Title:	Document Version:
D15.1 WiseGRID Integrated Ecosystem Preliminary Deploy and Demonstration	0.8

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

Contractual Delivery Date:	Actual Delivery Date:	Deliverable Type*-Security*:
M30 (April 2019)	M30 (April 2019)	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 Tasks 14.3 " WiseGRID integrated ecosystem preliminary deployment" and Task 15.2 "WiseGRID integrated ecosystem preliminary demonstration".

Keywords:

Preliminary Deployment, Preliminary Demonstration, Pilot Sites, Tool Developers

Revision History

Revision	Date	Description	Author (Organisation)
V0.1	18.03.2019	ToC	Foivos Palaiogiannis (ICCS)
V0.2	01.04.2019	First Round of contributions	Foivos Palaiogiannis (ICCS)
V0.3	09.04.2019	Second Round of contributions	Foivos Palaiogiannis (ICCS)
V0.4	15.04.2019	Include inputs from CRE, AUEB	Foivos Palaiogiannis (ICCS)
V0.5	16.04.2019	Review by ECO-EID	Ine Swennen (ECO-EID), Vincent Dierickx (ECO-EID)
V0.6	25.04.2019	Integration of comments	Foivos Palaiogiannis (ICCS)
V0.7	30.04.2019	Review by ETRA	Alvaro Nofuentes (ETRA)
V0.8	30.04.2019	Final Version	Foivos Palaiogiannis (ICCS)

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EXECUTIVE SUMMARY

This document presents the activities performed within Task T14.3 "WiseGRID integrated ecosystem preliminary deployment" and Task T15.2 "WiseGRID integrated ecosystem preliminary demonstration", which cover the period between August 2018, M22 – the first month of Preliminary Deployment activities -, and April 2019, M30 – the last month of Preliminary Demonstration activities -.

The main scope of the Preliminary Deployment and Demonstration activities is to deploy part of the integrated WiseGRID ecosystem at the five demo sites and test a core set of their critical functionalities in a real world environment. Since these activities come right after the Integrated Laboratory testing of the WiseGRID tools during which the Tool Developers of the project, following a certain procedure presented in D14.2, integrated the various tools and evaluated their performance, the activities constitute the first official real world application of the tools in WiseGRID project.

Preliminary Deployment activities followed the timeline discussed in D14.1, which was submitted on May 2018, and Preliminary Demonstration activities the timeline presented in D14.2, which was submitted on October 2018. The timeline is presented at the following figure.
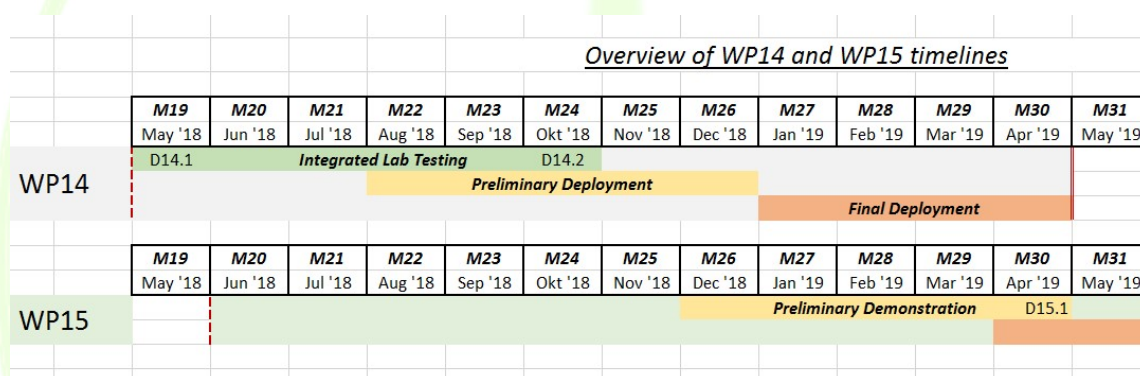
Figure 1 – Timeline of Preliminary Deployment and Demonstration activities.

As it is explained later in this report, the project partners agreed that the best approach to initiate the deployment activities was to deploy each WiseGRID tool at a single demo site. The following table presents the Pilot Sites at which each WiseGRID tool was deployed and demonstrated during Preliminary Deployment and Demonstration activities.

Table 1 – Pilot Sites at which WiseGRID tools will be deployed during Preliminary Deployment and Demonstration activities.

	WiseCORP	WiseHOME	WiseEVP	WG FastV2G	WG Staas/VPP	WG Cockpit	WG Resco	WiseCOOP
Crevillent	X	X	**X**	**X**		X		X
Terni	X		X		**X**	X	**X**	
Flanders	X	**X**	X		X		X	**X**
Mesogia	X	X				**X**		X

Kythnos	X		X		X	X		

During these activities, and in order to achieve the task objectives, the Pilot Sites of the WiseGRID project collaborated closely with the Tool Developers. Due to the approach followed (where each WiseGRID tool would be deployed at one Pilot Site), the main collaborations between the partners that were formed during this period and coordinated their activities are presented at the following figure (showing respectively the pilots of Flanders, Terni, Kythnos, Mesogia and Crevillent).
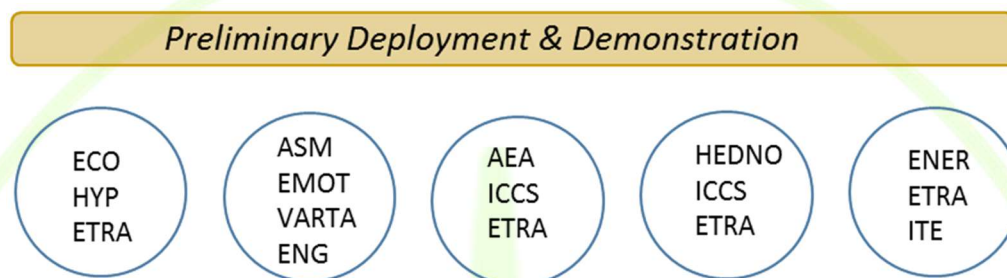
Figure 2 – Collaborations between partners during Preliminary Deployment & Demonstration activities.

This document presents in detail the activities undertaken by each Pilot Site (Flanders, Mesogia, Crevillent, Terni, Kythnos) during this period and the lessons learned from this procedure are discussed. Also, a Demo of the deployed WiseGRID tool and its functionalities is demonstrated. For the case of Flanders, a trial scenario for dynamic pricing, based on price-based elasticity model which uses past data, is presented (following the outputs Task 10).

Special attention was considered for each site in relation with technical issues but also related to the fulfilment of GDPR requirements. During this period, telcos and presentations to monitor and evaluate the implementation status of GDPR took place while specific reports were defined related to the status of accomplishment of the rules within GDPR. The Pilot Sites were recommended to join *certification in data privacy* and/or define an *internal Code of Conduct related to data privacy.*

Finally, the Pilot Sites were requested to review and update the list of Use Cases that will be demonstrated. This list is presented and discussed in contrast with the list provided in D14.1.

1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

The main purpose of this document is to present the activities performed within Task T14.3 "WiseGRID integrated ecosystem preliminary deployment" and Task T15.2 "WiseGRID integrated ecosystem preliminary demonstration". The activities of Preliminary Deployment started on August 2018 and ended on December 2018, and the activities of Preliminary Demonstration started on December 2018 and end on April 2019 with the submission of this report. During these activities the Pilot Sites of the WiseGRID project collaborated with the Tool Developers in order to perform the initial phase of the WiseGRID ecosystem deployment and demonstration, as presented in deliverable D14.1.

1.2 SCOPE OF THE DOCUMENT

The scope of this document is to present the integration activities of the five WiseGRID Pilot Sites during the period December 2018 – April 2019 and inform about the status of the deployment activities of the project. During this period, as described in D14.1, each Pilot Site had to start the deployment phase by deploying specific WiseGRID tool(s) and demonstrating some basic functionalities. The steps undertaken to achieve this goal are presented here. In addition, other parallel deployment activities are also described here. Finally, following the discussion at the Consortium Meeting in Paris, at March 2019, an update of the Use Cases that will be demonstrated by each Pilot Site is presented.

1.3 STRUCTURE OF THE DOCUMENT

This document starts with a short overview of the scope and timeline of the Preliminary Deployment and Demonstration activities and also it describes the approach that was followed in order to achieve the specified goals. Following this, the activities undertaken by each Pilot Site, during this period, are presented and the lessons learned from these procedures are discussed. Also, a Demo of the deployed WiseGRID tool functionalities is demonstrated. Then, the updated version of the list of Use Cases that each site will demonstrate is presented, in contrast with the list presented at D14.1. Finally, the conclusions regarding the status of the project and the next steps are discussed.

2 PRELIMINARY DEPLOYMENT & DEMONSTRATION ACTIVITIES OVERVIEW

2.1 SCOPE OF THE ACTIVITIES

The main scope of the Preliminary Deployment and Demonstration activities is to deploy part of the integrated WiseGRID ecosystem at the five demo sites and test a core set of their critical functionalities in a real environment. Besides that, as explained in deliverable D14.1, for this activity two side objectives were also set: on the one hand, to give feedback to the tool developers for the performance of the deployed tools at real world conditions and on the other hand to activate the Pilot Sites so as to prepare the whole infrastructure before the final deployment.

2.2 TIMELINE OF THE ACTIVITIES

Preliminary Deployment activities followed the timeline discussed in D14.1, which was submitted on May 2018, and Preliminary Demonstration activities the timeline presented in D14.2, which was submitted on October 2018. Preliminary deployment started at M22, August 2018 and ended at M25, December 2018. At the end of these activities, at M26, December 2018, started the Preliminary demonstrations which end with the submission of this deliverable, M30, April 2019. During these months, besides the teleconferences (telco's) organised among the partners, two main telcos related to these activities were conducted, the first at the end of M25, November 2018, and the second in the mid of M28, February 2019. At these telco's all Pilot Sites and Tool Developers participated and discussed on the progress of the activities and the issues that occurred.
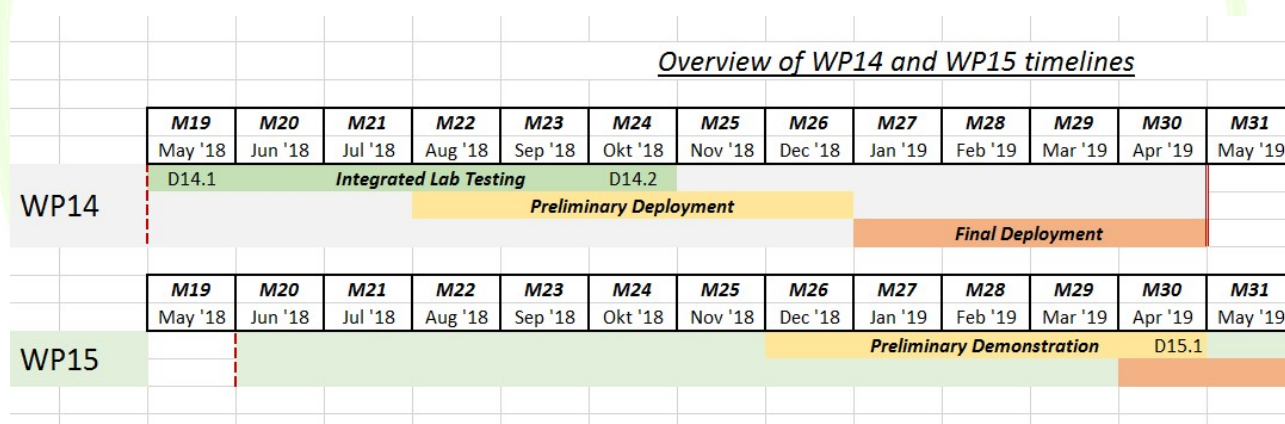
Figure 3 – Timeline of Preliminary Deployment and Demonstration activities.

2.3 APPROACH OF THE ACTIVITIES

The deployment of the tools at the demo sites requires a close collaboration between the Pilot Site leaders and the Tool Developers. Each pilot site has different infrastructure and different technical capabilities, which means that even the same tool needs to be configured appropriately according to the existing set up. As presented in the deliverables D2.1 and D14.1, most of the tools of WiseGRID ecosystem will be eventually deployed at more than one sites.

The Preliminary Deployment comes right after the Integrated Laboratory testing of the WiseGRID tools during which the Tool Developers of the project, following a certain procedure presented in D14.2, integrated

the various tools and evaluated their performance. This means, that preliminary deployment activities constitute the first official real-world application of the tools.

In order to facilitate a better collaboration between the Pilot Site leaders and the Tool Developers and allow for a more focused work of the latter, the project partners agreed that the best approach to initiate the deployment activities was to deploy each WiseGRID tool at a single demo site. The following table presents the Pilot Sites at which each WiseGRID tool was deployed and demonstrated during Preliminary Deployment and Demonstration activities.

Table 2 – Pilot Sites at which WiseGRID tools will be deployed during Preliminary Deployment and Demonstration activities.

	WiseCORP	WiseHOME	WiseEVP	WG FastV2G	WG Staas/VPP	WG Cockpit	WG Resco	WiseCOOP
Crevillent	X	X	X	X		X		X
Terni	X		X		X	X	X	
Flanders	X	X	X		X		X	X
Mesogia	X	X				X		X
Kythnos	X		X		X	X		

As a result of this categorization, the collaborations presented in Figure 4 were formed and maintained throughout the Preliminary Deployment period.
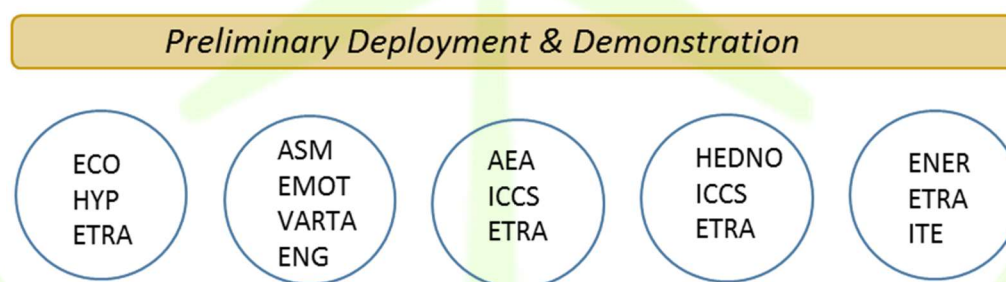
Figure 4 – Collaborations between partners during Preliminary Deployment & Demonstration activities.

At Chapter 3 the activities of these teams are presented in detail.

GDPR

The deployment activities are fully coordinated between sites for specific common issues. Special attention was considered for each site in relation with technical issues but also related to the fulfilment of GDPR requirements. In the former stages, but also during deployment period there have been performed telco's and presentations to monitor and evaluate the implementation status of GDPR. Specific Reports were defined and each site keeps an updated evidence related to the status of accomplishment of related rules within GDPR.

As examples, it is necessary to point out that the following issues have been addressed within each site:

- Establishment of Controllers and Processors,

- Training of dedicated stuff for processing,

- Define Principles relating to processing of personal data,

- Agreement between Controller and Processor(s),

- Allocation of responsibilities within labour contracts,

- Define consent from data subjects and receive consent forms,

- Define and fill in Records,

- Measures (controls) defined within Performed DPIA are considered,

- Define Procedure in case of personal data breach,

The Pilot Sites were recommended to join *certification in data privacy* and/or define an *internal Code of Conduct related to data privacy*.

Monitoring and audit are continually improved during processing activities.

GDPR accomplishment assessment will continue during the whole deployment period. If further on, there shall be identified risks in relation to personal data processing, these will be immediately evaluated and specific actions in line with GDPR considerations will be applied.

3   PRELIMINARY DEPLOYMENT ACTIVITIES AT PILOT SITES

3.1 FLANDERS

3.1.1 REPORT OF THE DEPLOYMENT ACTIVITIES

3.1.1.1 WiseCOOP/WiseHOME

The different tools that the WiseGRID ecosystem is composed of, will enable Ecopower as a supplier and producer to find new opportunities for more local renewable energy. By engaging in the WiseGRID ecosystem, Ecopower will try to optimize its portfolio of production, prosumers and consumers.

In Flanders main pilot site (Ghent, Buurzame Stroom) 100 SMX's from NobelGrid are to be integrated in WiseGRID ecosystem. All of them are connected to a Flukso. On 4/4/2019, Ecopower organised an end user event in Ghent with residents of the neighbourhood. During this event, features and characteristics of the WiseHOME were explained to households in Ghent where an SMX and Flukso were installed. Also, expectations regarding end users' input by the project were highlighted.

Figure 5 – WiseHOME end user event in Ghent.

All of the end users will receive log in details for the WiseHOME. During the demonstration phase of WiseGRID, they will be asked to test the WiseHOME tool. At the start of the demonstration phase, they will be receiving a questionnaire containing questions about their home characteristics and energy consumption profile. At the end of the demonstration phase, a feedback questionnaire about the WiseHOME functionalities will be carried out. These tasks are required for the WP16 activities With the WiseHOME app, Ecopower wants to create a service for its customers that will give them more power to reduce their energy bills. Also, the possibilities of engaging them in balancing and ancillary services will be investigated.

WiseCOOP has been deployed for the Buurzame Stroom zone as well. Ecopower will apply the data recovered by the SMX's to simulate and experiment with dynamic tariffs. This will help Ecopower to aggregate, enabling a cooperative power plant. This way, Ecopower wants to guide companies and groups of users to optimize their interaction and transactions with DSO's in the most grid-efficient and cost-effective way by also linking these tools to the services provided by the WG StaaS/VPP tool.

The following tasks were performed in preparation for the deployment of WiseCOOP/WiseHOME in the Flanders pilot site.

• Creation of a virtual machine (VM) in the dedicated AWS Virtual Private Cloud.

    Specifications:

    Ubuntu 18.04

    Instance Type: c5.xlarge

    Root Volume: 16 GB

    Data Volume: 80 GB

    Security group: wg-etra

• Mounting of the data volume on reboot of the VM.

• Provision of a user and keypair (certificate) to ETRA with root permissions to install the software components.

• Creation of a VPN certificate and assignment of a fixed IP for the VM.

- Connection of the VM to the VPN on reboot.

- Configuration of the domain coop.wisegrid.be and route traffic to the VM.

- Redirection of HTTP requests to HTTPS.

- Troubleshooting

    o Dropped internet connections

    o Dropped wireless connections

    o Faulty meters

    o Users have de-installed meters, removed cables, changed wi-fi passwords

    o Thus far, 80 of the SMX's deployed in H2020 NobelGrid have currently been converted for WiseGrid.

- Configuration

    o Checking driver settings

    o Configuring new SMX drivers, for installations where new PV systems have been installed

    o Rectifying misconfigured phase measurements on Flukso systems

    o Switching data endpoint from NobelGrid ESB to WiseGrid IOP

3.1.1.2 WG STaaS/VPP

Although was not in the pre-deployment plan, the installations of batteries in Flanders has had high priority. In Ghent, 5 VARTA pulse 6 battery systems were deployed. The first battery system was installed on 22/10/2019 in Jacob's nest. The remaining 4 battery systems were deployed in DSds cohousing on 3/4/2019 and 4/4/2019. All of the 5 houses, where battery systems of VARTA are installed, dispose of a PV installation. Therefore, these households were also equipped with a separate PV production meter by the WiseGRID project. A contract between VARTA, the residents and Ecopower were modelled, agreed and signed by the three parties.

Figure 6 – Cohousing dsDS, Wim Depuydt, Ghent (c) Filip Dujardin.

Figure 7 – Varta installing Pulse 6 at Jacob's nest.

Figure 8 – Varta Pulse 6 system in DSds cohousing (location 1 of 4).

Figure 9 – Varta Pulse 6 system in DSds cohousing (location 2 of 4).

The Ampere Energy battery system consists of three AMPERE TOWER S 12.3, equalling a total storage capacity of 36 kWh. The system has been installed on 10/04/2019, 11/04/2019 and 15/04/2019 in the premises of the OXFAM headquarters in Ghent. This location is an ideal site for the installation of the battery system due to the present PV installation of 83 kWp and the current high level of injection on site. The commissioning of the system by Ampere Energy has taken place on 16/04/2019 and 17/04/2019. A contract between Ampere Energy, OXFAM and Beauvent (owner PV on roof of OXFAM office) has been modelled, agreed and signed by the three parties.

Figure 10 – Ampere Energy battery system at OXFAM headquarters.

3.1.1.3   WiseEVP

In the Buurzame Stroom zone, 3 EVs (Renault Zoé) of Partago have been deployed (totalling 104 kWh storage). None of them are controllable by WiseEVP as the EVs are charged by public EVSEs. Despite all efforts, no suitable location for a private EVSE was found within the project zone. Within the whole of Flanders, data from 44 EVs (40 Renault Zoé and 4 Nissan eNV200) are collected and 5 EVSEs are controllable by WiseEVP.

For the preliminary deployment of WiseEVP, necessary hardware was provided - consisting of EVs and EVSEs - and communication protocols were tested.

In Table 3 the details of the EVSE infrastructure that WiseEVP will control are listed. It consists in total of 6 sockets, on 5 devices. Each device is capable of being configured by OCPP1.6 protocol. To provide adequate data and sufficient hardware devices to test WiseEVP, new locations where searched and found by Partago, and on these location compatible EVSEs were installed.

Figure 11 – EVSE installed at the Jacob's nest.

All EVSEs are connected to the household electricity grid at the premise, behind the electricity meter. No EVSEs were directly connected to the distribution grid.

Table 3 – Details of EVSE infrastructure that WiseEVP will control.

ID OF EVSE	NAME EVSE	MODEL	COOR-DINATES	OWNER	CONNECTION_TYPE	NUMBER OF SOCKETS
53	Partago HQ	EVLink 2 Parking (Schneider Electric)	51.05645, 3.70114	Partago	Type 2 — 3 x 32A (230V)	2
37	Partago Jacobs Nest	EVLink 2 Smart Wallbox (Schneider Electric)	51.0771, 3.66857	Partago	Type 2 — 3 x 16A (230V)	1
102	Partago Nekkersberglaan	EVLink 2 Smart Wallbox (Schneider Electric)	51.04555, 3.69592	Partago	Type 2 — 1 x 32A (230V)	1
114	Partago Rodeberg	EVLink 2 Smart Wallbox (Schneider Electric)	51.06826, 3.66653	Partago	Type 2 — 1 x 16A (230V)	1
23	Partago Zwijnaarde	EVLink 2 Smart Wallbox (Schneider Electric)	51.00595, 3.70728	Partago	Type 2 — 1 x 32A (230V)	1

During preliminary deployment of WiseEVP, it has been tested data connection between WiseEVP and the EVSE at Partago HQ. For this, the production EVSE management software, running 24/7, was disconnected from the EVSE, and WiseEVP took over control of the EVSE. These tests took place during working hours. Outside the working hours the original management software of the EVSE was put back in place.

During the preliminary deployment phase, the EV-fleet of Partago which will be monitored in the Flanders pilot site, grew to 44 EVs. This represents a total of 1,6MWh of battery capacity. A summary of the monitored vehicles is found in Table 4. Whenever new vehicles are added to the fleet of Partago, they will be integrated in WiseEVP for monitoring.

Table 4 – Monitored vehicles from Partago fleet.

MODEL	BATTERY CAPACITY	CONNECTION TYPE AND MAX CHARGE POWER	AMOUNT
Renault Zoé 22	22 kWh	Mennekes Type 2 / 22 kW	8
Renault Zoé 40	41 kWh	Mennekes Type 2 / 22 kW	32
Nissan eNV200	24 kWh	Mennekes Type 2 / Chademo / 53 kW	1
Nissan eNV200	40 kWh	Mennekes Type 2 /	3

3.1.2 LESSONS LEARNED AND POSSIBLE RISKS

WiseEVP

The authentication at the EVSE is done via identification by RFID. Every EV in the project has a single RFID card for identification. This RFID card is also used for charging at public charging stations not monitored by the WiseGRID project. At the Partago EVSEs, the EVSE management platform recognises those RFID tags and matches them to a database for authorisation. WiseEVP has a limited, local database of RFID tags, namely one RFID tag for every monitored EV. These are put in manually. On the contrary, at Partago, the production EVSE management platform matches the RFID tags to a public database of RFID tags, each tag connected to a MSP (Mobility Service Provider),that distributes public charging passes. This allows an EVSE to be used by users from multiple MSPs. One socket of one EVSE in the project (ID 53 in Table 3) needs to be able to be activated by public users (because it is used by visitors at that location). Obviously, this is not possible through WiseEVP, since roaming agreements with other MSP are not made. Therefore, during the demonstration pilot phase, this socket will not participate. Lesson learnt is that for future experiments, public roaming agreements with MSPs might be negotiated to allow for more charging sessions.

