only CE certification). If the equipment will be installed after the electricity meter, the only certification needed is CE.
* The smart meters tender has not been completed yet, so the initially considered smart meters are not in place. However, this is going to be mitigated by using smart meters already developed in previous projects or installed in a previous stage of other pilot project in Kythnos.
* The safety and operation of the Distribution Grid cannot be hindered during or by the demonstration of the WG Cockpit.
* Data privacy and security for the participants. It is mandatory to anonymize all data. The user name should not be known to the partners.
* In order to extract reliable results and a representative outcome from the deployment and demonstration of WG tools, a significant number of user should not only agree to participate, but also to engage with the project, actively use the proposed tools and give feedback on them. In order to mitigate this, adequate incentives should be provided.
* Lack of regulatory framework regarding storage technologies. This can be mitigated, since this is a pilot project through which several storage technologies and their integration in grid operations could be tested and used for further development of the framework.
* Lack of aggregators or energy cooperatives currently in Kythnos, which is the main customer segment targeted by WiseCOOP. However, there is an ongoing discussion regarding the potential of establishing such an entity on the island.

9 KPIs

Following the methodology described in section 3.3, 52 KPIs are defined (Table 30 and ANNEX E). 16 of them belong in the "specific" category, while the rest of them are defined according to the WiseGRID project needs and are, therefore, categorized as "project" KPIs. Furthermore, the relevance of each KPI in quantifying the WiseGRID project impacts is identified either as direct or as indirect (i.e. the improvement observed in a KPI with direct relevance can be attributed directly to the solutions proposed within the Project), resulting in 34 KPIs that measure the direct impact of the WiseGRID solutions and 18 KPIs that measure the indirect impact. Last but not least, even though each KPIs is defined only once, there may be identified more than one PUCs to which a KPI is relevant.

Table 30 – KPIs inventory

KPI ID	KPI name	KPI category	Project relevance	Related PUC(s)
1	Increased RES and DER hosting capacity	Specific (B.1)	Direct	HL-UC 1_PUC_5
2	RES curtailment	Specific (B.2)	Direct	HL-UC 1_PUC_2, HL-UC 2_PUC_3, HL-UC 3_PUC_4, HL-UC 7_PUC_2
3	SAIDI	Specific (B.3)	Direct	HL-UC 2_PUC_1, HL-UC 4_PUC_2
4	SAIFI	Specific (B.3)	Direct	HL-UC 2_PUC_1
5	CAIDI	Specific (B.3)	Direct	HL-UC 2_PUC_1
6	CAIFI	Specific (B.3)	Direct	HL-UC 2_PUC_1
7	LV faults clearance time	Specific (B.3)	Direct	HL-UC 2_PUC_1
8	Voltage variation	Specific (B.3)	Direct	HL-UC 1_PUC_3, HL-UC 2_PUC_3, HL-UC 4_PUC_2
9	Frequency deviation	Specific (B.3)	Indirect	HL-UC 4_PUC_3
10	State estimation performance evaluation	Specific (B.3)	Indirect	HL-UC 2_PUC_2
11	Extended asset life time	Specific (B.4)	Direct	HL-UC 1_PUC_4
12	VPP participation in flexibility requests	Specific (B.5)	Direct	HL-UC 6_PUC_3
13	Increased EV demand flexibility availability	Specific (B.5)	Direct	HL-UC 3_PUC_2
14	Increased demand flexibility execution	Specific (B.5)	Direct	HL-UC 3_PUC_4
15	Active participation in EV demand flexibility	Specific (B.5)	Direct	HL-UC 3_PUC_2
16	Improved competitiveness of the electricity market	Specific (B.6)	Direct	HL-UC 6_PUC_2
17	Ancillary services cost	Project	Direct	HL-UC 4_PUC_3
18	Load forecasting accuracy	Project	Indirect	HL-UC 2_PUC_2
19	Support the distribution grid using cogeneration	Project	Direct	HL-UC 5_PUC_4
20	System awareness total time latency	Project	Indirect	HL-UC 2_PUC_2
21	Measurements redundancy	Project	Indirect	HL-UC 2_PUC_2
22	State estimation convergence	Project	Indirect	HL-UC 2_PUC_2

KPI ID	KPI name	KPI category	Project relevance	Related PUC(s)
23	Data validation ratio	Project	Indirect	HL-UC 2_PUC_1
24	Assets data collection reliability	Project	Indirect	HL-UC 3_PUC_1, HL-UC 6_PUC_1
25	Technical losses	Project	Direct	HL-UC 2_PUC_3
26	Energy generation capability per investment ratio	Project	Direct	HL-UC 1_PUC_5
27	Network RES visibility	Project	Indirect	HL-UC 1_PUC_1, HL-UC 2_PUC_1
28	GHG emissions	Project	Direct	HL-UC 3_PUC_4, HL-UC 7_PUC_1, HL-UC 7_PUC_3
29	Flexibility forecasting accuracy	Project	Indirect	HL-UC 6_PUC_3
30	VPP participation in voltage control requests	Project	Direct	HL-UC 6_PUC_3
31	Supplier portfolio imbalance	Project	Direct	HL-UC 7_PUC_2
32	EVSE data collection reliability	Project	Indirect	HL-UC 3_PUC_1
33	EVSE availability index	Project	Indirect	HL-UC 3_PUC_1
34	EVSE average communication failure duration	Project	Indirect	HL-UC 3_PUC_1
35	EVSE average communication failure frequency	Project	Indirect	HL-UC 3_PUC_1
36	Success in meeting user charging objectives	Project	Direct	HL-UC 3_PUC_2
37	Sucess in user authentication	Project	Indirect	HL-UC 3_PUC_2
38	Success in charging rescheduling	Project	Direct	HL-UC 3_PUC_3
39	Battery balance	Project	Direct	HL-UC 4_PUC_4
40	Reaction time improvement for providing primary control reserve	Project	Indirect	HL-UC 4_PUC_3
41	Penetration of dynamic energy tariffs	Project	Direct	HL-UC 7_PUC_1, HL-UC 7_PUC_3
42	Demand response campaign penetration	Project	Direct	HL-UC 7_PUC_1, HL-UC 7_PUC_3
43	Peak load	Project	Direct	HL-UC 4_PUC_2, HL-UC 7_PUC_2
44	Peak to average ratio	Project	Direct	HL-UC 2_PUC_3, HL-UC 7_PUC_1, HL-UC 7_PUC_3
45	Net metering	Project	Direct	HL-UC 7_PUC_1, HL-UC 7_PUC_2
46	Self-consumption ratio	Project	Direct	HL-UC 1_PUC_5, HL-UC 4_PUC_1, HL-UC 7_PUC_2
47	Self-sufficiency	Project	Direct	HL-UC 4_PUC_1
48	Energy cost	Project	Direct	HL-UC 3_PUC_3, HL-UC 4_PUC_1, HL-UC 4_PUC_2, HL-UC 7_PUC_1, HL-UC 7_PUC_3

KPI ID	KPI name	KPI category	Project relevance	Related PUC(s)
49	Energy savings	Project	Direct	HL-UC 5_PUC_2, HL-UC 7_PUC_1, HL-UC 7_PUC_3
50	Flexibility on offer	Project	Direct	HL-UC 7_PUC_2
51	Comfort level	Project	Indirect	HL-UC 5_PUC_4
52	Optimal use of thermal resources	Project	Indirect	HL-UC 5_PUC_4

10 CONCLUSIONS

The present report documents the results of the combined efforts of the partners of WiseGRID project within WP2 WiseGRID Use cases, requirements and KPIs definition. Being part of the fundamental work performed under Sub-Project 1, WP2 elaborates on various aspects of the project architecture with a special focus on the demonstration activities in the pilot sites. The systematic and disciplined identification of the issues and challenges, which are expected to be encountered during the process, forms the basis of the successful integration of smart grid technologies and solutions proposed within WiseGRID. Thus, all tasks relevant to development, deployment and impact assessment are greatly facilitated. Additionally, by putting to use established methodologies, it is made possible to produce content of high quality on which the subsequent WPs can capitalize to a maximum degree, while allowing the identification – at an early stage – of the opportunities offered by the fact that a diversified set of partners contributed either directly (as authors) or indirectly (as reviewers and validators) as well as of potential barriers, giving enough time to tackle them.

Having as guide the needs of the distribution grid users, WiseGRID will develop nine technological solutions in the form of the WiseGRID tools: WG IOP (a scalable, secure and open ICT platform, with interoperable interfaces, supporting the effective operation of the energy network); WG Cockpit (for controling, managing and monitoring the distribution grid); WG StaaS/VPP (a technological solution targeted towards aggregators with a portfolio based on distributed generation and storage); WiseCOOP (a solution supporting consumers and prosumers in their roles of energy retailers, local communities and cooperatives); WG RESCO (a solution addressed to RESCOs for providing RES services to end-users); WiseHOME (an interface with the residential electricity consumer or prosumer); WiseCORP (a technological solution targeting businesses, industries, ESCOs and public facility consumers and prosumers for energy usage monitoring and analysis); WiseEVP (a technological solution for vehicle sharing companies or EV fleet managers and EV infrastructure operators); and WG FastV2G (EV charging station solution that enables using EVs as dynamic distributed storage devices).

The first step for producing technological solutions of high value for the end-users – be them physical entities, e.g. prosumers, EV users, or institutions and organizations, e.g. DSO, EV fleet manager, VPP Operator – is the proper definition of the requirements (functional, operational, legal, etc.) to which each WG product must conform. To this end, the Volere methodology has been employed and a corroborative, iterative process has been followed. 5 rounds of requirements definition, validation and revision have been successfully completed, with all partners contributing in the process using their own technical expertise. As a result, 385 requirements have been identified in total, each one intended to describe specific characteristics of the WG tools. Apart from the description and type of the requirement, specific acceptance criteria have been described, while, keeping a realistic view of the matter, a priority is assigned to each requirement referring to the development process of each WG tool.

Moving on to the demonstration activities, the various situations where the WG tools will prove to be significantly advantageous both for the users of the distribution grid, as well as for the DSO are described through 129 UCs (27 PUCs and 102 SUCs). These are categorized under seven HL-UCs each one directed towards a different aspect of the distribution grid. *HL-UC 1 Distributed RES integration in the grid* addresses the optimal integration of intermittent RES units to the grid, both from operational side and from business side. *HL-UC 2 Decentralized grid control automation* describes situations relevant to the activities of the DSO, who is responsible for ensuring the smooth operation of the distribution grid and for facilitating optimal integration of various resources. *HL-UC 3 E-mobility integration in the grid with V2G* tackles one of the main challenges of today's and future's distribution grid: the integration of EVs as active resources. *HL-UC 4 Battery storage integration at substation and prosumer level* refers to the efficient management of battery storage units as resources offering new types of services to the grid. *HL-UC 5 Cogeneration integration in public buildings/housing* addresses the monitoring and management of the thermal resources within the distribution grid. *HL-UC 6 VPP technical and economic feasibility* gives a holistic description of the monitoring and management of VPPs as well as of the participation of VPPs in the market procedures. *HL-UC 7 Citizens empowerment in energy market and reduction of energy poverty* is directed towards the consumer side and the application of DR strategies that are beneficial both for the end-user as well as for the distribution grid at large.

Building up on the seven HL-UCs, four scenarios are formulated, each one tackling a different objective set within WiseGRID. Thus, *Scenario 1 Innovative and advanced demand-response mechanisms* explores the application of DR strategies by Aggregators, Suppliers and VPP Operators with a view to achieve enhanced user acceptance, while, at the same time, portfolio optimization is possible as well as provision of services to the Grid and Market Operators. *Scenario 2 Smartening of the distribution grid* addresses the seamless and reliable operation of the distribution grid in the presence of DERs, VPPs abd increased penetration of RES. *Scenario 3 Integration of renewable energy storage systems in the network* focuses on the use of energy storage systems for managing and balancing optimally the network, be them battery storage systems, EVs, or buildings acting as thermal storage units. *Scenario 4 Smart integration of electric mobility services* is targeted towards the integration of EVs and the charging infrastructure in the network as well as the provision of flexibility while respecting user preferences.

These scenarios and UCs will be used as a basis for the demonstration activities to be performed in the five pilot sites. Within the pilot site formal analysis, apart from the current situation and the existing infrastructure, potential barriers have been identified. Furthermore, given the capabilitities, the individual characteristics as well as the various possibilities offered by each pilot site, the UCs – and by extension the scenarios – have been mapped, resulting in having all five pilot sites declaring intention to implement – to a greater or smaller degree – all four scenarios.

Last but not least, impact assessment and up-scaling of the findings of the Project require tangible evidence. Following the GRID+ methodology as set out by EEGI, 52 KPIs have been defined. Each one of the KPIs is intended to quantify the results of the application of the proposed solutions and UCs (possible more than one) to the five pilot sites, thus achieving a pragmatic view of the results and achievements of the WiseGRID project.

11 REFERENCES AND ACRONYMS

11.1 REFERENCES

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11.2 ACRONYMS

Acronyms List	
ACER	Agency for the Cooperation of Energy Regulators
ACF	Autocorrelation Function
ADR	Automated Demand Response
ADSL	Asymmetric Digital Subscriber Line
AGC	Automatic Generation Control
AMI	Advanced Metering Infrastructure
AMR	Automatic Meter Reading
API	Application Programming Interface
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business As Usual
BoEU	Blocks of Energy Units
BRP	Balance Responsible Party
CAIDI	Customer Average Interruption Duration Index
CAIFI	Customer Average Interruption Frequency Index
CAPEX	Capital Expenditures
CCS	Central Control Systems
CE	Conformité Européene
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Électrotechnique
CHP	Combined Heat and Power
CIM	Common Information Model
CIS	Customer Information System

Acronyms List	
DER	Distributed Energy Resources
DG	Distributed Generation
DHW	Domestic Hot Water
DMS	Distribution Management System
DR	Demand Response
DS	Dispatch Scheduling
DSM	Demand-Side Management
DSO	Distribution System Operator
DSS	Decision Support System
ECC	Energy Control Centre
EEGI	European Electricity Grid Initiative
ERP	Enterprise Resource Planning
ESCO	Energy Services Company
ETSI	European Telecommunications Standards Institute
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FPI	Fault Passage Indicators
GHG	Greenhouse Gas
GIS	Geographical Information System
GPRS	General Packet Radio Services
GSM	Groupe Spécial Mobile
GUI	Graphical User Interface
HHI	Herfindahl-Hirschman Index
HL-UC	High-Level Use Case
HMI	Human-Machine Interface
HV	High Voltage
HVAC	Heating, ventilation and air conditioning
IoT	Internet of Things
IP	Internet Protocol
JSON	JavaScript Object Notation
KPI	Key Performance Indicator
LV	Low Voltage
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
MDMS	Meter Data Management System

Acronyms List	
ME	Maximum Error
MV	Medium Voltage
OMS	Outage Management System
OPEX	Operational Expenditures
OSCP	Open Smart Charging Protocol
P2H	Power to Heat
PDC	Phasor Data Concentrator
PLC	Programmable Logic Controller
PMU	Phasor Measurement Unit
PMV	Predicted Mean Vote
PoD	Point of Delivery
PS	Primary Substation
PUC	Primary Use Case
PV	Photovoltaic
R&I	Research and Innovation
RAE	Regulatory Authority for Energy
RBAC	Role-Based Access Control
RDAS	Rolling Day Ahead Scheduling
RES	Renewable Energy Sources
RESCO	Renewable Energy Services Company
ReST	Representational State Transfer
RMSE	Root Mean Squared Error
RTD	Real Time Dispatch
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control And Data Acquisition
SCR	Self-Consumption Ratio
SLA	Service Level Agreement
SMM	Smart Metrology Meter
SMX	Smart Meter eXtension
SoC	State of Charge
SoH	State of Health
SP	Sub-project
SS	Secondary Substation

Acronyms List	
SSR	Self-Sufficiency Ratio
SUC	Secondary Use Case
TSO	Transmission System Operator
UC	Use Case
USM	Unbundled Smart Meter
UTC	Coordinated Universal Time
V2G	Vehicle to Grid
V2H	Vehicle to Home
VPP	Virtual Power Plant
WG	WiseGRID
WP	Work Package

12 ANNEX A – COMPLETE SET OF WISEGRID REQUIREMENTS

In this paragraph, the complete set of the WiseGRID requirements identified within WP2 is presented.

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
AMG_001	Bidirectional communication between DSO and involved energy stakeholders is established.	Advanced models for Smartening the distribution grid	Functional and data requirements		Appropriate hardware/software allowing bidirectional communication is in place.	5		ICCS (Georgina Asimakopoulou)
AMG_002	Contractual agreements between the DSO and the rest of the actors are in place.	Advanced models for Smartening the distribution grid	Legal requirements	The rules for performing the various transactions should be clearly described.	Yes/No	5		ICCS (Georgina Asimakopoulou)
AMG_003	The proprietor of the unit (if different from the DSO) has signed a contract with the DSO that describes the conditions that apply regarding the load control actions.	Advanced models for Smartening the distribution grid	Legal requirements	The technical characteristics (e.g. ramping ability, available capacity) of the unit should be known. Furthermore, the notice, frequency and duration events, remuneration/penalties based on ramping ability and accuracy of the response should be specified.	Yes/No	5		ICCS (Georgina Asimakopoulou)
AMG_004	Reliable calculation of customer response to control signals.	Advanced models for Smartening the distribution grid	Functional and data requirements		A specific methodology for calculating and updating the customer baseline is in place (e.g. use of historical data, if available; establishment of control group).	5		ICCS (Georgina Asimakopoulou)
AMG_005	Characteristics of load control actions (timeframe, triggering events) should be well-established.	Advanced models for Smartening the distribution grid	Legal requirements	The technical characteristics and the constraints of the available resources should be taken into account.	Yes/No	5		ICCS (Georgina Asimakopoulou)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
AMG_006	The resource operator has signed a contract with the DSO that describes the conditions that apply regarding the load control actions	Advanced models for Smartening the distribution grid	Legal requirements	The contract describes in detail the notice, frequency and duration of the events as well as remuneration/penalties for conformance/non-conformance to the control actions.	Yes/No	5		ICCS (Georgina Asimakopoulou)
AMG_007	The Prosumers, EVs and other local energy resources have signed a contract with the resource operator for load control actions.	Advanced models for Smartening the distribution grid	Legal requirements	The contract describes in detail the notice, frequency and duration of the events as well as the remuneration for participation/conformance to control signals and penalties for non-conformance.	Yes/No	5		ICCS (Georgina Asimakopoulou)
AMG_008	Actors portfolio (characteristics) is known.	Advanced models for Smartening the distribution grid	Functional and data requirements	The specific characteristics should be available per actor/customer. These include the technical (capacity, the ramping ability) and economic characteristics per actor/customer.	Yes/No	5		ICCS (Georgina Asimakopoulou)
AMG_009	The optimization algorithm is robust.	Advanced models for Smartening the distribution grid	Functional and data requirements	The optimization algorithm should be able to produce a solution in all cases with only minor exceptions. For these exceptions, a backup plan should be in place (e.g. by using less advanced algorithms).	A minimum threshold (e.g. 90%) of the cases for which the optimization algorithm gives a solution.	5		ICCS (Georgina Asimakopoulou)
AMG_010	The optimization algorithm produces reliable results.	Advanced models for Smartening the distribution grid	Functional and data requirements	Depending on the type of the problem and of the solver used, the status report of the solver should indicate one of the acceptable termination states, while the solution is reached within the pre-specified tolerances.	The optimization terminates normally and produces a feasible solution.	5		ICCS (Georgina Asimakopoulou)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
AMG_011	Adequate amount of pieces of equipment for monitoring the distribution network is installed.	Advanced models for Smartening the distribution grid	Functional and data requirements	The observability analysis is used to determine the minimum number of network points for installing the necessary monitoring equipment.	Yes/No	5		ICCS (Georgina Asimakopoulou)
AMG_012	Regulation allows islanded operation of part of the distribution network.	Advanced models for Smartening the distribution grid	Legal requirements	Operating part of the distribution network in island mode is only possible if so prescribed by the regulatory framework.	Yes/No	3		ICCS (Georgina Asimakopoulou)
ARC_001	The systems designed within WiseGRID must be based on open standards (as much as possible).	Architecture	The scope of the product	Open Standards will allow the smooth integration of external systems	Compatibility Test	4		ICCS (Aris Dimeas)
ARC_002	the WiseGRID products must have appropriate interfaces to work with various systems and securely exchange data with operational facilities	Architecture	The purpose of the product	Establish a secure line between WiseGRID apps and operating facilities and data	Communication establishment in lab testing	5		HEDNO (alexandros karagiannis)
ARC_003	End Users should be grouped by consumption profiles and invited to interact in favour of more energy efficiency	Architecture	Usability and humanity requirements	In order to activate the consumers' interest for energy efficiency, it is better to have peer to peer group	WiseGRID technological solutions consider profiling capabilities	4	To me, the consumers should be invited to have more sober energetic attitudes. In order to achieve this, it is easier to involve consumer by putting them in relations / competition / comparison with people that have similar consumption patterns. The fact that you have a certain number of people in the household, that you are part of a certain type of household is important to achieve relevant grouping of those consumer. It is the clearest	RESC (Stanislas dHerbemont)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
							way to creating communities that then we can bring to be more energy sober. This segmentation should be done by the aggregator (the cooperative) in relationship with the supplier. The purpose of this requirement is to develop the tool in the way that will support this community building orientation. Regarding the products, this proposal concerns mostly WiseCOOP and WiseHOME. But once again this is more of an interlinking principle of the deployment of the WiseGRID ecosystem. We need to be able to create tools that will support the cooperatives and other aggregators to create and sustain communities in their consumers. The next step being to mobilize those communities to save energy.	
ARC_004	WiseGRID System should be designed according principles of modularity, scalability and interoperability	Architecture	Operational requirements	It is about the possibility to build the systems as independent but interoperable blocks. It also means interoperable with not WiseGRID tools. It is also important for the exploitation of project results	The Wise GRID solution must be suitable for market needs in terms of interoperability and scalability	4		ENG (Giusi Caruso)
ARC_005	Strong WiseEVP and WG FastV2G coordination due to the fact that they are using so much common data	Architecture	The scope of the work		An accurate interconnection between these tools.	5		ETRA (Álvaro Nofuentes)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
ARC_006	WiseEVP has a EVSE mgmt. module and a EV fleet mgmt. module	Architecture	The scope of the product	WiseEVP allows management of both charging equipment and EVs, aiming for businesses that own EVSE and EVs, to optimize charging.	WiseEVP functionalities cover the two business approaches	5		PARTA (Joachim Jacob)
DRF_001	WiseHOME should allow the user to choose their own level of automation, including a level transparent to the user where no action is required from his side	Consumer-centric demand response framework	Users of the product	The consumer experience is that the dis-engagement after a few month of utilization of the product make it difficult to run the full deployments, therefore we should strive to make it as easy to use as possible	Demonstration of functionality in app	4		RESC (Stanislas dHerbemont)
DRF_002	The Forecasting module will connect with weather data forecasts in order to estimate the upcoming demand	Consumer-centric demand response framework	The scope of the work		Demonstration of capacity to retrieve relevant data from external sources	4		AMP (Xavier Benavides)
DRF_003	The user needs to be able to configure the electricity tariff, or connect it with some Public API in case of real-time pricing	Consumer-centric demand response framework	Usability and humanity requirements		Demonstration of functionality in app	5		AMP (Xavier Benavides)
DRF_004	Energy Storage should be used in order to provide flexibility to the DR	Consumer-centric demand response framework	The scope of the product		Demonstration of app capability to handle storage and availability of storage devices in pilots sites	5		AMP (Xavier Benavides)
DRF_005	The system should be compatible with others at the project in order to be able to share information	Consumer-centric demand response framework	Naming conventions and definitions		Demonstrated interoperability between WiseGRID tools	5		AMP (Xavier Benavides)
DRF_006	Different types of demand flexibility profiles will be defined as part of the consumer-centric DR	Consumer-centric de-	The scope of the product	Namely comfort-based flex profiles, price-based flex profiles & EV flexibility profiles	Availability of demand flexibility profile model definitions	3		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
	profiling addressing the objectives of the project	mand response framework						
DRF_007	The comfort-based demand flexibility profiles should be designed taking into account remote monitoring (and controllable) of building loads examined in the project	Consumer-centric demand response framework	The scope of the work	Comfort-based demand flexibility profiles at device level	Flexibility models embed consideration of available loads characteristics	5	Models will be tuned to the available pilot assets and their characteristics to improve their applicability	HYP (k.tsatsakis)
DRF_008	As part of comfort-based demand flexibility, we should address comfort profiles associated with the operation of energy-hungry HVAC devices	Consumer-centric demand response framework	The scope of the product	The focus is on HVAC and lighting device modelling as controllable device types	Availability of respective models	4	Final functionality definition and deployment will depend on asset availability at the pilot sites	HYP (k.tsatsakis)
DRF_009	Towards the extraction of visual comfort profiles, information about luminance levels (luminance sensors) under different operational conditions(lighting device status) is required	Consumer-centric demand response framework	Functional and data requirements	Visual profiling by analysing luminescence levels in building premises	Availability of real-time luminance information	5		HYP (k.tsatsakis)
DRF_010	Towards the extraction of thermal comfort profiles, information about thermal context (temperature & humidity sensors) under different operational conditions(HVAC device status) is required	Consumer-centric demand response framework	Functional and data requirements	Data requirements for the extraction of thermal profiles	Availability of real-time indoor temperature & humidity information	5		HYP (k.tsatsakis)
DRF_011	Towards the extraction of HVAC demand flexibility profiles, information about operational conditions (HVAC device status) and HVAC energy consumption is required	Consumer-centric demand response framework	Functional and data requirements	Data requirements for HVAC demand flexibility profiling extraction	Availability of real-time information about the operational mode and energy consumption of energy assets	5		HYP (k.tsatsakis)
DRF_012	Towards the extraction of Lighting demand flexibility profiles, information about operational	Consumer-centric de-	Functional and data requirements	Data requirements for lighting devices demand flexibility profiling extraction	Availability of real-time information about operating model and energy consumption of indoor lighting system	5		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
	conditions (Lighting device status) and energy consumption is required	mand response framework						
DRF_013	The potential of defining comfort-based flexibility profiles for DHW devices should be also examined	Consumer-centric demand response framework	The scope of the product	Taking into account the availability of water heater devices in premises	Decision outcome on whether to include these profiles based on pilot site availability of DHW	3	Monitoring and control of DHW devices (status, water temperature) is required for modelling this device	HYP (k.tsatsakis)
DRF_014	The extraction of comfort-based flexibility profiles should be based on accurate DER models	Consumer-centric demand response framework	The scope of the product	DER modelling is an anchor point for demand flexibility profiling extraction	Availability of DER models	4		HYP (k.tsatsakis)
DRF_015	Towards the extraction of comfort-based demand flexibility profiles, information about energy cost (retailer tariffs) is required	Consumer-centric demand response framework	Functional and data requirements	Data requirements for demand flexibility profiling extraction	Availability of applicable energy cost information (e.g. tariff)	4		HYP (k.tsatsakis)
DRF_016	Comfort-based demand flexibility profiles shall support the implementation of demand shifting strategies (P2H flexibility profiling extraction)	Consumer-centric demand response framework	The scope of the product	P2H (Virtual Energy Storage) exploiting the thermal inertia of HVAC and DHW devices	Demonstration of demand shifting through power-to-heat (e.g. pre-heating)	4	P2H flexibility will also be modelled and profiled, considering operations, comfort preferences and construction characteristics that uniquely define the thermal mass/ inertia properties of a given space to act as virtual energy storage median.	HYP (k.tsatsakis)
DRF_017	Comfort-based flexibility profiles should ensure the minimum of occupants disturbance on building environment	Consumer-centric demand response framework	Functional and data requirements	Flexibility Profiling taking into account comfort boundaries	Profiles should provide the capability for demand shifting/shedding without reducing comfort levels below 90%	4		HYP (k.tsatsakis)
DRF_018	Comfort based Flexibility Profiles should be exploited towards the implementation of automated DR strategies	Consumer-centric de-	The scope of the product	To implement a non-intrusive AutoDR optimization control	Usage of profiles in automated DR control logic	4		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
		mand response framework		logic, building occupant preferences need to be taken into account.				
DRF_019	Price based Flexibility Profiles should be defined, reflecting the enrolment of prosumers on price based DR scenarios	Consumer-centric demand response framework	The scope of the product	Price based Elasticity Profiles for individuals as an outcome of this process	Availability of profile definition	5		HYP (k.tsatsakis)
DRF_020	High-level Demand Elasticity Profiles should be provided in lack of low level information (device level) information	Consumer-centric demand response framework	Functional and data requirements	When no low level data available from premises, extraction of price based elasticity profiles	Availability of profiles	3		HYP (k.tsatsakis)
DRF_021	Towards the extraction of price based flexibility profiles, information about market prices (real-time hourly prices, day-ahead hourly prices, pricing schemes) is required	Consumer-centric demand response framework	Functional and data requirements	Real life tariff schemes will be examined as input parameters of the model	Availability of market prices	4		HYP (k.tsatsakis)
DRF_022	Towards the extraction of price based flexibility profiles, information about external weather conditions should be available	Consumer-centric demand response framework	Functional and data requirements	External weather data required for the analysis	Availability of weather conditions/forecast information	5		HYP (k.tsatsakis)
DRF_023	Towards the extraction of price based flexibility profiles, information about individual consumer consumption is required	Consumer-centric demand response framework	Functional and data requirements	Smart meter consumption data are required for the analysis	Availability of real-time energy consumption information (at the sub-metering level if possible)	5		HYP (k.tsatsakis)
DRF_025	A central data management unit should be responsible for capturing real-time and historical information required for the extraction of the different profiling types	Consumer-centric demand response framework	Functional and data requirements	WiseGRID Big Data Repository to provide access on the data streams required by the profiling engine	Availability of data management unit	5	The central data management layer should handle data streams flowing from the different demand side end-points, The central data management unit should route the data from	HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
							building environment to Applications Layer	
DRF_026	Real-time information required for the extraction of (comfort-based, price based and EV based) Demand Flexibility profiles, should be available in real-time through an automated way	Consumer-centric demand response framework	Functional and data requirements	WiseGRID Interoperable Process to provide access on the different data streams from building GWs (device/sensor level information), smart meter consumption/weather/price data, etc.	WiseCOOP should have access to all needed real-time information through a shared infrastructure that supports information exchange among WG tools and other actors	5	The central data management layer should handle data streams flowing from the different demand side end-points, The central data management unit should route the data from Building environment to Applications Layer in real-time	HYP (k.tsatsakis)
DRF_027	The consumer-centric DR profiling is running as a standalone service calculating the amount of potential flexibility at each demand side end point	Consumer-centric demand response framework	Performance requirements	Continuous calculation of the potential amount of demand flexibility (different types of flexibility defined)	Availability of demand flexibility estimation engine at end-user premises	5		HYP (k.tsatsakis)
DRF_028	An Advanced Flexibility Analysis component should be designed to provide analytics over demand flexibility providing assets (demand, VES & Electric Vehicles)	Consumer-centric demand response framework	The scope of the product	Analytics over demand flexibility profiling data to facilitate DR strategies implementation	Availability of the component	4		HYP (k.tsatsakis)
DRF_029	The Advanced Flexibility Analysis should exploit the results from consumer- centric DR profiling engine	Consumer-centric demand response framework	Functional and data requirements	More specifically potential demand flexibility values	User preferences are taken into account during flexibility analysis	5		HYP (k.tsatsakis)
DRF_030	Sample analytics over the streams of flexibility data (aggregation, filtering & clustering) will be supported by the Advanced Flexibility Analysis engine	Consumer-centric demand response framework	Functional and data requirements	Analytics over demand flexibility profiling data to facilitate DR strategies implementation	Demonstrated support	5		HYP (k.tsatsakis)
DRF_031	Input values (capacity, response capability, location, time) will	Consumer-centric de-	Functional and data requirements	Input parameters for the analytics process	Flex analysis takes into consideration the available asset characteristics	5		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
	set the configuration parameters for the analytics process	mand response framework						
DRF_032	Along with real-time analytics, short term and midterm forecasting of demand flexibility should be provided by the Advanced Flexibility Analysis engine	Consumer-centric demand response framework	Functional and data requirements	Demand Flexibility Forecasting as a main prerequisite for the implementation of DR strategies	Availability of demand flexibility forecasts	5		HYP (k.tsatsakis)
DRF_033	The outcomes of Advanced Flexibility Analysis engine may available for visualization or to a DSS for DR strategies implementation at consumers level	Consumer-centric demand response framework	Functional and data requirements	Analytics results to be exploited by different means	Visualization of flex analysis outcomes in UI	5		HYP (k.tsatsakis)
DRF_034	An Optimization DSS component should be designed to enable the aggregation of multiple consumers to participate in DSM strategies	Consumer-centric demand response framework	Functional and data requirements	Aggregation of actual demand flexibility as a core functionality of DSS	Component availability	5		HYP (k.tsatsakis)
DRF_035	The Optimization DSS component should be designed to allow for the selection of the appropriate aggregated demand side assets (demand, VES & EVs) to participate in DR programs	Consumer-centric demand response framework	Functional and data requirements	Selection of consumers to participate in DRprograms	User ability to select assets for DR campaign participation in DSS	5		HYP (k.tsatsakis)
DRF_036	The Optimization DSS component should enable interacting with different grid and market stakeholders requesting demand flexibility for the business services	Consumer-centric demand response framework	Functional and data requirements	DSOs, Aggregators, ESCOs triggering DR requests	Demonstration of information exchange with stakeholders	5		HYP (k.tsatsakis)
DRF_037	The Optimization DSS component should take into account the different DR contracts towards the selection of customers to participate in the associated campaigns	Consumer-centric demand response framework	Functional and data requirements	DSS optimization taking into account the contractual agreements	Demonstration of functionality	5		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
DRF_038	The Optimization DSS component should be designed to dispatch the DR signal to the different demand side end points	Consumer-centric demand response framework	Functional and data requirements	DR signal dispatching taking into account the type of the contract: Device specific control commands, price signals triggered to the users etc.	Functionality demonstration	5		HYP (k.tsatsakis)
DRF_039	The Optimization DSS component should be designed to dispatch the associated DR signal by taking into account the DR Contract	Consumer-centric demand response framework	Functional and data requirements	DR Contract constrains will mandate the implementation of the appropriate DR strategies	Functionality demonstration	4		HYP (k.tsatsakis)
DRF_040	The Optimization DSS component should estimate the impact of DR strategies to the active consumers, by taking into account the outcomes from consumer-centric DR profiling engine	Consumer-centric demand response framework	Functional and data requirements	A posteriori DR compensation for participation in DR dispatch signal (demand flexibility calculation)	Functionality demonstration	5		HYP (k.tsatsakis)
GEN_001	WiseGRID must advance the UN sustainable development goals (e.g., low carbon energy security, energy efficiency over consumption)	General Requirements	Cultural and political requirements		UN sustainable development goals are taken into account in the definition of project use cases	5		QMUL (Filippos Proedrou)
GEN_002	WiseGRID must advance a low carbon based circular economy (cradle to grave production and waste management; renewables penetration)	General Requirements	Cultural and political requirements		Overall results of the project foster the penetration of renewable resources	5		QMUL (Filippos Proedrou)
GEN_003	WiseGRID must foster citizens' empowerment and decentralization of the energy system (e.g., prosumers' markets, micro-generation, community energy)	General Requirements	Cultural and political requirements		Overall results of the project foster the empowerment of consumers and prosumers	5		QMUL (Filippos Proedrou)
GEN_004	WiseGRID must promote consumer-centric smart grid related data management systems	General Requirements	Security requirements		Consumers of WiseGRID technological solutions have control	5		QMUL (Filippos Proedrou)

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					of the data they provide to the ecosystem			
GEN_005	WiseGRID must promote a 'level playing field' which does not discriminate between competitors (e.g., suppliers, aggregators) as well as flexibility solutions (e.g., storage, DR, EVs)	General Requirements	Operational requirements		Services exchanged among the WiseGRID technological solutions do not prioritize any actor among others	5		QMUL (Filippos Proedrou)
GEN_006	WiseGRID must make use of existing standards or standards under development to provide easier access to market and the dissemination of the resulting solutions worldwide	General Requirements	Legal requirements	In several occasions the use of existing standards at very different level can provide easier access to markets worldwide. In the other hand using standards for defining technical requirements can lead to solutions with higher reproducibility.	Project will investigate and WisEGRID solutions interfaces will use proper standards	3		AENOR (Miguel Angel)
GEN_007	WiseGRID can promote new standards using the results of the project looking for a higher market penetration	General Requirements	Legal requirements	The variety of results can promote standards in topics not already covered.	Gaps found by the project on the considered standards will be highlighted	3		AENOR (Miguel Angel)
GEN_008	The apps developed should be aligned and easy adaptable to the regulatory framework	General Requirements	Legal requirements		Apps are designed modularly and consistently	4		HEDNO (Dimitrios Stratogiannis)
GEN_009	Quality of historical data from pilot sites must be assured	General Requirements	Operational requirements	The quality of the data will affect the quality of the results of the profiling algorithms	Required historical data series are complete and correct	5	Several use cases of the project will depend on profiling of data series, which, in turn, will depend on historical data likely to be obtained from periods previous to the project. These data series must be complete (no missing periods) and correct.	ETRA (Alberto Zambrano)

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GEN_010	All product GUIs should be designed utilizing user (stakeholder) feedback at the design phase	General Requirements	Look and feel requirements		Pilot-site partners are highly involved in the design and evaluation of the tool	4		AUEB (George Thanos)
GEN_011	The apps developed within WiseGRID should be compatible with different operating systems (Windows, Android, Linux, MacOS, iOS, etc.)	General Requirements	Functional and data requirements		Apps interfaces to end-users are designed with platform-agnostic technologies	5		VS (Benjamin Kraft)
GEN_012	A support system to the users should be created for the support of the tools deployment in the pilot sites	General Requirements	Users of the product	Without continuous and local support to the user, we will risk their dis-engagement and therefore we will not be able to deploy the tools of the projects in good conditions	Single Contact Point in the local language to the users	4	This support system should be built in partnership with the local cooperatives.	RESC (Stanislas dHerbemont)
GEN_013	Maximize the implementation of local renewable production	General Requirements	The scope of the work	In order for the local system to provide value to the grid, there is a need for local production	KWh produced per inhabitant	3		RESC (Stanislas dHerbemont)
GEN_014	The governance of the system needs to be collegial and include the end-users	General Requirements	Usability and humanity requirements	The democratic governance of the system will ensure the user engagement	Cooperative organizations are supported by the project outcomes	5		RESC (Stanislas dHerbemont)
GEN_015	Standard Communication Protocols need to be used	General Requirements	Naming conventions and definitions		Standard protocols and data models are considered at the interfaces of the different WiseGRID products	5		AMP (Xavier Benavides)
GEN_017	WiseGRID must prioritize self-generation	General Requirements	Cultural and political requirements		Self-consumption optimization criteria is relevant to the WiseGRID technological solutions	5		QMUL (Filippos Proedrou)
GEN_018	Feedback option of every WiseGRID final product	General Requirements	Usability and humanity requirements		Having a way to receive feedback from the end-users	2		ETRA (Álvaro Nofuentes)
GEN_019	Advertising to encourage users to use WiseGRID products	General Requirements	Cultural and political requirements		Having a way to promote WiseGRID tools to the end-users	2		ETRA (Álvaro Nofuentes)

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GEN_020	Implementation of algorithms that calculate forecast of renewable production according to meteorological data (solar irradiation, wind…)	General Requirements	Functional and data requirements	Forecasting algorithms shall be implemented as modules to be reused among all products requiring this functionality	Having reliable algorithms to forecast renewable energy production	5		ETRA (Álvaro Nofuentes)
GEN_021	WiseGRID products translation to different languages	General Requirements	Usability and humanity requirements		Having a reliable translation in all the decided languages	4		ETRA (Álvaro Nofuentes)
GEN_022	Granularity at the device level to identify and to isolate anomalous devices.	General Requirements	Operational requirements		Availability to isolate an identify anomalous devices thanks to a granular implementation	5		ETRA (Álvaro Nofuentes)
GEN_023	Phasor Measurement Units (PMUs) in strategical places in order to monitor the quality of the grid.	General Requirements	Operational requirements		An optimized deployment of the PMUs	5		ETRA (Álvaro Nofuentes)
GEN_024	Smart meters infrastructure should be deployed and integrated into the grid	General Requirements	Functional and data requirements		A correct deployment of the smart meters	5		ETRA (Álvaro Nofuentes)
GEN_025	Smart meter must have a network connection	General Requirements	Functional and data requirements		Having a way of communication between the smart meters and the interested actors	5		ETRA (Álvaro Nofuentes)
GEN_026	Real data in real-time from smart meters, sensors, metering, etc. must to be available	General Requirements	Functional and data requirements		Availability to have all the required measured data	5		ETRA (Álvaro Nofuentes)
GEN_027	The WiseGRID app ecosystem should support coherent user management between apps.	General Requirements	Mandated constraints	Several different tools may require knowledge about a single user/stakeholder (e.g. a facility manager will the user of the WiseHOME tool and a customer of the StaaS/VPP and WiseCOOP tools). A coherent way to manage users is needed.	Functionality implemented in WiseGRID app ecosystem	4	It is not clear where (in which tool) this functionality best belongs. A coherent WG user directory can protect against double entries and ensure data consistency. User authentication and authorization to access WG tools are necessary features to ensure the baseline data protection. Further features of user	HYP (Antonis Papanikolau)

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							management tools may also be welcome.	
GEN_028	Date time data will always be processed in UTC	General Requirements	Mandated constraints	In order to avoid ambiguity, date times will be always processed in UTC, and translated to local time only when displayed to users of the applications	All modules developed within the project adhere to this requirement	5		ETRA (Alberto Zambrano)
GEN_029	Data owners will decide for which purposes their data can be used	General Requirements	Legal requirements	The platform will support several different functionalities, requiring different data (mostly coming from the prosumers). Those will have the capacity to limit the scopes where their data is used	Access control mechanism is put in place, checking whether end-users have given permission to use their data for each of the functionalities of the platform	5		ETRA (Alberto Zambrano)
OSS_001	Encourage the coupling of the electrical and thermal systems	Optimized storage solutions	The scope of the work	In order to promote stability in the local area network, the use of the heating system is an asset		3		RESC (Stanislas dHerbemont)
RSC_002	RESCO shows data monitoring from Unbundled Smart Meters in real-time (max 10 seconds)	RESCO services	Functional and data requirements		data derived by USM are shown in quite real-time	5		ENG (Antonello Corsi)
RSC_007	It receives real-time inputs from Unbundled Smart Meters	RESCO services	Functional and data requirements			5		ENG (Antonello Corsi)
RSC_009	RESCO sends signals for reducing/increasing power consumption to selected consumers	RESCO services	Functional and data requirements		RESCO can send signal about power consumption	5		ENG (Antonello Corsi)
RSC_010	It aims at improving the grid and support grid operators to better manage the energy network which including distributed renewables and other new energy resources, such as EV and batteries.	RESCO services	The purpose of the product		WG RESCO will support the smartening of the distributed energy grid	5		ENG (Antonello Corsi)

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RSC_011	Portfolio management (list of equipment deployed, lists of clients, billing…)	RESCO services	Operational requirements	RESCO companies need a tool to manage all their assets (where are they located, depreciation and remaining useful life), customers (addresses, installed assets) and customers revenue calculation (e.g. how much money they get from grating their roofs, base	Having a portfolio of all the required items	4		ETRA (Álvaro Nofuentes)
RSC_012	Maintenance of provided equipment information (solar panels, batteries€¦) including information of the current status	RESCO services	Operational requirements	RESCO companies need a tool to manage all their assets (where are they located, depreciation and remaining useful life), customers (addresses, installed assets) and customers revenue calculation (e.g. how much money they get from grating their roofs, base	The RESCO has to have a way to know the status of its assets and the necessary maintenance actions	3		ETRA (Álvaro Nofuentes)
RSC_013	User profiling (which business scenario suits better to each end-user)	RESCO services	Operational requirements		Having a reliable algorithm to make this decision	4	The scenarios are: - Consumer only contracts energy from RESCO. - The user pays a fee to use the energy and sell the surplus. - The user doesn't pay a fee but surplus is given back to RESCO.	ETRA (Álvaro Nofuentes)
RSC_014	Owner and end-user direct communication	RESCO services	Operational requirements	To include a channel for effectively notifying information to customers	Having a reliable communication between the RESCO and its clients	3		ETRA (Álvaro Nofuentes)
RSC_015	List of RESCO companies that provide services (including price and location information).	RESCO services	Functional and data requirements		Having an updated list of RESCOs using WG RESCO	2	This requirement is focused on the new end-users	ETRA (Álvaro Nofuentes)
RSC_016	Implementation of a payment platform	RESCO services	Operational requirements	End-user direct payment	Having a reliable and safe payment platform	2		ETRA (Álvaro Nofuentes)

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RSC_017	RESCOs should receive signals from the DSO about curtailment danger.	RESCO services	Functional and data requirements			3		HEDNO (Dimitrios Stratogiannis)
RSC_018	It should provide RES production forecasting.	RESCO services	Functional and data requirements			4		HEDNO (Dimitrios Stratogiannis)
RSC_019	WG RESCO must facilitate selling the energy managed by RESCO in the corresponding wholesale market	RESCO services	The scope of the work	RESCOs get profit from selling energy produced by their assets	WG RESCO provides the RESCO all necessary information for interacting with the wholesale market	5		ETRA (Alberto Zambrano)
RSC_020	Monitor energy produced by installed RES assets	RESCO services	Functional and data requirements	That information is necessary for the proper operation of the RESCO business	WG RESCO provides clear information about the production of the installed RES assets	5	One business model of RESCOs consists on installing RES on customer premises, allow customers to self-consume produced energy and keep the rights to sell energy surplus in the wholesale market. A variant of this business model consists on renting customers premises (paying customers a fix fee) and keeping the rights over all the production.	ETRA (Alberto Zambrano)
RSC_021	Monitor energy consumed by customers	RESCO services	Functional and data requirements	That information is necessary for the proper operation of the RESCO business	WG RESCO provides clear information about the consumption of its customers	5	One business model of RESCOs consists on installing RES on customer premises, allow customers to self-consume produced energy and keep the rights to sell energy surplus in the wholesale market. It is therefore necessary to measure up to which extent the customers perform self-consumption.	ETRA (Alberto Zambrano)

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RSC_022	WG RESCO must provide information to its customers	RESCO services	The scope of the work	Customers allowed to self-consume energy need to get a clear insight of how much energy has been self-consumed, compared to total production	WG RESCO sends those details to WiseHOME and WiseCORP, in order to make them available to end-users	2	This is not fundamental to the operation of RESCO business, but can boost acceptance among customers	ETRA (Alberto Zambrano)
COP_002	Intelligent decision algorithms to solve local imbalance between local production and local consumption	WiseCOOP app	Functional and data requirements		WiseCOOP incorporates a module to handle consumption and production balance of the portfolio	5	To solve an imbalance between local production and local consumption a decision tree should be available to decide in which order which technology is controlled to solve the imbalance. In both directions. E.g. when there is too much production: decision to store (also which storage system) or to sell. On the other hand, when there is too little production: decide whether to discharge storage or to buy from grid or DR/DSM.	ECO (Ine Swennen)
COP_003	Users of the platform will have access to consumption measurements of the aggregated prosumers	WiseCOOP app	Functional and data requirements	Individual energy consumption measurements is an input of further functionalities	WiseCOOP app is able to access historical consumption data of prosumers	5	Target users of the platform are aggregators (e.g. cooperatives of prosumers). Consumption data is required for aggregation purposes (trading in the flexibility market, negotiating better tariffs, etc.)	ETRA (Alberto Zambrano)
COP_004	Users of the platform will have access to production measurements of the aggregated prosumers	WiseCOOP app	Functional and data requirements	Individual energy production measurements is an input of further functionalities	WiseCOOP app is able to access historical production data of prosumers	5	Target users of the platform are aggregators (e.g. cooperatives of prosumers). Production data is required for aggregation purposes (trading in the flexibility market, optimise local consumption towards	ETRA (Alberto Zambrano)

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							net balance, negotiating better tariffs, etc.)	
COP_005	Users of the platform will have access to battery status of the aggregated prosumers	WiseCOOP app	Functional and data requirements	Battery status is a needed input for further functionalities	WiseCOOP app is able to query real-time status of aggregated batteries	4	Target users of the platform are aggregators (e.g. cooperatives of prosumers). Battery status is required for aggregation purposes (trading in the flexibility market, optimise local consumption towards net balance, negotiating better tariffs, etc.)	ETRA (Alberto Zambrano)
COP_006	WiseCOOP shall be able to cluster prosumers accordingly to their consumption pattern	WiseCOOP app	Functional and data requirements	The objective is aggregating prosumers under common patterns that will be used to negotiate better tariffs	Clustering module is available	4		ETRA (Alberto Zambrano)
COP_007	WiseCOOP shall be able to cluster prosumers accordingly to their production pattern	WiseCOOP app	Functional and data requirements	The objective is aggregating prosumers under common patterns that will be used to negotiate better (selling) tariffs	Clustering module is available	4		ETRA (Alberto Zambrano)
COP_008	WiseCOOP shall be able to assist the selection of the proper tariffs for each cluster	WiseCOOP app	Functional and data requirements	Energy demand pattern will be compared with available energy tariffs to assist the selection of the best one	Tariff selection assistant module is available	4		ETRA (Alberto Zambrano)
COP_009	WiseCOOP shall be able to aggregate the cooperatives' partners available flexibility	WiseCOOP app	Functional and data requirements	All cooperative partners will participate as a whole in the flexibility market	Flexibility aggregation module is available	4	Integration with WiseHOME will be needed	ETRA (Alberto Zambrano)
COP_011	RES generation should never be limited (full priority) in times of potential grid congestion or local imbalance. Appropriate scenarios should be evoked to avoid grid problems.	WiseCOOP app	Operational requirements		WiseCOOP portfolio optimization modules prioritize RES generation	5		ECO (Ine Swennen)

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COP_013	Users of the platform shall be able to participate in DR programs as a whole	WiseCOOP app	Functional and data requirements	All cooperative partners will participate as a whole in the DR mechanisms	Demand-response module (allowing aggregation and triggering of individual DR requests) is available	4	Integration with consumer-centric DR framework and WiseHOME will be needed	ETRA (Alberto Zambrano)
COP_014	WiseCOOP shall offer billing functionalities for cooperatives with a retailer role	WiseCOOP app	Functional and data requirements	The application shall offer the cooperative functionality to bill its partners accordingly to their consumption and applied tariff	Billing module is available	4		ETRA (Alberto Zambrano)
COP_015	WiseCOOP shall be able to geographically map the clustered consumers to grid lines	WiseCOOP app	Functional and data requirements	Network Operator will have a clear view of the clustered consumers and map them to corresponding grid lines	WiseCOOP will interconnect with GIS modules	5		HEDNO (alexandros karagiannis)
COP_016	WiseCOOP shall be able to geographically map the clustered prosumers to grid lines	WiseCOOP app	Functional and data requirements	Network Operator will have a clear view of the clustered prosumers and map them to corresponding grid lines	WiseCOOP will interconnect with GIS modules	5		HEDNO (alexandros karagiannis)
COP_017	WiseCOOP shall be able to have access to measurements of the interconnected entities and transform them accordingly	WiseCOOP app	Functional and data requirements	WiseCOOP will communicate with various systems to collect data and establish communication for efficient data exchange	WiseCOOP includes the necessary modules to access all the required data	4		HEDNO (alexandros karagiannis)
COP_018	Platform will require permission from prosumers to access and operate with their data	WiseCOOP app	Legal requirements	Production/Consumption pattern data is owned by prosumers. The platform will need them to grant access to their data	Access control mechanism is put in place, checking whether prosumers have given access grants to their data	5		ETRA (Alberto Zambrano)
COP_020	Permission from domestic battery owners will be required in order to aggregate those batteries under Storage as a Service services	WiseCOOP app	Legal requirements	Explicit grants will be requested to domestic battery owners in order to use their batteries for flexibility aggregation and Storage as a Service services	Access control mechanism is put in place, checking whether end-users have given permission to use their domestic batteries	5		ETRA (Alberto Zambrano)
COP_021	WiseCOOP app could support gamification initiatives among the cooperatives members.	WiseCOOP app	Functional and data requirements		This will incentivize them to be more active and participate in DR campaigns & efficiency/energy optimization strategies.	2		HEDNO (Stamatia Gkiala Fikari)

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COP_022	WiseCOOP app should provide visualization of the KPIs of the energy management strategies and DR campaigns of the cooperative.	WiseCOOP app	Functional and data requirements		I think KPI visualisation is already available at another product of ETRA and in this case will enable the Aggregator to better manage and improve the energy strategies applied.	3		HEDNO (Stamatia Gkiala Fikari)
COP_023	WiseCOOP demand shifting mechanisms will focus in implicit (price-based) demand-response	WiseCOOP app	The scope of the work	Price-based campaigns are a reasonable way to encourage behavioural demand shedding and shifting among aggregated members	WiseCOOP supports price-based DR mechanisms	5		ETRA (Alberto Zambrano)
COP_024	An information channel from aggregator to portfolio members will be available	WiseCOOP app	The scope of the work	Information about DR campaigns, contribution to portfolio, etc. has to be displayed to members of the portfolio	Integration between WiseHOME/WiseCORP (member applications) and WiseCOOP is available	5		ETRA (Alberto Zambrano)
CRP_001	Platform users' shall have access to measured data of their related facilities	WiseCORP app	Functional and data requirements	Basic monitoring functionality shall be provided	Facility monitoring module is available	4		ETRA (Alberto Zambrano)
CRP_002	Manageable loads must include a control interface	WiseCORP app	Functional and data requirements	WiseCORP will include functions to optimize consumption via load shifting or flexibility. These loads must be controllable	Open protocols exists allowing the control of a selected set of available loads	4		ETRA (Alberto Zambrano)
CRP_003	Energy tariffs must be available	WiseCORP app	Functional and data requirements	Energy tariffs are an input to further functionalities	A module providing details on available commercial energy tariffs is available	4		ETRA (Alberto Zambrano)
CRP_004	Energy price at wholesale electricity market must be available	WiseCORP app	Functional and data requirements	Complementary information to tariffs with predefined prices	Access to the energy price curves is available	4		ETRA (Alberto Zambrano)
CRP_005	Platform will have access to energy measurements (consumption and production) of the platform users' related facilities	WiseCORP app	Functional and data requirements	This input is needed for further functionalities	Consumption and production measurements of required facilities are accessible	4		ETRA (Alberto Zambrano)

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CRP_006	WiseCORP shall show consump-tion and production evolution charts	WiseCORP app	Functional and data require-ments	Basic functionality of the plat-form includes energy-related monitoring	Energy monitoring module is available	4		ETRA (Alberto Zambrano)
CRP_007	WiseCORP shall show consump-tion and production KPIs	WiseCORP app	Functional and data require-ments	Functionality will include met-rics on the evolution of certain energy-related measurements	KPI analysis module is available	4		ETRA (Alberto Zambrano)
CRP_008	Platform users should get in-formed about the economic cost of the energy consumed in their facilities	WiseCORP app	Functional and data require-ments	Necessary to assist corpora-tions in the reduction of the energy bill	Economic cost module is availa-ble	4		ETRA (Alberto Zambrano)
CRP_009	Platform users' shall be able to watch the energy mix and CO_2 emissions associated to their consumption	WiseCORP app	Functional and data require-ments	This is a desired functionality to help organisations move to-wards greener energy sources	Energy mix and CO_2 calculation module is available	4		ETRA (Alberto Zambrano)
CRP_010	WiseCORP will be able to con-trol smart devices (HVAC, light-ing, industrial processes) for en-ergy optimization purposes	WiseCORP app	Functional and data require-ments	Optimization of energy con-sumption will need control on smart devices to perform shift load, demand-response actua-tions, etc.	app allows users to manage their controllable smart devices	4		ETRA (Alberto Zambrano)
CRP_011	WiseCORP will be able to mini-mize economic costs by using flexibility	WiseCORP app	Functional and data require-ments	WiseCORP will allow cost-based optimization of con-sumption. WiseCORP will in-clude flexibility trading as a possibility to optimize energy-associated economic costs	WiseCORP Optimization mod-ule is available and offers cost-based optimization	4	Interaction with Flexibility market will be necessary	ETRA (Alberto Zambrano)
CRP_012	WiseCORP will be able to mini-mize CO_2 emissions by using flexibility	WiseCORP app	Functional and data require-ments	WiseCORP will allow CO_2-based optimization of consumption. WiseCORP will include flexibil-ity trading as a possibility to optimize energy-associated CO_2 emissions	WiseCORP Optimization mod-ule is available and offers CO_2-based optimization	4	Interaction with Flexibility market will be necessary	ETRA (Alberto Zambrano)
CRP_013	WiseCORP will be able to trade flexibility in the market	WiseCORP app	Functional and data require-ments	Different energy-consumption optimizations will use available flexibility and its price in mar-ket as a parameter	WiseCORP is able to interact in the flexibility market	4		ETRA (Alberto Zambrano)

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CRP_014	WiseCORP will allow end-users to choose usage of their flexibility (optimize energy demand, costs or CO_2 emissions, or offer it in the flexibility market)	WiseCORP app	Functional and data requirements	Aggregated flexibility shall be used in a range of different objectives. Users' of the platform will selected the preferred one	The platform allows users to select the preferred usage, and implements all different options	4		ETRA (Alberto Zambrano)
CRP_015	WiseCORP will exchange data with operational facilities	WiseCORP app	Functional and data requirements		WiseCORP incorporates all necessary modules to retrieve data from the controlled facilities	5		HEDNO (alexandros karagiannis)
CRP_016	WiseCORP will need communication networks to incorporate various entities in data exchange	WiseCORP app	Relevant facts and assumptions	A communication network is assumed to be operational for WiseCOOP and WiseCORP Apps	Integration between WiseCOOP and WiseCORP exists	5		HEDNO (alexandros karagiannis)
CRP_017	WiseCORP will need synchronization mechanism	WiseCORP app	Functional and data requirements	Access to real-time measurement systems and energy devices needs to be synchronized in order to make sense of the collected information	All devices participating from the data collection are synchronized in time	4		HEDNO (alexandros karagiannis)
CRP_018	WiseCORP APP users shall have a secure protocol for data exchange and defined security rules for operational facilities integration to platform	WiseCORP app	Functional and data requirements	DSOs operational facilities data and systems must be securely accessed by WiseGRID APPS	Communications with field sensors and meters are made in a secure manner	5		HEDNO (alexandros karagiannis)
CRP_019	One user of WiseCORP (i.e. a company or organisation) may be able to monitor and control several facilities from the platform	WiseCORP app	The scope of the product	Organisations may need to monitor and control more than one facility. This aspect has to be taken into account in the platform design	Platform supports multiple facilities per user	5		ETRA (Alberto Zambrano)
CRP_020	WiseCORP shall calculate demand and generation forecasts	WiseCORP app	The scope of the product	In order to perform energy optimization, demand and generation forecasts will be needed	A forecast module is included in the platform	5	Historical data for calculating initial forecasts for the pilots will be required.	ETRA (Alberto Zambrano)
CRP_021	WiseCORP will facilitate the participation of companies in demand-response programmes	WiseCORP app	The scope of the product	As part of the energy management and optimization, participation in DR programmes will be considered	WiseCORP platform is integrated with the demand-response mechanisms developed in the project	4		ETRA (Alberto Zambrano)

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CRP_022	WiseCORP shall allow its users to set constraints to the remote control of the smart appliances	WiseCORP app	Operational requirements	Users may allow automatic management of the smart appliances as part of the DR schemes, but always under certain limits	WiseCORP GUI includes an interface for setting these constraints	4	E.g. EVs must be fully charged every morning, HVAC temperature modification limits calendar, etc.	ETRA (Alberto Zambrano)
CRP_023	Users of the platform (companies, municipalities, etc.) will explicitly be informed (upon registration) about the data required and how it will be managed	WiseCORP app	Legal requirements	Since data is owned by the end-users of the platform, those need to be informed about how their data will be used	Disclaimer including this information is shown as part of the registration process	5		ETRA (Alberto Zambrano)
CRP_024	End-users of the platform (organisations, municipalities, etc.) will grant permissions to the platform to access and operate with their data	WiseCORP app	Legal requirements	Since data is owned by the end-users of the platform, those need to grant access to their data	Access control mechanism is put in place, checking whether end-users have given access grants to their data	5		ETRA (Alberto Zambrano)
CRP_025	WiseCORP app should provide information on energy production and storage equipment status and their maintenance details.	WiseCORP app	Functional and data requirements		WiseCORP is supposed to give the facility managers the ability to manage their energy assets.	5		HEDNO (Stamatia Gkiala Fikari)
CRP_026	WiseCORP app should offer access to historical data of consumption, production of the facilities and KPIs of different management strategies in them.	WiseCORP app	Functional and data requirements		This will help the facility manager to have a more complete idea of the total consumption, production and energy management results.	5	Maybe, WiseCORP app could also some relevant statistical analysis of them.	HEDNO (Stamatia Gkiala Fikari)
CRP_027	WiseCORP app could include a map with all the facilities and the relevant assets for better visualization to facilitate the managers/users.	WiseCORP app	Operational requirements		This would give to the app user a direct and better picture of the performance of the equipment to assist the user in asset management and maintenance.	3		HEDNO (Stamatia Gkiala Fikari)
CRP_028	WiseCORP app shall provide visualization of the energy transferred to and from the EV fleet of the company, if it exists and	WiseCORP app	Functional and data requirements		This would give a more complete picture of the complete absorption of injection of power from/to the network inside the corporate premises.	3	As I've seen at HL-UC Leaders TELCO and WG Architecture slide, WiseCORP will not be used to manage the EVs of businesses/industries etc. However, if	HEDNO (Stamatia Gkiala Fikari)

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	uses its infrastructure as charging station.						the EV fleet is connected at the power installation of the infrastructure of the company, then it is probably included in its loads. Thus, only a visualization of them could give a better and more complete idea to the facility manager for the electricity consumed or produced at its premises.	
EVP_001	Different models of EV's should easily be integrated in WiseEVP	WiseEVP	Functional and data requirements	We should allow EV fleet managers to integrate different models of EV	Be able to integrate all models into WiseEVP	5	Partago works with Renault Kangoo ZE and Renault Zoe.	PARTA (Joachim Jacob)
EVP_002	Charging speed of charging station can be manually set	WiseEVP	Usability and humanity requirements	The EV fleet manager should be able (perhaps in specific cases) to manually set the EV charging to full speed, overruling the planning.	Function is present	4	The mobility of the EV users is of primordial importance. EV fleet manager should be able to allow full charging when necessary.	PARTA (Joachim Jacob)
EVP_003	EVP must provide API's to allow integration in other fleet mgmt. tools	WiseEVP	Functional and data requirements	Fleet managers use existing software, which they might continue using if the EVP functionality can be added calling the WiseEVP API's.	Function is present	3		PARTA (Joachim Jacob)
EVP_004	WiseEVP collects data from vehicles and charging stations on one platform	WiseEVP	The scope of the product	WiseEVP should allow to analyse data coming from EV's and EVSE directly.	data is shown in platform	5		PARTA (Joachim Jacob)
EVP_005	Different models of charging stations should easily be integrated in WiseEVP	WiseEVP	The scope of the product	Different manufacturers of charging stations exist, they all should be easily be integrated into the platform.	Function is present	5		PARTA (Joachim Jacob)
EVP_006	WiseEVP should provide basic fleet mgmt. functionalities: maintenance, documents administration, damage reporting, etc.	WiseEVP	Usability and humanity requirements	If WiseEVP has the scope to be a fleet mgmt. platform, basic functionalities should be available.	Functions are present	5		PARTA (Joachim Jacob)

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EVP_007	WiseEVP should have a simple mechanism to link the availability / calendar of each car to the charging control engine	WiseEVP	Usability and humanity requirements	Car sharing providers use different scheduling tools to schedule car usage.	Function is present	5		PARTA (Joachim Jacob)
EVP_010	The WiseEVP will receive the state of the distribution network from the WiseGRID Cockpit.	WiseEVP	Functional and data requirements		The WiseEVP receives the state of the distribution network	5		ITE (Irene Aguado)
EVP_014	The WiseEVP will receive the DSO flexibility needs through the WiseGRID Cockpit	WiseEVP	The scope of the product		The WiseEVP receives flexibility requests according to the flexibility products definition in the scope of project	4		ITE (Irene Aguado)
EVP_015	The WiseEVP will calculate the aggregated flexibility capabilities of the EVSEs under its management	WiseEVP	The scope of the product		The EVSEs flexibility capabilities will be aggregated per regulation area	5		ITE (Irene Aguado)
EVP_017	The WiseEVP will reschedule the EVSE charging sessions to meet DSO needs	WiseEVP	The scope of the product		The flexibility product requested by the DSO should be provided by the aggregated modification of the active charging sessions	5		ITE (Irene Aguado)
EVP_018	The WiseEVP will allow EVSE booking	WiseEVP	The scope of the product		The user is able to book an EVSE through an interface to the WiseEVP	5	The booking settings should include the user charging preferences (as if it was done in the EVSE) such as SoC objective or time limit.	ITE (Irene Aguado)
EVP_019	The WiseEVP will establish a two way communication with DSOs	WiseEVP	The scope of the product	WiseEVP should take account of the DSO needs for charging and distribution grid balance	The DSO is able to interact with the WiseEVP through the WG Cockpit	5		HEDNO (alexandros karagiannis)
EVP_020	The WiseEVP should have a link to energy markets (Energy Exchange, Balancing and Ancillary Services Markets)	WiseEVP	Functional and data requirements		The WiseEVP is able to receive market signals and participate in flexibility markets	3		VS (Benjamin Kraft)

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EVP_021	The platform will share data in order to provide information to the demand forecasting module	WiseEVP	Functional and data requirements		The WiseEVP and the WG IOP are connected and able to exchange information	4		AMP (Xavier Benavides)
EVP_022	WiseEVP could merge data from owned EVSE and from publicly available EVSE	WiseEVP	The scope of the product	A neighbourhood might contain publicly available EVSE (charging stations). Data that these public EVSE broadcast, perhaps via Wise IOP, might be directly integrated in the WiseEVP platform for the EV fleet manager. This allows making optimal use of EVSE.	The WiseEVP is able to monitor all kind of EVs (with different property models)	5		PARTA (Joachim Jacob)
EVP_024	EVSE unique identifier	WiseEVP	Functional and data requirements		Having only one identifier per EVSE	5		ETRA (Álvaro Nofuentes)
EVP_025	Smart card or unique digital token per user	WiseEVP	Functional and data requirements		Having only one identifier per EV user	5		ETRA (Álvaro Nofuentes)
EVP_026	The users have to provide their personal data, EV data and preferences in the context of EV.	WiseEVP	Usability and humanity requirements		All the necessary user data has been provided	3		ETRA (Álvaro Nofuentes)
EVP_027	Clear identification of the EVSE on its casing.	WiseEVP	Usability and humanity requirements	To allow user to physically find the charging station.	Availability to easily find the desired EVSE.	4		ETRA (Álvaro Nofuentes)
EVP_028	The end-user should be registered and authorised in order to charge and/or book an EV in the system.	WiseEVP	Usability and humanity requirements		Only registered users can use WiseEVP in order to use EVSE functionalities	4		ETRA (Álvaro Nofuentes)
EVP_029	List of available charging stations with booking possibilities	WiseEVP	Operational requirements		A clear observability of the non-used/booked EVSEs.	4		ETRA (Álvaro Nofuentes)
EVP_031	EV status available (SoC)	WiseEVP	Functional and data requirements		Easy SoC observability	5		ETRA (Álvaro Nofuentes)

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EVP_032	Notification of near charging stations	WiseEVP	Usability and humanity re-quirements		A clear observability of the near charging stations	2		ETRA (Álvaro Nofuentes)
EVP_033	WiseEVP should perform and make use of grouping of EVSE in regulation areas.	WiseEVP	Operational requirements		It is part of the EVSE network configuration, which should be supported by WiseEVP.	4		HEDNO (Sta-matia Gkiala Fikari)
EVP_034	It must facilitate the manage-ment of EV fleet of indus-tries/companies etc.	WiseEVP	The scope of the product		This must happen, since facility managers will use WiseEVP to manage their EV fleets (if any) and not WiseCORP.	5		HEDNO (Sta-matia Gkiala Fikari)
EVP_035	WiseEVP should support the end-user's ability to choose the preferable type of EV charging (among the ones described in HLUC3).	WiseEVP	Functional and data require-ments		This is one of the core-function-alities of the WiseEVP as de-fined in HLUC3.	4		HEDNO (Sta-matia Gkiala Fikari)
EVP_036	WiseEVP must provide real or near real-time monitoring of the EVSE equipment (and the EV fleet) to the EVSE manager (and EV fleet manager).	WiseEVP	Functional and data require-ments		EVSE monitoring is a prerequi-site for most efficient manage-ment of EVSE network and for facilitating the end-user to book a charging session and choose the available WiseEVP while be-ing on road.	5		HEDNO (Sta-matia Gkiala Fikari)
EVP_037	Anonymising charging data to assure data privacy in case of private EVs.	WiseEVP	Legal require-ments		This is a vital requirement when talking about private EVs and it can be a similar module as the one used for anonymising data of the consumers for the rest of the apps.	5		HEDNO (Sta-matia Gkiala Fikari)
EVP_038	In case of EV fleets, WiseEVP shall provide to the EV fleet manager (/owner) information on the EVs usage and position	WiseEVP	Functional and data require-ments	Based on HL-UC3 PUC 1 SUC 3.1.2.	WiseEVP is by definition a tool to help EVSE and EV fleet man-agers/owners to effectively manage their assets. The loca-tion and usage data are im-portant for this to be achieved.	3		HEDNO (Sta-matia Gkiala Fikari)