The EV management software from Partago gathers charging data apart from EVSEs directly monitored by WiseEVP. Hence, we collect charging data from EVs, charging on EVSEs not connected to WiseGRID ecosystem. However, this data might be of high value for the project. In the architecture of WiseEVP, this source of information is not being used. The lesson learnt is that charging data from the EV Management platform (hence, indirect EVSE charging data) should be collected and taken into account. This source of information has at least two useful advantages to the goal of WiseGRID. First, it enhances the spatiotemporal prediction of the total amount of power needed by the EV fleet. Furthermore, it can also predict EVSE status of EVSEs

not directly (data-) connected to WiseEVP within the control area of the WiseGRID tools. Therefore, the latter data might assist the short-term forecast on energy consumption of the local grid that is being monitored by WiseGRID tools.

SMX deployment

As an SMX data connection to the ecosystem relies purely on the private internet connection, it is error prone. In the integrated SLAM implementation, this is not the case, as an integrated mobile transmission is foreseen. Sometimes the cause of an offline SMX can be physical (plug is not sufficiently connected to the Flukso or SMX anymore) or due to internet changes (Wi-Fi password changed, new internet provider,...)

Battery deployment

The coordination to enable the installation of the VARTA and Ampere Energy battery systems requested numerous site visits in order to find a suitable site selection and to collect the requirements for the battery systems provided. Also, the contract modalities and price negotiations needed several constructive teleconferences.

3.1.3 DEMO OF THE TOOL

3.1.3.1 WiseCOOP

WiseCOOP tool provides ECOPOWER a detailed view of the energy behaviour of its portfolio of customers, enabling in addition different kind of analytics to support their business decisions, enabling demand response mechanisms and making it able to empower its customers by providing them reliable information, KPIs and comparisons about their energy behaviour.

Currently, the tool is monitoring 63 customers, out of which contracts for 40 of those have been created. Only those customers bound to a contract are considered in the analytics presented by WiseCOOP.

Dashboard

The dashboard represents an overview of the energy offtake and injection of their customer portfolio. This information is represented in a daily chart. In addition, the offtake and injection distribution according to the configured groups of customers is also displayed in the form of pie charts (currently, a single "Buurzame Stroom" group is configured).
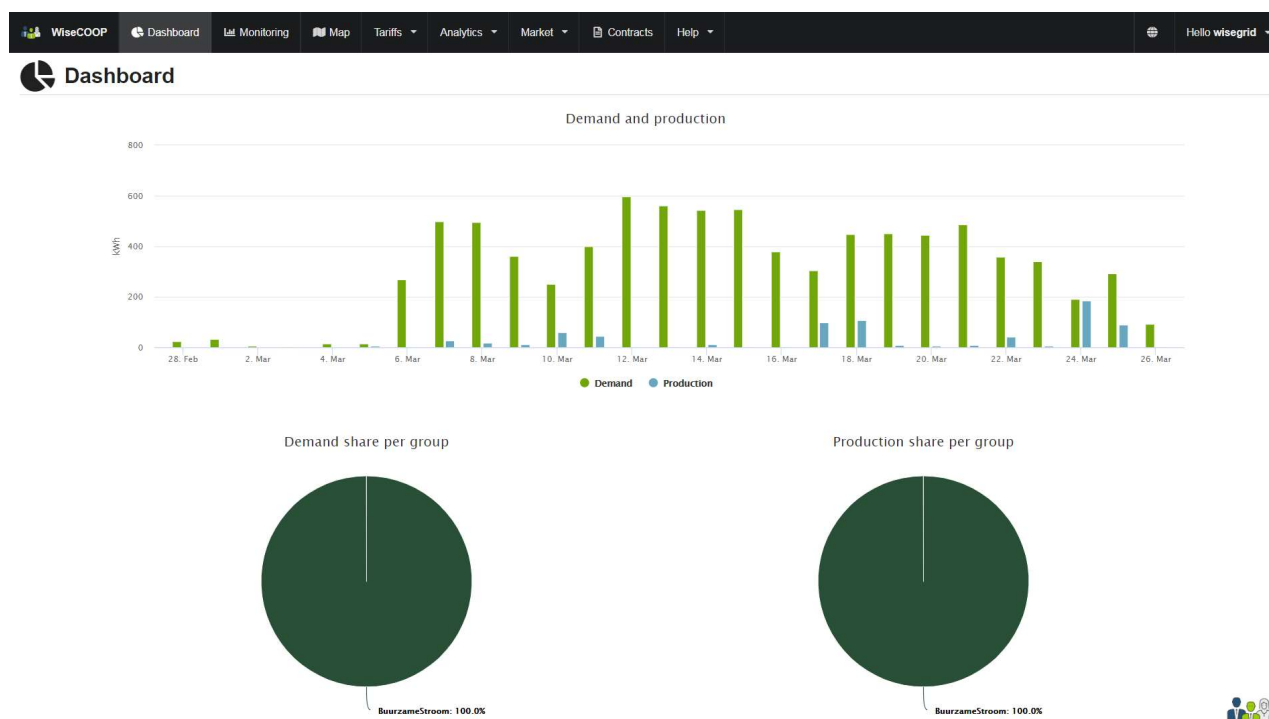
Figure 12 – WiseCOOP UI - Dashboard.

Monitoring

The monitoring section allows the operator to get an insight of the different parameters measured by the metering devices (a combination of Fluksos and SMXs in the Flanders pilot site). This information includes electric parameters (voltage, current, active and reactive power, power factors, frequency) as well as energy readouts (imported/exported energy). Data can be represented in 4 different aggregations: raw (every 5 seconds approx.), 15 minutes, 1 hour and 1 day. This way, the operator is free to get the information in the most appropriate manner to its interests.
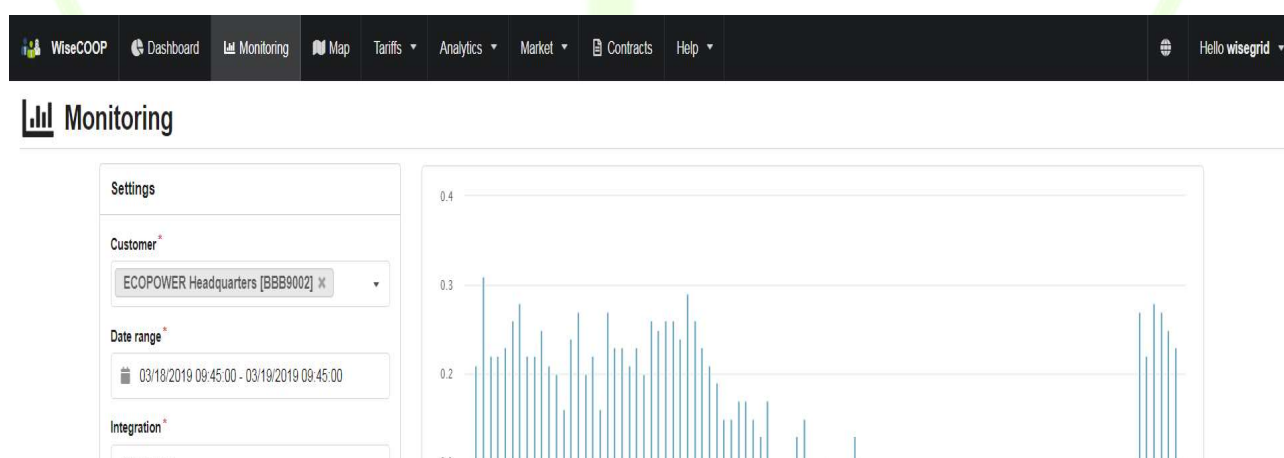
Figure 13 – WiseCOOP UI - Monitoring.

Map

The map section displays the injection and offtake data for each customer in a geographical representation, for the selected time period. Data is represented in a form of heat map, where different colors ranging from red to green are assigned according to the relative injection/offtake metered for each of the customers in comparison with the rest.
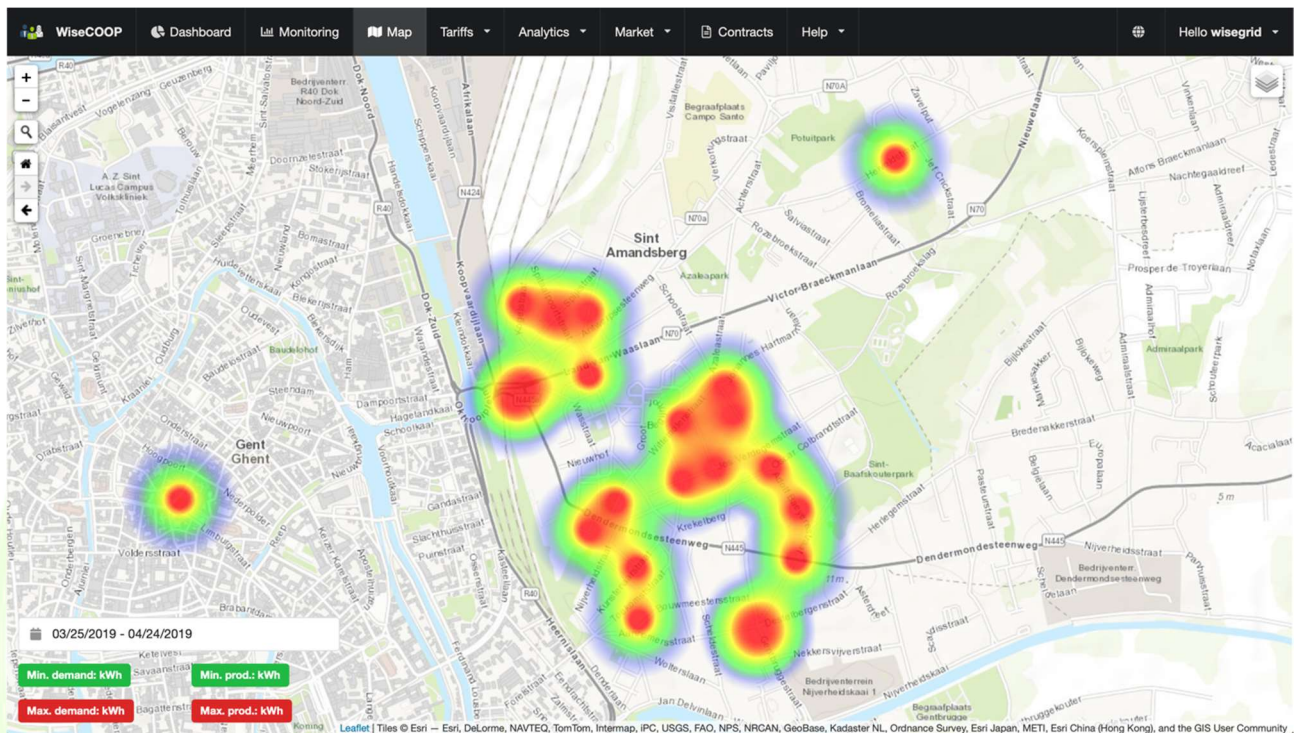
Figure 14 – WiseCOOP UI - Map.

Group analytics

Under the group analytics section, indicators are given only for those customers that are members from a certain group. Customers are assigned to a group during the configuration of the contract. This group will be furthermore used in the WiseHOME application, when collective reports comparing individual versus neighbourhood energy behaviour are provided. Nevertheless, the WiseCOOP tool offers also the ability to assign different tags to the customers, which essentially is used to group customers in groups according to different criteria, for each of those analytics and comparisons can be also performed.

The indicators provided for the groups include:

- Hourly energy injection and offtake
- Heat map representation of injection and offtake
- CO_2 emissions (accordingly to national energy mix)
- Energy costs (accordingly to national wholesale market in Belgium – BELPEX – day-ahead prices)

Figure 15 – WiseCOOP UI - Group analytics - Demand and production.
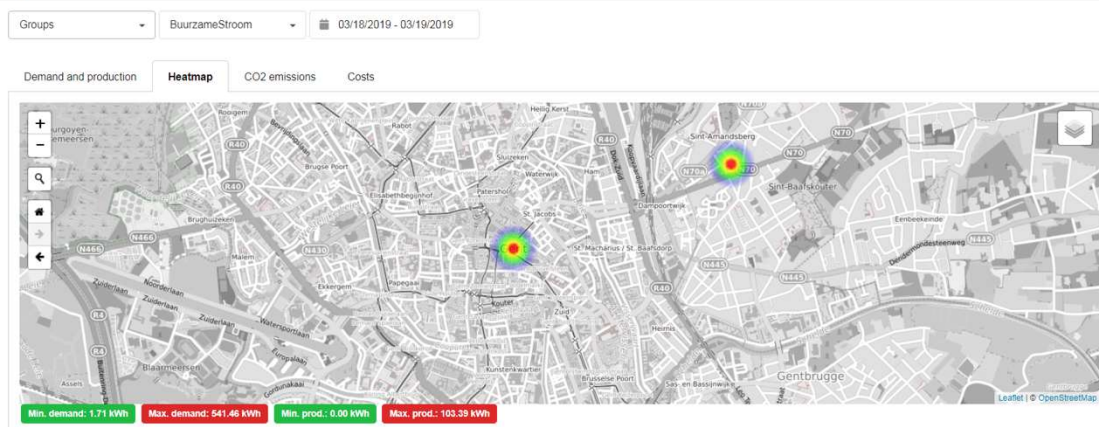
Figure 16 – WiseCOOP UI - Group analytics - Map.
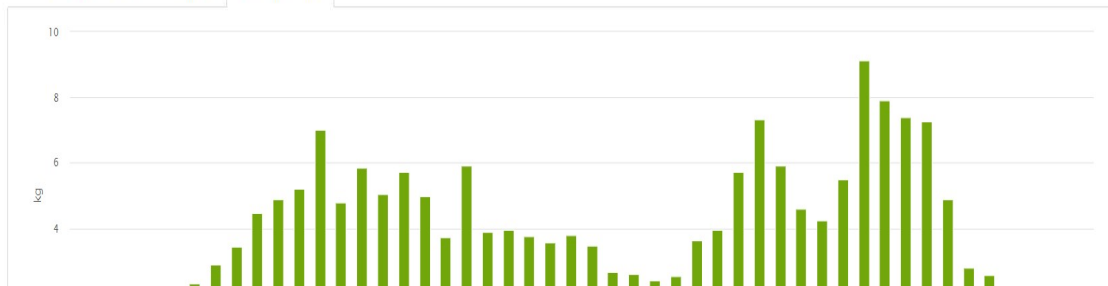
Figure 17 – WiseCOOP UI - Group analytics - CO_2 emissions.

Figure 18 – WiseCOOP UI - Group analytics - Costs.

Individual analytics

Under the individual analytics section, the operator needs to select one customer and one of the groups/tags the customer is assigned to. Once the selection is performed, the tool automatically calculates the average behaviour of the members of the selected group (as the average values of all members of that group for the considered KPIs) and represents this information together with the specific data for the selected customer. This way, a reliable comparison of the customer against the members of its group is represented.

The comparisons provided include:

- Hourly energy injection and offtake
- CO_2 emissions (accordingly to national energy mix)
- Energy costs (accordingly to national wholesale market – BELPEX – day-ahead prices)
- Profiling: represents the 4 former indicators in a polar chart, where the group average corresponds to the 100% values. This allows to get an overview of the behaviour of the customer in relation to the group at a glance
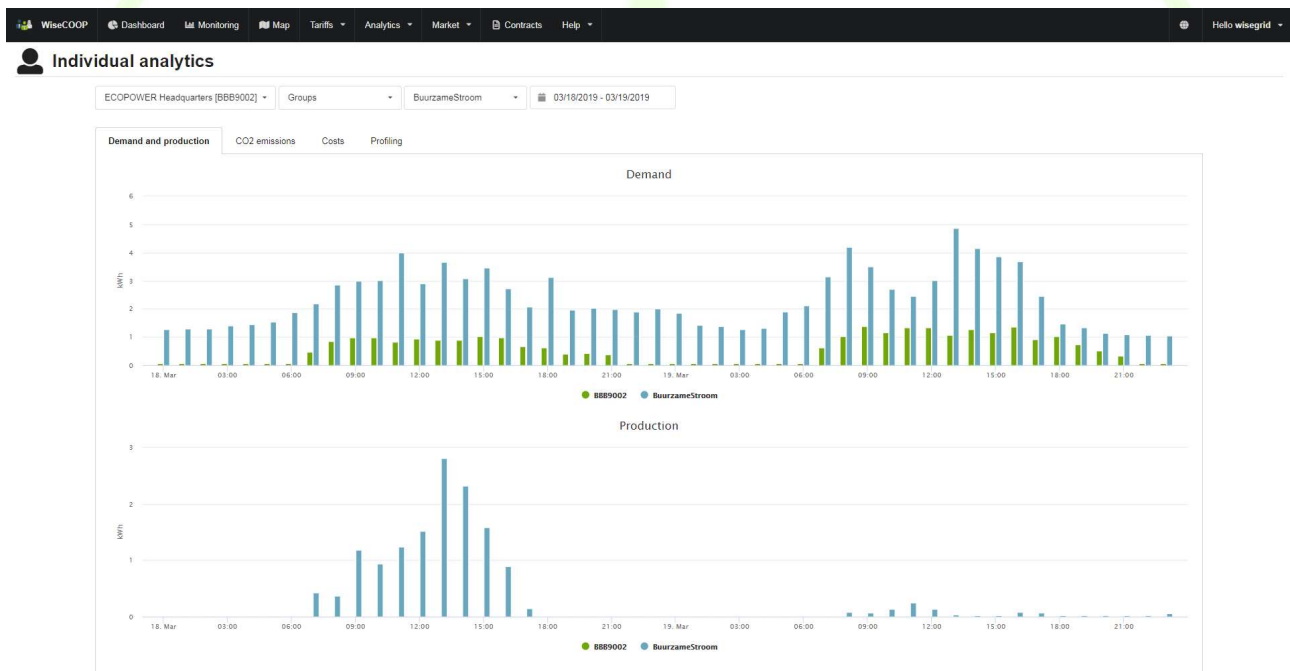
Figure 19– WiseCOOP UI – Individual analytics – Demand and production.

Figure 20 – WiseCOOP UI - Individual analytics - CO₂ emissions.

Figure 21 – WiseCOOP UI - Individual analytics - Costs.

Figure 22 – WiseCOOP UI - Individual analytics – Profiling.

Clusters

Additionally, WiseCOOP enables the ability to automatically identify groups of customers that behave similarly according to different criteria. As the project evolves, different criteria clustering will be developed following the interest of the pilot site coordinator partners. Currently, modules have been developed that cluster according to the following criteria:

- Average energy demand distribution in 2 periods (08-18 and 18-08) and working/non-working days
- Average daily production
- Average daily CO_2 emissions
- Average daily energy costs
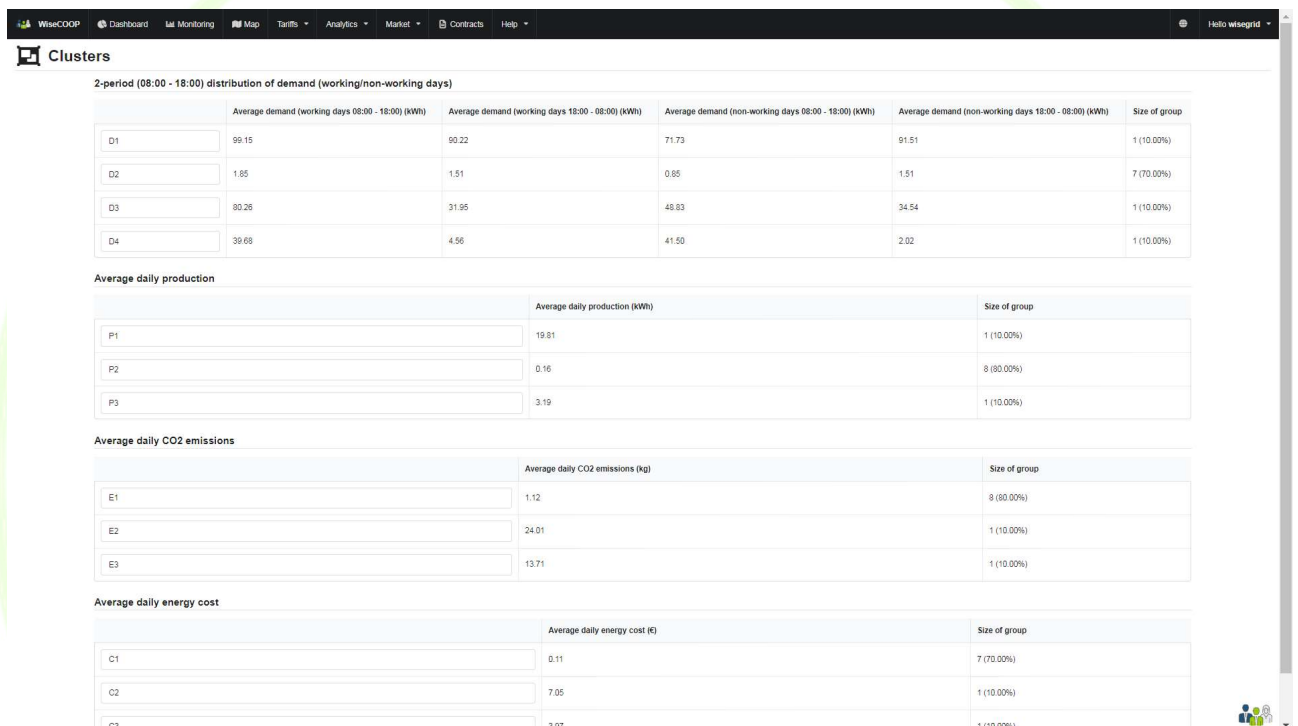
Figure 23 – WiseCOOP UI - Clusters.

Energy trade dashboard

The energy trade dashboard section is intended to provide the retailer an overview of the most relevant aspects of the wholesale market (day-ahead prices and energy mix) and its portfolio (forecasted and actual energy injection and offtake). This information is relevant as decision support on the amount of energy to plan to be bought from the wholesale market in order to meet the demand of the customer portfolio. In addition, it offers the required information to evaluate the accuracy of the forecast models of the WiseCOOP tool.
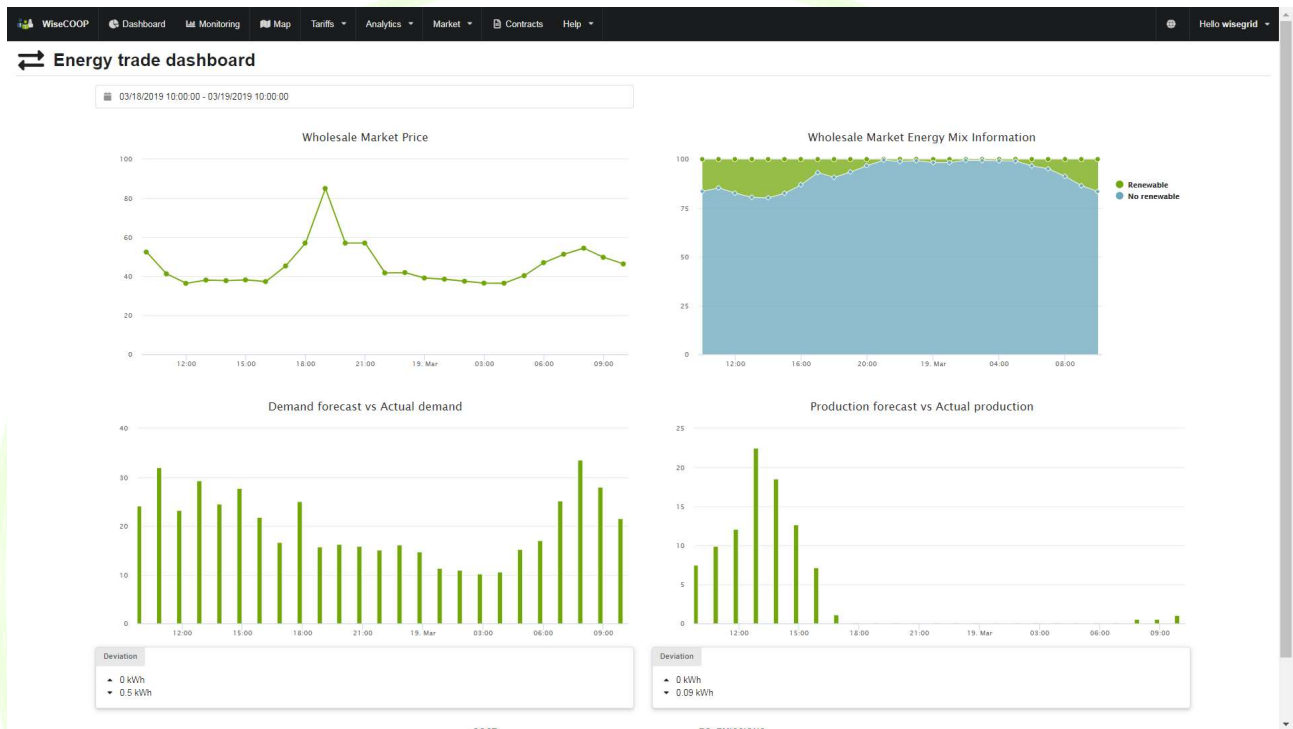
Figure 24 – WiseCOOP UI – Energy trade dashboard.

Contracts

The contracts section allows the operator to define the required information about her portfolio of customers. In this section, the contracts can be created, updated or removed. It is important to note that only those customers with a contract created in the application participate in the analytics of WiseCOOP. Each contract includes:

- Name of customer
- Address and geolocation
- Meter Id
- Battery Id (optional, allows customer to visualize storage information in the WiseHOME tool)
- Tariff
- Capacity
- Group
- Tags

Figure 25 – WiseCOOP UI – Contracts.

3.1.3.2 WiseHOME

The WiseHOME app is the tool of the WiseGRID tool chain that serves as the interface with the residential electricity consumer or prosumer. Its goal is to provide a deep and comprehensive understanding of the energy consumption and production of the household to the user, in order to raise awareness about how energy is used, e.g. its time profile, what is the impact on total electricity intake from the grid, etc. In addition to this, 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 for instance. Finally, WiseHOME will also serve as the interface toward the user for the deployment of implicit (price-based) demand response campaigns by the supplier and/or cooperative within the context of the WiseGRID project. In essence, WiseHOME aims to become an innovative tool through which retailers, cooperatives and aggregators can establish communication channels with their customers in order to solidify their loyalty via awareness about consumption patterns as well as delivery of personalised triggers for energy demand modulation. This channel will effectively become the enabler for the empowerment of active citizen participation in the energy system.

Sign up screen

Any citizen that wants to use the WiseHOME app must be a customer of an electricity retailer or cooperative that uses the WiseCOOP product to manage its operations. The retailer/cooperative is responsible for providing to the potential user the necessary information in order to successfully register to the WiseHOME app. This information includes the URL of the retailer-specific instance of the WiseHOME app, the assetKey (the unique customer identifier in the retailer portfolio) and the name of the retailer/cooperative which can be recognised by the WiseHOME app. The process and method of obtaining this information has been specified in Deliverable 7.2 "WiseCOOP and WiseCORP Apps implementation and lab-testing".

To register the user must go to the WiseHOME web app (using the URL provided by the WiseCOOP operator) and click on the "Sign up" link at the bottom of the screen. She will then encounter the following screen,
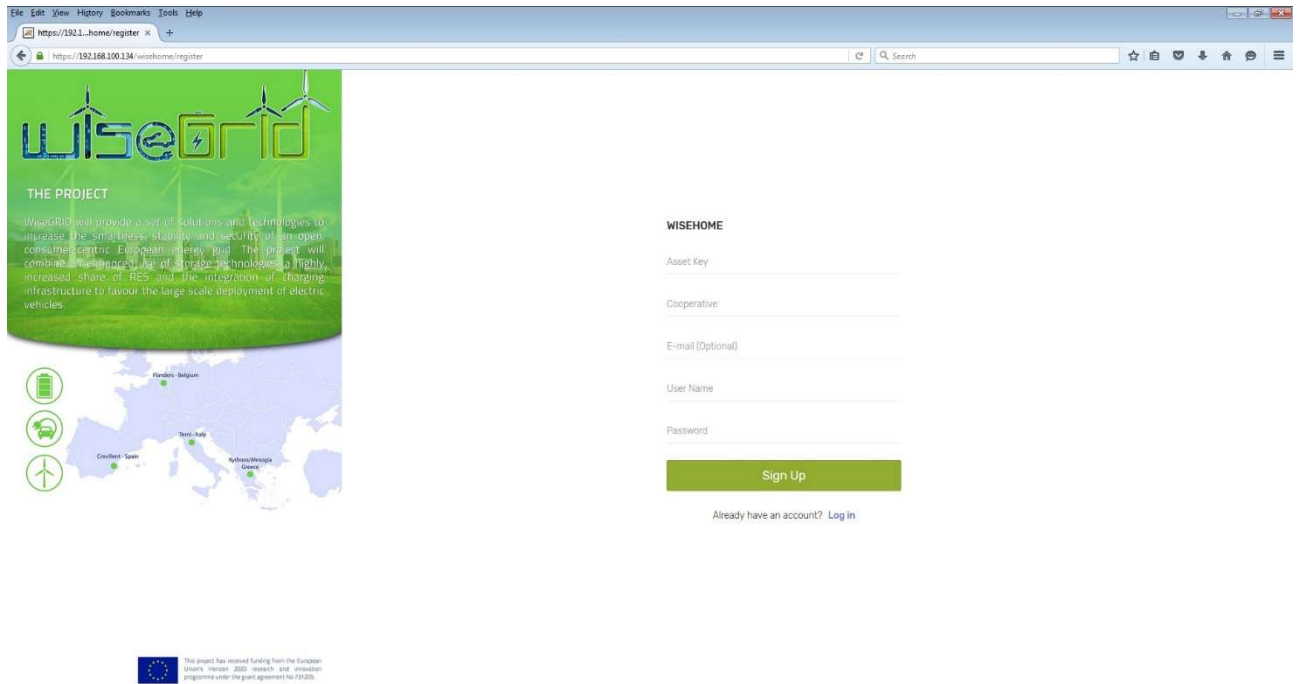
Figure 26 – Sign up screen.

Once the information is filled in and the user clicks on the "Sign Up" button, the WiseHOME app checks the validity of the required information (assetKey, cooperative) and if this check is successful a new account is created. Then the user is led to the log in screen.

Log in screen

The first screen the user encounters when going to the WiseHOME URL by defaults points to the log in screen, which is much more commonly needed in typical usage scenarios. He is then confronted with the following page, where he should fill in the required information.
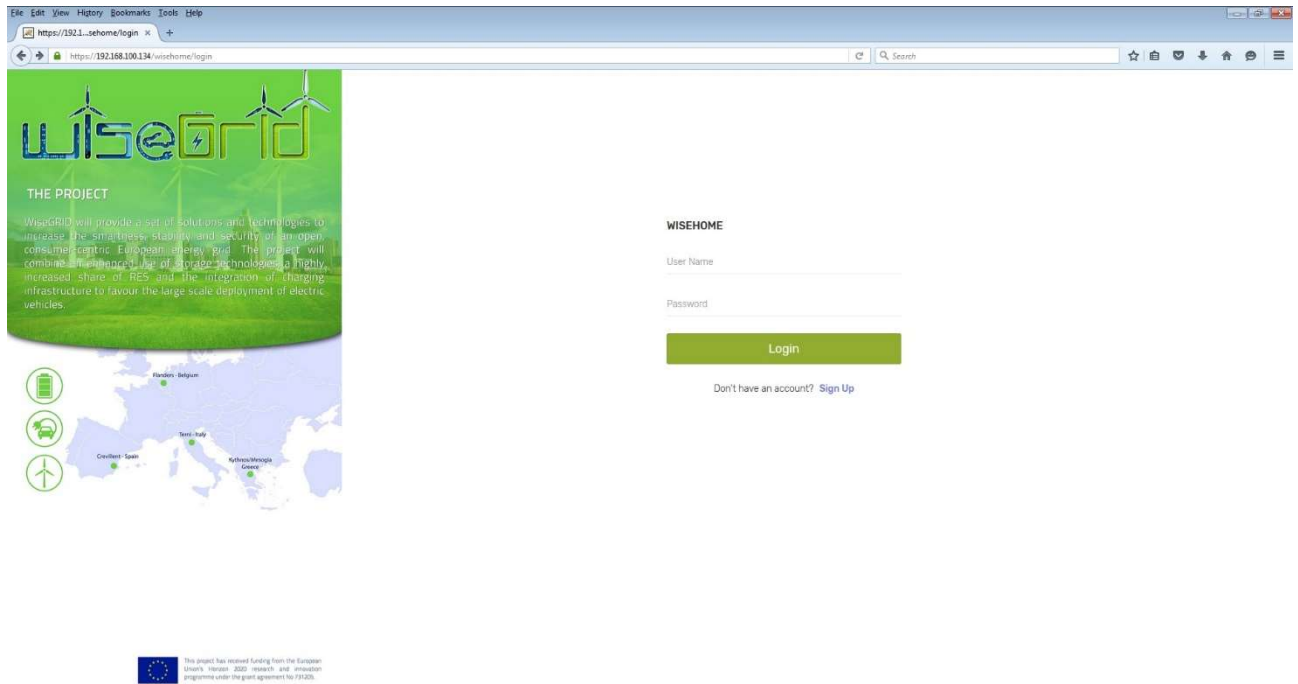
Figure 27 – Log in page

Configuration screen

When the user logs in the WiseHOME app for the first time, he is asked to provide some information about the devices available in the home, namely batteries and PV installations. The information to be provided includes whether such devices are available, whether the user opts them in for remote control by the operator of the WiseCOOP application as well as information about capacities and vendors/models[1]. This information needs to be provided only once per home to the WiseHOME app. If another user registers with the same assetKey (which implies the same household) the configuration screen will not appear.

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[1] It is important to note that at this stage this information is not actively used by the WiseCOOP operator, mainly due to the lack of infrastructure for remote control of the devices. This feature has been added to WiseHOME to enable future Demand Response related use cases where the retailer/cooperative may wish to engage in more complex commercial agreements with their customers in order to leverage residential assets for portfolio balancing.
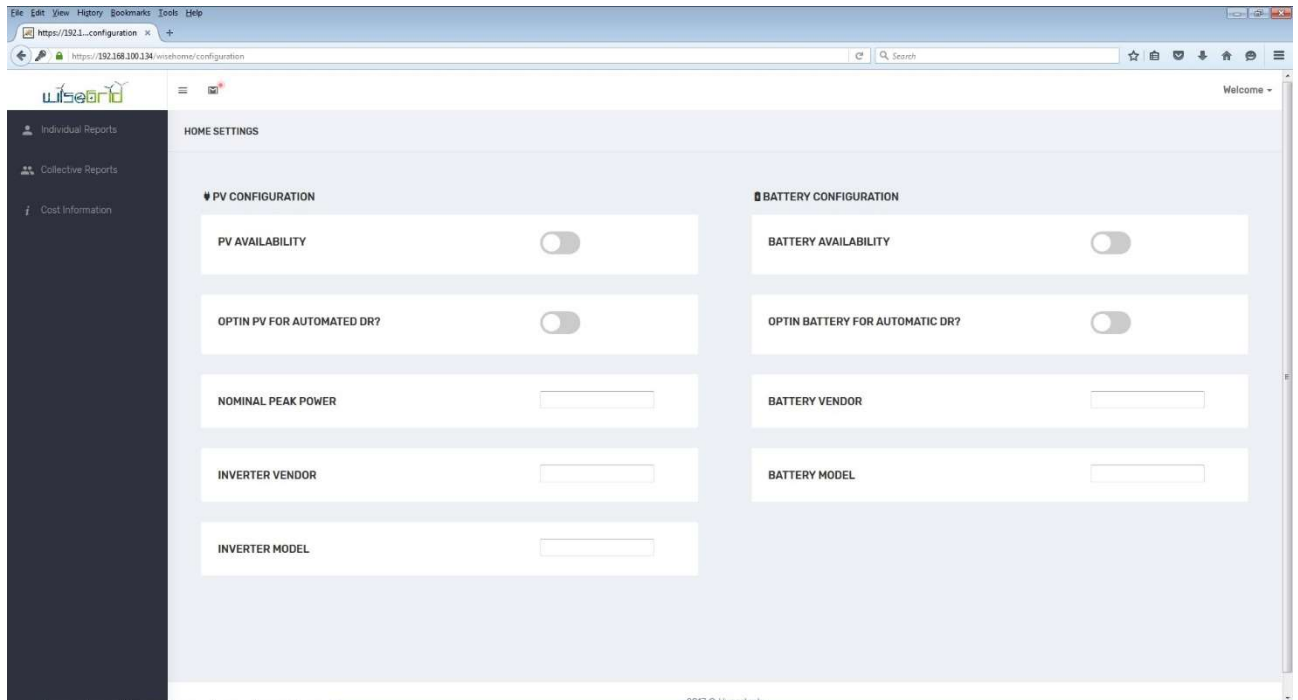
Figure 28 – Configuration screen.

Individual reports

This screen shows a snapshot of information about the user's home energy performance through a variety of metrics.

The screen is separated in two main components. The left component displays the actual information for the household. The right component gives an overview of the historical information available for the household.

The upper section of the left component is Actual Power, illustrating the current instantaneous offtake from the grid or injection in the grid. This means that, for consumers (WiseHOME users without PV installation on their roof), the gauge arrow will be in the red zone if the consumer is consuming a significant amount of electricity. If the consumer is consuming a small amount of electricity, the arrow will be situated in the yellow zone. Evidently, the gauge arrow will never be in the green zone for a consumer since they cannot have injection without a PV installation. For prosumers (WiseHOME users with PV installation on their roof), the gauge arrow will be situated in the red zone (offtake from the grid) when the amount of consumption of the household is higher than the amount of production that is currently being produced by the PV installation on their roof. If the household is producing more electricity than is currently consumed within the household, the arrow will point to the green zone of injection. To conclude, the gauge arrow will turn to the yellow zone when production of the household by its PV installation equals the amount of consumption that is currently been used.

The bottom section of the left component, Storage and PV, gives information about the status of renewable and storage devices available in the home.

The upper section of the right component, Consumption pie chart, shows the amount of electricity injected (green line) compared to the amount of offtake from the grid (red line) for a given period of time. This data can be displayed for different time frames ranging from day, week, month to year.

On the bottom section of the right component, Payment information, information about energy cost and

rewards are displayed.
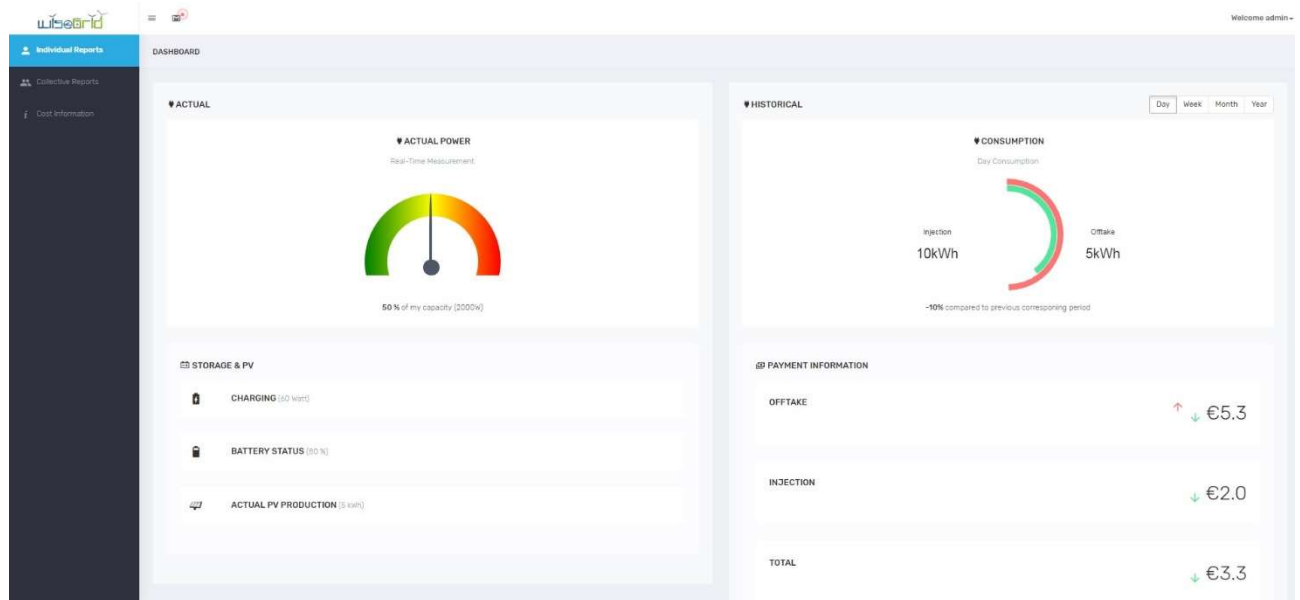
Figure 29 – Individual reports screen.

Energy consumption drill-in

The user can click on the consumption diagram in order to drill-in and see the evolution of the household energy injection and/or offtake over time for the appropriate reference period.
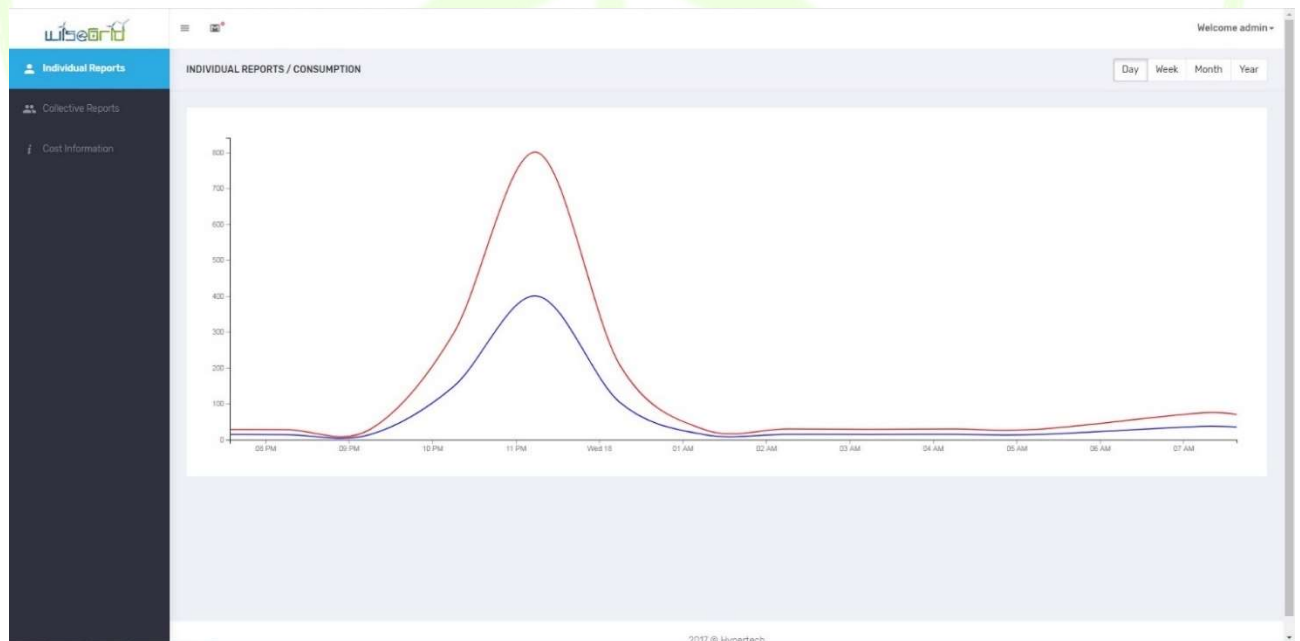
Figure 30 – Drill-in to time-series of energy consumption.

Collective reports

The collective reports tab illustrates information about the performance of groups of energy consumers and prosumers, as these are defined by the energy retailer or aggregator who is operating the associated WiseCOOP deployment.

Like the individual report tab, this screen is separated in two main components as well. The left component displays the actual information for the group of energy consumers and prosumers. The right component gives an overview of the historical information available for the group of energy consumers and prosumers.

The left component visualises the Actual balance of the group of energy consumers and prosumers. If for a given moment, the production by this group of energy consumers and prosumers is lower than the consumption of this group of energy consumers and prosumers, the group will need to import electricity. The gauge arrow will point to the red zone. Reversely, if the group of energy consumers and prosumers is producing more electricity than is currently being consumed by this group, then the group will export electricity. The gauge arrow will be then situated in the green zone. If the production of the group is in equilibrium with the consumption of the group, the gauge arrow will point to the yellow zone.

The upper section of the right component shows the Energy balance pie chart for the group of energy consumers and prosumers for a given period of time. This chart summarizes the amount of electricity injected (green line) and the amount of offtake from the grid (red line) by the group of energy consumers and prosumers for a given time period. This data can be displayed for different time frames ranging from day, week, month to year.