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EVP_040	WiseEVP shall provide historical consumption and charging session data from each EVSE.	WiseEVP	Functional and data requirements		Historical data are useful for acquiring a more complete idea of the assets usage and health monitoring, assisting also in better planning. The visualisation of historical data is a feature of many more apps, so similar module could perhaps be used here.	4		HEDNO (Stamatia Gkiala Fikari)
EVP_041	WiseEVP should contain a pricing mechanism for rewarding the performed balancing.	WiseEVP	Functional and data requirements		This could be an incentive for the end-user to choose charging session types which offer regulation services to the network.	3		HEDNO (Stamatia Gkiala Fikari)
EVP_042	WiseEVP should provide information about the energy price curves to the users.	WiseEVP	Functional and data requirements		The user should have transparent access to price data to have an understanding of the charging cost or of the benefit arising from different charging types.	4		HEDNO (Stamatia Gkiala Fikari)
EVP_043	WiseEVP communicates with charging stations through open smart charging protocol of the OpenChargeAlliance (OSCP protocol)	WiseEVP	Functional and data requirements	OCPP is a standard for communicating with charging stations.	WiseEVP can communicate with any charging stations that supports OCPP (or later protocols) over the network.	5		PARTA (Joachim Jacob)
EVP_044	The status of EVSE can be changed easily from public, private, out-of-order, etc. by the manager, or by the EVSE itself.	WiseEVP	Functional and data requirements	This allows communicating the availability of EVSE to users.	WiseEVP has a toggle per EVSE to check or uncheck its status.	5	Basic functionality in an EVSE platform.	PARTA (Joachim Jacob)
EVP_045	WiseEVP gathers data from EVs: location, SoC, status of the car,etc. via API	WiseEVP	Functional and data requirements	Data of EVs will be available from servers of the manufacturer or the fleet manager. EVSE should be easily configurable so that this data can be plugged in, per car.	Per car, or a fleet of cars, an API can be configured from where data about the EVs status can be captured.	5		PARTA (Joachim Jacob)

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EVP_046	The EVSE operator or the fleet manager has an updated list of known users (for authentication process)	WiseEVP	The scope of the product	There is an unique registration system that maintains an updated list of known users for the EVSE infrastructure usage		4		ITE (Irene Aguado)
EVP_047	The EV user has a valid account in the WiseEVP for the authentication process.	WiseEVP	The scope of the product		There's is an unique registration system for the EVSE infrastructure usage	4		ITE (Irene Aguado)
EVP_048	The EV user only will provide flexibility to the system allowing the system to module his charging session if he wants (charging types 2 and 3). If not, his car will be charged asap (charging type 1)	WiseEVP	Users of the product		The user charging requirements (final SoC and time to remove the car) are met at the end of the charging session	4		ITE (Irene Aguado)
EVP_049	The EVSE Operator or the EV Fleet manager will be able to configure the EVSE network through the WiseEVP (EVSE location, number of sockets, maximum and minimum power, etc.)	WiseEVP	The scope of the product	The EVSE network is available in the Wise EVP including the location and the characteristics of each EVSE		5		ITE (Irene Aguado)
EVP_050	The WiseEVP will calculate the EV load forecasting per regulation area and/or for the whole system	WiseEVP	The scope of the product		The load forecast is calculated per regulation area	4		ITE (Irene Aguado)
EVP_051	The WiseEVP will calculate the reference load profile per regulation area	WiseEVP	The scope of the product	The reference load profile is the first charging profile that the EVSE follows before applying power modulation to provide flexibility	The reference load profile is calculated per regulation area	4		ITE (Irene Aguado)
EVP_052	The WiseEVP will schedule the type 2-3 charging sessions of the EVSE network following an economic criterion if no other grid or RES requests are triggered.	WiseEVP	The scope of the product	Other requests may be triggered to support the grid, to maximise RES integration or to contribute to the household energy management (V2H)	The charging sessions price is as low as possible	4		ITE (Irene Aguado)

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EVP_053	The EVSE Operator needs to know the regulation areas division based on coordinates or based on network topology (this information may be retrieved from the DSO outside the system).	WiseEVP	Functional and data requirements		The network model including regulation areas is available in the Wise EVP	4		ITE (Irene Aguado)
EVP_054	Before starting with the charging session schedule processes, the data collection from EVSE should be performed to have historical data and to know the status of the EVSEs	WiseEVP	Functional and data requirements		The EVSE status is available in the Wise EVP in almost real-time	4		ITE (Irene Aguado)
EVP_055	The WiseEVP will modulate the power output of his EVSE network to help the DSO with the grid operation	WiseEVP	The scope of the work		The EVSEs follow the Wise EVP requests to follow the charging sessions	4		ITE (Irene Aguado)
EVP_056	The WiseEVP will modulate the power output of his EVSE network to maximise the RES integration answering the flexibility requests performed by the RESCOs or Aggregators through the WG StaaS/VPP	WiseEVP	The scope of the product	The EVSEs follow the Wise EVP requests to follow the charging sessions modulation		4		ITE (Irene Aguado)
EVP_057	WiseEVP allows setting a pricing model for booking an EVSE: reservation cost, cancellation cost, extending booking cost, etc.	WiseEVP	Functional and data requirements	Booking requires the implementation of related price aspects.	Function is implemented	5		PARTA (Joachim Jacob)
EVP_058	WiseEVP has a console at an EVSE or a hub of EVSE's	WiseEVP	Functional and data requirements	When WiseEVP manages a hub of EVSE's, instead of one, a separate console for welcoming, authenticating and directing users is possible, as opposed to every EVSE having their own interaction screen.	Two different types of devices can be implemented in WiseEVP: console device and EVSE device.	5		PARTA (Joachim Jacob)

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EVP_060	WiseEVP should allow grouping EVSEs in one hub, sharing the same location	WiseEVP	Functional and data requirements	EVSE's on the same location, should be managed together to increase efficiency in their use (e.g. by booking).	Function is implemented	5		PARTA (Joachim Jacob)
BDP_001	The platform shall be able to work with several types of data	WiseGRID Big Data Platform	Functional and data requirements	The platform will support several different functionalities	Different kind of data is accepted by the platform	5	E.g. grid monitoring data (U, P, Q, f), prosumer consumption/production, prosumer flexibility, etc.	ETRA (Alberto Zambrano)
BDP_002	The platform shall be able to apply different algorithms on the data	WiseGRID Big Data Platform	Functional and data requirements	The platform will support several different functionalities	There exists a procedure to configure the platform to execute different algorithms, depending on the desired functionality	5		ETRA (Alberto Zambrano)
BDP_003	The platform should provide enough storage capacity to deal with the storage of data managed within the project	WiseGRID Big Data Platform	Operational requirements	Several important features to be developed within the project work on big amounts of data	The necessary platforms with enough storage capacity will be allocated for the demonstration of the project	5	Data of several types and in several forms will be managed in the project: real-time, historical, raw, integrated, etc.	ETRA (Alberto Zambrano)
BDP_004	Data quality assessment and substitution	WiseGRID Big Data Platform	Functional and data requirements	Bad data should be identified, marked as such and substituted by an estimated value whenever possible	BDP provides mechanisms for bad/missing data identification	4		ETRA (Alberto Zambrano)
BDP_005	Temporal and spatial integration	WiseGRID Big Data Platform	Functional and data requirements	Raw measurements from every single metering source are likely to be integrated temporally and/or spatially for subsequent management and analysis	BDP provides mechanisms for efficient data aggregation	4		ETRA (Alberto Zambrano)
BDP_006	Clustering	WiseGRID Big Data Platform	Functional and data requirements	Certain data will be used to classify its sources into different groups, accordingly to the similarities they present in those characteristics relevant to the system	BDP must be able to execute clustering algorithms on the data	4		ETRA (Alberto Zambrano)

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BDP_007	Periodic data analysis is supported	WiseGRID Big Data Platform	Functional and data requirements	A set of analysis will be periodically performed over the new received data. The platform will support the periodic (pre-scheduled) execution of analysis algorithms	BDP must allow prescheduled periodic execution of analysis algorithms	4		ETRA (Alberto Zambrano)
BDP_008	Data reduction	WiseGRID Big Data Platform	Functional and data requirements	Data that has been already processed should be differentiated and archived	BDP is able to execute periodic archiving of processed data	2		ETRA (Alberto Zambrano)
BDP_009	The platform shall be able to apply privacy policies on different segments of data	WiseGRID Big Data Platform	Functional and data requirements		Data-filtering accordingly to privacy policies is possible	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_010	The platform shall be able to communicate with a defined number of protocols	WiseGRID Big Data Platform	Functional and data requirements		Standard protocols are considered for interfacing with the Big Data module	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_011	The platform will be able to work as a distributed system	WiseGRID Big Data Platform	Functional and data requirements		Big data modules will be built upon technologies allowing clustering	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_012	The database(s) will store data based on CIM data model (extensions may be needed from standardized CIM)	WiseGRID Big Data Platform	Functional and data requirements		Standard data models (as CIM) are considered	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_013	Where CIM is difficult to apply and data models have complex and hybrid structure, database(s) shall be able to store and retrieve JSON structures	WiseGRID Big Data Platform	Functional and data requirements		Platform supports JSON documents storage	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_014	The platform will be able to make data carving	WiseGRID Big Data Platform	Functional and data requirements		Platform supports data carving	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_015	The platform will have a real-time data section which will allow much higher number of transactions than on persistent database section	WiseGRID Big Data Platform	Functional and data requirements		Real-time processing is supported by the big data platform	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)

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BDP_016	Access to different database information will be based on Role-based Access Control (RBAC)	WiseGRID Big Data Platform	Functional and data requirements		Role-based access control can be applied to limit access to data stored in the big data platform	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_017	The platform will support powerful scripts which will support data protection schemes according to GPDR requirements	WiseGRID Big Data Platform	Functional and data requirements		Platform allows execution of batch scripts	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_018	The platform will support powerful data security features.	WiseGRID Big Data Platform	Functional and data requirements		Platform integrates access control mechanisms	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_019	The platform will need a concept if key management for the data security features.	WiseGRID Big Data Platform	Functional and data requirements		Platform integrates well-established security controls	1	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_020	The platform will allow micro transactions for different segmented markets. Blockchain solution will be considered.	WiseGRID Big Data Platform	Functional and data requirements		Platform allows micro transactions	1	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_021	The platform will allow data anonymization by using anonymous labels in some databases and personal reference in other databases	WiseGRID Big Data Platform	Functional and data requirements		Privacy issues are considered in the design of the databases	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_022	The platform will allow data anonymization by using aggregation of personal data, where the applications allow and gives meaning for the aggregated data (e.g. aggregated active powers of a cluster of end-users)	WiseGRID Big Data Platform	Functional and data requirements		Platform allows execution of data k-anonymization algorithms	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
BDP_023	Triggered data analysis is supported	WiseGRID Big Data Platform	Functional and data requirements	A set of analysis will be performed triggered by certain events (such as reception of new data). The platform will support execution of analysis	BDP must allow programming triggers for launching execution of analysis algorithms	4		ETRA (Alberto Zambrano)

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				algorithms upon preconfigured triggers				
WCP_001	Smart meters shall be installed in enough ratio to allow proper measurements of the grid buses	WiseGRID Cockpit	Operational requirements	Functionalities of WG cockpit depend on a proper sensorization of the grid	Proper sensorization exists	5	Will affect the demonstrable functionalities in each pilot	ETRA (Alberto Zambrano)
WCP_002	Smart meters shall be installed in participant prosumers to allow proper consumption/production/power quality measurements	WiseGRID Cockpit	Operational requirements	Functionalities of WG cockpit depend on a proper sensorization at prosumers side	Proper sensorization exists	5	Will affect the demonstrable functionalities in each pilot	ETRA (Alberto Zambrano)
WCP_003	WiseGRID cockpit must visualize all collected measurements of the grid	WiseGRID Cockpit	Functional and data requirements	Data visualization of the incoming data will be offered to grid operators	Visualization module is available	5		ETRA (Alberto Zambrano)
WCP_004	WiseGRID cockpit must visualize KPIs of Power Quality-related metrics	WiseGRID Cockpit	Functional and data requirements	The platform will work on data to extract meaningful indicators on power quality	KPI module analysis is available	5		ETRA (Alberto Zambrano)
WCP_005	DER attached to the grid must include control interfaces	WiseGRID Cockpit	Operational requirements	In order to use DER flexibility for grid imbalance management and power quality management, those need to be controllable	Open protocols exists allowing the control of a selected set of DER	5		ETRA (Alberto Zambrano)
WCP_006	Flexibility market must offer an open interface to post requests	WiseGRID Cockpit	Operational requirements	WiseGRID Cockpit will use the flexibility market for grid imbalance management	Flexibility market offers an open API	5	Flexibility market as defined by USEF. WG Cockpit will be the platform used by DSOs to operate in this market.	ETRA (Alberto Zambrano)
WCP_007	VPPs and Storage aaS (including DR, RES, VE and batteries) must offer an open interface to post requests	WiseGRID Cockpit	Operational requirements	VPPs and Storage aaS will be used as part of the grid imbalance management	An open API towards VPPs and Storage aaS exists	5		ETRA (Alberto Zambrano)
WCP_008	WG Cockpit must provide an interface to inform fault detections to operators	WiseGRID Cockpit	Functional and data requirements	Grid operators shall have a clear view of the faults detected on the grid	Fault detection module is available	5		ETRA (Alberto Zambrano)

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WCP_009	WG Cockpit must provide operators with grid reconfiguration proposals in the event of (expected) faults	WiseGRID Cockpit	Functional and data requirements	The platform will be able to compute and offer reconfiguration alternatives as a fault preventive measure	Grid reconfiguration module is available	5		ETRA (Alberto Zambrano)
WCP_010	WG Cockpit must be able to automatically apply optimized grid reconfiguration	WiseGRID Cockpit	Functional and data requirements	The platform will be able to compute and apply reconfiguration alternatives as a fault preventive measure	Grid reconfiguration module is available	5		ETRA (Alberto Zambrano)
WCP_011	Switches available in the feeders must be controllable	WiseGRID Cockpit	Operational requirements	Automatic reconfiguration will require access to controllable switches	Open protocols exists allowing the control of feeder switches	4		ETRA (Alberto Zambrano)
WCP_012	The platform will be able to manage grid imbalance	WiseGRID Cockpit	Functional and data requirements	This is a major desired functionality of the platform	Grid imbalance management module exists	5	Measurements and controllable elements (controllable DER, DR, flexibility market) will be used to balance the grid	ETRA (Alberto Zambrano)
WCP_013	WG Cockpit must perform grid state estimation	WiseGRID Cockpit	Functional and data requirements	In order to improve observability, state estimation shall be performed	Grid State Estimation module is available	5		ETRA (Alberto Zambrano)
WCP_014	The WiseGRID Cockpit will monitor the distribution network	WiseGRID Cockpit	The scope of the product		The distribution network is monitored in almost real-time	5		ITE (Irene Aguado)
WCP_015	The WiseGRID Cockpit will improve the flexibility of the distribution network	WiseGRID Cockpit	The scope of the product		Flexibility or DR capabilities are executed	5	This will be achieved by enabling DSOs to participate in demand-response schemes	ITE (Irene Aguado)
WCP_016	The WiseGRID Cockpit will enhance RES integration in the distribution network	WiseGRID Cockpit	The scope of the product		RES integration requests are executed	5	WG Cockpit will include simulator for assessing effect of distributed RES on the MV/LV grid	ITE (Irene Aguado)
WCP_017	The WiseGRID Cockpit will detect faults in the distribution network	WiseGRID Cockpit	The scope of the product		When a fault occurs, an alarm/alert is triggered	5	WG Cockpit will perform intelligent monitoring of the grid, triggering alerts when a fault is predicted or detected	ITE (Irene Aguado)

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WCP_018	The WiseGRID Cockpit will self-configure the distribution network	WiseGRID Cockpit	The scope of the product		After a fault the distribution network is configure to avoid supply interruptions	5	self-healing strategies involving intelligent monitoring and tele control, as well as participation in demand-response mechanisms, will be investigated	ITE (Irene Aguado)
WCP_019	The WiseGRID Cockpit will manage remotely the switching elements in the distribution network	WiseGRID Cockpit	The scope of the product		After a fault the distribution network is configure to avoid supply interruptions	5		ITE (Irene Aguado)
WCP_020	WiseGRID should use open standards, if possible and define interfaces for all interconnected systems under WiseGRID Cockpit APP	WiseGRID Cockpit	The scope of the product		Standard protocols and data models are considered at the interfaces of the WiseGRID Cockpit	5		HEDNO (alexandros karagiannis)
WCP_021	The WiseGRID Cockpit will enable a connection bus between different various operational facilities and applications of the DSOs	WiseGRID Cockpit	The scope of the product		WiseGRID Cockpit combines information from different existing modules of the DSO	5		HEDNO (alexandros karagiannis)
WCP_022	The WiseGRID Cockpit should be able to provide suggested solutions as best practises to faults in case of repetition, or in cases of grid reconfiguration	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit includes functionality for self-healing and operation advisory	4		HEDNO (Dimitrios Stratogiannis)
WCP_023	The topology of the grid at pilot sites must be known in advance	WiseGRID Cockpit	Operational requirements	Several functionalities of the WG Cockpit rely on the topology of the grid	Topology description in a standard format exists for the pilot sites	5		ETRA (Alberto Zambrano)
WCP_024	The developed fault location algorithms should work effectively on both underground and overhead networks	WiseGRID Cockpit	Functional and data requirements	Due to the different structure of the underground and overhead networks (distance between cables etc.) different types of errors may occur	The developed algorithms should detect successfully the most common errors in each region	3		ICCS (Styliani Sarri)
WCP_025	Real-Time or near Real-Time update of asset database/GIS	WiseGRID Cockpit	Functional and data requirements	Appropriate hardware/software allowing Real-Time or	The asset database/GIS should be updated within a minute	3	This requirements considers major changes in the	ICCS (Styliani Sarri)

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				near Real-Time update of asset database is in place.	once the user filled the appropriate form		system such as the installation of a new transformer. Changes in the status of switches (and the topology) are not considered as major changes	
WCP_026	Bidirectional communication between installed devices and central control unit	WiseGRID Cockpit	Functional and data requirements	Appropriate hardware/software allowing Bidirectional communication between installed devices and central control unit is in place.	Each interface between installed devices and central control units should comply with at least one communication protocol that supports bi directional communication	3	Bi directional communication is important element of advanced distributed control	ICCS (Styliani Sarri)
WCP_027	Data transfer between different applications based on a common data model	WiseGRID Cockpit	The scope of the product	Adoption of Common Information Model (CIM) is recommended	Existence of interfaces/wrappers in all WG application that support the common data model	3		ICCS (Styliani Sarri)
WCP_028	It should perform/provide the results of load flow analysis	WiseGRID Cockpit	Operational requirements		WiseGRID Cockpit provides load flow analysis capabilities	3		HEDNO (Dimitrios Stratogiannis)
WCP_029	It should provide information on the status of the asset and their maintenance to the DSO.	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit includes asset monitoring and maintenance functionalities	5		HEDNO (Dimitrios Stratogiannis)
WCP_030	WG Cockpit shall provide clear and effective visualization of the topology, so that the DSO can easily spot the whole affected area in case a fault happens at the grid.	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit is able to display information on the network topology view	4		HEDNO (Dimitrios Stratogiannis)
WCP_031	WG Cockpit must have an open interface with GIS (through IOP).	WiseGRID Cockpit	Functional and data requirements		Standard data model is considered for GIS representation	5		HEDNO (Dimitrios Stratogiannis)
WCP_032	WG Cockpit must support communication with DMS, through IOP	WiseGRID Cockpit	Functional and data requirements		Standard protocols are considered for communicating with DSM systems	5		HEDNO (Dimitrios Stratogiannis)

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WCP_033	It should allow DSOs to generate curtailment warnings.	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit monitoring functions shall be able to provide curtailment warnings	4		HEDNO (Dimitrios Stratogiannis)
WCP_034	Cockpit allows the active voltage control and the management of switching components in the network	WiseGRID Cockpit	The scope of the product		by means of cockpit the active voltage control and the management of switching components in the network will be possible	5		ENG (Antonello Corsi)
WCP_035	It provides support for grid automation based on Unbundled Smart Meters measurements	WiseGRID Cockpit	The scope of the product		grid automation will be supported by means of USM measurement	5		ENG (Antonello Corsi)
WCP_036	It have to support grid operators to better manage and control the energy network	WiseGRID Cockpit	The scope of the product		Management and control of the energy grid is the core of the WiseGRID Cockpit functionalities	5		ENG (Antonello Corsi)
WCP_037	It provides SCADA support and DER dispatch services, for Smart Grid using real-time data (at the consumer level) and direct control of DER's	WiseGRID Cockpit	The scope of the product		WiseGRID Cockpit includes modules for integration with SCADA and DER control protocol standards	5		ENG (Antonello Corsi)
WCP_038	It provides Energy quality monitoring service (e.g. voltage levels and voltage asymmetries, current asymmetries in low voltage, time of voltage, failures at customer levels)	WiseGRID Cockpit	The scope of the product		WiseGRID Cockpit monitors energy quality	5		ENG (Antonello Corsi)
WCP_039	It shows energy grid load, RES forecast, state estimation and load flow	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit visualizes all managed KPIs	5		ENG (Antonello Corsi)
WCP_040	WG Cockpit will support grid energy storage system (g-ESS) optimisation for grid capacity management. In this context, g-ESS will be DSO asset and shall be combined with SaaS (Storage as	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit is able to use grid level batteries and smaller (aggregated) batteries	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)

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	a Service) offered by market aggregators							
WCP_041	WG Cockpit will support grid survey and will highlight critical nodes in terms of voltage and critical sections in terms of power flow	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit provides alerts accordingly to the received measurements	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
WCP_042	WG Cockpit will have suitable interface to energy market platform	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit implements a module to receive information from the energy market	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
WCP_043	WG Cockpit will have suitable interface to balancing market platform	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit implements a module to interact with the ancillary services market	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
WCP_044	WG Cockpit should perform/provide the results of short circuit calculations	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit includes a visualization module for the results of short circuit calculations	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
WCP_045	WG Cockpit shall provide zoning of the grid with clear allocation of each RES, storage and/or dispatchable consumer. This would manage also the visualization of the topology, so that the DSO can easily evaluate actors implication within various operating	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit allows zoning of the grid	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
WCP_046	WG Cockpit will have a refreshing period for data update to suit various functions availability.	WiseGRID Cockpit	Functional and data requirements		WiseGRID Cockpit supports different data update intervals as required by the particular functionalities	5	Issued by Sanduleac and Chimirel	CRE (Catalin Chimirel)
FVG_001	The WiseFastV2G should be able to inject energy in the distribution network in a controlled manner (bidirectional power flow (from EV to Grid), depending on the capabilities of the EV)	WiseGRID FastV2G	The scope of the product	The WiseGRID FastV2G injects and consumes energy from the network following the orders received by the Wise EVP	FastV2G includes a control interface	5		ITE (Irene Aguado)

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FVG_002	The user should be able to introduce his/her charging preferences through the WiseFastV2G (SoC objective, time limit, price, etc.).	WiseGRID FastV2G	Functional and data requirements	The user preferences are saved in the Wise EVP	FastV2G and WiseEVP are integrated	4		ITE (Irene Aguado)
FVG_003	The WiseFastV2G should be able to perform a fast charging in less than 30 minutes.	WiseGRID FastV2G	The scope of the product		The charging session is performed in less than 30 minutes	5		ITE (Irene Aguado)
FVG_004	The WiseFastV2G should be able to perform Mode 3 charging (slow charging) following a charging pattern received from the WiseEVP.	WiseGRID FastV2G	The scope of the product		The WiseGRID FastV2G injects and consumes energy from the network following the orders received by the Wise EVP	4		ITE (Irene Aguado)
FVG_005	The WiseFastV2G will have two different connectors: Chademo and Combo connectors.	WiseGRID FastV2G	The scope of the product		Two different connectors are available in the WiseFastV2G	5	Based on IEC 61851-1, IEC 61851-23/24 and IEC 15118-1/2/3, standard definitions	ITE (Irene Aguado)
FVG_006	The WiseFastV2G should be able to authenticate users	WiseGRID FastV2G	The scope of the product		The authentication process is performed	3		ITE (Irene Aguado)
FVG_007	The characteristics of the grid need to allow implementation of the charging stations	WiseGRID FastV2G	Operational requirements	Not a technical expert on this! But in general, is the local grid suited for the required charging stations? E.g. some grids in Belgium lack the N phase on the grid, which is required to charge the Renault Zoe	Technical constraints at pilot sites are considered in the design	5		PARTA (Joachim Jacob)
FVG_008	The users should be matched to predefined templates based on DSO needs through the WiseFastV2G	WiseGRID FastV2G	Functional and data requirements		There exists a workflow allowing FastV2G to activate certain services upon DSO requirement	4		HEDNO (alexandros karagiannis)
FVG_009	The WiseFastV2G should be able to manage and monitor the consumption of electric energy	WiseGRID FastV2G	Functional and data requirements		FastV2G provides energy metering data	5		EMOT (Lio Mancinelli)

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FVG_011	EVSE to provide info to the user about charging capabilities (power output) and about optimizing the energy usage and reduction CO_2 footprint of the EV	WiseGRID FastV2G	Usability and humanity requirements		User-friendly way of communication between EVSE and EV user	4		ETRA (Álvaro Nofuentes)
FVG_012	EV charging constraints	WiseGRID FastV2G	Functional and data requirements		A clear visibility of the EV charging constraints	5	Like minimum charging power/current.	ETRA (Álvaro Nofuentes)
FVG_013	EVSE capable of communicating status (free, reserved, in use, out of order), as well to user as to WG IOP.	WiseGRID FastV2G	Operational requirements		A well-defined communication paths.	4		ETRA (Álvaro Nofuentes)
FVG_014	EV minimum desired SoC at the end of the process is well known	WiseGRID FastV2G	Functional and data requirements		A clear observability of the final SoC	4		ETRA (Álvaro Nofuentes)
FVG_015	Identification method available on EVSE for users (smart card reader or smartphone /web-app, etc.)	WiseGRID FastV2G	The scope of the product	The user needs to be authenticated before using the EVSE	The authentication process is performed	4		ITE (Irene Aguado)
FVG_016	The EVSEs installed in a home environment will participate in the house energy management process modulating the power consumption and even injecting power to the household electric installation (V2H)	WiseGRID FastV2G	The scope of the product		The EVSEs offer flexibility capabilities to the WiseHOME	4		ITE (Irene Aguado)
FVG_017	Home EVSEs will be able to calculate its V2H and smart charging capabilities.	WiseGRID FastV2G	The scope of the product		The EVSEs offer flexibility capabilities to the WiseHOME	4		ITE (Irene Aguado)
FVG_018	EVSE has a visual identification means: blinking leds, led screen with info, or a console at it to allow direct user interaction	WiseGRID FastV2G	Functional and data requirements	WiseEVP manages the EVSE: but the interaction with the user can happen at the EVSE itself (authenticate/activate), or can happen through a console when WiseEVP manages a hub. The user needs to simply find	EVSE has components to allow its identification to guide users, and can be configured in WiseEVP/mgmt. tools	5		PARTA (Joachim Jacob)

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				the right EVSE of the hub which it is pointed to.				
IOP_001	IOP must implement authentication mechanisms to identify its clients	WiseGRID Interoperable Platform	Functional and data requirements	Different SW modules connecting to IOP need to be identified to allow access control policies on the data exchanged	Authentication mechanism is in place	5		ETRA (Alberto Zambrano)
IOP_002	IOP must implement access control mechanisms over the information exchanged	WiseGRID Interoperable Platform	Functional and data requirements	Different SW modules will exchange data through the IOP, and mechanisms should be put in place to protect unauthorised access to data	Access Control mechanisms are in place	5		ETRA (Alberto Zambrano)
IOP_003	It collects and transfers heterogeneous and massive data stream coming from energy network	WiseGRID Interoperable Platform	Functional and data requirements		Verify network connection availability and performance	5		ENG (Antonello Corsi)
IOP_004	IOP manages heterogeneous data information	WiseGRID Interoperable Platform	Functional and data requirements		Typologies of data to be verified	5		ENG (Antonello Corsi)
IOP_005	guidelines to integrate the energy applications have to be identified	WiseGRID Interoperable Platform	Open issues			3		ENG (Antonello Corsi)
IOP_006	IOP must interface with different energy distributed resources of the smart grid and energy market actors	WiseGRID Interoperable Platform	Functional and data requirements		IOP will be able to interface with DER and other market actors	5		ENG (Antonello Corsi)
IOP_007	IOP is based on standards and interoperable technologies based on web services	WiseGRID Interoperable Platform	Performance requirements		t	5		ENG (Antonello Corsi)
IOP_008	IOP must manage data according privacy policy	WiseGRID Interoperable Platform	Functional and data requirements		privacy policy will be taken in account for manage data	5		ENG (Antonello Corsi)
IOP_009	IOP must follow a privacy-preserving data collection policy	WiseGRID Interoperable Platform	Functional and data requirements	IOP does not collect data in general. But it does collect authentication data of users.	privacy issue has to be described more specific	4		ENG (Antonello Corsi)

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IOP_010	IOP has to assure security	WiseGRID Interoperable Platform	Security requirements		security mechanism have to be considered for manage data	5		ENG (Antonello Corsi)
IOP_011	IOP has to assure high performance and efficiency on data aggregation and filtering	WiseGRID Interoperable Platform	Performance requirements			4		ENG (Antonello Corsi)
IOP_012	WG IOP shall send and receive data through WG IOP components.	WiseGRID Interoperable Platform	Functional and data requirements		That's the main role of WG IOP platform.	5	WG IOP components read field data, validate against a model and send to WG IOP. (As it was mentioned in the HLUC Leaders Telco).	HEDNO (Stamatia Gkiala Fikari)
IOP_013	A common framework shall be put in place for intercommunication among all modules and applications.	WiseGRID Interoperable Platform	Operational requirements		This will strengthen the interoperability of the platform and the scalability of the system.	5	Based on WG IOP Micro workshop.	HEDNO (Stamatia Gkiala Fikari)
IOP_014	It needs to support asynchronous communication.	WiseGRID Interoperable Platform	Operational requirements			4		HEDNO (Dimitrios Stratogiannis)
IOP_015	IOP should provide the centralised user authentication system	WiseGRID Interoperable Platform	The scope of the product	Users booking and activating charging sessions on the WiseEVP console need to be able to authenticate	Function is implemented	3		PARTA (Joachim Jacob)
IOP_016	IOP has repository of communication modules readily accessible and installable by different Wise tools	WiseGRID Interoperable Platform	The scope of the work	IOP performs communication. Each Wise tool should be able to install the required communication tool, e.g. WiseHOME for a certain heat pump, WiseEVP for a certain EVSE, VPP for a certain storage device.	The repository of IOP modules is available and Wisetools can connect to it	5		PARTA (Joachim Jacob)
SAS_040	StaaS/VPP should be able to integrate multiple stationary storage systems as a type of controllable distributed energy production in the virtual power plant	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Stationary storage systems are considered on the StaaS/VPP design	4	Like V2G, stationary storage systems could be seen as regular distributed production systems that can be discharged on command. The StaaS/VPP	ECO (Ine Swennen)

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							should be able to control this discharging based on SoC.	
SAS_002	Algorithms should strive for maximal lifespan of battery	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		ECO (Ine Swennen)
SAS_003	Algorithms for selection of best suited combinations of storage units have to consider type of storage, availability of storage system, power capability, remaining energy content, current aging status, efficiency, demand and production forecasts	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		VS (Benjamin Kraft)
SAS_004	Tool must collect and process data from storage systems	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		VS (Benjamin Kraft)
SAS_005	Tool must be linked to energy market.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		VS (Benjamin Kraft)
SAS_006	Algorithms have to define if participation of storage systems in energy market/energy transfer is beneficial or not. (Aging of system + loss of energy + unavailability during period vs. income)	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		VS (Benjamin Kraft)
SAS_007	Not only energy transfer to/from energy market but also to/from other storage systems should be considered	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			1		VS (Benjamin Kraft)
SAS_008	Communication structure/protocols used for data transfer between storage systems and platform should be secure and inline with current standards	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		VS (Benjamin Kraft)

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SAS_009	Aggregated data from storage systems should be anonymised	WiseGRID Storage-as-a-Service/VPP	Legal requirements			4		VS (Benjamin Kraft)
SAS_010	Tool must include billing function. If necessary data transfer with smart meters has to be established as well	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		VS (Benjamin Kraft)
SAS_011	Addition to SAS_003: Grid status should be included in selection algorithms as well. Link to WG Cockpit?	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		VS (Benjamin Kraft)
SAS_012	Tool calculates how the overall VPP-power is distributed to the different storage systems according to ranking. Selection criteria are mentioned in SAS_03	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		VS (Benjamin Kraft)
SAS_013	Tool should integrate Renewable Energy Generation	WiseGRID Storage-as-a-Service/VPP	The scope of the product			4		AMP (Xavier Benavides)
SAS_014	The tool should notify the user for the uses	WiseGRID Storage-as-a-Service/VPP	Usability and humanity requirements			3		AMP (Xavier Benavides)
SAS_015	The tools needs to take into account the needs from the DR module	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		AMP (Xavier Benavides)
SAS_016	Platform shall allow both short-term and long-term contracts	WiseGRID Storage-as-a-Service/VPP	Operational requirements	The needs for energy storage and production may range from minutes to months	The platform allows third parties to ask both for short and long-term contracts	2	e.g. long-term production contract to compensate reduction of PV production during winter, which may be compensated by long-term storage technologies; or short-term production contract to deal with unforeseen peak on the demand	ETRA (Alberto Zambrano)

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SAS_017	The system must calculate the optimal bid to be placed in the market.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements	Mathematic formulas/checks and the convergence time allows the module to evaluate the quality of the results	The module, next to the results, should inform about the quality of the results (optimal, suboptimal, etc.)	3		ICCS (Styliani Sarri)
SAS_018	Command verification	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements	The system must be able to measure the unit's response and verify its operation is consistent with the acknowledge event	Acknowledge events are always sent. In addition they can be compared to the actual response.	3		ICCS (Styliani Sarri)
SAS_019	The tool must be able to manage all VPP participants contracts	WiseGRID Storage-as-a-Service/VPP	The scope of the product	The different contracts between VPP participants contain technical details/constraints. All these data should be managed and stored in the DBs of WiseGRID application.	The tool should be able to manage at least 20 different types of contracts	3		ICCS (Styliani Sarri)
SAS_020	System Scalability	WiseGRID Storage-as-a-Service/VPP	Performance requirements	The system shall support a minimum number of simultaneous dispatch of control signals to different types of devices	The system must be able to control at least 20 devices simultaneously	4		ICCS (Styliani Sarri)
SAS_021	VPP Cyber/Physical protection	WiseGRID Storage-as-a-Service/VPP	Security requirements	Detection algorithms for intrusion by unauthorized persons are installed. The system should detect and avoid attempted intrusions by unauthorized persons or processes	The system should comply with the Cyber Security Standards/Processes required in each country	3		ICCS (Styliani Sarri)
SAS_022	VPP User Management	WiseGRID Storage-as-a-Service/VPP	Security requirements	The tool should prevent access to data (energy, meteorological, customer contracts, etc.) from unauthorized persons or client applications.	The System should comply with the privacy rules in each region and all process/ sub process in all levels will have user identification methods	3		ICCS (Styliani Sarri)
SAS_023	Tool's downtime during upgrade operations	WiseGRID Storage-as-a-Service/VPP	Maintainability and support requirements	The system should have a mechanism that will allow the fast installation of upgrades	Downtime time less than 1 hour during upgrades	3		ICCS (Styliani Sarri)

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SAS_025	VPP participants as well as their meters and sensors must have an Internet connection and be operative	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Having a 24h connectivity	4		ETRA (Álvaro Nofuentes)
SAS_026	The VPP energy grid status of important components must be available (voltage, frequency…)	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Having VPP grid status information periodically	5		ETRA (Álvaro Nofuentes)
SAS_027	Decentralized energy generators and/or energy consumers portfolio (including their characteristics)	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Having a portfolio of all the RES and consumers	3		ETRA (Álvaro Nofuentes)
SAS_028	Receiving notifications and requests by WG cockpit (DSO) about status of the distribution Grid	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Having a way of communication between the DSO and the VPP	5		ETRA (Álvaro Nofuentes)
SAS_029	Nominal battery characteristics	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Collecting the most important nominal characteristics of all the batteries	2		ETRA (Álvaro Nofuentes)
SAS_030	Power and energy capability of the storage system in order to meet the black start requirements	WiseGRID Storage-as-a-Service/VPP	Operational requirements		Availability of having storage system information in order to plan and provide black starts	4		ETRA (Álvaro Nofuentes)
SAS_031	Implementation of an algorithm that calculates the best option to manage an energy production surplus.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements		Having a reliable algorithm to make this calculation	5		ETRA (Álvaro Nofuentes)
SAS_032	WG StaaS/VPP should provide islanding mode in case of a power outage.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		HEDNO (Dimitrios Stratogiannis)
SAS_033	The GUI of the Aggregator app version should assist in prosumer portfolio management, with the list of the related prosumers, their assets and their location in grid topology.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		HEDNO (Dimitrios Stratogiannis)

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SAS_034	It should provide information on the overall status of VPP, regarding current production, SoC, and forecasting.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		HEDNO (Dimitrios Stratogiannis)
SAS_035	It should support ADR.	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			4		HEDNO (Dimitrios Stratogiannis)
SAS_036	It should provide VPP flexibility forecast	WiseGRID Storage-as-a-Service/VPP	Functional and data requirements			5		HEDNO (Dimitrios Stratogiannis)
SAS_037	StaaS/VPP must facilitate selling the energy managed by VPP in the corresponding wholesale market	WiseGRID Storage-as-a-Service/VPP	The scope of the work	VPP gets profit from selling energy produced by their assets	StaaS/VPP provides the VPP operator all necessary information for interacting with the wholesale market	5		ETRA (Alberto Zambrano)
SAS_038	VPP will only aggregate controllable assets	WiseGRID Storage-as-a-Service/VPP	Mandated constraints	Since VPP must provide assured services, all assets aggregated by VPP have to be controllable	StaaS/VPP design takes this constraint into account	5		ETRA (Alberto Zambrano)
SAS_039	An information channel from VPP operator to portfolio members will be available	WiseGRID Storage-as-a-Service/VPP	The scope of the work	Information contribution to portfolio, status of assets, etc. has to be displayed to members of the portfolio	"Acceptance criteria	Integration between WiseHOME/WiseCORP (member applications) and StaaS/VPP is available"	5	ETRA (Alberto Zambrano)
HOM_001	End-users should get access to energy consumption, local generation (if any) and storage (if any) information (real-time and historical) in a personalized way	WiseHOME app	Functional and data requirements	WiseHOME app for individual domestic consumers and prosumers to enable efficient monitoring of real-time energy consumption/ generation/ storage data	Availability of information visualization	5		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
HOM_002	End-users should get access to energy cost & CO_2 intensity information (real-time and historical data) in a personalized way	WiseHOME app	Functional and data requirements	The main features and functionalities included in this application are emissions monitoring and analytics along with economic management	Availability of information visualization	5		HYP (k.tsatsakis)
HOM_003	End-users should get informed about retailer prices and available tariff schemes	WiseHOME app	Functional and data requirements	One of the main features and functionalities included in this application is financial and economic management of end-users assets	Availability of information visualization	4		HYP (k.tsatsakis)
HOM_004	Along with real-time information end-users will receive information about short term consumption and generation forecast	WiseHOME app	Functional and data requirements	Production and consumption forecast information to facilitate end-users towards a better understanding of energy usage	Availability of information visualization	3		HYP (k.tsatsakis)
HOM_005	Advices and recommendations about efficient energy usage should be triggered to the end-users	WiseHOME app	Functional and data requirements	Advices and recommendations about energy usage will facilitate end-users towards a better understanding of energy consumption	Advice/notification demonstration	5		HYP (k.tsatsakis)
HOM_006	Notifications about activation of manual driven DR Strategies should be available via WiseHOME app	WiseHOME app	Functional and data requirements	WiseHOME app as the means of active participation of end-users in manual driven DR strategies	Demonstration of notifications	4		HYP (k.tsatsakis)
HOM_007	The end-users should get informed about incentives (for DR participation) or penalization (for non DR participation)	WiseHOME app	Functional and data requirements	Following participation in DR strategies, the end-users will get informed about incentives (for participation) or penalization (for non-participation)	Availability of information/notification	4		HYP (k.tsatsakis)
HOM_008	The app should be as user-friendly as possible	WiseHOME app	Usability and humanity requirements	Because of the number of foreseen functionalities we need to keep in mind to keep the app easy-to-use for the end-user.	Positive user evaluation of the app friendliness after the pilot tests	5		ECO (Ine Swennen)
HOM_009	Consumer or prosumers need to have an opt-out option for	WiseHOME app	Functional and data requirements	Demonstration of app functionality and its operation		3		AUEB (George Thanos)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
	DR/ADR programs (if ADR is exploited in the project).							
HOM_010	The application GUI should be designed in a user-centric way i.e. involving the feedback of the end-user at the design phase	WiseHOME app	Look and feel requirements	Availability of user feedback during design cycle and compliance to the feedback		4		AUEB (George Thanos)
HOM_011	The granularity of consumption and generation information presented to the consumers/prosumers should be at least (min) at an hourly level	WiseHOME app	Functional and data requirements	Demonstration of feature given data availability		5	I guess this should apply to other products as well as it influences the underlying algorithms and optimisation schemes.	AUEB (George Thanos)
HOM_012	WiseHOME app should include remote control of smart devices for end-users	WiseHOME app	Functional and data requirements	Demonstration of app functionality and its operation		4		VS (Benjamin Kraft)
HOM_013	WiseHOME app should illustrate cost savings	WiseHOME app	Functional and data requirements	Demonstration of feature in app GUI		3		VS (Benjamin Kraft)
HOM_014	WiseHOME shall allow its users to set constraints to the remote control of the smart appliances	WiseHOME app	Operational requirements	Users may allow automatic management of the smart appliances as part of the DR schemes, but always under certain limits	WiseHOME GUI includes an interface for setting these constraints	4	E.g. EV must be fully charged every morning, HVAC temperature modification limits calendar, etc.	ETRA (Alberto Zambrano)
HOM_015	Notifications about activation of ADR strategies should be available via WiseHOME app	WiseHOME app	Functional and data requirements	Following participation in DR strategies, the end-users will get informed in case of ADR campaign	Notification demonstration	4		HYP (k.tsatsakis)
HOM_016	End-users should get informed about active DR contracts in a personalised way	WiseHOME app	Functional and data requirements	The end-users should get informed about the DR contracts they are enrolled	Information availability	4		HYP (k.tsatsakis)
HOM_017	End-users should get informed about the best practices towards optimally participating in active DR contracts	WiseHOME app	Functional and data requirements	Best practices per DR contact to ensure the optimal participation of end-users in DR programmes (DR Convenience)	Information availability	3		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
HOM_018	Simple analytics over historical data (consumption/ generation/ cost etc.) will be provided by the tool	WiseHOME app	Functional and data requirements	Sample Analytics (aggregation, segmentation) over historical data to present meaningful information to the end-users	Visualization demonstration	3		HYP (k.tsatsakis)
HOM_019	End-users (prosumers) should get access to local generation data, if any	WiseHOME app	Functional and data requirements	Along with access on consumption data, local generation (if any) data should be visualized	Information visualization demonstration	4		HYP (k.tsatsakis)
HOM_020	End-users (prosumers) should get access to local storage data if any	WiseHOME app	Functional and data requirements	Along with access on consumption data, local storage (if any) data should be available	Information visualization demonstration	4		HYP (k.tsatsakis)
HOM_021	Apart from DR strategies, ESCOs and Aggregators may trigger additional messages to the portfolio users via the app	WiseHOME app	Functional and data requirements	Messages about energy efficiency; notifications about grid issues, etc.	Functionality demonstration	3		HYP (k.tsatsakis)
HOM_022	The application will support social networks integration, to allow that way comparison with similar peers	WiseHOME app	Functional and data requirements	Integration with social media like Facebook and Twitter to promote end-users compare with similar peers	Functionality demonstration	3		HYP (k.tsatsakis)
HOM_023	The end-users will be able to configure the Home app settings (username, password, social media connection)	WiseHOME app	Functional and data requirements	A configuration menu should be available for the end-users to appropriately configure specific parameters	Functionality demonstration	4		HYP (k.tsatsakis)
HOM_025	Data must be presented in an accessible, understandable and flexible format	WiseHOME app	Usability and humanity requirements	Messages and information must be presented in an accessible, understandable and flexible format that enables users to take action	Positive feedback from pilot site users	5		HYP (k.tsatsakis)
HOM_027	WiseHOME will only provide access to authenticated users	WiseHOME app	Security requirements	End user credentials are required for accessing the app to address privacy and security concerns	Functionality demonstration	4		HYP (k.tsatsakis)
HOM_028	Data should be consistent ensuring that way the reliability of the app	WiseHOME app	Performance requirements	The overall development of the app should ensure high levels of reliability	No unresolved observation of data coherency problems during pilot testing	4		HYP (k.tsatsakis)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
HOM_029	The structure of the app should address scalability requirements	WiseHOME app	Performance requirements	The overall structure of the app should be scalable enough to enable the connection of multiple user	No perceived app performance degradation in pilot testing due to mass deployment	3		HYP (k.tsatsakis)
HOM_030	Users should be able to access WiseHOME from any device with a browser	WiseHOME app	Operational requirements	Web app development to ensure connectivity from an accessible via a variety of platforms and operating systems	Demonstration of app access through several devices	4		HYP (k.tsatsakis)
HOM_031	Under automated demand-response, cleanest energy sources must always be prioritized against fossil-fuel based ones	WiseHOME app	Operational requirements	Addressing comment received to UC 5.2	Automated DR algorithms take into account the kind of energy source	3		ETRA (Alberto Zambrano)
HOM_032	Remotely controllable loads	WiseHOME app	Operational requirements	Needed to allow automated DR	Having a portfolio of remotely controllable loads	4		ETRA (Álvaro Nofuentes)
HOM_033	Real-time monitoring information about indoor/exterior conditions in buildings	WiseHOME app	Functional and data requirements	Indoor conditions needed for automated optimization. Outdoor conditions needed for RES production forecast	Availability to monitor the conditions (internal or external) of a building	3		ETRA (Álvaro Nofuentes)
HOM_034	Maintenance of devices information (solar panels, boilers, air conditioning, etc.)	WiseHOME app	Operational requirements	Providing information to the user about near revisions (accorded to his ESCO) or about good maintenance practices of his/her devices.	Having a way of communication between the ESCO and their clients	1		ETRA (Álvaro Nofuentes)
HOM_035	Calculation of the optimal power term for each prosumer	WiseHOME app	Operational requirements	Allows reduction of bill for prosumers	Having a reliable algorithm to make this calculation	2		ETRA (Álvaro Nofuentes)
HOM_036	Market information availability	WiseHOME app	Functional and data requirements	Tariff comparison	Having a reliable communication with the Market	5		ETRA (Álvaro Nofuentes)
HOM_037	Anonymizing data from private EVs	WiseHOME app	Security requirements		Availability of having a reliable way to anonymize EV data	4	Data between a EV managed by WiseHOME and other WG tools involved should be anonymized	ETRA (Álvaro Nofuentes)

[Requirement ID]	[Description]	[Classification]	[Type]	[Rationale]	[Acceptance criteria]	[Priority]	[Comments]	[Author]
HOM_038	WiseHOME app should include a user support section.	WiseHOME app	Usability and humanity requirements		The app should be as user-friendly as possible in order to keep the end-user engaged.	4		HEDNO (Stamatia Gkiala Fikari)
HOM_039	Private EV owners end-users should get access to EV management for domestic charging.	WiseHOME app	Functional and data requirements		Since WiseEVP is not available for residential customers, WiseHOME should cover this "gap" and support the private EV owners on residential level.	3		HEDNO (Stamatia Gkiala Fikari)
HOM_040	WiseHOME app shall allow its users to set constraints on the use of their data.	WiseHOME app	Usability and humanity requirements		In order to protect sensitive data.	3		HEDNO (Stamatia Gkiala Fikari)
HOM_041	WiseHOME will be able to execute the home EVSE's flexibility offers (V2H and/or smart charging capabilities)	WiseHOME app	The scope of the product		The flexibility offers are executed	4		ITE (Irene Aguado)
HOM_042	WiseHOME must have access via WG IOP to assets-to-be-controlled or their load controller via remotely accessible APIs (preferably over IP, e.g. ReST interfaces)	WiseHOME app	Operational requirements	WiseHOME is a digital application that requires interfaces in order to communicate with tangible energy assets. These interfaces do not constitute part of the application and must be available, usually provided by the asset vendor.	WiseHOME can remotely control energy assets	5		HYP (Antonis Papanikolau)

13 ANNEX B – UC INVENTORY

In this paragraph, the UCs inventory is presented. In total 129 UCs have been defined, out of which 27 PUCs and 102 SUCs. Each UC is characterized by its implementation priority (L: low; M: medium; H: high) within the WiseGRID project. Additionally, the WiseGRID tools employed by each UC are presented and categorized as either main or auxiliary. In the same table, the priority for implementing each UC in the respective pilot sites is indicated using a scale from 1 (low priority) to 5 (high priority), or "-" (not applicable).

Table 31 – UCs inventory

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID (CRE)																	
1	**HL-UC 1_PUC_1_Network monitoring**	**CRE**	**H**	**Main**		**Aux.**							**4**	**-**	**5**	**4**	**4**
2	HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections	ETRA	H	Main		Aux.	Aux.						4	-	5	4	4
3	HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections	CRE	H	Main		Aux.							4	-	5	4	4
4	HL-UC 1_SUC_1.3_KPI management	ETRA	H	Main		Aux.							4	-	5	4	5
5	HL-UC 1_SUC_1.4_Big data storage analysis	ETRA	H	Main		Aux.							4	-	5	3	3
6	**HL-UC 1_PUC_2_Control strategies for reducing RES curtailment**	**CRE**	**H**	**Main**		**Aux.**		**Aux.**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**4**	**-**	**4**	**3**	**3**
7	HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption	CRE	H	Main		Aux.	Aux.	Aux.	Aux.				3	-	4	3	3
8	HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means	ETRA	H	Main		Aux.		Aux.	Aux.	Aux.	Aux.	Aux.	2	-	4	3	3
9	HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies	ETRA	H	Main		Aux.		Aux.	Aux.		Aux.	Aux.	4	-	4	3	3
10	HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode	ETRA	L	Aux.		Aux.				Aux.	Aux.	Aux.	4	-	4	3	3
11	**HL-UC 1_PUC_3_Voltage support and congestion management**	**CRE**	**H**	**Main**	**Aux.**	**Aux.**		**Aux.**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**4**	**-**	**5**	**3**	**3**
12	HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)	CRE	H	Main	Aux.	Aux.			Aux.	Aux.	Aux.	Aux.	4	-	4	3	3
13	HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)	CRE	M	Main	Aux.	Aux.		Aux.	Aux.	Aux.	Aux.	Aux.	4	-	4	3	3
14	HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases	CRE	L	Main		Aux.							4	-	5	3	3

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
15	**HL-UC 1_PUC_4_Grid planning analysis**	**CRE**	**L**	**Main**		**Aux.**							**4**	**-**	**5**	**-**	**-**
16	HL-UC 1_SUC_4.1_EV charge points planning analysis	CRE	L	Main		Aux.							3	-	5	-	-
17	HL-UC 1_SUC_4.2_Grid storage planning analysis	CRE	L	Main		Aux.							4	-	5	-	-
18	**HL-UC 1_PUC_5_Promote RES via RESCO companies**	**CRE**	**M**			**Aux.**	**Main**	**Aux.**	**Aux.**			**Aux.**	**2**	**5**	**4**	**2**	**3**
19	HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance	CRE	M			Aux.	Main						2	5	4	2	3
20	HL-UC 1_SUC_5.2_Monitor domestic RES production	CRE	M			Aux.	Main						2	3	4	2	3
21	HL-UC 1_SUC_5.3_Monitor domestic clients consumption	CRE	M			Aux.	Aux.		Aux.			Main	2	3	4	2	3
22	HL-UC 1_SUC_5.4_Manage energy selling	CRE	M			Main	Main		Aux.			Aux.	2	5	4	2	3
23	HL-UC 1_SUC_5.5_Energy cost management	CRE	M			Aux.	Main					Aux.	3	5	4	2	3
HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION (ICCS)																	
24	**HL-UC 2_PUC_1_Distribution network real-time monitoring**	**ETRA**	**H**	**Main**		**Aux.**		**Aux.**	**Aux.**		**Aux.**		**4**	**-**	**5**	**4**	**4**
25	HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters	ETRA	H	Main		Aux.							4	-	5	4	2
26	HL-UC 2_SUC_1.2_Data concentration	ETRA	H	Aux.		Main							4	-	5	4	4
27	HL-UC 2_SUC_1.3_Monitoring power quality in the grid	ETRA	H	Main		Aux.							4	-	5	4	4
28	HL-UC 2_SUC_1.4_Fault detection and identification	ETRA	H	Main		Aux.		Aux.	Aux.		Aux.		5	-	5	3	-
29	HL-UC 2_SUC_1.5_Asset management	ETRA	H	Main									5	-	5	4	4
30	**HL-UC 2_PUC_2_Real-time distribution system awareness**	**ICCS**	**H**	**Main**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**Aux.**	**4**	**-**	**5**	**4**	**3**
31	HL-UC 2_SUC_2.1_RES and load forecasting	ICCS	H	Main	Aux.	Aux.	Aux.	Aux.	Aux.	Aux.	Aux.	Aux.	4	-	5	5	5
32	HL-UC 2_SUC_2.2_Topology processor	ICCS	M	Main		Aux.							4	-	5	4	2
33	HL-UC 2_SUC_2.3_Network observability analysis	ICCS	H	Main		Aux.							4	-	5	5	3
34	HL-UC 2_SUC_2.4_Load flow calculation	ICCS	H	Main									4	-	5	5	5
35	HL-UC 2_SUC_2.5_State estimation	ICCS	H	Main		Aux.			Aux.				4	-	5	5	3
36	HL-UC 2_SUC_2.6_Bad data detection, identification and replacement	ICCS	H	Main		Aux.							4	-	5	4	4

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
37	**HL-UC 2_PUC_3_Grid control**	**ICCS**	**H**	**Main**		**Aux.**	**Aux.**	**Aux.**	**Aux.**		**Aux.**		**4**	**-**	**5**	**3**	**3**
38	HL-UC 2_SUC_3.1_Load control	ICCS	H	Main		Aux.							4	-	5	3	3
39	HL-UC 2_SUC_3.2_DR as a service to the grid	ICCS	H	Main	Aux.	Aux.		Aux.	Aux.	Aux.	Aux.	Aux.	4	-	5	3	3
40	HL-UC 2_SUC_3.3_Optimization algorithm	ICCS	H	Main		Aux.		Aux.	Aux.		Aux.		4	-	4	4	4
41	HL-UC 2_SUC_3.4_Reconfiguration	ICCS	M	Main		Aux.		Aux.	Aux.		Aux.		4	-	5	3	2
42	HL-UC 2_SUC_3.5_Islanding procedures for the local grid	ICCS	L	Main		Aux.		Aux.	Aux.		Aux.		4	-	4	3	-
43	HL-UC 2_SUC_3.6_Cold ironing	ICCS	M	Main		Aux.				Main			-	-	4	-	3
HL-UC 3 e-MOBILITY INTEGRATION IN THE GRID WITH V2G (ITE)																	
44	**HL-UC 3_PUC_1_EVSE and EV fleet monitoring**	**ETRA**	**H**		**Main**	**Aux.**					**Main**	**Main**	**2**	**5**	**5**	**2**	**4**
45	HL-UC 3_SUC_1.1_Data collection from EVSE	ETRA	H		Main	Aux.					Main	Aux.	2	5	5	2	4
46	HL-UC 3_SUC_1.2_Data collection from EVs	ETRA	H		Aux.	Aux.					Main	Main	2	5	5	2	4
47	**HL-UC 3_PUC_2_Interaction of the user with EVSE**	**ITE**	**M**		**Main**	**Main**					**Main**		**1**	**3**	**4**	**2**	**4**
48	HL-UC 3_SUC_2.1_Users' authentication	ITE	M		Main	Main					Main		1	-	4	2	4
49	HL-UC 3_SUC_2.2_Charging session request	ITE	M		Main	Main					Main		1	5	4	2	4
50	HL-UC 3_SUC_2.3_Charging session booking	ITE	M		Aux.	Main					Main		2	3	4	2	4
51	**HL-UC 3_PUC_3_EV charging management**	**ITE**	**M**	**Main**	**Main**	**Main**					**Main**		**1**	**1**	**5**	**2**	**4**
52	HL-UC 3_SUC_3.1_EVSE network configuration	ITE	M	Main	Main	Main					Main		1	1	5	2	4
53	HL-UC 3_SUC_3.2_EV load forecasting	ITE	M		Main	Main					Main		1	3	5	2	4
54	HL-UC 3_SUC_3.3_EV flexibility estimation	ITE	M			Main					Main		1	1	5	2	4
55	HL-UC 3_SUC_3.4_Reference charging load profile calculation	ITE	M								Main		1	-	4	2	4
56	HL-UC 3_SUC_3.5_Charging session schedule	ETRA	H		Aux.	Aux.					Main		1	1	4	2	4
57	**HL-UC 3_PUC_4_Interaction with the energy infrastructure**	**ITE**	**M**	**Main**	**Main**	**Main**		**Main**			**Main**	**Main**	**3**	**2**	**5**	**2**	**4**
58	HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests	ITE	M	Main	Main	Main					Main		1	-	5	2	4

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
59	HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration	ETRA	H		Aux.	Aux.		Aux.			Main		1	3	5	2	4
60	HL-UC 3_SUC_4.3_EV providing V2H services	ITE	M			Main						Main	3	-	4	2	4
HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL (AMP / VS)																	
61	**HL-UC 4_PUC_1_Batteries management at prosumer level**	**AMP / VS**	**H**			**Aux.**				**Main**		**Main**	**2**	**5**	**3**	**2**	**4**
62	HL-UC 4_SUC_1.1_Increase of self-consumption	AMP / VS	H			Aux.				Main		Main	2	5	3	2	4
63	HL-UC 4_SUC_1.2_Time-of-use management	AMP / VS	M			Aux.				Main		Main	2	5	3	2	4
64	HL-UC 4_SUC_1.3_Peak shaving	AMP / VS	M			Aux.				Main		Main	2	5	3	2	3
65	**HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)**	**AMP / VS**	**M**	**Aux.**		**Aux.**	**Aux.**	**Main**	**Main**	**Aux.**		**Aux.**	**-**	**4**	**5**	**2**	**4**
66	HL-UC 4_SUC_2.1_Batteries dispatch management	AMP / VS	H	Aux.		Aux.		Main	Aux.	Aux.		Aux.	-	4	4	2	4
67	HL-UC 4_SUC_2.2_Black start capabilities	AMP / VS	L	Aux.		Aux.		Main	Aux.				-	4	4	1	4
68	HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonization	AMP / VS	M	Aux.		Aux.	Aux.	Main	Main	Aux.		Aux.	2	4	5	2	4
69	HL-UC 4_SUC_2.4_Backup power for residential area	AMP / VS	L	Aux.		Aux.		Main	Main	Aux.		Aux.	2	-	4	1	4
70	**HL-UC 4_PUC_3_Ancillary services**	**AMP / VS**	**M**	**Aux.**		**Aux.**		**Main**	**Aux.**	**Aux.**		**Aux.**	**-**	**3**	**5**	**2**	**4**
71	HL-UC 4_SUC_3.1_Market scheduling	AMP / VS	H	Aux.		Aux.		Main	Aux.				-	3	3	2	4
72	HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system	AMP / VS	M	Aux.		Aux.		Main	Aux.	Aux.		Aux.	-	3	4	2	4
73	HL-UC 4_SUC_3.3_Batteries automatic dispatch	AMP / VS	M	Aux.		Aux.		Main	Aux.	Aux.		Aux.	-	3	4	1	4
74	**HL-UC 4_PUC_4_Combination of battery storage systems**	**AMP / VS**	**M**	**Aux.**		**Aux.**		**Main**	**Aux.**	**Aux.**		**Aux.**	**-**	**4**	**3**	**2**	**4**
75	HL-UC 4_SUC_4.1_Parameter configuration of storage systems	AMP / VS	M	Aux.		Aux.		Main	Main	Aux.		Aux.	-	4	3	2	4
76	HL-UC 4_SUC_4.2_Priority list of units running	AMP / VS	M	Aux.		Aux.		Main	Aux.	Aux.		Aux.	-	4	3	2	4
HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING (ICCS / EPA)																	
77	**HL-UC 5_PUC_1_Thermal monitoring**	**ICCS / EPA**	**M**			**Aux.**				**Main**			**-**	**-**	**-**	**5**	**-**
78	HL-UC 5_SUC_1.1_Monitoring gas meters	ICCS / EPA	L			Aux.				Main			-	-	-	5	-
79	HL-UC 5_SUC_1.2_Monitoring CHP	ICCS / EPA	M			Aux.				Main			-	-	-	5	-

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
80	HL-UC 5_SUC_1.3_Monitoring buildings	ICCS / EPA	M			Aux.				Main			-	-	-	5	-
81	**HL-UC 5_PUC_2_Cogeneration and HVAC management**	**ICCS / EPA**	**M**			**Aux.**				**Main**			**-**	**-**	**-**	**4**	**-**
82	HL-UC 5_SUC_2.1_Forecasting thermal needs	ICCS / EPA	M			Aux.				Main			-	-	-	5	-
83	HL-UC 5_SUC_2.2_Real-time control set-points	ICCS / EPA	M			Aux.				Main			-	-	-	2	-
84	HL-UC 5_SUC_2.3_Control devices	ICCS / EPA	M	Aux.		Aux.	Aux.		Aux.	Main		Aux.	-	-	-	2	-
85	HL-UC 5_SUC_2.4_Alarm management	ICCS / EPA	M	Aux.		Aux.	Aux.		Aux.	Main		Aux.	-	-	-	3	-
86	**HL-UC 5_PUC_3_Comfort-based demand flexibility models**	**ICCS / EPA**	**M**			**Aux.**				**Main**		**Aux.**	**-**	**-**	**-**	**5**	**-**
87	HL-UC 5_SUC_3.1_Thermal model of households	ICCS / EPA	M			Aux.				Main		Aux.	-	-	-	5	-
88	HL-UC 5_SUC_3.2_Thermal model of building	ICCS / EPA	M			Aux.				Main			-	-	-	5	-
89	HL-UC 5_SUC_3.3_Thermal flexibility modeling	ICCS / EPA	M			Aux.				Main			-	-	-	5	-
90	**HL-UC 5_PUC_4_Cogeneration and HVAC optimisation**	**ICCS / EPA**	**M**	**Aux.**		**Aux.**		**Aux.**		**Main**			**-**	**-**	**-**	**4**	**-**
91	HL-UC 5_SUC_4.1_VPP participation	ICCS / EPA	L			Aux.		Aux.		Main			-	-	-	3	-
92	HL-UC 5_SUC_4.2_Provision of ancillary services	ICCS / EPA	M	Aux.		Aux.		Aux.		Main			-	-	-	4	-
93	HL-UC 5_SUC_4.3_System optimisation	ICCS / EPA	M	Aux.		Aux.	Aux.	Aux.	Aux.	Main		Aux.	-	-	-	4	-
HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY (ENG)																	
94	**HL-UC 6_PUC_1_VPP monitoring and management**	**ENG**	**H**			**Aux.**		**Main**					**-**	**5**	**3**	**1**	**1**
95	HL-UC 6_SUC_1.1_Resource metering	ETRA	H			Aux.		Main					-	5	3	1	1
96	HL-UC 6_SUC_1.2_VPP RES forecast	ENG	H			Aux.		Main					-	5	3	1	1
97	HL-UC 6_SUC_1.3_VPP flexibility forecast	ENG	H			Aux.		Main					-	5	3	1	1
98	HL-UC 6_SUC_1.4_Strategies definition	ETRA	M			Aux.		Main		Aux.		Aux.	-	5	3	1	1
99	**HL-UC 6_PUC_2_VPP market participation**	**ENG**	**M**			**Aux.**		**Main**					**-**	**5**	**2**	**1**	**1**
100	HL-UC 6_SUC_2.1_VPP market participation and bid calculation	ENG	M			Aux.		Main					-	5	2	1	1
101	HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation	ENG	M			Aux.		Main					-	5	2	1	1

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
102	HL-UC 6_SUC_2.3_VPP unit scheduling	ENG	M			Aux.		Main		Aux.		Aux.	-	5	2	1	1
103	**HL-UC 6_PUC_3_VPP real-time control**	**ETRA**	**H**	**Aux.**		**Aux.**		**Main**		**Aux.**		**Aux.**	**-**	**5**	**3**	**1**	**1**
104	HL-UC 6_SUC_3.1_Real-time flexibility calculation	ETRA	M			Aux.		Main					-	5	3	1	1
105	HL-UC 6_SUC_3.2_VPP implementation of ancillary services	ETRA	M	Aux.		Aux.		Main					-	5	3	1	1
106	HL-UC 6_SUC_3.3_Real-time decision making	ETRA	H			Aux.		Main					-	5	3	1	1
107	**HL-UC 6_PUC_4_VPP users relationship management**	**ENG**	**L**			**Aux.**		**Main**		**Aux.**		**Aux.**	**-**	**5**	**2**	**1**	**1**
108	HL-UC 6_SUC_4.1_Manage contractual issues	ENG	L			Aux.		Main		Aux.		Aux.	-	5	1	1	1
109	HL-UC 6_SUC_4.2_Define and manage member compensation	ENG	L			Aux.		Main		Aux.		Aux.	-	5	1	1	1
110	HL-UC 6_SUC_4.3_DSM and DR mechanisms	ENG	H			Aux.		Main		Aux.		Aux.	-	5	2	1	1
HL-UC 7 CITIZENS EMPOWERMENT IN ENERGY MARKET AND REDUCTION OF ENERGY POVERTY (HYP)																	
111	**HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector**	**HYP**	**H**			**Aux.**		**Aux.**	**Aux.**	**Main**			**3**	**4**	**1**	**3**	**1**
112	HL-UC 7_SUC_1.1_Monitor energy demand	HYP	H			Aux.			Aux.	Main			3	4	1	5	1
113	HL-UC 7_SUC_1.2_Enriched information visualization	HYP	H			Aux.		Aux.	Aux.	Main			3	4	1	5	1
114	HL-UC 7_SUC_1.3_Integration with DR mechanisms	HYP	H			Aux.		Aux.	Aux.	Main			2	4	1	3	1
115	HL-UC 7_SUC_1.4_Net metering & self-consumption	HYP	M			Aux.			Aux.	Main			2	4	1	3	1
116	HL-UC 7_SUC_1.5_Energy cost management for large infrastructures	HYP	M			Aux.			Aux.	Main			3	4	1	3	1
117	**HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market**	**HYP**	**H**	**Aux.**		**Aux.**			**Main**	**Aux.**		**Aux.**	**2**	**5**	**1**	**3**	**1**
118	HL-UC 7_SUC_2.1_Enriched information visualization	HYP	H			Aux.		Aux.	Main	Aux.		Aux.	3	5	1	5	1
119	HL-UC 7_SUC_2.2_Portfolio profiling & analytics	HYP	H			Aux.		Aux.	Main	Aux.		Aux.	3	5	1	5	1
120	HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading	HYP	H			Aux.		Aux.	Main	Aux.		Aux.	3	5	1	5	1
121	HL-UC 7_SUC_2.4_Billing services	HYP	M			Aux.		Aux.	Main	Aux.		Aux.	3	5	1	5	1
122	HL-UC 7_SUC_2.5_Energy cost management and optimization	HYP	M			Aux.			Main	Aux.		Aux.	3	5	1	3	1
123	HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control	HYP	M	Aux.		Aux.		Aux.	Main	Aux.		Aux.	-	5	1	2	1

		Main responsible partner	UC priority	WiseGRID tools									Pilot sites implementation				
				WG Cockpit	WG FastV2G	WG IOP	WG RESCO	WG STaaS	WiseCOOP	WiseCORP	WiseEVP	WiseHOME	Crevillent	Flanders	Terni	Mesogia	Kythnos
124	HL-UC 7_SUC_2.7_Manual DSM strategies activation	HYP	H	Aux.		Aux.		Aux.	Main	Aux.		Aux.	2	5	1	3	1
125	**HL-UC 7_PUC_3_Clients engagement for active market participation**	**HYP**	**H**			**Aux.**	**Aux.**	**Aux.**	**Aux.**			**Main**	**3**	**5**	**1**	**3**	**1**
126	HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring	HYP	H			Aux.	Aux.		Aux.			Main	3	5	1	5	1
127	HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers	HYP	L			Aux.	Aux.		Aux.			Main	3	5	1	5	1
128	HL-UC 7_SUC_3.3_Participation in DR programs	HYP	H			Aux.		Aux.	Aux.			Main	2	5	1	3	1
129	HL-UC 7_SUC_3.4_Residential net metering & self-consumption	HYP	M			Aux.	Aux.	Aux.				Main	3	5	1	3	1

14 ANNEX C – PRIMARY USE CASES

14.1 HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID

Use Case ID	HL-UC 1_PUC_1_Network monitoring
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	This PUC addresses the observability of the electricity distribution network in presence of RES. It has four main components. The first one deals with measurements acquisition (Voltage [U], Active Power [P], Reactive Power [Q] from nodes, P, Q from RES production connected to the nodes and P, Q from network sections or specific lines). The second one deals with the forecast of RES production, consumption and of total power flow in critical sections, based on the data already collected. The third component is looking to provide the DSO with the necessary mechanisms in order to calculate Key Performance Indicators (KPIs) to assess the correct operation of the grid. The fourth component is dealing with the big amount of data –field measurements, mainly– obtained from the Advance Metering Infrastructure (AMI) deployed in the grid during the scope of the project.
Actors involved	• DSO (DMS, AMI) • RESCO (RES unit, Smart Meter, Sensor) • Prosumer (RES unit, Smart Meter, Sensor)
Triggering Event	DSO need a permanent and continuous real-time overview of the status of the distribution grid
Pre-condition	• Data availability • Type and structure of data, reporting rate • Data collection should be in real-time (or very close to real-time) in order to secure various solutions to avoid RES curtailment • Data should be obtained mainly through real-time readout of smart meters (U, I, P, Q, f); in particular situations will be also available U, and U angles data from PMU equipment. • Interoperability between the tools of different data source providers • Privacy (including agreements for data sharing Data Protection Impact Assessment [DPIA] and post-project data management) • Scaling of the current situation to look for real limit situations will be possible (anticipation of RES production) • Communication protocols must be interoperable • Data security & reliability (avoid bad data, lost data, modified data, etc.)
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	DSO has access to a clear insight of the status of the distribution grid
Typical steps	

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1	RES prediction over grid capacity	Forecast of expected RES generation	Generation forecast of each RES.	RES units	DSO
2	Data collection from grid	Grid parameters are collected and stored in the big data platform to be processed	P, Q, U, angles	RES Units, AMI,	DSO
3	Power flow calculations	Evaluate power flow through grid elements	P, Q, U, angles	DMS	DSO
4	Determine limits violations	Compare power flow results with grid elements limits and evaluate relevant KPIs to trigger alarms and provide information to DSO operator	P, Q, U	DMS	DSO
5	Grid congestion	DSO calculates individual RES reduction to get below the maximum limit	Limits of generation	DSO	RES units
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	No grid data	Evaluation of grid status cannot be performed		DSO	
2	False grid data	Results of the evaluation could be corrupted and consequently real grid status misinterpreted	Grid data	DSO	
3	False grid data	Erroneous DSO decisions	Grid status	DSO	
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, HYP, VS				
Priority	High				

Use Case ID	**HL-UC 1_PUC_2_Control strategies for reducing RES curtailment**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	This PUC focuses on optimizing the general strategy of reducing or avoiding RES curtailment by using the relevant inputs from SUCs, which have different technics in order to achieve the afore-mentioned goal. For this, all HL-UC 1_SUC_2.1 to HL-UC 1_SUC_2.4, are used as candidates for the optimisation. The main purpose is to find various solutions for solving the grid congestions by various means: stimulate local consumption, storage, use of V2G or other means, thus making a stable energy ecosystem which does not stress the grid and the system stability.
Actors involved	• RES Unit • DSO • RESCO

	• Consumer • Prosumer • EVSE Operator • Storage Unit • Battery Operator • Forecast Provider • Balancing Responsible Party • VPP Operator
Triggering Event	• Trip of a grid element (line) • Overload on a specific grid element (line) • Signal for overtemperature on a transformer
Pre-condition	• Data availability • Type and structure of data, reporting rate • Data collection should be in real-time (or very close to real-time) in order to secure various solutions to avoid RES curtailment • Data should be obtained mainly through real-time readout of smart meters (U, I, P, Q, f); in particular situations will be also available U, and U angles data from PMU equipment. • Short-term forecast of the production and consumption of the locally generated RES owned by the community. Adapted behaviour of community • Signal from the DSO about curtailment danger • Incentives or grid injection conditions for prosumers, thus allowing local automation for controlling maximum injection of power to the grid • Virtual community solar / prosumer automation • Signals from the inverters themselves. Based on their Voltage level, a more direct monitoring and reaction on the curtailment risk should be possible? • Incentive to end-user to use energy in that period • Interoperability between the tools of different data source providers • Privacy (including agreements for data sharing Data Protection Impact Assessment [DPIA] and post-project data management) • Scaling of the current situation to look for real limit situations will be possible (anticipation of RES production) • Communication protocols must be interoperable • Data security & reliability (avoid bad data, lost data, modified data, etc.)
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCORP • WiseCOOP • WiseHOME • WiseEVP • WG STaaS/VPP

Post-condition	Any of the mentioned events would reduce the grid capacity for the zone. The proposed measures (increase consumption, reduce generation or storage to batteries, would improve the operating regime.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Signal for overtemperature on a transformer	Check steady state regime and find transformer impact on operation	Technical parameters	DSO	DSO
2	Change regime	Increase consumption for the zone	Dispatch order. Increasing level	DSO	Consumer, Prosumer
3	Change regime	Decrease generation for the zone	Dispatch order. Decreasing generation level	DSO	RES Unit, VPP Operator
4	Change regime	Switch battery generation to battery storage	Dispatch order. Change operating regime to storage.	DSO	EV Fleet Manager VPP Operator
5	Steady state regime changes	Check new steady state regime			

Realization	
Main responsible partners (Author)	ETRA, CRE
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, HYP, ITE, VS
Priority	High

Use Case ID	HL-UC 1_PUC_3_Voltage support and congestion management
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	The PUC describes the actions of RESCO in case of a Voltage problem/congestion or any other request by the DSO, keeping voltage level in accepted boundaries with RES implications, while reducing network losses and signalizing possible network congestions. The methods shall be both global and local as voltage unlike frequency is a zonal parameter for power grids. This is an important activity that is likely performed on a permanent basis to keep the grid voltage stability within normal ranges. Centralised and Decentralised voltage control solutions shall be considered as well as voltage symmetry between the phases.
Actors involved	• DSO • DMS • RES Unit • ESCO • Producer

	• Prosumer • VPP Operator • EV Fleet Manager • EVSE
Triggering Event	The voltage level is permanently monitored by DSO to decide actions for keeping voltages within admissible range. In example, the trip of a compensation unit (a generator that was producing both P and Q, or a synchronous compensator that generates only Q).
Pre-condition	• Grid Data availability • Operating DMS • Accurate Forecast information • Data collection should be in real-time (or very close to real-time) • Performance regulators for generation units
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WG RESCO
Post-condition	Voltages will be maintained within admissible range.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Event in the grid	Notification from the DSO (problem in the network) to the RES aggregator (in the area with the problem, list of RES in the area)	Power flow data	DSO	RESCO
2	Resources evaluation	Analysis of RES/ definition list of RES that could participate in the Voltage Control/Congestion Management	List of RES Units	RESCO	DSO
3	Find availabilities	Get Forecasts (HL-UC 1_SUC_1.2)	Reactive power reserves, tap changer positions	RESCO	DSO
4	Define possible units to supply support	Calculations by DSO/ verification	Power flow analyses	DMS	DSO
5	Monitor and Orders	The aggregator monitors the RES and sends corrective actions	Orders increase decrease reactive power	RESCO	RES Units

6	Monitor and Orders	DSO monitors the system and sends corrective actions	Orders increase decrease reactive power	DSO	RESCO
Realization					
Main responsible partners (Author)	CRE, ETRA				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, HYP, VS				
Priority	High				

Use Case ID	**HL-UC 1_PUC_4_Grid planning analysis**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	The objective of this PUC is to provide to DSOs tools for the grid planning activities. Indicative examples of possible topics that need to be addressed are the following: • Where is storage needed? • What type of storage is needed? • Where should public EVSEs be more convenient installed?
Actors involved	• DSO • Public Authority
Triggering Event	DSO willing to study the impact in the grid of the installation of RES/Storage/EVSEs prior to taking the decision. This recurrent trigger is also affected by new grid connection requests. That would mean that a new grid user wishes to connect to the public grid and therefore a system study to find best connection solution is issued.
Pre-condition	• Grid topology • Historic power flow information • Specific models and algorithms in order to provide simulation scenarios and decision support are needed
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	Based on the connection study, impact of connection of EVSEs, batteries or RES generation can be estimated (e.g. identifying critical points on the grid that could benefit from the presence of grid batteries, or limitations of the grid to support the load of EVSEs or the generation).

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	DSO is requested to perform an analysis to find out investment	Upon necessity of integrating new EVSEs on the grid, the DSO needs to	Topology, Historic power flow data, Number of EVSEs, EVSE properties,	DSO, Public Authority	DSO

	needed to integrate new EVSEs on the grid	analyse the impact of installing those under different locations of the grid	EVSE expected usage		
2	DSO performs analysis of the grid to check feasibility of the installation (HL-UC 1_SUC_6.1)	DSO uses the simulation tool to estimate the impact of the EVSEs connected to different points of the grid	Estimated power flow curve for different scenarios Identification of critical possibly overloaded sections of the grid	DSO	DSO
3	DSO identifies overloaded sections on the grid	DSO identifies overloaded sections on the grid and plans a study of mitigation by using grid (or distributed) batteries	Topology Historic power flow data	DSO	DSO
4	DSO performs analysis of impact of installation of batteries to solve identified problems	DSO makes use of the simulation tool to estimate the location and storage capacity needed to flatten the demand curve	Estimated power flow curve for different scenarios Identification of proper points of connection of batteries and required capacity	DSO	DSO

Realization	
Main responsible partners (Author)	ETRA, CRE
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, VS
Priority	Low

Use Case ID	**HL-UC 1_PUC_5_Promote RES via RESCO companies**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	The objective of this PUC is to support the operations of RESCO companies, namely: • create an inventory of their assets, • monitor and control all parameters related to their assets Measuring the economic impact for RESCO companies and their customers, RESCO companies will enable the provision of energy from RES to its consumers, where the serviced household/business does not own (operate and maintain) the RES generation equipment. Customers of RESCO will be able to self-consume energy produced by RES units, while RESCO will be able to bring on market the energy surplus. These companies will encourage the adoption of distributed generation through RES.
Actors involved	• Producer

	• RESCO • Consumer • Aggregator • Public Authority
Triggering Event	• New business model – RESCO • Renting roof-top areas for installing generation units • Mix between (1-15)min refreshing and opportunities for market
Pre-condition	• Grid Data availability • Connection facility • Accurate Forecast information • Agreement between RESCO and prosumer. • Data collection should be in real-time (or very close to real-time). • Interoperability between the tools of different data source providers (via WG IOP) • Energy poverty mitigation schemes developed in parallel of the RES production • Participative module interface to support the integration of decentralized RES production
WiseGRID systems involved	• WG RESCO Information exchange with: • WG IOP • WiseHOME • WiseCORP
Post-condition	Clear and correct data from RESCO companies concerning RES capacities and customers within the grid. Also, DSO is able to update its grid topology data with information of RES (existing and planned) and other customers.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	RESCO asset inventory	Assess and hierarchize RESCO's assets and parameters	Data on assets and their parameters	RESCO	RESCO
2	Ongoing monitoring and control of assets' parameters	Permanent assessment of assets' parameters and of their modification in time	Assessment of assets' parameter	RESCO	RESCO
3	Assets' economic impact upon the RESCO and their customers	Assess the economic impact of RESCO's assets	Assessment of economic impact	RESCO	RESCO

Realization

Main responsible partners (Author)	ETRA, CRE

Contributing partners	ENER, ECO, ASM, HEDNO, ENG, HYP
Priority	Medium

14.2 HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION

Use Case ID	**HL-UC 2_PUC_1_Distribution network real-time monitoring**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	The smart grid environment requires the upgrade of tools for monitoring at all levels of the grid. These components will provide the data necessary for monitoring the grid. This PUC aims to validate new smart grid technologies and business models and provide two-way communication between a) on the one hand, distributed generation, storage, demand assets, and b) on the other hand, the existing grid operator (dispatch centre). The measurement techniques may include various device types including smart meters (HL-UC 2_SUC_1.1), remote terminal units (RTUs), and phasor measurement units (PMUs). Measurements are captured, stored (HL-UC 2_SUC_1.2), and analysed (HL-UC 2_SUC_1.3) in order to determine in every moment the status of the grid. Thanks to these analyses, faults can be detected (HL-UC 2_SUC_1.4), thus assuring the correct functioning of the system. Additional tasks for the maintenance of the elements in the grid are considered as well (HL-UC 2_SUC_1.5).
Actors involved	• DSO (DMS, AMI, GIS, ERP, SCADA) Contributing actors: • VPP Operator • Aggregator • EVSE Operator
Triggering Event	• Periodically, or • During the everyday operation of the DSO, or • When a fault is detected.
Pre-condition	• Monitoring Loads, DGs and Prosumers • Bidirectional communication • Cyber/physical security • Reliable ICT support layer • Low latency added by the data gathering process • Common Data Model • Topology and elements forming the system are well known • Smart Meters (AMI) are deployed in strategic points of the grid in order to acquire metering data
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WG STaaS/VPP

	• WiseCOOP • WiseEVP
Post-condition	DSO is able to correctly manage the grid and its elements.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Grid information	Information and details of the grid and its elements is acquired and integrated into the system (basis for HL-UC 2_SUC_1.5).	Grid topology, grid elements and technical details, communication protocols	DSO, SCADA	DMS, ERP, GIS
2	Field data acquisition and concentration	AMI periodically sends metering data (electrical and consumption measurements) to the DMS following the procedure described in HL-UC 2 SUC 1.2.	Metering data	AMI	DMS
3	Power quality analysis	DMS periodically analyses the data received and monitors the power quality (HL-UC 2_SUC_1.3).	System status report	DMS	DSO

Exception path #1

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
4	Fault detection	When a fault is detected and identified, the system tries different strategies in order to solve it (HL-UC 2_SUC_1.4).	Circuit breakers events, ancillary services requests, self-healing report	DMS	SCADA, VPP Operator, Aggregator, EVSE Operator, DSO

Exception path #2

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Catalogue maintenance	At any time, DSO can update the asset catalogue with new information to reflect changes in reality.	Asset information	DSO	DMS, ERP

Realization

Main responsible partners (Author)	ETRA
Contributing partners	ICCS, ENER, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 2_PUC_2_Real-time distribution system awareness**
Cluster	Smartening Distribution Grid

Classification	Primary Use Case
Description	It is important to be capable of identifying the operating conditions of an electrical grid at every time-step. This can be achieved if the status of the grid is known. Additionally, it is important to monitor the grid status as regularly as possible (namely, as close as possible to "real-time"); therefore, it is crucial to reach high refresh rates of system awareness. The grid operation may be characterized by the following states: normal, emergency and restorative, since its operation conditions change due to sudden and unexpected events. If the state changes to emergency, then it is necessary to take suitable corrective measures and bring the state back to normal. The measurements are acquired in suitable concentration structures, such as SCADA, AMI, and PDC (HL-UC 2_SUC_1.2). Once the topological data are known (HL-UC 2_SUC_2.2) and the network is found to be fully observable (HL-UC 2_SUC_2.3), the measurements, together with other data, are processed by the state estimator (HL-UC 2_SUC_2.5) which aims at filtering/removing the measurement noise and compute a system state that is as close as possible to the true one. It is possible to use the load flow analysis tool to verify the state estimation calculation or make a comparison (HL-UC 2_SUC_2.4). If bad data is detected (HL-UC 2_SUC_2.6), then the state estimation process has to be re-executed, otherwise the state estimation result is wrong. The estimated state is passed on to the Energy management system (EMS) and Distribution Management Systems (DMS) applications (HL-UC 2_PUC_3), which are related to the real-time grid control and operation.
Actors involved	• DSO (DMS, AMI, SCADA, PDC, GIS) • TSO (Energy Management System) • Aggregator • EVSE Operator • RES Unit • VPP Operator <u>Contributing actors:</u> • ESCO • Supplier • EV fleet Manager • AMI (Smart Meter) • Prosumer • Distributed Energy Resources
Triggering Event	Need to identify the operating conditions of the grid at every time-step.
Pre-condition	• Availability of measurements • Availability of forecasts • Development of suitable data concentration structures • Fast telecommunications • GPS synchronization
WiseGRID systems involved	• WG Cockpit <u>Information exchange with:</u> • WG IOP • WiseCORP

	• WiseCOOP • Wise HOME • WiseEVP • WG FastV2G • WG STaaS/VVP
Post-condition	The estimated state is passed on to the Energy management system (EMS) and Distribution Management Systems (DMS) applications, which are related to the real-time grid control and operation.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Measurements acquisition	This PUC interacts with HL-UC 2_PUC_1 and receives the available measurements via the data concentration points.	Measurements	DSO, TSO, Aggregator, EVSE Operator, RES Unit, VPP Operator	DSO
2	Calculation of the real-time system state	This step includes the following steps: a) Topology processing and identification, b) Observability analysis, c) State estimation and d) bad data detection. Other tools employed in the process may be the forecasting tools and the load flow calculation.	Topological information, optimal measurements placement, system state, bad data	DSO	DMS (and EMS)
3	Coupling with the real-time applications	The estimated state is forwarded to the DMS and EMS applications, related to real-time grid control and operation.	Estimated state	DSO	DMS (and EMS)

Realization

Main responsible partners (Author)	ICCS
Contributing partners	ASM, ENER, ETRA, HEDNO
Priority	High

Use Case ID	**HL-UC 2_PUC_3_Grid control**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	The main goal of the Distribution System Operator (DSO) is to ensure the network operation and management in a reliable and economic manner under normal and abnormal conditions. Furthermore, being part of the electricity system, the distribution grid and its resources can contribute to the smooth operation of the entire system. Thus, application of grid control –especially under abnormal situations– is motivated either by the inherent needs of the distribution grid operated by the DSO or by the extraneous needs of the transmission system operated by the Transmission System Operator (TSO).

	Accomplishing these goals requires continuous monitoring of the prevailing conditions in the MV/LV distribution network (HL-UC 2_PUC_1) and identification of the operating state of the distribution network (HL-UC 2_PUC_2). Combining this information, the DSO determines the necessary preventive actions in case the distribution grid state is identified as insecure (inherent needs) or in case the TSO has sent a request for specific actions or a notification regarding the current state of the transmission system (HL-UC 2_PUC_3). These actions include a combination of control actions performed by the DSO over available loads of conventional type in a direct way (HL-UC 2_SUC_3.1) or indirectly through an intermediary (HL-UC 2_SUC_3.2, HL-UC 2_SUC_3.6, HL-UC 1 SUC_4.2, HL-UC 7_SUC_2.7, HL-UC 7_SUC_2.8), adjustments in the network topology (HL-UC 2_SUC_3.4), islanding of the local grid (HL-UC 2_SUC_3.5) –if deemed necessary– with control over RES units (HL-UC 1_PUC_3), EVs (HL-UC 3_SUC_4.1), VPPs (HL-UC 6_SUC_3.2) and buildings (HL-UC 5_SUC_4.2). The decision-making process for solving the distribution grid operation problems and/or for contributing to the smooth operation of the transmission system is facilitated through the use of optimization methods (HL-UC 2_SUC_3.3) and can refer either to the day-ahead scheduling or the real-time operation of the grid, while the objective of the optimization might be different depending on the circumstances.
Actors involved	• Aggregator • DSO (DMS) • EVSE Operator • TSO • VPP • Harbour Control System Contributing actors: • Prosumer • ESCO • EV • EVSE • RES Unit • Supplier • Harbour Operator
Triggering Event	Periodically or on demand (the DSO receives an alarm regarding the state of the distribution grid from its DMS or a request from the TSO).
Pre-condition	• Network monitoring is available. • The operating state of the distribution grid is known. • Bidirectional communication between DSO and involved energy stakeholders is established. • Control equipment ensuring resource manageability and fast time-to-respond is installed. • Reliable measurement of customer response (e.g. amount of load shed). • Remote operation of sectionalizing and tie switches and other grid equipment is possible. • Contractual agreements between the DSO and the rest of the actors are in place describing the rules of the transactions performed. • Cybersecurity

WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCOOP • WiseEVP • WG STaaS/VPP • WG FastV2G				
Post-condition	The distribution grid returns to its normal state of operation. If deemed necessary, the healthy parts of the grid are islanded.				
Typical steps					
Step No.	**Event**	**Description of process/Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Periodically	The DMS monitors the distribution network.	None	DSO (DMS)	DSO (DMS)
	Distribution network constraint detection	The DMS detects an impending distribution network constraint.	None	DSO (DMS)	DSO (DMS)
	Request from TSO	The TSO sends a request to the DSO for taking specific actions.	Type of action, component affected (e.g. reduction of loading of specific transmission line)	TSO	DSO (DMS)
2	Send data	WG Cockpit receives data regarding the network constraint (HL-UC 2_PUC_1), the current conditions in the distribution grid and the available resources (HL-UC 1_PUC_1, HL-UC 2_PUC_2, HL-UC 3_PUC_1, HL-UC 6_PUC_1, HL-UC 6_PUC_3, HL-UC 7_PUC_2).	Location and type of network constraint, production/consumption of grid users, available flexibility per type and grid user, line loading, bus voltages/ angles	DSO (DMS), Aggregator, EVSE Operator, VPP	DSO (DMS)
3	Determine corrective actions	WG Cockpit applies the optimization algorithm (HL-UC 2_SUC_3.3) and calculates the necessary corrective actions.	Actions per component of the distribution grid	DSO (DMS)	DSO (DMS)
4	Formulate and send control signals	The DMS formulates and sends the control signals to the components of the distribution grid (HL-UC 2_SUC_3.1, HL-UC 2_SUC_3.2, HL-UC 2_SUC_3.6).	Control signals (energy production, consumption, amount of load to be shed, state of switch, timeframe)	DSO (DMS)	Aggregator, EVSE Operator, VPP, Harbour Control System

5	Send response to control signals	The components send their response to the control signals (HL-UC 1_PUC_3, HL-UC 2_SUC_3.1, HL-UC 2_SUC_3.2, HL-UC 2_SUC_3.4, HL-UC 2_SUC_3.5, HL-UC 2_SUC_3.6, HL-UC 3_SUC_4.1, HL-UC 6_SUC_3.2, HL-UC 7_SUC_2.7-2.8).	Response to control signals	Aggregator, EVSE Operator, VPP, Harbour Control System	DSO (DMS)
6	Constraint resolved	A notification that the constraint has been resolved is issued and the alarm is turned off.	Constraint resolved		
	Formulate and send response to request from TSO	The response to the request is formulated (in case of compliance, the amount and timing of the load shedding/increase; in case of non-conformance, declaration of inability to follow and satisfy the request) and sent to the TSO.	DSO response to TSO request	DSO (DMS)	TSO
Exception path					
Step No.	**Event**	**Description of process/Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Send response to control signals	Several components declare inability to follow the control signal.	IDs of components unable to respond to control signals	Aggregator, EVSE Operator, VPP	DSO (DMS)
2	Re-determine corrective actions	Return to typical step 2.	None	DSO (DMS)	DSO (DMS)
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	ASM, ENER, HEDNO				
Priority	High				

14.3 HL-UC 3 E-MOBILITY INTEGRATION IN THE GRID WITH V2G

Use Case ID	**HL-UC 3_PUC_1_EVSE and EV fleet Monitoring**
Cluster	Smart Integration of Grid Users from Transport
Classification	Primary Use Case

Description	This PUC describes the data collection process from the EVSEs and the EVs. This PUC contains two SUCs: HL-UC 3_SUC_1.1 Data collection from EVSE: This SUC describes the data gathering from each EVSE to the WiseEVP and the WG IOP. The gathered data will be mainly the energy parameters that are provided by a smart meter per socket (power, current, etc.) and also EVSE status information (available, reserved, charging, unavailable, faulted etc.). HL-UC 3_SUC_1.2 Data collection from EVs: This SUC describes the data gathering from the EVs to the WiseEVP/WiseHOME and the WG IOP.				
Actors involved	• EV • EVSE Contributing actors: • EV Fleet Manager • EVSE Operator (EVSE Operator) • EV User				
Triggering Event	Monitoring can be executed periodically or on demand triggered by the EVSE Operator/EV Fleet Manager/EV User				
Pre-condition	• Data coming from EVSEs and the EVs from the demonstration sites should be available and accessible to the partners (in the pilots). • The EVSE and EV data will be handled considering the EU and national laws regarding privacy and data protection, • Data should be consistent and reliable, and of high resolution Data protocol needed (new one or standard) • Deployed EVSEs • Security in Communications • EVSE unique identifier • Connected cars (today, by default in EVs) • Anonymizing data from private EVs • Agreements for public broadcasting of the data. • Connectivity and Interoperability between the systems				
WiseGRID systems involved	• WG FastV2G • WiseEVP • WiseHOME Information exchange with: • WG IOP				
Post-condition	• Correct communication between actors. • Overview on the status of the EVSE portfolio and the EV fleet.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	Configuration parameters collection	Initially, the EVSEs and the EVs send their permanent characteristics (i.e. vendor name, type, number of connectors, maximum power etc.). When no automatic retrieval of this information is feasible, the EVSE Operator/EV Fleet Manager will manually provide it.	EVSE-EV configuration parameters	EVSEs, EV	EVSE Operator, EV Fleet Manager, EV User
2	Operational parameters collection	Periodically, the EVSEs and the EVs send their current status.	EVSE-EV status	EVSEs, EV	EVSE Operator, EV Fleet Manager, EV User
3	Data communication among WiseGRID apps	The WG IOP enables the data exchange among the different WiseGRID apps.	EVSE/EV status, EVSE/EV parameters	EVSE Operator, EV Fleet Manager EV User (Domestic)	Data Provider

Realization	
Main responsible partners (Author)	ETRA
Contributing partners	ITE, HYP, EMOT, PARTA, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 3_PUC_2_Interaction of the user with EVSE**
Cluster	Smart Integration of Grid Users from Transport
Classification	Primary Use Case

Description	This PUC describes the interaction of the EV User (driver) with the charging infrastructure (EVSEs) in order to authenticate, start a charging session or book an EVSE. The user will be able to select (or book in advance) three different types of charging sessions: • Type 1: Charging on user demand. Once the EV User plugs the EV and selects the desired final SoC, the EVSE charges the EV at the maximum power. • Type 2: Smart charging. Once the EV User plugs the EV and selects the desired final SoC and selects the time to disconnect the EV, the EVSE performs a flexible charging session managing the charging power output to follow energy prices, to avoid network congestion, to maximise the RES integration, etc. • Type 3: Smart charging with V2G. The principle is exactly the same as type 2 but allowing power injection in the electrical network (V2G), meaning that enhanced network services can be provided. Note: The EVSEs just “perform” the charging sessions. The charging sessions and charging characteristics are scheduled at a higher level at the WiseEVP. It includes the following SUCs: 3.2.1 User’s authentication This SUC describes the authentication process through an EVSE before starting the charging session (also WiseEVP involved). The same process will be applied if the EV User needs to log through Smartphone Apps or web applications to the WiseEVP for booking or other purposes (if they are in the scope of WiseGRID). 3.2.2 Charging session request This SUC describes how the user starts and ends a charging session through an EVSE (types 1, 2 and 3) 3.2.3 Charging session booking This SUC describes how the user requests a charging session, now or in the future (booking) at an EVSE or through other interfaces (e.g. mobile) to the WiseEVP providing the required information about the user’s EV and the aforementioned information depending on the charging type.
Actors involved	• EV User • EV • EVSE Operator • EV Fleet Manager
Triggering Event	Allowing the interaction of the EV User with the EV charging infrastructure.
Pre-condition	• Identification method available on EVSE (smart card reader or smartphone /web- app, etc.) • Identification method available for user (smart card, account in the smartphone account, etc.) • Identification method information displayed on EVSE to allow user to identify the correct charging point • The EVSE Operator or the fleet manager has an updated list of known users. • EVSEs able to consume and optionally inject energy from the grid. • EVSEs able to modulate the power output. • The EVSEs are capable of communicating status, digitally and analog e.g. with leds (free, reserved, out of order, in use, etc.) • The EV User has a valid account in WiseEVP for the authentication process.

WiseGRID systems involved	• WG FastV2G (and other EVSEs) • WG IOP • WiseEVP
Post-condition	The user is able to interact with the charging infrastructure making use of the following functionalities: • Authenticate in an EVSE (specifically in the WG FastV2G). • Start a charging session (types 1-3) in an EVSE (specifically in the WG FastV2G). • Book an EVSE in advance.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Authentication process (HL-UC 3_SUC_2.1)	Before using any of the WiseGRID system related with the charging infrastructure the user has to be authenticated	Authentication data	EV User	EV Fleet Manager, EVSE Operator
2	Book an EVSE (HL-UC 3_SUC_2.3)	The user is able to book an EVSE in advance.	EVSE Id, charging session parameters (type of charging session (1-3), final desired SoC (max 100%), size of battery and time to remove the EV (dd/mm/yy hh:mm)).	EV User	EV Fleet Manager, EVSE Operator
3	Charging session request (HL-UC 3_SUC_2.2)	The user is able to configure and start a type 1, type 2 or type 3 charging session directly on an EVSE	Charging session parameters (type of charging session (1-3), final desired SoC (max 100%), size of battery and time to remove the EV (dd/mm/yy hh:mm)).	EV User	EV Fleet Manager, EVSE Operator

Realization

Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

Use Case ID	**HL-UC 3_PUC_3_EV charging management**
Cluster	Smart Integration of Grid Users from Transport
Classification	Primary Use Case

Description	This PUC describes all the processes that take place in the WiseEVP to manage the charging sessions of the EVSE and to schedule the charging session according to the EV User preferences. It includes the following SUCs: 3.3.1 EVSE network configuration This SUC describes how the EVSE network in the Wise EVP is configured grouping the EVSEs under its management in regulation areas and providing the main characteristics of each EVSE: location, number of sockets, maximum power, charging modes, V2G capabilities, public/private management, plugged directly in the network or inside a household, etc. 3.3.2 EV load forecasting This SUC describes how the Wise EVP performs EV load forecasting with in different time frames (following day, following number of hours, etc.) and how often they are updated to provide them to the Wise Tools interacting with the market and managing the electrical network. 3.3.3 EV flexibility estimation This SUC describes how management of multiple EVSE connected to the same 'regulation area' allows for offering flexibility in the energy demand for charging EVs, in order to respond to demands of the grid operator based on the current status of the grid. 3.3.4 Reference load profile calculation This SUC describes how Wise EVP calculates the reference load profile per regulation area. The reference load profile will be the default charging session profile used by the EVSEs (per regulation area) if the user selects types 2-3 charging sessions. Then, according to the RES and grid needs, this profile will be periodically updated (or not) as a result of the rescheduling processes (see HL-UC 3_SUC_4.1 and HL-UC 3_SUC_4.2). 3.3.5 Charging session schedule This SUC describes how the Wise EVP schedules the type 2-3 charging sessions of its EVSE network when no flexibility requests are triggered.
Actors involved	• EVSE Operator • EV Fleet Manager • DSO (indirectly, outside the system)
Triggering Event	The need for the EVSE Operator or the Fleet Manager to manage the EV charging infrastructure and calculate the potential flexibility services that might be offered to other WiseGRID tools.
Pre-condition	• The EVSE Operator needs to know the regulation areas division based on network topology (topology will be managed by WG Cockpit and offered to other applications via IOP). • The data collection from EVSE should be performed to have historical data and to know the status of the EVSEs (HL-UC 3_SUC_1.1). • Active or expected charging sessions type 2 or 3 (HL-UC 3_SUC_2.2 and HL-UC 3_SUC_2.3). • Although is not indispensable, the execution of HL-UC 3_SUC_4.1 and HL-UC 3_SUC_4.2 will produce relevant information to enrich the reference load profile calculation.

WiseGRID systems involved	• WiseEVP • WG IOP • WG FastV2G • WG Cockpit
Post-condition	The EVSE Operator or the Fleet Manager are able to manage the EV charging infrastructure making use of the following functionalities: • Configure the EVSE network. • Forecast the EV load. • Estimate the EV flexibility. • Calculate the reference load profile. • Schedule the charging sessions.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data collection from EVSEs (HL-UC 3_SUC_1.1)	The data collection from EVSEs is running to have historical data and to know the status of the EVSEs.	EVSEs historical data, EVSEs real-time status	Data Provider	EVSE Operator, EV Fleet Manager
2	Network configuration (HL-UC 3_SUC_3.1)	The EVSE Operator or the Fleet Manager adds/removes/modifies the regulation areas or the EVSE parameters	Regulation areas configuration parameters, EVSEs configuration parameters	EVSE Operator, EV Fleet Manager	EVSE Operator, EV Fleet Manager
3	EV load forecasting (HL-UC 3_SUC_3.2)	The EV load forecasting is calculated periodically (every day and/or every number of hours).	EV load forecasting	EVSE Operator, Fleet Manager	Data Provider
4	EV flexibility calculation (HL-UC 3_SUC_3.3)	The flexibility estimation are calculated periodically (every number of hours) for each regulation area or for the whole system and cover different time frames (the following day, the rest of the day, the following hours, etc.)	EV flexibility for the time frame (hour, power up, power down)	EVSE Operator, EV Fleet Manager	Data Provider
5	Reference load profile calculation (HL-UC 3_SUC_3.4)	The reference load profile is calculated periodically per regulation area (e.g. once a day).	Reference load profile per regulation area (power to be consumed or injected per hour per each EVSE)	EVSE Operator, EV Fleet Manager	EVSEs

6	Charging requests (HL-UC 3_SUC_2.2 and HL-UC 3_SUC_2.3)	The EV Users request charging session directly in the EVSEs and configure their preferences	EV active charging sessions	EVSEs	EVSE Operator, EV Fleet Manager
7	Charging session schedule process (HL-UC 3_SUC_3.5)	The charging session schedule process (CSSP) is performed every five minutes to manage the active charging session	Load profile per EVSE (power to be consumed or injected per hour)	EVSE Operator, EV Fleet Manager	EVSEs
Realization					
Main responsible partners (Author)	ITE				
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO				
Priority	Medium				

Use Case ID	**HL-UC 3_PUC_4_Interaction with the energy infrastructure**
Cluster	Smart Integration of Grid Users from Transport
Classification	Primary Use Case
Description	This PUC describes how the EV charging infrastructure might module its power output to provide flexibility to the grid, to maximise the RES integration and to participate in the house energy management process (V2H). It includes the following SUCs: 3.4.1 Charging reschedule to follow grid requests This SUC describes how an EVSE network might modulate its power output after a grid request from the grid operator (DSO). This means that the power output of each socket is regulated (lowered or increased) based on the status of the grid (local net excess or shortage of energy). 3.4.2 Charging reschedule to maximise RES integration This SUC describes how WiseEVP reschedules the type 2-3 charging session of its EVSE network after a RES request received from the RESCOs/Aggregators send by the WG STaaS/VPP to execute a portion or all the flexibility defined for each regulation area. 3.4.3 EV providing V2H services This SUC describes how an EVSE installed in a home environment can participate in the house energy management process modulating the power consumption and even injecting power to the household electric installation.
Actors involved	• DSO • Fleet Manager • EVSE Operator • Market Operator • RESCO • Aggregator (VPP Operator) • EV • EVSE

	• Domestic prosumers (indirectly) • EV User
Triggering Event	The need to manage the EV infrastructure to help in the electric network operation, to integrate RES and to support the household energy management process.
Pre-condition	• At least one EV should be charging following a Type 2-3 charging session (HL-UC 3_SUC_2.3). • EV flexibility estimation should be running periodically in the WiseEVP (HL-UC 3_SUC_3.3). • Charging session schedule process should be running periodically in the WiseEVP (HL-UC 3_SUC_3.5) • The data collection from EVSE should be performed to know the status of the EVSEs (HL-UC 3_SUC_1.1). • The EVSE network should have been configured (HL-UC 3_SUC_3.1). • The EVSE is able to manage its power output. • The EVSE is able to calculate its V2H and smart charging capabilities.
WiseGRID systems involved	• EVSE (not WG FastV2G) • FastV2G (and other EVSEs) • WG Cockpit • WG IOP • WG STaaS/VPP • WiseEVP • WiseHOME
Post-condition	The EV charging infrastructure modulates its power output to provide flexibility to the grid, to maximise the RES integration and to participate in the house energy management process (V2H).

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data collection from EVSEs (HL-UC 3_SUC_1.1)	The data collection from EVSEs is running to have historical data and to know the status of the EVSEs.	EVSEs historical data, EVSEs real-time status	-	EVSE Operator / EV Fleet Manager
2	Charging requests (HL-UC 3_SUC_2.2 and HL-UC 3_SUC_2.3)	The EV Users request charging session directly in the EVSEs and configure their preferences	EV active charging sessions	EVSEs	EVSE Operator / EV Fleet Manager
3	Charging session schedule process (HL-UC 3_SUC_3.5)	The charging session schedule process (CSSP) is performed every five minutes to manage the active charging session	Load profile per EVSE (power to be consumed or injected per hour)	EVSE Operator / EV Fleet Manager	EVSEs
4	Charging reschedule to	The charging session reschedule process (CSRP) is	Flexibility product to be	EVSE Operator / EV Fleet	EVSEs

	follow grid requests (HL-UC 3_SUC_4.1)	performed if a flexibility product is agreed between the EVSE Operator or Fleet Manager and the DSO	executed	Manager	
5	Charging reschedule to maximise RES integration (HL-UC 3_SUC_4.2)	The CSRP is performed if a flexibility product is agreed between the RESCOs or Aggregators and the EVSE Operator or Fleet Manager.	Flexibility product to be executed	EVSE Operator / EV Fleet Manager	EVSEs
6	EV providing V2H services (HL-UC 3_SUC_4.3)	The WiseHOME executes the V2G or smart charging capabilities offered by a household EVSE to include them in the domestic energy management process	V2G or smart charging capability to be executed	Domestic prosumer	EVSEs

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

14.4 HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL

Use Case ID	**HL-UC 4_PUC_1_Batteries management at prosumer level**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	To get a more flexible RES generation and a more efficient distributed generation system on the grid, it is necessary to set up storage facilities. The most efficient way to accomplish this would be a combined use of batteries together with a management system at consumer/prosumer level. This control would facilitate higher energy generation by distributed renewable energy resources. This system also enables consumers to become prosumers, who then as active grid-users can maximize the generation from RES both with balance between generation and consumption, and also grid load control. With a smart time-of-use management as well as power peak reduction the prosumer is also in the position to reduce its energy cost. Since automotive batteries can provide V2H services as well this PUC is linked to HL-UC 3 SUC 4.3 EV providing V2H services.
Actors involved	• Prosumer • Consumer • Forecast Provider • Storage Unit • Market Operator <u>Contributing actors:</u> • Battery Operator

Triggering Event	The battery is either triggered by a sensor measuring the current production/consumption or price signals.
Pre-condition	• Batteries installed at prosumer facilities • Prosumer consumption & production forecast is available • Real-time consumption & production measurements are available • Real-time battery data (SoC& electrical parameters) are known • Asset mapping • GIS system installed • Weather forecast are available • Integration of batteries with renewables at local level • Interface with control system of the batteries is installed • Time of use tariff information is available (through contractual agreements and perhaps tariff signals) • Pricing info is available (through contractual agreements and perhaps tariff signals) • Characteristics of the energy delivery point (contractual/technical, etc.) • Nominal battery characteristics are known • Equipment for power control of battery devices is installed
WiseGRID systems involved	• WiseCORP • WiseHOME Information exchange with: • WG IOP
Post-condition	The prosumers, or consumers, are active users of the grid. As a result, their energy consumption and, consequently, their electricity bill are reduced.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Prosumer information	Obtain information about consumption and production forecast	Forecast info	Forecast Provider/ Storage Unit	Storage Unit
2	Market information	Obtain information about electricity prices and tariffs	Prices and tariffs info	Market Operator	Storage Unit
3	Consumption plan (periodically)	Manage the storage system operation (moments of charging, discharging or stand-by)	System status	Storage Unit	Storage Unit

Realization

Main responsible partners (Author)	AMP, VS
Contributing partners	ETRA, CRE, ECO, HEDNO, AEA, ICCS, ITE
Priority	High

Use Case ID	**HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	Batteries enable the grid to become more stable for several reasons. If batteries used as storage devices are managed by a system, they can reduce the grid's fluctuations by means of coordinated control of the grid's voltage and frequency. They can, as well, ensure a quick response in case of a grid outage (fast restoration), reducing the blackout duration and improving the consumer supply safety.
Actors involved	• Storage Unit • Aggregator • Forecast Provider • Market Operator • VPP Operator
Triggering Event	User starts configuring VPP/Aggregator platform. Data for the management procedure are available. Depending on the SUC there are several triggering events possible, either driven by economical aspects or aspects regarding the security of supply /e.g. backup power).
Pre-condition	• Storage Units/Batteries installed • Power control of installed batteries • Demand/production forecast • Weather forecast • Characteristics of the energy delivery point (contract/technical) • Nominal battery characteristics • Real-time battery measurements • Data interface for data exchange and control purposes • Real-time prosumer consumption • Real-time prosumer production • Real-time grid status • Battery close to power stations • Converter with off grid-ability • Battery must always be capable of providing the necessary power and energy (low self-discharge and recharging strategy) • Data interface in order to transfer data (battery state, signal to start battery operation)
WiseGRID systems involved	• WG STaaS/VPP • WiseCOOP Information exchange with: • WG IOP • WG Cockpit • WG RESCO • WiseHOME • WiseCORP

Post-condition	A number of storage systems are managed in order to support the grid and gain monetary benefit.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Configuration	The management platform is configured		VPP, Aggregator	
2	Data collection	Market Data and forecast and technical data are transmitted to the platform	Market data, forecast data	Market Operator, Forecast Provider	VPP, Aggregator
3	Coordinated management	Calculations are performed and command data are sent to the storage units	Command data	VPP, Aggregator	Storage Unit
4	Receive response	The VPP Aggregator receives the response of the Storage Units	Response to command	Storage Unit	VPP Aggregator
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication error	The communication in Typical step 2 fails.	Failure to collect data	VPP Aggregator	VPP Aggregator
2	Own estimation of data	Use estimated values for the missing data (though historical values or through application of advance techniques (if possible).	Estimated values	VPP Aggregator	VPP Aggregator
3		Continue with Typical step 3.			
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication error	The communication in Typical step 3 fails.	Failure to send commands	VPP Aggregator	VPP Aggregator
2	Retry	Attempt to communicate with the Storage Unit until the communication is restored or until a certain amount of time has passed.	Command data	VPP Aggregator	
3b	Communication not restored	A communication alert is issued.	Communication error	VPP Aggregator	-
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS				

Priority	Medium

Use Case ID	**HL-UC 4_PUC_3_Ancillary services**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	Energy Storage Systems can provide services that are important for a satisfactory operation of the network, such as reactive power support, load following, back-up service, peak shaving, power quality (PQ) and disturbance compensation to name a few. Through various control algorithms, such as droop control, virtual inertia, etc., generation and storage units can coordinate their operations offering significant benefits for the utility grid. The aggregation of battery systems based on modern communication, at any level, can offer several services related indirectly with the energy storage as the market regulation. Ancillary services like "active power reserves" and "frequency response", would be possible based on energy and power availability. This UC is linked to HL-UC 6_SUC_2.2 and This UC is linked to HL-UC 6_SUC_3.2
Actors involved	• Aggregator • Storage Unit • VPP Operator <u>Contributing actors:</u> • DSO • Prosumer • Producer • Market Operator • Forecast Provider • Battery Operator
Triggering Event	Ancillary services are tendered. If the market prices for ancillary services are high and the Storage Unit is available, the Storage Unit participates in these markets.
Pre-condition	• Storage Units/Batteries with power control • Data interface for data exchange and control purposes • Characteristics of the energy delivery point • Information regarding the prospective amount of load and production, electricity prices and weather conditions should be available (through forecasting) • Equipment enabling the real-time metering of prosumer consumption and production, producer generation and battery status should be installed • Battery characteristics • Grid parameters info forecast • Grid parameters info real-time (voltage and frequency) • Pricing for ancillary services • Prequalification criteria have to be met (criteria depend on the country) • Pricing info forecast • Regulation / Market requirements for ancillary services are met

	• Information on ancillary markets in pilot site countries must be well known • Real-time pricing info • Real-time weather info • Pricing/market info • Cost functions for Ancillary services (for bidding purposes)
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WiseCOOP • WG Cockpit • WG IOP • WiseHOME • WiseCORP
Post-condition	The batteries provide the power according to the market scheduling.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	An order from VPP to activate a service	An activation signal is sent from the VPP to the Storage Unit	Activation signal	VPP Operator, Aggregator	Storage Unit
2	Service being performed	The Storage Unit performs the service		Storage Unit	
3	Register the service performed and inform VPP	The service is registered and information are sent back to the VPP	Notification on service performed	Storage Unit	VPP Operator, Aggregator

Realization

Main responsible partners (Author)	AMP, VS
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS
Priority	Medium

Use Case ID	**HL-UC 4_PUC_4_Combination of battery storage systems**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	With the combination of different storage technologies high power (e.g. ultra capacitors) and energy (e.g. batteries) contents can be achieved at the same system. In common use, it is necessary to obtain information about the status of every unit by means of a standard of information trading. This information can be used for managing in a coordinated manner the system(s) of the area of interest. Technical specifications of any battery connected to the system will be available for “grid operators” and “management systems” and will be used for both administrative

	and operative (controlling) functions. This information about the specifications of every battery model included in the system must be available for both reading and controlling
Actors involved	• Market Operator • Aggregator • VPP Operator Contributing actors: • Battery Operator • Prosumer • Consumer • DSO • RESCO • Forecast Provider
Triggering Event	Creation of communities of prosumers/consumers for trading energy and information.
Pre-condition	• Internet access point • Real-time battery status • Use a common standard for exchanging information • Data security • Platform/Cloud which collects the data • Data storage for historical battery storage data • Data transfer rate must be high enough (exact numbers should be defined) • TSO – DSO exchange and cooperation • Battery control • Power control of storage devices • Type of storage • Availability of storage system • Power capability of battery storage system • Remaining energy content (SoC) • Current aging status (SoH) • Efficiency • Demand and production forecasts • Pricing, Contract data, tariff-structure of prosumer • Safe and fast data interface • Computational power (100s or 1000s of Battery storage system data might be arise)
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG Cockpit • WiseHOME • WiseCORP • WG IOP • WiseCOOP

Post-condition	A set of storage units is optimally controlled by a superimposed aggregator or VPP platform. Each storage units supplies the power according to control signals from the platform.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Forecast Information	Information about consumption, production and weather	Forecast information	Forecast Provider	Battery Operator
2	Storage system select	Selection of the Storage System Unit. It depends on prosumer characteristics	Prosumer consumption, load profile	Prosumer	Battery Operator
3	Parameters	Information about Grid and prosumer parameters	Grid/ prosumer parameters (P, V, f, etc.)	DSO/ Prosumer	Battery Operator
4	Configuration	Individual Storage System configuration	Configuration parameters	Battery Operator	Storage Unit
5	System and market status	Obtain information about status of every storage system, pricing, contract data and tariff-structure of prosumer	SoC and SoH/ Energy price	Storage Unit/ DSO	Market Operator, Aggregator/VPP Operator
7	Priority list (periodically)	Create a list of units charging, discharging or stand-by according to priorities established	List of orders	Aggregator/VPP Operator	Storage Unit
8	Follow real-time status	Obtain information about prosumer's real-time demand and production	Prosumer's real-time demand and production	Storage Unit, Prosumer	Market Operator, Aggregator/VPP Operator
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Loss of communication	The communication to the storage systems is lost	Internal		
2	System failure	A Storage Unit fails and an error signal is sent to the VPP platform	Error signal	Storage Unit	VPP operator, aggregator
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, CRE, ECO, ICCS, ITE, ENG, HEDNO				
Priority	Medium				

14.5 HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING

Use Case ID	**HL-UC 5_PUC_1_Thermal monitoring**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	The first step for the integration of Cogeneration in WiseCORP and the efficient management of CHPs and Thermal Storage is Monitoring the relevant components in the system. In this Primary UC, three components are monitored: • Gas Consumption in Households The natural gas consumption in Households is monitored through Gas Meters. It is assumed that an AMR installed in the premises of the Gas Distribution Company exists. • Combined Heat and Power The monitoring of CHPs is complicated due to the different size and vendors. Furthermore, multiple values are monitored such as production (thermal and electrical), status, alarms, consumption etc. • Buildings In this PUC, Buildings are also monitored through BMS: multiple values are monitored such as temperature, electrical consumption per activity etc. Again, a characteristic that increases the complexity is the differences between the buildings in terms of size, usage and installed equipment. In the cases of CHPs and Buildings, the existence of Thermal Storage will be also considered. Thus, the relevant critical values should be also monitored.
Actors involved	• ESCO • Gas Distribution Company • Operator Contributing actors: • Building Management System • AMR • CHP • Gas Meter
Triggering event	The WiseCORP requests for data/measurements periodically or on demand.
Pre-condition	• Measuring equipment available (especially in the case of buildings and CHPs) • Reliable Telecommunication
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	The accurate knowledge of the gas consumption in households, the status/monitoring of CHP and access to BMS data.

Typical steps

Step No.	**Event**	**Description of process/Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	Get data from Gas Meters	Receive measurements from the AMR.	Consumption measurements	Gas Distribution Company	ESCO
2	Get data from CHP	Receive measurements from the CHPs.	Consumption, production (thermal and electrical), device status	ESCO	ESCO
3	Get data from buildings	Receive measurements from the Building Management System.	Consumption, production (e.g. PV) and conditions data	ESCO	ESCO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG, HEDNO				
Priority	Medium				

Use Case ID	**HL-UC 5_PUC_2_Cogeneration and HVAC management**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	This PUC is responsible for the control of CHP, HVAC and the thermal loads of the buildings. The Use Case will consider the schedules proposed by HL-UC_5_PUC_4 and will be responsible for following them as accurately as possible. Of course, if deviations will be detected, the PUC should proceed with all the necessary actions. Part of this process is the forecasting of the thermal needs of the various assets. The forecasting will take into account the thermal models developed in HL-UC_5_PUC_3 as well as the online measurements made available through HL-UC_5_PUC_1. This PUC has two main SUCs. HL-UC_5_SUC_2.2 is responsible for calculating the optimal set-points and HL-UC_5_SUC_2.3 for sending the set-points to all assets as well as for receiving input. Finally, an important functionality is the alarm management. This is a complex task, since the assets may have a variety of technologies and sizes. Thus, the algorithm should be intelligent enough to cope with these challenges.
Actors involved	• ESCO Contributing actors: • Building Management System • CHP • Gas Distribution Company (AMR) • Gas Meter • VPP Operator
Triggering event	The WiseCORP requests data/measurements periodically or on demand.
Pre-condition	• Thermal models • Measurements (historical and current) • Online measurements

	• Knowledge of all the technical constraints
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	The accurate knowledge of the gas consumption in households, the status/monitoring of CHP and access to BMS data.

Typical steps

Step No.	**Event**	**Description of process/Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Periodically	The WiseCORP runs HL-UC_5_SUC_2.1 and forecasts the thermal needs.		ESCO	ESCO
2	Calculate set-points	Using field measurements (HL-UC 5_PUC_1) and the schedules calculated in HL-UC 5_PUC_4, the necessary online set-points/schedules are calculated.	Schedules	ESCO	ESCO
3	Periodically	Send control signals to the various assets.	Control Signal	ESCO	CHP
4	Periodically	Alarm management.	Warnings	ESCO	ESCO

Exception path

Step No.	**Event**	**Description of process/Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Alarm	Predefined procedures should ensure the safety of equipment and personnel.	Warnings	ESCO	ESCO

Realization

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, HEDNO
Priority	Medium

Use Case ID	**HL-UC 5_PUC_3_Comfort-based demand flexibility models**
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	The goal of this PUC is to develop and adapt models of buildings and households as well as their usage patterns that collectively affect energy demand. By the developed term, advanced algorithms will receive as much information as available (e.g. size of building, usage, construction materials, meteorological information, number of residents, user comfort preferences, real-time indoor environmental information from sensors, etc.) and will create a model of the thermal behaviour.

	Next, these models can be adapted or improved using the measurements coming from HL-UC_5_SUC_2.1 through an iterative process. Special models will be developed for households due to the lack of sufficient online measurements. Thus, special models will try to utilize as well as possible the available information. Another important feature is the estimation of the thermal flexibility and the amount of thermal (and not only) energy that can be shifted. Flexibility will be sought by shifting energy consumption while remaining within user comfort preferences. Building thermal inertia will be the main attribute to be exploited in order to maximize demand flexibility. This operation will also receive input from HL-UC_5_SUC_2.3 and the results of the various control actions will further allow the adaptation of these models.
Actors involved	• ESCO <u>Contributing actors:</u> • Building Management System • CHP • Consumer • Sensor • Smart Meter
Triggering event	The WiseCORP requests data/measurements periodically or on demand.
Pre-condition	• Measuring equipment available (especially in the case of buildings and CHPs) • Reliable Telecommunication
WiseGRID systems involved	• WiseCORP <u>Information exchange with:</u> • WG IOP • WiseHOME
Post-condition	The accurate knowledge of the gas consumption in households, the status/monitoring of CHP and access to BMS data.

Typical steps

Step No.	Event	Description of process/Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Periodically or on demand	Create model for households.	model	ESCO	ESCO
2	Periodically or on demand	Create model for building.	model	ESCO	ESCO
3	Periodically or on demand	Calculate thermal flexibility.	model	ESCO	ESCO

Realization

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, ETRA, HYP, HEDNO
Priority	Medium

Use Case ID	HL-UC 5_PUC_4_Cogeneration and HVAC optimisation
Cluster	Demonstration of Energy Storage Technologies
Classification	Primary Use Case
Description	This use case focuses on market and business decisions related to the CHP, HVAC and building management. The main priority is the satisfaction of the local needs in a secure and efficient approach. However, additional gains may derive by the participation in a VPP or the provision of Ancillary Services (AS) to the distribution network. Therefore, the first step is to define the role of each asset and whether it should participate in the VPP or provide Ancillary Services (AS) to the distribution network. An optimisation algorithm takes these business decisions. Of course, in all cases, the technical constraints should not be violated, nor the comfort level in the buildings. Finally, two algorithms (and corresponding SUCs) optimise the participation of the assets in the VPP and the Ancillary Services. For example, this PUC will identify the optimal bids (assuming it is a model based on bids) for the participation in the VPP operations. The algorithm will produce a set of schedules that will be sent to HL-UC_5_PUC_2 for implementation.
Actors involved	• ESCO • DSO Contributing actors: • VPP Operator • Building Management System • CHP • Consumer • Sensor
Triggering event	The algorithm may run periodically or on demand.
Pre-condition	• Measuring equipment available (especially in the case of buildings and CHPs) • Reliable telecommunication
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WG STaaS/VPP • WG Cockpit
Post-condition	Schedules for VPP participation and provision of ancillary services.

Typical steps

Step No.	Event	Description of process/Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Policy selection	Decide which assets will provide AS and which assets will participate in the VPP.	Schedules	ESCO	ESCO

2	VPP participation	Define schedules for the VPP participation.	Schedules	ESCO	ESCO
3	Provision of AS	Define schedules for the provision of AS.	Schedules	ESCO, DSO	ESCO, DSO

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, ETRA, HEDNO
Priority	Medium

14.6 HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY

Use Case ID	**HL-UC 6_PUC_1_VPP monitoring and management**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	The goal of this PUC is to monitor the state of the resources (industrial, domestic and public facilities, EVs, energy storages etc.) belonging to the VPP (current status) (HL-UC 6_SUC_1.1) as well as to provide forecasting for RES, demand (HL-UC 6_SUC_1.2) and flexibility (HL-UC 6_SUC_1.3), and use that information for defining suitable strategies for managing (internal) grid and market issues (HL-UC 6_SUC_1.4).
Actors involved	• VPP Operator • VPP Component (RES Unit, Smart Meter, Storage Unit) • Consumer, Prosumer, Producer (Smart meter, Sensor, AMI) • Forecast Provider • Battery Operator • Supplier • Aggregator • Market Operator • Load Controller • DMS
Triggering Event	The VPP status monitoring runs periodically, while other HL-UC 6_SUC_1.2, HL-UC 6_SUC_1.3, HL-UC 6_SUC_1.4 will be invoked when requested from the VPP Operator.
Pre-condition	• Decentralized energy generation and/or energy consumers and prosumers portfolio characteristics should be available. • Smart Meter must have a network connection. • Smart Meters and Meter/sensor infrastructure at Consumer, Producer and Prosumer level including production and consumption, must be available, deployed and integrated into the grid • Decentralized energy generation and/or energy Consumers portfolio characteristics should be available. • Wholesale and retail electricity prices must be available and accessible. • Energy grid condition and forecasting must be available. • Energy market status data must be available.

WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	Monitoring of the VPP status and potential strategy options to be implemented in the short term (24/48 hours)

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Periodically	The system monitors VPP assets (HL-UC 6_SUC_1.1).	VPP assets data	VPP Components	VPP Operator
2	RES forecast	VPP Operator every day and when it is required, applies RES forecasting (HL-UC 6_SUC_1.2).	RES forecast	Forecast Provider, VPP Operator	VPP Operator
3	Flexibility calculation	VPP Operator every day and when it is required, implements the flexibility estimation module (HL-UC 6_SUC_1.3).	Flexibility estimation	VPP Operator	VPP Operator
4	VPP Strategy	Finally, the optimal strategy is defined (HL-UC 6_SUC_1.4).	Strategy options	VPP Operator	VPP Operator

Realization

Main responsible partners (Author)	ENG
Contributing partners	ETRA, VS, AMP, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 6_PUC_2_VPP market participation**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	This PUC manages the VPP within energy market participation. It helps the VPP to participate to the energy (day-ahead and intra-day) (HL-UC 6_SUC_2.1) as well as to the ancillary services market (HL-UC 6_SUC_2.2) and to calculate the most appropriate bid to be submitted in that energy market, where appropriate. Then according to these results, it supports the VPP to define a single strategy for the participation in these types of energy markets (HL-UC 6_SUC_2.3).
Actors involved	• VPP Operator • Market Operator • VPP Component • Load Controller
Triggering Event	Periodically (according to the market rules)
Pre-condition	• VPP real-time consumption/production data are available. • Energy market status data and information about prices are available and accessible.

	• Energy grid condition and load/RES forecasting of the VPP must be available. • Interaction with energy market data systems (bidding, etc.)
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	The VPP Operator is able to participate in the energy market defining and submitting bids for the different markets types if appropriate.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Energy and ancillary Market participation	The VPP Operator invokes the HL-UC 6_SUC_2.1 and the HL-UC 6_SUC_2.2 in order to calculate the optimal bids for the energy and ancillary services market participation and sends the characteristics of the bids to the Market Operator.	Bid data	VPP Operator	Market Operator
2	Energy and ancillary Market results	The VPP Operator is informed by the Market Operator regarding the result of the market settlement pertaining to the bids submitted by the VPP Operator.	Bid status (accepted/ rejecter)	Market Operator	VPP Operator
3	Unit scheduling	Based on the market response, the optimal unit schedule is identified and sent to the VPP Components.	Unit scheduling	VPP Operator	VPP Components

Realization	
Main responsible partners (Author)	ENG
Contributing partners	ETRA, ECO, ASM, HEDNO
Priority	Medium

Use Case ID	**HL-UC 6_PUC_3_VPP real-time control**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case
Description	This PUC aims at providing a real-time control on the VPP. In order to do that it is necessary to identify the current available flexibility by taking into consideration the real-time measurements (HL-UC 6_SUC_3.1), to receive notifications and requests by the local DSO through the ancillary services market in order to implement ancillary services (HL-UC 6_SUC_3.2), and to define the appropriate commands that the VPP Operator will send to the VPP Components (HL-UC 6_SUC_3.3).
Actors involved	• VPP Operator Contributing actors: • VPP Component • DSO

	• Market Operator • Prosumer • Storage Unit • Forecast Provider
Triggering Event	Periodically
Pre-condition	• Receiving notifications and requests by DSO (WG Cockpit) about status of the distribution grid. • Market price availability. • Information regarding the portfolio characteristics is available (HL-UC 6_SUC_4.2). • Interface with VPP Components must be available. • Contractual and policy constraints must be defined and become available. • Availability to access to real-time data (HL-UC 6_SUC_1.1). • An algorithm that calculates the flexibility with all the data provided.
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG Cockpit • WG IOP • WiseCORP • WiseHOME
Post-condition	The VPP operates smoothly.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Periodically	Flexibility calculation.	HL-UC 6_SUC_3.1 output	VPP Component	VPP Operator
2	DSO request	DSO request.	HL-UC 6_SUC_3.2 output	Market operator	VPP Operator
3	VPP Operator decisions	VPP Operator decides the real-time operation of the VPP Components.	HL-UC 6_SUC_3.3 output	VPP Operator	VPP Component

Realization

Main responsible partners (Author)	ETRA
Contributing partners	ENG, BYES, HYP, AMP, ITE, ICCS, VS, EPA, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 6_PUC_4_VPP users relationship management**
Cluster	Smartening Distribution Grid
Classification	Primary Use Case

Description	This PUC is about the possibility to manage more efficiently the grid load avoiding peak by means of DSM and DR mechanisms, which push consumers (in an aggregated way) at VPP level to consume more or less RES according to the need of the grid. In this direction, this PUC describes the functionalities needed by the VPP Operator to manage the portfolio of VPP members. Such functionalities include: describes management of the contractual issues and SLA (HL-UC 6_SUC_4.1), management of member compensation (HL-UC 6_SUC_4.2) and DR actions (HL-UC 6_SUC_4.3).
Actors involved	• VPP Operator • Consumer, Prosumer, Producer • Load Controller
Triggering Event	Periodically (the VPP Operator manages a portfolio of assets)
Pre-condition	• The VPP energy grid status must be available (HL-UC 6_SUC_1.1). • Energy consumption, RES and flexibility forecasting must be available (HL-UC 6_SUC_1.2 and HL-UC 6_SUC_1.3). • A customer portfolio must be identified • Contractual requirements, SLA have to be defined at different level and for the different VPP Components (HL-UC 6_SUC_4.2). • Access to information regarding the electricity market prices is needed • VPP participants as well as their meters and sensors must have an internet connection and be operative. • Contractual requirements (SLA) have to be defined between aggregator (VPP) and end-users in the portfolio • Contractual requirements (SLA) have to be defined between aggregator (VPP) and customers requesting energy • Interface with the assets in the portfolio is requested, including control over storage units • RES deployment planning support module is available.
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WiseHOME • WiseCORP
Post-condition	Distribution of energy among VPP members is performed

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Contract definition	The relationship between VPP and its users starts with the subscription of the contract (managed by the HL-UC 6_SUC_4.2). From this moment the user profile is generated and managed in order to identify how to better involve customers in the programme managed by the VPP.	Contract, VPP consumers profile, SLA, etc.	VPP Components	VPP Operator

2	DR mechanisms	According to the needs/condition of the VPP and the strategy defined in the HL-UC 6_SUC_1.4, DR mechanisms (HL-UC 6_SUC_4.4) are invoked in order for the VPP to be self-sufficient.	DR requests	VPP Operator	VPP Components
3	Sell RES	If RES surplus is available (after ensuring the self-sufficiency of the VPP) the surplus is sold to customers participating in specific VPP programs (HL-UC 6_SUC_4.1).	RES quantity, Customer information, price agreed	VPP Components	VPP Operator
4	Billing	The billing for VPP customers is calculated (HL-UC 6_SUC_4.3).	Billing	VPP Operator	VPP Components

Realization	
Main responsible partners (Author)	ENG
Contributing partners	ETRA, BYES, AMP, ITE, ICCS, CRE, ECO, ASM, HEDNO
Priority	Low

14.7 HL-UC 7 CITIZENS EMPOWERMENT IN ENERGY MARKET AND REDUCTION OF ENERGY POVERTY

Use Case ID	**HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector**
Cluster	Demand Response
Classification	Primary Use Case
Description	To ensure the active engagement of businesses, industries, ESCOs, local communities and public facilities in energy markets and energy management initiatives, a corporate application tool should be available. This is a tool to facilitate the management of large infrastructures and promote the concept of smarter and responsible energy players by giving them more power and protection and also ownership, reducing their energy bill, supporting self-consumption by means of real-time data coming from all their energy devices and by means of DR and load optimization schemes. To sum up, the goal of this PUC is to facilitate professionals (e.g. Facility Managers) on daily activities.
Actors involved	• Prosumer • Consumer • Facility Manager Contributing actors: • ESCO • RESCO • Aggregator • Supplier • Load Controller • Sensor • BMS
Triggering Event	This PUC describes an energy management tool for the Facility Manager of tertiary buildings. As such, it will be mainly triggered by user requests or by external signal requesting modifications of the energy supply/demand profile of the building.