The bottom section of the right component displays the source of consumption of the group of energy consumers and prosumers. The source of consumption is consisted out of three categories; production on site (e.g. PV production of prosumers that are member of the group), production nearby (e.g. cooperative wind power plant) or grid import (when none of the aforementioned applies).
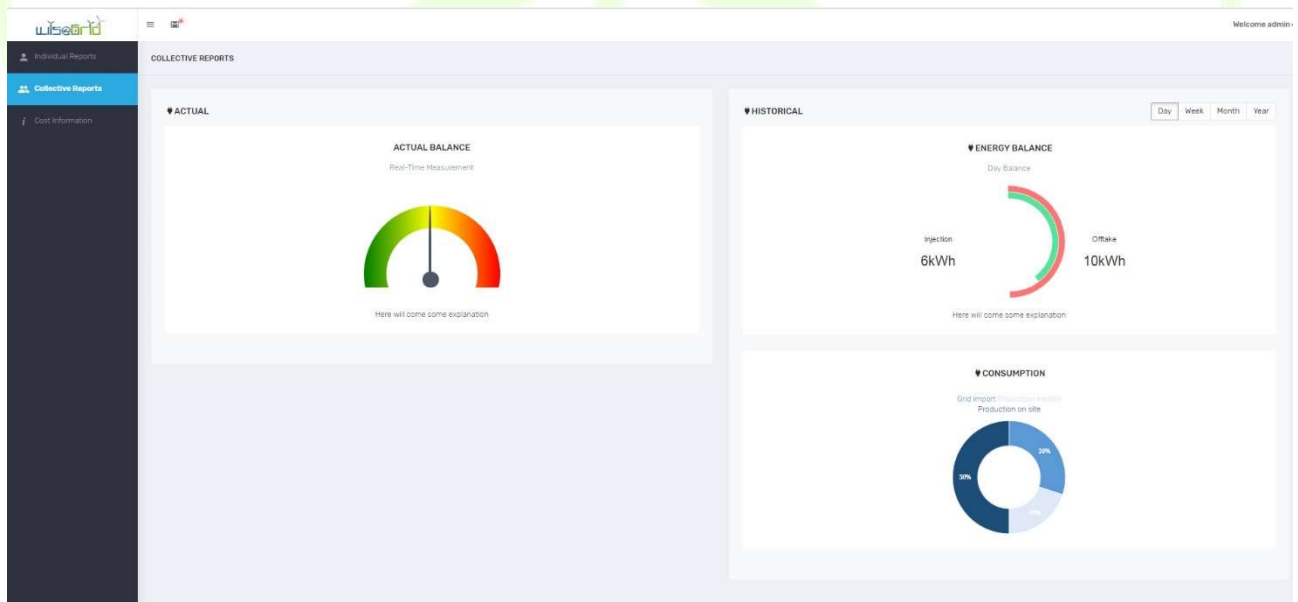
Figure 31 – Collective reports screen

Cost information

The purpose of the tab is twofold. On the one hand to inform the user about his energy cost in a graphical manner and by showing the evolution of cost. On the other hand, it also illustrates the impact of a dynamic tariff of the energy cost of the consumer. The left diagram shows the dynamic electricity price, while the right one shows the cumulative energy cost for the period of reference. The difference in total energy cost caused by the application of dynamic prices can be become evident in this manner. Furthermore, an interested user can also look into and anticipate price patterns, so as to schedule his/her energy consumption accordingly and reduce his energy costs.
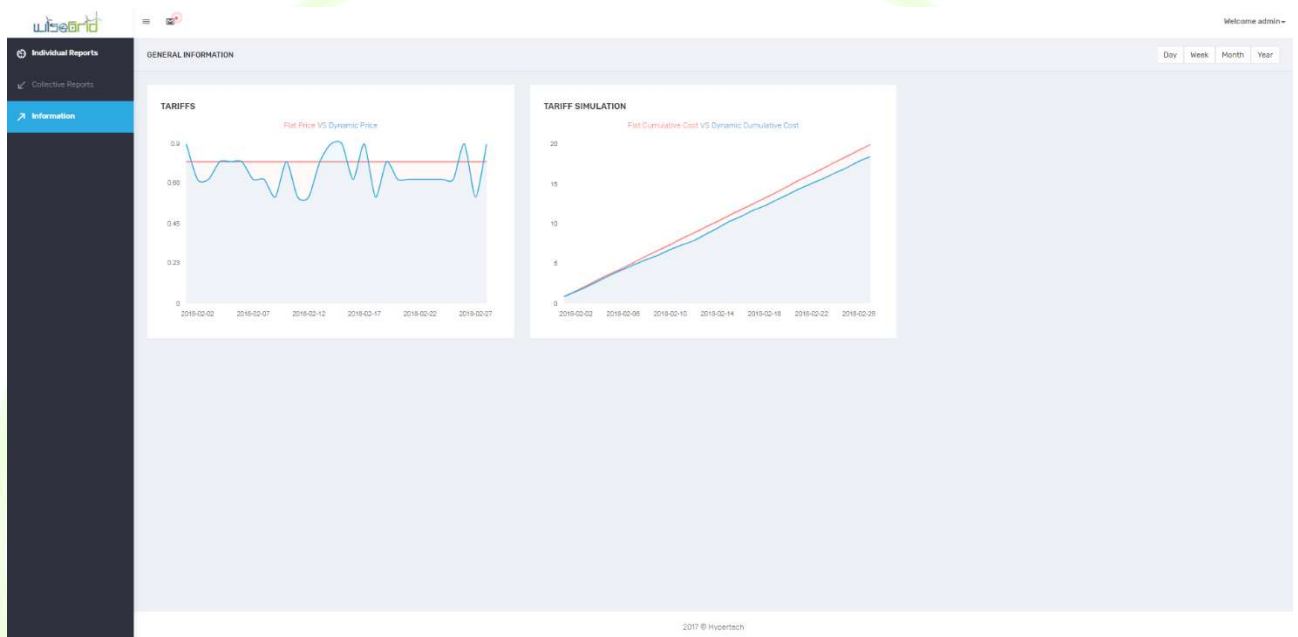
Figure 32 – Cost information screen

Notifications centre

The WiseHOME app includes a notification centre which will receive messages from the WiseCOOP operator in case he wants to contact the user. The most frequent use will be the transmission of demand response requests – either as price signals or as pleads to reduce load - by the retailer or the cooperative, so that the user can anticipate and respond to very high price signals.
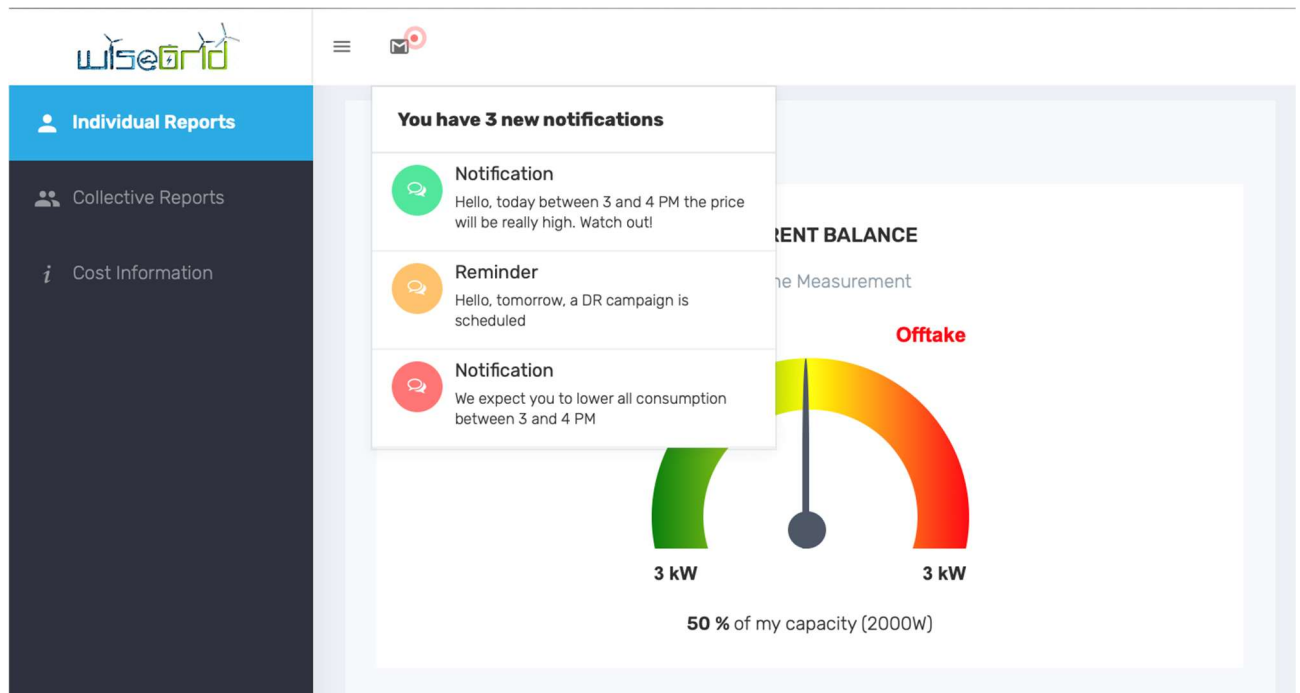
Figure 33 – Notification centre.

3.1.4   Dynamic pricing trials scenario for Flanders: Preliminary evaluation results of the price-based elasticity model using past data.

3.1.4.1 Introduction

As described in Deliverable 10.2 (*please refer to Section 6*) WiseGRID designed a set of models that provide **predictions for the consumption of each individual household (and as a result for the whole retailer's clientele) with respect to two parameters: the applied retail price and the environmental temperature (i.e., the temperature outside of the consumer's' premises).** These models are essential for the designer of dynamic pricing schemes in order to make a more accurate and efficient targeting of consumers participating in such a program**. As a first step in this deliverable it is evaluated their applicability and performance** over a dataset including the consumption of four categories of users located in Ghent (one of the WiseGRID pilot sites) for the whole year 2018.

The aim of this is twofold. Firstly, **to verify that the performance of the models and their basic properties are data-agnostic.** This target is achieved since the documented results in this deliverable are based on a different dataset that the one considered in 10.2. Furthermore, the current dataset is indicative for the consumption patterns of the citizens in Ghent. Thus, the analysis is valuable as **a feasibility and requirements study for the effective planning for the dynamic-pricing trials at the Ghent pilot site.** For instance, the obtained results for the user's price and temperature sensitivity may be utilized as a proxy for the actual reactions of the consumers during the trials and in this way to limit the duration required for the training of the models. Similarly, the available consumption data and the relative findings may be used in a complementary way with those that will be obtained during the trials, **providing an enriched dataset that is expected to improve the accuracy of the models.**

3.1.4.2 Preliminaries

This section briefly reminds the design principles of the two consumption-prediction models, which were firstly introduced in Deliverable 10.2 (Section 6). Before proceeding, recall that both of them consider that each day is divided into two periods, namely "peak" and "off-peak" (hereafter the abbreviation "p" and "op" is used respectively). Their title is aligned with the consumption fluctuations that are observed during the daylong time interval.

The former, namely "**Simple**", assumes that the consumption of the users at period $j\epsilon\{p,op\}$ depends only on the price and environmental temperature during this period. This model is suitable for users who lack shifting capabilities and thus their reaction to the dynamic prices is limited only during the period that they are applied (e.g. load curtailment). For its concrete definitions, refer to equations 25 and 26 in Deliverable 10.2. On the contrary, the **Normalized** model assumes that the consumption during any period depends on the price and the temperature of both peak and off-peak periods. Since this model is designed to capture inter-period dependencies, it is more suitable for users who are capable to shift part of their loads. Such users may be those who are equipped with automated consumption management systems or retired citizens who have a higher consumption flexibility compared to those working. For its concrete definition refer to equations 27 and 28 in Deliverable 10.2.

Both models require a subset of the data to be utilized as the "training period", over which the least square linear regression is applied, to calibrate the price and the temperature sensitivity of the users. In this deliverable we follow the same approach as in 10.2 and consider the training period to consist by the last 30 days just before each day of prediction interest. This approach is justified by the fact that the consumption of the users appear with intense seasonal variations (see Figure 34) and consequently we expect that a training dataset of the most recent past will be the most appropriate indicator for their consumption. Thus, the models provide predictions for the days is the set $D = \{31,32, \dots 200, 300, 301, \dots, 365\}$, since the first thirty days are necessary input for the predictions of day 31.

Finally, for the reader's convenience we remind the metrics to be utilized for the models' performance evaluation. Before proceeding, recall that Q stand for the consumption, P for the price and T for the temperature, while t refers to the days of the dataset. The formula of the "Absolute Percentage Error" of a specific user "i", reads as follows:

$$APE_{i,j,t} = \frac{|Q_{i,j,t} - Q_{i,j,t}^{pred}|}{Q_{i,j,t}} , \forall\ t\epsilon D, j \in \{p, op\}$$

In the above formula, if we subtract the consumption of a specific user with $Q_{j,t} = \sum_{i=1}^{M} Q_{i,j,t}$, we obtain the $APE_{j,t}$ of the aggregate consumption. The "Mean Absolute Percentage Error" computes the APE in average terms over the whole evaluation set. Its concrete mathematical formulation reads as follows:

$$MAPE_{i,j}^{D} = \frac{1}{|D|} \sum_{t\epsilon D} APE_{i,j,t} , j \in \{p, op\}$$

For clarity reasons it is mentioned that the MAPE may also refer to the aggregate consumption. Additionally, it may be applied over a subset of days in D, depending on the investigation objective.
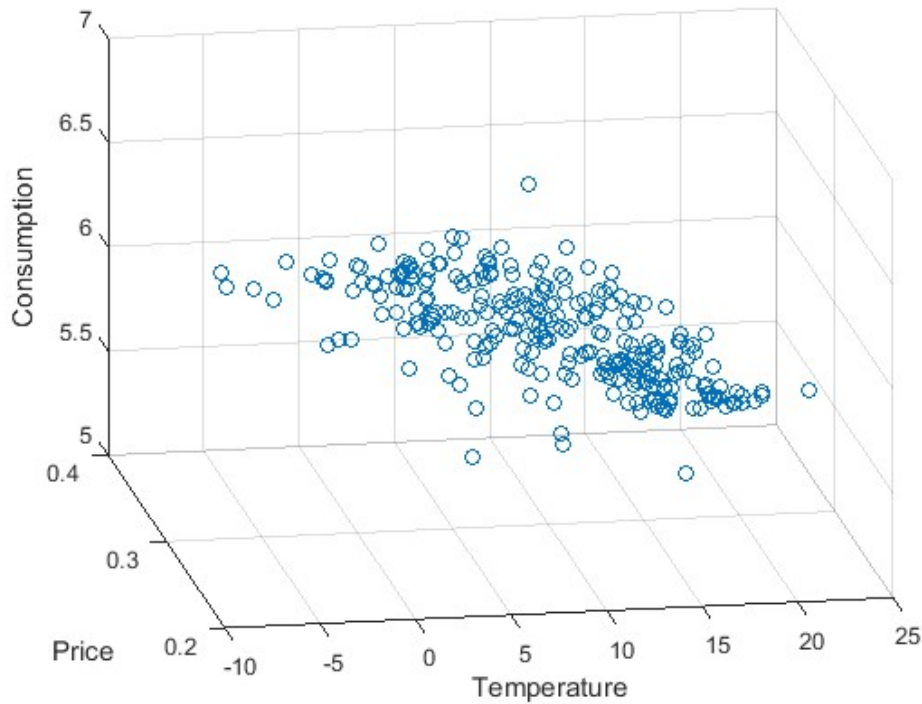
Figure 34 – The dependencies of the off-peak consumption of a specific user, with the price and temperature variations.

3.1.4.3 Accuracy of the proposed models

This section presents the performance evaluation of the two models. Figure 35 depicts the accuracy of the "Simple" model in terms of the $APE_{i,p}$ of the prediction of the individual consumption during the peak period, i.e., separately for each user.
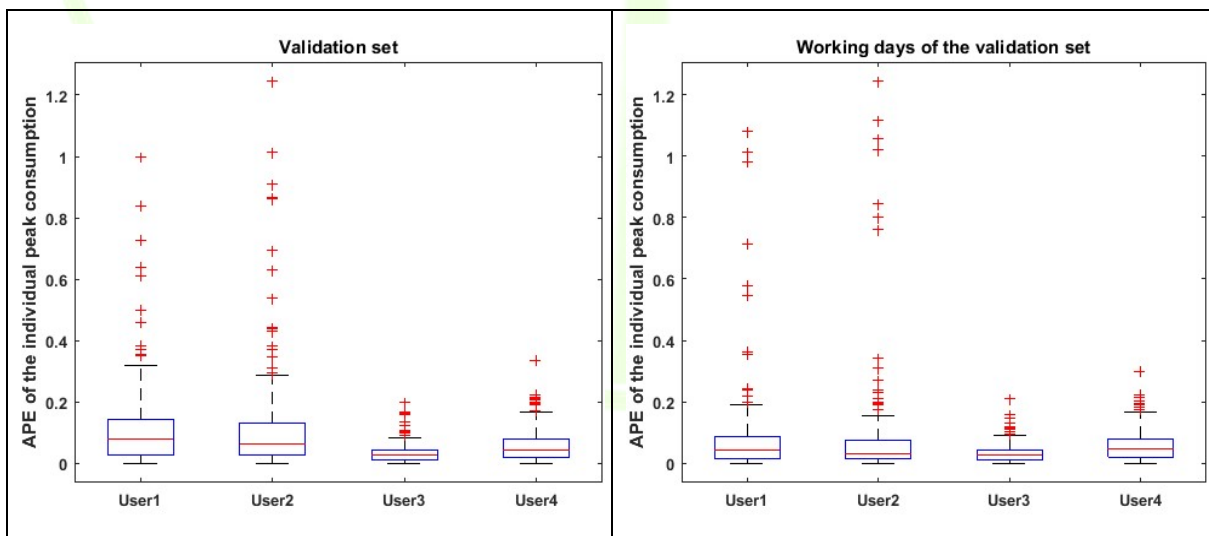
Figure 35 – APE of the users' individual peak consumption, as obtained by the Simple model. Left: for the whole validation set D. Right: After excluding the weekends.

The left-hand side of the figure presents the results for the whole evaluation set D. The model achieves $MAPE_{i,p} = \{10.36, 10.57, 3.18, 5.73\}\%$, $i = 1,2,3,4$ for each of the four users respectively. Furthermore, we evaluated the model if we exclude the weekends both from the training and the evaluation set (right). This approach is motivated by the fact that the consumers may appear with different statistical behaviour during the weekends due to their lifestyle pattern, a fact that may affect the performance of the model. Indeed, in this case the predictions of the consumption are improved and the model returns $MAPE_{i,p} = \{7.63, 7.80, 3.11, 5.71\}\%$, $i = 1,2,3,4$. Notice that the greater improvement is achieved for the two first users, i.e., those with the highest error in the former case. For clarity reasons it is mentioned that similar results are obtained, although less intense, if we consider only the working days for the computation of the MAPE (validation set), but keep including the weekends in the training phase ($MAPE_{i,p} = [8.67, 8.56, 3.14, 5.76]\%$, $i = 1,2,3,4$). This improvement in the performance of the model, is reflected also in the prediction of the aggregate consumption. More specifically, the mean absolute percentage error over all the users and all the days of the validation set, $MAPE_p = 2.69\%$, while if we exclude the weekends both for the training and the validation period, the prediction model achieves $MAPE_p = 2.54\%$.

Aligned with the analysis above, we now procced with the performance evaluation of the Simple model during the off-peak period. Figure 36 presents the relevant results.
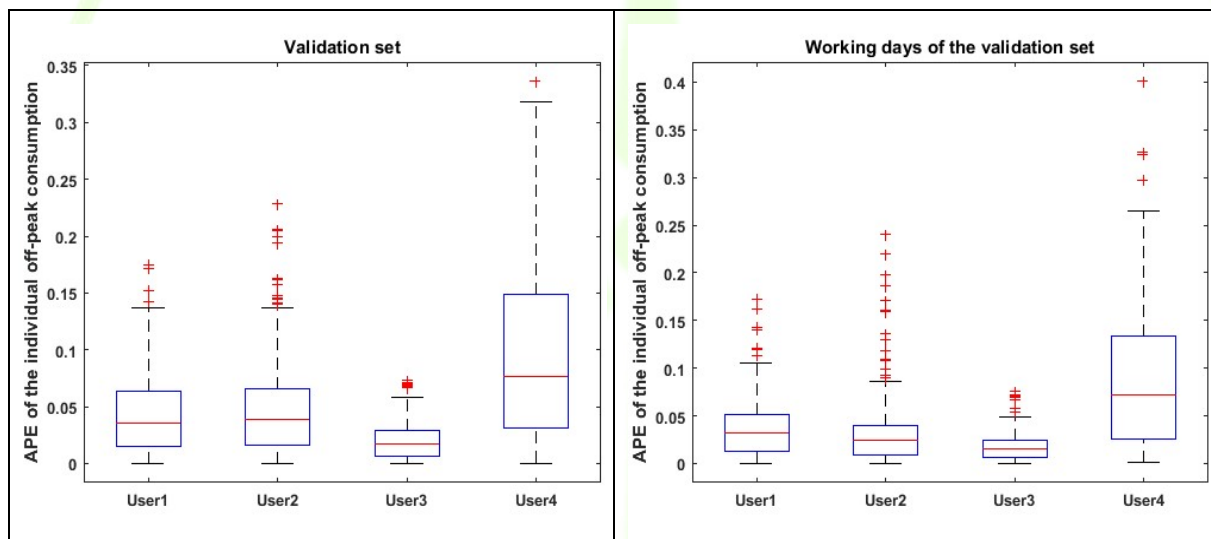
Figure 36 – APE of the users' individual off-peak consumption, as obtained by the Simple model. Left: for the whole validation set D. Right: After excluding the weekends.

For the whole validation set, the model returns $MAPE_{i,op} = \{4.24, 4.56, 1.97, 9.38\}\%$, $i = 1,2,3,4$, while if we omit the weekends both from the training and validation phase we obtain $MAPE_{i,op} = \{3.7, 3.25, 1.76, 8.89\}\%$, $i = 1,2,3,4$. Here also, the better prediction accuracy of the individual consumption for all the users has a positive impact on the prediction of the aggregate consumption, since the model achieves $MAPE_{op} = 2.88\%$ and 2.59% respectively for the two aforementioned datasets.

These observations are helpful for the successful planning of the dynamic pricing trials that will be performed in the WiseGRID pilot sites. More specifically, the analysis should firstly check if the statistical behaviour of the users is differentiated during the weekend and consequently avoid including them in the planning horizon of the trials. In this way, the project will not only avoid collecting statistically heterogeneous data, but also prevent the fatigue effect to appear, due to the repetitive dynamic pricing signals during their weekend leisure time. For clarity reasons it is emphasized that the model may also provide predictions for the weekends, but the training phase should consist by similar days e.g., weekends of the recent past or by the same periods of previous years. This prerequisite makes questionable if the duration of the trials is long

enough for the collection of the adequate data that guarantee the reliable evaluation of the models. For the rest of this section, the results refer to the dataset which includes only the working days.

Figure 37 presents the boxplots of the APE of the individual consumption, as obtained by the normalized model for the peak (left) and off-peak (right) periods of the working days. In average terms, the $MAPE_{i,p} = \{7.38 \quad 7.62 \quad 3.17 \quad 5.13\}\%, i = 1,2,3,4$ and $MAPE_{i,op} = \{5.78 \quad 5.62 \quad 3.23 \quad 6.72\}\%, i = 1,2,3,4$. Notice that the normalized model achieves similar or worse accuracy (particularly for the off-peak period), apart for the predictions of user's "4" consumption. Aiming to investigate the diverse comparative performance of the models on specific users, in the next section we introduce a classification criterion that characterizes them according to their load-shifting behaviour. This approach allows to identify those users who perform load-shifting and consequently apply the suitable (user-specific) model for their predictions, leading to a hybrid combination of the two models that utilizes their design properties and provides more accurate results.
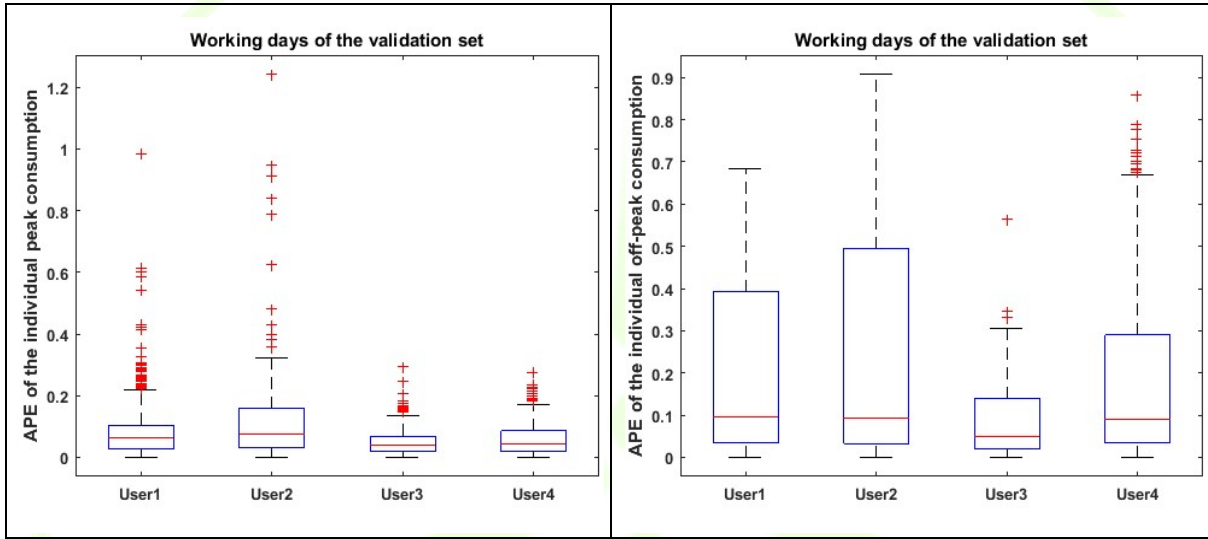
Figure 37 – APE of the users' individual consumption, as obtained by the Normalized model only for the working days of the validation set. Left: peak period. Right: off-peak period.

Cross Performance Evaluation

In what follows we investigate if the normalized model, that is designed to capture the load-shifting reactions of the users due to the difference of the prices between the two periods, achieves better performance results for those users who appear with this attribute. Before presenting the results, we firstly introduce some definitions that are utilized for the characterization of the users according to their shifting behaviour.