Pre-condition	• The necessary infrastructure (e.g. sensors) for collecting real-time information regarding the indoor building conditions, energy generation & consumption, user energy-related behaviours as well as access to historical traces of this information are critical. • Availability of market information (e.g. retail electricity prices, available tariffs). • Response to DR signal requesting some energy service to be delivered by the building requires the availability of controllable loads that can be directly controlled by WiseCORP to accomplish the seamless service delivery. • Interfacing of WiseCORP with the IT systems of the Aggregator and Supplier are prerequisites for the correct exchange of DR signals. This may be accomplished through the WG IOP tool.				
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP • WG STaaS/VPP				
Post-condition	The Facility Manager has a complete and detailed overview of the energy-related aspects of the facilities.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Continuous monitoring & collection of energy consumption/ generation information in the home (per asset/ device/ appliance where possible)	Energy data	Sensor, Smart Meter (Meter Responsible Party), BMS	Facility Manager, Prosumer, Consumer
2		Continuous monitoring & collection of indoor & outdoor environmental parameters (incl. temperature at the minimum)	Environmental conditions	Sensor, BMS	Facility Manager, Prosumer, Consumer
3		Continuous monitoring & collection of user comfort preferences (through explicit or implicit actions)	User preferences	Sensor, BMS	Facility Manager, Prosumer, Consumer
4		Calculation of relevant, user selected KPIs and information visualization for the Facility Manager to get insights on the building performance	KPIs values	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
5	DR signal	Trigger user into action through visual cues or act upon assets via direct load control to modify consumption/ generation profile	Alerts, tips, control commands	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
6		Continuous optimization of controllable loads towards self-consumption or costs/CO_2 reduction	Setpoints	Facility Manager	BMS
Exception path					

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1a	Communication error	Inform the user about the existence of a communication error and prompt him to investigate the cause	Notification	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
1b		Provide diagnostics	What data cannot be collected from which sensor	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
1c		Continue operation with limited functionality that requires only available data	KPI values, alerts, tips, commands	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer

Realization	
Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market**
Cluster	Demand Response
Classification	Primary Use Case
Description	To support the active involvement of traditional (Suppliers) and new business (Aggregators, cooperatives) roles in energy markets a portfolio management tool will support the engagement of Consumers and Prosumers in emerging business models (e.g. real-time pricing, DR). The tool is an application for energy Suppliers, Aggregators, local communities and cooperatives of Consumers and Prosumers (and other intermediary companies) to help domestic and small businesses, Consumers and Prosumers achieve better energy deals: better services, prices and opportunities to participate in ancillary service markets will be offered to the final Consumers/Prosumers. This includes aggregation models such as VPP where the Aggregator (or other intermediate) gathers a portfolio and operates them as a unified and flexible resource on the energy market. In summary, the goal of this PUC is to provide the engine that facilitates energy stakeholders (Aggregators & Suppliers).
Actors involved	• Aggregator • Supplier • Facility Manager • Consumer • Prosumer • DSO • TSO

	• Smart Meter (Meter Responsible Party) • Sensor • Market Operator • Load Controller Contributing actors: • Forecast Provider • ESCO
Triggering Event	This PUC encapsulates the functionality required by the Aggregator or Supplier in order to offer and manage DR campaigns. The trigger for this UC is their action to build the necessary infrastructure for DR management.
Pre-condition	This PUC outlines a technical solution that makes sense within a business context that includes the entity managing the DR campaign (Aggregator for explicit DR, Supplier for implicit DR), Pro/Consumers (residential, tertiary, industrial) that will modify their supply/demand profiles as well as the entities that require the DR for their own purposes (e.g. DSO for grid stability, BRP for energy balancing, etc.) The establishment of this business context (incl. the necessary commercial arrangements and adherence to flexibility trading frameworks/schemes) is a precondition for the invocation of the PUC as well as the availability of technical infrastructure (e.g. ICT systems & interfaces) so that these actors can exchange information (e.g. flexibility requests/offers/orders, price information, DR signals, forecasts, flexibility profiles, etc.) Furthermore, availability of information is necessary for the successful execution of the PUC. Information about the aforementioned entities and their relevant assets (e.g. Prosumer demand and supply assets) is needed. Execution of the UC requires accurate consumption/generation profile baselines and forecasts taking into account the actual/predicted building environment and usage conditions. Finally, financial and market information (e.g. energy retail/wholesale prices) is required. Another important pre-condition is the availability of electricity demand/storage/ supply assets that can be remotely controlled (in a direct load control fashion from the Aggregator management system) to facilitate the execution of typical explicit DR scenarios.
WiseGRID systems involved	• WiseCOOP Information exchange with: • WG IOP • WiseHOME • WiseCORP • WG Cockpit
Post-condition	The Supplier and Aggregator have the necessary technical and commercial framework in place to launch, implement and manage DR campaigns.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1		Definition of Supplier/Aggregator KPIs to steer optimization process	KPIs	Supplier, Aggregator	Supplier, Aggregator
2		Monitoring of client energy consumption/ generation profiles	Energy consumption/	Supplier, Aggregator,	Supplier, Aggregator

			generation of building	Smart Meter (Meter Responsible Party)	
3		Monitoring of market information	Retail/wholesale prices	Market Operator	Supplier, Aggregator
4		Generation of comfort-based demand flexibility building profiles	Demand flexibility	Supplier, Aggregator	Supplier, Aggregator
5	Flexibility activation request	Incoming request to deliver flexibility (or other service) based on pre-existing commercial/ contractual arrangement [this step is optional]	Detailed flexibility activation request (how much, when, where, etc.)	DSO, TSO	Supplier, Aggregator
6		Local optimisation to define the necessary DR signal to be dispatched to the clients in order to achieve some objective (e.g. energy service provision, Supplier profile balancing)	Real-time energy monitoring info, flex request, demand flexibility per building	Supplier, Aggregator	Supplier, Aggregator
7		Dispatch of DR signal to the clients	DR signals	Supplier, Aggregator	Facility Manager, Consumer, Prosumer
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Lack of real-time information to calculate demand/ flexibility forecast	Inform user about lack of information	Notification	Aggregator, Supplier	Aggregator, Supplier
1b		Prompt user for further action (assemble VPP based on older forecast or declare inability to serve incoming requests)	User prompt	Aggregator, Supplier	Aggregator, Supplier
1c		If older forecasts should be used, continue with step 5 of typical path	Notification	Aggregator, Supplier	Aggregator, Supplier
1d		If request should be ignored, decline upcoming service requests	Notification	Aggregator, Supplier	DSO, TSO, Supplier
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO				

Priority	High

Use Case ID	**HL-UC 7_PUC_3_Clients engagement for active market participation**
Cluster	Demand Response
Classification	Primary Use Case
Description	Towards citizen's empowerment in energy market and reduction of energy poverty, as the main objective of HL-UC 7, we have to ensure that even the small (residential) clients move from passive entities to active elements of the electricity grid. In order to ensure client participation, information about electricity usage and energy market (retail & ancillary services) operation should be available in an appealing but not intrusive way. This can be done with a personalized application for individual domestic Consumers and Prosumers covering different types of functionalities like: real-time monitoring of consumption and production, participating in DR programs (visualizing DR signals, e.g. price information), alerts, energy saving tips, etc. This is actually the main objective of this PUC: to establish a dynamic channel of communication with the domestic Consumers and Prosumers, enabling their transformation to active grid elements.
Actors involved	• Consumer • Prosumer Contributing actors: • RESCO • Aggregator • Supplier • DSO • Sensor • Smart Meter (Metering Responsible Party)
Triggering Event	Either a user request for information or external source trigger (from the Supplier e.g. a DR signal) to inform the client about some energy-related issue.
Pre-condition	• Means for the tool to interface with the inhabitants that shape the residential energy demand patterns in a visual, intuitive and easy-to-use manner. • Existing commercial engagement with a market actor (Supplier, cooperative or Aggregator) that can supply the necessary information in order to maximize the effectiveness of the application. This implies interfacing capabilities with their ICT systems (e.g. WG STaaS/VPP, WiseCOOP) for the exchange of necessary information. • Availability of infrastructure (and connectivity with them) for capturing information about the energy demand in the home, the resident preferences and environmental conditions/forecasts as well as for controlling devices to shape the demand/supply profile.
WiseGRID systems involved	• WiseHOME Information exchange with: • WG IOP • WiseCOOP

	• WG RESCO • WG STaaS/VPP				
Post-condition	Continuous and consistent use of the WiseHOME application will lead to a better understanding of residential energy consumption/production aspects by the citizens and an altered demand profile, which brings benefits to themselves and the relevant energy actors (grid operator, Supplier, market operator, etc.).				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Continuous monitoring & collection of energy consumption/ generation information in the home (per asset/ device/ appliance where possible)	Energy data	Sensor	Consumer, Prosumer
2		Continuous monitoring & collection of indoor & outdoor environmental parameters (incl. temperature at the minimum)	Environmental conditions	Sensor	Consumer, Prosumer
3		Continuous monitoring & collection of user comfort preferences (through explicit or implicit actions)	User preferences	Sensor	Consumer, Prosumer
4		Calculation of relevant KPIs	Historical traces, measurement	Consumer, Prosumer	Consumer, Prosumer
5		Information visualization	KPI values, time-series	Consumer, Prosumer	Consumer, Prosumer
6	DR signal	Trigger user into action through visual cues	Notifications, tips	Consumer, Prosumer	Consumer, Prosumer
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication error	Inform the user about the existence of a communication error and prompt him to investigate the cause	Notification	Consumer, Prosumer	Consumer, Prosumer
1b		Provide diagnostics	What data cannot be collected from which sensor	Consumer, Prosumer	Consumer, Prosumer
1c		Continue operation with limited functionality that requires only available data	KPI values, alerts, tips, commands	Consumer, Prosumer	Consumer, Prosumer
Realization					

Main responsible partners (Author)	HYP
Contributing partners	HYP, ETRA, AMP, VS, ENER, ECO, ASM, HEDNO
Priority	High

15 ANNEX D – SECONDARY USE CASES

15.1 HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID

15.1.1 HL-UC 1_PUC_1_Network monitoring

Use Case ID	HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case

Description	This SUC concerns the activity of data collection from places with RES production (specifically connected to distribution grid) and from critical sections of the distribution grid, such as feeders, HV/MV and MV/LV transformers. It will rely mainly on readout of instrumentation data (U, I, P, Q) from unbundled and decentralised smart meters (HL-UC 2_SUC_1.1) placed at RES installations and at critical sections monitored for capacity management. The purpose of this use case is to provide appropriate inputs to allow adequate monitoring of the distribution grids statuses (e.g. in HL-UC 1_SUC_1.2 and HL-UC 1_PUC_2).
	Several sources of energy data will be analysed, taking into account the specific characteristics of each pilot site where demonstration will take place. Communication protocols are an important issue due to the necessity to integrate different vendors.
	It is the intention to use SMX (as part of USM concept) as middle layer equipment to make conversion from a variety of protocols in a minimal set of CEN-CENELEC standards, such as IEC61850 and IEC62056 family (DLMS/COSEM).
	Data to be collected:
	• RES production data
	  ○ Load profiles of energy (+A, -A, +R, -R)
	  ○ Real-time data (U, I, P, Q, f)
	  ○ Steady state power flow data, as collection of data for a specific moment in the network
	  ○ User flexibility data (in energy or power variation)
	• RES-affecting weather data from weather stations (to be handled to ESCO/DSO/Aggregator)
	  ○ Solar irradiation
	  ○ Wind speed
	  ○ Outdoor temperature
	  ○ Outdoor humidity (optional)
	• ESCO data to be handled to the RES (incentives, green situation)
	• DSO data to be handled to ESCO and user
	  ○ Signal of possible curtailment

Actors involved	• DSO (DMS, AMI)

	• RESCO (RES Unit, Smart Meter, Sensor) • Prosumer (RES Unit, Smart Meter, Sensor)
Triggering Event	Periodically (USM read new data based on the period set in their configuration).
Pre-condition	• Type and structure of data, reporting rate. • Internet-connected smart meters. • Data collection period should be very close to real-time (1-10 seconds desirable, 1 minute acceptable) in order to secure various solutions to avoid RES curtailment. • Interoperability between the tools of different data source providers. • Privacy (Including agreements for data sharing, DPIA and post-project data management). • Scaling of the current situation to look for real limit situations will be possible (anticipation of RES production). • Communication protocols must be interoperable. • Data security & reliability (avoid bad data, lost data, modified data, etc.) • Interaction among WiseGRID tools via WG IOP.
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WG RESCO
Post-condition	• DMS and is able to access new RES data coming from AMI. • DSO is presented with a proper vision on the status of the grid based on real measurements.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data acquisition	Metering data from RES units and sensors in critical network sections is periodically read by the AMI deployed.	Metering data	RES Unit, Sensor	AMI, Smart Meter
2	Data dispatch	AMI sends the read data to the DMS as described in HL-UC 2_SUC 1.3.	Metering data	AMI, Smart Meter	DMS
3	Data validation and storage	DMS assesses the integrity of the data and stores it for subsequent use.		DMS	
4	Geolocation data acquisition	DMS retrieves geolocation data from GIS.	Geolocation data	GIS	DMS
5	Data analysis	DMS combines the received data, analyses it, and presents it to the DSO in the form of a grid capacity status report.	Grid capacity status report	DMS	DSO

Realization

Main responsible partners (Author)	ETRA
Contributing partners	CRE, HYP, ENG, ICCS, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This activity is based on collected real-time data stored in a short-term historical database and forecast of both RES production and consumption. Monitoring is based mainly on the following functions: • Real-time Network data collection • Power Flow Calculation and State Estimation • Congestions and Contingency Analysis • Alarming and Security Enhancement • Short-Circuit Analysis • Data Export Forecast is based on long-term and short-term evaluations (mainly weather influence). Forecast data will be mainly for: solar irradiance (in W/m^2), wind, outdoor temperature, presence of snow. The latter influence both generation and consumption with a stronger impact depending on the season of the year. Additionally, consumption can be forecasted by means of measuring critical network sections, analysing historical consumption data, weather forecasting, calendar information (special events, holidays), etc. Establishing patterns between climatologic data and RES consumption would help with the forecasting tasks.
Actors involved	• RES Unit • Forecast Provider • Producer • DSO
Triggering Event	Forecast is updated hourly
Pre-condition	• Remote Terminal Units [RTUs] availability within the network • Forecast tools availability • Data collection and network management functions should be in real-time (or very close to real-time) • Privacy for grid users' data • Data security & reliability (avoid bad data, lost data, modified data, etc.)
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP

Post-condition	The RES production within the specified zone will be reconsidered so the grid congestions are fixed.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Short term forecast with high wind	Define wind diagrams and Solar Irradiation	Wind speed and gusts	Forecast Provider	Producer
2	Forecast data evaluation	Estimate the RES generation expected	Generation values	Forecast Provider	DSO
3	Validate estimated generation	Confirm the results from generation estimates.	Generation level of each RES unit	RES Unit	DSO
4	Overload of grid elements	Calculate the total load of main grid elements	Overload of grid elements	DSO	
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication failure	Data missing for producers		Forecast Provider	Producer
2	Lack of data	Data missing	forecast	Forecast Provider	Producer
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, VS				
Priority	High				

Use Case ID	**HL-UC 1_SUC_1.3_KPI management**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC aims at providing the DSO with the necessary mechanisms in order to calculate Key Performance Indicators (KPIs) to assess the correct operation of the grid. This involves several tasks: • KPI definition: A set of KPIs that provides straightforward information to ensure an easy way to monitor the status of the grid is required. • KPI implementation: The necessary algorithms to calculate the value of the KPIs must be implemented and available for the applications to use. • KPI calculation: In order to calculate their values, algorithms must periodically be feed with new data (i.e. measurements) from the field.

	• KPI visualization: Finally, the results (i.e. KPI values) of these algorithms must be presented to the DSO in a visual, easy-to-understand way. Although focused in the management of the grid by the DSO, the procedures described in this SUC can be reused for other purposes in the context of WiseGrid.
Actors involved	• DSO (AMI, DMS)
Triggering Event	New KPI values are calculated periodically. The frequency of calculation takes into consideration the frequency of acquisition of new measurements, although it is not mandatory that they coincide.
Pre-condition	• Goals to be measured by KPIs are well known. • Measurements can be periodically obtained from the field. • Computing power and data storage capacity are adequate for the task.
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	DSO is presented with KPI indicators that clearly assess the status of the grid.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	KPI definition and implementation	An initial set of KPIs is defined to measure crucial aspects of the grid. Algorithms for each of them are implemented and ready to calculate values based on measurements received.	KPI information and calculation algorithms		DMS
2	Data acquisition	Metering data from assets in the network is periodically read by the AMI deployed and sent DMS, where they are stored.	Metering data	AMI	DMS (repository)
3	KPI calculation	New values received from the AMI (currently stored in the DMS) are used as inputs for the algorithms that calculate the new KPI values.	Metering data	DMS (repository)	DMS (KPI module)
4	KPI value storage	The calculated value is added to the repository where historical values of the KPI are stored for subsequent evolution evaluation.	KPI value	DMS (KPI module)	DMS (repository)
5	KPI visualization	The new KPI value is presented to the DSO together with the last values, so the evolution on achieving the goal represented by the KPI is clear.	KPI values	DMS	DSO

Exception path #1

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	KPI redefinition	The initial set of KPIs is redefined due to improvement reasons, changes in the grid, etc.	New KPI information and calculation algorithms		DMS
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	KPI calculation error	If the new value of the KPI cannot be calculated (e.g. due to lack of new measurements), a default value marked as such will be stored instead.	KPI value marked as "missing"	DMS (KPI module)	DMS (repository)
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	HYP, ENER, ECO, ASM, HEDNO				
Priority	High				

Use Case ID	**HL-UC 1_SUC_1.4_Big data management**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The main purpose of this SUC is dealing with the big amount of data –field measurements, mainly– obtained from the Advance Metering Infrastructure (AMI) deployed in the grid during the scope of the project. The tasks included under this SUC are: • Data storage: Applications should have enough storage capacity to deal with the storage of data of several types and in several forms: real-time and historical, raw and integrated, etc. • Data quality assessment and substitution: Bad data should be identified, marked as such (if it has not already been) and substituted by an estimated value whenever possible. • Temporal and spatial integration: Raw measurements from every single piece of metering are likely to be integrated temporally (into larger intervals of time) and/or spatially (grouping together data from interrelated entities) for a better management and subsequent analysis. • Clustering: Certain data will be used to automatically classify its sources into different groups, accordingly to the similarities they present in those characteristics that are relevant to the system • Data analysis: A periodical set of analyses –which details are out of the scope of this SUC and will be defined in other UCs– should be periodically performed over the new data received. The results of these analyses are likely to be stored as well. • Data reduction: Either after integration or analysis, data that will be used for several purposes (further analyses, reporting, etc.) should be differentiated from those which use has already taken place and will no longer be needed (it has already been integrated

	or analysed). For those pieces of data not to be used anymore, a periodical process will take care of discard them so no wasted space is occupied.
Actors involved	• DSO (AMI, DMS)
Triggering Event	• A new piece of data from a meter arrives to the DMS (WG Cockpit). • Several tasks in this SUC (assessment, integration, reduction) are launched periodically.
Pre-condition	• Measurements can be periodically obtained from the field. • Computing power and data storage capacity are adequate for the task. • Analyses to be performed over data –e.g. KPI analysis (HL-UC 1 SUC 1.3), power quality in the grid (HL-UC 2, SUC 1.2)– are well defined and the type and form of the data they will be using is well known. • Ideally, methods for data estimation and substitution –e.g. keep last value, retrieve from historical data, calculate from the device model– are available. • The frequency and specific data used by every process of this SUC should be well defined and coordinated among them.
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	A repository of useful, processed field data is available for DSO within the DMS.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Raw data storage	Raw metering data from the AMI is handled to the DMS following the procedure described in HL-UC 2 SUC 1.3 (note that this piece of data can already be marked as non-valid or estimated). The value is stored as it arrives.	Metering data	AMI	DMS
2	Data quality assessment and substitution	Periodically, a background process assesses the integrity and validity of a subset of the data (likely, the most recent one), focusing on the information as a whole as opposed to individual pieces of information. Bad data will be marked as such and replaced when possible.	Assessed metering data	DMS	DMS
3	Data integration	Periodically, a background process integrates batches of the most recent data following temporal and/or spatial criteria. These criteria can be defined off-line or let the DSO set them via DMS interface.	Integrated metering data	DMS	DMS
4	Data analysis	Periodically, different analyses over either raw or treated data are performed, according to the	Analysis result	DMS	DMS

		criteria defined in other UCs. The results of these analyses are stored for subsequent presentation to the DSO.			
5	Data reduction	Periodically, a background process identifies and discards those pieces of data that will no longer be used by any component or application.	Discarded metering data	DMS	DMS

Realization	
Main responsible partners (Author)	ETRA
Contributing partners	ENG, CRE, ICCS, ENER, ECO, ASM, HEDNO
Priority	High

15.1.2 HL-UC 1_PUC_2_Control strategies for reducing RES curtailment

Use Case ID	**HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Encouraging neighbourhood transactions considers the potential of using the excess of RES production by finding possible energy delivery within the neighbourhood pool of energy users. This would imply that DSOs have the right to give relevant signals that curtailment could occur and that additional local consumption may avoid this situation. Market participants like: suppliers, aggregators and storage operators may find deals for "intraday" transactions to avoid curtailment. This SUC considers the potential of using the excess of RES production by finding possible use through the neighbour pool of energy users (same feeder or same transformer supply), eventually being co-owners of RES. For such intraday transaction a curtailment negotiated price may be used. Concerning co-owners, they want to maximize their consumption based on their share of production. This can be a cascading effect of use-case for real-time self-consumption.
Actors involved	• RES Unit • DSO • BRP • Consumer • Aggregator • VPP Operator • Storage Units
Triggering Event	There is a RES production exceeding grid capacity.
Pre-condition	• Real-time data monitoring • Forecast on short-term on production and consumption of the locally generated RES owned by community. Adapted behaviour of community • Signal from the DSO about curtailment danger • Incentive to end-user to use energy in that period

	• Security and privacy including data management • Interoperability between tools • Post-analysis of results (quality of response of the community) • Changes of regulation • Forecast tools availability • Market tools • Communication facilities for all interested parts • Privacy for load data				
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCOOP • WG STaaS/VPP • WG RESCO				
Post-condition	The grid congestion would consider that generation reduction is necessary. If new consumers or storage is identified in the area, then the congestion can be reduced or even cancelled.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Overload on the grid connection of a zone.	Assuming there are two lines connecting a zone, the DMS will indicate a specific percentage overload.	Grid parameters	RES units	DSO
2	DSO analyse of the steady state regime	Evaluate if additional consumption and increase of storage is possible.	Steady state results (voltage in nodes and P and Q flows).	DMS	DSO
3	Get energy market prices	Receive market prices and evaluate energy balancing prices.	Incentives prices for additional consumption or switch from generation to charge	BRP	DSO
4	DSO signal to consumer	DSO sends signals to suppliers, consumers and storage.	Price and quantities proposals	DSO	Aggregator, VPP Operator, Storage Unit
5	DSM	Balance between production and consumption			
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, HYP, VS				

Priority	High

Use Case ID	**HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC focuses on distributed grid storage and aims to investigate another way of avoiding curtailment, by using storage resources available in the grid, either grid-connected or distributed at end-customers. A solution based on cooperative / aggregated storage is supposed to be implemented. Normally, large storage facilities are notifying the "market" and grid operators for the operations within "next day". On the other hand, there could be many small storage facilities (mostly integrated in the consumers grid) that could jointly have a possible impact on the "load flow" of different parts of the grid. Such "storage aggregation" could help the operating conditions of the grid by "off-loading" specific parts of the grid. For both "large storage" and "small storage" facilities can be also found a place within the balancing activities. Based on further market development, the balancing shall be operational both in centralised (at the level of system operator) and decentralised means (for the balancing responsible parties).
Actors involved	• DSO • RESCOs • Prosumer • Aggregators (including Cooperatives and VPP Operators). • Storage Units • Battery Operator • EVSE Operator • VPP Operator
Triggering Event	Risk of RES curtailment
Pre-condition	• HL-UC 1_SUC_2.3 has to be implemented • RES forecasting information • Agreements with Battery Operators • Market information for Battery Operators • Data collection available in real-time (or very close to real-time) • Market regulation • Interface to storage system (including control)
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCORP (indirectly) • WiseCOOP • WiseHOME (indirectly) • WiseEVP • WG STaaS/VPP

Post-condition	Having reduced RES curtailment as much as possible according with grid possibilities.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	RES surplus signal	The production of renewable energy makes that the production curve exceeds the demand curve. The DSO sends a flexibility request to the appropriate actors to avoid curtailment.	Flexibility request: Risk of RES curtailment (HL-UC 1_SUC_2.3)	DSO	EVSE Operator, Battery Operator, Aggregator, ESCO VPP Operator
2	RES surplus signal	Aggregators (cooperatives, VPP operators, ESCOs, etc.) send to its portfolio of clients owning domestic batteries the RES surplus advice.	Flexibility request: Risk of RES curtailment (HL-UC 1_SUC_2.3)	Aggregator	Consumer
3	Request answer	The clients of the aggregator's portfolio send their answers to the aggregator. (In cases where automatic DR mechanisms are in place, interaction of clients is not required)	Answer: - No - Yes (amount of energy accepted in which intervals of time and the price or each kWh)	Consumer	Aggregator
4	Request answer	The actors that have been asked, send their answer to the request made by the DSO.	Answer: - No - Yes (amount of energy accepted, in which intervals of time and the price of each kWh)	EVSE Operator, Battery Operator, Aggregator, ESCO, VPP operator	DSO
5	Management of the answers	The DSO sends the RES surplus to the actors that have accepted the request (in order of acceptance).	Storage units/stations to send the RES surplus	DSO	Storage Unit
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Late acceptation of a RES surplus	An actor accepts the request of storage but all the RES surplus in this period of time have been already absorbed by other actors (e.g. unforeseen increase on load).	Flexibility request in this period of time modifying the previous active request accordingly to the new situation.	DSO	EVSE Operator, Battery Operator, Aggregator, ESCO

1	Late acceptation of a RES surplus	A cooperative client accepts the request of storage but all the RES surplus have been already absorbed by other actors (e.g. unforeseen increase on load).	Flexibility request in this period of time modifying the previous active request accordingly to the new situation.	Aggregator	Consumer
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	CRE, AMP, ITE, ICCS, VS, ENER, ECO, ASM, HEDNO				
Priority	High				

Use Case ID	**HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC aims to provide information about curtailment level, to be used by other SUCs to prepare one or a combination of strategies before curtailment becomes necessary. This is a prerequisite for HL-UC 1_SUC_2.1 and HL-UC 1_SUC_2.2. This would be a “start order” for analysing and deciding the various solutions to be applied for reducing RES curtailment. The idea is for DSO to issue timely signals to RES operators/owners and aggregators, so they can prepare a plan with various solutions for best approach of curtailments reduction. Market information shall be an important issue both on the day ahead market and also on balancing market as moments to find the congestions could be medium or very short time in advance.
Actors involved	• DSOs • Prosumers • Consumer • ESCOs (including RESCOs) • Aggregators • EVSE Operator • Battery Operators • Market Operator
Triggering Event	A risk of RES curtailment is determined.
Pre-condition	• Grid Data availability • Accurate Forecast information • Data collection should be in real-time (or very close to real-time) in order to secure various solutions to avoid RES curtailment. • Market data. • Data Privacy
WiseGRID systems involved	• WG Cockpit Interfacing with: • WG IOP

	• WiseHOME • WiseCOOP • WiseEVP • WG STaaS/VPP				
Post-condition	Warning correctly sent to its addressee.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	RES surplus	There is a prevision of RES surplus.	Time with RES surplus, amount of energy surplus in periods of 10 minutes, amount of energy surplus total	DSO	DSO
2	Market prices collection	The DSO has necessity of Market prices.	Market prices	Market Operator	DSO
3	Message	The DSO tries to reduce RES curtailment by encouraging neighbour transactions. (HL-UC 1_SUC_2.1)	Message of flexibility request: Risk of RES curtailment: - Time with RES surplus - Amount of energy surplus in periods of 10 minutes - Amount of energy surplus total - Market price of each kWh	DSO	Aggregator, VPP Operator
4	Message	The DSO tries to reduce RES curtailment by using grid storage distributed means. (HL-UC 1_SUC_2.2)	Message of flexibility request: Risk of RES curtailment Request of storage capacity: - Time with RES surplus - Amount of energy surplus in periods of 10 minutes - Amount of energy surplus total - Market price of each kWh	DSO	EVSE Operator, Battery Operator, Aggregator, ESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Information from market not available	Market prices needed in step 2 of the typical path are not available.	Market prices are not available	Market Operator	DSO
2	Information from market	Old market prices have to be used to	Use old market prices for implement the message	DSO	DSO

	not available	implement the message.			

Realization	
Main responsible partners (Author)	ETRA
Contributing partners	CRE, AMP, ITE, ICCS, VS, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case

Description	This is a particular case when there is no balance with the power system, therefore the production and consumption (including storage) need to be all the time in equilibrium.
	The prosumers can be domestic houses, municipalities, factories, storage stations, etc.
	Such conditions bring more constraints in the operation as there is no chance to change "interconnection" schedule.
	Under such conditions all systems for storage or for change on alternative technologies are more relevant.
	2 main scenarios are possible:
	• Scenario 1: Production is higher than the demand.
	    o Case 1.1: Empty batteries. Filling the batteries.
	    o Case 1.2: Full batteries. Shifting consumption.
	• Scenario 2: Demand is higher than the production
	    o Case 2.1: Reduction of consumption.
	    o Case 2.2: Use stored energy.
	    o Case 2.3: Connection of power generation support (this case doesn't avoid RES curtailment but avoids blackout).
	The cases inside their respective scenarios are ordered according to priority criteria. These cases will be explained in the "Typical steps" in a general way that can involve all the prosumers described before.

Actors involved	• EVSE Operator • Public Authorities • Prosumers • Distributed Energy Resources • DMS
Triggering Event	Avoid RES curtailment in island mode because that increases the risk of have no provision of electricity.
Pre-condition	• Back-up capacity. • Grid status measurements at relevant points. • Power generation support. • Forecast information.

	• Data collection should be in real-time (or very close to real-time) in order to secure various solutions to avoid RES curtailment. • Performant regulators for generating units.
WiseGRID systems involved	• WG Cockpit • WiseCORP • WiseEVP • WiseHOME • WG IOP
Post-condition	RES curtailment avoided.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Case 1.1	The production is higher than the demand and there is storage capacity.	Command to store energy in the batteries	DMS	Distributed Energy Resources, Prosumer/ Public Authorities/EVSE Operator
2	Case 1.2	The production is higher than the demand but there is no storage capacity	Use of DR mechanisms in order to shift consumption, moving consumption to current time	DMS	Distributed Energy Resources, Distributed Energy Resources, Prosumer/ Public authorities/EVSE Operator
3	Case 2.1	Demand is higher than the production.	Use of DR mechanisms in order to shift consumption, moving consumption to current time	DMS	Distributed Energy Resources, Prosumer/ Public authorities/EVSE Operator
4	Case 2.2	Demand is higher than the production and the consumption is already optimized.	To use stored energy	DMS	Distributed Energy Resources, Prosumer/ Public authorities/EVSE Operator
5	Case 2.3	Demand is higher than the consumption, the consumption is already optimized and the batteries are empty	To connect the power generation support.	DMS	Distributed Energy Resources, Prosumer/ Public authorities/EVSE Operator

Exception path #1

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1	Scenario 1: Technical problems	If there is any technical problem in the batteries that doesn't allow store energy, goes to case 1.2.	Technical problems in the batteries, message of load shifting.	DMS	Distributed Energy Resources, Prosumer/ Public authorities/EVSE Operator
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Scenario 2: Technical problems	If there is any technical problem in the batteries that doesn't allow dump energy in the grid, goes to case 2.3.	To connect the power generation support.	DMS	Distributed Energy Resources, Prosumer/ Public authorities/EVSE Operator
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	CRE, AMP, ITE, ICCS, VS, ENER, ECO, ASM, HEDNO				
Priority	Low				

15.1.3 HL-UC 1_PUC_3_Voltage support and congestion management

Use Case ID	**HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (centralized)**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Centralized voltage control (secondary) means a coordinated increase/decrease of reactive power and tap changes for various RES Units within a zone, regardless they are large or small generators. This activity is coordinated by a Dispatch centre.
Actors involved	• DSO • RES Unit • ESCO • Producer • Prosumer • VPP Operator • EVSE Operator
Triggering Event	The voltage profile deviates significantly from the nominal value. Voltage drop within a large area. Trip of a large generator that was generating both P and Q.
Pre-condition	• Grid Data availability • Operating DMS • Accurate forecast information • Data collection should be in real-time (or very close to real-time). • Performant regulators for generating units
WiseGRID systems involved	• WG Cockpit Information exchange with:

	• WG IOP • WG RESCO
Post-condition	Voltage is recovered within all affected area and back in admissible range.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Significant Event in the grid	Notification from the DSO (problem in the network) to the RES aggregator (in the area with the problem, list of RES in the area)	Power flow data	DSO	RESCOs
2	Grid parameters are changing	Get measurements from the RES	Voltages and Reactive power	DMS	DSO
3	Large area Resources evaluation	Analysis of RES/ definition list of RES that could participate in the Voltage Control/Congestion Management	List of RES Units	RESCOs	DSO
4	Find availabilities	Get forecasts (HL-UC 1_SUC 1.2)	Reactive power reserves, tap changer positions	RESCOs	DSO
5	Offer from RESCOs	Send list to DSO and offer	List of RES units and available reactive power within each	RESCOs	DSO
6	Define possible units to supply support	Calculations by DSO/ verification	Power flow analyses	DMS	DSO
7	Select RES Units to supply support	DSO provides schedules/ requested actions	Units to give support and quantities	DSO	RESCO
8	RESCO accept order	Aggregator accepts the list of Large RES Units to be committed.	Units to give support and quantities	RESCOs	DSO
9	Monitor and Orders	The aggregator monitors the RES and sends corrective actions	Orders increase decrease reactive power	RESCO	RES Units
10	Monitor and Orders	DSO monitors the system and sends corrective actions	Orders increase decrease reactive power	DSO	RESCOs

Realization

Main responsible partners (Author)	CRE, ETRA
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, HYP, VS

Priority	High

Use Case ID	**HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (decentralized)**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC demonstrates the possibility to improve voltage level by using local loops of automation (within grid users' installations) for the available RES Units in the area. It can be developed for improving U level to the nominal value in a non-coordinated way. An innovative way is to use also P in voltage control (LV networks) by coordinating better the local storage, where exist. Decentralized voltage control (primary) makes reference to grid users installations (affecting a small area - node). Normally is an AVR (automatic voltage control) using local reactive resources and tap changers that are trying to keep voltage level limits of their medium voltage busbar. An important issue is to coordinate primary control with secondary as their outputs could create a voltage collapse in extreme cases. Even the mixed voltage control by both P and Q control is more difficult, it could significantly increase the voltage regulation due to specific R and X values within MV and LV grid.
Actors involved	• DSO • RES Unit • ESCO • Producer • Prosumer • VPP Operator • EVSE Operator
Triggering Event	Local voltage drop due to various reasons. Within a Prosumer installation, a capacitor is tripping.
Pre-condition	• Grid Data availability • Accurate Forecast information • Data collection should be in real-time (or very close to real-time) • Performant regulators for converters within generation units
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCORP (indirectly) • WiseCOOP • WiseHOME (indirectly) • WiseEVP • WG FastV2G (indirectly) • WG STaaS/VPP
Post-condition	Local voltage is recovered within admissible range.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Local Event in the grid	Notification from the DSO (problem in the network) to the RES aggregator (in the area with the problem, list of RES in the area)	Power flow data	DSO	RESCO
2	Grid parameters are changing in small area or one node	Get measurements from the RES	Voltages and Reactive power	DMS	DSO
3	Resources evaluation	Analysis of RES/ definition list of RES that could participate in the Voltage Control/Congestion Management	List of RES Units	RESCO	DSO
4	Find availabilities	Get Forecasts (SUC 1.2)	Reactive power reserves, tap changer positions	RESCO	DSO
5	Offer from RESCO	Send list to DSO and offer	List of RES units and available reactive power within each	RESCO	DSO
6	Define possible units to supply support	Calculations by DSO/ verification	Power flow analyses	DMS	DSO
7	Select RES Units to supply support	DSO provides schedules/ requested actions	Units to give support and quantities	DSO	RESCO
8	RESCO accept order	Aggregator accepts the list of local Small RES to be committed.	Units to give support and quantities	RESCO	DSO
9	Monitor and Orders	The aggregator monitors the RES and sends corrective actions	Orders increase decrease reactive power	RESCO	RES Units
10	Monitor and Orders	DSO monitors the system and sends corrective actions	Orders increase decrease reactive power	DSO	RESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Voltage drop is too high and	Prosumer inform the DSO about event	Voltage levels within the Prosumer	Prosumer	Aggregator, DSO

	there is not enough resources to recover rated voltage		substation. Reactive power exchange between prosumer and public grid		
2	Recover Zone voltage control	DSO is mobilising other reactive power resources within the area	Reactive power set-points, voltage level setpoints	DSO	RES Units, Producer, Prosumer, Aggregator, VPP Operator, EVSE Operator

Realization	
Main responsible partners (Author)	CRE, ETRA
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, HYP, ITE, VS
Priority	Medium

Use Case ID	**HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC refers to less extreme situations, where all phases are operating but the voltage symmetry is compromised due to asymmetrical loads. This SUC aims to improve both voltage level quality (and consequently consumers' efficiency) and loss reduction, as balanced networks have lower losses for the same total power flow. This can be achieved by controlling reactive power on each phase and by being able to modulate also active power between phases. Clear means to perform both, need to be detailed. It is envisioned that voltage control will be made on each phase in low voltage networks, such that asymmetries due to single-phased connections (which bring unbalanced loads) can be reduced.
Actors involved	• DSO • RES Unit • ESCO • Producer • Prosumer • VPP Operator
Triggering Events	Voltage symmetry is compromised due to asymmetrical loads.
Pre-condition	• Grid Data availability (reactive power resources on each phase) • Data collection should be in real-time (or very close to real-time) - e.g. voltage, P and Q on each phase and • Performant regulators for single-phased generation units which can control, Q (inverter based) and 3-phased which can control separately each phase, for both P and Q

WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WG RESCO				
Post-condition	The loads of the phases would be balanced and therefor the voltages would move towards a more symmetric condition.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Local unbalance within the three phases of the grid due to asymmetrical loads	Notification from the DSO (problem in the network) to the RES aggregator (in the local area with the problem, list of RES in the area)	Power flow data	DSO	RESCO
2	Voltages get asymmetric	Get measurements from the RES	Voltages and Reactive power	DMS	DSO
3	Resources evaluation	Analysis of RES/ definition list of RES that could participate in the Voltage phases balance.	List of RES Units	RESCO	DSO
4	Offer from RESCO	Send list to DSO and offer	List of RES units and available reactive power within each	RESCO	DSO
5	Define possible units to supply support	Calculations by DSO/ verification	Power flow analyses	DMS	DSO
6	Select RES Units to supply support	DSO provides schedules/ requested actions for Small RES – Voltage Symmetry	Units to give support and quantities	DSO	RESCO
7	Monitor and Orders	The aggregator monitors the RES and sends corrective actions	Orders increase decrease reactive power	RESCO	RES Units
8	Monitor and Orders	DSO monitors the system and sends corrective actions	Orders increase decrease reactive power	DSO	RESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	PV cells are connected to the faulty phase	Inverter will try to regulate the generation in line with faulty phase original consumption.	Unbalanced active power	DMS	DER (Inverter)

2	PV Inverter try to balance generation with consumption	Where enough generation, the consumer will remain supplied. Where not enough generation, the PV Inverter will trip and consumer will be outage.	Unbalanced active power	DMS	DER (Inverter)

Realization	
Main responsible partners (Author)	CRE, ETRA
Contributing partners	ENER, ECO, ASM, HEDNO, ENG
Priority	Low

15.1.4 HL-UC 1_PUC_4_Grid planning analysis

Use Case ID	**HL-UC 1_SUC_4.1_EV charge points planning analysis**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The objective of this SUC is to provide tools and insights for DSOs for future grid planning and optimally expand the local electricity grid with EVSEs. Consequently, DSOs need to carefully consider where EVSEs will be installed, thus grid redesign could be required. Prioritisation of the locations of future EVSE infrastructure requires: • knowledge of current grid infrastructure (RES production, EVSE) and capacity status • demand for EVSE infrastructure by EV users, EV fleet managers and EVSE operators • knowledge of current public space layout, and urban design plans of the public space • knowledge of tender procedures of the local authorities.
Actors involved	• DSO • Public Authority
Triggering Event	EVSE Operator or EV Fleet Manager necessities of new charging points
Pre-condition	• Grid topology and structure availability • Analysis of grid capacity throughout the year (accurate forecast information) • Demand of EV fleet managers and EV users • Interoperability between the tools of different data source providers (via WG IOP) • Specific models and algorithms in order to provide simulation scenarios and decision support are needed • Historical data from EV/EVSE infrastructures is available for analysis • Communication with local authorities as owners of the public space and the parties designing the public space
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP

Post-condition	Based on solid planning EV grid users will have a smooth and continuous connection.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	DSO is requested to prepare to the installation of a set of EVSEs	Public authority expresses its desire to install a certain amount of new EVSEs	Number of EVSEs, EVSE properties, EVSE expected usage	DSO, ESCO, EVSE Operator, EV Fleet Manager, Public Authority	DSO
2	Retrieval of historic power flow data and grid information	In order to perform simulation of impact, historic power flow data of the grid, as well as a topological model are required	Topology, historic power flow curve	DSO	DSO
3	Define simulation scenarios	DSO will simulate different scenarios in order to explore impact of alternative connection points	For each scenario: connection points, demand model of EVSEs connected to each connection point	DSO	DSO
4	Run simulation scenarios	For each scenario, expected demand curve is estimated, and compared with the nominal capacity of the grid elements in order to identify critical points	For each scenario: estimated power flow curve per grid section, identification of stressed section of the grid	DSO	DSO, ESCO, EVSE Operator, EV Fleet Manager, Public Authority
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, VS				
Priority	Low				

Use Case ID	**HL-UC 1_SUC_4.2_Grid storage planning analysis**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC will involve the simulation of different storage penetration ratios, decision support on best location of storage assets. It will also evaluate case-by-case possibilities for necessary storage (capacity and energy) and optimum storage technology. In order to plan for maximal capacity of the grid, the location of installed electricity storage components that can produce and use electricity need to be carefully considered. This SUC will involve the simulation of different levels of storage penetration (cumulated MWh of storage means in a certain local grid).

	The support will assist to decide: • Best location of storage assets in a local grid. • Necessary storage (power and energy) in a certain local grid. • Optimal storage technology at a certain local grid.
Actors involved	DSO
Triggering Event	DSO identification of overloaded sections on the grid
Pre-condition	• Grid topology and structure availability • Collection of historical aggregated load curves of consumers and of production curves for producers/prosumers (e.g. with 15 minutes resolution, which can be obtained from smart meters without privacy concerns) • Algorithm to simulate impact of storage technology on grid operation • Specific models and algorithms in order to provide simulation scenarios and decision support and needed
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	By having a permanent clear picture of the state of the DSO's grid, of connected generation facilities and of storage capacities, the system becomes stable and predictive in case of new connection requests.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	DSO identifies a section of the grid nearly overloaded	DSO identifies peaks of demand that may overload certain sections of the grid. An analysis is performed in order to estimate the impact of placing storage capabilities to flatten the demand curve	Identification of overloaded element in the grid	DSO	DSO
2	Retrieval of historic power flow data and grid information	In order to perform simulation of impact, historic power flow data of the grid, as well as a topological model are required	Topology, historic power flow curve	DSO	DSO
3	Define simulation scenarios	DSO will simulate different scenarios in order to explore impact of alternative connection points	For each scenario:, connection points, simulated battery capabilities	DSO	DSO
4	Run simulation scenarios	For each scenario, expected demand curve is estimated, and compared with the nominal capacity of the grid elements in order to verify	For each scenario: estimated power flow curve per grid section, comparison of	DSO	DSO

		that overload problem is solved	current and estimated situation of overloaded elements		

Realization	
Main responsible partners (Author)	ETRA, CRE
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, ITE, VS
Priority	Low

15.1.5 HL-UC 1_PUC_5_Promote RES via RESCO companies

Use Case ID	**HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The objective of this SUC is to support the operations of RESCO companies: make an inventory of their assets, monitor and control all parameters related to their assets, measure the economic impact for them and their customer RESCO companies. These companies will encourage the adoption of distributed RES. The application will be developed to administrate all distributed RES installations from the residential area. The purpose of this is related to installation part (investment) and also the operation and maintenance of the distributed facilities.
Actors involved	• Producer • Prosumer • RESCO • Consumer
Triggering Event	RESCO continuously maintains inventory of clients and assets and reviews new licenced RESCO/producers.
Pre-condition	• Grid Data availability • Connection facility • Agreement between RESCO and prosumer. • Accurate inventory information • Data collection should be in real-time (or very close to real-time). • Interoperability between the tools of different data source providers (via WG IOP) • Sensor/smart meter infrastructure for information collection and sending • RES deployment planning support information
WiseGRID systems involved	• WG RESCO Information exchange with: • WG IOP
Post-condition	RESCO company has a clear view of the portfolio of clients, installed assets, expected lifetime, preventive and planned maintenance actions. By mapping RESCO companies' assets and their parameters, DSOs are also able to prepare real-time operations updating RES status within their network. Corroborated

	with the real-time status of the grid, RESCO companies and DSOs can promote RES to the final user and distributed generation.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	RESCO client portfolio update	Upon customer (un)registration, client portfolio is accordingly updated	Customer personal data Contract data	Prosumer, Producer, Consumer	RESCO
2	RESCO asset inventory update	Upon installation/removal of assets on customer premises, asset portfolio is accordingly updated	Data on assets and their parameters Associated client	RESCO	RESCO
3	Ongoing monitoring and control of assets' parameters	Permanent assessment of assets' parameters and of their modification in time	Assessment of assets' parameter (e.g. remaining lifespan and impact on efficiency, preventive maintenance tasks)	RESCO	RESCO
3	Assets' economic impact upon the RESCO and their customers	Assess the economic impact of RESCO's assets	Assessment of economic impact	RESCO	RESCO
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG				
Priority	Medium				

Use Case ID	**HL-UC 1_SUC_5.2_Monitor domestic RES production**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC will be focused on the determination of the domestic RES production capacity in relation to the limits for domestic RES usage within different grid parts. The algorithm will evaluate grid facilities, load profiles, weather conditions and most suitable RES technologies to be used. In the prosumer situation (consumption, RES and storage behind the meter), control of maximum grid injection will be considered as main automation, avoiding the need of RES curtailment.
Actors involved	• DSO • RESCO • Prosumer

	• RES Unit • AMI • Smart meter
Triggering Event	Continuous retrieval of data of installed domestic RES assets and client portfolio (new data received every 15 minutes), including also information of new connection requests.
Pre-condition	• Data collection should be in real-time (or very close to real-time) • For prosumer, a local control of grid power exchange should be operational, in order to limit the grid injection to a maximum allowed value, agreed with DSO based on grid availability • Interoperability between the tools of different data source providers (via WG IOP)
WiseGRID systems involved	• WG RESCO Information exchange with: • WG IOP
Post-condition	Up to date data of production of domestic RES units installed in the RESCO customer's premises. Up to date grid data of domestic RES within specific grid elements is made available.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data acquisition	Metering data from RES units is periodically read by the AMI deployed	Metering data	RES Unit	AMI, Smart Meter
2	Data dispatch	AMI sends the read data to the RESCO company	Metering data	AMI, Smart Meter	RESCO
3	Data validation and storage	RESCO assesses the integrity of data and stores it for subsequent use		RESCO	

Exception path

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Lack of data	Production data is missing at a certain point of time	Estimated production (based on context data)	RESCO	RESCO

Realization

Main responsible partners (Author)	ETRA, CRE
Contributing partners	ENER, ECO, ASM, HEDNO, HYP, ENG
Priority	Medium

Use Case ID	HL-UC 1_SUC_5.3_Monitor domestic clients consumption
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC will focus on determining the most relevant load profile (LP) of the residential consumption for the specific area. The procedure will evaluate both “generation possibilities” and “consumption most probable” based on specific season, day-night cycle, weather conditions and patterns, etc. The application will also record specific load profiles for domestic consumption and will build a data base to be considered for further estimations (forecasting and profiling). Considering 4 seasons and working/weekend days, as well as RES availability, a number of 4x2x2=16 specific load profiles should be considered, at 15 minutes LP resolution. Average LPs over seasons, day types and solarisation type (sunny/cloudy) shall be produced, as non-high private data to be used in RESCO profiling.
Actors involved	• DSO • Producer • RESCO • Consumer • Prosumer • AMI • Smart Meter
Triggering Event	RESCO retrieves information on domestic demand periodically
Pre-condition	• Grid Data availability • Connection facility • Accurate Forecast information • Data privacy should be preserved for domestic end-customers • Data collection should be in real-time (or very close to real-time) and will include 1 minute and 15 minutes load profiles • Processing of real-time data (e.g. below 1 minute) and 1 minute load profiles should be aggregated in 15 minutes LPs (LP15), or LP15 should be read directly from energy meters • LP15 should be averaged over seasons, day type (work/holidays) and type of solarisation (sunny/cloudy) and specific profiles (16-20) should be used by DSO as non-private sensitive data • Interoperability between the tools of different data source providers (via WG IOP)
WiseGRID systems involved	• WG RESCO Information exchange with: • WG IOP • WG HOME • WiseCORP

Post-condition	Precisely mapping the load profile of residential consumers within a specific area, RESCOs have a clear picture of the generation gap/generation surplus within that area thus being able to support/divert investments towards where necessary.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data acquisition	Metering data from customer's home is periodically read by the AMI deployed.	Metering data	DSO, Prosumer, Consumer, RESCO	AMI, Smart Meter
2	Data dispatch	AMI sends the read data to the RESCO company	Metering data	AMI, Smart Meter	RESCO
3	Data validation and storage	RESCO assesses the integrity of data and stores it for subsequent use	Metering data	RESCO	RESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
3	False domestic consumption data	Overdue domestic consumption data update	Domestic consumption data	Prosumer, ESCO, Consumer	DSO, Prosumer, ESCO, Consumer
4	Poor investment decision	Uncorrelated investment decision with field data	Investment information (e.g. financial, ROI)	Prosumer, ESCO, Consumer	Prosumer, ESCO
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, HYP, ENG				
Priority	Medium				

Use Case ID	**HL-UC 1_SUC_5.4_Manage energy selling**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC defines how the RESCO can forecast the energy surplus that will be available from its assets in short-term (day-ahead). This surplus is calculated considering also forecasted production (based on data coming from HL-UC 1_SUC_7.2) and forecasted demand (based on data coming from HL-UC 1_SUC_7.3) of its customers.
Actors involved	• RESCO • Market Operator

<table>
<tr><td colspan="2">Triggering Event</td><td colspan="4">Periodically, an estimation of the energy production needs to be communicated to the market operator (e.g. daily)</td></tr>
<tr><td colspan="2">Pre-condition</td><td colspan="4">• Grid Data availability
• Connection facility
• Residential energy consumption profiles
• Accurate forecast information
• Optimization algorithm to calculate the best efficiency planning.
• Data collection should be in real-time (or very close to real-time)
• Market information
• Interoperability between the tools of different data source providers (via WG IOP)</td></tr>
<tr><td colspan="2">WiseGRID systems involved</td><td colspan="4">• WG RESCO
<u>Information exchanges with:</u>
• WG IOP
• WiseHOME
• WiseCOOP</td></tr>
<tr><td colspan="2">Post-condition</td><td colspan="4">RESCO is able to offer energy in the wholesale market</td></tr>
<tr><td colspan="6">Typical steps</td></tr>
<tr><td>Step No.</td><td>Event</td><td>Description of process/ Activity</td><td>Info. exchanged</td><td>Actor producing the information</td><td>Actor receiving the information</td></tr>
<tr><td>1</td><td>Forecast RES units production</td><td>Based on historical information (retrieved by HL-UC 1_SUC_6.2), and contextual information (e.g. weather forecast), RES production for next day is forecasted</td><td>RES production curve forecast</td><td>RESCO</td><td>RESCO</td></tr>
<tr><td>2</td><td>Forecast customers demand</td><td>Based on historical information (retrieved by HL-UC 1_SUC_6.3), and contextual information (e.g. day of week, quarter of year), customer demand for next day is forecasted</td><td>Customer demand curve forecast</td><td>RESCO</td><td>RESCO</td></tr>
<tr><td>3</td><td>Energy production surplus forecast</td><td>Information from typical steps 1-2 is crosschecked to estimate the energy surplus for next day</td><td>RES production surplus curve forecast</td><td>RESCO</td><td>RESCO</td></tr>
<tr><td>4</td><td>Market participation and bid calculation</td><td>Based on the information provided by typical step 3, the RESCO offers the energy surplus in the wholesale market</td><td>Wholesale market bids</td><td>RESCO</td><td>Market Operator</td></tr>
<tr><td colspan="6">Exception path</td></tr>
</table>

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Missing or incorrect measurements	Forecast is calculated according to extrapolated data. Accuracy of forecast is therefore affected, and security margins may prevent the calculation of optimum bids			
Realization					
Main responsible partners (Author)	ETRA, CRE				
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, VS, HYP				
Priority	Medium				

Use Case ID	**HL-UC 1_SUC_5.5_Energy cost management**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The objective of this SUC is to provide KPIs and data to RESCO companies to check the investment they do when installing the assets (e.g. the cost associated to installing a PV on the rooftop of a customer), estimating the costs of maintenance, and monitor the profit of the produced energy. This will be connected to findings from HL-UC_1_SUC_5.4. KPIs: kWh/m^2, kWh/occupancy, kWh/production unit, kWh/ shift, kWh/€ invested (depending on application)
Actors involved	• DSO • Producer • RESCO • Consumer • Aggregator • Public Authority
Triggering Event	RESCO operational efficiency planning and forecasting
Pre-condition	• Grid data availability • Connection facility • Accurate Forecast information • Grid cost monitoring (to be added to the KPIs) • Data collection should be in real-time (or very close to real-time) • Market information • Interoperability between the tools of different data source providers (via WG IOP)
WiseGRID systems involved	• WG RESCO

	Information exchange with: • WG IOP • WiseHOME
Post-condition	Up-to-date information on energy KPIs of RESCO investments, resulting in reliable information for RESCO companies leading to upgrading/updating RESCO's investment and/or future investment opportunities.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Financial audits	Review of investment's initial KPIs	KPIs, initial reports	RESCO, Producer, Aggregator, Public Authority, Consumer	RESCO
2	KPIs comparison	Compare and contrast KPIs	KPIs	RESCO	RESCO
3.a	If KPI is positive	Continual monitoring	KPIs, reports	RESCO	RESCO
3.b	If KPI is negative	Compare and contrast with best practices and positive KPIs and propose and plan improvements	Improvement proposal plan, positive KPIs, best practices and best available techniques, reports	RESCO	RESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Non-updated data	Review of investment's initial KPIs Compare and contrast KPIs	KPIs	RESCO, Producer, Aggregator, Public authority, Consumer	RESCO

Realization	
Main responsible partners (Author)	ETRA, CRE
Contributing partners	ENER, ECO, ASM, HEDNO, ENG, HYP
Priority	Medium

15.2 HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION

15.2.1 HL-UC 2_PUC_1_Distribution network real-time monitoring

Use Case ID	**HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC describes an architectural systematization where all smart meter functionalities are adequately grouped in two separate (unbundled) components. The

	first component is the Smart Metrology Meter (SMM), whereas the second component is the Smart Meter eXtension (SMX). The SMM is responsible to record the metrological data. It is capable of recording data in highly secured manner, but has limited functionalities. The SMX overcomes this functional limitation by providing advanced functionalities that support the future evolution of the smart grid and energy services. SMXs can provide data to: • DMS (RTUs, protection devices, SCADA, substation automation) • PQ Monitoring System (HL-UC 2 SUC 1.3) • AMR (Electronic Meters) USM Capabilities: • Measurements in high frequency (~1min) • Local processing power • Local services The USM will provide several different measurements in the LV network by monitoring loads, DRES and prosumers, among others.
Actors involved	• DSO (DMS, AMI, GIS, ERP)
Triggering Event	Periodically (USM read new data based on the period set in their configuration).
Pre-condition	• Fast, cheap and reliable communication ○ Fast: Minimum bandwidth is defined. ○ Cheap: Maximum cost/MB is defined. ○ Reliability: SLAs are defined. • Bidirectional communication • Common Data Model • Minimum (and common) frequency of reading and sending measurements is defined. • Cyber/physical security and data privacy. • Connectivity between the systems.
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	• DMS and ERP are able to access new data coming from AMI. • DSO is presented with a proper vision on the status of the grid based on real measurements.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Field data acquisition	AMI periodically sends metering data (electrical and consumption measurements) to the DMS following the	Metering data	AMI	DMS

		procedure described in HL-UC 2 SUC 1.2.			
2	Data validation and storage	DMS assesses the integrity of the data and stores it for subsequent use.		DMS	
3	Customer data acquisition	DMS retrieves customer-related data from ERP.	Customer data	ERP	DMS
4	Geolocation data acquisition	DMS retrieves geolocation data from GIS.	Geolocation data	GIS	DMS
5	Data analysis	DMS combines and analyses all data received and presents it to the DSO in the form of a grid status report.	Grid status report	DMS	DSO

Realization	
Main responsible partners (Author)	ETRA
Contributing partners	ICCS, ENER, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 2_SUC_1.2_Data concentration**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The devices that read the data –measurements, alarms, etc.– generated by the different components in the grid (HL-UC 2_SUC_1.1) need to transmit them through the telecom network to a central point. There, a set of functionalities and operations are performed, including: • Data de-encapsulation (according to the used transmission protocol) and translation into a common data model. • Basic data validation (when the model of the device sending the data is well known), including bad data detection (HL-UC 2_SUC_2.6). • Time-alignment. • Buffering. • Forwarding data to the applications, services, modules, etc. that require them - including data access control mechanisms (triggering event for HL-UC 2_SUC_1.3). The used type of measurement device defines the data concentration structure. For example, the conventional measurements coming from RTUs are typically transmitted to a SCADA system, whereas in case of new measurement equipment, such as PMUs, it is necessary to use a Phasor Data Concentrator.
Actors involved	• DSO (DMS, AMI, SCADA) • Smart Meter • Sensor
Triggering Event	Smart Meter/Sensor sends new piece of data (measurement, alarm, etc.) to the AMI.
Pre-condition	• Measurement devices and transmission protocol used are well known.

	• Coordination between different, distributed concentration points. • Good communication with real-time applications (such as state estimation, voltage control etc.). • Reliable ICT support layer. • Data access control. • Low latency added by the data gathering process.
WiseGRID systems involved	• WG IOP Information exchange with: • WG Cockpit
Post-condition	DMS receives the new piece of information.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data reception	Data concentrator receives a new piece of data coming from the field. The sender is identified.	Field data (measurement, alarm, etc.)	Smart Meter, Sensor	AMI
2	Data validation	A basic validation is performed on the data, based on: - Type and model of the sender. - Type of data and existing thresholds. - etc.	Validated data	AMI	
3	Receiver identification	Data concentrator identifies potential receivers of the data, based on: - Subscriptions. - Permissions. - etc.	List of receivers	AMI	
4	Data broadcasting	Data concentrator broadcasts the data to the identified receivers.	Validated data	AMI	DMS, etc.

Exception path #1

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
2a	Bad data identification	If data does not pass the validation process, it is marked as bad data before proceeding with the UC execution. If the data can be substituted by an estimated value, the later will be sent instead (identified as such).		AMI	

Realization

Main responsible partners (Author)	ETRA

Contributing partners	ICCS, ENER, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 2_SUC_1.3_Monitoring power quality in the grid**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Power quality monitoring is the process of gathering, analysing, and interpreting raw measurement data into useful information. Gathering data is usually carried out by continuously acquiring measurements of voltage and current over an extended period. Available assets such as unbundled smart meters placed at prosumers (HL-UC 2 SUC 1.1), FRTU data from sensors installed at the MV/LV network and power quality analysers can fulfil this purpose. Power quality encompasses a wide variety of conditions on the power system, which are described by various quality indices. The range of conditions that must be characterized creates challenges both in terms of the monitoring equipment performance specifications and in the data-collection requirements. The following objectives of power quality monitoring are proposed: • Monitoring to characterize system performance • Monitoring the reliability of the system: This is related to the amount of time end-users are totally without power for an extended period of time. • Voltage Disturbances (EN 50160): This is related to requirements concerning the supplier's side, which characterize voltage parameters of electrical energy in public distribution systems.
Actors involved	• DSO (DMS, AMI, GIS, ERP) • Consumer (indirectly)
Triggering Event	Periodically (new measurements are received and analysed regularly).
Pre-condition	• AMI is placed in strategic monitoring locations of the network. • Type, quantity and periodicity of measurements is defined. • Thresholds to determine the power quality of the grid are set. • Devices specifications are well known. • Sensible data is managed with proper privacy and security.
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	DSO is presented with a proper vision on the power quality of the grid based on real measurements.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	Field data acquisition	Data from AMI is retrieved, validated and stored as explained in HL-UC 2 SUC 1.1	Metering data (mainly voltage and current measurements)	AMI	DMS
2	Topology data acquisition	DMS retrieves topology data from GIS.	Topology data	GIS	DMS
3	System performance analysis	DMS analyses the data received and generates a report on the performance of the system.	System performance report	DMS	DSO
4	Alarm generation	Additionally, if the outcome of the analysis is that system performance exceeds the defined threshold(s), the DMS will alert to the DSO.	System performance alarm	DMS	DSO
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
3	System reliability analysis	DMS analyses the power supplied to the end-users during the last period and generates a report on the reliability of the system.	System reliability report	DMS	DSO
4	Alarm generation	Additionally, if the outcome of the analysis is that system reliability is under the defined threshold(s), the DMS will alert to the DSO.	System reliability alarm	DMS	DSO
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
3	Voltage quality analysis	DMS analyses the voltage measurements received and generates a report on the voltage quality of the system.	Voltage quality report	DMS	DSO
4	Alarm generation	Additionally, if the outcome of the analysis is that voltage quality is out of the defined threshold(s), the DMS will alert to the DSO.	Voltage quality alarm	DMS	DSO
5	Customer report	At the end of the period (or at any moment), a report with the voltage disturbances that have affected a customer can be generated.	Voltage disturbances report	DMS, ERP	DSO, Consumer
Realization					

Main responsible partners (Author)	ETRA
Contributing partners	ICCS, ENER, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 2_SUC_1.4_Fault detection and identification**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC will focus on fault detection algorithms and self-healing strategies that include the following steps: i) Automatic detection of faults, ii) Automatic determination of the approximate location of the fault, iii) Automatic isolation of the faulted section of the feeder, and iv) Automatic restoration service. Moreover, in this SUC the impact of high penetration of DERs and microgrids on these strategies will be examined. This SUC describes the procedure to perform fault detection which will trigger the mechanisms described by HL-UC 2 PUC 3 for grid control.
Actors involved	DSO: needs to minimise the duration of outages when those occur • DMS: The DMS system receives the information and sends the appropriate commands (e.g. to remote controlled breakers, etc) according to the advanced control strategies (fault location algorithm, self-healing algorithm, etc) • GIS: The geographical area of the affected network is identified • AMI: Sends the available information to the DMS system • SCADA: Sends the available information to the DMS system VPP Operator: is able to provide energy to the grid (as per SUC 6.3.2) Aggregator: aggregated prosumers are able to provide energy from RES to the grid (as per SUC 7.2.6) EVSE Operator: is able to provide energy from EVs to the grid (as per SUC 3.4.2)
Triggering Event	One of the following problems is detected in a certain area of the distribution grid: • Outage • Power flow exceeding capacity threshold of the line
Pre-condition	• Network topology with redundancy (energy can flow by several different paths to reach its destination) • Data from topology processor (e.g. circuit breakers status) • Installed devices must be able to detect different types of faults (phase to phase, phase to ground) • Substations are compliant with IEC 61850 • Bidirectional communication between field devices and SCADA • Bidirectional communication between SCADA and DMS • Availability of an ancillary services market

<table>
<tr><td colspan="2"></td><td colspan="4">Information on the ancillary services (providers of distributed energy supply, amount of power/energy that can be supplied and supply points)</td></tr>
<tr><td colspan="2">WiseGRID systems involved</td><td colspan="4">WG Cockpit
<u>Information exchange with</u>
WG IOP
WG STaaS/VPP
WiseCOOP
WiseEVP</td></tr>
<tr><td colspan="2">Post-condition</td><td colspan="4">Depending on possibilities of the scenario:
Supply is automatically restored in the affected area
Indications are given to DSOs with instructions to restore supply as soon as possible</td></tr>
<tr><td colspan="6">Typical steps</td></tr>
<tr><td>Step No.</td><td>Event</td><td>Description of process/ Activity</td><td>Info. exchanged</td><td>Actor producing the information</td><td>Actor receiving the information</td></tr>
<tr><td>1</td><td>Acquisition of data from field devices (HL-UC 2 SUC_1.1 and HL-UC 2 SUC_1.3)</td><td>The DMS monitors the status of the distribution grid by retrieving measurements from field devices (substation-level and smart meters)</td><td>Power flow measurement, circuit breakers status, fault passage indicators measurements</td><td>AMI, SCADA</td><td>DMS</td></tr>
<tr><td>2</td><td>Acquisition of data from customers</td><td>The DSO enables channels in order to receive indications of faults directly from customers (via specific apps, phone calls, etc.)</td><td>Incident notification, location of incident</td><td>Consumer, Prosumer</td><td>DSO</td></tr>
<tr><td>3</td><td>Get grid topology</td><td>In order to study the location and root causes of the fault, topology of the grid is needed</td><td>Grid topology</td><td>DMS</td><td>-</td></tr>
<tr><td>4</td><td>Fault detection</td><td>Cross-check acquired data in order to detect the exact location (e.g. substation) and type (outage, voltage deviation, etc.) of fault</td><td>-</td><td>DMS</td><td>-</td></tr>
<tr><td>6</td><td>Report to DSO operators</td><td>A detailed report of the detected faults presented to the DSO operators</td><td>Report detailing details of fault detected</td><td>DMS</td><td>DSO</td></tr>
<tr><td colspan="6">Realization</td></tr>
<tr><td colspan="3">Main responsible partners (Author)</td><td colspan="3">ETRA</td></tr>
<tr><td colspan="3">Contributing partners</td><td colspan="3">ICCS, HEDNO, ENER</td></tr>
<tr><td colspan="3">Priority</td><td colspan="3">High</td></tr>
</table>

Use Case ID	HL-UC 2_SUC_1.5_Asset management
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC will focus on keeping a well informed and updated list of all network components and their characteristics. Moreover, it includes the process of all the available data for planning, asset maintenance and other utility enterprise applications that increase asset utilization and reduce operational costs. By developing asset management functionalities, the network operator will be able to use power system assets at full efficiency, to their real end-of-life and without disruption of service due to failure. The assets' related data managed with this use case are: • Nominal parameters: model, brand, type, ranges, etc. • Geographical location • Hierarchies and relations between assets • Maintenance information: both preventive and corrective actions
Actors involved	DSO: • DMS: asset management of primary components of the substation (circuit breaker, power transformer, etc.) • ERP • GIS
Triggering Event	The DSO uses the WG Cockpit to modify the catalogue of assets
Pre-condition	All assets have been registered within the WG Cockpit
WiseGRID systems involved	WG Cockpit
Post-condition	Catalogue of assets is updated accordingly to DSO's needs

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Asset catalogue accessed	DSO operator accesses asset catalogue within the DMS (which implements an access control policy)	Username, password, user profile	DSO	DMS
2	Asset catalogue is shown to DSO operator	The DMS GUI shows information of those assets for which the DSO operator has access permissions	Asset details	DMS, GIS	DSO
3	DSO operator modifies asset	DSO operator makes use of the DMS GUI to change, add, remove or program a maintenance action on an asset	Asset, action, parameters	DSO	DMS, GIS

4	Asset catalogue modified	DMS performs the change	Confirmation	DMS	DSO
5	DMS triggers necessary actions to ERP	In case that maintenance actions have been programmed, ERP needs to be informed about them	Asset, maintenance action details (start time, deadline, priority)	DMS	ERP

Realization	
Main responsible partners (Author)	ETRA
Contributing partners	ICCS, HEDNO, ENER, ASM
Priority	High

15.2.2 HL-UC 2_PUC_2_Real-time distribution system awareness

Use Case ID	**HL-UC 2_SUC_2.1_RES and load forecasting**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Forecasting modules are important for all operations of the WiseGRID app and components. Furthermore, forecasting modules can be significantly improved if more data are available. This SUC will make reference to the forecasting modules focused on the operation of the DSO and the distribution network. In order to increase the performance of these modules, data requests to external systems will be sent. Finally, the results of the algorithms will be available to external actors/applications. Privacy issues are not investigated at this stage. It is obvious that some data exchanges might not be possible due to regulation restrictions. Type of considered forecasts: • RES Forecast: Forecast of RES production, availability of RES • Load Forecast: Forecast of total demand at a substation (primary or secondary), flexibility forecast • EV Forecast: Forecast of total demand for EV charging, EV Flexibility forecast (how much energy can be shed per substation) Some advantages of accurate forecasting are the following: • Possibility to have increased penetration of RES due to increased reliance on renewable power and availability. These results in reduction in fossil fuel–based generation and lower operational electricity generation costs (sum of fuel costs, and start and shutdown costs) • Reduction in the amount of curtailment required and better predictability of ramping requirements • Possibility to replace missing real-time measurements with forecasts in order to be able to compute the state of the monitored grid The time-granularity/horizon of the forecast can be: • Very short-term =1h (5 or 15 min steps), • Short-term 6-8 h (15min-1hour step),

	• Medium-term (24h-48h, 1-hour step) and • Long-term (1 week, 1-hour step) Suitable methods of big data analysis, time series and machine learning can be used to produce accurate forecasts.
Actors involved	• Forecast Provider • DSO (DMS) • TSO (Energy Management System) • ESCO • Supplier • VPP Operator • Aggregator • EV Fleet Manager • EVSE Operator
Triggering Event	• Periodic • Lack of real-time measurements or need to increase the knowledge of the grid state • Need to reduce undesired operations, such as RES curtailment or increased ramp-up/ramp-down rates
Pre-condition	• Actors are enrolled in contracts for the provision of Forecast services • Identify the desired time horizon of the forecast and the needed amount of forecast information • Provision of forecast error by the forecasting tools (quantiles) • Availability of Active and Reactive energy, Voltage measurements • Availability of Meteorological Forecasts and assessment of their impact on forecast accuracy
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCOOP • WiseCORP • Wise HOME • WiseEVP • WG FastV2G • WG STaaS/VVP
Post-condition	The forecasts are sent by the different actors who produce them to the DSO. Then, they can be used either to replace missing measurements or improve the grid operation.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	Perform the forecast	The different actors that are responsible for performing the forecast, use suitable methods and tools to produce the forecast information. Then, they forward the result to the DSO.	RES production, total demand, flexibility demand, total demand for EV charging More specifically: power, energy, voltage, current, weather information, GDP, Forecast time-granularity, forecast refresh rate, forecast accuracy and prediction intervals	Forecast Provider, ESCO, Supplier, VPP Operator, Aggregator, EV fleet Manager, EVSE Operator	DSO
2	Use of forecasts	The DSO, depending on the received signals, decides which applications need the forecasts and sends them the needed information.	Forecast results	DSO	DMS, TSO (EMS)
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Low forecast accuracy	In case the forecasts are characterized by an accuracy that is lower than the one needed by the apps that use them, then the actors that provide the forecast may make another attempt that aims at improving the forecast accuracy. In practice, this can be done by updating the used equipment and software packages or use a more accurate forecast method.	Forecast accuracy, accuracy needed by the applications that use the forecasts and mismatch	Forecast Provider, ESCO, Supplier, VPP Operator, Aggregator, EV fleet Manager, EVSE Operator	DSO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	HEDNO, ASM, ENER, ETRA				
Priority	High				

Use Case ID	**HL-UC 2_SUC_2.2_Topology processor**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Topology processing is an important step in the state estimation process (HL-UC 2_SUC_2.5), as well as in the load flow calculation (HL-UC 2_SUC_2.4). It refers to the

	determination of the system topology by using available measurements and connectivity data of switch status indicators. Hence, the topology processor determines both the connectivity of the electrical network and the location of metering devices in terms of bus-sections and switching devices (breakers and switches). The topology processor analyzes the status of circuit breakers and switching devices in order to determine: • The interconnections of physical nodes; • The electrical buses to which each element (i.e., electrical lines, transformers or shunt devices) is connected and • The existence of electrical islands. The status of switching devices can be either telemetered or entered manually by the DSO/TSO. The conventional topology processing is conducted before the network observability analysis (HL-UC 2_SUC_2.3), the state estimation (HL-UC 2_SUC_2.5) and bad data detection (HL-UC 2_SUC_2.6). Once the topology processor has configured the diagram of the network, the next step is to trigger the network observability analysis (HL-UC 2_SUC_2.3) and the state estimator. Actual data gathered from the field are not in a bus-branch format, as needed by the state estimator or the load flow analysis, since the network connectivity is typically given in terms of bus-sections and switching devices (i.e. physical model representation). The topology processor makes the transformation to the model required by the state estimator and the load flow analysis. Additionally, it calculates the network admittance matrix and the location of loads and generators in the grid. The topology processor is a background, off-line processor and is used to provide accurate network data for other DMS applications.
Actors involved	• DSO (GIS, SCADA, DMS) • TSO (Energy Management System)
Triggering Event	The Topology Processor is activated either by a periodic timer, on user demand or when a change in switch state is detected.
Pre-condition	• Identification of network buses and elimination of de-energized buses • Identification of all the different components connected to active buses, such as electrical lines, transformers, shunt reactors/capacitors, generating units etc. • Determination of the different islands in the network • Designation of the different types of network buses: slack bus, PQ buses, PV buses
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	The topology processor calculates the bus-branch network model and the network admittance matrix, which are used by the network observability analysis, the state estimator and the load flow calculation.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Calculate the bus-branch network	The topology processor uses all necessary information to transform the network physical model to the bus-	Connectivity data of switch status indicators, bus-sections and switching	DSO, TSO	DSO (TSO)

	model and the network admittance matrix	branch network model and calculates the network admittance matrix.	devices (breakers and switches), studied network parameters, series and shunt line elements		
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Topological errors	Topological errors arise from the misconfiguration of one or more network elements, as a consequence of erroneous input data to the network configurator concerning the status of circuit breakers and switches. The system topology provided by the configurator becomes inconsistent with the actual network topology. There can be single or multiple topological errors. They have to be detected and fixed, otherwise the state estimation solution is wrong.	Network elements (e.g. transmission lines, transformers, shunt reactors, shunt capacitors etc.) Status of circuit-breakers	DSO, TSO	DSO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	HEDNO, ASM, ENER, ETRA				
Priority	Medium				

Use Case ID	**HL-UC 2_SUC_2.3_Network observability analysis**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	An electrical network is fully observable if, for a given set of measurements and their locations, it is possible to estimate its system state at all network buses. The network observability is defined by the type, number and location of available measurements, as well as by the measurement model. In particular, if something changes in the grid topology, such as a connection of a new line, switch operations etc., the network is not necessarily still observable by using the previous measurements placement. In this case, a new observability study must be conducted in order to determine a new measurements configuration. There are several ways to treat the observability analysis problem, by using graph theory or mathematical techniques. The minimum set of measurements that can guarantee the full network observability is called critical and if one of them is re-moved the system state cannot be computed correctly. On the other hand, it is pos-sible to add more measurement devices than the critical ones and, in this case, the extra measurements are called redundant. The redundant information leads to a

	higher accuracy in the state estimation results. If the network is found to be non-observable, it is possible to add some extra measurement devices or re-examine the location of existing measurement equipment.
Actors involved	• DSO (GIS, SCADA, PDC, DMS) • AMI (Smart Meter)
Triggering Event	The network observability analysis is conducted offline before the execution of the state estimation and is not re-conducted, unless something changes in the network topology or in the operation of installed measurement equipment.
Pre-condition	• Knowledge of the network topology • Knowledge of the number and type of available measurement devices • Determine zero-injection buses • Knowledge of network observability criteria
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	The outcome of the observability analysis is the optimal (according to different criteria) placement of measurement devices or the detection of observable islands.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Determine optimal measurements placement	The network observability analysis uses the network admittance matrix (provided by the topology processor) and the available measurements, in order to compute the optimal measurements placement. The latter depends also on the type of available measurements (e.g. V, I, P, Q, phasors etc.). The result is given to the state estimator.	Network admittance matrix, number of available real measurement devices , type of used measurements, zero-injection buses	DSO	DSO

Exception path

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	The observability criteria are not satisfied	In this case, the network observability analysis tool checks if the problem is solved (i.e., if the cause of the problem is fixed). If not, it replaces the missing real measurements with pseudo-measurements. The latter may consist of typical load profiles, historical measurements or forecasts. Then, the observability analysis tool sends	Network admittance matrix, number of available real measurement devices, type of used measurements, zero-injection buses, pseudo-measurements	DSO	DSO

		a message to the state estimator that the problem has been solved.			