Let $\bar{P}_j = \frac{1}{|D|} \sum_{t \epsilon D} P_{t,j}, j \epsilon \{p, op\}$ denote the average price over the whole validation set for the peak and off-peak periods respectively. Then, let $A = \left\{ t \left| \frac{|\bar{P}_p - P_{t,p}|}{P_{t,p}} < a, \frac{|\bar{P}_{op} - P_{t,op}|}{P_{t,op}} < a \right. \right\}$ denote those days for which the price during both the peak and off-peak periods varies within a small interval around the average price (either higher or lower), where a is a percentage threshold. Additionally, let $H_p = \left\{ t \left| \frac{P_{t,p} - \bar{P}_p}{P_{t,p}} > a, \frac{|\bar{P}_{op} - P_{t,op}|}{P_{t,op}} < a \right. \right\}$, denote the set of days when the percentage difference (not absolute) of the peak price compared to the average one is higher that this threshold, while the off-peak price still varies within the aforementioned interval. For clarity reasons it is mentioned that H_{op} is defined symmetrically. Finally, let $A_d = \{ t \epsilon A | d - t > b \}$, be the $b - closest$ days before day "d" in the H_A set.

The criterion that characterized the users according to their consumption-shifting behaviour reads as follows: They are these users whose average off-peak consumption over each day "d" in the H_p set, is higher (or higher than a threshold as it will become apparent in the sequel) than their average off-peak consumption during the A_d set of days. The formula of the "Percentage Load Shifting" metric reads as follows:

$$PLS_{i,op,d} = \frac{Q_{i,op,d} - \frac{1}{|A_d|}\Sigma_{t\epsilon A_d}\ Q_{i,op,t}}{\frac{1}{|A_d|}\Sigma_{t\epsilon A_d}\ Q_{i,op,t}}$$

Taking the average over the H_p set of days, we define the "Mean Percentage Load Shifting":

$$MPLS_{i,op} = \frac{1}{|H_p|}\sum_{d\epsilon H_p} PLS_{i,op,d}$$

Positive values of this metric mean that the corresponding user actually shifts her load and vice versa. Notice that we restrict the consumption comparison basis, consisting only by the $b-closest$ subset of days in A for each day "d" of evaluation interest. This is because the consumption of the users appears with intense seasonal variations and we want to exclude the impact of this parameter on the characterization of the users.

Setting $a = 2.5\%$ for determining the A set, we obtain $MPLS_{i,op}[2.89, 0.57, 1.7, 16,1]\%, i = 1,2,3,4$ and setting $a = 5\%$ we obtain $MPLS_{i,op}[2.69, -0.48, 1.6, 24.3]\%, i = 1,2,3,4$. It becomes apparent that only user "4" appears with a clear shifting behaviour. This is not only because her $MPLS$ is significantly higher than the others, but also as we increase parameter a (from 2.5% to 5%) her $MPLS$ increases (from 16.1% to 24.3%), while for the others it varies to similar values around zero. Notice that a higher value of parameter a, actually makes stricter the criterion according to which a day is included in the H_p set, because it increases the required difference of the applied peak-price compared to the average one. Thus, we expect that the impact of the price on the behaviour of the users who appear with the shifting attribute to increase with a, as it is actually observed.

Our approach is justified also by the results in terms of the APE and $MAPE$ metrics. Figure 38 present the $APE_{4,t}^{H_p}$ for the two values of parameter a (left: 2.5%, right: 5%).
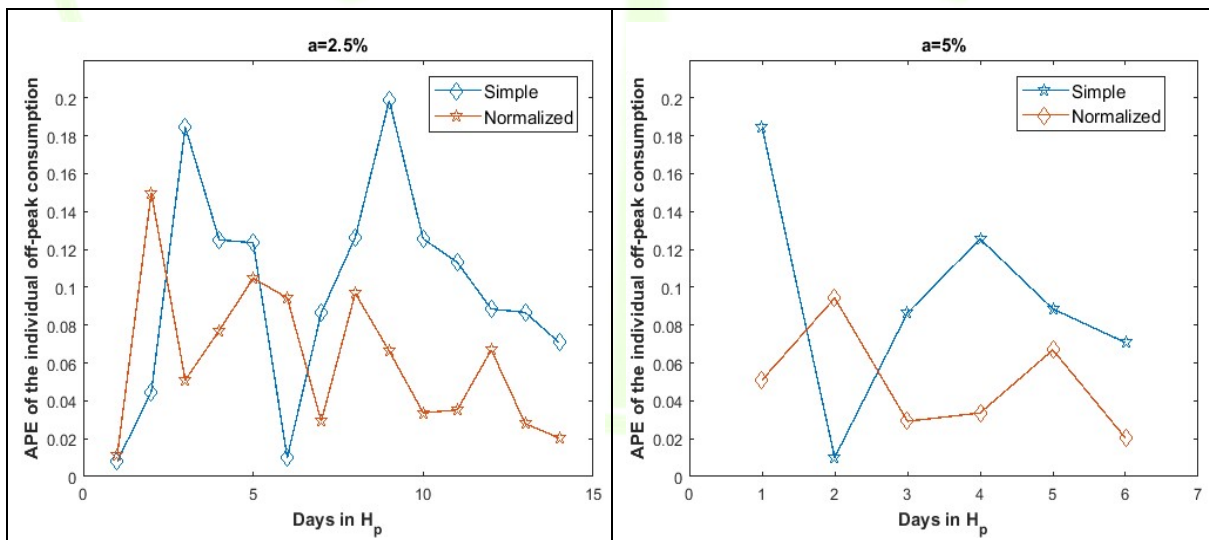
Figure 38 – APE of the user's "4" off peak consumption as obtained by the two models.

In the former case, the normalized model provides better prediction for 11 out of the 14 days in the evaluation set, while in the latter for 5 out of 6 days. In terms of $MAPE_{4,op}^{H_p}$, we obtain in the first case 9.94% and 6.18% for the simple and the normalized models respectively, while in the second 9.43% and 4.92%.

It becomes apparent, that the higher value of a, apart from the more distinct characterization of the users with respect to their shifting behaviour, results also to better performance for the normalized model both in terms of APE and $MAPE$. Observe that both the percentage of the days that it provides better results and its average accuracy, increase with a. In other words, the higher the shifting tendency of the users, the higher is the performance difference of the normalized model compared to the simple one. The explanation for this observation is as described above: A higher threshold for the characterization of the H_p set, determines the price as the dominant parameter that affect the shifting behaviour of the users and probably excludes other random parameters (than the price) that are not captured in the model.

For completeness reasons, we also present the MAPE of the three other users for both models over the same validation sets as defined by the two values of parameter a. For $a = 2.5\%$, we obtain $MAPE_{i,op} = \{4.16, 3.7, 2.08\}\%, i = 1,2,3$ and $MAPE_{i,op} = \{7.6, 8.8, 3.99\}, i = 1,2,3$ for the simple and the normalized models respectively. For $a = 5\%$, we obtain $MAPE_{i,op} = \{4.12, 4.5, 2.43\}\%, i = 1,2,3$ and $MAPE_{i,op} = \{12.0, 12.9, 5.07\}\%, i = 1,2,3$. Notice that in both cases, the simple model provides better predictions for all the three users and its performance is not noteworthily affected by the value of parameter a. On the contrary, the performance of the normalized model deteriorates with a. This is because the peak-price is included in the off-peak prediction and thus for those users who are not affected by the inter-period price difference, a higher value of the peak-price results to higher prediction error for the off-peak consumption. These findings indicate that the applied criterion, not only achieves to identify those users who shift, but also avoids applying the normalized model to those users that are not characterized by this behaviour (it has good performance both in terms of false-positives and false-negatives).

The better performance of the normalized model for the user who appears with shifting behaviour, motivates the construction of the hybrid model for the prediction of the aggregate consumption. This approach considers that the applied prediction model is user-specific, according to the shifting attribute of each user. More specifically, the hybrid model identifies the shifting property of user "4" based on the $MPLS$ criterion as defined above and utilizes the normalized model for predicting her consumption during the H_p days. For the rest three users, the simple model is applied. Figure 39 juxtaposes the APE of the aggregate consumption as obtained the hybrid model, with the case when the simple one is applied to all four users. The two figures correspond to the two different values of parameter a, as reported previously. For $a = 2.5\%$, the hybrid model provides more accurate predictions for 11 out of the 14 days in the evaluation set, while for $a = 5\%$ for 5 out of 6 days. In terms of the $MAPE$, we obtain 3.14% versus 2.65% and 2.87% versus 2.58 for the simple and the normalized respectively and for the two values of a. Here also, the performance of the hybrid model is improving with a, with respect to both metrics.
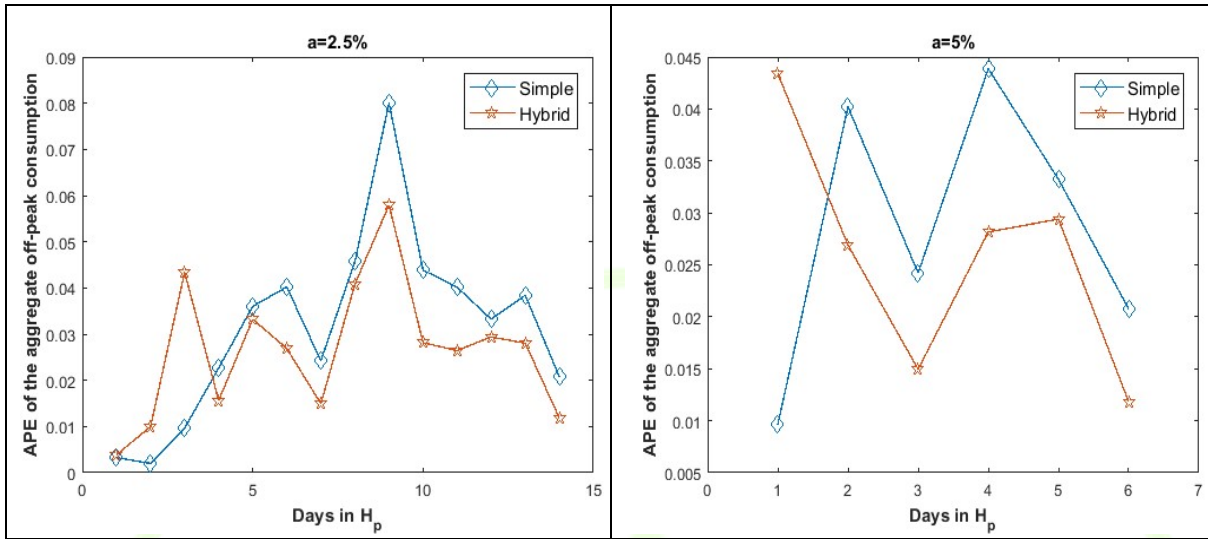
Figure 39: APE of the aggregate off-peak consumption, for two values of parameter a (left: a=2.5%, right: a=5%). The hybrid model outperforms the simple one, both with respect to the number of days that provides more accurate results and also on average terms.

Aiming to investigate the robustness of our approach, we now proceed to the comparative performance evaluation of the normalized model for the peak period of the days in the H_p set. Figure 40 juxtaposes its predictions with those obtained by the simple model, for user "4" and for both values of parameter a. The results are aligned with the above analysis, since we obtain MAPE = 7% versus 5.3% and 8.32% versus 4.08% for the simple and the normalized models respectively, for $a = 2.5\%$ and $a = 5\%$. Similarly, as above, the performance of the two models is inverse when applied to the other three uses (not depicted here) who have no inter-period dependencies. For $a = 2.5\%$ $MAPE_{i,p} = \{6.51 \quad 5.74 \quad 3.65\}\%, i = 1,2,3$ and $MAPE_{i,p} = \{6.99 \quad 6.8 \quad 3.65\}\%, i = 1,2,3$ for the simple and the normalized model respectively. For $a = 5\%$, $MAPE_{i,p} = \{3.32 \quad 3.43 \quad 4.61\}\%, i = 1,2,3$ and $MAPE_{i,p} = \{7.54 \quad 6.9 \quad 4.9\}\%, i = 1,2,3$.
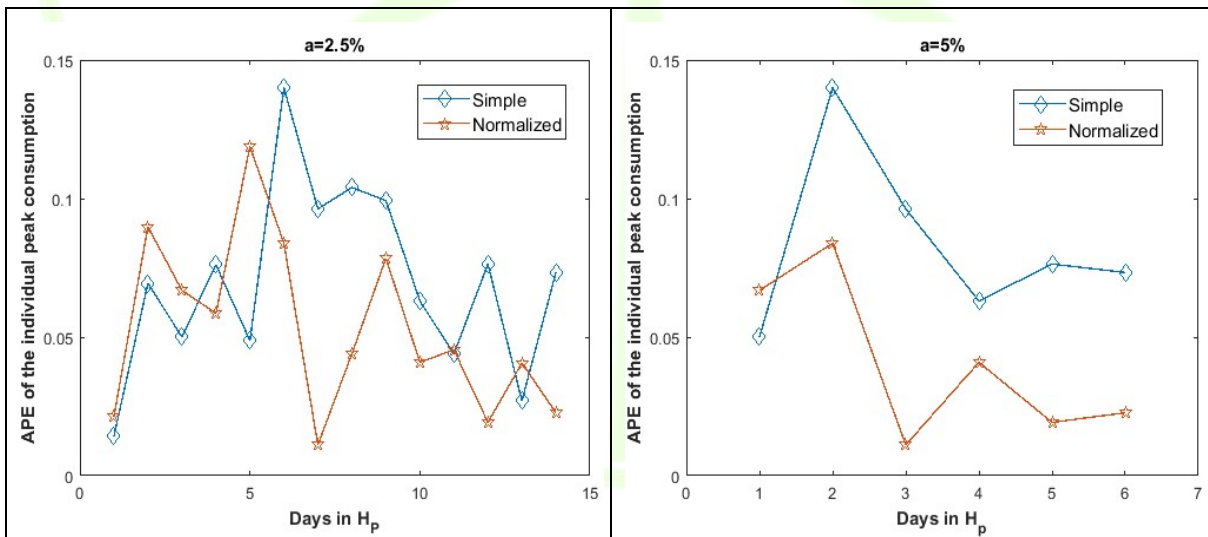
Figure 40 – APE of the individual peak consumption of user 4, for two values of parameter a (left: a=2.5%, right: a=5%). The normalized model outperforms the simple one.

Finally, Figure 41 presents the predictions of the two models in terms of the aggregate peak consumption. Clearly, the hybrid outperforms the normalized one, both with respect to the APE and the MAPE, since we

obtain $MAPE_p = 3.57\%$ versus $MAPE_p = 3\%$ and 4.62% versus 3.63% for the simple and the hybrid respectively, for the two values of parameter a.
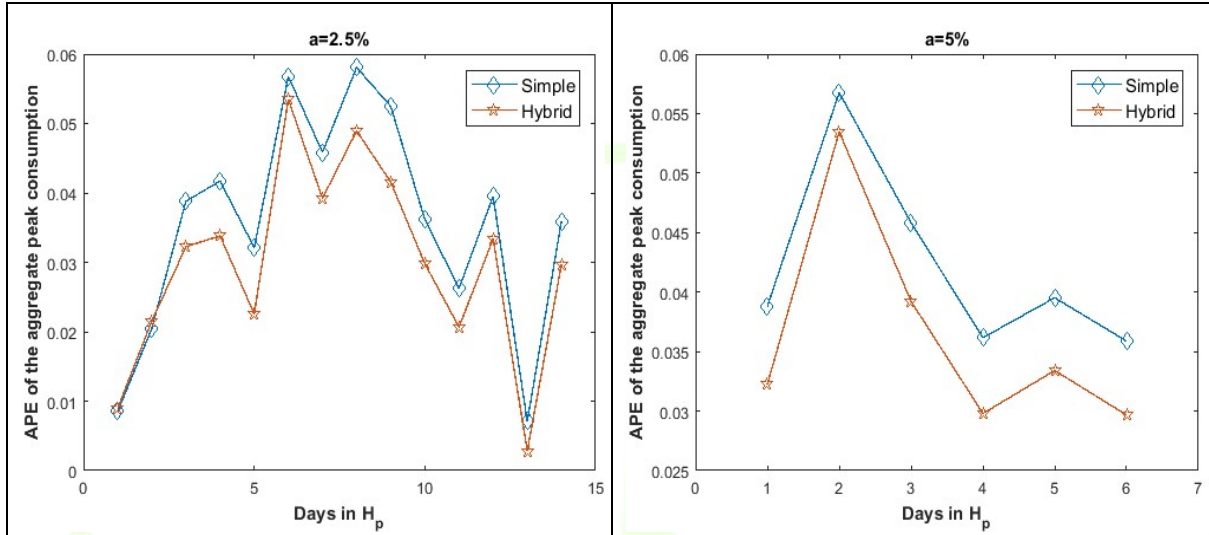
Figure 41 – APE of the aggregate peak consumption, for two values of parameter a (left: a=2.5%, right: a=5%). The hybrid model outperforms the simple one, both with respect to the number of days that provides more accurate results and also on average terms. .

It is mentioned that the investigation of the users' shifting behaviour in the opposite direction, i.e., from off-peak to peak period is meaningless over the available dataset, since the off-peak price never exceed the peak one. Finally, for clarity reasons we emphasize that the model can capture higher values of parameter a, but in this deliverable we adjust its value to the available dataset, aiming to obtain the adequate cardinality of the set H_p that allows the reliable evaluation of our approach. The combination of all the findings in this section, indicate that our approach for the classification of the users according to their shifting property and the design of the hybrid model which applies user-specific predictions are both robust and are expected to provide accurate results during the dynamic-pricing trials in the context of the WiseGRID project.

3.1.4.4 Computation of the dynamic price to be applied

This section presents the results of the algorithm which may be utilized by the retailer for the computation of the dynamic price that achieves a certain magnitude of load curtailment. The algorithm is analytically described in Deliverable 10.2 (Section 6.3.7) and its pseudocode is omitted here for simplicity reasons, but for the reader's convenience we briefly mention its main functionality. It utilizes the user-specific price sensitivity coefficients, as computed by the least square regression process, and gradually updates the price until the prediction of the aggregate consumption results for the desired curtailment to be realized. The comparison basis for load curtailment may be computed as the average consumption of the users during the days of the recent past, when no dynamic-pricing event was activated. Alternatively, it may be the predictions of the model for the same day, assuming that the dynamic price will not be announced by the retailer (in this deliverable, the second option is followed).

Figure 42 presents the computed prices. It can be observed that the iterative algorithm converges to values relatively close to the actual ones (apart from two cases for the off-peak period). This is a very promising result for the accurate computation of their values during the dynamic-pricing trials at the WiseGRID pilot sites. Finally, the fact that the computed prices are mainly lower that the actual ones, reveals that the regression process overestimates the price sensitivity of the users.
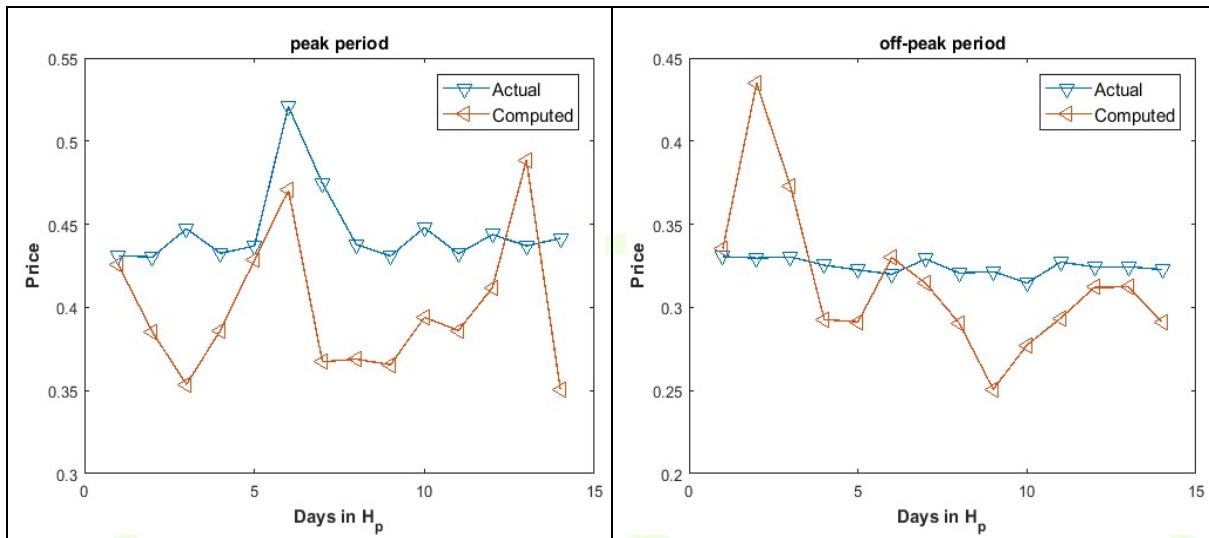
Figure 42 – Computation of the dynamic prices and comparison to those actually applied.

3.2 MESOGIA

3.2.1 REPORT OF THE DEPLOYMENT ACTIVITIES

As it was shown at deliverable D2.1, the pilot site "Mesogia" is located in the area of Mesogia at the south-eastern part of Attica, near Athens, and belongs to HEDNO's Department of Attica Region (the area is depicted within the red line in Figure 1). Mesogia area includes the municipalities of Koropi, Lavrio, N. Makri and the interconnected islands of Kea, Andros and Tinos. The area of its jurisdiction is depicted in Figure 43, where the green dot represents the Network Development and Operation branch of Attica region, where the operators of SCADA/DMS are located too.

Figure 43 – Mesogia area with indication of the substations at the interconnected islands.

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.

Mesogia pilot site will host the deployment of WG IOP, WG Cockpit, WiseCORP, WiseCOOP and WiseHOME applications, involving DSO's operational systems and different kinds of end-users.

3.2.1.1 ICT infrastructure

HEDNO deployed at its premises a new server by March 2019 and it was installed in ICT laboratory, as shown at Figure 44. Technical specifications of the server had been finalized taking into consideration suggestions and comments from the subject matter experts / tool developers as follows:

Dell R740 w/

Chassis for up to 16 x 2.5" drives

2 x Intel® Xeon® Silver 4116 2.1G, 12C

64GB RAM (2 x 16GB RDIMM)

2x 16GB microSDHC/SDXC Card

PERC H730P+ RAID Controller, 2Gb NV Cache, Adapter, Low Profile

7 x 600GB 15K RPM SAS 12Gbps

1 x Broadcom 57416 2 Port 10Gb Base-T + 5720 2 Port 1Gb Base-T, rNDC

DVD+/-RW

iDRAC9, Enterprise

2 x 750W PSU

Rail Kit w/ CMA

VMware vSphere Essentials, 3 hosts, max 2 CPU per host 3YR

3Yr Basic Warranty – NBD

3Yr Data Protection - Keep Your Hard Drive

Table 5 – Configuration of virtual machines.

Server configuration	Existing (GB)	Required	Difference
Processor #1 cores	12		
Processor #2 cores	12		
Total processor cores	24	24	0
Memory	64	48	0
Storage space	1800	1790	10

Table 6 – Cluster structure

Virtual machine name	Virtual machine function	Processor cores (pcs)	RAM Memory (GB)	Storage (GB)
IOP	Message Broker	4	16	50
ETRA	Central Server for ETRA algorithms	7	16	200
BD Config 1	Big Data config server for storing cluster configuration	1	1	10
BD Config 2	Big Data config server for storing cluster configuration	1	1	10
BD shard 1	Big Data shard #1 for data storage	1	2	500

Virtual machine name	Virtual machine function	Processor cores (pcs)	RAM Memory (GB)	Storage (GB)
BD shard 1	Big Data shard #2 for data storage	1	2	500
BD shard 3	Big Data shard #3 for data storage	1	2	500
APP router 1	Application router #1 for processing client requests	4	4	10
APP router 2	Application router #2 for processing client requests	4	4	10
TOTALS		24	48	1790

Figure 44 – WiseGRID Dell Server at HEDNO premises.

Communication between HEDNO and tool developers is via secure VPN using 10 certificates (9 certificates with fix IP address and 1 certificate for dynamic IP address) provided by ETRA. It is also required that HEDNO provides credentials and instructions to the required partners in order for them to connect to the server.

3.2.1.2 WG Cockpit

The first step was to select the MV lines to be included in the pilot project in order to facilitate the tools deployment. The three lines chosen are the P-210 N. Makris, P-490 N. Makris and 1-10 Markopoulou. In Figure 45, the three lines are shown, as well as the towns they serve. The two first lines start from the same HV/MV substation (network distribution center). P-490 N. Makris is the MV line feeding the settlement of Meltemi and line 1-10 Markopoulou is the line to which is connected the HEDNO offices building in Mesogia area. There are residential customers, commercial, industrial, agricultural LV and MV customers, public buildings and RES plants (mainly PV) connected to these lines.
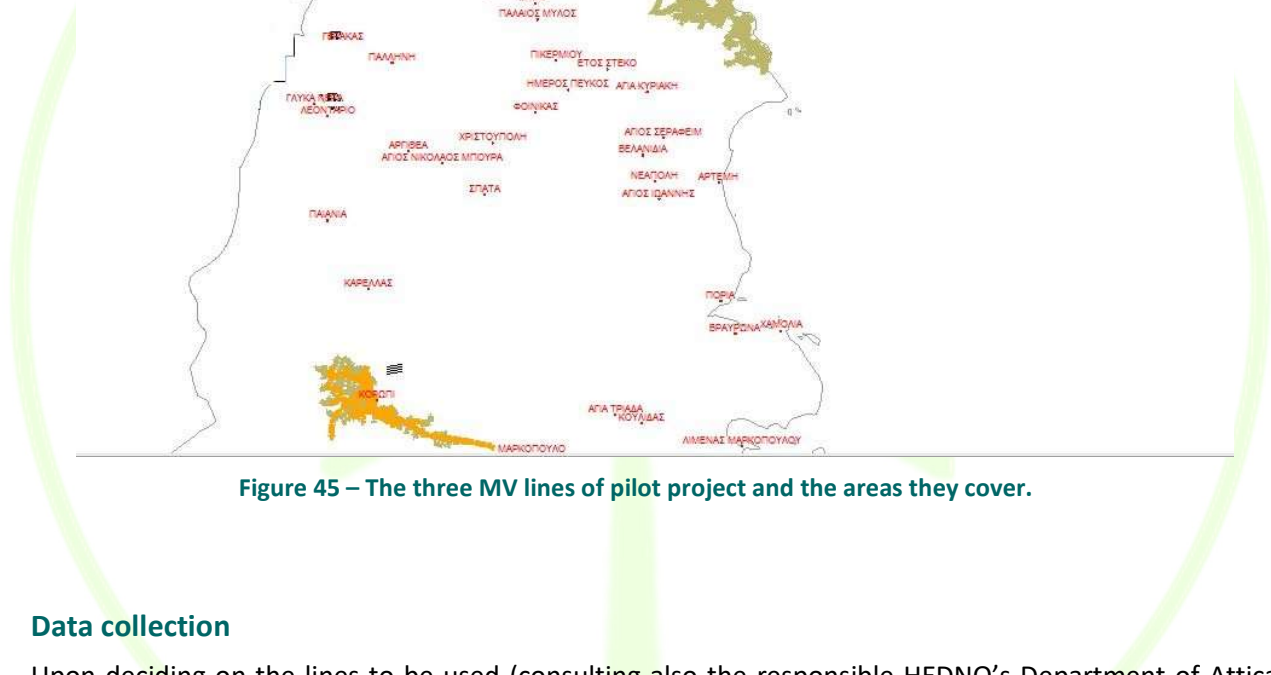
Figure 45 – The three MV lines of pilot project and the areas they cover.

Data collection

Upon deciding on the lines to be used (consulting also the responsible HEDNO's Department of Attica Region), the data regarding the lines, the equipment and usage points had to be collected. The AutoCAD drawings provided by Attica Region and the .json files provided by the Communications Systems & GIS Section of Network Department were the source of the lines topology data, as well as the main technical data for the equipment involved (cables, switches, nominal values of substations, locations of MV customers). Additional data, like the cable characteristics, were also gathered. Drawings of the three lines are shown in Figure 46. ICCS provided also the geographical representation of the LV network of Meltemi, Figure 47.

1-10 Markopoulou

P-490 N. Makris

P-210 N. Makris
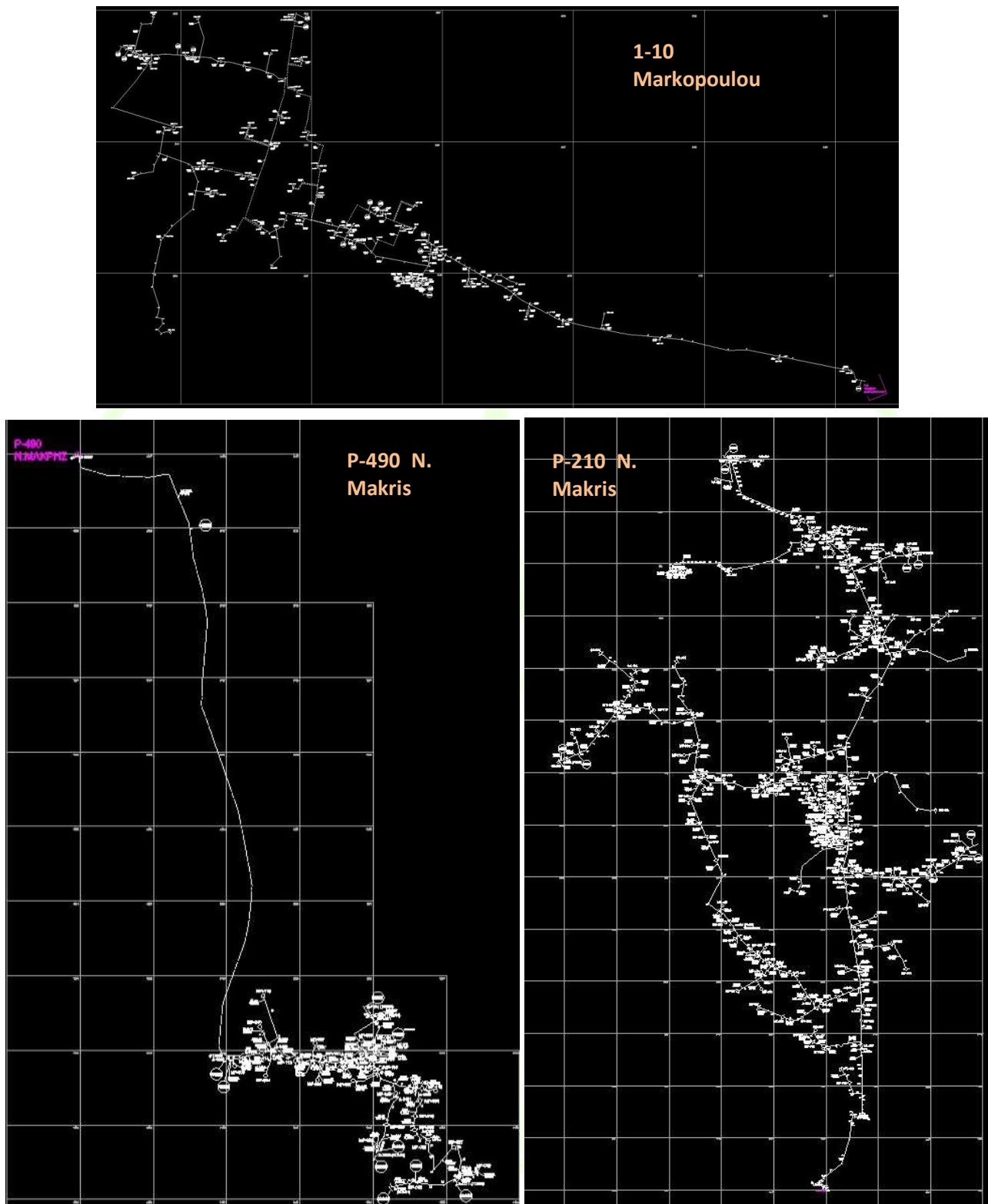
Figure 46 – The AutoCAD drawings of the MV lines.

Figure 47 – The geographical representation of LV network at Meltemi.

As WG Cockpit needs a high level of network monitoring and a big volume of data (e.g. for forecast, state estimation algorithms etc), and WiseHOME, WiseCORP and WiseCOOP applications require citizen engagement the sources of energy consumption data and the end-users that could contribute were identified; (around 17) telemetered MV customers (commercial, tertiary sector and public buildings), users with SmarterEMC2, SLAM and SMX smart meters, telemetered RES (around 11 MV and LV network connected ground-mounted PVs) and telemetered big LV customers (for this category the identification of the customers connected to these lines is in process). The last category of data needed regarding network operation was data coming from SCADA/DMS, measurements from remotely-monitored HV/MV substations, alerts, events etc. in order to identify its availability and format and decide how it could be used for WG Cockpit.

Data integration in WG Cockpit

GeoJSON files (extracted from HEDNO GIS application (GE Smallworld)) representing the 3 Medium Voltage lines were provided to ETRA along with single line diagrams, so that lines could be imported to WG Cockpit and shown at its UI, as it is presented at Figure 48.

Figure 48 – GEOJSON representation of MV line P-210 Neas Makris as an input to WG Cockpit UI.

Figure 49 – Single line diagram of MV line 1-10 Markopoulou.

HEDNO used ICCS Topology Manager as a drawing tool to design the 3 MV lines of Mesogia pilot site. Topology Manager is an extension of MS Visio environment using ICCS stencil for the depiction of Buses, Loads, Switches, Transformers and Generators.

In order to achieve this, the SCADA Autocad files along with GIS GeoJSON representations and equipment technical data collected were used. The starting bus of each line (marked as slack bus) is the HV/MV transformer at the Network Distribution Centre. For simplicity reasons and because GIS at Mesogia does not yet depict all the LV network, both MV customers (owning their MV/LV substations) and HEDNO's MV/LV substations are indicated as loads. Especially for the latter, their loads are determined by the aggregated load of LV customers under each substation or the nominal value.

Indicatively, a part of P-210 N. Makris line diagram as drawn at Topology Manager is depicted at Figure 50. Upon the completion of the lines drawing, the ICCS converter is used to convert MS Visio file to CIM rdf/xml, as shown at Figure 51.
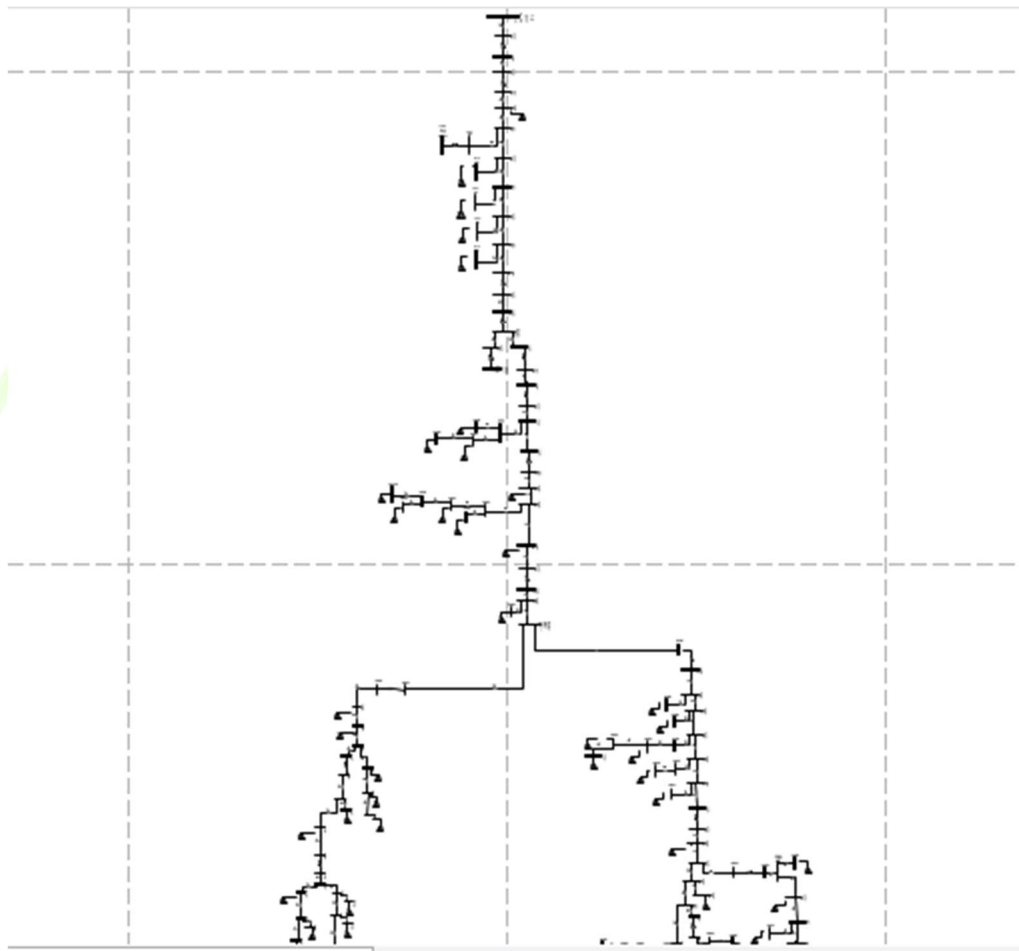
Figure 50 – ICCS Topology Manager depicting part of MV line P-210 Neas Makris

Figure 51 – ICCS CIM/RDF Converter for topology.

Test of Power flow Calculator (3-Phase Power Flow Analysis)

As described previously, the three Medium Voltage Lines topology and the LV grid of Meltemi region were drawn in Microsoft Visio and then using ICCS' Topology Manager (TM) were transformed to CIM representation. Another feature of Topology Manager is its capability to extract the information included in Visio drawing to an .xlsx format. More specifically, the TM extracts the data at an .xlsx file which has a predefined form appropriate to include all the necessary information for a Three Phase Power Flow.

The .xlsx file that is exported from the TM includes information regarding the buses, branches, transformers and switches. The topological information come from the Visio drawing, however information regarding the line conductor material and dimensions are already included in a list. Also, as it has been agreed, the values of the loads are filled in the Excel file from another service in order to renew the input data independently of the Visio drawing. Therefore, the values of the loads are by default zero. At the following figure the MS Excel input file, with data from P490 line is presented. The branches with no data indicate a switch.

f_bus	t_bus	Status	type_id	Phase Conductor type_id	Neutral Conductor type_id	length (m)	Spacing_id	A	B	C	N
1	2	1	1	23	0	20	501	1	2	3	0
2	4	1	0								
4	5	1	4	402	0	9630	525	1	2	3	0
5	6	1	0								
6	7	1	1	23	0	140	501	1	2	3	0
6	42	1	1	23	0	240	501	1	2	3	0
7	8	1	1	1	0	60	501	1	2	3	0
7	9	1	1	23	0	40	501	1	2	3	0
9	40	0	0								
42	46	1	1	23	0	100	501	1	2	3	0
46	48	1	1	22	0	330	501	1	2	3	0
46	52	1	1	23	0	30	501	1	2	3	0

Figure 52 – Part of the branch data of P490 line of Mesogia.

During the preliminary deployment period, and before the integration of the 3 MV lines in the WG Cockpit of Mesogia pilot, in order to check if the topology and the extracted excel file are electrically correct, for each line a power flow simulation was executed with arbitrary load data, defined as the 60% of the nominal power of each MV/LV substation. Results of the simulation are presented at the following figure.

link_name	currA_mag	currA_angle	currB_mag	currB_angle	currC_mag	currC_angle
_2-4	846,470394	-0,395159	846,480364	3,793675	846,508062	1,699248
_5-6	846,470394	-0,395159	846,480364	3,793675	846,508062	1,699248
_9-40	0	0	0	0	0	0
_52-71	782,546189	-0,397279	782,55605	3,791559	782,583673	1,697129
_79-88	765,886915	-0,397674	765,896723	3,791165	765,924203	1,696734
_114-123	647,358285	-0,392936	647,367385	3,795907	647,392519	1,701473
_130-139	0	0	0	0	0	0
_141-152	563,059844	-0,412132	563,067943	3,776713	563,090722	1,682278
_154-170	140,235301	-0,433248	140,236715	3,755582	140,240898	1,661158
_170-172	86,012851	-0,397531	86,013717	3,7913	86,016278	1,696876

Figure 53 – Branch Currents at P490 MV line of Mesogia.

CIM & HEDNO development involvement

HEDNO is evolving on the assembly of xml messages as CIM Payloads in the context of API/Wrappers development. More specifically, HEDNO is using IEC CIM 61968 v15 standard along with CIMTool as development environment in order to represent:

1. operational measurements from SCADA system (current, voltage), as shown at Figure 54 and

2. switch status from SCADA system (open/close), as shown at Figure 55.

More specifically, HEDNO is also exploring the possibility of using Python as development tool to automate the following processes:

- read initial excel file from a specified directory.

- modify data in respect to xml syntax rules,

- validate xml file against xsd file in respect to CIM standard rules and

- create final CIM xml message, convert to json.

```xml
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
<ns1:MeterReadings xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:ns1="http://iec.ch/TC57/2011/MeterReadings#">
  - <ns1:MeterReading>
    - <ns1:Meter>
      - <ns1:Names>
          <ns1:name>K.Δ 1-10</ns1:name>
        - <ns1:NameType>
            <ns1:name>EndpointID</ns1:name>
          - <ns1:NameTypeAuthority>
              <ns1:name>HEDNO</ns1:name>
            </ns1:NameTypeAuthority>
          </ns1:NameType>
        </ns1:Names>
      </ns1:Meter>
    - <ns1:Readings>
        <ns1:timeStamp>2018-12-11T12:32:19+02:00</ns1:timeStamp>
        <ns1:value>20915.64</ns1:value>
        <ns1:ReadingType ref="0.0.0.12.1.1.54.0.0.0.0.0.0.0.0.0.0.29.0"/>
      </ns1:Readings>
    - <ns1:Readings>
        <ns1:timeStamp>2018-12-11T12:31:19+02:00</ns1:timeStamp>
        <ns1:value>20900.986328125</ns1:value>
        <ns1:ReadingType ref="0.0.0.12.1.1.54.0.0.0.0.0.0.0.0.0.0.29.0"/>
      </ns1:Readings>
    - <ns1:Readings>
        <ns1:timeStamp>2018-12-11T11:50:19+02:00</ns1:timeStamp>
        <ns1:value>20979.12109375</ns1:value>
        <ns1:ReadingType ref="0.0.0.12.1.1.54.0.0.0.0.0.0.0.0.0.0.29.0"/>
      </ns1:Readings>
    - <ns1:Readings>
        <ns1:timeStamp>2018-12-11T11:49:19+02:00</ns1:timeStamp>
        <ns1:value>21008.421875</ns1:value>
        <ns1:ReadingType ref="0.0.0.12.1.1.54.0.0.0.0.0.0.0.0.0.0.29.0"/>
      </ns1:Readings>
```

Figure 54 – Sample of CIM validated xml for operational measurements from SCADA automation system.

```xml
<?xml version="1.0" encoding="UTF-8" standalone="true"?>
- <ns1:EventMessage xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:ns2="http://iec.ch/TC57/2007/CIM-schema-cim12#" xmlns:ns1="http://iec.ch/TC57/2011/schema/message">
  - <ns1:Header>
      <ns1:Verb>changed</ns1:Verb>
      <ns1:Noun>Switches</ns1:Noun>
    </ns1:Header>
  - <ns1:Payload>
    - <ns2:Switches>
      - <ns2:Switch>
          <ns2:mRID>Δ-10302</ns2:mRID>
          <ns2:name>Δ-10302</ns2:name>
          <ns2:normalOpen>true</ns2:normalOpen>
        </ns2:Switch>
      - <ns2:Switch>
          <ns2:mRID>Δ-10006</ns2:mRID>
          <ns2:name>Δ-10006</ns2:name>
          <ns2:normalOpen>false</ns2:normalOpen>
        </ns2:Switch>
      - <ns2:Switch>
          <ns2:mRID>Δ-8340</ns2:mRID>
          <ns2:name>Δ-8340</ns2:name>
          <ns2:normalOpen>false</ns2:normalOpen>
        </ns2:Switch>
      </ns2:Switches>
    </ns1:Payload>
  </ns1:EventMessage>
```

Figure 55 – Sample of CIM validated xml for switch position change from SCADA automation system.

3.2.1.3 WiseCOOP/WiseHOME

At September 2018 a citizen engagement workshop took place, with an important participation of citizens of Mesogia, that were more interested about energy and innovation. One of the main outcomes, was the fact that despite their initial interest expressed, the citizens hesitated to participate actively in the next project steps. In order to improve this situation and increase their engagement new activities are going to be launched including the installation of new meters and a new workshop in Mesogia and Meltemi area.

Citizen engagement enhancement

HEDNO intends to implement a small pilot project of smart meters with PLC communication technology at approximately 200 Low Voltage (LV) customers power-supplied from the line 1-10 Markopoulou (Substation MM-473) in Mesogia area, in order to increase the observability of the LV line and enhance citizens' participation. The implementation of the pilot project, and more specifically the procurement and installation of the aforementioned smart meters, depends on the results of the site survey regarding the signal strength between the Data Concentrator Unit and smart meters.

Check of installed SLAM/SMX communication status

The SLAM/SMX devices installed during the NobelGRID project will be used for the purposes of WG Cockpit and WiseCOOP/WiseHOME. These devices are 150 in total and have been installed at various sites. In order to integrate them in the WiseGRID ecosystem it is required to test their current status and resolve any pending issues, usually occurring due to communication problems.

For that purpose, ICCS with the collaboration of HEDNO and ETRA, have started resolving these issues. Currently most of the problems related to SLAM have been dealt with. The SMXs will be considered after the SLAMs.

3.2.1.4 WiseCORP

WiseCORP in Mesogia pilot will be tested on the two Combined Heat and Power units (microCHP) owned by ICCS and EDA. During Preliminary Deployment both partners were managing to identify the most appropriate sites for the units to be installed, since they had specific space and safety requirements, minimum warm water consumption and gas supply (which is not existent at all parts in Athens). The results of these efforts were to select as appropriate a private medical clinic in Peristeri region of Greece for the EDA's unit and the Sport Center facilities of the NTUA campus for ICCS's unit. As a following step the partners prepared the hosting site and proceeded to the selection of the appropriate installer. For both cases the installation is about to start and the paperwork is being prepared in order to proceed to the licensing of the units.

3.2.2 LESSONS LEARNED AND POSSIBLE RISKS

Lessons Learned

- During the process of gathering all the necessary data, there were difficulties arising from the wide dispersion of systems used by a DSO, where sections of information may be found in one system and others in another, even if the "object of interest" remains the same.

Moreover, attention is needed when dealing with customers' data. Either way, HEDNO is entitled by law to collect, process and store the metering data of the users. The consent form is still under discussion inside the company in order to be finalised, while the usage points and consumption data will appear under aliases in order to protect the end-users anonymity.

- For the purposed of WG Cockpit, ICCS provided the Power Quality module. This module has been tested and verified with realistic data. However, the specific requirements of input data of this tool make it difficult to find real-time data. In Mesogia, currently there is no possibility of retrieving data of such type.
- During HEDNO's research on CIM, it required lot of effort and time and proved to be a challenging task, as the learning curve is quite steep at the very beginning, but afterwards is becomes easier to proceed.

Possible risks

- The number of users who will agree in signing the consent forms, answer the prosumers' questionnaire and participate actively in activities of the pilot project cannot be guaranteed. That's why HEDNO and

ICCS have tried to create an as wide as possible pool of potential customers, even through past projects and installation of new smart meters, in order to mitigate this risk. Also, HEDNO keeps always seeking new and effective ways to approach more users in the region, inform them and propose to them to participate.

- One of the most crucial parts for the operation of the CHPs is the licensing from the DSO. As a result it is a procedure which might take an amount of time. For the case of ICCS this might be a slightly longer process due to the fact that it is installed by a public institute (NTUA).

- The replacement of the old electromechanical meters with new smart-meters based on G3PLC to LV customers under the substation 473 of line 1-10 Markopoulou depends highly on the outcome of the signal strength test.

- It is really difficult to precisely know in advance the time needed for the CHP units licensing procedure to be completed upon submitting all the necessary documents.