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	HEDNO, ASM, ENER, ETRA
Priority	High

Use Case ID	**HL-UC 2_SUC_2.4_Load flow calculation**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The ability of a DSO to perform a large number of simulations to arrive at an operating plan for the real-time operation of the power system is fundamental. The steady-state applications are those that power flows are originally designed for, that is, to calculate the operating conditions given the load power consumption at all buses of the electric power system and the generator power production at each power plant and the network. Examples of these applications are: • Pre-fault steady-state system conditions to obtain flows and voltages, etc. • Post-fault steady-state conditions to obtain flows and voltages following a contingency • Static security assessment identifying any voltage and flow violations in the pre-fault and post-fault conditions. • Voltage stability studies identifying the maximum system margin or load increase. • Other system parameter calculations such as losses, generator reactive reserves, etc. Power flow calculation involves the solution of a set of nonlinear equations; depending on the network topology (most electrical networks in medium voltage level operate with a radial topology whereas in high voltage the majority of the grids are meshed) different load flow techniques can be used. Except for the topology, power distribution systems have other characteristics that are different compared to transmission systems, such as: • High R/X ratios • Unbalanced lines and loads • Lack of real-time measurements It is important to note that load flow is different compared to state estimation, since the latter: • Considers that measurements are affected by noise • Uses all kinds of available measurements and not only the ones of load flow • Uses novel methods to detect errors • Combines the theory of load flow and statistical analysis • Solves an optimization problem to get a more accurate and reliable system state

Actors involved	• DSO (GIS, SCADA, DMS)				
Triggering Event	The load flow can be used as tool (off-line) for system planning purposes or on-line in order to assess system performance and operations under a given condition. The tool is triggered either by a network event or by the users.				
Pre-condition	• Network topology • State of the switches • Knowledge of different types of network buses (load buses, voltage-controlled buses, slack bus) • Knowledge of the injected power P, Q at load buses, P, V at voltage-controlled buses and the voltage phasor (magnitude and phase) at the slack bus				
WiseGRID systems involved	• WG Cockpit				
Post-condition	The voltage magnitude and phase at each bus and the real and reactive power flows at each line.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Calculate system state and power flows	The load flow calculation tool communicates with the topology processor and with SCADA and uses the network admittance matrix as well as the measurements at the three different load flow bus types to compute all the remaining unknown quantities.	Network admittance matrix, location of loads and generators, P, Q measurements at load buses, P, V measurements at voltage-controlled buses, voltage phasor measurements at the slack bus	DSO (SCADA, GIS)	DSO (DMS)
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Problem related to measurements	The load flow calculation tool does not have any ways to detect bad data or replace missing measurements with pseudo-measurements. Additionally, unlike state estimation, it requires measurements from all network buses and not only from some of them. Hence, if some measurements are missing or if they are inaccurate or wrong, the load flow will not be calculated or its outcome will be wrong. In this case, it has to be replaced by state estimation.	Number and location of missing or inaccurate/wrong measurements	DSO	DSO

		Otherwise the problem of missing or inaccurate measurements must be solved.			

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	HEDNO, ASM, ENER, ETRA
Priority	High

Use Case ID	**HL-UC 2_SUC_2.5_State estimation**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	In power systems, the knowledge of the system state is required by several fundamental functions and applications, such as security assessment, voltage control and stability analysis. Until the late seventies, conventional load flow calculations provided the system state. However, the loss of even one measurement made the aforementioned calculation impossible. Additionally, the presence of measurement errors affected dramatically the computed state. In order to overcome these limitations, load flow theory (HL-UC 2_SUC_2.4) has been combined with statistical estimation resulting in the so-called state estimation. State estimation consists in the solution of an optimization problem that processes the measurements together with the network model in order to determine the optimal estimate of the system state. The output of state estimation is typically the voltage magnitude and phase (phase-to-ground voltage phasors) at all the network buses. If the voltage phasors are computed, then - for a given network topology, it is possible to compute all other parameters of interest, such as the power injections and power flows, the current injections and flows, the power losses, etc. The measurement redundancy is crucial in order to be able to afford loss of measurements, identify measurement and network parameter errors, and filter out the measurement noise. The necessary inputs of state estimation are the network topology (HL-UC 2_SUC_2.2), the acquired measurements and monitoring information (coming from HL-UC 2_PUC_1), and the measurement uncertainties/noise.
Actors involved	• DSO (DMS, AMI, GIS) • Aggregator • Prosumer • VPP Operator • EV Fleet Manager • RES Unit • Distributed Energy Resources
Triggering Event	The state estimator is calculated periodically.
Pre-condition	• Network topology (e.g., lines lengths, resistance, reactance, susceptance, connectivity) • Data from topology processor (e.g., circuit breakers status)

	• Network observability and critical measurements identification • Detect gross errors and other sources of bad/missing data • Knowledge of measurement devices and sensors accuracy • Type of acquired measurements per device (e.g., P, Q, V, I, etc.) • Load forecasting output
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCOOP
Post-condition	The system state becomes available and can be forwarded to real-time applications that use it as input.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Trigger topology processor	The state estimator sets off the topology processor, which responds by sending back the network admittance matrix and the location of loads and generators.	Studied network parameters Series and shunt line elements, circuit breakers status, switches status, points of absorbed/injected power	GIS	DMS
2	Acquisition of dynamic (continuously updated) data	This involves the acquisition of measurements from all parts of the system. In particular, the measurements come from AMI (Unbundled Smart Meters), SCADA (e.g., RTUs), and third parties via the WG IOP.	Active power, Reactive power, Power factor, Bus Voltage, Injected and/ or Line Current, Energy	AMI, Aggregator, Prosumer, VPP Operator, EV, RES Unit, DER	DMS
3	State estimation calculation	The state estimator uses the above-mentioned information in order to filter the measurements noise and produce as outcome the optimal system data. The system state consists in the phase-to-ground voltage phasors at all network buses. It also returns the currents, the injected and line powers, power losses etc.	-	DMS	-
4	Trigger the bad data detector	The verification of the accuracy and reliability of the estimated state is conducted by interacting with the bad data detector.	Residuals, measurement weights (accuracy)	DMS	-

5	Coupling with real-time applications	The state estimator forwards its outcome to various applications included in the Grid Control (HL-UC 2_PUC_3).	System state	DMS	DSO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	The observability criteria are not satisfied	If the observability criteria cease to be satisfied, the system state cannot be calculated anymore. Some of the possible causes may be missing packets, loss of GPS synchronization, problem in the operation of connected sensors and/or measurement devices etc. The state estimator communicates with the observability analysis tool, in order to solve the issue by replacing the missing measurements. Then, it asks the observability analysis tool to check if the problem is solved, so that it can proceed to the re-estimation of the system state.	Number of available measurements, number of network buses, location of measurements, rank of the measurements Jacobian of the state estimator	DMS	DSO
2	Bad data are detected	If bad data is detected, the estimator interacts with the bad data detector and the following actions are taken: 1) The bad data (i.e. erroneous or inaccurate measurements) are removed, 2) the system state is re-calculated, 3) a bad data detection control is performed again. If there are more bad data, then the process described above (steps 1 to 3) is followed again, until they are fully removed and/or replaced with healthy data.	Residuals, measurement weights (accuracy)	DMS	DSO

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	HEDNO, ASM, ENER, ETRA
Priority	High

Use Case ID	HL-UC 2_SUC_2.6_Bad data detection, identification and replacement
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC aims at detecting the existence of gross errors in the measurement set. The latter can be due to several reasons, such as: malicious attacks, loss of GPS synchronization, missing packets, etc. Bad data detection refers to the process of determining whether or not the measurement set contains any bad data, while bad data identification is the procedure of finding out which specific measurements actually contain bad data. Once these two steps/processes are completed, the next step is the removal of any problematic, erroneous or bad data or, where possible, their replacement with non-erroneous measurements or pseudomeasurements. Bad data detection, identification and replacement is a key process in order to estimate correctly the system state. Otherwise, the outcome of the state estimation is wrong. Redundant measurements are also very important in the context of this process. Redundant measurement information allows to identify and locate bad data consisting of: • Gross measurement errors • Small modelling errors • Small parameter errors • Inaccurate knowledge of measurement variances In case a measurement is critical, special measures need to be followed. The bad data detection methods cannot be applied to measurements that are critical. There are several methods to perform bad data detection, based either on pre-processing or on post-processing. One of the most common methods is the calculation of the so-called Largest Normalized Residuals.
Actors involved	• DSO (DMS, AMI, SCADA, PDC)
Triggering Event	The bad data detection tool is executed at the end of every state estimation cycle, at the same refresh rate and if it is positive (namely, if bad data are detected), it is re-executed continuously until all bad data are removed.
Pre-condition	• ICT Support layer: reliable GPS synchronization and communication channels • Cybersecurity • Determine critical measurements
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	All bad data are either removed or replaced with non-erroneous measurements and the process of state estimation can be re-activated.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Run the bad data detection algorithm	The bad data detection and identification algorithm is executed for the first time at the end of the state estimation	Location of critical measurements, measurement array,	DSO	DSO

	execution for the first time	process during every time-step. If no bad data is detected, then the process moves on to the next time-step. Otherwise, what follows is Exception Event #1.	measurement accuracy, status of GPS synchronization, existence of missing packets		
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Bad data removal or replacement	If bad datais detected, then their locations are identified and they are removed from the measurement array (unless they can be replaced with correct measurements or pseudomeasurements). Then the state estimation process is re-executed until all bad data are removed.	Measurement array, measurement accuracy	DSO	DSO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	HEDNO, ASM, ENER, ETRA				
Priority	High				

15.2.3 HL-UC 2_PUC_3_Grid control

Use Case ID	**HL-UC 2_SUC_3.1_Load control**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Controllable loads, as components of the MV/LV distribution grid and due to their dependability, constitute a resource available to the DSO for facilitating his task regarding the operation and control of the distribution grid or for contributing to the overall system security and reliability in real-time. These loads are of conventional type and are connected directly to the distribution network. Due to their significant size and their special technical characteristics (e.g. desalination units) they are under the direct responsibility of the DSO. The latter takes on the duty of managing and operating such units. Additionally, these units are also considered a capacity resource connected to the grid. The nature of these loads allows the day-ahead planning of their deployment as well as the rescheduling of their operation in real-time. The DSO periodically monitors the prevailing conditions in the distribution network and decides and sends appropriate control signals to the loads under his responsibility. The loads, in turn, respond to these signals either by performing the requested action or by declaring inability to follow the request. In the first case (and if stipulated), they will receive a compensation, while in the second case a non-conformance penalty applies (if the DSO is also the owner of the facility, the compensation/penalty is not applicable). In the latter case, the DSO is responsible for performing appropriate adjustments in the dispatch signals.

Actors involved	• DSO • Load Controller • Prosumer (Smart Meter)
Triggering Event	The Load Controller receives a control signal from the DSO.
Pre-condition	• The proprietor of the unit (if different from the DSO) has signed a contract with the DSO that describes the conditions that apply regarding the load control actions (notice, frequency and duration events, remuneration/penalties based on ramping ability and accuracy of the response). • Proper control equipment (Smart Meter, Load Controller) ensuring resource availability and fast time-to-respond is installed in the premises of the unit. • Reliable calculation of customer response (amount of load shed). • Definition of timeframe and triggering events. • Cybersecurity
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP
Post-condition	Proper load control actions have been taken. If not possible, a response declaring inability to follow the control signal is sent.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data reception	The Load Controller receives a load control signal from the DSO (DMS).	Load control signal (energy consumption or amount of load to be shed, timeframe)	DSO (DMS)	Load Controller
2	Condition of equipment	The Load Controller observes the condition of the equipment.	Current electricity consumption levels of subsystems (if any)	Smart Meter	Load Controller
3	Calculation of margin	Based on the technical characteristics and the condition of the equipment, the Load Controller calculates the available margin for the operation of the equipment.	Available operational margin of the equipment (maximum amount of load to be shed or maximum load increase)	Load Controller	Load Controller
4	Formulate response to control signal	Based on the available margin, the Load Controller formulates the response to the control signal (in case of compliance, the amount and timing of the load shedding/increase; in case of non-conformance, declaration of inability to follow the control signal).	Response to control signal	Load Controller	Load Controller

5	Send response to control signal	The Load Controller sends to the DSO (DMS) the response to the control signal.	Response to control signal	Load Controller	DSO (DMS)

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	ASM, ENER, HEDNO
Priority	High

Use Case ID	**HL-UC 2_SUC_3.2_DR as a service to the grid**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Controllable loads, as components of the MV/LV distribution grid and due to their dependability, constitute a resource available to the DSO for facilitating his task regarding the operation and control of the distribution grid or for contributing to the overall system security and reliability in real-time. These loads are of conventional type and are connected to the premises of private and public buildings (households, businesses, industries). As such, these loads, even though controllable, are not under the direct control of the DSO or the TSO due to their small size. They are rather managed by a resource operator (Aggregator, EVSE Operator, VPP) within a framework explicitly described in the contractual agreement between the resource operator and the client (Prosumer, EV) with controllable loads. More specifically, the agreement defines all parameters for requesting load control actions, pertaining to the notice, frequency and duration of events, as well as the remuneration and non-conformance penalties. A similar agreement is also signed between the Aggregator and the DSO describing the respective parameters. In case the resource operator receives a control signal from the DSO, and based on the available loads to be controlled (information practically available through the contractual agreements), he calculates and sends appropriate dispatch signals (increase/decrease electricity consumption) to the clients. The latter, in turn, respond to these signals either by performing the requested action or by declaring inability to follow the request. In the first case, they will receive a compensation, while in the second case a non-conformance penalty applies. In the latter case, the Aggregator is responsible for re-defining the dispatch signals such that the total electricity consumption deviation conforms to the DSO's DR request.
Actors involved	• Aggregator • EVSE Operator • VPP Operator • DSO (DMS) Contributing actors: • Prosumer (Smart Meter) • EV
Triggering Event	The resource operator (Aggregator, EVSE Operator, VPP) receives a control signal from the DSO.

Pre-condition	• The resource operator has signed a contract with the DSO that describes the conditions that apply regarding the load control actions (notice, frequency and duration events, remuneration/penalties). • The Prosumers, EVs have signed a contract with the resource operator for load control actions (notice, frequency and duration events, remuneration/penalties for participation/conformance to control signals). • Proper equipment (Smart Meter, Load Controller) is installed in the premises of the Prosumer, EV. • Reliable calculation of customer response (amount of load shed). • Definition of timeframe and triggering events. • Cybersecurity.
WiseGRID systems involved	• WG Cockpit <u>Information exchange with:</u> • WG IOP • WiseCOOP • WG STaaS/VPP • WiseCORP • WiseHOME • WiseEVP • WG FastV2G
Post-condition	Proper load control actions have been taken. If not possible, a response declaring inability to follow the control signal is sent.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data reception	WG Cockpit receives data regarding the current conditions in the distribution system (HL-UC 1_PUC_1, HL-UC 2_PUC_2, HL-UC 3_PUC_1, HL-UC 4_PUC_4, HL-UC 6_PUC_1) including the available flexibility.	Production/ consumption of grid users, line loading, bus voltages/ angles	DSO (DMS), Aggregator, EVSE Operator, VPP Operator	DSO (DMS)
2	Status comparison	The DSO (DMS) compares the schedule of the resources as calculated by HL-UC 2_SUC_3.3 with the current status of the resources.		DSO (DMS)	DSO (DMS)
3	Resources rescheduling	If the current resource status deviates significantly from the one calculated by HL-UC 2_SUC_3.3, HL-UC 2_SUC_3.3 is invoked.		DSO (DMS)	DSO (DMS)

4	Send control signals	The DMS sends the control signal to the resource operators (invokes HL-UC 1_PUC_3, HL-UC 3_PUC_4, HL-UC 4_PUC_3, HL-UC 6_PUC_3, HL-UC 7_SUC_2.7-2.8).	Load control signals (energy consumption or amount of load to be shed, timeframe)	DSO (DMS)	Aggregator, EVSE Operator, VPP Operator
5	Receive response to control signals	The DSO (DMS) receives the responses of the resource operators to the control signals.	Response to control signals	Aggregator, EVSE Operator, VPP Operator	DSO (DMS)
6		Return to step 1.			
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	ASM, ENER, HEDNO				
Priority	High				

Use Case ID	**HL-UC 2_SUC_3.3_Optimization algorithm**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Integration of resources, e.g. controllable loads, Storage Units, RES Units, in the system operation affects the state of the system. Furthermore, these resources – to the extent that they are controllable – can contribute to achieving an optimized operation of the electricity system, the more so when combined with the flexible configuration of the grid topology through application of proper control actions over grid equipment (e.g. tap changers, switches, etc.). Application of optimization algorithms assists the decision-making process regarding the operating schedule of various grid components in order to solve/prevent eventual distribution grid operation problems and/or for contributing to the smooth operation of the transmission system. This SUC aims to develop optimization software appropriate for solving problems pertaining to the operational scheduling of the distribution grid (system reconfiguration, resource planning, voltage/frequency control) under normal and abnormal (emergency) situations. To this end, after receiving and appropriately reformulating the data regarding the current conditions in the distribution grid (HL-UC 1_PUC_1, HL-UC 2_PUC_2, HL-UC 3_PUC_1, HL-UC 4_PUC_4, HL-UC 6_PUC_1) and/or the network constraint (HL-UC 2_PUC_1), the optimization algorithm is applied. The result of the optimization is then translated into control signals of appropriate format.
Actors involved	• Aggregator • DSO (DMS) • EVSE Operator • VPP Operator • Harbour Control System
Triggering Event	Data reception regarding the current conditions in the distribution grid and/or the network constraint.

Pre-condition	• Portfolio of different actors integrated in the system is well known. • The optimization algorithm is robust and produces reliable results (established optimization software and solvers are used).				
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCOOP • WiseEVP • WG STaaS/VPP				
Post-condition	A set of control signals per component of the distribution grid is available.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data reception	WG Cockpit receives data regarding the network constraint (HL-UC 2_PUC_1) and the current conditions in the distribution grid (HL-UC 1_PUC_1, HL-UC 2_PUC_2, HL-UC 3_PUC_1, HL-UC 4_PUC_4, HL-UC 6_PUC_1).	Location and type of network constraint, production/ consumption of grid users, line loading, bus voltages/ angles	DSO (DMS), Aggregator, EVSE Operator, VPP Operator	DSO (DMS)
2	Data pre-processing	The received data are formulated in order to comply with the format required by the optimization algorithm.	-	-	-
3	Optimization	The algorithm calculates the optimal status of the components of the distribution grid.	Production, consumption levels per Aggregator, EVSE Operator, VPP, network topology (e.g. state of sectionalising switches)	DSO (DMS)	DSO (DMS)
4	Control signals formulation	The results of the optimization are translated into control signals of appropriate format.	Control signals per component of the distribution grid	DSO (DMS)	DSO (DMS)
5	Send control signals	The control signals are sent to the resources of the grid.	Control signals per component	DSO (DMS)	DSO (DMS), Aggregator, EVSE Operator, VPP

			of the distribution grid		Operator, Harbour Control System

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	ASM, ENER, HEDNO
Priority	High

Use Case ID	**HL-UC 2_SUC_3.4_Reconfinguration**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Network reconfiguration is an important operation for maintaining the reliable and secure operation of distribution networks, especially in case of high RES share. This process is defined as altering the topological structure of the distribution network by modifying the operational state of the sectionalizing and tie switches, while maintaining its radial structure. The objectives of network reconfiguration may be power loss reduction, load balancing among feeders, voltage quality improvement, enhanced reliability and service restoration. Network reconfiguration timeframe may vary depending on the implementation objective. Under normal conditions, this operation determines the optimal network topology in mid- or long-term horizon based on forecasted scenarios of load and RES production profiles. Under emergency conditions, a fast network reconfiguration is requested after the fault occurrence in order to supply the non-faulted area while the requested load shedding is minimum. This SUC describes the procedure for deciding the network topology through the use of an algorithm and for applying the network reconfiguration decisions. To this end, the new grid topology is simulated and assessed in terms of achieving a secure operation (no network congestion, voltage levels within prescribed limits), a sequence of commands is calculated in order to ensure a smooth transition from the current network topology to the new one, while, as a last step, these commands are executed. This UC is not incorporated in HL-UC 2_SUC_3.3 since the calculations may concern longer period.
Actors involved	• Aggregator • DSO (DMS) • EVSE Operator • VPP Operator
Triggering Event	The DSO (DMS) decides on a new network topology (in order to prevent problems that arise or may arise in the distribution network, e.g. overvoltage or congestion) or the user of the DMS decides to evaluate a specific period (on demand).
Pre-condition	• Proper equipment is installed in the distribution grid for monitoring and controlling the grid components (e.g. controllable sectionalising switches). • Sufficient measurement in the distribution network allowing the accurate estimation of state. • Cybersecurity.
WiseGRID systems involved	• WG Cockpit

	Information exchange with: • WG IOP • WiseCOOP • WiseEVP • WG STaaS/VPP				
Post-condition	A new distribution grid topology is selected and applied.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Event Warning	WG Cockpit receives warning regarding the state of the grid (HL-UC 2_PUC_2) or it is launched on demand by the user in order to evaluate a specific period (e.g. next month).	Location and type of network problem	DSO (DMS)	DSO (DMS)
2	Data reception	WG Cockpit receives data regarding the network constraint (HL-UC 2_PUC_1) and the current conditions in the distribution grid (HL-UC 1_PUC_1, HL-UC 2_PUC_2, HL-UC 3_PUC_1, HL-UC 4_PUC_4, HL-UC 6_PUC_1).	Location and type of network constraint, production/ consumption of grid users, line loading, bus voltages/ angles	DSO (DMS), Aggregator, EVSE Operator, VPP Operator	DSO (DMS)
3	Calculations	The algorithm calculates the optimal status of the components of the distribution grid.	Status of sectionalising switches, set-points to DER, EV, VPP	DSO (DMS)	DSO (DMS)
4	Commands	Sending commands to the components of the Grid.	Commands sectionalising switches, set-points to DER, EV, VPP	DSO (DMS)	DSO (DMS), Aggregator, EVSE Operator, VPP Operator
5	Verification	WG Cockpit analyses again the system status (HL-UC 2_PUC_2).	Location and type of network problem	DSO (DMS)	DSO (DMS)
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	No solution found	In case the calculations of typical step 3 do not reach a solution, other actions may be taken (HL-UC 2_SUC_3.1, HL-UC 2_SUC_3.2, HL-UC 2_SUC_3.3).	Warning	DSO (DMS)	DSO (DMS)
Realization					

Main responsible partners (Author)	ICCS
Contributing partners	ASM, ENER, ETRA, HEDNO
Priority	Medium (it is not easy to test it in real network)

Use Case ID	**HL-UC 2_SUC_3.5_Islanding procedures for the local grid**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC describes the methods for the management of the distribution network after an unintentional or intentional islanding event. The operator may send commands to all distributed resources ignoring market constraints. Within this SUC the islanded part of the network is monitored and the balance between local production (RES and DG units) and demand is ensured. This SUC is responsible for operating the available RES and DG units in an optimal manner. Additionally, if DR mechanisms are available, this SUC has an additional tool to ensure the grid operation. The DSO, through the information provided by all available systems (AMR/AMI, SCADA, etc.) and other actors is able to apply these procedures.
Actors involved	• Aggregator • DSO (DMS) • EVSE Operator • VPP Operator
Triggering Event	Warning from the DSO that part of the network is in island mode.
Pre-condition	• Regulation allows islanded operation of part of the distribution network. • Proper equipment (controllable loads and DGs) is installed in the distribution grid • Sufficient capacity of RES and DGs. • Sufficient measurement in the distribution network allowing the accurate estimation of state. • No loss of communication during the event. • Secure electrical isolation of the islanded part of the distribution network from the main grid.
WiseGRID systems involved	• WG Cockpit Information exchange with: • WG IOP • WiseCOOP • WiseEVP • WG STaaS/VPP
Post-condition	The islanded part of the network operates safely.
Typical steps	

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Event Warning	WG Cockpit receives warning for island operation in part of the network	Location and type of network problem	DSO (DMS)	DSO (DMS)
2	Data reception	WG Cockpit receives data regarding the network constraint (HL-UC 2_PUC_1) and the current conditions in the distribution grid (HL-UC 1_PUC_1, HL-UC 2_PUC_2, HL-UC 3_PUC_1, HL-UC 4_PUC_4, HL-UC 6_PUC_1).	Location and type of network constraint, production/ consumption of grid users, line loading, bus voltages/ angles	DSO (DMS), Aggregator, EVSE Operator, VPP Operator	DSO (DMS)
3	Pre-processing	Analysis of the available RES and DG resources, as well as of the available load flexibility		DSO (DMS)	DSO (DMS)
4	Calculations	The algorithm calculates the optimal operation of RES and DG as well the flexibility needs.	Set-points for DER, EV, VPP, DR	DSO (DMS)	DSO (DMS), Aggregator, EVSE Operator, VPP Operator
5	Commands	Commands are sent to the components of the Grid.	Set-points to DER, EV, VPP, DR	DSO (DMS)	DSO (DMS), Aggregator, EVSE Operator, VPP Operator
6	Verification	WG Cockpit analyses again system status (HL-UC 2_PUC_2).	Location and type of network problem	DSO (DMS)	DSO (DMS)
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	No solution found	If no solution is possible, emergency load shedding takes place if available.	Command to (all) non-critical loads	DSO (DMS)	DSO (DMS)

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	ASM, ENER
Priority	Low (it is not easy to demonstrate it in the Distribution Network, additionally in several countries there are regulatory issues)

Use Case ID	**HL-UC 2_SUC_3.6_Cold ironing**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case

Description	New EU regulations ask to improve air quality in the European harbours. The problems in the air quality are caused by several docked ships, having their engines in operation in order to cover critical electrical loads (such as refrigerators, communication equipment, lighting etc.). One approach, called cold ironing, suggests that when a ship is docked in the harbour, it should receive electricity supply from the harbour and shut down the internal combustion engines. This process, besides the significant changes in the harbour's infrastructure, will require significant amount of energy and capacity in order to provide energy to all ships. Thus, a management system is necessary that will be able to shed non critical loads if deemed necessary. The process (and, by extension, this use case) can be initiated by two similar events: • A ship is about to dock in the harbour. • There is (or is about to happen) a congestion event in the distribution grid. In both cases the amount of energy that can be shed within the harbour should be calculated. Next, control actions should follow in order to ensure that the minimum number of non-critical loads is shed.
Actors involved	• DSO (DMS) • Harbour Control System Contributing actors: • Harbour Operator
Triggering Event	A (large) ship is entering the harbour or the DSO sends a request for load shedding.
Pre-condition	• Controllable Cold ironing infrastructure in harbour • Ships should have the ability to shed non critical loads • Bidirectional Communication with the DSO
WiseGRID systems involved	• WG Cockpit • WiseCORP Information exchange with: • WG IOP
Post-condition	No over/under voltages in the main substation of the harbour

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Event Warning	WG Cockpit receives warning regarding the state of the grid (HL-UC 2_PUC_2) or the harbour informs the DSO that a new ship is about to dock.	Location and type of network problem	DSO (DMS). Harbour Control System	DSO (DMS)
2	Data reception	WG Cockpit receives data regarding the network constraint (HL-UC 2_PUC_1) and the consumption of all ships.	Location and type of network constraint, consumption of	DSO (DMS), Harbour Facility	DSO (DMS)

			ships (critical and non critical loads)		
3	Data reception (ship load shedding profiles)	The DSO receives profiles/details of the non critical loads that can be shed (includes info such as how many minutes each load can be shed, constraints etc.).	List of load that can be shed and the associate information	Harbour Control System	DSO (DMS)
4	Calculations	The algorithm calculates the necessary amount of energy that can be shed, taking into count all the constraints.	Schedule with setpoints	DSO (DMS)	DSO (DMS)
5	Commands	Sending commands to the harbour/ships.	Schedule with switching operations	DSO (DMS)	Harbour Control System
6	Verification	WG Cockpit analyses again the system status (HL-UC 2_PUC_2).	Verification that there will be no problem otherwise return to step 2	DSO (DMS)	DSO (DMS)
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	No solution found	In case the calculations of typical step 3 do not reach a solution, other actions may be taken (HL-UC 2_SUC_3.1, HL-UC 2_SUC_3.2, HL-UC 2_SUC_3.3).	Warning	DSO (DMS)	DSO (DMS)
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	ETRA, AEA, HEDNO				
Priority	Medium (it is not easy to test it in real network)				

15.3 HL-UC 3 E-MOBILITY INTEGRATION IN THE GRID WITH V2G

15.3.1 HL-UC 3_PUC_1_EVSE and EV fleet monitoring

Use Case ID	**HL-UC 3_SUC_1.1_Data collection from EVSE**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case

Description	This SUC describes how and which data from EVSE is collected and sent to other WiseGRID products. The EVSE can be: • Privately owned by a natural person, typically one or two sockets. • Owned by an EV Fleet Manager, typically in the range of dozens to hundred sockets. • Owned by an EVSE Operator, typically in the range of thousands sockets. The gathered data sent by the EVSE is: • Fixed parameters: manufacturer, type of sockets, number of sockets, communication protocol accepted, modes of charging provided, maximum power output, location, unique identifier • Energy parameters, measured by a smart meter on each socket: current power, current voltage, current and frequency. • EVSE status information: out of service, number of sockets in use, current user ID attached latest maintenance. An EVSE Operator can choose to broadcast public status data concerning the EVSE network it is responsible for to other WiseGRID apps via WG IOP. The WG IOP will distribute data published by the EVSE Operators to the corresponding parties, allowing them to know the status of the EVSE equipment in a certain area.
Actors involved	• EV Fleet Manager • EVSE Operator • EV User • EVSE
Triggering Event	Monitoring can be executed periodically or on demand triggered by the EVSE Operator/EV Fleet Manager/EV User
Pre-condition	• Data model and communication protocol needed (new one or standard, i.e. OCPP, IEC15118 etc.). • Internet connected EVSEs. • Security and consistency in communications. • EVSE unique identifier
WiseGRID systems involved	• WG FastV2G • WiseEVP Information exchange with: • WG IOP • WiseHOME (only if domestic charging station)
Post-condition	EVSEs' status and operation monitoring based on real measurements and information

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1	1st connection of the EVSE to the grid and the internet.	The EVSE configuration parameters are gathered.	Fixed parameters: location, type of charging possible, number of sockets, etc. Status parameters: active/out of order, current power, voltage, current, number of sockets in use, user ID of user charging, etc.	EVSE	EVSE Operator, EV Fleet Manager, EV User
2	EVSE status monitoring	The EVSE status data is gathered.	Number of sockets in use, socket availability schedule	EVSE	EV Fleet Manager, EV User, EVSE Operator
3	Charge on Demand	The EVSE user's charging request is gathered. This information is necessary for the authentication process in HL-UC 3_SUC_2.1	Current user ID, type of charge required (fast, slow, etc.)	EVSE	EV Fleet Manager, EV User, EVSE Operator
4	EVSE charge monitoring	Energy parameters are gathered.	Transaction ID, current power, voltage, current, frequency, timestamp	EVSE	EV Fleet Manager, EV User, EVSE Operator
5	End of charge	The EVSE current status data is gathered.	Number of sockets in use, socket availability schedule	EVSE	EV Fleet Manager, EV User, EVSE Operator
6	EVSE data collection on demand	EVSE energy and status information is gathered.	Energy parameters, current status information	EVSE	EV Fleet Manager, EVSE Operator, EV User
7	Data communication among WiseGRID apps	The EVSE Operator chooses the data that he/she wants to share.	EVSE chosen data	EVSE Operator EV Fleet Manager	Data Provider
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EVSE out of service	Failure in the EVSE.	Status: Out of service	EVSE	EVSE Operator/EVSE EV Fleet Manager/EV User

2	Communication failure	When the communication path between the EVSE and the EVSE Operator/EV Fleet Manager/EV User is broken	Communication failure	EV Fleet Manager, EV User, EVSE Operator	EV Fleet Manager, EV User, EVSE Operator
3	Reconnection	The EVSE parameters are gathered.	EVSE identifier, location, number of sockets, status: On, socket availability schedule	EVSE	EVSE Operator/EV Fleet Manager
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	ITE, HYP, EMOT, PARTA, ENER, ECO, ASM, HEDNO				
Priority	High				

Use Case ID	**HL-UC 3_SUC_1.2_Data collection from EVs**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes the data gathering from the EVs to the WiseGRID involved products. Two different types of ownership of the EV exist: • **Private EVs**: EV data is gathered in WiseHOME. (Note: WiseHOME collects also data from private EVSE). • **Fleet EVs:** Data of each EV is gathered in WiseEVP. (Note: WiseEVP also gathers data of EVSE owned by the EV Fleet Manager). When the EV is connected to an EVSE, data of the car is gathered during connection: • fixed data o model and make o connector types o allowed maximal charging speed o capacity of battery • status data: o location o battery SoC • battery real capacity A fleet manager (WiseEVP) or a natural person owning an EV, can choose to broadcast public status data from his/her EV via the WG IOP. The WG IOP can distribute data among different parties wanting to know the status of the EVs at a certain area by collecting EV data from fleet managers and/or EV Users.This can be useful e.g. for EVSE Operators to broadcast pricing information to EV drivers in need for charging.
Actors involved	• EV Fleet Manager • EV User • EVSE Operator

	• EV • EVSE
Triggering Event	Periodically or on demand triggered by the EV Fleet Manager/EV User
Pre-condition	• Data model and communication protocol needed (new one or standard) • Connected EVs to EVSEs • Security and consistency in Communications • Anonymizing data from private EVs • EV unique identifier • Agreements for public broadcasting of the data.
WiseGRID systems involved	• WiseEVP • WiseHOME (only if domestic user) Information exchange with: • WG IOP • WG FastV2G
Post-condition	EV monitoring based on real measurements and information

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Integration of the EV in WiseGRID	The EV configuration parameters are gathered.	Model name, identifier, charging capacity Allowed maximal charging speed, type of charging connection (CHAdeMO, CCS, etc.)	EV, EV User	EV Fleet Manager, Domestic EV User
2	EV operational data	EV operational parameters are gathered.	SoC, maximum current allowed, plugged status	EV	EVSE, EVSE Operator, EV Fleet Manager, EV User
3	Data communication among WiseGRID apps	The Fleet Manager or the EV User chooses the data that he/she wants to share.	EV chosen data	EV Fleet Manager, EV User (Domestic)	-

Realization

Main responsible partners (Author)	ETRA
Contributing partners	ITE, HYP, EMOT, PARTA, ENER, ECO, ASM, HEDNO
Priority	High

15.3.2 HL-UC 3_PUC_2_Interaction of the user with EVSE

Use Case ID	**HL-UC 3_SUC_2.1_Users' authentication**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case

Description	This SUC describes the authentication process of a user, before starting a charging session to withdraw energy from the grid. A user can be a private EV owner, or a user of an EV, which is part of a fleet. So 'user' refers to two different scenarios. • Private EV owner: the car coincides with the user. The authentication of the car also enables identification of the user. • Fleet EV User: the car does not coincide with the user. The authentication of the car also enables identification the EV fleet owner, who delivers services to the user. The link with physical person and car is made through the car booking schedule by the EV fleet service provider. Methods of identification: • The EVSE Operator or Fleet Manager can authenticate the user by smart card reader at an EVSE or hub of EVSEs. The smart card is checked to a list of known users, available to the EVSE owner/operator. • The EVSE Operator or Fleet Manager can authenticate the user by letting the user establish a mobile Internet connection (e.g. scanning with a smartphone the RFID/QR/alphanumeric code of the EVSE). The user has an account on the site/mobile app/API that establishes the connection with the EVSE. The EVSE Operator checks the account that requested the connection online to a list authenticated users, available to the EVSE owner/operator. • The EVSE Operator or Fleet Manager can authenticate the user by simply reading out the identification of the car upon charging (wireless or wired), which then identifies the user. The car is checked to a list of known users, available to the EVSE owner/operator. Authentication allows delivering services (is the user entitled to use the service) and charging the user for the service (stricto sensu: identification). Authentication process is only needed for public use EVSEs. For those EVSEs installed at home the authentication process won't be needed. The EVSEs installed in a corporation may be treated as "public use EVSEs" or "home EVSEs" and will use or not the authentication process described in this use case. This use case has been described considering that there is only one EVSE per location (most feasible situation in countries with a low deployment of charging infrastructure). If instead of one EVSE per location, there are more than one (EVSE hub) the authentication process will be performed through an intermediate component connected to all the EVSEs (totem). This second scenario is the likely situation in countries or areas with a large deployment of EVs.
Actors involved	• EV User • EV • EVSE • EVSE Operator • EV Fleet Manager
Triggering Event	The need of identifying EV Users before using an EVSE.
Pre-condition	• User identification technologies available on EVSE or the authentication totem of a hub (smart card reader or smartphone /web- app, etc.) • EVSE identification displayed on EVSE to allow user to identify the correct charging point of a hub (if assigned an EVSE by the authentication totem of a hub)

	• Identification method available for user (smart card, account in the smartphone account, etc.) • The EVSE Operator or the fleet manager has an updated list of known users.				
WiseGRID systems involved	• WiseEVP • WG FastV2G (and other EVSEs) • WG IOP				
Post-condition	After the authentication process, the EV User is identified or not through the EVSE and hence authorised to use the EVSE or not.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	List of known users update	The EVSE Operator or the fleet manager updates in the WiseEVP the list of known users (when is needed because there are new users or users to be removed)	List of known users (and related authentication information depending on the authentication method)	EVSE Operator / EV Fleet Manager	-
2	EVSE access request	The EV User makes use of an identification method in the EVSE (smart card, smartphone app or EV direct connection)	Authentication information (depends on the authentication method).	EV User / EV	EVSE
3	Authentication request	The EVSE forwards the EV User authentication request to the WiseEVP.	Authentication information (depends on the authentication method).	EVSE	EVSE Operator, EV Fleet Manager
4	Authentication process	The WiseEVP checks if the EV User credentials are included in the most updated list of valid users.	None	EVSE Operator, EV Fleet Manager	EVSE Operator, EV Fleet Manager
5	Authentication response	The WiseEVP answers the EVSE if the user is allowed to use the EVSE or not.	User accepted or rejected.	EVSE Operator, EV Fleet Manager	EVSE
6	EVSE access response	The EVSE shows to the EV User the result of the authentication process.	User accepted or rejected.	EVSE	EV User / EV
Exception Path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Authentication request	The EVSE forwards the EV User authentication request to the WiseEVP.	Authentication information (depends on the authentication method).	EVSE	EVSE Operator, EV Fleet Manager

2	Communication failure	The authentication request cannot be communicated to the WiseEVP due to communication failure	Cannot reach the targeted end-point	EVSE	EVSE
3a	Local Authorisation response	In case Local authorisation management is supported by the EVSE, it can respond to the authorisation request with respect to a local authorisation list provided by the EVSE Operator or the fleet manager	Authentication information	EVSE	EV User/EV
3b	Local Authorisation response	In case local authorisation management is not supported, EVSE informs EV User/EV that EVSE is faulted due to communication error with the back-office system	Authentication Failure due to communication error	EVSE	EV User/EV

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

Use Case ID	**HL-UC 3_SUC_2.2_Charging session request**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the user starts a “charging on demand” session (type 1), a “smart charging” session (type 2) or a “smart charging with V2G” session (type 3) through an EVSE. When the user (driver) arrives to an EVSE, first of all he/she will perform the authentication process (described in HL-UC 3_SUC_2.1 “Users’ authentication”). If he/she is authenticated, the EVSE will check if there is a booking associated to this user: • If there is a booking linked to the user, the EVSE will ask the user to connect the EV to the EVSE and the charging session previously selected during the booking process will start (see HL-UC 3_SUC_2.4 “EVSE booking”). • If there is not a booking linked to the user, the EVSE will ask the user to select the charging session he/she wants to perform (Type 1, 2 or 3), the final SoC desired and the time to remove the EV. If the time spam is not enough to charge the EV to the desired SoC, the EVSE will inform and will assign directly the minimum time needed. If the time to remove the EV conflicts another booking, the EVSE will inform the maximum time allowed in order to avoid conflict. Once the user accepts the charging conditions, the EVSE will ask the user to connect the EV and the charging session will start. If the user does not

	accept the charging conditions, the EVSE will provide advice about the closest EVSE able to cover the user request (at least 3 alternative EVSEs). The charging session will be running until: • The desired battery SoC is reached or the agreed charging period is finished; • the EV User (prior authentication) asks the EVSE to stop the charging process (even if the charging session is not finished) • a new booked charging session should be started • an unexpected failure occurs and the charging process is terminated either by the EV or the EVSE While a charging session is running, the EV cannot be unplugged without driver's authentication (and may also by the other special authentications like maintenance crews). If a driver with a booking arrives to an EVSE and the EVSE already has a plugged EV, he/she will get an alternative EVSE recommendation prior authentication through the EVSE. The owner of the EV that exceeds the agreed time to remove the car will suffer a penalty. This use case has been described considering that there is only one EVSE per location (most feasible situation in countries with a low deployment of charging infrastructure). If instead of one EVSE per location, there are more than one (EVSE hub) the charging session request will be performed through an intermediate component connected to all the EVSEs (totem). This totem will show the user which EVSE is available for his/her charging session request once the process is completed. This second scenario is the likely situation in countries or areas with a large deployment of EVs.
Actors involved	• EV User • EV • EVSE • EVSE Operator • EV Fleet Manager
Triggering Event	The EV User wants to use an EVSE to charge his/her EV.
Pre-condition	• The EV User has to be authenticated according to HL-UC 3_SUC_2.1 (Users' authentication) for public use EVSEs and maybe corporation EVSEs (usually not for home EVSEs). • The EVSE Operator/EV Fleet Manager maintains an updated booking list • Grid connected EVSEs • EVSEs able to modulate power output. • EVSEs able to consume and inject energy from the grid. • There is a secure and reliable communication path between the EVSE and the EVSE Operator/EV Fleet Manager
WiseGRID systems involved	• WiseEVP • WG FastV2G (and other EVSEs) • WG IOP
Post-condition	The charging session is performed following the EV User preferences and the EVSE availability.
Typical steps	

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Charging session booking schedule	The EVSE Operator or the fleet manager updates in the WiseEVP the charging session booking schedule (from the smartphone or web app)	Charging session booking schedule (EVSE ID, EV User ID, charging session parameters)	EVSE Operator / EV Fleet Manager	-
2	Charging session request	After authentication (HL-UC 3_SUC_2.1), the EV User selects the type of charging session (type 1-3) and introduces the main parameters associated.	Charging session parameters (type of charging session (1-3), final desired SoC (max 100%) and time to remove the EV (dd/mm/yy hh:mm)).	EV User	EVSE
3	Charging session feasibility	The EVSE checks that the parameters introduced by the EV User are feasible. For example, if the time spam is not enough to charge the EV to the desired SoC according with the EVSE capabilities.	None	EVSE	EVSE
4	EVSE availability request	The EVSE forward the EV User's request to the Wise EVP	EVSE Id, User ID and charging session parameters	EVSE	EVSE Operator /EV Fleet Manager
5	EVSE availability process	The WiseEVP checks if the requested charging session is compatible with the other charging sessions scheduled for that EVSE	None	EVSE Operator /EV Fleet Manager	EVSE Operator /EV Fleet Manager
6	EVSE availability response	The WiseEVP accepts the requested charging session.	Charging session accepted	EVSE Operator /EV Fleet Manager	EVSE
7	Charging session response	The EVSE forwards the charging session acceptance to the EV User and asks him/her to plug the EV	Charging session accepted	EVSE	EV User
8	Charging session start	The EV User plugs the car and asks for the charging session start	Charging session start request	EV User	EVSE
9	Charging session performance	The EVSE charges the EV following the EV User preferences (charging on demand, smart charging and V2G). If type 2 and 3 are	None	EVSE	EVSE

		selected the WiseEVP will manage this charging session scheduling it to obtain the lowest price.			
10	Charging session end	The charging session ends by reaching the SoC desired by the EV User.		EVSE	EV User
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Charging session request	In step 2 Charging session request, if the EV User booked the EVSE in advanced, the EVSE would directly start with the charging session after authentication (because the charging session was set during the booking process)	Already set charging session	EV User	EVSE
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Charging session request	In step 2 Charging session request, ,if a EV User with a booking arrives to an EVSE and the EVSE already has a plugged EV, he/she will get an alternative EVSE recommendation prior recommendation through the EVSE	Authentication information	EV User	EVSE
2	Alternative EVSEs request	The EVSE asks to the WiseEVP to suggest at least 3 alternative EVSEs for the booked charging session	EVSE ID, User ID	EVSE	EVSE Operator / EV Fleet Manager
3	Alternative EVSEs identification request	The WiseEVP requests from the IOP the availability of the nearest EVSEs for the EV User	Area for which EVSE availability is requested	EVSE Operator /EV Fleet Manager	Data Provider
4	Alternative EVSEs identification response	The IOP provides data concerning the nearest available EVSEs (HL-UC 3_SUC_1.1)	Available EVSEs	Data Provider	EVSE Operator /EV Fleet Manager
5	Alternative EVSEs response	The WiseEVP provides 3 alternative and available EVSEs for the booked charging session	3 alternative EVSEs	EVSE Operator /EV Fleet Manager	EVSE

6	Alternative EVSEs response	The EVSE forwards to the EV User the WiseEVP response	3 alternative EVSEs	EVSE	EV User
Exception path #3					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Charging session feasibility	In step 3, if the charging session introduced by the EV User is not feasible, the EVSE will calculate new feasible proposals for the charging session.	None	EVSE	EVSE
2	Charging session proposal	The EVSE proposes to the EV User feasible charging session alternatives based on his/her preferences. For example, longer charging time or maximum reachable SoC with the time spam provided	Feasible charging alternatives	EVSE	EV User
3	Charging session proposal	The EV User selects from the list of charging sessions proposed by the EVSE	Selected charging session	EV User	EVSE
Exception path #4					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EVSE availability process	In step 5, If the requested charging session conflicts another booking, the WiseEVP will calculate the maximum time allowed to avoid conflict. The WiseEVP will also look for the nearest EVSEs available to perform the charging session requested by the user (At least 3 options).	None	EVSE Operator /EV Fleet Manager	EVSE Operator /EV Fleet Manager
2	EVSE availability answer	The WiseEVP forwards the calculated information to the EVSE	Maximum time to use the selected EVSE. Nearest available EVSEs to perform the requested charging session (at least 3 options)	EVSE Operator /EV Fleet Manager	EVSE
3	Charging alternatives	The EVSE shows to the user the maximum time that EVSE can	Maximum time to use the selected EVSE.	EVSE	EV User

		be used and other near available EVSEs	Nearest available EVSEs to perform the requested charging session (at least 3 options)		
4	EV User response to EVSE's charging alternatives	The EV User should select one of the charging alternatives proposed by EVSE. If EV User accepts the maximum time to use the selected EVSE step 7	Selection of charging alternative	EV User	EVSE

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

Use Case ID	**HL-UC 3_SUC_2.3_Charging session booking**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the user books a charging session. A user is in this use case the EV driver, planning his/her trip, during which he/she might require to charge the EV. The EV User will perform the charging session booking through the user specific dedicated interfaces of the WiseEVP (smartphone app or web interface). The user will be able to select directly the EVSE location, to introduce an address to get the nearest available EVSEs or to select an area to see all publicly available EVSEs, with filtering possibilities e.g. on speed of charging, connector types etc. The existence of EVSE hubs instead of one EVSE per location does not affect the process described in this use case. After the authentication process on the booking interface, the user will book the charging session with the same parameters as when he starts a charging session directly in the EVSE (as described in HL-UC 3_SUC_2.2 and HL-UC 3_SUC_2.3).
Actors involved	• EV User • EVSE Operator/ EV Fleet Manager
Triggering Event	The EV User wants to book a charging session at an EVSE location in advance of the trip to charge his/her EV.
Pre-condition	• The WiseEVP has the most updated list of EVSEs (HL-UC 3_SUC_3.1). • The WiseEVP maintains an updated list of the EVSEs operational status. • The WiseEVP displays public available charging stations. • The EV User has a valid account in the WiseEVP for the authentication process. • The EVSE Operator or the EV Fleet Manager has an updated list of known users.
WiseGRID systems involved	• WiseEVP • WG IOP

	Information exchange with: • WG FastV2G				
Post-condition	The EV User is able to book an EVSE in advance.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	List of known users update	The EVSE Operator or the fleet manager updates in the WiseEVP the list of known users (when is needed because there are new users or users to be removed)	List of known users (and related authentication information depending on the authentication method)	EVSE Operator / EV Fleet Manager	-
2	EVSE booking schedule	The EVSE Operator or the fleet manager updates in the WiseEVP the EVSE booking schedule (from the smartphone or web app)	EVSE booking schedule (EVSE ID, EV User ID, charging session parameters)	EVSE Operator / EV Fleet Manager	-
3	Authentication request	The EV User writes his/her authentication credential in the WiseEVP interface.	Authentication information (depends on the authentication method).	EV User	EVSE Operator/EV fleet Manager
4	Authentication process	The WiseEVP checks if the EV User credentials are included in the most updated list of known users.	None	EVSE Operator/EV fleet Manager	EVSE Operator/EV fleet Manager
5	Authentication answer	The WiseEVP answers the EV User is registered in the system or not	User accepted or rejected.	EVSE Operator/EV fleet Manager	EV User
6	EVSE request	The EV User selects the desired available EVSE and provides the charging parameters	EVSE Id, charging session parameters (type of charging, booking duration etc.)	EV User	EVSE Operator/EV fleet Manager
7	EVSE answer	The EVSE confirms the availability of the EVSE	EVSE confirmation	WiseEVP	EV User
8	Charging session request	The EV User selects the type of charging session (type 1-3) and introduces the main parameters associated.	Charging session parameters (type of charging session (1-3), final desired SoC (max 100%), time to leave the EV and time to remove the EV (dd/mm/yy hh:mm)).	EV User	WiseEVP

9	Charging session feasibility	The WiseEVP checks that the parameters introduced by the user are feasible. For example, if the time spam is not enough to charge the EV to the desired SoC according with the EVSE capabilities.	None	WiseEVP	WiseEVP
10	EVSE availability process	The WiseEVP checks if the requested booking is feasible or not	None	EVSE Operator/EV fleet Manager	EVSE Operator/EV fleet Manager
11	EVSE availability answer	The WiseEVP accepts the requested charging session and confirms the booking.	Charging session accepted	EVSE Operator/EV fleet Manager	EV User
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EVSE request	In step 6, the EV User can select directly an EVSE or introduce an address or select an area	Address /Area	EV User	EVSE Operator/EV fleet Manager
2	EVSE response	The WiseEVP will provide the nearest EVSEs to the address or the available EVSEs in the area	List of available EVSEs close to the introduce area or in the selected area	EVSE Operator/EV fleet Manager	EV User
3		Return to Typical step 6			
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Charging session feasibility	In step 9, if the charging session introduced by the user is not feasible, the WiseEVP will calculate new feasible proposals for the charging session.	None	EVSE	EVSE Operator/EV fleet Manager
2	Charging session proposal	The WiseEVP shows the user feasible charging session proposals based on his/her preferences. For example, longer charging time or maximum reachable SoC with the time spam provided	Feasible proposal/s to the EV User.	EVSE Operator/EV fleet Manager	EV User
3	Charging session proposal	The EV User selects from the list of charging session proposed by the WiseEVP	Selected charging session	EV User	EVSE Operator/EV fleet Manager
Exception path #3					

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	EVSE availability process	In step 10, f the requested charging session conflicts another booking, the WiseEVP will calculate the maximum time allowed to avoid conflict. The WiseEVP will also look for the nearest EVSEs available to perform the charging session requested by the user (At least 3 options).	None	EVSE Operator/EV fleet Manager	EVSE Operator/EV fleet Manager
2	EVSE availability answer	The WiseEVP shows to the user the maximum time that EVSE can be used and other near available EVSEs	Maximum time to use the selected EVSE. Nearest available EVSEs to perform the requested charging session (at least 3 options)	WiseEVP	EV User

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

15.3.3 HL-UC 3_PUC_3_EV charging management

Use Case ID	**HL-UC 3_SUC_3.1_EVSE network configuration**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the EVSE network in the Wise EVP is configured grouping the EVSEs under its management in regulation areas and providing the main characteristics of each EVSE: location, number of sockets, maximum power, charging modes, V2G capabilities, public/private management, plugged directly in the network or inside a household, etc. Grouping the EVSEs in regulation areas is vital to later provide balancing services to the electric network. This means that it is important to know the amount of power that the EVSEs are able to reduce if the DSO requests it, but also WHERE in the network this power reduction is done. As a prerequisite, the WiseEVP needs to have the regulation areas division implemented (based on network topology).
Actors involved	• EVSE Operator/EV Fleet Manager • DSO (indirectly, outside the system)

Triggering Event	The EVSE Operator needs to add/remove/modify the regulation areas or the EVSE parameters.
Pre-condition	The EVSE Operator needs to know the regulation areas division based on coordinates or based on network topology (topology will be managed by WG Cockpit and offered to other applications via IOP).
WiseGRID systems involved	• WiseEVP • WG IOP • WG FastV2G • WG Cockpit
Post-condition	The EVSE network is configured.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Add, modify or remove a regulation area	The EVSE Operator adds, modifies or removes a regulation area in the WiseEVP	At least 3 sets of coordinates to define the regulation area. Network topology included in each regulation area (selection of a group of primary or secondary substations)	EVSE Operator	EVSE Operator
2	Add, modify or remove an EVSE	The EVSE Operator adds, modifies or removes an EVSE defines its main parameters (the associated regulation area is assigned by the system using the coordinates/address or network access point).	EVSE Id, address /Coordinates, secondary substation, primary substation, number of sockets, maximum charging power (per socket), minimum charging power (per socket), V2G capabilities, public/private access, directly connected to the network/ Inside a house or corporation	EVSE Operator	EVSE Operator

Realization

Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

Use Case ID	**HL-UC 3_SUC_3.2_EV load forecasting**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the Wise EVP performs EV load forecasting with in different time frames (following day, following number of hours, etc.) and how often they are updated to provide them to the Wise Tools interacting with the market and managing

	the electrical network. Wise EVP will upload the forecast periodically to the WG IOP and the other Wise Tools will gather the forecasting through there. The forecast will take into account the historical data, the future booked charging sessions and the charging sessions in process. Also if any of the EVSEs are out of service. The forecast will be calculated for the whole EVSE network managed by the Wise EVP and/ or for each defined regulation area.
Actors involved	• EVSE Operator • EV Fleet Manager
Triggering Event	The EV load forecasting will be calculated periodically (every day and/or every number of hours).
Pre-condition	• The data collection from EVSE should be performed to have historical data and to know the status of the EVSEs (HL-UC 3_SUC_1.1). • The EVSE network should have been configured (HL-UC 3_SUC_3.1). • The charging session bookings should be available and corresponding EV information should be linked (and therefore, dependencies to make this happen should be fulfilled). • Data format and type of data in which the forecasting is uploaded is known.
WiseGRID systems involved	• WiseEVP • WG IOP • WG FastV2G
Post-condition	The EV load forecasting is updated in the WG IOP to be used by other WiseGRID components.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EVSE consumption data update	The WiseEVP receives periodically from the WG IOP the EVSE consumption data (from an initial date to a final date) for the whole system or for a regulation area.	Initial date, final date, whole system / Regulation area	EVSE Operator, EV Fleet Manager	Data Provider
2	EVSE consumption data answer	The WG IOP answers the requested information	For each hour between the initial and the final date and for each EVSE: date, hour, EVSE Id, EVSE consumption.	Data Provider	EVSE Operator, EV Fleet Manager
3	EVSE status request	The WiseEVP asks the WG IOP for the EVSE status (out of service, charging, etc.) at that moment for the whole system or for a regulation area.	Whole system / Regulation area	EVSE Operator, EV Fleet Manager	Data Provider

4	EVSE status answer	The WG IOP answers the requested information	For each EVSE: date, hour, EVSE Id, EVSE status.	Data Provider	EVSE Operator, EV Fleet Manager
5	Charging session booking schedule	The EVSE Operator or the fleet manager updates in the WiseEVP the charging session booking schedule (from the smartphone or web app)	Charging session booking schedule (EVSE ID, EV User ID, charging session parameters)	EVSE Operator / EV Fleet Manager	-
6	EV load forecasting	The WiseEVP calculates the EV load forecasting for the following day or for a number of coming hours	EV load forecasting	EVSE Operator, EV Fleet Manager	WiseEVP
7	EV load forecasting update	The WiseEVP sends an EV load forecasting update to the WG IOP (to be retrieved by other WiseGRID tools if needed)	EV load forecasting	EVSE Operator, EV Fleet Manager	Data Provider

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

Use Case ID	**HL-UC 3_SUC_3.3_EV flexibility estimation**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case

Description	This SUC describes how management of multiple EVSE connected to the same ‘regulation area’ allows for offering flexibility in the energy demand for charging EVs, in order to allow adequately responding to demands of the grid operator based on the current status of the grid. The flexibility can also provide means for the EVSE Operator to minimize charging costs. At every moment, an EVSE Operator has a certain amount of flexibility while still meeting the charging demands. This flexibility allows him/her to respond to the demand of the grid operator, for absorption of excess energy, or for lowering energy demand. The flexibility depends on: • Number of sockets in use. • Charging types being requested by the users. • The capabilities of the EVSE. • The capabilities of the connected cars. WiseEVP calculates the flexibility of its EVSE network per regulation area. The EVSE manager can consult the flexibility estimation to manage the charging costs. The WiseEVP can send the flexibility capabilities per regulation area to the WG IOP to be available for other WG IOP (and also to match these flexibility offers with flexibility request for grid agents, PUC 4). Cars with V2G capabilities can deliver energy back to the grid. In this case, an EV Fleet Manager, operating V2G-capable cars and compatible EVSE (FastV2G), can deliver energy back. Note: Type 1 (charging on demand) offers not flexibility because the use just wants his EV charged asap. The other types 2-3 offer different levels of flexibility as the user allows modulate the absorbed power and even also to inject electricity to the network.
Actors involved	• EVSE Operator
Triggering Event	The flexibility estimation will be calculated periodically (every number of hours) for each regulation area or for the whole system and will cover different time frames (the following day, the rest of the day, the following hours, etc.) indicating the uncertainty on the predictions.
Pre-condition	• The charging session bookings should be available and corresponding EV information should be linked (and therefore dependencies to make this happen should be fulfilled). • The data collection from EVSE should be performed periodically to have nearly-real-time data and to know the charging sessions that the EVSEs are performing (HL-UC 3_SUC_1.1). • The EVSE network should have been configured (HL-UC 3_SUC_3.1).
WiseGRID systems involved	• WiseEVP • WG IOP
Post-condition	The flexibility capabilities with different time horizons (for the whole system and/or per regulation area) are updated in the WG IOP to be matched with flexibility requests sent by other WiseGRID components.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1	Running charging sessions request	The WiseEVP asks the WG IOP for the running charging sessions for the whole system or in a regulation area in a time frame (next hours, rest of the day, following day, etc.)	Whole system / Regulation area	EVSE Operator, EV Fleet Manager	Data Provider
2	Running charging session answer	The WG IOP answers the requested information	For each EVSE and for the time frame: EVSE Id, charging session parameters	Data Provider	EVSE Operator, EV Fleet Manager
3	Charging session booking schedule	The EVSE Operator or the fleet manager updates in the WiseEVP the charging session booking schedule (from the smartphone or web app)	Charging session booking schedule (EVSE ID, EV User ID, charging session parameters)	EVSE Operator / EV Fleet Manager	-
4	EV load forecasting	The WiseEVP calculates the EV flexibility for the time frame and for the whole system or a regulation area	EV flexibility for the time frame (hour, power up, power down)	-	-
5	EV load forecasting update	The WiseEVP sends an EV flexibility capabilities to the WG IOP	EV flexibility for the time frame (hour, power up, power down)	EVSE Operator / EV Fleet Manager	-

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

Use Case ID	**HL-UC 3_SUC_3.4_Reference charging load profile calculation**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the Wise EVP calculates the reference load profile per regulation area. The reference load profile will be the initial charging session profile used by the EVSEs (in each regulation area) if the user selects types 2-3 charging sessions. Then, according to the RES and grid needs, this charging session profile will be updated (or not) during the charging session as a result of the rescheduling processes (see HL-UC 3_SUC_4.1 and HL-UC 3_SUC_4.2) in a periodic time basis to be defined. This reference load profile will be calculated taking into account the historical data based on the grid and RES support requests of each regulation area.
Actors involved	• EVSE Operator (indirectly)

Triggering Event	The reference load profile will be calculated periodically per regulation area (e.g. once a day).				
Pre-condition	• The data collection from EVSE should be performed to have historical data and to know the status of the EVSEs (HL-UC 3_SUC_1.1). • The EVSE network should have been configured (HL-UC 3_SUC_3.1). • Although is not indispensable, the execution of HL-UC 3_SUC_4.1 and HL-UC 3_SUC_4.2 will produce relevant information to enrich the reference load profile calculation.				
WiseGRID systems involved	• WiseEVP				
Post-condition	The reference load profile per regulation area is calculated and sent to each EVSE at the beginning of the charging session.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EVSE consumption data request	The WiseEVP asks the WG IOP for the EVSE consumption data (from an initial date to a final date) for each regulation area.	Initial date, final date, regulation area	EVSE Operator, EV fleet Manager	Data Provider
2	EVSE consumption data answer	The WG IOP answers the requested information	For each hour between the initial and the final date and for each EVSE: date, hour, EVSE Id, EVSE consumption.	Data Provider	EVSE Operator, EV fleet Manager
3	Charging reschedule information retrieval	The WiseEVP retrieves the historical information regarding the charging reschedule processes executed per regulation area	Charging reschedule historical information per regulation area	EVSE Operator / EV Fleet Manager	EVSE Operator / EV Fleet Manager
4	Reference load profile calculation	The WiseEVP calculates the reference load profile calculation per regulation area	Reference load profile per regulation area (power to be consumed or injected per hour per each EVSE)	EVSE Operator / EV Fleet Manager	EVSE Operator / EV Fleet Manager
5	Reference load profile update	The WiseEVP sends to each EVSE the new reference load profile to be followed (depending to which regulation area the EVSE belongs to)	Reference load profile (power to be consumed or injected per hour per each EVSE)	EVSE Operator / EV Fleet Manager	EVSE
Realization					
Main responsible partners (Author)	ITE				
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO				

Priority	Medium

Use Case ID	**HL-UC 3_SUC_3.5_Charging session schedule**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the Wise EVP schedules the type 2-3 charging sessions of its EVSE network when no flexibility requests are triggered. The charging session schedule process (CSSP) will be performed every five minutes in the WiseEVP. This process will take into account all the EVSEs that have an active session at that time. According to HL-UC 3_SUC_3.4, when an EVSE starts charging, it automatically follows the reference load profile assigned to its regulation area: this is at a certain point in time, the EV gets a default predefined power output, which fluctuates as the charging continues. This reference load profile gets then adjusted by CSSP per EVSE to meet the user's preferences. Also main economic criteria and others may be considered. The CSSP iteration period (5 minutes) may be reconsidered during the development of the project. If a user selects Type 1 for charging, his/her EV will not participate in the CSSP process, but the CSSP of other EVSE running type 2-3 charging types will be recalculated by taking account of those Type 1 charging EVSEs
Actors involved	• EVSE Operator • EV Fleet Manager • Market Operator • EV User • EV • EVSE
Triggering Event	The necessity of satisfying the type of charge desired by the EV User.
Pre-condition	• Connected EVSEs • Security in communications • HL-UC 3_SUC_2.3 should be implemented • EVSE unique identifier • EVSEs able to consume and inject energy from the grid • EVSEs able to modulate the power output (for consumption and injection) • EV initial status (SoC) is well known • EV minimum desired SoC at the end of the process is well known • The WiseEVP needs to have price signals for the CSSP optimization (market price of time of use tariff) • Load forecasting (data from HL-UC 3_SUC_3.2) • Flexibility (data from HL-UC 3_SUC_3.3) • Connectivity and interoperability between the systems • Interface with EVSE to send/modify charging profiles
WiseGRID systems involved	• WiseEVP <u>Information exchange with:</u>

	• WG IOP • WG FastV2G
Post-condition	EV charged as requested according to the type of charge desired by the EV User.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Start of the charge /periodically	The EVSE Operator/ EV Fleet Manager requests market prices.	Market prices	Market Operator	EV Fleet Manager
2	Start of the charge/ periodically	CSSP / CSSP iteration.	Number of current EVSEs that have active session at that time and its type of charge, booking schedule, reference power output profile (HL-UC 3_SUC_3.4), market prices	-	-
3	Charge process	Electrical parameters that each EVSE must provide to its respective EV according to the current CSSP.	Current power, voltage, current, frequency	EVSE	EV
4	EV charged	The EV has been already charged as desired	EV charged, disconnect	EV	EVSE

Exception path #1

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Market-WG IOP/WiseEVP disconnection	Market prices are not available.	Market prices are not available	Market Operator	EVSE, EV Fleet Manager
2	CSSP iteration	“Market price” is not a criterion of changing the CSSP until fixing the problem.	Use old market prices for calculating the CSSP	-	-

Exception path #2

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	CSSP iteration	Change in market prices.	New market price	Market Operator	EVSE

2	CSSP iteration	Recalculation of the CSSP according to the new market price.	New CSSP (new electrical parameters): Current power, Voltage, Current, Frequency	-	-
Exception path #3					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	CSSP iteration	Change in number and/or model of EVs.	New number of current EVSEs that have active session at that time and its type of charge	EV	EVSE
2	CSSP iteration	Recalculation of the CSSP according to the new EVs.	New CSSP (new electrical parameters): Current power, voltage, current, frequency	-	-
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	ITE, HYP, EMOT, PARTA, ENER, ECO, ASM, HEDNO				
Priority	High				

15.3.4 HL-UC 3_PUC_4_Interaction with the energy infrastructure

Use Case ID	**HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how an EVSE network might modulate its power output after a grid request from the grid operator (DSO). This means that the power output of each socket is regulated (lowered or increased) based on the status of the grid (local net excess or shortage of energy). For this process, two processes will run in parallel: • The EVSE Operator or the Fleet will offer the flexibility capabilities of his EVSE network per regulation area Manager through the WiseEVP based on the type of charging session selected by his customers (running or booked sessions) according to HL-UC 3_SUC_3.3 (EV flexibility estimation). • The DSO will request flexibility products per regulation area through the WG Cockpit (HL-UC 2_SUC_3.2). Flexibility products will be defined in the scope of the WiseGRID project. Some examples off flexibility products are: ○ Reduction of “xx” kWh each hour in regulation area “y” from “yy/dd/mm” to “yy’/dd’/mm’ hh’:mm’”.