3.2.3 DEMO OF THE TOOL

The main relevant work performed for the deployment of this tool was on the integration of the large networks explained above. The results of the integration of Mesogia's grid are shown in the following figures. There, the operator of Mesogia is able to see all the lines of its grid and also to see the substations. Clicking on the different elements of the grid, the operator is able to see the status of the same. It is still needed to configure all the smart meters to communicate with the WG Cockpit in order to show all the monitoring and control potential of the tool. This capabilities, that will be shown in D15.2, were not the main work at this stage as the local partners decided to firstly work on the definition of the topology, the configuration of the power flow calculator of the grid… as these actions could suppose greater risk for the final deployment of the tool than the communication of the smart meters with WiseGRID which is much more straightforward.
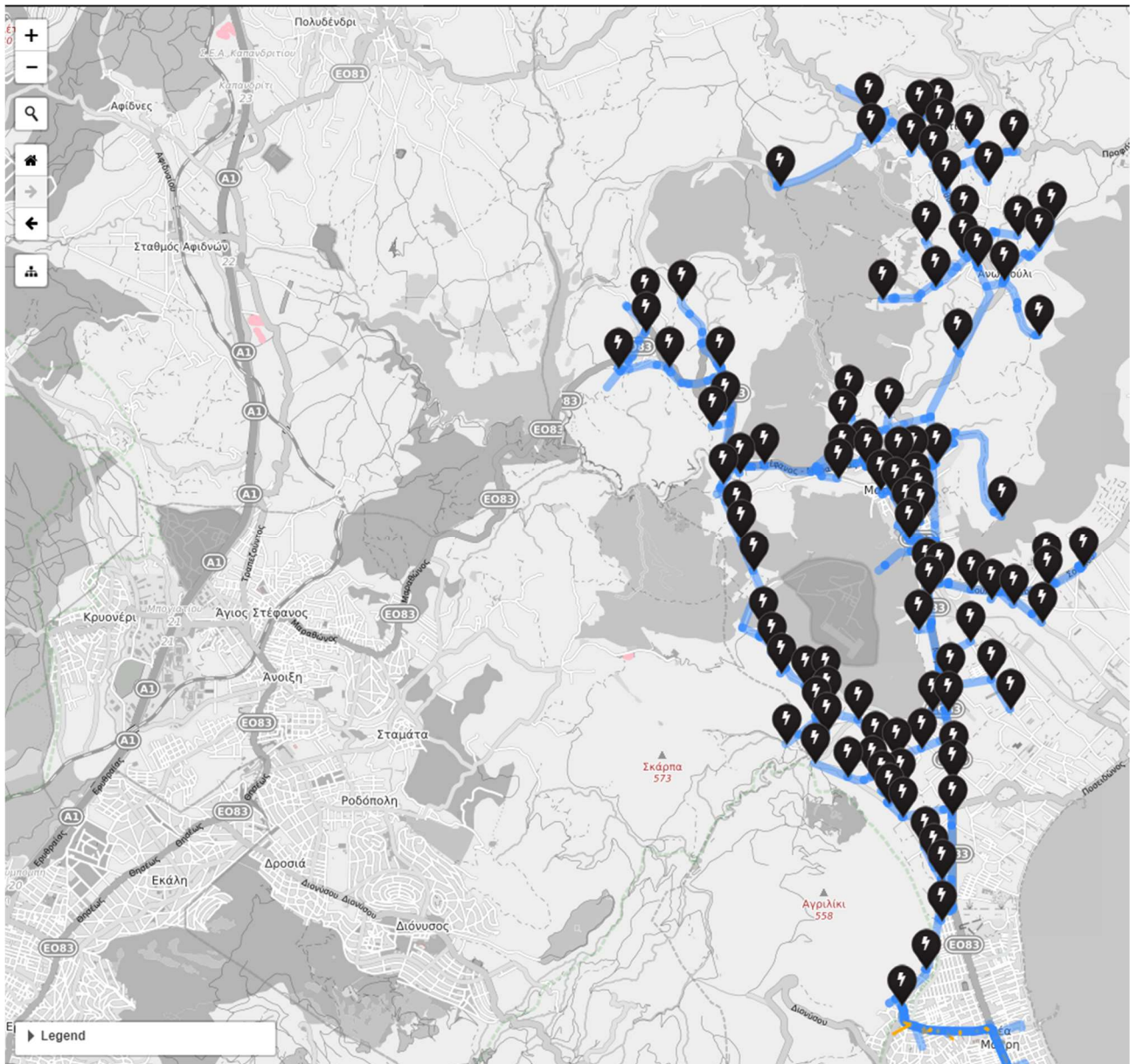
Figure 56 - WG Cockpit's representation of P-210 Network
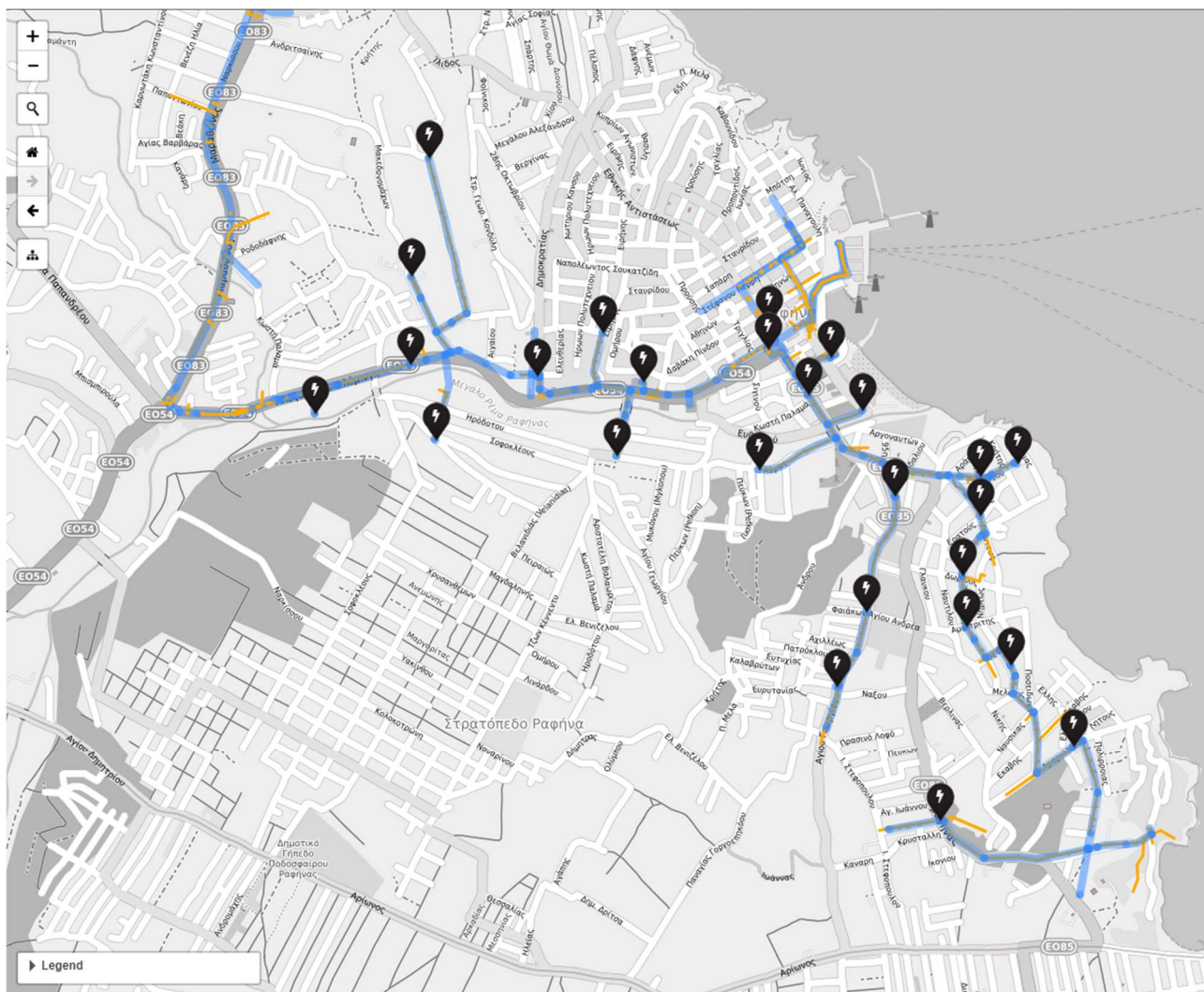
Figure 57 - WG Cockpit's representation of P-490 Network

Figure 58 - WG Cockpit's representation of 1-10 Markopoulou Network

3.3 CREVILLENT

3.3.1 REPORT OF THE DEPLOYMENT ACTIVITIES

3.3.1.1 ICT infrastructure

Before starting the deployment of the tools, a study has been made to know the data storage requirements of the servers in order to be sure that the tools will run smoothly during all the demo phase of the project. The minimal specifications can be found in Deliverable 5.1 "WiseGRID cloud-based big data infrastructure". According to that, the hardware provided by ENERCOOP is:

- 2 x CPU Intel Xeon E5 112 GB RAM

- 2 x SSD 120GB 10G Ethernet PCI Card

Figure 59 – Crevillent Pilot Site Rack Servers.

As part of the software provided to fulfil with the necessities of the tools, ENERCOOP has initially provided 9 virtual machines Ubuntu Server 16.04 with the following characteristics:

o **Wisegrid-IOP:**
   o **CPU cores: 4**
   o **RAM: 4GB**
   o **HD: 50 GB**
	o **Wisegrid-BD-Shard2:**
	   o **CPU cores: 1**
	   o **RAM: 2GB**
	   o **HD: 500GB**

o **Wisegird-ETRA:**
   o **CPU cores: 7**
   o **RAM: 16GB**
   o **HD: 200GB**
	o **Wisegrid-BD-Shard3:**
	   o CPU cores: 1
	   o RAM: 2GB
	   o HD: 500GB

o **Wisegrid-BD-Config1:**
   o CPU cores: 1
   o RAM: 1GB
   o HD: 10GB
	o **Wisegrid-APP-Router1:**
	   o CPU cores: 4
	   o RAM: 4GB
	   o HD: 10GB

o **Wisegrid-BD-Config2:**
   o **CPU cores: 1**
   o **RAM: 1GB**
   o **HD: 10GB**
	o **Wisegrid-APP-Router2:**
	   o CPU cores: 4
	   o RAM: 4GB
	   o HD: 10GB

o **Wisegrid-BD-Shard1:**
   o **CPU cores: 1**
   o **RAM: 2GB**
   o **HD: 500GB**	

All the tools to be tested in Crevillent (WG Cockpit, WiseCOOP, WiseCORP, WiseEVP, WG FastV2G, WiseHOME and WG IOP) have already been installed on those servers.

In the Pilot Site of Crevillent it was planned to be pre-deployed the WiseEVP and the WG FastV2G, the tools related with electromobility in the WiseGRID framework. It was decided in this way for a couple of reasons. The first one is that ENERCOOP has a small fleet of EVs and EVSEs that made manageable the first steps of the integration of WiseEVP. The second one was that we could also gain experience in the integration

of WiseEVP with a special charging station as the WG FastV2G and have this knowledge in case we arise different problems in the integration of the heterogeneous types of EVSEs in Flanders and Terni.

3.3.1.2 WiseEVP

WiseEVP has been integrated with the 4 EVSEs, property of Enercoop.

The first one is an *Ingerev City Duo* from Ingeteam placed at the parking of ENER headquarters. This charging point is OCPP compliant and allows to charge 2 EVs at the same time.

Figure 60 – Charging point at headquarters.

Figure 61 – Charging point at industrial plant.

The other three charging points are *RVE-WB* from Circutor placed at the ENER industrial plant. Those are also OCPP compliant and allow only one charge at the same time.

The EVSEs communicate with WiseEVP by means of the EVSE Wrapper (explained in Deliverable 9.1 "WiseEVP Design"). This EVSE wrapper is developed with .NET Framework technology and, therefore, requires Windows operating system to run. For this reason, we additionally required a machine with Windows to run this module (50 MB RAM required). As main steps taken for communicating with the EVSEs, it is possible to highlight:

- ENER IT department has configured its own network so that the EVSEs communicate with the Windows machine via VPN (for security, the communication is encapsulated in a VPN tunnel).

- Between ETRA and ENER, the EVSEs have been reconfigured to communicate with the EVSE wrapper by OCPP and to send the data with the frequency and form required by WiseGRID.

Concerning the EVs, ENER owns one Renault ZE 40 and one Renault Kangoo. Currently, Crevillent is missing a monitoring system for their fleet of vehicles. Within WP9, an EV wrapper for monitoring those vehicles has been developed. The system consists on the following:

- An OBD2 reader with Bluetooth capabilities has being installed in each of the vehicles.

Figure 62 – OBD2 reader installed.

- The EV Wrapper software consists on an Android app which:
  o Connects via Bluetooth with the OBD2 reader in order to trigger queries to the ECU in order to obtain the necessary parameters (SoC, travelled distance, battery capacity…)
  o Publishes the information in real-time to the WG IOP using the agreed communication mechanisms and common data model for EVs.

ENER employees who drive the EVs, have therefore installed the app on their phones to allow it to monitor and send the required data to WiseEVP.

3.3.1.3 WG FastV2G

Figure 63 – WG FastV2G installation.

For installing the WG FastV2G, firstly ENER had to reconfigure the electricity distribution box of the building to feed the WG FastV2G. Then, ENER allowed Ethernet connection for connecting the WG FastV2G to the company servers. Once these preliminary activities were performed, ITE made a visit to the industrial plant to install the EVSE.

Firstly, they connected the station to the three-phase network and enabled the Ethernet connection to work remotely. Once these actions were completed, three tests have been carried out:

1. Unidirectional loading.

2. Download.

3. Intelligent charging, where the transition from load to discharge has been validated and vice versa.

The configuration with WiseEVP was straightforward due to the previous work performed for connecting with the other EVSEs.

Concerning the other tools, their deployment activities will be further explained in Deliverable 15.2 "WiseGRID integrated ecosystem intermediate deployment and demonstration". However, in this section will be highlighted the main steps taken on them.

3.3.1.4 WG Cockpit

Integration with the new SCADA installed in ENER premises. The new SCADA with TEDISNET technology feeds WG Cockpit with the required data for performing its calculations. In addition, as other main step taken, the definition of the topology of ENER's network has been integrated in the tool from the plans provided by ENER.

3.3.1.5 WiseCOOP

FTP configuration to give access to the demand and production data (SO2 files) to WiseCOOP to carry out the studies of the consumers involved.

3.3.1.6 WiseHOME

As WiseHOME is fed by WiseCOOP analytics, the main activities for assuring its testing dealt with the identification of the final users and their signature of the consent form (developed under the scope of the Data Protection Impact Assessment).

3.3.1.7 WiseCORP

Is required the installation of 4 SMXs for monitoring the demand and production data of the 4 buildings included in the trials. Z-WAVE sensors and actuators will be also integrated with the SMX together with temperature and brightness sensors and dimming actuators for allowing automated Demand Response capabilities with the HVACs and the illumination devices.

In order to enable control of the required devices (HVACs and possibly lighting) and monitoring of contextual information (mainly luminance and temperature), one SMX will be installed in each of the buildings participating in the project. So far, activities have been performed in the lab-testing environment in order to integrate the required field devices within WiseCORP.

3.3.2 LESSONS LEARNED AND POSSIBLE RISKS

During the integration between WiseEVP and the fleet of vehicles, some communication problems have been faced. Although in a lab environment, simulating the response of an EV, the tests were fine, once the OBD2 were installed in the real ENER EVs, the Bluetooth connection with the OBD2 device failed. In order to

find the root of the issue, ETRA developed an update of the Android app. This update shows a message to the driver (once the problem arises) asking him/her for sending a report to ETRA. Once the driver sends the reports to ETRA, ETRA is able to analyse them and try to find the communication problem of the app.

This experience reaffirmed the opinion of the Consortium of the need of having a standard for communicating with CAN buses from EVs (in the same way that conventional vehicles already have).

It is not expected to have more problems with the EV communications (the other WiseEVP pilots, Flanders and Terni have their own tracking system and during the lab testing phase the communication tests were successful) and as during this phase no problems with the communications with EVSEs have arisen, no other possible risks on this topic are envisaged.

3.3.3   DEMO OF THE TOOL

3.3.3.1   WiseEVP

The dashboard currently represents the charts of energy used by the charging stations and the associated CO_2 emissions of this energy demand. CO_2 emissions are currently based on the national energy mix information. Oncoming work is planned to take into consideration the production of the solar farm in the town in the calculation of more accurate energy mix figures.
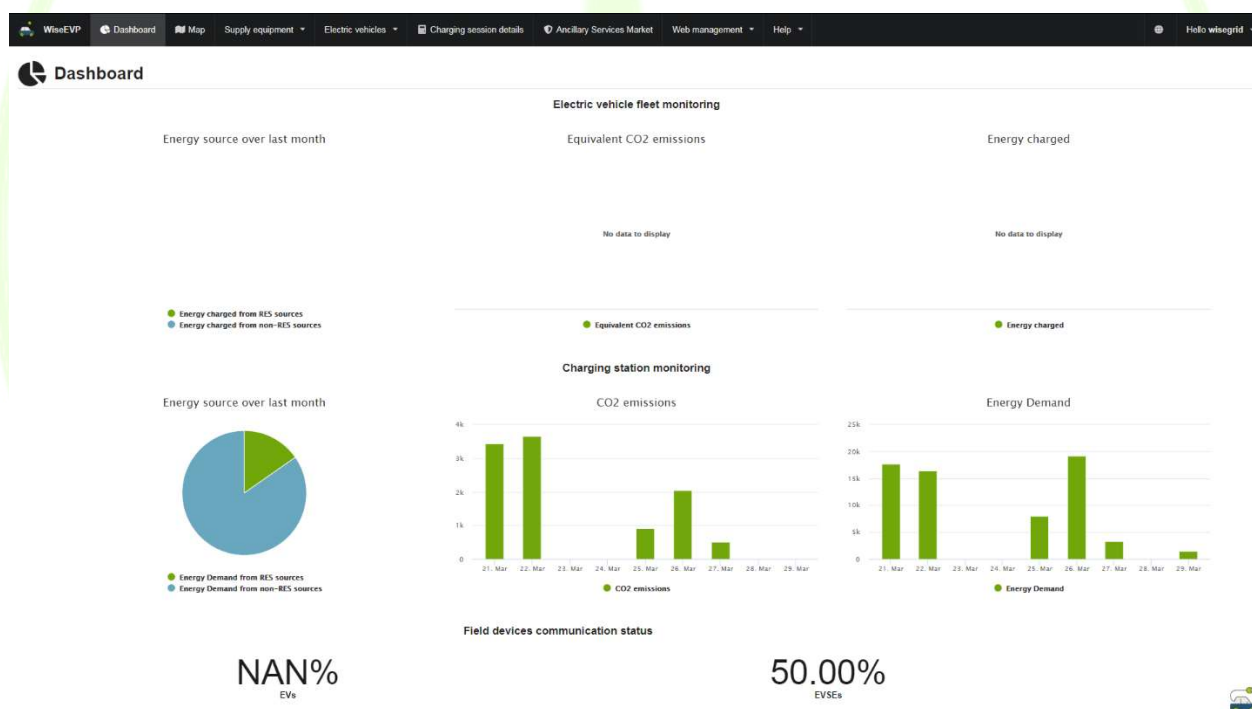
Figure 64 – WiseEVP UI – Dashboard.

Over the map, all four charging stations – one located at ENERCOOP offices in the centre of the town, and three located at ENERCOOP's warehouse –, as well as their status, are represented.
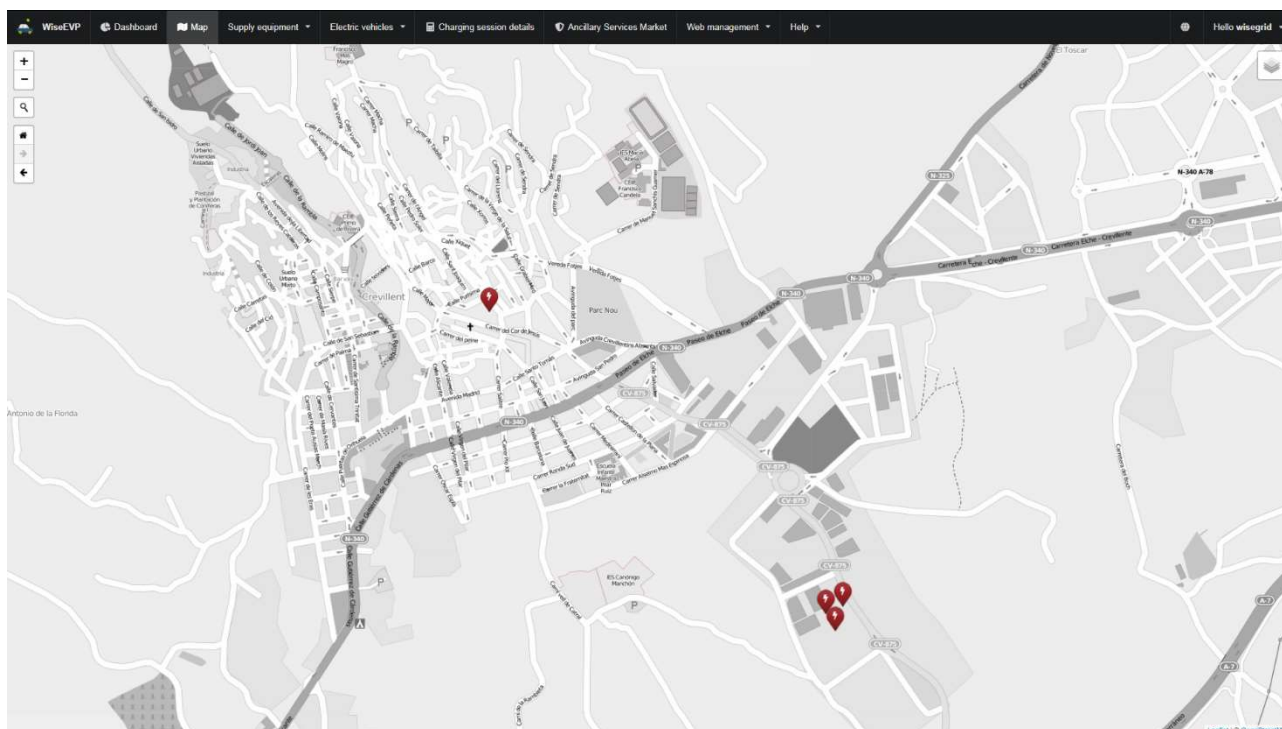
Figure 65 – WiseEVP UI – Map.