	○ Power limit set to “xx” kW in regulation area “y” from “yy/dd/mm” to “yy’/dd’/mm’ hh’:mm’”. If the DSO and the EVSE Operator or Fleet Manager agree in executing a flexibility product, the charging session reschedule process (CSRP) will happen periodically in the WiseEVP to send to each EVSE socket the new profile to follow while the flexibility product is activated. The CSRP iteration period (5 minutes) may be reconsidered during the development of the project. If a user selects Type 1 for charging, his/her EV will not participate in the CSRP process. In case of V2G capabilities area available, the EVSE Operator can even choose to deliver energy stored in the batteries of the EV back to the grid.
Actors involved	• DSO • EV Fleet Manager • EVSE Operator
Triggering Event	The EVSE Operator or EV Fleet Manager has a flexibility offer that matches with a DSO flexibility request.
Pre-condition	• At least one EV should be charging following a Type 2-3 charging session (HL-UC 3_SUC_.2.3). • EV flexibility estimation should be running periodically in the WiseEVP (HL-UC 3_SUC_3.3). • Charging session schedule process should be running periodically in the WiseEVP (HL-UC 3_SUC_.3.5) • The data collection from EVSE should be performed to know the status of the EVSEs (HL-UC 3_SUC_1.1). • The EVSE network should have been configured (HL-UC 3_SUC_.1). • DSO is able to trigger flexibility requests (HL-UC 2_SUC_3.2).
WiseGRID systems involved	• WiseEVP • WG FastV2G (and other EVSEs) • WG Cockpit • WG IOP
Post-condition	A flexibility product request by the DSO is executed by the flexibility capabilities of the EVSE network of the EVSE Operator or the Fleet Manager

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Flexibility request	The DSO (WG Cockpit) asks the EVSE Operator/EV Fleet Manager (WiseEVP) via the WG IOP for available flexibility in a regulation area	Regulation area Flexibility product	DSO	EVSE Operator/EV Fleet Manager
2	Flexibility offer	The Fleet Manager or the EVSE Operator through the Wise EVP send to the DSO (via the WG IOP)	Regulation area Flexibility product	EVSE Operator/EV Fleet Manager	DSO

		the flexibility products that they can offer per flexibility area			
3	Flexibility matching	The WG IOP matches flexibility requests and offers	Flexibility product matched	Market Operator	Market Operator
4	Flexibility confirmation	The WG IOP informs the DSO (through WG Cockpit) and the EVSE Operator (through WiseEVP) that a flexibility product will be executed	Flexibility product to be executed	Market Operator	EVSE Operator/EV Fleet Manager, DSO
5	CSRP activation	The WiseEVP deactivates the CSSP and activates the CSRP (that will be running until the flexibility product ends)	None	-	-
6	CSRP calculation	In the scope of CSRP process, the Wise EVP calculates the load profile to be followed by each EVSE	Load profile to be followed by each EVSE	-	-
7	CSRP execution	The WiseEVP sends the new load profile to each EVSE	Load profile	EVSE Operator/EV Fleet Manager	EVSE
8	CSRP deactivation	When the flexibility product ends, the WiseEVP deactivates the CSRP and activates the CSSP	None	-	-
Realization					
Main responsible partners (Author)	ITE				
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO				
Priority	Medium				

Use Case ID	**HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case
Description	This SUC describes how the Wise EVP reschedules the type 2-3 charging session of its EVSE network after a RES request is received from the RESCOs/Aggregators to execute a portion or all the flexibility defined for each regulation area. This SUC requires the proper execution of other SUCs: • HL-UC 3_SUC_3.5 needs to be running periodically. • HL-UC 3_SUC_3.3 needs to be implemented. Flexibility products will be defined in the scope of WiseGRID project. Some examples of flexibility products are: • Reduction of “xx” kWh each hour in regulation area “y” from “yy/mm/dd hh:mm” to “yy’/mm’/dd’ hh’:mm’”. • Power limit set to “xx” kW in regulation area “y” from “yy/mm/dd hh:mm” to “yy’/mm’/dd’ hh’:mm’”.

	The CSRP iteration period (5 minutes) may be reconsidered during the development of the project. If a user selects Type 1 for charging, his/her EV will not participate in the CSRP process.
Actors involved	• EVSE Operator • Market Operator • RESCO • Aggregator (VPP Operator) • EV • EVSE
Triggering Event	The necessity of rescheduling a started charging session in order to maximise RES consumption.
Pre-condition	• Select the most suitable flexibility market framework • Data protocol needed (new one or standard such as OCPP or LG2WAN) • Connected EVSE • Smart EVSE (capable to control/modulate the output) • EV initial status (SoC) is well known • EV minimum desired SoC at the end of the process is well known • EV charging constraints (like minimum charging power/current) • Physical proximity (distance) of RES to EVSE for better efficiency. • Load forecasting • Connectivity and Interoperability between the tools • RESCO is able to trigger flexibility requests (HL-UC 1_SUC_2.2).
WiseGRID systems involved	• WiseEVP Information exchange with: • WG IOP • WG FastV2G • WiseCOOP • WG STaaS/VPP
Post-condition	EV charged as desired by the user having consumed all the RES flexibility allowed.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Charge process	Electrical parameters that each EVSE must provide to its respective EV according to the current CSSP.	Current power, voltage, current, frequency	EVSE	EV
2	RES flexibility	The RESCO/Aggregator activates a flexibility product linked to a regulation area	Flexibility (Power and Energy parameters)	RESCO/ Aggregator	EVSE Operator

3	Acceptation of the flexibility	The EVSE Operator calculates the aggregated flexibility of the charging infrastructure per regulation area and accepts all the amount of flexibility possible.	Amount of flexibility accepted	EVSE Operator	RESCO/ Aggregator, EVSE
4	CSRP start	The Wise EVP deactivates the CSSP and activates the CSRP process. This process calculates the load profile to be followed by each EVSE socket with an active session in the regulation area using the flexibility provided by the user.	New load profile according to: number of current EVSEs that have active session at that time and its type of charge, booking schedule, reference power output profile (HL-UC 3_SUC_3.4), available flexibility	-	-
5	Charge process	Electrical parameters that each EVSE must provide to its respective EV according to the current CRSP.	Current power, voltage, current, frequency	EVSE	EV
6	End of flexibility request	The CSRP will be running until the end of the flexibility request. Then, the CSRP will be deactivated and the CSSP will be activated.	CSSP (new electrical parameters)	-	-
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Aggregator/RESCO-WG IOP/WiseEVP disconnection	Connection problems among the Aggregator/RESCO – WG IOP - WiseEVP	Flexibility requested is not available	RESCO/Aggregator	EVSE
2	CSSP iteration	Not starting a CSRP and continuing with CSSP iterations until fixing the problem.	CSSP	-	-
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	CSRP iteration	Change in number and/or model of EVs.	New number of current EVSEs that have active session at	EV	EVSE

			that time and its type of charge		
2	CSRP iteration	Recalculation of the CSSP according to the new EVs.	New CSRP (new electrical parameters)	-	-

Realization	
Main responsible partners (Author)	ETRA
Contributing partners	ITE, HYP, EMOT, PARTA, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 3_SUC_4.3_EV providing V2H services**
Cluster	Smart Integration of Grid Users from Transport
Classification	Secondary Use Case

Description	This SUC describes how an EVSE installed in a home environment can participate in the house energy management process modulating the power consumption and even injecting power to the household electric installation.
	The EVSE will send periodic information every five minutes to the WiseHOME following these rules:
	• While the EV is plugged to the EVSE but not charging the EVSE will send to the WiseHOME:
	  o EV SoC.
	  o V2H capabilities (power able to inject currently, power injection duration and SoC after injection).
	• While the EV is charging, the EVSE will send to the WiseHOME:
	  o EV SoC.
	  o Smart charging capabilities (power able to reduce and impact in the charging session duration).
	  o V2H capabilities (power able to inject, power injection duration and impact in the charging session duration).
	The period to send the aforementioned information (5 minutes) may be reconsidered during the development of the project.
	The WiseHOME will be able to execute these smart charging or V2H capabilities (automatically integrated in the global energy management of the home or offering them to the domestic prosumer).
	In the scope of this SUC it is assumed that the EVSEs do not include fast charging functionalities.
	In the scope of this SUC the domestic prosumer and the EV User are the same actor.

Actors involved	• Domestic Prosumers (indirectly) • EV User
Triggering Event	The EV is connected to an EVSE installed in a home environment and is able to participate in the home energy management.
Pre-condition	• There is a system performing the household energy management (HL-UC 7_SUC_3.4 and/or HL-UC 3_SUC 4.3). • The EVSE is able to manage its power output.

	• The EVSE is able to calculate its V2H and smart charging capabilities.
WiseGRID systems involved	• EVSE (not WG FastV2G). • WiseHOME • WG IOP
Post-condition	The EVSE offers V2H and smart charging capabilities to the WiseHOME to participate in the household energy management.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EV connection	The EV User / domestic prosumer plugs the EV to the domestic EVSE	None	EV User / Domestic Prosumer	EVSE
2	EV capabilities offer	The EVSE sends periodic information to the WiseHOME	EV SoC, V2H capabilities, smart charging capabilities	EVSE	WiseHOME
3	Home energy management process	The WiseHOME executes the energy management process for the house or receives a direct order from the domestic prosumer with the final decision to execute a EV capability offer	EV capability to be executed	WiseHOME	WiseHOME
4	EV capabilities execution	The WiseHOME request the EVSE to execute one of its capabilities	EV capability to be executed	WiseHOME	EVSE
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	EV capabilities offer	In step 1, if the EV is connected but not charging, it will not send smart charging capabilities, only EV SoC and V2H capabilities	EV SoC, V2H capabilities	EVSE	WiseHOME

Realization	
Main responsible partners (Author)	ITE
Contributing partners	ITE, ETRA, ASM, ENER, HEDNO, EMOT, PARTA, ECO
Priority	Medium

15.4 HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL

15.4.1 HL-UC 4_PUC_1_Batteries management at prosumer level

Use Case ID	**HL-UC 4_SUC_1.1_Increase of self-consumption**
Cluster	Demonstration of Energy Storage Technologies

Classification	Secondary Use Case
Description	In order to increase prosumer consumption, the batteries allow the power generated by the solar modules to reach the highest possible degree of efficiency, by taking into account the short-term forecast of RES, energy consumption and battery status. The battery gauges the power and energy consumption of the grid-user (prosumer) with an energy meter and evaluates the storage capacity resulted from the solar energy. The prosumer's normal consumption together with the energy stored will define overall self-consumption of the prosumer. This will have to be managed from both perspectives: power and energy.
Actors involved	• Prosumer • Battery Operator • Storage Unit • Smart Meter/Current Sensor
Triggering Event	Depending on sensor data (at house connection point) the storage unit charges when energy production from PV is higher than the load and discharges when the load is higher than the production. Moreover, specific algorithms can be used to ensure that the storage unit is powered during the highest PV production (noon) which additionally relieves the grid.
Pre-condition	• Batteries installed in prosumer facilities • RES (PV) installed in prosumer facilities • RES+Prosumer consumption & production forecast • Real-time prosumer consumption & production measurements • Real-time battery SoC & electrical parameters Interface with control system of the prosumer load forecast • Nominal battery characteristics
WiseGRID systems involved	• WiseCORP • WiseHOME Information exchange with: • WG IOP
Post-condition	Over a specific period the prosumer can increase its self-consumption and thus reduce its electricity bill.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Sensor data readout	The storage unit gets a signal from the installed energy meter concerning the current production or consumption of the household	Overall Consumption/ production of household	Smart Meter/Sensor	Storage Unit
2	Power calculation	Depending on the signal and in combination with operation strategies the battery power set-point is internally calculated and utilized		Storage Unit	

3	Storage Unit data transmission and billing information	The storage Unit sends data to a database/platform. Via WiseGRID the user can see the amount of self-consumed energy as well as the resulting cost reduction	Storage Unit data	Storage Unit	Prosumer
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Sensor data is not transmitted	Wait for signal, if nothing appears, a failure signal is sent to operator	Current load/production at house connection point, failure signal	Storage Unit	Prosumer, Battery Operator
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Self-consumed energy not transmitted	Storage Unit doesn't work properly, failure signal is sent to operator	Failure signal	Storage Unit	Prosumer, Battery Operator
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, CRE, ECO, HEDNO, ICCS, ITE				
Priority	High				

Use Case ID	**HL-UC 4_SUC_1.2_Time-of use management**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	Time-of-use tariff plans distinguish between time periods to apply lower or higher energy prices. Typically, energy is more costly during the day due to high demand, while at night hours the price drops. This SUC aims at performing an optimization at prosumer level based on energy cost. The basic idea is to make use of batteries to store energy and use it in those hours when the energy is more expensive, thus reducing the energy bill. DR mechanisms can be integrated in the management as well.
Actors involved	• Prosumer • Forecast Provider • Battery Operator • Market Operator • Aggregator • Retailer

	• Storage Unit
Triggering Event	This UC recommends to prosumers change, if there's a significant change in energy price signal during the day or if different price zones are defined in the energy tariff (e.g. high prices during day and low prices during night).
Pre-condition	• Batteries installed in prosumer facilities • Prosumer consumption & production forecast • Real-time consumption & production measurements • Weather forecast • Real-time battery SoC & electrical parameters • Power control of batteries devices • Integration of batteries with RES • Time of use tariff information • Characteristics of the energy delivery point (contract information regarding different price zones/technical aspects regarding maximum power) • Nominal battery characteristics • Interface with control system of the batteries • 15-minute granularity of the schedules produced • Event based or scheduled-based triggering of the calculations • The optimal charge-discharge pattern is produced according to economic criteria • This pattern can change if higher priority commands/requests appear • Standard communication interfaces • Local regulation • Information provided to the user
WiseGRID systems involved	• WiseCORP • WiseHOME <u>Information exchange with:</u> • WG IOP
Post-condition	Increment of hourly-discrimination tariffs. The Storage Unit charges in times of production surplus (low prices) and discharges during low prices. In a larger context with a lot of storage units in place. Power Plant load profile can changes a little, increasing the production at evening-night hours and, consequently, descending the load at morning hours. A more stable production is achieved.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	User tariff	Knowledge about prosumer tariff	Type of tariff	Prosumer	Battery Operator
2	Market tariff	Information about condition of a specific tariff	Tariff conditions	Market Operator, Aggregator, Retailer	Battery Operator

3	Consumption plan	Plan the consumptions (or battery charges) at the cheapest times	Consumption plan	Battery Operator	Storage Unit
4	Billing Information	Billing information are sent to the prosumer	Billing information	Storage Unit	Prosumer
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Tariff without discrimination	If the end-user does not contract a discrimination tariff, the Storage Unit will not charge anything from the grid and will do it only with RES (or DER) production	Forecast production	Forecast Provider, Retailer, Battery Operator	Storage Unit
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ECO-EID, HEDNO, ICCS, AEA, PARTA, ENER, ITE (V2H)				
Priority	Medium				

Use Case ID	**HL-UC 4_SUC_1.3_Peak shaving**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The concept of "peak shaving" is based on demand forecast. If in that prevision appear a very high consumption point, the energy storage system must be able to save a percentage of its capacity until this point arrives. With this, the energy storage system can reduce the power consumption of that moment. This way the grid becomes more stable, due to the reduction of high power peak consumption from a variable load (e.g. a consumer/prosumer). Although the energy saving may seem lower in this case, is the same in comparison with a case without peak shaving, due to the integration of the power has the same value in both cases. The economy saving is equal or major in this situation, due to the reduction of the penalties of excess power consumption.
Actors involved	• Prosumer • Storage Unit • Smart Meter • Sensor • Forecast Provider • Battery Operator
Triggering Event	If in the consumption forecast a high power peak is estimated, the status of peak shaving is activated and the system saves a certain percentage of its capacity to reduce

	it. When the power exceeds a certain limit, the storage unit starts to discharge which lowers the power peak.
Pre-condition	• Prosumer consumption production forecast • Real-time prosumer consumption & production • Nominal battery characteristics • Real-time battery SoC & electrical parameters • Interface with control system of the batteries • Characteristics of the energy delivery point (contractual/technical, etc.) • Tariffs info
WiseGRID systems involved	• WiseCORP • WiseHOME Information exchange with: • WG Cockpit
Post-condition	• The higher consumption peaks have disappeared. The energy production form large power plant has fewer variations and, consequently, the grid is more stable.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Forecast	Obtain information about prosumer production and consumption forecast	Prosumer consumption and production forecast	Forecast Provider	Storage Unit
2	Technical data	Decide the “high power peak” limit	Characteristics of the delivery point	Battery Operator/ Prosumer	Storage Unit
3	Power peak detection	Decide which consumption power points must be controlled and reduced	Higher power peaks	Battery Operator/ Prosumer	Storage Unit
4	Energy reserve	Establish the percentage of the capacity which must be saved to reduce those power peaks (step 2)	Energy percentage	Battery Operator/ Prosumer	Storage Unit
5	Control loop	Real-time information about the status of every parameter and forecast info	Demand and production tracking	Sensor, Forecast Provider	Storage Unit
6	Peak shaving	Energy discharge at the correct moment	-	-	-
Exception path#1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	No high power peaks appear	In the demand forecast info (Typical steps, step 1) does not appear any high power point	Prosumer consumption and production forecast	Forecast Provider, Sensor	Storage Unit
Exception path#2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Higher power peaks never appear	The higher power peaks appear in the demand forecast does not appear, due to an error of the prevision. The energy is discharged at any moment later of the last higher power peak.	Prosumer consumption and production real-time	Sensor	Storage Unit
Exception path#3					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Higher power peaks appear suddenly	A higher power peak appears suddenly and the system has not any information about it. The system try to track the consumption and discharge all available energy	Prosumer consumption and production real-time	Sensor	Storage Unit
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ECO, HEDNO, ICCS, ITE				
Priority	Medium				

15.4.2 HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)

Use Case ID	**HL-UC 4_SUC_2.1_Batteries dispatch management**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The energy control is performed at the local controller of the battery Storage Unit. The Energy Management System sets the control mode of the battery device (e.g. the batteries are given a fixed discharge/charge set-point, are in standby mode, etc.). Moreover the aggregator can give power commands to the installed battery devices, based on the load of the user, a fixed discharge/charge set-point or set the devices in standby mode (aggregator can set power if it is needed). The battery Storage Unit is operated in such a way that the customer requirements are met without disturbing network stability. This UC is linked to HL-UC 6_SUC_2.3.
Actors involved	• Storage Unit • Battery Operator

	• Aggregator • Prosumer (Sensor) • Forecast Provider • Energy Management System • VPP Operator • DSO
Triggering Event	Depending on the prosumer, grid and market status the charging/discharging power to be provided by the Storage Unit is defined and the dispatch is activated.
Pre-condition	• Batteries • Power control of battery devices • Demand / production forecast • Weather forecast • Characteristics of the energy delivery point (contract/technical) • Nominal battery characteristics • Real-time battery measurements • Data interface for data exchange and control purposes • Real-time prosumer consumption and production measurements are available • Real-time grid status
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WG Cockpit • WiseCORP • WiseHOME • WiseCOOP
Post-condition	The batteries charge/discharge according to the defined power.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Data collection	Storage Units, Prosumer, grid and market status data as well as forecast data are collected	State of the Storage Units, current energy consumption and production, market data like electricity price	DSO, Storage Unit, Battery Operator, Prosumer (sensor), Market Operator	Aggregator, VPP Operator
2	Power calculation	Depending on the collected data the optimal charge/discharge power for the (each) Storage Unit is calculated		Aggregator, VPP Operator	

3	Power command	The calculated power is transmitted to the Storage Units	Calculated target power of the (each) Storage Unit	Aggregator, VPP Operator	Storage Unit, Battery Operator
4	Power Provision	The local controller of the Storage Unit receives the power command and sets internally the power for the inverter.		Storage Unit	
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	No prosumer data/status available	Send request, if still no data available no battery dispatch possible	Signal that battery dispatch is not possible	Prosumer (sensor)	Aggregator, VPP Operator
2	No grid data/status available	Send request, if still no data available no battery dispatch possible	Signal that battery dispatch is not possible	DSO	Aggregator, VPP Operator
3	No market data/status available	Send request, if still no data available no battery dispatch possible	Signal that battery dispatch is not possible	Market Operator	Aggregator, VPP Operator
4	Power command is not transmitted	Retry data transmission, if not possible Storage Unit retains current power output	Target Power for Storage Unit	Aggregator, VPP Operator	Storage Unit, Battery Operator
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS				
Priority	High				

Use Case ID	**HL-UC 4_SUC_2.2_Black start capabilities**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	In case of a grid outage, some power plants have small diesel generators to the greater power plants need assets to restart the energy production without relying on the external utility network. Several power plants use diesel generators to accomplish this. In such a situation, the energy needed could be supplied by the battery systems connected to the grid. If these batteries have been charged using renewable energy sources, like solar power, the restart of the plant is done with zero-emissions energy.
Actors involved	• Storage Unit • Battery Operator • Aggregator • Producer (Power plant)

	• VPP Operator • DSO
Triggering Event	Due to a failure, a grid outage occurs and the load in the grid can't be supplied with energy anymore
Pre-condition	• Batteries with off grid-capability • Power control of battery devices • Characteristics of the energy delivery point (contract/technical) • Nominal battery characteristics • Real-time battery measurements • Data interface for data exchange and control purposes • Real-time grid status • Information about the necessary energy that the power plant needs in order to restart • Proximity of storage units to the power plant
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WG Cockpit • WiseCOOP
Post-condition	The batteries are capable of providing the power for the power plants

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Disconnection	After a Power Outage occurs the Storage Unit is disconnected from the grid			Storage Unit
2	Grid check	The Storage Unit check if the grid is disconnected and send a "ready to supply" signal	Grid status	Storage Unit, DSO	Battery Operator, Aggregator, VPP Operator, Producer (power plant)
3	Storage Unit check	The Storage Unit check internally if enough energy is available for a black start	Storage Unit status	Storage Unit	Battery Operator, Aggregator, VPP Operator, Producer (power plant)
4	Start Command	If Grid and Storage Unit check is positive, a start command is sent to the Storage Unit	Start Command for Storage Unit	Battery Operator, Aggregator, VPP Operator, Producer (power plant), DSO	Storage Unit,

5	Power Provision	The local controller of the Storage Unit receives the start command and sets the power for the inverter. The Storage Unit provides the power according to the measured load/production		Storage Unit	
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Start command is not transmitted	Retry data transmission. If not possible storage unit is in standby mode	Start command	Battery Operator, Aggregator, VPP Operator, Producer (power plant)	Storage Unit
2	Failure/erroneous part of the grid is not disconnected	Recheck grid status. If failure still available, storage unit is in standby mode	Grid status	Storage Unit	Battery Operator, Aggregator, VPP Operator, Producer (power plant)
3	Not enough energy is available	Check storage unit status. If enough energy is not available, storage unit sends alarm signal	Storage Unit status (energy content)	Storage Unit	Battery Operator, Aggregator, VPP Operator, Producer (power plant)
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS				
Priority	Low				

Use Case ID	**HL-UC 4_SUC_2.3_Power management for peak shaving and load harmonization**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The Energy management system reads the parameters of the batteries and decides if the battery is available for each service or sets it to standby or recovery mode. The battery storage unit manages the provision of active and reactive power in order to support the grid in terms of peak shaving and load harmonization. DR mechanisms can be integrated in the management as well. In this context the current grid status and production/demand forecasts have to be taken into consideration. The operation strategy must calculate the optimal charge-discharge path according to economic criteria. This UC is linked to HL-UC 6_SUC_4.3

Actors involved	• Storage Unit • Battery Operator • Aggregator • VPP Operator • DSO • Prosumer • Smart Meter • Forecast Provider • Producer (power plant) • Market Operator
Triggering Event	If grid parameters, the load or the production at the connection exceeds a certain limit the battery starts providing active or reactive power
Pre-condition	• Storage Units/Batteries • Demand/Production forecast • Power control of battery devices • Characteristics of the energy delivery point (contract/technical) • Nominal battery characteristics • Real-time battery measurements • Data interface for data exchange and control purposes • Real-time grid measurement • Information about the necessary energy that the power plant needs in order to restart • Capability of controlling reactive power • Response time of batteries (+ communication path) must meet requirements (exact numbers have to be defined, grid code) • DR campaigns functionality from DSO to aggregator and from aggregator to prosumers is available
WiseGRID systems involved	• WG STaaS/VPP • WiseCOOP (DR campaigns) Information exchange with: • WG IOP • WG Cockpit • WiseCORP/WiseHOME (DR campaigns) • WGRESCO
Post-condition	Power peaks are reduced and the load profile is harmonized

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Load/ Production forecast	A load and production forecast is calculated	Load and production forecast	Forecast Provider	Aggregator, VPP Operator

2	Limit violation	Grid parameter, the load or production limit is exceeded and detected by some Smart Meters/Sensor	Current load/production at connection point	Smart Meter, Sensor, DSO	Storage Unit, Battery Operator, Aggregator, VPP Operator, Prosumer
3	Power Provision	The Storage Unit provides the active or reactive power according to the measured load/production		Storage Unit	
4	DR campaign	In order to keep the load low and thus relief the grid a DR campaign is initiated. Signals are sent to controllable loads	Signals for initiating DR campaigns	DSO	Prosumer, Aggregator, VPP Operator
5	Recharging/ Discharging	According to the load and production forecast the storage unit is charged/ recharged in order to be able to provide power for the next load/production peak. A command with a target power is send to the storage unit.	Recharging/ Discharging target power	Battery Operator, Aggregator, VPP Operator	Storage Unit
6	Power Provision	The Storage Unit provides the power according to the measured load/production		Storage Unit	
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Measurement data is not transmitted	Retry data transmission. If not possible storage unit is in standby	Current load/production	Smart Meter	Storage Unit, Battery Operator, Aggregator, VPP Operator
2	Load/production forecast is not available	Retry data transmission. If not possible storage unit is in standby	Load/production forecast	Forecast Provider	Aggregator, VPP Operator
3	Not enough energy is available	Check storage unit energy status, if enough energy is not available, storage unit sends alarm signal	Storage Unit energy (SoC) status + Alarm signal	Storage Unit	Battery Operator, Aggregator, VPP Operator, Producer (power plant)
4	Not enough power is available	Check storage unit power capability, if the request exceeds the power capability of	Storage Unit power status + alarm signal	Storage Unit	Battery Operator, Aggregator, VPP Operator,

		the battery, storage unit sends alarm signal			Producer (power plant)

Realization	
Main responsible partners (Author)	AMP, VS
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS
Priority	Medium

Use Case ID	**HL-UC 4_SUC_2.4_Backup power for residential area**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The scenario of supplying electricity to critical loads even during a grid outage will be examined. When in need, DSO is able to request the aggregator to provide the energy stored in the batteries from its portfolio and use it as backup energy source for a residential area. The system operator configures which percentage of the overall capacity is reserved for this purpose.
Actors involved	• Storage Unit • Battery Operator • Aggregator • VPP Operator • DSO • Prosumer
Triggering Event	Due to a failure, a grid outage occurs and the load in the grid can't be supplied with energy anymore
Pre-condition	• Storage Units/Batteries with voltage control capability • AC hardware for islanding mode • Characteristics of the battery are in line with demand requirements of the area • Reserved capacity depends on different parameters (probability of outage, other services requirements, etc.) and changes over time • Need to notify consumers and retailers for the situation • Start a DR program • Safety needs to be analysed • Real-time battery measurements • Data interface for data exchange and control purposes (IEC 61850 should be used) • Real-time grid measurement
WiseGRID systems involved	• WG STaaS/VPP • WiseCOOP (DR campaigns) Information exchange with: • WG IOP • WG Cockpit

	• WiseCORP/WiseHOME (DR campaigns)
Post-condition	The batteries provide the power in order to supply residential loads until the grid failure is cleared.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Disconnection	After a Power Outage occurs the Storage Unit is disconnected from the grid			Storage Unit
2	Grid check	The Storage Unit checks if the grid is disconnected and sends a "ready to supply" signal	Grid status	Storage Unit	DSO, Battery Operator, Aggregator, VPP Operator, Producer (power plant)
3	DR campaign	In order to keep the load low a DR campaign is initiated. Signals are sent to controllable loads	Signals for initiating DR campaigns	DSO	
4	Start Command	If grid check is positive a start command is sent to the Storage Unit	Start command for Storage Unit	DSO	Storage Unit
5	Power Provision	The local controller of the Storage Unit receives the start command and sets internally the power for the inverter.		Storage Unit	
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Measurement data is not transmitted	Retry data transmission, if it is not possible storage unit is kept in standby mode	Current load/ production	Smart Meter, Sensor	Storage Unit, Battery Operator, Aggregator, VPP Operator
2	Start command is not transmitted	Retry data transmission, if it is not possible storage unit is kept in standby mode	Start command	DSO	Storage Unit, Battery Operator, Aggregator, VPP Operator

Realization	
Main responsible partners (Author)	AMP, VS
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS
Priority	Low

15.4.3 HL-UC 4_PUC_3_Ancillary services

Use Case ID	**HL-UC 4_SUC_3.1_Market scheduling**

Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	Storage facilities are making the grid more flexible as the battery system can attenuate the demand fluctuations. This service lets the grid work in a larger variety of regimes with variable production levels. Information on the production and consumer forecast and market prices are needed in order to anticipate the potential use of the portfolio. This UC is linked to HL-UC 6_PUC_2 including HL-UC 6_SUC_2.1, HL-UC 6_SUC_2.2 and HL-UC 6_SUC_2.3
Actors involved	• Storage Unit • Battery Operator • Aggregator • VPP Operator • DSO • Market Operator • Forecast Provider Contributing actors • Prosumer • Sensor • Smart Meter
Triggering Event	Based on generation and load forecast and current market data the potential for market scheduling is evaluated. If a positive situation occurs (high market prices, storage units available) the market scheduling is initiated
Pre-condition	• Storage Units/Batteries installed • Data interface for data exchange and control purposes • Information regarding the prospective amount of load and production, electricity prices and weather conditions should be available (through forecasting) • Equipment enabling the real-time metering of prosumer consumption and production, producer generation and battery status should be installed • Grid parameters info forecast • Grid parameters info real-time (voltage and frequency) • Pricing for ancillary services • Regulation / Market requirements for ancillary services are met • Information on ancillary markets in pilot site countries must be well known
WiseGRID systems involved	• WG STaaS/VPP Information exchange with • WG IOP • WG Cockpit • WiseCOOP
Post-condition	The batteries provide the power according to the market scheduling.
Typical steps	

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Evaluation	Based on market data, grid data, forecasts (electricity price, load, production) and storage unit availability a potential market scheduling is evaluated	Market data, forecasts, Grid data	Forecast Provider, Market Operator, DSO	Aggregator, VPP Operator, Battery Operator
2	Market scheduling	Based on positive evaluation, the market scheduling is performed on the aggregator or VPP platform. A schedule for the storage unit is calculated and transmitted to the storage unit	Schedule for the Storage Unit	Aggregator, VPP Operator, Battery Operator	Storage Unit, DSO/TSO, Market Operator
3	Power Provision	The local controller of the Storage Unit receives the start command and sets internally the power for the inverter.		Storage Unit	
4	Feedback	Information about battery state and supplied power, energy from the storage unit are sent to the platform.		Storage Unit	Aggregator, VPP Operator, Battery Operator
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Load/ production electricity price forecast are not available	Retry data transmission, if not possible no participation in market scheduling	Notification Load/production electricity price forecast are not available	Forecast Provider, Market Operator	Aggregator, VPP Operator, Battery Operator
2	Not enough energy is available	Check storage unit energy status, if not enough energy is available, no participation in market scheduling	Storage Unit energy (SoC) status + Alarm signal	Storage Unit	Battery Operator, Aggregator, VPP Operator,
3	Not enough power is available	Check storage unit power capability, if not enough power is available, no participation in market scheduling	Storage Unit power status + alarm signal	Storage Unit	Battery Operator, Aggregator, VPP Operator,
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS				
Priority	High				

Use Case ID	**HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system**

Cluster	Demonstration of Energy Storage Technologies				
Classification	Secondary Use Case				
Description	The storage system (unit) needs to estimate the optimal dispatch in order to achieve the applications and services configured. In this direction, suitable priority and cost functions need to be established, in order to provide a coherent use of the system when receiving different commands from different applications/users.				
Actors involved	• Storage Unit • Battery Operator • Aggregator • VPP Operator • Forecast Provider Contributing actors: • DSO • Prosumer • Producer • Market Operator				
Triggering Event	A market scheduling has taken place and the Storage Unit receives information about services that have to be provided.				
Pre-condition	• Storage Units/Batteries with power control • Data interface for data exchange and control purposes • Information regarding the prospective amount of load and production, electricity prices and weather conditions should be available (through forecasting) • Equipment enabling the real-time metering of prosumer consumption and production, producer generation and battery status should be installed • Pricing/Market info • Information on ancillary markets in pilot site countries must be well known • Cost functions for selecting the optimal set of services				
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WG Cockpit • WiseCOOP • WiseHOME/WiseCORP (DR campaigns)				
Post-condition	The batteries provide the power according to the defined services				
Typical steps					

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Service information to Storage Unit	Information about services that have to be provided are transmitted to the Storage Unit	Service information	Aggregator, VPP Operator, Battery Operator	Storage Unit

2	Internal Storage Unit Dispatch	An internal dispatch takes place in order to meet the defined services		Storage Unit	
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Internal Storage Unit Dispatch	Internal Storage Unit Dispatch doesn't work and alarm signal is sent to VPP Operator/Aggregator	Alarm signal	Storage Unit	Battery Operator, Aggregator, VPP Operator
2	Service Information	The service information to the storage system are not transmitted correctly	Information about what kind of services should be performed	Battery Operator, Aggregator, VPP Operator	Storage Unit
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Charging/ recharging request	In case the internal dispatch wasn't accurate or unforeseen situation occurs, a request for charging/ discharging strategy is sent to the VPP or Aggregator platform	Charging/ recharging request	Storage Unit	Aggregator, VPP Operator, Battery Operator
2	Charging/ recharging strategy	On the platform the charging/recharging power is calculated based on market data and a power command is sent to the Storage Unit	Charging/ recharging strategy	Aggregator, VPP Operator, Battery Operator	Storage Unit
3	Power Provision	The local controller of the Storage Unit receives the power command and sets internally the power for the inverter.		Storage Unit	
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS				
Priority	Medium				

Use Case ID	**HL-UC 4_SUC_3.3_Batteries automatic dispatch**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case

Description	The batteries, in order to provide ancillary services, need to operate automatically. The dispatch should be authorized by the user or aggregator, but the loop control needs to be implemented in the battery in order to achieve a fast and secure response. Ancillary services to be provided by batteries could be: "active power reserve" or "black start". Active power reserves are used in two ways: automatically (secondary regulation) or manually (tertiary regulation). In case the "battery" was selected for "secondary regulation", then it would be part of the "central regulator" loop from the dispatch centre that would send signals (regulation order for increase or decrease) to the battery. This regulation would be in a longer time frame (6-10 seconds) to overcome the primary regulation loop. In case the battery is selected for tertiary regulation, then the battery operator will manually increase/decrease the power based on "dispatch order".
Actors involved	• Storage Unit • Battery Operator • Aggregator • VPP Operator Contributing Actors: • DSO • Prosumer • Producer • Market Operator
Triggering Event	Authorization by Aggregator or VPP Operator.
Pre-condition	• Storage Units/Batteries with power control • Data interface for data exchange and control purposes • Information regarding the prospective amount of load and production, electricity prices and weather conditions should be available (through forecasting) • Equipment enabling the real-time metering of prosumer consumption and production, producer generation and battery status should be installed • Pricing/Market info • Information on ancillary markets in pilot site countries must be well known • Multiple operation mode selection • Automatic control loop (automatic tracker): Comparison between prosumer consumption and battery injection to feedback the control loop
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WG Cockpit • WiseCORP • WiseHOME • WiseCOOP
Post-condition	The batteries provide the power according to the defined services.
Typical steps	

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Authorization	Information about services that have to be provided are transmitted to the Storage Unit	Authorization signal	Aggregator, VPP Operator, Battery Operator	Storage Unit
2	Internal Storage Unit Dispatch	An internal dispatch takes place in order to meet the defined services		Storage Unit	
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Authorization signal is not transmitted	Retry signal transmission, if it is not possible, the storage unit is in standby mode and doesn't perform dispatch	Current load/production	Storage Unit, Battery Operator, Aggregator, VPP Operator	
2	Measurement data not available	Retry data transmission, if not possible storage unit is in standby	Grid data	Smart Meter, Sensor	Storage Unit, Battery Operator, Aggregator, VPP Operator
Realization					
Main responsible partners (Author)	AMP, VS				
Contributing partners	ETRA, ENER, ECO, ASM, HEDNO, ENG, ICCS				
Priority	Medium				

15.4.4 HL-UC 4_PUC_4_Combination of battery storage systems

Use Case ID	**HL-UC 4_SUC_4.1_Parameter configuration of storage systems**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The operating parameters and configurations need to be established and modeled in a standard way so that all Storage Units are compatible with the management system. These parameters are necessary to be set up to get a correct function of the system; every storage system needs be correctly configured (power, frequency and voltage limits, minimum energy content that has to remain in the Storage Unit) by the end-users or the Battery Operator indeed.
Actors involved	• Battery Operator • Market Operator • Prosumer • DSO • Storage Unit
Triggering Event	Configuration of every Storage Unit according to identified operation strategy.

Pre-condition	• Use a common standard for exchanging information • Battery control • Battery characteristics • Set parameters with information from Market Operator • Information exchanged via WG IOP (including metering from batteries to applications)
WiseGRID systems involved	• WG STaaS/VPP • WiseCOOP Information exchange with: • WG Cockpit • WG IOP • WiseHOME • WiseCORP
Post-condition	Every storage system on the grid will be working with compatible configuration parameters. This allows the creation of Virtual Power Plants (VPP) or energy storage communities to improve the production and the storage. The Storage Units are configured in an appropriate manner.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Grid parameters	Know nominal parameters of the grid	Grid nominal parameters	DSO	Battery Operator
2	User requirements	Information about prosumer requirement	Prosumer requirement	Prosumer	Battery Operator
3	Configuration	Individual Storage System configuration defined by intelligent algorithms	Configuration parameters	Battery Operator	Storage Unit
4	Change Grid/ Prosumer parameters	A change occurred with the initial configuration parameters	Grid/Users parameters	DSO, Prosumer	Battery Operator
5	Retry configuration	Retry set up the parameter configuration	Configuration parameters	Battery Operator	Storage Unit

Exception path #1

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Failure configuration	Configuration Error (error flag) when the Storage System is configured	Error status	Storage Unit	Battery Operator
2	Retry configuration	Retry set up the parameter configuration	Configuration parameters	Battery Operator	Storage Unit

Realization

Main responsible partners (Author)	AMP, VS

Contributing partners	ETRA, CRE, ECO, ENG, HEDNO, ICCS, ITE
Priority	Medium

Use Case ID	**HL-UC 4_SUC_4.2_Priority list of units running**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	Depending on the operation parameters and status, a priority list needs to be formulated to guarantee the optimal usage of each battery taking into account ageing and profitability. Algorithms for the selection of the best suited combinations of storage units must consider type of storage, availability of storage system, power capability, remaining energy content, current aging status, efficiency, demand and production forecasts. Algorithms that run on the VPP platform have to define if participation of storage systems in energy market/energy transfer is beneficial or not. In the end "cost" resulting from Aging of system + loss of energy + unavailability during period has to be compared among each storage unit and compared to the expected income)
Actors involved	• Aggregator • VPP Operator Contributing actors: • Market Operator • Storage Unit • Market Operator • Prosumer • Forecast Provider
Triggering Event	Should be performed periodically
Pre-condition	• Use a common standard for exchanging information • Battery control • Battery characteristics • Set parameters with information from Market Operator • Information exchanged via WG IOP (including metering from batteries to applications) • Type of storage • Knowledge of the availability of storage system • Knowledge of the power capability of battery storage system • Calculation of remaining energy content (SoC) • Calculation of current aging status (SoH) • Efficiency • Demand and production forecasts • Pricing, Contract data, tariff-structure of prosumer • Safe and fast data interface • Computational power (100s or 1000s of Battery storage system data might be arise)

WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WiseCOOP • WG Cockpit • WG IOP • WiseHOME • WiseCORP				
Post-condition	A priority list of the Storage Units is established.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Demand forecast	Obtain information about prosumer's demand forecast.	Prosumer's demand forecast	Forecast Provider	Market Operator, Aggregator
2	Production forecast	Obtain information about prosumer's production	Prosumer's production forecast	Storage Unit	Market Operator, Aggregator
3	System status	Obtain information about status of every storage system	SoC and SoH	Storage Unit	Market Operator, Aggregator
4	Market status	Obtain information about pricing, contract data and tariff-structure of prosumer	Prosumer information/data	Aggregator, Market Operator	Market Operator, Aggregator
5	Priority list	Create a list of units charging, discharging or stand-by according to priorities stablished	List of orders	Aggregator, VPP Operator	Storage Unit
6	Follow user's demand	Obtain information about prosumer's real-time demand	Prosumer's real-time demand	Storage Unit	Market Operator, Aggregator
7	Follow user's production	Obtain information about prosumer's real-time production	Prosumer's real-time production	Storage Unit	Market Operator, Aggregator
8	Priority list loop	Recalculate the priority list (step 5)	List of orders	Aggregator, VPP Operator	Storage Unit
Exception path #1					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Error status	If "Typical step 3" gives an error in any Storage System Unit, a message is sent to users	Error status	Aggregator, VPP Operator	Prosumer
Exception path #2					

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Communication error	A unit cannot send or receive information	Communication failure		-
2	Retry communication	Retry obtain or sent information from/to the Storage System Unit during certain attempts	Prosumer's demand or production / SoC and SoH	Aggregator, VPP Operator	Storage Unit
3	Error message	If "Exception path#2 step2" is not possible, an error message is sent to users.	Error message	Aggregator, VPP Operator	Prosumer

Realization	
Main responsible partners (Author)	AMP, VS
Contributing partners	ETRA, CRE, HEDNO, ICCS
Priority	Medium

15.5 HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING

15.5.1 HL-UC 5_PUC_1_Thermal monitoring

Use Case ID	**HL-UC 5_SUC_1.1_Monitoring gas meters**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The ESCO will request measuring data from the Gas Distribution Company for its customers. The customers include households, buildings and CHPs. For Buildings and CHPs, these are additional data to those of HL-UC 5_SUC_1.2 and HL-UC 5_SUC_1.3. The process starts from the ESCO, who sends list of customers to the Gas Distribution Company. The Gas Distribution Company checks the list and proceeds with the data collection (if it hasn't done it yet). The process has two main exception paths. The first covers the case of communication errors/ problems. In this case, the Gas Distribution Company should notify the ESCO. The second exception path is related to wrong/problematic data. Although both actors should check the data, in this case, the first check should be done by the Gas Distribution Company. In both cases, the only counter measure is to send the data again.
Actors involved	• ESCO • Gas Distribution Company (AMR) Contributing actor: • Consumer
Triggering event	The ESCO periodically or on demand requests Gas Meter measurements.
Pre-condition	• Gas Meter • Telecommunication infrastructure
WiseGRID systems involved	• WiseCORP Information exchange with:

	• WG IOP				
Post-condition	Knowledge of the gas consumption of the customers.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Send list of customers	The list of customers and the corresponding Gas Meter IDs are sent to the Gas Distribution Company.	List of customers	ESCO	Gas Distribution Company
2	Verification	The Gas Distribution Company checks the list of customers and verifies their validity.		Gas Distribution Company	Gas Distribution Company
3	Data collection	If on demand data request is possible, the Gas Distribution Company gets data from the Gas Distribution Company (AMR) (otherwise the Gas Distribution Company will send last day's data).	Gas Meter Data	Gas Distribution Company (AMR)	Gas Distribution Company
4	Send data	Send data to the ESCO.	Gas Meter Data	Gas Distribution Company	ESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication problem	In case of communication problem, no data will be available.	Warning, list of customers affected	Gas Distribution Company	ESCO
2	Bad data detection	Wrong/problematic data may exist.	Warning, list of customers affected	Gas Distribution Company	ESCO
3	Action	Request data again.		Gas Distribution Company	ESCO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG				
Priority	Low				

Use Case ID	**HL-UC 5_SUC_1.2_Monitoring CHP**
Cluster	Demonstration of Energy Storage Technologies

Classification	Secondary Use Case
Description	The monitoring of the CHPs is quite complex, since there are differences between CHPs in size, electronic infrastructure, the existence of thermal storage etc. The ESCO should have a complex database containing the basic characteristics of all CHPs as well as the special characteristics of each individual unit. Furthermore, the ESCO should know what the required information from each unit is. The ESCO should also consider the existence of thermal storage attached to the CHPs. In the process of this SUC, the ESCO initially creates a list of CHPs that it wants to request data from. The list may not include all CHPs for which the ESCO is responsible but a subset of them. Additionally, the ESCO should decide which data/info will be requested from each CHP. This may change, depending on the UC that will eventually use the data. Finally, the ESCO will cope focusing on communication problems and bad data. In both cases, the ESCO may request again the data.
Actors involved	• ESCO • CHP
Triggering event	The ESCO may ask for data periodically or on demand.
Pre-condition	• Measuring components installed in the CHP • Reliable communication
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	Knowledge of the status and condition of the CHP.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Check list of CHP	Create the list of CHPs that belong to this data request.	List of CHPs	ESCO	ESCO
2	Create list with required data	Create a list of required data per CHP.	List of tags	ESCO	ESCO
3	Request data	Send request to the CHP.	List of tags	ESCO	CHP
4	Data receive	Receive data.	Measurement, events, alarms	CHP	ESCO
5	Validation	Check data for errors.		ESCO	ESCO

Exception path

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Communication problem	In case of communication problem, no data will be available.	Warning, list of customers affected	ESCO	CHP

2	Bad data detection	Wrong/problematic data may exist.	Warning, list of customers affected	ESCO	CHP
3	Action	Request data again.		ESCO	CHP
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG				
Priority	Medium				

Use Case ID	**HL-UC 5_SUC_1.3_Monitoring buildings**				
Cluster	Demonstration of Energy Storage Technologies				
Classification	Secondary Use Case				
Description	Monitoring different buildings through their BMS is not an easy task mainly due to the different technologies, vendors and communication technologies. Furthermore, the various buildings may have different sizes, complexity and usage. The ESCO may monitor public buildings, offices, hospitals, hotels etc. Each one of these buildings has different requirements and contracts with the ESCO. The ESCO should also have for this case a complex database containing the basic characteristics of all buildings as well as the special characteristics of each individual unit. Again, the ESCO should know what the required information from each unit is. For this Use Case, the existence of Thermal Storage should be considered but not the case of a CHP, which is handled by a different Use Case (HL-UC 5_SUC 1.2_Monitoring CHP) Again, the ESCO should initially select the buildings it wants to monitor and next decide what kind of information is necessary. Finally, the ESCO should again validate the data and detect problems and errors.				
Actors involved	• ESCO • BMS				
Triggering event	The ESCO may ask for data periodically or on demand.				
Pre-condition	• Existence of BMS • Reliable communication				
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP				
Post-condition	Knowledge of the status and conditions inside the building.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Check list of available buildings	Create the list of buildings that belong to this data request.	List of buildings	ESCO	ESCO

2	Create list with required data	Create a list of required data per building.	List of tags	ESCO	ESCO
3	Request data	Send request to the buildings.	List of tags	ESCO	BMS
4	Data receive	Receive data.	Measurement, events, alarms	BMS	ESCO
5	Validation	Check data for errors.		ESCO	ESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication problem	In case of communication problem, no data will be available.	Warning, list of customers affected	ESCO	ESCO
2	Bad data detection	Wrong/problematic data may exist.	Warning, list of customers affected	ESCO	ESCO
3	Action	Request data again.		ESCO	BMS
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG				
Priority	Medium				

15.5.2 HL-UC 5_PUC_2_Cogeneration and HVAC management

Use Case ID	**HL-UC 5_SUC_2.1_Forecasting thermal needs**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	This SUC will use field measurements (HL-UC_5_PUC_1) and the developed thermal models (HL-UC_5_PUC_3) in order to estimate the thermal needs in the buildings and the infrastructure that belongs to the ESCO. The SUC will also estimate the thermal flexibility, namely the potential of thermal energy that can be shifted in a building without affecting the thermal comfort as decided by the residents. The calculations here do not include thermal storage, since this is part of the optimisation algorithm. This SUC will require close collaboration with HL-UC_5_PUC_3, since the feedback regarding the performance of the forecasting modules will allow the adaptation and the improvement of the thermal models. The forecast will be used by different HL-UC_5_PUC_1 in order to decide next actions as well as in HL-UC_5_PUC_2 for the control of the various assets.
Actors involved	• ESCO
Triggering event	The ESCO periodically or on demand may activate the SUC.
Pre-condition	• Thermal Models

	• Measurements (Historical and current)
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	Thermal needs forecast

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Define list of buildings/ infrastructure	The ESCO creates a list of customers for which forecast is requested.	List of customers	ESCO	ESCO
2	Get online data	Receive measurements using HL-UC_5_PUC_1 (thermal monitoring).	Online measurements	ESCO	ESCO
3	Get historical data	Get historical data for the selected building.	Historical data	ESCO	ESCO
4	Retrieve thermal model	Get thermal model (HL-UC_5_PUC_3) for the selected building.	Thermal Model	ESCO	ESCO
5	Calculate forecast	Calculate forecast.	Forecast	ESCO	ESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Error in forecasts	In case of errors in forecasts the ESCO should receive a warning.	Warning	ESCO	ESCO

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG
Priority	Medium

Use Case ID	**HL-UC 5_SUC_2.2_Real-time control set-points**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	This SUC will use field measurements (HL-UC_5_PUC_1) and the schedules calculated in HL-UC_5_PUC_4 and will calculate the necessary real-time set-points for the various devices. This module will provide set-points for: • HVAC

	• CHP • Buildings • Thermal Storage This SUC, next to HL-UC 5_SUC_2.3, actually implements the market and business decisions taken in HL-UC_5_PUC_4, thus safety of the residents and the equipment is of high priority. Therefore, the algorithm should mainly focus on all safety constraints as well as the comfort level requirements inside the buildings. The various technical constraints should always be respected. In all steps, multiple checks and validations should be taken into account. This SUC should also consider that there are different types of buildings or CHPs and the commands for each asset should also take into account additional constraints. The results will be provided in HL-UC_5_SUC_2.3 to send the set-points to the devices.
Actors involved	• ESCO
Triggering event	The algorithm runs periodically.
Pre-condition	• Online measurements • Knowledge of all the Technical Constraints • An algorithm to calculate setpoints
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	Set of commands and set-points.

Typical steps

Step No.	Event	Description of process/Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Get measurements	Get measurements for HL-UC_5_PUC_1.	Online measurements	ESCO	ESCO
2	Get schedules	Get the schedules (from HL-UC_5_PUC_4) that this algorithm should follow.	Schedules	ESCO	ESCO
3	Get technical data	Get all the technical characteristics of the involved units.	Technical data	ESCO	ESCO
4	Run algorithm	Execute algorithm.	Set-points/ commands	ESCO	ESCO
5	Validate	The results should be checked in order to avoid dangerous situations.	Accept results	ESCO	ESCO

Exception path

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1	Dangerous set-point	In case of dangerous results, the schedules should be recalculated.		ESCO	ESCO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG				
Priority	Medium				

Use Case ID	**HL-UC 5_SUC_2.3_Control devices**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	This SUC will deliver the set-points/commands calculated in HL-UC_5_SUC_2.2 in the various devices/assets. There are two methods to communicate with the assets. The first is with direct communication with them, which implies that multiple communication protocols exist, as well as that the system has really good knowledge about the devices. The other method is to communicate via WG IOP with other WG applications and with the devices that are attached to them. Again, since safety is extremely important in this SUC, in all steps, multiple checks should be taking place. Finally, the UC may receive warnings/alarms from HL-UC_5_SUC_2.5. Alarm treatment should have the highest priority in this SUC.
Actors involved	• ESCO • Building Management System (BMS) • CHP Contributing actors: • HVAC
Triggering event	The algorithm runs periodically.
Pre-condition	• Fast communication
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP • WiseHOME • WG RESCO • WG Cockpit
Post-condition	Optimal operation of controlled devices.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	Get measurements	Get measurements for HL-UC_5_PUC_1 and WG IOP.	Online measurements	ESCO	ESCO
2	Get schedules/set-points	Get the schedules from HL-UC_5_SUC_2.2.	Schedules	ESCO	ESCO
3	Send commands	Sends the commands according to the schedules.	Set-points / commands	ESCO	ESCO, BMS, CHP
4	Confirmation	Requests confirmation upon the receipt of the commands.	Acknowledgement	ESCO, BMS, CHP	ESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Alarm	In case of an alarm after the control action, process should be repeated from step 1.		ESCO	ESCO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG, ETRA, HYP				
Priority	Medium				

Use Case ID	**HL-UC 5_SUC_2.4_Alarm management**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The goal of this SUC is to collect and manage the alarms coming from the field devices. Due to the large amount of different buildings and devices (CHP, HVAC), a dedicated module (and SUC) is necessary. This use case should handle common cases in alarm management, such as: • Alarm identification and prioritization: Identify the severity of the alarms and handle first those with the highest priority. • Identification of false alarms. • Identification of which final system should receive the warming/ proceed with corrective actions. If the alarm should be forwarded to a different system, the final receiver should be identified quite fast. The system should communicate with other SUC, such as HL-UC_5_SUC_2.2 and HL-UC_5_SUC_2.3 and deliver the proper warnings. Warnings or messages should also be sent after the clearing of the error. Finally, an important part is the visualization of the alarms. Effective visualization of alarms is important for operators of such complex systems.
Actors involved	• ESCO

	• Building Management System • HVAC • CHP
Triggering event	The algorithm is executed each time an alarm arrives.
Pre-condition	• Fast communication • Advanced data model to handle data from a variety of sources
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP • WiseHOME • WG RESCO • WG Cockpit
Post-condition	Early and fast detection of problems.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Receive alarm	Receive alarms from any source.	Alarms	Building Management System, HVAC, CHP	ESCO
2	Alarm management	Initial screening of the alarms. Sometimes multiple alarms are generated from the same event, thus the algorithm should clear the redundant alarms.	List of critical alarms	ESCO	ESCO
3	Alarm visualisation	The system should provide accurate information to the operators.		ESCO	ESCO
4	False alarm detection	Using data from HL-UC 5_PUC_1 and other methodologies, the system will try to detect false alarms.	List of false alarms	ESCO	ESCO

Realization

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, ETRA, HYP
Priority	Medium

15.5.3 HL-UC 5_PUC_3_Comfort-based demand flexibility models

Use Case ID	**HL-UC 5_SUC_3.1_Thermal model of households**
Cluster	Demonstration of Energy Storage Technologies

Classification	Secondary Use Case				
Description	This SUC will provide the thermal models of the households. Receiving info from HL-UC_5_PUC_1 as well, the WiseHOME application will run periodically and adapt/improve the performance of these models. The algorithm will be quite generic and will make estimations if no sufficient measurements exist.				
Actors involved	• ESCO Contributing actor: • Consumer • Sensor • Smart Meter				
Triggering event	The algorithm runs periodically.				
Pre-condition	• A minimum set of household info is required, such as size, construction date, heating infrastructure/devices, etc. • Time-series of correlated energy demand and indoor environmental measurements				
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WG HOME				
Post-condition	Thermal model of households.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Get data	Receive measurements from HL-UC_5_PUC_1 and WiseHOME.	Consumption and, if possible, internal conditions in the households	ESCO	ESCO
2	Get data	Receive info about the households.	Construction date, size, real-time measurements, building infrastructure, etc.	ESCO	ESCO
3	Calculate	Calculate or adapt the thermal model of the households.	Thermal model	ESCO	ESCO
Realization					
Main responsible partners (Author)	ICCS				
Contributing partners	VS, AMP, ENG, HYP				
Priority	Medium				

Use Case ID	**HL-UC 5_SUC_3.2_Thermal model of building**

Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	This SUC will provide the thermal models of the households. Receiving info from HL-UC_5_PUC_1 as well, the WiseCORP application will run periodically and adapt/ improve the performance of these models. The algorithm will be quite generic and will make estimations if no sufficient measurements exist.
Actors involved	• ESCO • BMS
Triggering event	The algorithm runs periodically.
Pre-condition	• Detailed description of the structure of the building in electronic format
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	Optimal operation of controlled devices.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Get data	Receive measurements from HL-UC_5_PUC_1 and WiseCORP.	Consumption and, if possible, internal conditions in the building	ESCO, BMS	ESCO
2	Technical description	Receive the technical characteristics of the building.	Building structure/ design	ESCO	ESCO
3	Calculate	Calculate or adapt the thermal model of the building.	Thermal model	ESCO	ESCO

Realization

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, ETRA
Priority	Medium

Use Case ID	**HL-UC 5_SUC_3.3_Thermal flexibility modelling**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	Using the models developed in HL-UC_5_SUC_3.1, HL-UC_5_SUC_3.2 and the forecast of thermal needs, the algorithm calculates the availability for thermal flexibility. The algorithm will provide the amount of thermal energy that can be shifted or curtailed without affecting the comfort level in the building or the

	household.
Actors involved	• ESCO
Triggering event	The algorithm runs periodically or on demand.
Pre-condition	• Existence of Models and Forecasts • Availability of real-time measurements of energy demand and indoor environmental conditions
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP
Post-condition	Optimal operation of controlled devices.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Get data	Receive measurements from HL-UC_5_PUC_1 and HL-UC_5_SUC_3.1, HL-UC_5_SUC 3.2 and HL-UC_5_SUC_2.1.	Measurements, models and forecasts	ESCO	ESCO
2	Calculate	Calculate the thermal model of the building.	Flexibility availability	ESCO	ESCO

Realization

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG
Priority	Medium

15.5.4 HL-UC 5_PUC_4_Cogeneration and HVAC optimisation

Use Case ID	**HL-UC 5_SUC_4.1_VPP participation**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	HL-UC_5_SUC_4.3 will provide the assets that will be committed for the participation in the VPP. Next, a negotiation will start with the VPP in order to define the optimal scheduling of these assets. The SUC will start by declaring which assets are available and how they can be used. Next, a suggested schedule will be received, which the algorithm should follow. This SUC should not violate any technical constrain or the comfort level in the buildings.
Actors involved	• ESCO • VPP Operator
Triggering event	The algorithm runs periodically.
Pre-condition	• Contract to participate in the VPP

WiseGRID systems involved	• WiseCORP Information exchange with: • WG STaaS/VPP • WG IOP
Post-condition	Optimal operation of controlled devices.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Resources to be committed	Receiving from HL-UC_5_SUC_4.3 the resources that are allowed to be used in the VPP.	List of assets, schedules	ESCO	ESCO
2	VPP declaration	The available assets as well as the constraints are declared to the VPP via HL-UC 6 SUC_2.3 VPP unit scheduling.	List of assets, constraints	ESCO	VPP Operator
3	Schedule received	A schedule is received, which the committed assets should follow.	Schedule	VPP Operator	ESCO
4	Optimisation	Calculation of the optimal commitment of the assets.	Schedule	ESCO	ESCO
5	Acknowledgement	Announcing the final schedule to HL-UC_5_PUC_2 and the VPP.	Schedule	ESCO	ESCO, VPP Operator

Realization

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG
Priority	Low

Use Case ID	**HL-UC 5_SUC_4.2_Provision of ancillary services**
Cluster	Demonstration of Energy Storage Technologies
Classification	Secondary Use Case
Description	The assets (CHP, buildings, HVAC, etc.) may provide ancillary services to the DSO, such as load shedding, provision of active/ reactive power etc. The assets that will provide the ancillary services will be identified from HL-UC_5_SUC_4.3. Next, a request will be sent to the DSO declaring the availability of those assets. The DSO will respond with a request on the type and the amount of ancillary services. Finally, the algorithm will calculate the optimal schedule of actions for the various assets.
Actors involved	• ESCO

	• VPP Operator • DSO				
Triggering event	The algorithm runs periodically.				
Pre-condition	• Contract with the DSO regarding the provision of ancillary services.				
WiseGRID systems involved	• WiseCORP Information exchange with: • WG STaaS/VPP • WG IOP • WG Cockpit				
Post-condition	Optimal provision of ancillary services.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Resources to be committed	Receiving from HL-UC_5_SUC_4.3 the resources that are allowed to be used in the VPP.	List of assets, schedules	ESCO	ESCO
2	AS declaration	The available assets as well as the constraints are declared to the DSO via HL-UC 2 SUC_3.3 Optimization algorithm.	List of assets, constraints	ESCO	DSO
3	Schedule received	A schedule is received as well as the requirements for ancillary services.	Schedule, ancillary services	DSO	VPP Operator, ESCO
4	Optimisation	Calculation of the optimal commitment of the assets.	Schedule	ESCO	ESCO
5	Acknowledgement	Announcing the final schedule to HL-UC_5_PUC_2 and the DSO.	Schedule	ESCO	VPP Operator, DSO, ESCO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Dangerous set-point	In case of dangerous set-points, the calculations should be repeated		ESCO	ESCO, VPP Operator
Realization					

Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, ETRA
Priority	Medium

Use Case ID	**HL-UC 5_SUC_4.3_System optimisation**				
Cluster	Demonstration of Energy Storage Technologies				
Classification	Secondary Use Case				
Description	This SUC will calculate the optimal participation of assets managed by this PUC in the VPP and the provision of ancillary services. The goal is to define the optimal participation in the other 2 SUCs. Furthermore, the algorithm should consider the local needs in each case and not to violate any constraints or the comfort level in the case of the buildings.				
Actors involved	• ESCO • VPP Operator • DSO Contributing actors: • Building Management System • HVAC • CHP				
Triggering event	The algorithm runs periodically.				
Pre-condition	• Fast communication • Contract with the DSO regarding the provision of ancillary services • Contract to participate in the VPP				
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WG STaaS/VPP • WiseCOOP • WiseHOME • WG RESCO • WG Cockpit				
Post-condition	Optimal operation of controlled devices.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Get measurements	Get measurement for all involved assets via HL-UC_5_PUC_1 and WG IOP.	Measurements	ESCO	ESCO

2	Get requests to participate in the VPP	Receive requests from the VPP operator regarding the day-ahead operation via HL-UC 6 SUC_2.3 VPP unit scheduling.	Requests for energy production, and cost/prices	VPP Operator	ESCO
4	Get requests regarding Ancillary Services	The DSO sends requests for the provision of ancillary services via HL-UC 2 SUC_3.3 Optimization algorithm.	Request for ancillary services	DSO	VPP Operator
5	Calculate optimal policy	The program calculates the optimal participation in VPP and provision of ancillary services.	Schedules	VPP Operator	VPP Operator, DSO
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Dangerous set-point	In case of dangerous set-points, the calculations should be repeated.		ESCO	ESCO/ VPP Operator

Realization	
Main responsible partners (Author)	ICCS
Contributing partners	VS, AMP, ENG, ETRA, HYP
Priority	Medium

15.6 HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY

15.6.1 HL-UC 6_PUC_1_VPP monitoring and management

Use Case ID	**HL-UC 6_SUC_1.1_Resource metering**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This HL-UC 6_SUC_1.1 provides information about the current status of the VPP. To this end, collection of metering data from all available metering infrastructure in the components of the VPP as well data coming from other WiseGRID systems is performed. Furthermore, an initial screening of the data is performed in order to detect ambiguous measurements, errors etc.
Actors involved	• Prosumer • Consumer • Producer • VPP Operator • AMI • VPP Component (RES Unit, Smart Meter, Storage Unit)
Triggering Event	Periodically (data of assets composing a VPP is retrieved every 15 minutes)

Pre-condition	• All contributing DER have an associated Smart Meter.Smart meters infrastructure should be deployed and integrated into the grid and home/building environment • Smart Meter must have a network connection • All contributing batteries have capabilities to communicate their status (set-point, state of charge) • Decentralized energy generation, energy storage and/or energy consumers portfolio characteristics are known • Information on details of assets of the portfolio (batteries capacity and nominal power, DER types and nominal power) • Topology of the grid is known • Location of batteries and DER portfolio on the grid topology is known
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	A clear picture of the status of the VPP is depicted, including: • Current SoC of every composing battery (and trend accordingly to current setpoint) • Current generation supplied to the grid of every composing prosumer • Voltage/Frequency/Power factor at every battery and DER connection • Aggregated battery SoC (per grid region) • Aggregated SoC trend according to current setpoints • Aggregated power generation (per grid region)

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data is received from field assets	AMI collects information from all field assets	Voltage, frequency, power factor, batteries: SoC, consumed power, produced power, DER: produced power, Prosumers: current energy supplied to the grid	RES Unit (Smart Meter), Prosumer (Smart Meter), Producer, Storage Unit	AMI
2	Data of portfolio assets is accessed by VPP Operator	VPP Operator retrieves data of those assets composing its portfolio	Voltage, frequency, power factor, Batteries: SoC, consumed power, produced power DER: produced power Prosumers: current energy supplied to the grid	AMI	VPP Operator
3	VPP Operator aggregates data by grid region	Data is aggregated accordingly to the grid regions where the VPP operates	Batteries: SoC, consumed power, produced power DER: produced power	VPP Operator	VPP Operator
4	Current status of VPP is updated	Results are stored in the status	For individual assets: Voltage, frequency, power factor	VPP Operator	VPP Operator

		database of the VPP Operator	Batteries: SoC, consumed power, produced power DER: produced power For operating regions (aggregated): SoC, consumed power, produced power		
Exception path #1 – Data of an asset is missing for a short period (< 1 hour)					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data for a particular asset is missing	Missing data is estimated with this coming from a theoretical model of the asset	Estimated data	VPP Operator	VPP Operator
Exception path #2 – Data of an asset is missing for a long period (> 1 hour)					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Data for a particular asset is missing (for more than one hour)	Asset is unsubscribed from the VPP until it works properly again. VPP Operator is notified of the failure.	Failure/subscription alert	VPP Operator	VPP Operator
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	VS, AMP, ENG, ASM, HEDNO, ECO				
Priority	High				

Use Case ID	**HL-UC 6_SUC_1.2_VPP RES forecast**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The production of RES units belonging to the VPP should be forecasted. The algorithms may be different from the ones developed for DSO, since data coming from the installation (e.g. weather station inside the RES facility) may be used and not only smart metering data and data from DMS. This forecasting will be used as an input to calculate the flexibility of the portfolio for further purposes. The horizon and the dispatch periods (interval) of the forecasts should be defined according to the market rules.
Actors involved	• VPP Operator • Forecast Provider • Prosumer

	• Producer (Smart Meter, Sensor, AMI) • RES Unit (Sensor)
Triggering Event	Periodically, according to the market rules (e.g., 24 hours in advance for defining internal strategy and participating to the day ahead market)
Pre-condition	• Availability of a sensor infrastructure around RES • The sensor infrastructure must have a network connection • Access to historical production data is available • Weather forecasting is available • Information on usage schedule (if any) for each asset is available • Algorithms for manage RES forecasting must be available. • VPP User profiling should be available
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	Forecasted production of RES units belonging to the VPP is made available.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Request	The VPP Operator through the system requests short term RES forecasting in order to be used as input for the HL UC 6_SUC_1.3 about flexibility calculation and HL UC 6_SUC_1.4 for VPP strategy for the next 24-48 hours. VPP will be able to select: interval of time (in the next 24-48 hours), VPP Components (one, all or group of user's components, e.g. by geo-area).	Short term RES forecasting request	VPP Operator	Forecast Provider
2	Request data	The system requests the data needed (e.g., VPP user profiles, typology of RES plant, weather forecasting etc.) in order to start with the calculation.	Data request	VPP Operator	Prosumer, Producer (Smart Meter, Sensor, AMI), RES Unit, Forecast Provider
3	Receive data	The VPP Components send the requested data to the VPP Operator	VPP user profiles, typology of RES plant, weather forecasting etc.	Prosumer, Producer (Smart Meter, Sensor, AMI), RES Unit, Forecast Provider	VPP Operator
4	Calculation	The system launches the calculation of the amount of	RES estimation	VPP Operator	VPP Operator

		RES for the interval period considered and VPP users.			
5	Visualisation	The VPP Operator visualises the amount of RES estimated for the period and users considered.	Visualisation of RES estimation	VPP Operator	VPP Operator
Exception path - Lack of connectivity or incomplete data					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Lack of con-nectivity or needed data	A lack of connectivity with VPP users' Sensors, AMI or Smart Meters occurs (Typical step 2) or missing/incomplete data is received (Typical step 3).	Characteristics of data not available	VPP Operator	VPP Operator
2a	Use esti-mated val-ues	If estimated values are availa-ble, they are used instead and the procedure continues with Typical step 4.	Estimated values for missing data	VPP Operator	VPP Operator
2b	Error mes-sage	If no estimated values are available, the calculations stop and an error message is dis-played.	Notification that it is impossible to proceed	VPP Operator	VPP Operator

Realization	
Main responsible partners (Author)	ENG
Contributing partners	ETRA, HYP, AMP, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 6_SUC_1.3_VPP flexibility forecast**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	Estimation in the short term (usually 24-48 hours) of the energy demand and available controllable resources for a given time horizon is performed in this SUC. The energy demand of controllable loads (from consumers) belonging to the VPP should be scheduled and by the case, forecasted. This will be an input to calculate the flexibility of the portfolio for further purposes. The flexibility of the VPP is coming from: controllable load, storage capacity, generation regulation capability (this is depending on the primary energy source). The HL-UC 6_SUC_1.3 should estimate the amount of energy that could be curtailed or shed. It should consider technical constraints or other requirements (e.g. regulation about the comfort level). It is important to point out that this HL-UC 6_SUC_1.3 may use additional measurements available only to the VPP. The horizon and the dispatchable periods of the forecasts should be defined according to the market rules.

Actors involved	• VPP Operator • Consumer • Prosumer • Producer (Smart Meter, Sensor, AMI) • Forecast Provider
Triggering Event	Periodically (according to the market rules) or on demand (when requested by the VPP Operator).
Pre-condition	• Smart meters and sensor infrastructure should be deployed and integrated into the VPP grid and home/building environment • Smart meter and sensor must have a network connection • Production (HL-UC 6_SUC_1.2) forecasts is available • Access to historical consumption data is available • Weather forecasting is available • Information on usage schedule for each asset is available • Technical/user constraints over assets in the portfolio are well known • VPP User profiling should be available
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	Short term predictions of demand and flexibility are made available.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	User request	Estimate demand profile baseline per client	Historical and real-time energy data, building usage/environmental conditions, user comfort preferences	Forecast Provider, VPP Operator	VPP Operator
2		Estimate demand flexibility profile forecast	Available assets and their operational set-point schedules, real-time energy data, user preferences	Forecast Provider, VPP Operator	VPP Operator
3		Classify clients into cluster according to their flexibility potential and its characteristics	Rate of change of supply/ demand, maximum shedding/ generation, off/on-time requirements, grid connection point, etc.	VPP Operator	VPP Operator
4	Periodically	The flexibility calculation module is invoked.	Short term flexibility forecasting request	Forecast Provider, VPP Operator	VPP Operator

5	Request for flexibility calculation	The VPP Operator requests short term demand and flexibility prediction estimation for the definition of the VPP strategy for the next 24-48 hours. VPP will be able to select: interval of time (in the next 24-48 hours), VPP users (one,all or group of users e.g. by geo-area).	Short term flexibility forecasting request	Forecast Provider, VPP Operator	VPP Operator
6	Request data	The VPP Operator requests the data needed (e.g., VPP user profiles, load profile, weather forecasting etc.) for the calculations.	Type of data per VPP Component that are necessary for the calculation	VPP Operator	Consumer, Prosumer, Producer (Smart meter, Sensor, AMI), Forecast Provider
7	Receive data	The VPP Operator receives the necessary data.	VPP user profiles, load profile, weather forecasting etc.	Consumer, Prosumer, Producer (Smart meter, Sensor, AMI), Forecast Provider	VPP Operator
8	Calculation	The VPP Operator launches the calculation of the demand and flexibility for the interval period considered and VPP Components.	Flexibility estimation		
9	Visualisation	The VPP Operator visualises the amount of flexibility estimated for the period and VPP Components considered.	Visualisation of flexibility estimation		VPP Operator
Exception path – Lack of connectivity or incomplete data					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Lack of connectivity or needed data	A lack of connectivity with VPP users' Sensors, AMI or Smart Meters occurs (Typical step 6) or missing/incomplete data is received (Typical step 7).	Characteristics of data not available	VPP Operator	VPP Operator
2a	Use estimated values	If estimated values are available, they are used instead and the procedure continues with Typical step 8.	Estimated values for missing data	VPP Operator	VPP Operator

2b	Error mes-sage	If no estimated values are available, the calculations stop and an error message is displayed.	Notification that it is impossible to proceed	VPP Operator	VPP Operator

Realization	
Main responsible partners (Author)	ENG
Contributing partners	ETRA, VS, AMP, HYP, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 6_SUC_1.4_Strategies definition**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC aims to provide to the VPP the best strategies for managing the energy flexibility and the stored energy. It takes into account the current status of the VPP as made available by HL-UC 6_SUC_1.1, the available forecasted RES resources (HL-UC 6_SUC_1.2) and the available forecasted flexibility (HL-UC 6_SUC_1.3), as well as resources committed to the execution of services already committed (energy sale or ancillary services). The main objective is to provide suggestions in order for the VPP Operator to maximize the profit by distributing the usage of the energy managed of the VPP. Implementation of this SUC requires an optimization algorithm that will advise the distribution of the available energy among the following possible uses: • Sell energy to the wholesale market • Distribute energy among VPP Components (local explicit DR campaigns in order to use energy at loads controlled by the VPP) • Store energy for future usage at batteries controlled by VPP • Use energy to meet committed ancillary services (explicit DR mechanisms to shift VPP Components' consumption or production as requested by the corresponding actor – DSO/BRP)
Actors involved	• Battery Operator • Supplier • Aggregator • VPP Operator • Market Operator • DMS • Prosumer • Storage Unit • Load Controller
Triggering Event	Periodically (for managing the energy flexibility and the stored energy in a VPP)
Pre-condition	• Current VPP status must be available. • Forecasting of load, flexibility (including also storage) and RES production must be available over the time.

	• Energy market status data must be available. • Proper equipment ensuring interaction with end-users (two-way communication) is installed. • The optimization algorithm is robust and produces reliable results.
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WiseHOME • Wise CORP • WG IOP
Post-condition	An optimized management of the energy flexibility.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Strategy planner triggered (on a periodic basis)	The strategy planner is triggered to calculate how the energy managed by the VPP should be distributed in a short-term horizon (e.g. 24 hours)		VPP Operator	VPP Operator
2	Data collection	Collection of Market prices. Current market prices are an indicator of the profit that may be obtained from selling the energy to the market	Market prices	Market Operator	VPP Operator
3	Data collection	Collection of data storage availability	Storage availability	Battery Operator	VPP Operator
4	Data collection	Collection of grid load forecast (if available). Grid load forecast can be used to forecast the request of ancillary services	Load forecast	Suppliers, Aggregators	VPP Operator
	Data Collection	Collection of energy and ancillary services requests from the wholesale market	Energy and ancillary services requests	Market Operator	VPP Operator
5	Data collection	Collection of ongoing ancillary services provided by the VPP (already booked)	VPP ongoing services provided	VPP Operator	VPP Operator
6	Options calculation	Calculation of the suitable distribution of the energy by means of a predefined algorithm.	Data collected in typical steps 1, 2, 3, 4 and 5	VPP Operator	VPP Operator
7	Suggestion accepted	The VPP Operator accepts the suggestion of the algorithm and continues to typical step 9.	Suggestion accepted message	VPP Operator	DMS

8	Suggestion rejected	The VPP Operator manually changes the suggested distribution.	Suggestion not accepted message Modified suggestion	VPP Operator	DMS
9a	Re-allocate and sell	The algorithm states that the suitable option is to sell the energy to the market.	Energy offer	VPP Operator	Market Operator
9b	Storage	The algorithm states that the suitable option is to store the energy.	Battery setpoints and schedule	VPP Operator	Battery Operator
9c	DR signal	The algorithm states that suitable option is using the energy to provide ancillary services (DR signal for shifting consumption/production).	Controllable elements setpoints and schedule	VPP Operator	Consumer, Prosumers, Load Controller
9d	Energy distribution	Distribute energy among controllable loads under VPP	Controllable loads setpoints and schedule	VPP Operator	VPP Operator
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Lack of data collection	One (or more) of the parameters needed from typical steps 1, 2, 3, 4 are not available	Type of data that is not available	VPP Operator	VPP Operator
2a	Use estimated values	If estimated values are available they are used instead.	Estimated values for missing data	VPP Operator	VPP Operator
2b	Adjust algorithm input data	If no estimated values are available, the input data for the algorithm are reduced to include only the available data	Reduced set of input data	VPP Operator	VPP Operator
3		Return to typical step 6.	None	VPP Operator	VPP Operator
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	ENG, ECO, ASM, HEDNO				
Priority	Medium				

15.6.2 HL-UC 6_PUC_2_VPP market participation

Use Case ID	**HL-UC 6_SUC_2.1_VPP market participation and bid calculation**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC describes a module for calculating the optimal participation of the VPP in the energy market (day-ahead and intraday) in order to sell energy surplus. The module

	calculates the optimal participation of the VPP units and proposes market bids that are in line with the market rules. Energy market participation is performed on the basis of price-quantity pairs for each dispatch period. The calculation considers Energy market status, unit status, technical constraints as well as information coming from the HL-UC 6_SUC_1.1.
Actors involved	• VPP Operator • Market Operator
Triggering Event	Periodically (according to the market rules) The algorithm in HL-UC 6_SUC_1.4 says that is suitable to sell energy to the market.
Pre-condition	• VPP real-time consumption/production data is available. • Energy grid condition and load/RES forecasting of the VPP is available. • Energy market status data is available. • Energy market rules for participating in day-ahead market are well known. • Energy market rules for participating in intra-day market are well known (including minimum time span ahead – 15 minutes, 1 hour, etc.). • Technical/user constraints over portfolio assets are well known.
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	VPP Operator is able to participate in the energy market through properly defined bids for the day-ahead and intraday market, if appropriate.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Bid calculation	The VPP Operator if required from the HL-UC 6_SUC_1.4 calculates the most appropriate bid according the results of the algorithm in HL-UC 6_SUC_1.4.	Energy quantity and price to be submitted to the Market Operator	VPP Operator	VPP Operator
2	Bid submission	The bid is submitted to the energy market.	Bid data (price-quantity pairs)	VPP Operator	Market Operator
3	Market response	At the end of the market interval, the market response is received.	Bid status (accepted/ rejected)	Market Operator	VPP Operator

Exception path

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Impossibility to submit the bid	The VPP Operator can not to submit the bid for different problem of the VPP	Notification that is not possible to submit	VPP Operator	VPP Operator

2	Recalculate the strategy	The VPP Operator invoke again the HL-UC 6_SUC_1.4 in order to define a new strategy to be applied without the possibility to participate to the energy market	Signal for recalculate the VPP strategy	VPP Operator	VPP Operator
Realization					
Main responsible partners (Author)	ENG				
Contributing partners	ETRA, ECO, ASM, HEDNO				
Priority	Medium				

Use Case ID	**HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC describes a module for calculating the optimal participation of the VPP in the ancillary services market providing ancillary services linked to flexibility. The module calculates the optimal participation of the VPP units and proposes market bids. Energy market participation is performed on the basis of price-services pairs for each dispatch period. The calculation considers unit status, technical constraints as well as information coming from the HL-UC 6_SUC_1.1.
Actors involved	• VPP Operator • Market Operator
Triggering Event	Periodically (according to the market rules) The algorithm in HL-UC 6_SUC_1.4 says that is suitable to provide ancillary services
Pre-condition	• VPP real-time consumption/production data • Energy grid condition and load/RES forecasting of the VPP is available. • Energy market status data must be available. • Energy market rules for participating in balancing energy market are well known. • Technical/user constraints over portfolio assets are well known.
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	VPP Operators is able to participate in the ancillary market through properly defined bids for the providing flexibility services, if appropriate.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Bid calculation	The VPP Operator if required from the HL-UC 6_SUC_1.4 calculates the most appropriate	Flexibility services (shift consumption), price	VPP Operator	VPP Operator

		bid according the results of the algorithm in HL-UC 6_SUC_1.4.			
2	Bid submission	The bid is submitted to the Ancillary services market.	Bid data (price-quantity pairs)	Market Operator	VPP Operator
3	Market response	At the end of the market interval, the market response is received.	Bid status (accepted/ rejected)	Market Operator	VPP Operator
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Impossibility to submit the bid	The VPP Operator can not to submit the bid for different problem of the VPP system	Notification that is not possible to submit	VPP Operator	VPP Operator
2	Recalculate the strategy	The VPP Operator invoke again the HL-UC 6_SUC_1.4 in order to define a new strategy to be applied without the possibility to participate to the ancillary services market	Signal for recalculate the VPP strategy	VPP Operator	VPP Operator
Realization					
Main responsible partners (Author)	ENG				
Contributing partners	ETRA, ECO, ASM, HEDNO				
Priority	Medium				

Use Case ID	**HL-UC 6_SUC_2.3_VPP unit scheduling**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This UC combines the results of HL-UC 6_SUC_2.1 (VPP market participation and bid calculation) and HL-UC 6_SUC_2.2 (VPP ancillary market participation and bid calculation) to define a single strategy for the participation in the energy markets. Also, within this SUC the quantities available for eventually balancing market with both components should be determined: capacity (as ancillary services) and energy (within energy market). The decision considers the optimal strategy that optimizes the benefit for the VPP and the VPP Components.
Actors involved	• VPP Operator • VPP Component • Load Controller
Triggering Event	Periodically (according to the market rules)
Pre-condition	• Results from HL-UC 6_SUC_2.1 and HL-UC 6_SUC_2.2 must be available. • Results from HL-UC 6_SUC_3.1 must be available. • VPP real-time consumption/production data are available. • Energy grid condition and RES/load forecasting of the VPP must be available.

WiseGRID systems involved	• WG STaaS/VPP Information exchange with • WG IOP • WiseHOME • WiseCORP				
Post-condition	Definition of the unit schedule per dispatch period (day by day according to market rules)				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Record and manage results from HL-UC 6_SUC_2.1	The VPP Operator records the market response received from HL-UC 6_SUC_2.1 and HL-UC 6_SUC_2.2 and identifies accordingly the optimal schedule for the different VPP Components.	Results from HL-UC 6_SUC_2.1 and optimal unit scheduling		VPP Operator
2	Send notification about the scheduling	The scheduling is sent to the VPP Components in order to manage the decisions defined at market levels	Unit scheduling notification derived from HL-UC 6_SUC_2.1	VPP Operator	VPP Components, Load Controller
3	Determine the participation to balancing market	The VPP Operator according to the results of HL-UC 6_SUC_3.1 (real-time flexibility availability) and matching it with the unit scheduling of Typical step 1, defines if the conditions for participating in the balancing market are appropriate and sends the response to HL-UC 6_SUC_1.4			
Realization					
Main responsible partners (Author)	ENG				
Contributing partners	ETRA, ECO, ASM, HEDNO				
Priority	Medium				

15.6.3 HL-UC 6_PUC_3_VPP real-time control

Use Case ID	**HL-UC 6_SUC_3.1_Real-time flexibility calculation**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC identifies the available flexibility using the available real-time measurements. For example, analyzing if there is any activity in a household and the level of consumption, may give an indication of the appliances in operation. This information can be used to monitor deviations and continuously adjust the calculated plan.

Actors involved	• VPP Operator • VPP Component (Prosumer, Storage Unit, Producer, Smart meter) • Forecast Provider				
Triggering Event	Periodically (for covering the VPP needs in real-time))				
Pre-condition	• Real-time data regarding the VPP condition is available (HL-UC 6_SUC_1.1). • Contractual agreements between the VPP Operator and the VPP Components (asset owners/managers and consumers) are in place (HL-UC 6_SUC_4.2). • An algorithm that calculates the flexibility with all the data provided.				
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP				
Post-condition	The VPP Operator have knowledge over the available flexibility.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Periodically	The VPP Operator looks after the smooth real-time operation of the VPP.			VPP Operator
2	Data retrieval	Collection of all the relevant parameters of the VPP Components.	Power, voltage, current, SoC, capacity, demand and production	VPP Component	VPP Operator
3	Forecast retrieval	Demand and production of all members of VPP is forecasted	Demand and production forecast	Forecast Provider	VPP Operator
4	Data validation	The data reported by the VPP Components are validated.		VPP Operator	VPP Operator
5	Flexibility calculation	The algorithm takes all the data collected and calculates the amount of current flexibility.	Amount of current flexibility (kW)	VPP Operator	VPP Operator
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication error	The communication in Typical step 2 fails.	Communication error	VPP Component	VPP Operator
2	Flexibility unavailable	The VPP Operator declares inability to provide flexibility due to unavailability.	Unavailability message	VPP Operator	
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	ENG, ECO, ASM, HEDNO				

Priority	Medium

Use Case ID	HL-UC 6_SUC_3.2_VPP implementation of ancillary services
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	As part of the distribution grid, the VPP is required to contribute to the smooth operation of the grid. In order to achieve that, the VPP Operator provides ancillary services to the grid considering notifications and requests by the local DSO through the ancillary services market. This SUC describes the next step, where the commands (P, Q production set-points or mode of operation) to be sent to the related VPP Components should be defined. The ancillary services treated in this SUC are: • Voltage and Reactive Power (Q) control in LV network: In order to perform voltage control, the main action will be to control Q production/consumption in the network points, where possible. • Frequency control: The VPP can provide frequency control to the grid adjusting its consumption/generation of active power. • Load/generation management: By increasing the generation power output during high load periods or by reducing the load, the stress on central generation can be relieved. Also, the DSO can have necessity of reallocate a RES energy surplus.
Actors involved	• DSO/BRP • VPP Operator • Market Operator
Triggering Event	The VPP Operator receives a request from the DSO (through the ancillary services market) to offer ancillary services.
Pre-condition	• Receiving notifications and requests by WG Cockpit (DSO) about status of the distribution grid. • Market price availability. • A clear framework describing the interactions between the VPP Operator and the DSO is set (contractual agreement is in place stating the remuneration/penalty for following the ancillary services requests). • Information regarding the portfolio characteristics is available (HL-UC 6_SUC_4.2)
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WG Cockpit
Post-condition	The VPP offers ancillary services to the grid.
Typical steps	

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1	Ancillary services request	The DSO/BRP sends a request to the VPP Operator for provision of ancillary services (offered in the ancillary services market).	Type of service that needs to be offered (reactive/active power, amount of energy reduction/increase)	DSO/BRP	VPP Operator
2	Real-time decision making	The VPP Operator decides on how to provide the ancillary services based on the available resources (HL-UC 6_SUC_3.1)	Allocation to the VPP Components of required ancillary services	VPP Operator	VPP Operator
3	DSO/BRP briefing	The VPP Operator informs the DSO that the request for ancillary services has been followed.	Message of successful completion	VPP Operator	DSO/BRP
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Communication error	The communication in Typical step 4 is not possible due to communication errors	Communication error	VPP Operator	VPP Operator
2	Unavailability message	The VPP Operator declares unavailability to execute the request for ancillary services.	Unavailability message	VPP Operator	DSO/BRP
Realization					
Main responsible partners (Author)	ETRA				
Contributing partners	ENG, ECO, ASM, HEDNO				
Priority	Medium				

Use Case ID	**HL-UC 6_SUC_3.3_Real-time decision making**
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	The goal of the SUC is to analyse the output of previous SUCs (HL-UC 6_SUC_3.1 and HL-UC 6_SUC_3.2) as well the resource metering (HL-UC 6_SUC_1.1) and define the final schedules to be sent to the different VPP Components that form the VPP portfolio. The commands should be in line with the proposed schedules and policies but should not violate any technical and/or contractual constraint.
Actors involved	• VPP Operator Contributing actors: • VPP Component

Triggering Event	Periodically (real-time operation of the VPP)
Pre-condition	• Interface with VPP Components must be available. • Contractual and policy constraints must be defined and become available. • The VPP Operator is aware of the status of the various VPP Components (HL-UC 6_SUC_1.1), of the calculated schedule (HL-UC 6_SUC_2.3) and of the available flexibility margins (HL-UC 6_SUC_3.1). • Information regarding the portfolio characteristics is available (HL-UC 6_SUC_4.2).
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP
Post-condition	The VPP operates smoothly and services are offered to the grid.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	VPP Operator decision	According to the schedule made in HL-UC 6_SUC_2.3, the VPP Operator has to make a decision about accepting or not accepting the schedule calculated in order to exchange ancillary services defined at market levels.	VPP Operator decision: accept or reject	VPP Operator	VPP Operator
2a	Schedule accepted	The VPP Operator formulates the schedule into appropriate signals to be sent to the VPP Components (taking into account real-time information from HL-UC 6_SUC_3.1 and HL-UC 6_SUC_3.2).	Signals for VPP Components	VPP Operator	VPP Operator
3	VPP Components commanding	Proper signals calculated in previous step are sent to the VPP Components	Signals for VPP Components	VPP Operator	VPP Components
2b	Schedule not accepted	An alternative schedule is provided by VPP Operator. Operation continues with typical step 2	Alternative schedule	VPP Operator	VPP Operator

Realization

Main responsible partners (Author)	ETRA
Contributing partners	ENG, ECO, ASM, HEDNO
Priority	High

15.6.4 HL-UC 6_PUC_4_VPP users relationship management

Use Case ID	**HL-UC 6_SUC_4.1_Manage contractual issues**

Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	This SUC provides to the VPP the functions for managing contractual issues (e.g., define service level agreements -SLA- about energy dispatching) with the actors (Prosumers and Consumers) connected to the distribution grid that are (or can be) part of the VPP energy group. It is a contact point between VPP and VPP Components (Consumers, Producers, Prosumers).
Actors involved	• VPP Operator • Consumer • Prosumer • Producer
Triggering Event	Consumers, Prosumers, Producers request to be part of the VPP or to participate to specific programs offered by the VPP Operator.
Pre-condition	• The VPP energy grid status must be available (HL-UC 6_SUC_1.1). • A customer portfolio must be identified • Contractual requirements, SLA have to be defined at different level and for the different Users
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WiseCORP • WiseHOME
Post-condition	Subscribed contracts from the VPP participants as well as records of the SLA (services level agreement) agreed between VPP and VPP participants

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Contract	When an actor is subscribing itself to participate to a VPP or at a specific program provided from it, has to accept the conditions of the contract defined by the VPP. The system has to record this aspect keeping them in the user profile.	Contract subscribed	Customer, Prosumer, Producer	VPP Operator
2	Collecting SLA	The system collects the different contracts and specific requirements in it, for instance Service Level Agreements (SLA) linked to them, pricing schema for the billing etc.	SLA, pricing schema etc.		VPP Operator

Realization

Main responsible partners (Author)	ENG
Contributing partners	ETRA, BYES, AMP, ITE, ICCS, CRE, ECO, ASM, HEDNO
Priority	Low

Use Case ID	HL-UC 6_SUC_4.2_Define and manage member compensation
Cluster	Smartening Distribution Grid
Classification	Secondary Use Case
Description	In order to manage energy selling, the VPP needs tools to help them define the energy price for compensating VPP members. It can be calculated taking into account: • Incomes of the VPP from selling energy bids at the wholesale market • Incomes of the VPP from delivering ancillary services • Participation of individual VPP members in the processes described above
Actors involved	• VPP Operator • Prosumer (VPP member)
Triggering Event	Periodically (once a month)
Pre-condition	• Access to information regarding the energy price in the wholesale market is needed • The bids for participation in the markets (wholesale HL-UC 6_SUC_2.1 and ancillary HL-UC 6_SUC_2.2) are available. • Contractual agreements between the VPP Operator and the VPP Components are in place (HL-UC 6_SUC_4.2).
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WiseCORP • WiseHOME
Post-condition	The consumers energy price and billing for the period agreed is defined.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Retrieve wholesale market incomes	The data of energy sold (and related incomes) at each market period of the month is retrieved	Curve of energy sold, curve of related incomes	VPP Operator	VPP Operator
2	Retrieve ancillary services market incomes	The data of ancillary services provided – energy, Q, P - (and related incomes) at each market period of the month is retrieved	Curve of traded values (energy, Q, P), curve of related incomes	VPP Operator	VPP Operator
3	History of individual dispatch signals per VPP member	History of individual dispatch signals is analysed in order to calculate the degree of contribution of VPP members to the corresponding energy bids and offered ancillary services	History of individual dispatch signals	VPP Operator	VPP Operator

4	VPP Members compensation calculation	Data from steps 1 to 3 is crosschecked in order to calculate the incomes corresponding to each VPP member. VPP Operator fees will also be taken into account	VPP member compensation	VPP Operator	Prosumer (VPP Member)

Realization	
Main responsible partners (Author)	ENG
Contributing partners	ETRA, BYES, AMP, ITE, ICCS, ECO, ASM, HEDNO
Priority	Low

Use Case ID	**HL-UC 6_SUC_4.3_DSM and DR mechanisms**				
Cluster	Smartening Distribution Grid				
Classification	Secondary Use Case				
Description	This SUC includes all the tools for enabling a VPP to communicate the DSM or DR mechanism to its customers (who sign a contract with the VPP). VPP members offer their smart assets (controllable loads, batteries and RES) to the VPP Operator, which will operate them accordingly to the needs of the VPP. This SUC describes which information shall be shared with the VPP members to provide them an insight of the contribution of their assets to the overall operation of the VPP.				
Actors involved	• VPP Operator • Consumers • Prosumers				
Triggering Event	Information to be shared with VPP members is periodically updated (e.g. daily)				
Pre-condition	• Contractual agreements between the VPP Operator and the VPP Components are in place (HL-UC 6_SUC_4.2).				
WiseGRID systems involved	• WG STaaS/VPP Information exchange with: • WG IOP • WiseCORP • WiseHOME				
Post-condition	VPP members have a clear insight of their contribution to the VPP operation				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Information of energy sold at wholesale/ ancillary services markets	Information of the daily operations of the VPP is communicated to its members	Daily operations	VPP Operator	Consumers and Prosumers (VPP members)

2	Estimation of VPP member compensation	HL-UC 6_SUC_4.3 is executed partially to give an estimation of the accumulated economic reward	Daily economic compensation per VPP member	VPP Operator	Consumers and Prosumers (VPP members)
Realization					
Main responsible partners (Author)	ENG				
Contributing partners	ETRA, ECO, ASM, HEDNO				
Priority	High				

15.7 HL-UC 7 CITIZENS EMPOWERMENT IN ENERGY MARKET AND REDUCTION OF ENERGY POVERTY

15.7.1 HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector

Use Case ID	**HL-UC 7_SUC_1.1_Monitor energy demand**				
Cluster	Smartening Distribution Grid				
Classification	Secondary Use Case				
Description	Monitor and forecast energy needs of business and industrial facilities is within the scope of this SUC. The monitoring of business and industrial facilities should be used as the basis for the rest of SUCs				
Actors involved	• Facility Manager • Consumer (business/ industrial facilities) • Prosumer • ESCO • Smart Meter				
Triggering Event	Data is refreshed periodically				
Pre-condition	• Market information (including for balancing) • Technological facilities for consumption monitoring • Technological facilities for monitoring ambient conditions & user preferences for human-centric asset control • Interoperability between the tools of different data source providers (via WG IOP)				
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP				
Post-condition	Near real-time information available for supporting decisions of the large consumers.				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**

1	Monitor the energy consumption	Retrieve the energy consumption different type of large consumers	Energy consumption measurements	Smart Meter	Facility Manager, ESCO
2	Define business-specific properties characterising the energy demand profile	In order to achieve a better understanding of the energy demand curve and facilitate forecast algorithms operation, certain information closely related to the business developed in the facilities (e.g. working days, festivities, scheduling of special events, etc.) will be captured	Energy needs related to influencing factors	Consumer, Prosumer, Facility Manager	Facility Manager, ESCO
3	Identify energy demand that can be modulated	Identify the devices (lighting, HVAC, industrial process, etc.) associated to the different demand measurements	Energy consumption	Consumer, Prosumer, Facility Manager	Facility Manager, ESCO
4	Energy demand forecast	Based on the information about the energy consumption and related parameters, forecast can be performed to support their decisions	Forecast on energy demand	Facility Manager, ESCO	Facility Manager, ESCO

Realization	
Main responsible partners (Author)	ETRA, CRE
Contributing partners	BYES, ITE, ICCS, ECO, HEDNO, ASM
Priority	High

Use Case ID	**HL-UC 7_SUC_1.2_Enriched information visualization**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The end-user (a Facility Manager) should be able to analyse the performance of the different demand assets in the premises under his responsibility (building or district) based on specific real-time and historical metrics and the associated Indicators (KPIs). Clear presentation of processed real-time data will be made available from the web-based Graphical User Interface. It enables its end-user to perform historical analytics on energy data and respective contextual parameters (environmental/business). Continuous (periodic and automatic) analysis of profiles (loads and flexibility) assists in extraction of trends and outliers as well as optimization strategies for the Facility Manager. Therefore, the scope of this SUC is the provision of an enriched visualization tool for the better management of large-scale infrastructures.
Actors involved	• Consumer • Prosumer • Facility Manager Contributing actors:

	• ESCO • RESCO • Aggregator • Supplier • Market Operator • Sensor • BMS • Smart Meter
Triggering Event	This SUC describes a user interface, which will be invoked by the user. Calculations of relevant metrics/KPIs will be made either periodically or upon user request depending on the requirements.
Pre-condition	The main pre-condition for an effective and user-friendly interface (web-app) is availability of all the data that can help the user achieve insights that would be impossible otherwise. Necessary data include the real-time situation of the building/premises, including: • energy consumption & generation, • occupancy patterns, • indoor/outdoor environmental conditions, • market information, • information related to specific supply contract details, • DR campaigns. In addition, time-series of this information in order to extract trends and generate alternative viewpoints for the user. This information may be gathered from a variety of sources, including the building sensor network and other WG tools (e.g. WG RESCO for self-consumption, WG VPP for participation in demand Aggregator portfolios, WiseCOOP for participation in DR campaigns, etc.) via the WG IOP tool which will facilitate information exchange.
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WG STaaS/VPP • WiseCOOP
Post-condition	User selected KPIs and other building information is displayed to the user.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		The WiseCORP tool continuously collects and validates a lot of real-time information (outlined in the pre-conditions) and creates time-series for further analysis (HL-UC 7_SUC_1.1).	Measurements	Sensor, Market Operator, ESCO, RESCO, Aggregator, Supplier, BMS, Smart Meter	Facility Manager, Consumer, Prosumer

2	User request	Request from user to view historical and real-time information about some specific building metric, KPI, measurement or any combination to generate additional insights.	KPI specification	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
3		WiseCORP processes the information accordingly to generate the required information	Historical traces of measurements	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
4		WiseCORP visualizes the information in a clear and user-friendly manner	KPI values/ time-series	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication error	Inform the user about the existence of a communication error and prompt him to investigate the cause	Notification	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
1b		Provide diagnostics	What data cannot be collected from which sensor	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
1c		Continue operation with limited functionality that requires only available data	KPI values, alerts, tips, commands	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
2a	Data validation errors	Inform user about data validation errors	Notifications	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
2b		Provide diagnostics	Which information from which sensor	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer
2c		Discard erroneous data from time-series, intrapolate missing values to the extent possible	Intrapolated values	Facility Manager, Consumer, Prosumer	Facility Manager, Consumer, Prosumer

Realization	
Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO

Priority	High

Use Case ID	**HL-UC 7_SUC_1.3_Integration with DR mechanisms**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The main objective of this SUC is to enable the end-users of the tool (ESCOs, Facility Managers) to participate in DR programs/campaigns by utilising the energy assets available in the premises under management. Towards the active participation of end-users in the DR contracts, a DR management should allow for the effective estimation of aggregated demand flexibility potential, by enabling real-time multi-criteria clustering of distributed resources available in premises (demand, storage) based on their capacity, response capability and flexibility potential at different spatial-temporal granularity. The amount of demand flexibility potential is further available to the DR Aggregators for further exploitation. Therefore, the scope of this SUC is the management of individual and aggregated amount of demand flexibility in tertiary premises to promote the active enrolment of industrial clients in DR programmes.
Actors involved	• Consumer • Prosumer • Facility Manager • Aggregator • Supplier • Load Controller <u>Contributing actors:</u> • Forecast Provider
Triggering Event	This SUC encapsulates all the steps necessary for participation of a tertiary premise in DR campaigns of demand-side Aggregators (explicit DR) & Suppliers (implicit DR). Part of it is executed periodically (in preparation for the DR signal) and part is triggered by the reception of a DR signal.
Pre-condition	The main pre-condition for effective enrolment and participation in DR campaigns/programs - apart from their availability - is availability of all the data that can facilitate the process of estimating, dispatching and monitoring flexibility. Necessary data include those that are related to the real-time situation of the building/premises, including: • energy consumption & generation, • occupancy patterns, • indoor/outdoor environmental conditions, • market information, • information related to specific supply contract details, • DR campaigns and signals. In addition, time-series of this information in order to extract reliable baselines that account for building usage and weather conditions are also needed. The combination of real-time and historical information is required for the generation of accurate forecasts, to the extent possible.

	This information will be gathered from a variety of sources, including the building sensor network and possibly other WG tools (e.g. WG RESCO for self-consumption, WG STaaS/VPP for participation in demand Aggregator portfolios, WiseCOOP for participation in DR campaigns, etc.) via the WG IOP tool, which will facilitate information exchange. Another important pre-condition is the availability of controllable assets that can shape their electricity demand and access to them via standardized machine-usable interface (e.g. ReST).
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP • WG STaaS/VPP
Post-condition	Should this SUC be successfully executed, the building assets will have participated in the DR campaign of an Aggregator or Supplier by appropriately modifying their electricity demand profile.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1		Demand flexibility forecasting	Sensor measurements, user preferences	Forecast Provider	Forecast Provider
2		Communication of forecast to the Aggregator	Electricity demand/supply forecast	Forecast Provider	Aggregator, Supplier
3		Calculation and dispatch of DR signal	DR signal (e.g. price, shed/shift request)	Aggregator, Supplier	Facility Manager, Prosumer, Consumer
4	DR signal dispatch	Estimation of optimal asset set to activate for the delivery of requested flexibility	Asset operational state, user comfort preferences	Facility Manager, Prosumer, Consumer	Facility Manager, Prosumer, Consumer
5		Setpoint command dispatch	Operation setpoint per asset	Facility Manager, Prosumer, Consumer	Load Controller
6		Monitoring of flexibility delivery	Energy consumption/ generation	Facility Manager, Prosumer, Consumer	Facility Manager, Prosumer, Consumer

Exception path

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1a	Unavailability of forecasted	Identify amount of flexibility required	DR signal, flexibility forecast	Facility Manager,	Facility Manager,

	demand flexibility			Prosumer, Consumer	Prosumer, Consumer
1b		Search for alternative ways to provide it to the Aggregator/ Supplier (e.g. via control of other energy assets)	Asset operational states, user preferences	Facility Manager, Prosumer, Consumer	Facility Manager, Prosumer, Consumer
1c		If alternative way is feasible, continue with typical path	Updated asset setpoint	Facility Manager, Prosumer, Consumer	Facility Manager, Prosumer, Consumer
1d		If alternative way is not feasible, inform Aggregator/Supplier about inability to deliver requested flexibility	Notification of inability to deliver	Facility Manager, Prosumer, Consumer	Aggregator, Supplier

Realization	
Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 7_SUC_1.4_Net metering & self-consumption**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The main objective of this SUC scenario is to allow the end-users of the tool (ESCOs, Facility Managers) to optimize demand at building/ district level in order to foster self-consumption, or reduce economic or environmental impacts. By exploiting the potential flexibility of distributed resources (demand, storage and local RES) at local level (e.g. within the building/premises), WiseCORP will enable the Facility Manager to schedule the demand, based on own RES production installation or production installations, self-owned/managed or provided by a RESCO. Therefore, the scope of this is the optimal management of individual demand flexibility and RES generation at local level.
Actors involved	• Facility Manager • Consumer • Prosumer • Load Controller <u>Contributing actors:</u> • ESCO • RESCO • Forecast Provider
Triggering Event	Periodically: This SUC will be triggered on regular time intervals in order to explore and exploit the opportunities for the optimization objective (self-consumption, net metering, cost reduction, CO_2 emission reduction). As per the USEF framework, probably a daily invocation is sufficient.

Pre-condition	The main pre-condition is availability of all the data that can facilitate the process of forecasting supply & demand and scheduling demand profile modification with minimum impact of building operations. Necessary data include the real-time situation of the building/premises, including: • energy consumption & generation (own or RESCO-owned), • building occupancy patterns, • indoor/outdoor environmental conditions, • market information, • information related to specific supply contract details, • DR campaigns and signals. In addition, time-series of this information in order to extract reliable baselines that account for building usage and weather conditions will be needed. The combination of real-time and historical information is required for the generation of accurate forecasts, to the extent possible. This information may be gathered from a variety of sources, including the building sensor network and other WG tools (e.g. WG RESCO for self-consumption, etc.) via the WG IOP tool, which will facilitate information exchange. Another important pre-condition is the availability of controllable assets that can shape their electricity demand and access to them via standardized machine-usable interface (e.g. ReST). This is necessary for the successful application of any demand profile modification decided.
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP
Post-condition	The building operations will have successfully been executed for a minimum energy cost and carbon footprint.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Estimate day-ahead generation & demand forecasts	Demand/supply forecasts	Forecast Provider	Consumer, Prosumer, Facility Manager
2		Estimate available demand flexibility in the building	Measurements, User preferences	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
3		Optimise demand profile for maximum renewable energy consumption or minimum energy costs based on real-time energy generation/ consumption profile	Demand and flexibility forecast	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager

4		Generate asset control command schedule	Asset operational state and forecast, target demand flexibility	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
5		Dispatch control signals to loads/demand assets	Control commands	Consumer, Prosumer, Facility Manager	Load Controller
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication problem with load controller	Inform the user about communication problem	Notification	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
1b		Provide diagnostics	Unresponsive load controller, affected energy asset	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
1c		Inform the user about the desired target setpoint for the energy asset and urge her to manually apply it	Notification, setpoint	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO				
Priority	Medium				

Use Case ID	**HL-UC 7_SUC_1.5_Energy cost management for large infrastructures**
Cluster	Demand Response
Classification	Secondary Use Case
Description	This main objective of this SUC is to enable the tariff comparison functionality that can be used by ESCOs/Facility Managers to determine from a set of available retailer tariffs, which is the most beneficial to choose. The evaluation criteria that are important for the Facility Manager will be defined as KPIs to ensure the relevance of the outcome for real-life facility management situations. By taking into account the different retailer tariffs, analysis of historical consumption data will be used to evaluate and decide on the selection of the electricity tariff that reduces the electricity bill for the premises.
Actors involved	• Consumer • Prosumer • Facility Manager Contributing actors: • Supplier

Triggering Event	This SUC is triggered by a request from the Facility Manager in order to reduce the energy costs of the buildings he manages.
Pre-condition	The main pre-condition for evaluating and selecting among a set of available tariff schemes for electricity purchase is availability of all the data that can facilitate an accurate forecasting of future costs and detailed analysis of past consumption and costs. Necessary data include the real-time situation of the building/premises, including: • energy consumption & generation (own or RESCO-owned), • indoor/outdoor environmental conditions, • market (energy prices) & financial (building energy costs) information, and • information related to prevailing and alternative tariff schemes. Past/historical time-series of this information is also critical in order to perform reliable & sufficiently detailed assessments of past consumption patterns and energy costs. The combination of real-time and historical information is required for the generation of accurate forecasts, to the extent possible. This information will be gathered from a variety of sources, including the building sensor network and other WG tools (e.g. WiseCOOP for energy tariff schemes, etc.) via the WG IOP tool, which will facilitate information exchange.
WiseGRID systems involved	• WiseCORP Information exchange with: • WG IOP • WiseCOOP
Post-condition	The Facility Manager obtains an overall evaluation of available tariffs and the estimated energy costs under these tariffs for the building.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Define the evaluation criteria based on which the best tariff will be selected.	Evaluation criteria (energy cost, emissions, financial penalties, power limits, etc.)	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
2		Collect information about available tariff structures and their conditions	Energy prices, tariff schemes & conditions	Supplier	Consumer, Prosumer, Facility Manager
3		Obtain historical trace of building energy demand (& generation) that will be used as the energy profile baseline	Historical energy traces	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
4		Estimate annual energy costs under all available alternative tariffs	Energy usage/ generation profiles	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager

5		Visualise energy cost information to the Facility Manager as well as other important information based on the evaluation criteria defined	Alternative energy cost per tariff scheme	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Unavailability of historical energy traces	Inform the user about lack of information for reliable cost estimations	Notification	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
1b		Extrapolate current measurements using average seasonal patterns to generate an average trace	Real-time measurements, seasonal patterns of similar buildings	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
1c		Inform user about reduced result confidence and return to typical path	Notification	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
2a	Inability to retrieve energy tariffs	Inform the user that available tariffs cannot be collected from Suppliers	Notification	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
2b		Prompt user to provide alternative tariffs manually	Energy cost	Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
2c		Return to typical path		Consumer, Prosumer, Facility Manager	Consumer, Prosumer, Facility Manager
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO				
Priority	Medium				

15.7.2 HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market

Use Case ID	**HL-UC 7_SUC_2.1_Enriched information visualization**
Cluster	Demand Response
Classification	Secondary Use Case

Description	The end-user of the tool (e.g. Aggregator, Supplier) should be able to analyse the performance of the asset portfolio (clientele assets that participate in the price/incentive-based DR programmes) based on specific real-time and historical metrics and the associated Indicators (KPIs) regarding their response to DR signals. Real-time data retrieved and further processed will be presented in the GUI of the tool. On the other hand, simple analysis over historical data will enable the end-users of the tool to drill in and get insights about the performance of individuals or group of clients that consist of the portfolio of the business stakeholder (Aggregator/Retailer etc.) Therefore, the scope of this SUC is the provision of an enriched visualization tool for the detailed monitoring of the portfolio that can lead to more insights and more efficient management by the Aggregator/Supplier.
Actors involved	• Aggregator • Supplier <u>Contributing actors:</u> • Consumer • Prosumer • Facility Manager • Smart Meter (Meter Responsible Party)
Triggering Event	Occasionally upon user-request.
Pre-condition	The main pre-condition involves the availability of necessary information and access by the Supplier/Aggregator IT systems. The information includes real-time and historical traces of data about the demand/supply profile of clientele buildings, the available energy-related assets and their characteristics, energy-related user behaviour that shapes the actual building energy demand/supply, market and financial information, etc. Access to this information by the Aggregator/Supplier may require the availability of sensors to generate it and interfaces with other IT systems in order to obtain it.
WiseGRID systems involved	• WiseCOOP <u>Information exchange with:</u> • WG IOP • WiseHOME • WiseCORP • WG STaaS/VPP
Post-condition	The Aggregator/Supplier obtains deep insights in the performance of his campaigns and clientele.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Definition of KPIs of interested that should be calculated by WiseCOOP across client portfolio	Evaluation criteria	Aggregator, Supplier	Aggregator, Supplier

2		Continuous monitoring of real-time client energy profiles and generation of historical traces	Energy data	Facility Manager, Consumer, Prosumer, Smart Meter (Meter Responsible Party)	Aggregator, Supplier
3		Continuous monitoring of building user energy-related actions & preferences	User preference information	Facility Manager, Consumer, Prosumer, Sensor	Aggregator, Supplier
4		Validation and pre-processing (e.g. normalization, cleaning) of collected data	Collected data sets	Aggregator, Supplier	Aggregator, Supplier
5		Calculation of KPIs upon user request	Historical data	Aggregator, Supplier	Aggregator, Supplier
6		Visualise user-requested information	KPI values/time-series	Aggregator, Supplier	Aggregator, Supplier
Exception path #2					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication error	Inform the user about the existence of a communication error and prompt him to investigate the cause	Notification	Aggregator, Supplier	Aggregator, Supplier
1b		Provide diagnostics	What data cannot be collected from which sensor	Aggregator, Supplier	Aggregator, Supplier
1c		Continue operation with limited functionality that requires only available data	KPI values, alerts, tips, commands	Aggregator, Supplier	Aggregator, Supplier
2a	Data validation errors	Inform user about data validation errors	Notifications	Aggregator, Supplier	Aggregator, Supplier
2b		Provide diagnostics	Which information from which sensor	Aggregator, Supplier	Aggregator, Supplier
2c		Discard erroneous data from time-series, intrapolate missing values to the extent possible	Intrapolated values	Aggregator, Supplier	Aggregator, Supplier
Realization					

Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ENER ECO, ASM, HEDNO
Priority	High

Use Case ID	HL-UC 7_SUC_2.2_Portfolio profiling & analytics
Cluster	Demand Response
Classification	Secondary Use Case
Description	The main objective of this SUC is to enable the target user (mainly demand Aggregators) to perform historical analytics over energy data and respective contextual parameters (environmental/business) of the various Prosumers (including residential and tertiary) in order to evaluate their potential to participate in explicit DR programmes. Multi-parameter analysis and correlation of Prosumer electricity demand and flexibility profiles will be performed under different scenarios towards identifying Prosumer clusters for the assembly of reliable, tradable flexibility bundles taking always into account the different business models & SLAs. The objective of this SUC is to analyse historical data on the evolution of different KPIs under specific control strategies/SLAs, identify anomalies and outliers as well as indicate specific factors that are potentially relevant to the performance of SLAs. Therefore the overall scenario addresses the scope of a data analytics tool as part of the cockpit of an Aggregator or Supplier. The scope of this SUC is to extend the analysis to the overall portfolio and treat the Prosumer profiles and most importantly the classes of Prosumer profiles, in a dynamic way taking into account the specific parameters of the predefined business models and SLAs. This SUC will be further explored when the actual loads and the respective business models have been identified towards the definition of the scenarios of interest for the project.
Actors involved	• Aggregator • Supplier Contributing actors: • Facility Manager • Prosumer • Consumer • Sensor • Smart Meter • ESCO
Triggering Event	Occasionally upon user-action.
Pre-condition	The main prerequisite – apart from an existing commercial arrangement with specific clauses - is the availability of the extensive information that is needed for the detailed analysis & characterization of the Aggregator client (tertiary buildings mostly) energy profile. Endogenous (e.g. assets, operations) as well as exogenous (e.g. weather, day of the week) parameters must be accounted for in order to produce an accurate energy baseline profile. Furthermore, market/financial as well as commercial arrangement details between Aggregator and Facility Manager must be known in order to evaluate the magnitude of allowable demand profile modifications. Historical traces of all the aforementioned information for a sufficient amount of time

	is required in order to account for seasonalities and time-dependent external parameters.
WiseGRID systems involved	• WiseCOOP Information exchange with: • WG IOP • WiseHOME • WiseCORP • WG STaaS/VPP
Post-condition	Prosumer profiles are analysed, characterised and clustered according to relevant parameters.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Continuous monitoring of real-time client energy profiles and generation of historical traces	Energy data	Sensor, Smart Meter, Facility Manager, Consumer, Prosumer	Aggregator, Supplier
2		Continuous monitoring of building user energy-related actions & preferences	User preference data	Sensor, Facility Manager, Consumer, Prosumer	Aggregator, Supplier
3		Profiling user behaviour & actions to extract comfort-based demand flexibility and price elasticity of demand per client	Flexibility/ elasticity profiles	Aggregator, Supplier	Aggregator, Supplier
4		Classify client profiles into clusters with similar characteristics (asset characteristics, DR reliability, etc.) depending on the DR scheme under question	Energy profiles, clusters thereof	Aggregator, Supplier	Aggregator, Supplier
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication problem prohibiting real-time information collection	Inform the user about communication problem	Notification	Supplier, Aggregator	Supplier, Aggregator

1b		Provide diagnostics	Missing information type, source and time period	Supplier, Aggregator	Supplier, Aggregator
1c		Intra/extrapolate missing information, whenever possible (sufficient reliable information exists)	Historical information traces	Supplier, Aggregator	Supplier, Aggregator

Realization	
Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO
Priority	High

Use Case ID	**HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading**
Cluster	Demand Response
Classification	Secondary Use Case
Description	Addressing the role of the Supplier as market representative for residential and commercial clients, this SUC aims to facilitate its operation towards purchasing the required amount of energy from the wholesale energy markets to meet the needs of its clients. A critical step in this process is the estimation of the total energy consumption profile of the Supplier clients, which largely corresponds to the energy profile that should be purchased in the wholesale market in order to avoid imbalances. Given the heterogeneity of client profiles (domestic, tertiary, etc.) intelligent ways to generate reliable forecasts will be needed. Demand forecasts can never be completely accurate due to the inherent unpredictability of fundamental parameters. The Supplier has a second opportunity to avoid portfolio imbalances by encouraging Consumers to shift their demand based on dynamic price signals. So the role of this SUC is twofold: 1) a-priori calculation of the demand bids to the electricity market by exploiting the demand forecasting tools available to the target user (retailer/cooperative) and 2) manage generation and demand in an optimised way considering also the potential of the flexibility of the portfolio and the impact of dynamic pricing schemes.
Actors involved	• Aggregator • Supplier • Market Operator • Facility Manager • Consumer • Prosumer Contributing actors: • Forecast Provider • Sensor • Smart Meter

Triggering Event	Periodically: This SUC will be triggered periodically in order to generate the necessary information for the Supplier to estimate the target energy quantity to be purchased in the wholesale market.
Pre-condition	Existing commercial arrangements (e.g. electricity supply contracts) between the Supplier and its clients must be in place, preferably including provisions for dynamic/real-time energy tariffs, for the successful execution of this UC. In addition, infrastructure capable of transmitting the prices fast enough and informing the client (e.g. displaying the price) is necessary so that they are informed and can act upon prevailing and short-term future prices. On top of these, detailed information is needed (either captured by the appropriate infrastructure or available from other tools/sources) for the accurate forecasting of the entire client portfolio for the necessary time horizon that is dictated by the wholesale market.
WiseGRID systems involved	• WiseCOOP Information exchange with: • WG IOP • WiseHOME • WiseCORP • WG STaaS/VPP
Post-condition	The Supplier has procured electricity in the wholesale market and is continuously supplying his clients using dynamic prices to minimise imbalances in his portfolio.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1		Continuous monitoring of real-time client energy profiles and generation of historical traces	Energy data	Sensor, Smart Meter, Facility Manager, Consumer, Prosumer	Aggregator, Supplier
2		Continuous monitoring of building user energy-related actions & preferences	User preference data	Facility Manager, Consumer, Prosumer, Sensor	Aggregator, Supplier
3		Comfort-based demand forecasting of individual clients	User preference & energy data	Forecast Provider, Aggregator, Supplier	Aggregator, Supplier
4		Demand forecasting of client groups based on any desired clustering criteria (e.g. client location)	Individual and group energy demand forecasts	Aggregator, Supplier	Aggregator, Supplier
5		Calculate purchase bid in wholesale electricity market based on	Portfolio demand, Supplier costs, profit margin	Market Operator	Aggregator, Supplier

		portfolio demand forecast		Aggregator, Supplier	
6		Monitor real-time energy profiles of clients	Energy data	Facility Manager, Consumer, Prosumer	Aggregator, Supplier
7		Detect deviations from forecasted profile	Energy profile forecasts, real-time energy measurements	Aggregator, Supplier	Aggregator, Supplier
8		Estimate contingency actions based on a comfort-based, portfolio-wide optimization	Client demand flexibility, calculated deviations	Aggregator, Supplier	Aggregator, Supplier
9		Calculate DR signals that will restore balance	Available client assets and comfort-based demand flexibility	Aggregator, Supplier	Aggregator, Supplier
10		Dispatch DR signals	DR signal with price information	Aggregator, Supplier	Consumer, Prosumer, Facility Manager
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication problem prohibiting real-time information collection	Inform the user about communication problem	Notification	Forecast Provider, Supplier, Aggregator	Forecast Provider, Supplier, Aggregator
1b		Provide diagnostics	Missing information type, source and time period	Forecast Provider, Supplier, Aggregator	Forecast Provider, Supplier, Aggregator
1c		Intra/extrapolate missing information, whenever possible (sufficient reliable information exists)	Historical information traces	Forecast Provider, Supplier, Aggregator	Forecast Provider, Supplier, Aggregator
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO				
Priority	High				

Use Case ID	**HL-UC 7_SUC_2.4_Billing services**
Cluster	Demand Response

<table>
<tr><td>Classification</td><td colspan="5">Secondary Use Case</td></tr>
<tr><td>Description</td><td colspan="5">This SUC covers the typical functionality of creating and reviewing the bills for the clients. The metering and billing data (received from the smart meter) are required for this process. Different configurations of billing process will be provided to the target users of the functionality (actors undertaking the retailer or Aggregator roles) taking into account the availability of data in the project.
Depending on the type of user of the application, client bill could be calculated using not only metering and billing/tariff information, but also the participation of the end-user in the different flexibility campaigns launched during in the billing period. These participations would be translated into discounts and/or revenues for the client, which cost would be defrayed using the profits obtained from the flexibility market.</td></tr>
<tr><td>Actors involved</td><td colspan="5">• Aggregator
• Supplier
• Facility Manager
• Consumer
• Prosumer
• Smart Meter</td></tr>
<tr><td>Triggering Event</td><td colspan="5">Periodically: The billing process takes place at regular time intervals depending on the contract between the Supplier/Aggregator and the Con/Prosumer.</td></tr>
<tr><td>Pre-condition</td><td colspan="5">Established commercial arrangements/contracts between Aggregator/Supplier and their clients stipulating the exact remuneration conditions must be available. One critical pre-condition is access to the metering data (at the required time granularity) to enable the calculation of the energy cost or client remuneration for participation in DR programmes.</td></tr>
<tr><td>WiseGRID systems involved</td><td colspan="5">• WiseCOOP
Information exchange with:
• WG IOP
• WiseHOME
• WiseCORP
• WG STaaS/VPP</td></tr>
<tr><td>Post-condition</td><td colspan="5">Supplier/Aggregator and Pro/Consumer financial claims have been billed. Actual payment collection/tracking is outside the scope of this SUC.</td></tr>
<tr><td colspan="6">Typical steps</td></tr>
<tr><td>Step No.</td><td>Event</td><td>Description of process/ Activity</td><td>Info. exchanged</td><td>Actor producing the information</td><td>Actor receiving the information</td></tr>
<tr><td>1</td><td></td><td>Collect metering information about each client</td><td>Metering data</td><td>Smart Meter</td><td>Supplier, Aggregator</td></tr>
<tr><td>2</td><td></td><td>Check compliance with contract provisions</td><td>Contract clauses, energy profiles</td><td>Supplier, Aggregator</td><td>Supplier, Aggregator</td></tr>
<tr><td>3</td><td></td><td>Validate response and compliance to any DR requests during relevant time period</td><td>DR signals, energy metering data</td><td>Aggregator</td><td>Aggregator</td></tr>
<tr><td>4</td><td></td><td>Calculate energy cost or fee that should be paid to the client</td><td>Energy demand/supply</td><td>Supplier, Aggregator</td><td>Supplier, Aggregator</td></tr>
</table>

		based on tariff/energy price, DR requests and corresponding response (e.g. service delivery, denial), etc.	profile, energy costs, DR fees		
5		Inform client about reconciliation requirements	Energy bill	Supplier, Aggregator	Consumer, Prosumer, Facility Manager
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	Metering information unavailable through Metering responsible party	Search for alternative ways to obtain historical trace of energy consumption/ generation in the building (e.g. from plug meters, clamps, etc.)	Energy consumption/ production historical trace	Aggregator, Supplier, Sensor, ESCO	Aggregator, Supplier
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO				
Priority	Medium				

Use Case ID	**HL-UC 7_SUC_2.5_Energy cost management and optimization**
Cluster	Demand Response
Classification	Secondary Use Case
Description	Towards a deregulated energy market environment, this SUC describes a tariff comparison functionality that can be used by an ESCO that offers services to energy Consumers/Prosumers to determine from the set of available tariffs offered by Suppliers, which is the most beneficial to choose for electricity cost minimization. Selection criteria can extend beyond mere energy cost (to include e.g. complimentary offers by the Supplier, Supplier brand, bill clarity, etc.) and will be defined with feedback from relevant stakeholders during the design of the relevant application. By taking into account different retailer tariff schemes and market models, an optimisation module will perform analytics over historical data to identify the electricity tariff that reduces the electricity bill of individual Supplier/ESCO clients (residential, commercial, etc.).
Actors involved	• Supplier • Facility Manager • Consumer • Prosumer • ESCO • Smart Meter (Meter Responsible Party) Contributing actors: • Forecast Provider

	• Market Operator
Triggering Event	Occasionally upon user-action.
Pre-condition	The most important pre-condition for this UC is that the actor who performs the analysis has permission to obtain and process the Consumer energy data. Information about available tariff schemes by eligible retailers should be publicly available and the actor should also possess information about the current tariff (price, provisions, conditions, etc.) and energy costs of the Consumer under investigation.
WiseGRID systems involved	• WiseCOOP Information exchange with: • WG IOP • WiseHOME • WiseCORP
Post-condition	Upon completion of this SUC, the actor that triggered it has insights on the best energy tariff for the specific Pro/Consumer whose data have been used for the evaluation/optimisation.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	User request	Collect historical trace of Prosumer/ Consumer energy data	Energy demand historical trace per Prosumer/ Consumer	Supplier, Smart Meter	Supplier, ESCO
2		Collect available tariff structures from (territorially, legally?) eligible Suppliers	Electricity provision tariff schemes	Supplier, ESCO, Market Operator	Supplier, ESCO
3		Estimate baseline energy demand forecast & alternative (flexible) demand forecasts	Energy profile, weather forecast, user preferences	Forecast Provider	Supplier, ESCO
4		Estimate energy cost under collected tariffs for all forecasts	Energy tariffs	Supplier	Supplier, ESCO
5		Generate complete comparison of cost and supply conditions under available tariffs	Energy cost comparison & breakdown	Supplier, ESCO	Prosumer, Consumer, Facility Manager
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Available Supplier tariffs cannot be collected	Inform user about inability to collect tariffs automatically	Notification	Supplier, ESCO	Supplier, ESCO

1b		Prompt user to manually provide alternative tariffs for evaluation	Energy tariffs	Supplier, ESCO	Supplier, ESCO
2a	Energy data for baselining unavailable	Inform user about unavailability of information	Notification	Supplier, ESCO	Supplier, ESCO
2b		Prompt user to manually provide an energy consumption/ generation baseline for energy cost evaluation	Energy profile	Supplier, ESCO	Supplier, ESCO

Realization	
Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO
Priority	Medium

Use Case ID	**HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The main objective of this SUC is to pave the way for the implementation of ADR strategies via direct load control. An innovative DR Optimisation module will allow for the selection of the appropriate aggregated demand side setup to provide specific ADR functions enabling the provision of services for stable and secure grid, while optimising actor participation in the market. For ADR services (Direct Load Control DR programmes), the incentives will be provided through customized user contracts. Furthermore, based on the contractual agreements and the intelligent devices/equipment installed in the smart home environment, a set of ADR strategies will be implemented and dispatched fully preserving the comfort preferences of Clients. Different types of signals (grid events, flexibility requests, price, awards etc.) may be examined as part of this SUC. The loads to be considered as having greater capacity to provide flexibility are the HVAC devices. To this end, the goal of this SUC is to facilitate the implementation of automated DR strategies by minimising or eventually eliminating required Consumer interaction and thus overall user inconvenience/discomfort.
Actors involved	• Aggregator • Supplier • Load Controller • DSO • TSO <u>Contributing actors:</u>

	• Facility Manager • Consumer • Prosumer
Triggering Event	A flexibility request from a DSO/TSO (or similar request for activation of balancing/ancillary services).
Pre-condition	Established contracts with specific SLAs, conditions and remuneration details for the use of client flexibility by the Aggregator through direct load control. Interfacing between the management systems of the Aggregator, the flexibility users (DSO, TSO) and the energy assets at the client premises that will be under the Aggregators direct load control. Capability of direct load control of energy assets to enable reliable flexibility provision.
WiseGRID systems involved	• WiseCOOP Information exchange with: • WG IOP • WiseHOME • WiseCORP • WG STaaS/VPP • WG Cockpit
Post-condition	The Aggregator has successfully responded to a request for flexibility (or other service) by a DSO/TSO or a BRP by sending the appropriate asset control command via direct load control.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Flexibility activation request	Process request and identify corresponding bid details	Signal to activate specific flex/service offer	DSO, TSO, Supplier	Aggregator, Supplier
2		Identify portfolio composition, extract asset characteristics	Client contracts, Aggregator bid log, client portfolio	Aggregator	Aggregator
3		Validate current availability and flexibility potential of assets committed to selected cluster	Real-time energy measurements, client demand flexibility	Aggregator	Aggregator
4		Break-down total DR requirement into optimal setpoint for client energy assets	Real-time energy measurements, client demand flexibility, Client asset characteristics, user preferences	Aggregator	Aggregator
5		Direct load control via dispatch of these setpoints appropriately	Operational setpoints	Aggregator	Load Controller

Exception path

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1a	Assets of corresponding VPP no longer available or operational	Inform user about inability of current portfolio configuration to deliver the promised service	Notification	Aggregator	Aggregator
1b		Execute step 5 of HL-UC 7_SUC_2.6 typical path to create a new cluster that can serve the request	Client/ asset characteristics, request requirements	Aggregator	Aggregator
1c		If step 2 is successful, continue with step 3 of typical path.	Notification	Aggregator	Aggregator
1d		If step 2 is not successful, inform DR signal sender about inability to deliver service.	Notification	Aggregator	Aggregator, Supplier, DSO, TSO

Realization	
Main responsible partners (Author)	HYP
Contributing partners	ETRA, BYES, HYP, ICCS, ECO, ASM, HEDNO
Priority	Medium

Use Case ID	**HL-UC 7_SUC_2.7_Manual DSM strategies activation**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The main objective of this SUC is to pave the way for the application of innovative DR Services based on manual user intervention, exploiting state-of-the-art price/incentive mechanisms towards stimulating Consumer participation and prolonged engagement in those services. It describes the process for the reception of an activation request by the Aggregator/Supplier, the processing of the information, the calculation of the optimal control commands per asset and the communication of the latter information as a recommendation to the asset owner/user. An innovative DR Optimisation module will allow for the selection of the optimal setup of their portfolio through manual DR campaigns to achieve high-response reliability levels for Supplier portfolio balancing or energy cost minimization for the Consumer. Applications (WiseHOME/WiseCORP), targeted to residential and commercial Consumer needs, will be developed and further provided to Consumers (as part of other UCs) towards the visualisation of monetary and DR indicators that will further trigger them in order to modify their energy behaviour e.g. sending them DR signals.
Actors involved	• Aggregator • Supplier

	• Facility Manager • Consumer • Prosumer • DSO • TSO
Triggering Event	A flexibility request from a DSO/TSO/BRP (or similar request for activation of ancillary services).
Pre-condition	The main pre-condition includes the existence of contractual engagement between the Aggregator/Supplier and the Consumer/ Prosumer/ Facility Manager as well as the necessary IT system interfaces for the communication of the DR signals and their display to the user. The same applies for the relationship of the Aggregator/ Supplier with DSO/ TSO/ BRP or other potential flexibility users. The terms for activation of flexibility or ancillary service activation have been already agreed and the Aggregator/ Supplier is ready to accept and act upon such an activation request.
WiseGRID systems involved	• WiseCOOP Information exchange with: • WG IOP • WiseHOME • WiseCORP • WG STaaS/VPP • WG Cockpit
Post-condition	The Aggregator/Supplier has informed the energy Consumers/ Prosumers that some action is necessary.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1	Flexibility or ancillary service activation request	Process request and identify corresponding bid details	Signal to activate specific flex/service offer	DSO, TSO, Supplier	Aggregator, Supplier
2		Identify portfolio composition, extract asset characteristics	Client contracts, bid details	Aggregator, Supplier	Aggregator, Supplier
3		Validate current availability and flexibility potential of assets committed to selected cluster	Real-time energy measurements, client demand flexibility	Aggregator, Supplier	Aggregator, Supplier
4		Break down total DR requirement into DR requirements per building/asset (e.g. reduce temperature by X deg C or shift operation of asset by Y hours)	Real-time energy measurements, client demand flexibility	Aggregator, Supplier	Aggregator, Supplier

5		Dispatch aforementioned requirements as recommendations for user to take manual action	Asset operation setpoint recommendations	Aggregator, Supplier	Consumer, Prosumer, Facility Manager
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Assets of corresponding cluster no longer available or operational	Inform user about inability of current cluster configuration to deliver the promised service	Notification	Aggregator, Supplier	Aggregator, Supplier
1b		Execute step 5 of HL-UC 7_SUC_2.6 typical path to create a new cluster that can serve the request	Client/ asset characteristics, request requirements	Aggregator, Supplier	Aggregator, Supplier
1c		If step 1b is successful, continue with step 3 of typical path.	Notification	Aggregator, Supplier	Aggregator, Supplier
1d		If step 1b is not successful, inform DR signal sender about inability to deliver service.	Notification	Aggregator, Supplier	Aggregator, Supplier, DSO, TSO
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	ETRA, BYES, HYP, ICCS, ENER, ECO, ASM, HEDNO				
Priority	High				

15.7.3 HL-UC 7_PUC_3_Clients engagement for active market participation

Use Case ID	**HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The end-user of the tool (residential Consumers/Prosumers) should be able to analyse the performance of its premises offering analytics over real-time and historical metrics and the associated Indicators (KPIs). An enriched visualization component will facilitate residential Consumers and Prosumers to understand the impact of their daily activities in energy consumption. Real-time data retrieved and further processed will be available from the GUI of the tool. In addition, the tool should enable end-users to perform historical analytics over energy data further associated with building contextual parameters (environmental/energy cost). Therefore, the scope of this SUC is the provision of an enriched visualisation tool for a better understanding of Pro/Consumers about their energy consumption.
Actors involved	• Consumer • Prosumer

	• Supplier • Aggregator • Smart Meter • Sensor Contributing actors: • RESCO
Triggering Event	Either a user-request or external source trigger (from the Supplier e.g. a DR signal) to inform the client about some energy-related issue.
Pre-condition	• Availability of infrastructure to capture the real-time environmental conditions in the home as well as the operational state and energy supply/demand of the major appliances. • Availability of historical traces of the aforementioned in order to provide meaningful insights to the user.
WiseGRID systems involved	• WiseHOME Information exchange with: • WG IOP • WiseCOOP • WG RESCO
Post-condition	The user has been informed and has deeper insights of some issue related to energy aspects. Moreover, he may have provided a command or rule for the control of residential devices.

Typical steps

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1		User selects KPIs of interest and other relevant parameters (time period, assets, etc.)	Selection criteria	Consumer, Prosumer	Consumer, Prosumer
2		Relevant information collection/ retrieval and validation	Energy data, DR information, environmental conditions, etc.	Aggregator, Supplier, Sensor, Smart Meter, RESCO	Consumer, Prosumer
3		Calculation of the KPI values/time-series	Energy data, DR information, environmental conditions, etc.	Consumer, Prosumer	Consumer, Prosumer
4		Visualisation of the information in a user-friendly manner	KPI values/ time-series	Consumer, Prosumer	Consumer, Prosumer

Exception path

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information

1a	Communication error	Inform the user about the existence of a communication error and prompt him to investigate the cause	Notification	Consumer, Prosumer	Consumer, Prosumer
1b		Provide diagnostics	What data cannot be collected from which actor	Consumer, Prosumer	Consumer, Prosumer
1c		Continue operation with limited functionality that requires only available data	KPI values, alerts, tips, commands	Consumer, Prosumer	Consumer, Prosumer
2a	Data validation errors	Inform user about data validation errors	Notifications	Consumer, Prosumer	Consumer, Prosumer
2b		Provide diagnostics	Which information from which sensor	Consumer, Prosumer	Consumer, Prosumer
2c		Discard erroneous data from time-series, intrapolate missing values to the extent possible	Intrapolated values	Consumer, Prosumer	Consumer, Prosumer
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	HYP, ETRA, AMP, VS, ENER, ECO, ASM, HEDNO				
Priority	High				

Use Case ID	**HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers**
Cluster	Demand Response
Classification	Secondary Use Case
Description	Moving beyond the individualism of a personalized app, the design framework for residential application should promote the concept of social collaboration and comparison with similar peers. Therefore, the main objective of this SUC is to facilitate communities to allow members to share information and motivate them to improve their DR performance through benchmarking and comparison with their peers. The community concept arises from two different needs: The alignment to the communities participating in the project whose primary function is working together toward a common purpose and the impact of comparisons and competition in achieving a challenge, which is promoted as an innovative idea toward energy market participation nowadays (gamification framework – leader-boards - and badges/rewards for the leaders of a challenge). There are two main ways of establishing social network collaboration through gamification: a) the community may be composed of the members of the cooperative or Aggregator who is responsible for setting a campaign or a challenge. b) However, sub-communities (facilitated by an Aggregator or cooperative) may be created ad-hoc (enrolling the users of the app as a standalone application). In the second case,

	the app will allow comparison among members or compute the aggregated impact of a specific challenge. A primary purpose of this SUC and the tools that will implement it is to further develop the community (using open source software including sandbox modules that will enable the community members to extend its functionality or create new ones).
Actors involved	• Consumer • Prosumer • Supplier • Aggregator • RESCO
Triggering Event	Periodically based on events of interest for the social/collaborative activities of the user.
Pre-condition	• Availability of active communities of residential energy • Pro/Consumers that will be further developed through this SUC. • Shared information (may be anonymised for privacy purposes) about the performance of community members. • Existing campaigns organised by Aggregators / Suppliers / cooperatives that aim to improve the energy-related behaviour of residential Pro/Consumers as well as availability of the necessary information (e.g. targets, metrics, challenges, rewards, participants, peer performance and benchmarks, etc.).
WiseGRID systems involved	• WiseHOME Information exchange with: • WG IOP • WiseCOOP • WG RESCO
Post-condition	The user is engaged and actively participating in gamification activities that stimulate better energy-related behaviours.

Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		Collection of information about peer performance (relevant KPIs to be identified)	Historical trace of energy consumption of peer group	Supplier, Aggregator, RESCO	Consumer, Prosumer
2		Utilisation of normative comparisons of energy performance to stimulate users to improve their performance	Leader-boards, gamification elements	Consumer, Prosumer	Consumer, Prosumer
3		Generation and visualisation of personal recommendations and alerts for improved residential energy consumption	Tips, alerts	Consumer, Prosumer	Consumer, Producer
Exception path					

Step No.	Event	Description of process/ Activity	Info. exchanged	Actor producing the information	Actor receiving the information
1a	Unable to retrieve peer characteristics & performance	Inform user about lack of peer information	Notification	Consumer, Prosumer	Consumer, Producer
1b		If historical data from peer are available, continue typical path using that information and inform user	Notification	Consumer, Prosumer	Consumer, Producer
1c		If historical information is unavailable, suspend comparisons and keep providing recommendations	Tips, alerts	Consumer, Prosumer	Consumer, Producer

Realization	
Main responsible partners (Author)	HYP
Contributing partners	HYP, ETRA, AMP, VS, ENER, ECO, ASM, HEDNO
Priority	Low

Use Case ID	**HL-UC 7_SUC_3.3_Participation in DR programs**
Cluster	Demand Response
Classification	Secondary Use Case
Description	One of the main objectives in the deregulated energy market environment is to promote DR mechanisms and tools allowing even residential Consumers to actively participate in the market for retail energy and ancillary services. This is actually the main objective of this SUC, to develop and integrate advanced mechanisms for DR that will enable final clients/Prosumers (household), individually or by means of third-party actors (retailers, Aggregators, etc.), to actively participate in the energy markets. The residential user should be able to participate in different types of DR programmes providing their potential for demand flexibility: a) Explicit DR: either by consenting to direct load control schemes by the Aggregator (if remotely controllable loads and the necessary communication path are available in the home) or through manual intervention on the loads upon DR signals from the Aggregator (intervention can be facilitated by the app in case the respective loads are remotely controllable through the web); b) Implicit DR: by actively participating in dynamic electricity pricing schemes. The WiseHOME app will also provide alerts, notifications, advices and tips to make the DR signals understandable to citizens and enable them to respond in the most appropriate and beneficial manner. The enrolment of residential clients in DR programmes should be facilitated in a smooth and non-intrusive way, ensuring the minimum of disturbance to end-clients. Moreover, collaborative DR strategies will be explored that amplify and improve the expected reliability of the DR response to a signal.

Actors involved	• Consumer • Prosumer • Load Controller • Supplier • Aggregator				
Triggering Event	Incoming event (e.g. price, demand shift/shed request) by an Aggregator or Supplier.				
Pre-condition	• Relevant commercial and contractual arrangements with the Supplier and/or Aggregator should be in place for the participation of residential clients in DR campaigns. Interfacing of the WiseHOME app with the IT systems of these actors (through WG IOP) is also critical for the successful exchange of the necessary messages. • Availability of appliances that can be controlled remotely (e.g. via IP) to facilitate user friendly, non-intrusive and engaging experience for the user. • Availability of infrastructure for real-time monitoring of indoor/outdoor conditions and energy consumption/generation per device of interest.				
WiseGRID systems involved	• WiseHOME Information exchange with: • WG IOP • WiseCOOP • WG STaaS/VPP				
Post-condition	After completion of this SUC, the electricity demand/supply profile of the home will have been adapted in order to optimise some objective function (e.g. home energy cost, grid balance, and Supplier portfolio balance).				
Typical steps					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1	DR signal dispatch	Signal is received by the WiseHOME app	DR signal	Aggregator, Supplier	Consumer, Prosumer
2		WiseHOME app informs the user about the incoming event/signal	Signal notification	Consumer, Prosumer	Consumer, Prosumer
3		Verification that currently available flexibility in the home can satisfy the request	Real-time energy information, available demand flexibility	Consumer, Prosumer	Consumer, Prosumer
4		WiseHOME estimates desired course of action (new setpoints for energy assets)	Configuration settings, user preferences, assets & their operational status	Consumer, Prosumer	Consumer, Prosumer
5		Application of new setpoints (either automatically or by	Alerts, control commands	Consumer, Prosumer	Load controller, Consumer, Prosumer

		prompting the user to perform them)			
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication error	Inform the user about communication problems	Notification	Consumer, Prosumer	Consumer, Prosumer
1b		Retry to establish communication with the Aggregator/ Supplier	Communication (e.g. ADR) control packets	Consumer, Prosumer	Aggregator, Supplier
2a	Available demand flexibility cannot satisfy flexibility request	Inform user that the available demand flexibility (satisfying user preferences) is insufficient to meet incoming request	Alert	Consumer, Prosumer	Consumer, Prosumer
2b		Prompt user for further action (deny request or ask user to manually control loads to satisfy request)	Notification	Consumer, Prosumer	Consumer, Prosumer
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	HYP, ETRA, AMP, VS, ENER, ECO, ASM, HEDNO				
Priority	High				

Use Case ID	**HL-UC 7_SUC_3.4_Residential net metering & self-consumption**
Cluster	Demand Response
Classification	Secondary Use Case
Description	The main objective of this SUC is to allow the end-users of the application (residential clients) to participate in net metering & self-consumption concepts, promoting that way the idea of green, carbon-free living. Nowadays, the mass penetration of PV rooftop in residences gives the opportunity to Prosumers to exploit the demand flexibility of residential equipment/loads in order to reduce the carbon footprint and/or energy costs. Availability of electricity storage can amplify the potential impact of self-consumption/net metering toward energy cost reduction. The purpose of this SUC is to offer the client the necessary tools in order to optimise the demand profile of the home in order to match some generation profile (local generation or cooperative owned). The WiseHOME app will facilitate net metering/self-consumption practices by informing the Consumer about RESCO strategies, green energy generation surplus (from the cooperative or their own installation), etc. and enabling him/her to adjust his/her consumption accordingly. The idea of net metering & self-consumption has been proven beneficial for large Consumers, and is now considered as a very interested case scenario also for small Prosumers.

Actors involved	• Consumer • Prosumer • Forecast Provider • Supplier • Aggregator • RESCO • ESCO Contributing actors: • Load Controller
Triggering Event	Periodically based on user-specification of appliance operation rules.
Pre-condition	• Availability of physical local generation (e.g. roof-top PV) or virtual local generation (e.g. participation in RESCoop portfolio) that can be used in a "self-consumption" fashion. This also includes the necessary infrastructure for forecasting, real-time monitoring and reporting of generation to the WiseHOME app. • Availability of demand flexibility model that can be used to modify the home demand profile within the preferences of occupants. • Availability of remotely/machine controllable energy loads and/or storage infrastructure (e.g. HVAC, battery) to enable automated device control.
WiseGRID systems involved	• WiseHOME Information exchange with: • WG IOP • WG RESCO • WG STaaS/VPP
Post-condition	Successful completion of this SUC will result in lower energy costs and/or reduced carbon footprint compared to the baseline.

Typical steps

Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1		User specifies rules for load/storage control in case of green energy surplus	Rules	Consumer, Prosumer	RESCO, Supplier, Aggregator, ESCO
2		Green energy supply forecast is estimated and communicated to applicable WiseHOME apps and third-party responsible for asset operation optimisation	RES energy supply forecast	Forecast Provider	Consumer, Prosumer, RESCO, Supplier, Aggregator, ESCO
3		Optimisation of demand profile per home by scheduling the operation of devices to meet the supply forecast with	Energy asset activation schedule	RESCO, Supplier, Aggregator, ESCO	Consumer, Prosumer

		minimum energy cost (manually or automatically)			
4		Real-time monitoring of green energy generation and informing WiseHOME apps	RES generation info	RESCO	Consumer, Prosumer
5		Setpoint dispatch to the devices according to actual availability of green energy	Energy asset control command	RESCO, Supplier, Aggregator, ESCO	Load Controller, Consumer, Prosumer
6		Re-optimization of device scheduling based on actual generation, if necessary	Updated energy asset activation schedule	RESCO, Supplier, Aggregator, ESCO	Consumer, Prosumer
Exception path					
Step No.	**Event**	**Description of process/ Activity**	**Info. exchanged**	**Actor producing the information**	**Actor receiving the information**
1a	Communication problems	Inform the user about occurring communication problems	Alert	Consumer, Prosumer	Consumer, Prosumer
1b		Retry to establish communication	Communication control packets	Consumer, Prosumer	RESCO, Supplier, Aggregator, ESCO
1c		If available information is sufficient (though not fully up-to-date or optimised) to continue with typical path, then continue with typical path and inform user	Notification	Consumer, Prosumer	Consumer, Prosumer
1d		If available information is insufficient, inform user that optimization for “self-consumption” is not possible	Notification	Consumer, Prosumer	Consumer, Prosumer
Realization					
Main responsible partners (Author)	HYP				
Contributing partners	HYP, ETRA, AMP, VS, ENER, ECO, ASM, HEDNO				
Priority	Medium				

16 ANNEX E – KPIs

16.1 B.1 INCREASED RES AND DER HOSTING CAPACITY

KPI ID	**KPI_1_Increased RES and DER hosting capacity**
Name	Increased RES and DER hosting capacity
Strategic Objective	• Sustainability

	• Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	This indicator measures the RES and DER capacity that the distribution network allows to be installed without deteriorating the service level for the grid users, while the necessary curtailment of RES and DER production does not expose the investor to investment viability risks.
Formula	For the Business-As-Usual scenario, the hosting capacity can be calculated using the existing established methodologies per country, e.g. as a percentage of the minimum substation load. For the Research and Innovation scenario, the additional RES and DER capacity that can be installed (with the innovative solutions in place) is calculated as the one that results in a maximum energy curtailment that does not deteriorate the viability of the investment.
Unit of measurement	MW
Related PUC(s)	• HL-UC 1_PUC_5_Promote RES via RESCO companies
Project relevance	Direct
GENERAL COMMENTS	
Several tools for measuring the investment viability can be employed, e.g. Return on Investment (ROI), Break Even Point, Net Present Value (NPV), Internal Rate of Return (IRR), etc., depending on their appropriateness for each case studied.	

16.2 B.2. REDUCED ENERGY CURTAILMENT OF RES AND DER

KPI ID	**KPI_2_RES curtailment**
Name	RES curtailment
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid • Demand Response
Description	The indicator will measure the amount of energy from Renewable Energy Sources (RES) that is not injected to the grid (even though it is available) due to operational limits of the grid.
Formula	$c_{RES} = \sum_{t \in T} \sum_{i \in I} \left(E_{i,t}^{prod} - E_{i,t}^{inj} \right)$ E_i^{prod}: available energy production of the i-th RES facility at period t E_i^{inj}: energy injected to the grid by the i-th RES facility at period t I: set of RES facilities under consideration T: set of time intervals of period under consideration excluding periods of scheduled maintenance and outages
Unit of measurement	MWh
Related PUC(s)	• HL-UC 1_PUC_2_Control strategies for reducing RES curtailment • HL-UC 2_PUC_3_Grid control • HL-UC 3_PUC_4_Interaction with the energy infrastructure

	• HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market
Project relevance	Direct
GENERAL COMMENTS	
Available energy production can be estimated using various methods according to the availability of data. In case solar irradiation or wind speed measurements are available, the respective formulas for calculating the power output could be used (e.g. for wind power output: $P = {}^{1}/_{2}\,\rho A v^3 C_P$, where P the power output in W, ρ, the air density in kg/m^3, A the rotor swept area in m^2, v the wind speed in m/s, C_P the power coefficient (dimensionless); for solar power output: $P = \eta AI$, where η is the efficiency of the solar panels that takes into account the losses due to shading, reflection, temperature, inverter, etc. as well as any power tracking equipment (dimensionless), A is the solar panel total area in m^2, I is the incident solar flux in W/m^2 that takes into account the panel tilt). In case no other data is available RES production forecasts could be used instead. Energy injected to the grid derives from metered data. If the current regulatory framework does not allow curtailment of energy from RES, simulation results could also be used.	

16.3 B.3. POWER QUALITY AND QUALITY SUPPLY

KPI ID	**KPI_3_SAIDI**
Name	System Average Interruption Duration Index
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	Average outage duration for each customer served (during a certain time period)
Formula	$$SAIDI = \frac{\sum_n cid_n}{nc}$$ cid_n: customer n interruption duration nc: total number of customers served
Unit of measurement	Time units
Related PUC(s)	• HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Direct
GENERAL COMMENTS	
SAIDI is periodically evaluated by the DSO (e.g. monthly).	

KPI ID	**KPI_4_SAIFI**
Name	System Average Interruption Frequency Index
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid

Description	Average number of interruptions that a customer experiences (during a certain time period)
Formula	$$SAIFI = \frac{\sum_n ci_n}{nc}$$ ci_n: number of interruptions suffered by customer n nc: total number of customers served
Unit of measurement	Interruptions per customer
Related PUC(s)	• HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Direct
GENERAL COMMENTS	
SAIFI is periodically evaluated by the DSO (e.g. monthly).	

KPI ID	**KPI_5_CAIDI**
Name	Customer Average Interruption Duration Index
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	Average outage duration that any given customer would experience (average restoration time)
Formula	$$CAIDI = \frac{\sum_n cid_n}{\sum_n ci_n} = \frac{SAIDI}{SAIFI}$$ cid_n: customer n interruption duration ci_n: number of interruptions suffered by customer n $SAIDI$: System Average Interruption Duration Index $SAIFI$: System Average Interruption Frequency Index
Unit of measurement	Time units
Related PUC(s)	• HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Direct
GENERAL COMMENTS	
CAIDI is periodically evaluated by the DSO (e.g. monthly)	

KPI ID	**KPI_6_CAIFI**
Name	Customer Average Interruption Frequency Index
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	Number of customers affected out of the whole customer base

Formula	$$CAIFI = \frac{\sum_n ci_n}{ndci}$$ ci_n: number of interruptions suffered by customer n $ndci$: number of distinct customers interrupted
Unit of measurement	Interruptions per customer
Related PUC(s)	• HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Direct
GENERAL COMMENTS	
CAIFI is periodically evaluated by the DSO (e.g. monthly)	

KPI ID	**KPI_7_LV faults clearance time index**
Name	LV faults clearance time index
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	Average duration of outages in LV (during a certain time period)
Formula	$$LVFCT = \frac{\sum t_n}{no}$$ t_n: duration of an outage no: total number of outages
Unit of measurement	Time units
Related PUC(s)	• HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Direct
GENERAL COMMENTS	
LV faults clearance time index is periodically evaluated by the DSO (e.g. monthly).	

KPI ID	**KPI_8_Voltage variation**
Name	Voltage variation
Strategic Objective	• Security of supply • Sustainability
Project Objective	• Smartening Distribution Grid
Description	The indicator will measure the deviation of the voltage on the network nodes. As a basis, the nominal voltage per node will be used.
Formula	$$\delta_V = \frac{\sqrt{\sum_{t=1}^{T}\sum_{n=1}^{N}(V_{n,t} - V_n)^2}}{T \cdot N} 100$$ $V_{n,t}$: voltage of node n at period t

	V_n: nominal voltage of node n T: number of time intervals of period under consideration N: number of nodes under consideration
Unit of measurement	%
Related PUC(s)	• HL-UC 1_PUC_3_Voltage support and congestion management • HL-UC 2_PUC_3_Grid control • HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)
Project relevance	Direct
GENERAL COMMENTS	
The index can be used to calculate the voltage deviation observed in the part of the distribution grid that is under consideration during a certain evaluation period. The ℓ^2-norm is used for the calculation of the voltage deviation from the nominal value.	

KPI ID	**KPI_9_Frequency deviation**
Name	Reduction of frequency deviation
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Demonstration of Energy Storage Technologies
Description	The indicator will measure the average frequency deviation from the nominal frequency (50 Hz).
Formula	Average voltage difference Δf_{Avg} : $$\Delta f_{Avg} = \frac{1}{T} \cdot \sum_{t=1}^{T} \lvert f_t - f_{nom} \rvert$$ f_t: currently measured voltage f_{nom}: nominal voltage T: number of time intervals
Unit of measurement	Hz
Related PUC(s)	• HL-UC 4_PUC_3_Ancillary services
Project relevance	Indirect
GENERAL COMMENTS	
The reduction of frequency deviation is somehow linked to the reaction time since the earlier provision of ancillary services stabilize the frequency and thus leads lo smaller deviations.	

KPI ID	**KPI_10_State estimation performance evaluation**
Name	State estimation performance evaluation
Strategic Objective	• Sustainability • Security of supply

Project Objective	• Smartening Distribution Grid • Demand Response
Description	This indicator consists of three sub-indicators: 1) The first sub-indicator will measure the Mean Absolute Error (MAE), the Root Mean Squared Error (RMSE) and the Maximum Error (ME) between the true (or the measured) and the estimated system state. 2) The second sub-indicator will measure the Autocorrelation Function (ACF) to evaluate the properties of a time series, which in this case is the estimated system state. It is, therefore, necessary to verify whether the residuals $\hat{y}_t - \hat{y}_{t-1}$ are non-correlated, where $\hat{y}_t$ is the estimated system state at time-step *t*. If the residuals are non-correlated, the ACF should be within the noise margins $\pm 1.96/\sqrt{N_s}$ with 95% of probability, where N_s is the total number of time-steps. The ACF is plotted for the first $\sim\sqrt{N_s}$ lags. 3) The third sub-indicator will measure the Refresh Rate (RR) of the state estimation process.
Formula	Mean Absolute Error (MAE) between true (or measured) and estimated system state: $$MAE = \frac{\sum_{t=1}^{N_s} \lvert e_t \rvert}{N_s}$$ e_t: estimation error at time-step *t* ($e_t = y_t - \hat{y}_t$) y_t: true (or measured) system state at time-step *t* $\hat{y}_t$: estimated system state at time-step *t* N_s: number of time-steps Root Mean Squared Error (RMSE) between true (or measured) and estimated system state: $$\text{RMSE} = \sqrt{\frac{\sum_{t=1}^{N_s} {e_t}^2}{N_s}}$$ e_t: estimation error at time-step *t* ($e_t = y_t - \hat{y}_t$) y_t: true (or measured) system state at time-step *t* $\hat{y}_t$: estimated system state at time-step *t* N_s: number of time-steps Maximum Error (ME) between true (or measured) and estimated system state: $$ME = \max\{e_{t,1}, \dots, e_{t,n_b}\}$$ e_t: estimation error at time-step *t* ($e_t = y_t - \hat{y}_t$) y_t: true (or measured) system state at time-step *t* $\hat{y}_t$: estimated system state at time-step *t* n_b: number of electrical network buses Autocorrelation Function (ACF): $$ACF = \frac{\gamma(h)}{\gamma(0)}$$ $\gamma(h)$: auto covariance function: $$\gamma(h) = \text{Cov}(X_{t+h}, X_t)$$ X_t: stationary time series (estimated system state) h: 1, 2, 3, etc. (defines the time-steps back in the past)

	Refresh Rate (RR) is the difference between two consecutive time-steps, during which the system state is estimated. $$RR = t_i - t_{i-1}$$ t_i: current time-step t_{i-1}: previous time-step
Unit of measurement	1) Depending on the definition of the system state (i.e., if it is in polar or in rectangular coordinates), it can be: • V (Volt) or p.u. (per unit) for the voltage magnitude and rad (radians) for the voltage phase, • V (Volt) or p.u. (per unit) for the real and imaginary part of the voltage. 2) For any stationary process, $\gamma(h)$ is bounded between -1 and 1. 3) min, s or ms
Related PUC(s)	• HL-UC 2_PUC_2_Real-time distribution system awareness
Project relevance	Indirect
GENERAL COMMENTS	
The MAE is conceptually simpler and more interpretable than the RMSE. However, the RMSE gives a relatively high weight (penalizes) to large errors Additionally, the RMSE avoids the use of the absolute value, which is highly undesirable in many mathematical calculations (f.e. in the case of the gradient or sensitivity calculation). The ME is a type of worst-case error, since it calculates the largest estimation error among the different network buses for every time-step. In case three-phase networks are tested, then it is possible to integrate also the three phases *α*, *b* and *c* in the calculation of the ME. For the ACF to make sense, the series must be stationary. The ACF plot is also called correlogram. The state estimation RR does not necessarily coincide with the measurements reporting rate (how frequent measurements are acquired). In particular, there may be obtained measurements from different types of devices, which are characterized by different reporting rates. Additionally, it is possible to control the state estimation RR, by taking advantage of forecasts as pseudo-measurements.	

16.4 B.4. EXTENDED ASSET LIFE TIME

KPI ID	**KPI_11_Extended asset life time**
Name	Extended asset life time
Strategic Objective	• Security of supply • Asset accountability for pro-active maintenance
Project Objective	• Smartening Distribution Grid
Description	This indicator will evaluate all assets within the designated grid area for the purpose of mapping and managing resources in terms of the infrastructure serving customers and all grid elements. Specifically, the indicator will measure (1) the actual availability of network capacity with respect to its standard value, (2) the utilization percentage of electricity network components and (3) the availability of network components.
Formula	$$LA = CAPEX + OPEX$$ LA: life-time of asset $CAPEX$: capital expenditures $OPEX$: operational expenditures

Unit of measurement	€
Related PUC(s)	• HL-UC 1_PUC_4_Grid planning analysis
Project relevance	Direct
GENERAL COMMENTS	
By having a clear picture of the whole electricity network components, the utilization percentage and real-time availability, the indicator is vital in terms of the technical resilience/system safety.	

16.5 B.5. INCREASED FLEXIBILITY FROM ENERGY PLAYERS

KPI ID	**KPI_12_VPP participation in flexibility requests**
Name	VPP participation in flexibility requests.
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	A VPP can provide ancillary services to the DSO such as absorbing RES energy surplus or providing more energy to the system. The DSO requests certain amount of energy (to provide or to absorb) and the VPP Operator decides the amount of energy accepted by the VPP. This indicator will calculate the degree of participation of the VPP in the above-mentioned kind of ancillary services.
Formula	$$Participation = \frac{\sum_{i \in I} A_i^{VPP}}{\sum_{i \in I} A_O^{VPP}} 100$$ A_{VPP}: active energy accepted by the VPP (kWh) A_O: active energy requested by the DSO (kWh) I: number of DSO requests made over time
Unit of measurement	%
Related PUC(s)	• HL-UC 6_PUC_3_VPP real-time control
Project relevance	Direct
GENERAL COMMENTS	
This KPI will provide a global scope about the VPP participation keeping in mind all the DSO requests made over time.	

KPI ID	**KPI_13_Increased EV demand flexibility availability**
Name	Increased EV demand flexibility availability
Strategic Objective	• Security of supply
Project Objective	• Smart Integration of Grid Users from Transport
Description	This KPI will evaluate the amount of energy that the smart charging strategies in EVSE enable to shift according to the EV users preferences compared to the total amount of power required for charging.
Formula	$$EFA = \frac{E_{EV\_avail.}}{E_{EV\_charging}} 100$$

	EFA : EV demand Flexibility Availability (%) $E_{EV\_avail.}$: amount of energy that may be shifted according with to the type of charging selected by the users during a monitoring period for a demo area (kWh) $E_{EV\_charging}$: total amount of energy required for charging during a monitoring period for a demo area (kWh)
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_2_Interaction of the user with EVSE
Project relevance	Direct

KPI ID	**KPI_14_Increased demand flexibility execution**
Name	Increased demand flexibility execution
Strategic Objective	• Security of supply
Project Objective	• Smart Integration of Grid Users from Transport
Description	This KPI will evaluate the amount of enregy that the smart charging strategies EVSE have been able to shift according to the EV users preferences compared with the total amount of power required for charging.
Formula	$$EFE = \frac{E_{EV\_shifted}}{E_{EV\_charging}} 100$$ EFE : EV demand Flexibility Execution (%). $E_{EV\_shifted}$: amount of energy that has been shifted according to the type of charging selected by the users during a monitoring period for a demo area (kWh). $E_{EV\_charging}$: total amount of energy required for charging during a monitoring period for a demo area (kWh).
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_4_Interaction with the energy infrastructure
Project relevance	Direct
GENERAL COMMENTS	
Add any general comments (e.g. regarding the calculation procedure).	

KPI ID	**KPI_15_Active participation in EV demand flexibility**
Name	Active participation in EV demand flexibility
Strategic Objective	• Sustainability
Project Objective	• Smart Integration of Grid Users from Transport
Description	This KPI will evaluate the willingness of the EV users to allow smart charging and V2G (charging types 2 and 3 defined in the scope of the WiseGRID project) in order to measure their active participation in providing flexibility to the system.
Formula	$$APEV = \frac{n_{active}}{n_{total}} 100$$ $APEV$: Active Participation in EV demand flexibility (%). n_{active}: number of type 2 and 3 charging sessions performed during a monitoring period for

	a demo area. n_{total}: total number of charging sessions performed by cars with smart charging or V2G capabilities during a monitoring period for a demo area.
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_2_Interaction of the user with EVSE
Project relevance	Direct
GENERAL COMMENTS	
If desired, this KPI may be also divided in two different KPIs: smart charging and V2G.	

16.6 B.6. IMPROVED COMPETITIVENESS OF THE ELECTRICITY MARKET

KPI ID	**KPI_16_Improved competitiveness of the electricity market**
Name	Improved competitiveness of the electricity market
Strategic Objective	• Market competitiveness
Project Objective	• Smartening Distribution Grid
Description	The competitiveness can be measured, considering the variation of the number of active energy suppliers or through the variation of market concentration (Herfindahl-Hirschman Index (HHI)).
Formula	$$H = \sum_{n \in N} s_i^2$$ s_i: the market share of firm i in the market N: the set of firms
Unit of measurement	-
Related PUC(s)	• HL-UC 6_PUC_2_VPP market participation
Project relevance	Direct
GENERAL COMMENTS	
HHI can take any value between 0 and 1. In a highly competitive market, the index is below 0.01. Values higher than 0.25 indicate a highly concentrated market.	

16.7 PROJECT SPECIFIC KPIS

KPI ID	**KPI_17_Ancillary services cost**
Name	Ancillary services cost
Strategic Objective	• Sustainability • Market competitiveness
Project Objective	• Demonstration of Energy Storage Technologies
Description	The indicator will measure cost for providing ancillary services.
Formula	$$C_{Anc} = P_{Anc} c_{P,Anc} + E_{Anc} c_{E,Anc}$$ C_{Anc}: total cost for providing ancillary services P_{Anc}: provided power used for providing ancillary services (kW) $c_{P,Anc}$: power cost for ancillary services (€/kW)

	E_{Anc}: provided energy used for providing ancillary services (kWh) $c_{E,Anc}$: energy cost for ancillary services in (€/kWh)
Unit of measurement	€
Related PUC(s)	• HL-UC 4_PUC_3_Ancillary services
Project relevance	Direct
GENERAL COMMENTS	
Simplified illustration of the resulting costs which mainly consist of cost for the provision of power and energy. A detailed calculation must consider that different units provide ancillary services and that prices depend on the unit, time, country etc.	

KPI ID	**KPI_18_Load forecasting accuracy**
Name	Load forecasting accuracy
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid • Smart Integration of Grid Users from Transport
Description	The indicator will measure the Mean Absolute Percentage Error (MAPE) between actual and forecasted load. Furthermore, the evolution of MAPE will be monitored through a moving window, observing how the MAPE value evolves, verifying the solution reduces its forecasting errors as time evolves.
Formula	Mean Absolute Percentage Error (MAPE) between actual and forecasted load. $$MAPE = \frac{\sum_{t=1}^{N} \left\lvert \frac{E_t}{L_t} \right\rvert}{N} 100$$ E_t: forecast error at period t ($E_t = L_t - F_t$) L_t: actual value of load at period t F_t: forecasted load at period t N: number of available data points of the load timeseries
Unit of measurement	%
Related PUC(s)	• HL-UC 2_PUC_2_Real-time distribution system awareness • HL-UC 3_PUC_3_EV charging management
Project relevance	Indirect
GENERAL COMMENTS	
The MAPE value can be monitored as time evolves through different curve evaluations. The same KPI can also be used for measuring the forecasting accuracy of EV load.	

KPI ID	**KPI_19_Support the distribution grid using cogeneration**
Name	Support the distribution grid using cogeneration
Strategic Objective	• Sustainability

	• Market competitiveness • Security of supply
Project Objective	• Demonstration of Energy Storage Technologies
Description	The CHP and the HVAC management system will cooperate with other applications such as the WG Cockpit in order to provide ancillary services to other actors. This KPI will evaluate the value for the provision of ancillary services/cooperation with other applications.
Formula	$$C = \frac{C_{elec} + C_{Gas} - P_{AS}}{S_T}$$ C_{elec}: cost for electricity (€) C_{Gas}: cost for natural gas (€) R_{AS}: revenues for the provision of Ancillary services to the DSO (€) S_T: total surface of the buildings managed by the application (m^2)
Unit of measurement	€/m^2
Related PUC(s)	• HL-UC 5_PUC_4_Cogeneration and HVAC optimisation
Project relevance	Direct
GENERAL COMMENTS	
The cost can take negative values, which indicate the profit incurred from the CHP operation. In the baseline scenario R_{AS} is zero. In the BAU scenario, there is no provision of ancillary services to the DSO. In the R&I scenario, facilitated by the cooperation between WiseGRID applications, the HVAC/CHP system provides ancillary services to the DSO.	

KPI ID	**KPI_20_System awareness total time latency**
Name	System awareness total time latency
Strategic Objective	• Sustainability • Security of supply
Project Objective	• Smartening Distribution Grid • Demand Response
Description	The indicator will measure the Total Time Latency (TTL), which is defined as the total time that is needed from the moment of the measurements' acquisition until the system state is estimated.
Formula	The Total Time Latency (TTL) is calculated as: $$\Delta t_{\text{total}} = \Delta t_1 + \Delta t_2 + \Delta t_3$$ where: $$\Delta t_i = t_i - t_{i-1}, \text{ i = 1, ... , 3}$$ and t_0: the time of measurements acquisition t_1: the time when measurements are gathered (e.g. in SCADA) t_2: the time of the beginning of the state estimation process t_3: the time when the state estimation process is completed.
Unit of measurement	min, s or ms

Related PUC(s)	• HL-UC 2_PUC_2_Real-time distribution system awareness
Project relevance	Indirect
GENERAL COMMENTS	
The time tagging of some steps of the process helps to estimate/compute the TTL with a higher precision. The time tagging is assisted by the GPS synchronization.	

KPI ID	**KPI_21_Measurements redundancy**
Name	Measurements redundancy
Strategic Objective	• Sustainability • Security of supply
Project Objective	• Smartening Distribution Grid • Demand Response
Description	The indicator will measure the Redundancy Factor, which is a useful metric to assess how *robust* a state estimator is. If an electrical network is observable, then this means that the number of obtained measurements (real and pseudo-measurements) is equal or larger than the number of system state variables. Otherwise, the system state cannot be computed. Hence, a number of measurements (placed in suitable locations) that is equal to the number of system state variables is called “essential” and the rest ones are called “redundant”. It should be noted that such a set of “essential” measurements might not be unique (different combinations are possible).
Formula	The Redundancy Factor is an indicator of the robustness of the state estimator and is defined as: $$\eta = \frac{m}{n}$$ m: the number of obtained measurements n: the number of system state variables The number of critical measurements is equal to n, whereas the number of redundant measurements is equal to $(m - n)$.
Unit of measurement	-
Related PUC(s)	• HL-UC 2_PUC_2_Real-time distribution system awareness
Project relevance	Indirect
GENERAL COMMENTS	
It is important to note that *redundant* measurements are different than the *critical* ones. Critical measurements are those without which the state of the system cannot be calculated, therefore all critical measurements in the system must be included in the set of essential measurements. On the other hand, it is possible to remove some redundant measurements and still have the grid observable. The existence of redundancy makes the state estimator more robust, more accurate and enables the easier replacement of bad/erroneous or inaccurate data. In practice, it is desirable to have a Redundancy Factor with a value between 1,5 and 2,8. If it is lower than 1,5, it means that the state estimator is not very robust and possibly errors may affect its performance. Additionally, in this case, the state estimation accuracy is lower. If the Redundancy Factor has a value larger than 2,8, this indicates high investment costs in data acquisition. As it can be seen, there is a trade-off.	

KPI ID	**KPI_22_State estimation convergence**

Name	State estimation convergence
Strategic Objective	• Sustainability • Security of supply
Project Objective	• Smartening Distribution Grid • Demand Response
Description	The indicator will measure the number of iterations needed for the state estimation to converge. The iterations are defined as the repetitive executions of the state estimation algorithm, until some certain criteria are satisfied.
Formula	The number of iterations increases, until some specific criteria are met. The way to calculate the number of iterations is by selecting the stopping condition and a threshold ε.
Unit of measurement	Number of iterations
Related PUC(s)	• HL-UC 2_PUC_2_Real-time distribution system awareness
Project relevance	Indirect

KPI ID	**KPI_23_Data validation ratio**
Name	Data validation ratio
Strategic Objective	• Sustainability • Security of supply
Project Objective	• Smartening Distribution Grid
Description	Every data collected by the DMS has to be validated. This KPI will calculate the percentage of validated data according to all the data received by the DMS.
Formula	$$Ratio = \left(\frac{VD}{RD} \cdot 100\right)_t$$ VD: Amount of validated data RD: Amount of received data t: Period of time studied
Unit of measurement	%
Related PUC(s)	• HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Indirect
GENERAL COMMENTS	
The KPI is repeatedly calculated within a predefined period of time. As soon as this period expires, the ratio is initialized with zero and the calculation restarts. By narrowing the refresh period, it is possible to have better information of the moment of the failure.	

KPI ID	**KPI_24_Assets data collection reliability**
Name	Assets data collection reliability.
Strategic Objective	• Market competitiveness • Security of supply

Project Objective	• Smartening Distribution Grid • Smart Integration of Grid Users from Transport
Description	The indicator will calculate the percentage of data correctly gathered from the assets (EVs, VPP Components, etc.).
Formula	$$Accuracy = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} x_{i,j}}{n \cdot m} 100$$ n: number of assets to be monitored m: number of parameters to be collected (for each asset) $x_{i,j}$: parameter to be collected. Two possible values: 1 if correctly collected; 0 if parameter not collected
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_1_EVSE and EV fleet monitoring • HL-UC 6_PUC_1_VPP monitoring and management
Project relevance	Indirect
GENERAL COMMENTS	
The index can be used for assessing the reliability of the data collection process regarding EVs (SoC, identifier, plugged status, etc.) or VPP Components (meters, sensors, etc.).	

KPI ID	**KPI_25_Technical losses**
Name	Technical losses
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	The indicator will measure the amount of energy losses in the distribution grid due to technical reasons.
Formula	$$E_{losses} = \sum_{t=1}^{T}\left(E_t^{inj} - E_t^{wd}\right)$$ E_t^{inj}: energy injected to the part of the distribution grid under consideration at period t E_t^{wd}: energy withdrawn from the part of the distribution grid under consideration at period t T: number of time intervals of period under consideration
Unit of measurement	MWh
Related PUC(s)	• HL-UC 2_PUC_3_Grid control
Project relevance	Direct

KPI ID	**KPI_26_Energy generation capability per investment ratio**
Name	Energy generation capabilities provided by the performed investment
Strategic Objective	• Market competitiveness

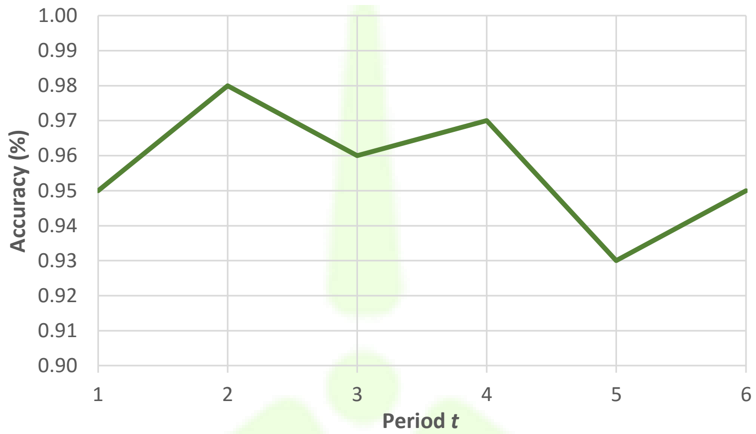
Project Objective	• Smartening Distribution Grid
Description	The objective of the RESCO company is to install RES in customer's premises at the lowest possible economic cost that will produce the highest possible amount of energy. Producing and selling energy is the way the RESCO can make profit. This indicator is calculated per RESCO customer, and crosschecks the amount of energy that is produced by installed assets with the corresponding costs of its installation and maintenance. Gives an indication of the efficiency (in economic terms) of the installations of each customer.
Formula	$$EGCpIr = \frac{E_{RES}}{I}$$ $EGCpIr$: energy generation capability per investment ratio (kWh/€) E_{RES}: Energy produced by installed RES (kWh) I: total investment costs of installed RES (€)
Unit of measurement	kWh/€
Related PUC(s)	• HL-UC 1_PUC_5_Promote RES via RESCO companies
Project relevance	• Direct

KPI ID	**KPI_27_ Network RES visibility**
Name	Network RES visibility
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	The indicator will measure the percentage of "on line" monitored RES. It will be the ratio between "on-line RES active power integrate at DMS" and "by meters measured energies of RES". The higher the value of the indicator will be, the better visibility will be in place.
Formula	RES Visibility Percentage (RVP) for a T period, will be the ratio: $$RVP_T = \frac{\sum_{n \in N} \sum_{t \in T} (\Delta t_t * P_{RESt})_n}{\sum_{m \in M} E_{RESm}} 100\%$$ P_{RESt}: active power within the minute t of the overall considered period T Δt_t: actual value of time step at period t, usually 1 minute N: total number of monitored RES units (in DMS) in the area M: total number of RES units in the area E_{RESm} active energy within the overall considered time period T
Unit of measurement	%
Related PUC(s)	• HL-UC 1_PUC_1_Network monitoring • HL-UC 2_PUC_1_Distribution network real-time monitoring
Project relevance	Indirect
GENERAL COMMENTS	
RVP can be evaluated within various periods T.	

KPI ID	KPI_28_GHG emissions
Name	Greenhouse Gas (GHG) emissions
Strategic Objective	• Sustainability
Project Objective	• Demand Response • Smart Integration of Grid Users from Transport
Description	Increasing the integration of DER and DER (or, equivalently, reducing their curtailment) through application of flexibility services on the part of the charging infrastructure as well as on the part of the consumers (e.g. through dynamic prices) results, ceteris paribus, to an energy mix with reduced participation of production from fossil fuels and, by extension, to reduced Greenhouse Gas (GHG) emissions, even if the energy consumed remains the same. This KPI aims to illustrate the reduction of carbon emissions by utilising the WiseGRID tools related to supply of cheap renewable energy to consumers.
Formula	$$GHG = \sum_h CEC_h L_h$$ CEC_h: the Carbon Emission Coefficient during each time interval h of the period under study; it must reflect the carbon emissions of the respective generation facilities and will be significantly lower when RES generation has a greater share in the total production than fossil fuel-based generation (tn CO_2/kWh) $L_h = \sum_{n \in N} l_n^h$: the total load across all users $n \in N$ during each time interval h of the period under study (kWh) H: the set of time intervals of the period under study N: the set of customers under study
Unit of measurement	tn CO_2
Related PUC(s)	• HL-UC 3_PUC_4_Interaction with the energy infrastructure • HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_3_Clients engagement for active market participation
Project relevance	Direct
GENERAL COMMENTS	
The duration of the time interval may vary depending on data availability. This KPI is affected by the achieved reduction in the curtailment of RES and DER production.	

KPI ID	KPI_29_Flexibility forecasting accuracy
Name	Flexibility forecasting accuracy
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	The indicator will calculate the accuracy between the flexibility forecasting and the real-time flexibility calculation inside the VPP in a specific period of time. Furthermore, the evolution of the accuracy will be monitored through a moving window.

Formula	$$Accuracy = \left(1 - \left\|\frac{F_c - F_f}{F_c}\right\|\right)_t 100$$ F_c: current flexibility (kWh) F_f: forecasted flexibility (kWh) t: period
Unit of measurement	%
Related PUC(s)	• HL-UC 6_PUC_1_VPP monitoring and management • HL-UC 6_PUC_3_VPP real-time control
Project relevance	Indirect
GENERAL COMMENTS	
The calculation of the index can be performed using a moving window.	



KPI ID	**KPI_30_VPP participation in voltage control requests**
Name	VPP participation in voltage control requests
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Smartening Distribution Grid
Description	A VPP can provide some Ancillary services to the DSO, such as voltage control. The DSO requests certain amount of reactive energy (to provide or to absorb) and the VPP Operator decides the amount of reactive energy accepted by the VPP. This indicator will calculate the degree of participation of the VPP in the above-mentioned kind of Ancillary services.
Formula	$$p = \frac{\sum_{i=1} R_{VPP}}{\sum_{i=1} R_O} 100$$ R_{VPP}: reactive energy accepted by the VPP (kVArh) R_O: reactive energy requested by the DSO (kVArh) i: number of DSO requests made over time
Unit of measurement	%
Related PUC(s)	• HL-UC 6_PUC_3_VPP real-time control

Project relevance	Direct
GENERAL COMMENTS	
This KPI will provide a global scope about the VPP participation keeping in mind all the DSO requests made over time.	

KPI ID	**KPI_31_Supplier portfolio imbalance**
Name	Reduction of supplier portfolio imbalance
Strategic Objective	• Market competitiveness
Project Objective	• Demand Response
Description	Minimising the portfolio imbalance of suppliers (usually also BRPs) is an important reason for them to launch and manage implicit DR schemes.
Formula	$$PI = \sum_{n \in N, h \in H} (P_h^n - C_h^n + G_h^n)$$ PI: cumulative portfolio energy imbalance of the actors P_h^n: amount of energy purchased from wholesale market for time slot h C_h^n: energy consumed in time slot h by consumers of the supplier within its balancing zone G_h^n: energy generated in time slot h within the balancing zone of BRP/supplier by the prosumers under its responsibility N: set of customers under study ($n \in N$) H: the set of time intervals of the period under study ($h \in H$)
Unit of measurement	MW
Related PUC(s)	• HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market
Project relevance	Direct

KPI ID	**KPI_32_EVSE data collection reliability**
Name	EVSE data collection reliability.
Strategic Objective	• Market competitiveness • Security of supply
Project Objective	• Smart Integration of Grid Users from Transport
Description	WiseEVP has necessity of collecting data from EVSEs (socket availability schedule, location, current power, etc.). The indicator will calculate the percentage of data correctly gathered from the EVSEs.
Formula	$$Reliability = \frac{\sum_{i=1}^{N} \sum_{j=1}^{n} x_{i,j}}{n \cdot N} 100$$ N: number of EVSEs to be monitored n: number of parameters to be collected (for each EVSE) $x_{i,j}$: parameter to be collected. Two possible values: 1 if correctly collected; 0 if parameter not collected
Unit of measurement	%

Related PUC(s)	• HL-UC 3_PUC_1_EVSE and EV fleet monitoring
Project relevance	Indirect

KPI ID	**KPI_33_EVSE availability index**
Name	EVSE availability index.
Strategic Objective	• Market competitiveness • Security of supply
Project Objective	• Smart Integration of Grid Users from Transport
Description	Percentage of EVSEs available during a certain time point. NOTE: available in this context means that communicate with the control system and have no significant faults (i.e. can be fully operable by the control system).
Formula	$$AI = \frac{\sum_{n=1}^{N} e_n}{N} 100$$ e_n: status of EVSE (1 = available, 0 = not available) N: number of EVSEs to be monitored
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_1_EVSE and EV fleet monitoring
Project relevance	Indirect
GENERAL COMMENTS	
The KPI is calculated periodically.	

KPI ID	**KPI_34_EVSE average communication failure duration**
Name	EVSE communication reliability.
Strategic Objective	• Market competitiveness • Security of supply
Project Objective	• Smart Integration of Grid Users from Transport
Description	Average communication failure duration for each EVSE (during a certain time period).
Formula	$$CR = \frac{\sum_{n=1}^{N} cfd_n}{N}$$ cfd_n: communication failure duration N: number of EVSEs to be monitored
Unit of measurement	Time unit
Related PUC(s)	• HL-UC 3_PUC_1_EVSE and EV fleet monitoring
Project relevance	Indirect

KPI ID	**KPI_35_EVSE average communication failure frequency**
Name	EVSE communication reliability.
Strategic Objective	• Market competitiveness

	• Security of supply
Project Objective	• Smart Integration of Grid Users from Transport
Description	Average number of communication failures per EVSE (during a certain time period).
Formula	$$CR = \frac{\sum_{n=1}^{N} cf_n}{N}$$ cf_n: number of communication failures of EVSE n N: number of EVSEs to be monitored
Unit of measurement	Number of communication failures per EVSE
Related PUC(s)	• HL-UC 3_PUC_1_EVSE and EV fleet monitoring
Project relevance	Indirect

KPI ID	**KPI_36_Success in meeting user charging objectives**
Name	Success in meeting user charging objectives
Strategic Objective	• Sustainability
Project Objective	• Smart Integration of Grid Users from Transport
Description	This KPI will evaluate number of charging sessions that end meeting the user objectives (selected SoC at selected hour) related to the whole set of charging session managed by the WiseGRID tools.
Formula	$$SUCO = \frac{n_{sucess}}{n_{total}} 100$$ $SUCO$: Active Participation in EV demand flexibility (%). n_{sucess}: number of charging session that end meeting the user objectives (selected SoC at selected hour) during a monitoring period for a demo area. n_{total}: total number of charging sessions performed by cars with smart charging or V2G capabilities during a monitoring period for a demo area.
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_2_Interaction of the user with EVSE
Project relevance	Direct
GENERAL COMMENTS	
If desired, this KPI may be also divided in two different KPIs: smart charging and V2G.	

KPI ID	**KPI_37_Success in user authentication**
Name	Success in user authentication
Strategic Objective	• Sustainability
Project Objective	• Smart Integration of Grid Users from Transport
Description	This KPI will evaluate the number of successful authentication attempts performed by the WiseGRID products.
Formula	$$SUA = \frac{n_{success}}{n_{total}} 100$$

	SUA: Success in user authentication (%) $n_{success}$: number of successful authentication attempts during a monitoring period for a demo area n_{total}: total number of authentication attempts during a monitoring period for a demo area
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_2_Interaction of the user with EVSE
Project relevance	Indirect

KPI ID	**KPI_38_Success in charging rescheduling**
Name	Success in charging rescheduling
Strategic Objective	• Sustainability
Project Objective	• Smart Integration of Grid Users from Transport
Description	This KPI will measure the success of the charging session rescheduling process (performed reschedule to provide the requested flexibility) related to the total amount of rescheduling requests during a monitoring period for a demo area.
Formula	$$SCR = \frac{n_{success}}{n_{total}} 100$$ SCR: Success in charging reschedule $n_{success}$: number of successful charging rescheduling processes performed during a monitoring period for a demo area n_{total}: total number of charging rescheduling requests during a monitoring period for a demo area
Unit of measurement	%
Related PUC(s)	• HL-UC 3_PUC_3_EV charging management
Project relevance	Direct
GENERAL COMMENTS	
Once the flexibility products are defined in the scope of the project, this KPI might be calculated referring to each different flexibility product. For example, if one flexibility product is the reduction of an amount of active power during an hour, the KPI could be calculated as the ratio between the active power provided by the rescheduling process and the reduction of active power requested. This ratio will be associated to each flexibility request, so for monitoring period in a demo area the KPI might be calculated as the mean value of the requests.	

KPI ID	**KPI_39_Battery balance**
Name	Battery Balance
Strategic Objective	• Sustainability • Market competitiveness
Project Objective	• Demonstration of Energy Storage Technologies
Description	The indicator will measure the deviation of use between all the batteries of the ESS, comparing their state of health (SoH). This KPI will measure the quality of the list running algorithm in terms of ageing and profitability.

Formula	$$SoH_{dev} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(SoH_i - \overline{SoH})^2}$$ SoH_i: state of health of battery i $\overline{SoH}$: average of the state of health of all batteries
Unit of measurement	%
Related PUC(s)	• HL-UC 4_PUC_4_Combination of battery storage systems
Project relevance	Direct

KPI ID	**KPI_40_Reaction time improvement for providing primary control reserve**
Name	Reaction time improvement for providing primary control reserve
Strategic Objective	• Sustainability • Market competitiveness • Security of Supply
Project Objective	• Demonstration of Energy Storage Technologies
Description	The indicator will measure the reaction time for providing primary control reserve.
Formula	$T_{respond}$: Average respond time between triggering event (e.g. frequency is out of bound) and the provision of power
Unit of measurement	s
Related PUC	• HL-UC 4_PUC_3_Ancillary services
Project relevance	Indirect
GENERAL COMMENTS	
The faster units (which provide ancillary services) react the better the grid support.	

KPI ID	**KPI_41_Penetration of dynamic energy tariffs**
Name	Penetration of dynamic energy tariffs
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Demand Response
Description	This KPI aims to track the increase of tertiary and industrial, or residential consumers exposing themselves to dynamic electricity tariff schemes (any such tariff, e.g. ToU, RTP, etc.) in WiseGRID pilot sites, hence to quantify the improvement in the penetration of DR mechanisms among these final consumers.
Formula	$$DPP = \frac{N_d}{N}100$$ DPP: dynamic price penetration N_d: number of consumers using dynamic tariffs

	N: number of consumers in eligible territory
Unit of measurement	%
Related PUC(s)	• HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_3_Clients engagement for active market participation
Project relevance	Direct

KPI ID	**KPI_42_Demand response campaign penetration**
Name	Demand response campaign penetration
Strategic Objective	• Market competitiveness
Project Objective	• Demand Response
Description	This KPI aims to track the increase of tertiary and industrial, or residential consumers participating in incentive-based DR campaigns in WiseGRID pilot sites, hence to quantify the improvement in the penetration of DR mechanisms among these final consumers.
Formula	$$DRP = \frac{N_{DR}}{N}100$$ DRP: DR penetration N_{DR}: number of consumers active in DR campaign N: number of consumers in eligible territory
Unit of measurement	%
Related PUC	• HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_3_Clients engagement for active market participation
Project relevance	Direct

KPI ID	**KPI_43_Peak load**
Name	Peak load
Strategic Objective	• Market competitiveness • Security of supply
Project Objective	• Demand Response • Demonstration of Energy Storage Technologies
Description	This indicator measures the load peak within a certain time interval. Peak load reduction is a good proxy of the DR service that has actually been delivered by the prosumers (and the corresponding aggregator/supplier) in response to a grid operator request in order to alleviate grid imbalance or the need for RES curtailment.
Formula	$$L_{peak} = \max_{h \in H} L_h$$ L_{peak}: the load peak during the period under study (kW) $L_h = \sum_{n \in N} l_n^h$: the total power of the load across all users $n \in N$ during each time interval h of the period under study (kWh/h) l_n^h: the load of user n during time interval h of the period under study (kWh/h) H: the set of time intervals of the period under study

	N: the set of customers under study
Unit of measurement	W
Related PUC(s)	• HL-UC 4_PUC_2_Batteries management at aggregator level (grid support) • HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market
Project relevance	Direct
GENERAL COMMENTS	
In some EU countries customer have to pay energy tariffs according to the highest peak demand in certain time interval. The reduction of the power peak, thus, not only leads to the relief of the grid but also lowers the overall energy cost. For the BAU scenario, the peak of the baseline load is used. The baseline load cannot be measured. Instead certain estimation techniques can be applied. These techniques vary according to the availability of actual measurements. Statistical and regression methods employ historical data for performing load forecast. In case historical data are unavailable, the consumption of a properly selected control group of users can be measured and used as baseline for the respective actual group of users it represents (both groups should have similar characteristics, in order to achieve a better estimation of the baseline load of the group under study).	

KPI ID	**KPI_44_Peak-to-average ratio**
Name	Peak-to-average ratio
Strategic Objective	• Sustainability • Security of supply
Project Objective	• Demand Response • Smartening Distribution Grid
Description	The peak-to-average ratio gives information regarding the shape of the load curve, i.e. it indicates how extreme the peak consumption is relative to the consumption during off-peak hours. Measures to flatten the consumption profile contribute to the reduction of PAR.
Formula	$$PAR = \frac{L_{peak}}{L_{avg}} = \frac{H \max_{h \in H} L_h}{\sum_{h \in H} L_h}$$ $L_{peak} = \max_{h \in H} L_h$: the load peak during the period under study (kW) $L_{avg} = \frac{1}{H} \sum_{h \in H} L_h$: the average load during the period under study (kW) $L_h = \sum_{n \in N} l_n^h$: the total power of the load across all users $n \in N$ during each time interval h of the period under study (kWh/h) l_n^h: the load of user n during time interval h of the period under study (kWh/h) H: the set of time intervals of the period under study N: the set of customers under study
Unit of measurement	%
Related PUC(s)	• HL-UC 2_PUC_3_Grid control • HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_3_Clients engagement for active market participation
Project relevance	Direct
GENERAL COMMENTS	

Source: A. H. Mohsenian-Rad, V. W. S. Wong, J. Jatskevich, R. Schober and A. Leon-Garcia, "Autonomous Demand-Side Management Based on Game-Theoretic Energy Consumption Scheduling for the Future Smart Grid," in IEEE Transactions on Smart Grid, vol. 1, no. 3, pp. 320-331, Dec. 2010. doi: 10.1109/TSG.2010.2089069

KPI ID	**KPI_45_Net metering**
Name	Net metering in portfolio of aggregator
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Demand Response
Description	This KPI aims to measure to which extent the energy produced within a portfolio of aggregated prosumers meets their demand. It impacts the costs of energy supply and supports investment decisions (e.g. installation of batteries or development explicit DR mechanisms).
Formula	$$NM = \sum_{t \in T} (D_t - P_t)$$ NM: net metering T: evaluation period t: metering period (e.g. 15 minutes) P_t: energy produced by on-site generation/energy drawn from on-site storage unit during metering period t (by the whole portfolio or on the customer premises) (kWh) D_t: energy demand during metering period t (by the whole portfolio or on the customer permises) (kWh)
Unit of measurement	kWh
Related PUC(s)	• HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market
GENERAL COMMENTS	
Negative values indicate that production overpassed demand in the considered period	

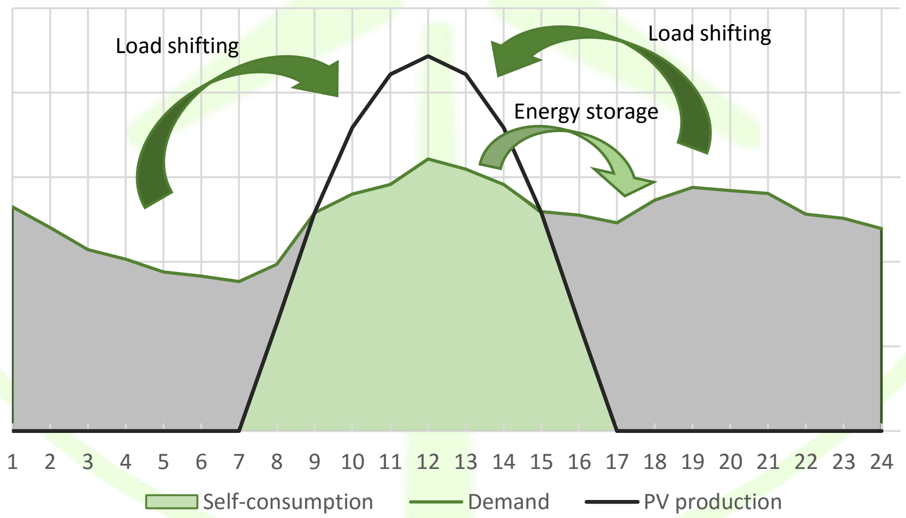
KPI ID	**KPI_46_Self-consumption ratio**
Name	Self-consumption ratio
Strategic Objective	• Sustainability • Security of supply
Project Objective	• Demand Response • Smartening Distribution Grid • Demonstration of Energy Storage Technologies
Description	Self-consumption ratio is a metric used for quantifying the amount of energy produced and consumed locally relative to the total production that is locally available from on-site generation units (most of the times the self-generated energy comes from PV). It is calculated

	as the ratio of self-consumption divided by the self-generated energy.
Formula	$$SCR = \frac{\sum_{t \in T} \min(P_t, D_t)}{\sum_{t \in T} P_t} 100$$ SCR: self-consumption ratio T: evaluation period t: metering period (e.g. 15 minutes) P_t: energy produced by on-site generation/energy drawn from on-site storage unit during metering period t (by the whole portfolio or on the customer permises) (kWh) D_t: energy demand during metering period t (by the whole portfolio or on the customer permises) (kWh)
Unit of measurement	%
Related PUC(s)	• HL-UC 1_PUC_5_Promote RES via RESCO companies • HL-UC 4_PUC_1_Batteries management at prosumer level • HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market
Project relevance	Direct
GENERAL COMMENTS	

The SCR is usually calculated over a certain time period (e.g. a year).

This KPI aims to measure the efficiency of load shifting mechanisms and energy storage towards increasing the ratio of energy produced by members of the portfolio that is self-consumed within the portfolio. However, this KPI could also be used for individual evaluation of self-consumption per customer. Furthermore, this KPI is important for the RESCO business, since the energy delivered to the grid is of its property and can be marketed.

Higher value of the ratio signifies that the best use of the locally generated energy is made, since it is consumed locally.



KPI ID	**KPI_47_Self-sufficiency**
Name	Self-sufficiency
Strategic Objective	• Sustainability
Project Objective	• Demonstration of Energy Storage Technologies

Description	The self-sufficiency rate (SSR) illustrates the ratio between the consumption of self-generated energy and the overall energy consumption. Consumption of self-generated energy includes the self-generated energy stored at the local storage.
Formula	$$SSR = \frac{\sum_{t\in T}\min(P_t, D_t)}{\sum_{t\in T} D_t}100$$ SSR: self-sufficiency ratio T: evaluation period t: metering period (e.g. 15 minutes) P_t: energy produced by on-site generation/energy drawn from on-site storage unit during metering period t (by the whole portfolio or on the customer permises) (kWh) D_t: energy demand during metering period t (by the whole portfolio or on the customer permises) (kWh)
Unit of measurement	%
Related PUC(s)	• HL-UC 4_PUC_1_Batteries management at prosumer level
Project relevance	Direct
GENERAL COMMENTS	
SSR is calculated over a certain time period (e.g. a year). The higher the ratio the less energy is purchased from the grid making the end-user less dependent on utilities and energy prices.	

KPI ID	**KPI_48_Energy cost**
Name	Energy cost
Strategic Objective	• Market competitiveness
Project Objective	• Demand Response • Demonstration of Energy Storage Technologies • Smart Integration of Grid Users from Transport
Description	The indicator will measure the energy cost that depends on the purchased energy from the grid as well as the electricity price per kWh.
Formula	$$c = \sum_h p_h L_h$$ c: energy cost (€) p_h: electricity price according to tariff during time interval h (€/kWh). $L_h = \sum_{n\in N} l_n^h$: the total load served through energy purchased from the grid across all users $n \in N$ during each time interval h of the period under study (kWh) l_n^h: the load of user n during time interval h of the period under study (kWh/h) H: the set of time intervals of the period under study N: the set of customers under study
Unit of measurement	€
Related PUC(s)	• HL-UC 3_PUC_3_EV_Charging management • HL-UC 4_PUC_1_Batteries management at prosumer level • HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)

	• HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market • HL-UC 7_PUC_3_Clients engagement for active market participation
GENERAL COMMENTS	
This KPI can be used either for calculating the total energy cost for the consumers or the charging cost. The same formula can also be used for quantifying the energy cost per individual customer. The period under study may vary according to the needs of each case studied. By limiting the number of time intervals to just one, the energy cost during peak hours can be calculated. The reduction of energy cost can be related to the application of smart charging and V2G (charging types 2 and 3 defined in the scope of the WiseGRID project), to different applications that batteries cover (increase of self-sufficiency and self-consumption but also usage of different tariffs) or to different methods of demand management. For the calculation of the charging cost for the BAU scenario, it is considered that all the charging sessions are type 1 (according to the charging types definition in the scope of WiseGRID project). This means using the maximum available power of the EVSE to reach the final SoC selected by the user as soon as possible.	

KPI ID	**KPI_49_Energy savings**
Name	Energy savings
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Demand Response • Demonstration of Energy Storage Technologies
Description	This indicator is usually used for project evaluation (where suppliers are involved), and for consumer behaviour change (for consumers). It will measure the difference between measured and reference consumption data, evaluated within a predefined period of time.
Formula	$$ES = \sum_{h \in H} \sum_{n} CBL_n^h - L_h$$ ES: energy savings (kWh) CBL_n^h: baseline load of user n during time interval h of the period under study (kWh/h) $L_h = \sum_{n \in N} l_n^h$: the total power of the load across all users $n \in N$ during each time interval h of the period under study (kWh/h) l_n^h: the load of user n during time interval h of the period under study (kWh/h) H: the set of time intervals of the period under study ($h \in H$) N: the set of customers under study ($n \in N$)
Unit of measurement	kWh
Related PUC(s)	• HL-UC 5_PUC_2_Cogeneration and HVAC management • HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector • HL-UC 7_PUC_3_Clients engagement for active market participation
Project relevance	Direct
GENERAL COMMENTS	

The load of each user can be obtained through actual data from energy meters that allow, at least on an hourly basis, the recording of the consumption. The baseline load cannot be measured. Instead certain estimation techniques can be applied. These techniques vary according to the availability of actual measurements. Statistical and regression methods employ historical data for performing load forecast. In case historical data are unavailable, the consumption of a properly selected control group of users can be measured and used as baseline for the respective actual group of users it represents (both groups should have similar characteristics, in order to achieve a better estimation of the baseline load of the group under study).

KPI ID	**KPI_50_Flexibility on offer**
Name	Flexibility on offer
Strategic Objective	• Sustainability • Market competitiveness • Security of supply
Project Objective	• Demand Response
Description	This KPI aims to quantify the aggregated flexibility that is offered to grid operators or BRPs by aggregators/suppliers.
Formula	The maximum demand flexibility that is on offer by an aggregator and/or supplier can be quantified as follows: $$\max_{h \in H} \sum_{n \in N} DF_h^n$$ DF_h^n: demand flexibility profile of individual consumer n during interval h N: set of customers under study ($n \in N$) H: the set of time intervals of the period under study ($h \in H$)
Unit of measurement	%
Related PUC(s)	• HL-UC 7_PUC_2_Dynamic aggregation of demand side assets and active participation into energy market
Project relevance	Direct
GENERAL COMMENTS	
In order to compare the value of the index to a BAU scenario, the time period and territorial context of WiseGRID pilot sites will be assumed.	

KPI ID	**KPI_51_Comfort Level**
Name	Comfort Level
Strategic Objective	• Sustainability
Project Objective	• Demonstration of Energy Storage Technologies
Description	The WiseGRID applications controlling CHPs and HVAC should ensure the comfort level inside the buildings/ households. The comfort level should be kept within acceptable limits. Thermal comfort of occupants is quantified using the Predicted Mean Vote (PMV) index, which predicts the mean response of a large group of people according to the ASHRAE thermal sensation scale. Using PMV, the index Predicted Percentage of Dissatisfied (PPD), quantifying the percentage of the people who felt more than slightly warm or slightly cold,

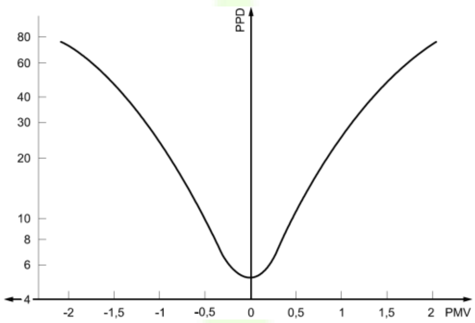
	is also calculated. By calculating the PMV and PPD indices, the ISO Thermal Acceptance Limits per ISO 7730:2005 are produced.
Formula	$$PMV = (0.303e^{-0.036M} + 0.028)L = aL$$ M: rate of metabolic generation per unit DuBois surface area, W/m^2 L: thermal load on the body (W/m^2) a: the sensitivity coefficient. $$PPD = 100 - 95e^{-0.03353}PMV^4 - 0.2179PMV^2$$
Unit of measurement	PMV: - PPD: %
Related PUC(s)	• HL-UC 5_PUC_4_Cogeneration and HVAC optimisation
Project relevance	Indirect

GENERAL COMMENTS

The PMV index is a dimensionless quantity. The value of the PMV index is from (-3, 3), which corresponds to the human's feeling from cold to hot. Zero value of the PMV index means neutral. More specifically, the values of the PMV index are as follows:

Human feeling description	PMV index
Hot	3
Warm	2
Slightly warm	1
Neutral	0
Slightly cool	-1
Cool	-2
Cold	-3

The relationship between PPD and PMV is as follows:



The ISO Thermal Acceptance Limits are presented in the following table. Class A represents the maximum satisfaction in the environment, class B the medium satisfaction and category C the minimum satisfaction.

Class	A	B	C
PMV	$-0.2 < PMV < +0.2$	$-0.5 < PMV < +0.5$	$-0.7 < PMV < +0.7$
PPD	< 6	< 10	< 15

Sources:

ANSI/ASHRAE Standard 55-2010, Thermal Environmental Conditions for Human Occupancy.

ISO 7730:2005(E), Ergonomics of the thermal environment — Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria. N. Djongyang, R. Tchinda, D. Njomo, "Thermal comfort: A review paper," Renewable and Sustainable Energy Reviews, Vol. 14, No. 9, December 2010, Pages 2626-2640, ISSN 1364-0321, doi: 10.1016/j.rser.2010.07.040. W. Guo and M. Zhou, "Technologies toward thermal comfort-based and energy-efficient HVAC systems: A review," 2009 IEEE International Conference on Systems, Man and Cybernetics, San Antonio, TX, 2009, pp. 3883-3888. doi: 10.1109/ICSMC.2009.5346631.

KPI ID	**KPI_52_Optimal use of thermal resources**
Name	Optimal use of thermal resources and cogeneration
Strategic Objective	• Sustainability • Market competitiveness
Project Objective	• Demonstration of Energy Storage Technologies
Description	The WiseGrid system should ensure efficient and economic management of CHP and thermal resources. The management should not affect the comfort level in the building.
Formula	$C_x = \frac{C_{elec} + C_{Gas} - R_{VPP} - R_{AS}}{S_T}$ C_{elec}: cost for electricity (€) C_{Gas}: cost for natural gas (€) R_{VPP}: revenues from the VPP participation (€) R_{AS}: revenues for the provision of ancillary services to the DSO (€) S_T: total surface of the buildings managed by the application (m^2)
Unit of measurement	€/m^2
Related PUC(s)	• HL-UC 5_PUC_4_Cogeneration and HVAC optimisation
Project relevance	Indirect
GENERAL COMMENTS	
The cost can take negative values, which indicate the profit incurred from the CHP operation. In the BAU scenario R_{VPP} and R_{AS} are zero.	