The EVSE detail section of the UI currently provides details on the current status of the selected charging station, making it possible to see a detailed view of the energy demand of each one of the stations and their current status. Since charging stations integrated so far are OCPPv1.5 compliant, they do not support dynamic charge, and therefore no profile is being calculated for those stations.
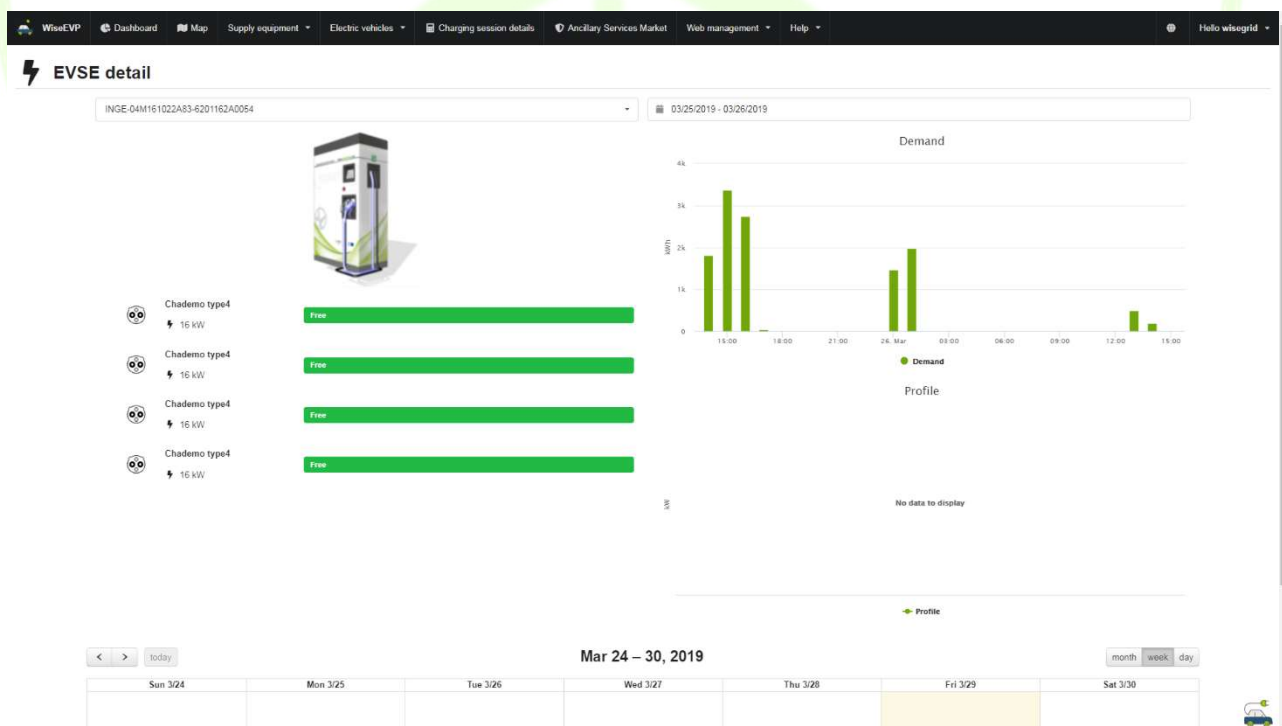
Figure 66 – WiseEVP UI – EVSE details.

The EVSE indicators section provides an overview of the energy, economic and environmental impact of the charging stations installation over the selected month.
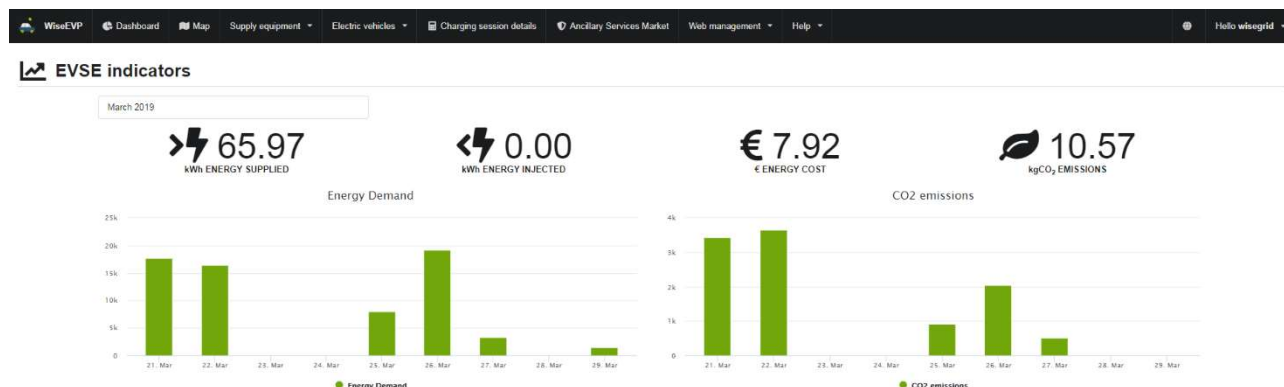
Finally, the charging session details makes it possible to look for particular charging sessions, giving a detailed overview of the energy charged and its economic and environmental impact. The application automatically compares the data with the theoretic dumb charge (i.e. charge as fast as you can), in order to represent the impact of the regulation algorithms in the cost, equivalent emissions and duration of the charging session.
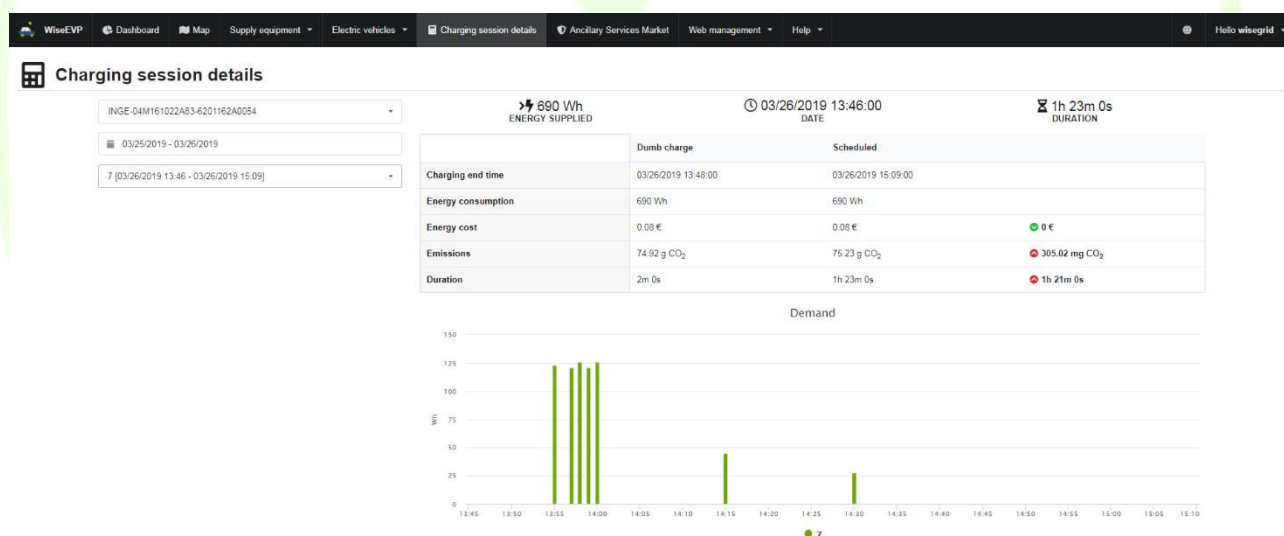
Figure 68 – WiseEVP UI – Charging session details.

3.4 TERNI

3.4.1 REPORT OF THE DEPLOYMENT ACTIVITIES

The preliminary and first deployment of equipment and systems in the Terni trial site started in August 2018 with the aim to demonstrate the WISEGRID integrated ecosystem solution. Several activities were carried out by ASM Terni and ENG, with the fruitful collaboration of other technical partners, in order to pave

the way for an effective large-scale demonstration in the City of Terni. Two main objectives have been targeted: the deployment of the WiseGRID tools and the finalisation of the SLAMs and SMXs installation, already deployed during the Nobel GRID project [1] but specifically fine-tuned for WiseGRID.

According to D 14.1, reference [2], Terni Pilot Site has to be demonstrator of functionalities and UCs provided by the following tools, as in Figure 69 :

- WG Cockpit,
- WG RESCO,
- WG STaaS/VPP,
- WiseEVP,
- WiseHOME,
- WiseCOOP,
- WiseCORP.
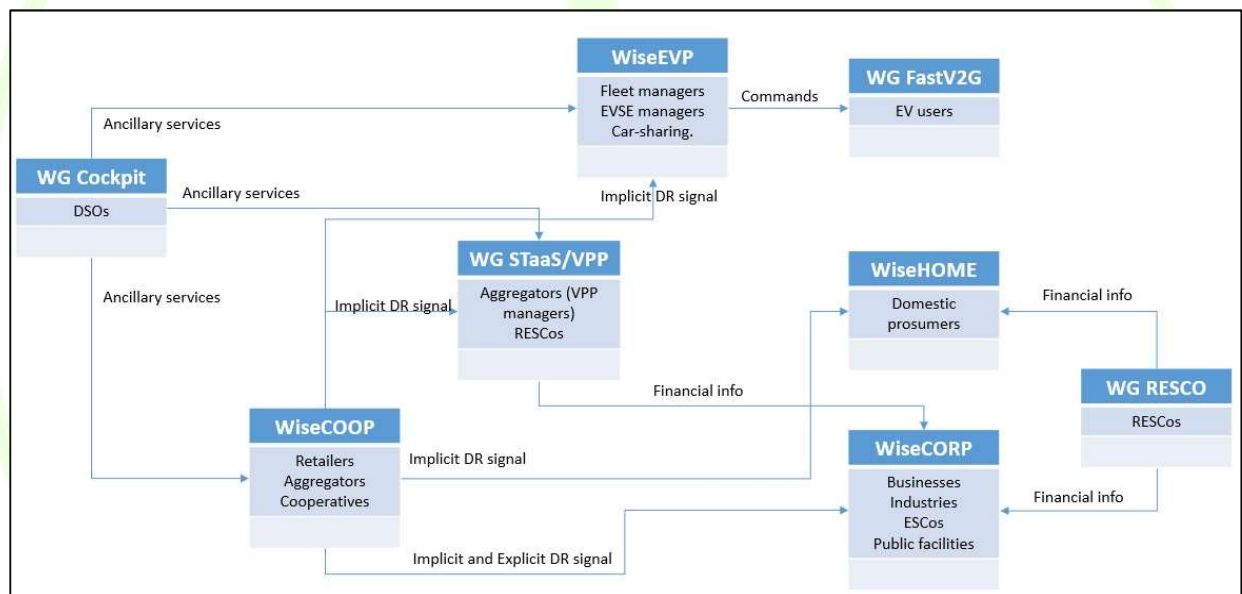
Figure 69 – General Architecture of WiseGRID project.

3.4.1.1 WG RESCO & WG STaaS/VPP

As foreseen by the GA [3], the preliminary deployment was carried out from August 2018 to December 2018, starting with a couple of tools which were installed locally for testing specific functionalities; in a meanwhile a suitable server infrastructure was deployed and fine-tuned for the project purposes. Notably, the following tools were preliminary hosted in Terni server farm:

- WG RESCO,
- WG STaaS/VPP.

In order to allow their functionalities, ASM Terni also provided a server to properly host the instances of the following services:

- IOP

- RT Monitor

- A server devoted only to the BIG DATA Platform

In this respect, the approach, shared by all partners, was to deploy 3 servers, one devoted to the WG IOP, one for the DB and the last one devoted to the Docker installation. For this reason, ASM made available 3 VMs specifically installed in its own server farm; HW requirements have been provided according to specifications found out by the Lab Testing activities carried out by tools providers in the previous period (i.e., since February 2018 to July 2018) and reported in the related Deliverables. For the preliminary deployment, the following resources were made available to the project:

- 3 Servers with Linux OS:

    - 8 GB RAM and 4 CPU for each server

    - 20 GB for tool server

    - 10 GB for IOP server

    - 100 GB for the server deployed for the DB

The resources have been increased during the final deployment because of the increasing number of the running tools, additional RAM, memory for HD and CPU have been taken from the local server farm already installed and consolidated in ASM. With respect to the communication, server is currently available by means of LAN, VPN and they also contains public services, as foreseen by the project architecture. During this phase, ENG, as technical partner of the pilot site, carried out the docker installations of the tools, basic installation of Rabbit MQ broker and related configurations as well as a mongo DB installation. All the installation is actually up and running and, since October 2018, the local installations have been public available at the following link:

- WG RESCO: http://wisegrid.ddns.net:8080,

- WG STaaS/VPP: http://wisegrid.ddns.net:3000

With respect to the final deployment, a part of the remaining tools (WG Cockpit, WiseCOOP, WiseCORP, WiseEVP) have been installed by ETRA and RAM memory of the server was increased up to 16 GB. For all of them, Docker installation was done, and the tool is actually up and running.

With respect to WiseEVP, EMOT, supported by ETRA, carried out tests in its own laboratory to verify the tool functionality before its installation in the pilot site; specifically, it was verified that the electric vehicles and the charging stations data were published in real time on the platform and that the functions of the tool were executable properly. The single-board computer equipped within EMOT smart charging stations, shown in Figure 70, has been tested to allow remote control via WiseEVP, thus enabling the use of electric mobility in Demand Response campaigns orchestrated by WiseGRID tools.

Figure 70 – Raspberry Pi 3, installed in EMOT EVSE, used for WiseEVP laboratory tests.

3.4.1.2 WiseCOOP & WiseHOME

As for WiseHOME, data are gathered from WiseCOOP and its instances are deployed at HYPERTECH premises, since it does not need any local installation.

During the same period, ASM finalised the near real time Smart Meters installation, namely SMX and SLAM originated from Nobel GRID project. The aim of this activities was to fine tune communication between Smart Meter and SMX and SLAM with the server; in addition, a set of customers was selected to perform demonstration activities for more meaningful results as well as to be aligned with the WiseGRID goals. Figure 71 reports in the map of the city, the main installation of SMX and SLAM, notably:

- 6 public facilities (schools)
- 27 business/service (tertiary) producers (with a medium size of 30 kW)
- 15 industries/Industrial (Secondary) Producers (with a medium size of 50 kW)
- 51 residential/domestic (with a medium size of 3 kW)
- 10 PV arrays (with a medium size of 20 kW)
- 7 Primary substations
- 7 ASM blocks of energy units
- 33 small industrial loads

With respect to the rest of SMX/SLAM developed over Nobel GRID project, some of them were disconnected because of closing the contract, others are under maintenance and their replacement is ongoing. The general purpose of this activity has been not only to involve a number of people as high as possible, but also

to cover different type of electricity Figure 71 shows the distribution of different categories of consumers and producers scattered across the city of Terni.
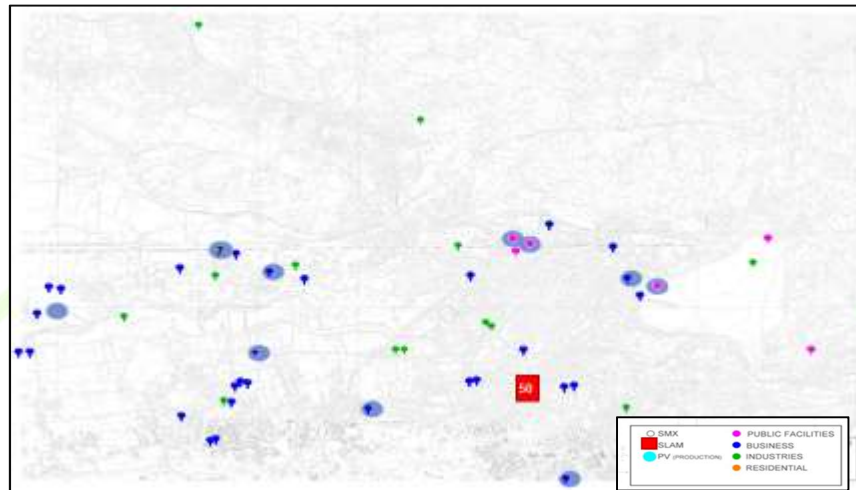
Figure 71 – Near Real time SMs installed in the distribution network of Terni.

A thorough energy assessment was carried out by ASM Terni on the apartment building in which 50 SLAMs were installed during NobelGrid (Figure 72). In detail, based on the information stored in the ASM Terni database, the energy consumption of this specific building has been analysed in order to understand behavioural changes due to the weather conditions and over the time. It is worth noting that understanding the electricity consumption of householders year by year is fundamental to show how much the WiseGRID tools are able to engage citizens in the energy ecosystem, changing their behaviours.

Figure 72 – SLAM installation in an apartment building in Terni.

Therefore, ASM analysed the electricity consumption of the 50 householders living in the apartment building from 2015 to 2017, normalising the value using the number of people living in each flat and the related square meters. As shown in Figure 73, five classes were identified, namely 0.5, 1.0, 1.5, 2.0 and 2.5

kWh/p/m^2 which had a different trend in energy consumption. The analysis shows that the 1.5 kWh/p/m^2 class decreases in number over the period whilst it is evident a rise in number of 1.0 kW/p/m^2 from 2015 to 2017, probably due to a raising awareness in energy saving.
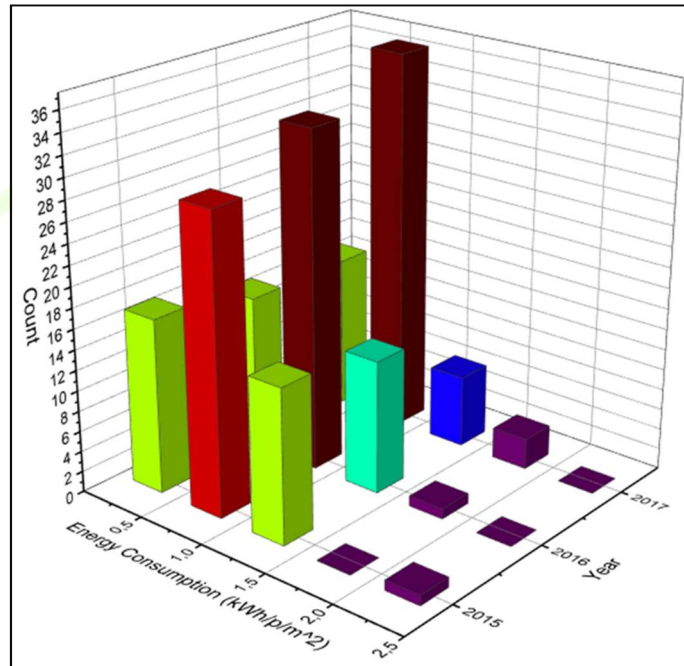
Figure 73 – Energy consumption of customers in the apartment building.

Moreover, the influence of weather conditions on the energy consumption of the average value of both the 60 apartment building householders and more than 10,000 domestic consumers were investigated. Figure 74 shows that the energy consumption of the apartment building is slightly higher than the average value of the random population. Rain is partially correlated with the energy consumption whilst temperature shows a strong correlation both in winter (heating) and in summer (cooling).
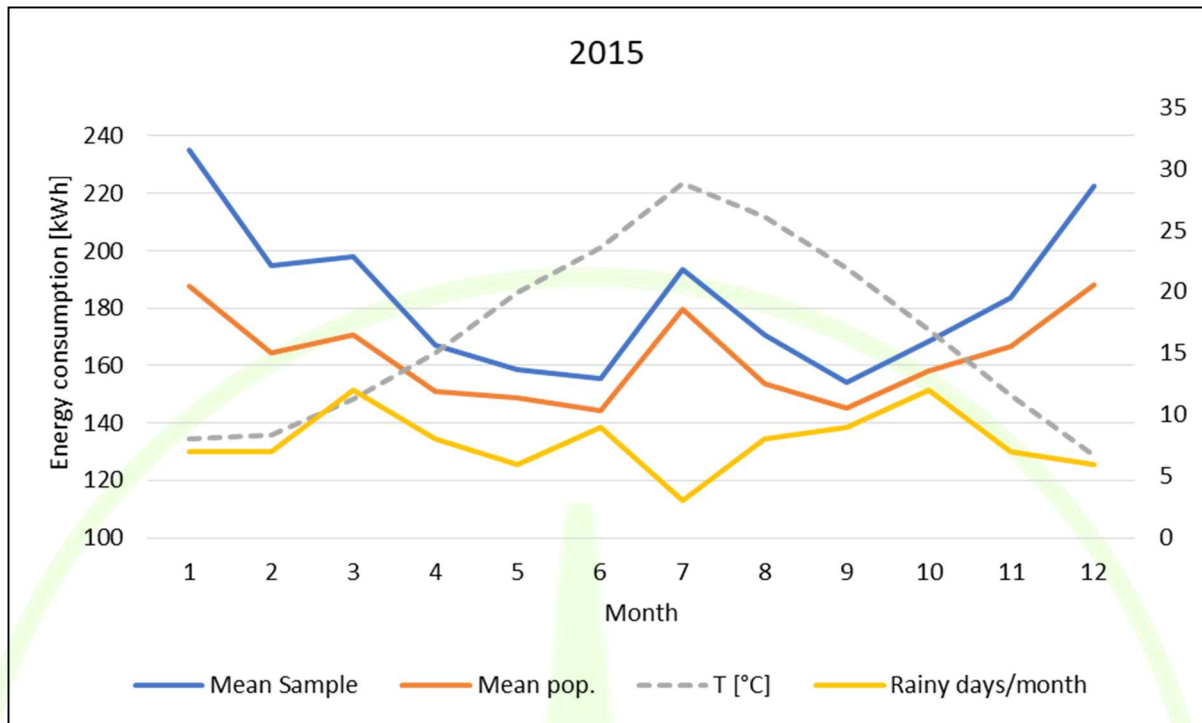
Figure 74 – Influence of weather conditions on the Energy consumption.

Besides, to demonstrate the WiseGRID Use Cases linked to the RESCO tool, in January 2019 ASM Terni finalised the installation at its headquarters, already presented in [4], of a Building Energy Management System, able to control its HVAC (Heating, Ventilation and Air Conditioning) system. . Figure 75 shows the diagram of BEMS system installed in the ASM Terni headquarters. BEMS consists of different modules, which are programmable units that implement open protocols (LON, BACnet, KNX, EnOcean, Modbus, M-Bus, OPC); an integrated building management software has been also put in operation, duly customised for the WiseGRID project.
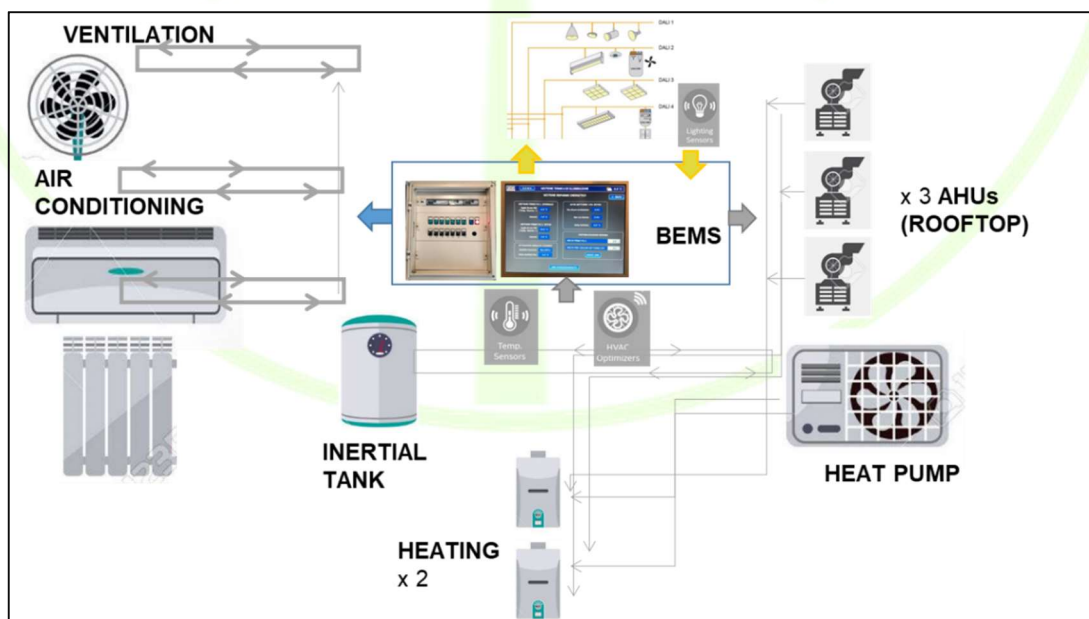
Figure 75 – BEMS diagram in Terni.

3.4.2 LESSONS LEARNED AND POSSIBLE RISKS

During the deployment activities, ASM, ENG and the other technical partners have actively collaborated to deploy the WiseGRID solutions in Terni trial site, overcoming all the obstacles facing over the period due to a good coordination between partners and a proper timeline established from the beginning. However, since in the future the deployed infrastructure has to receive data from an increasing number of SMX/SLAM, problems could arise on the big data storage especially due to the limited IT resources, although all the components are currently running without issues.

As for the storage system, the following risks have been identified:

- Environmental conditions (temperature, safety equipment….) are less demanding due to the use of EV batteries, which integrate their own safety monitoring and equipment.

- Stability trouble on storage system prototype.

- Battery maintenance: battery under voltage on one battery, need to change it on second quarter of 2019. This results on key information for storage adaptation. It leads to a software adaptation on new storage system.

3.4.3 DEMO OF THE TOOL

3.4.3.1 WiseGRID RESCO
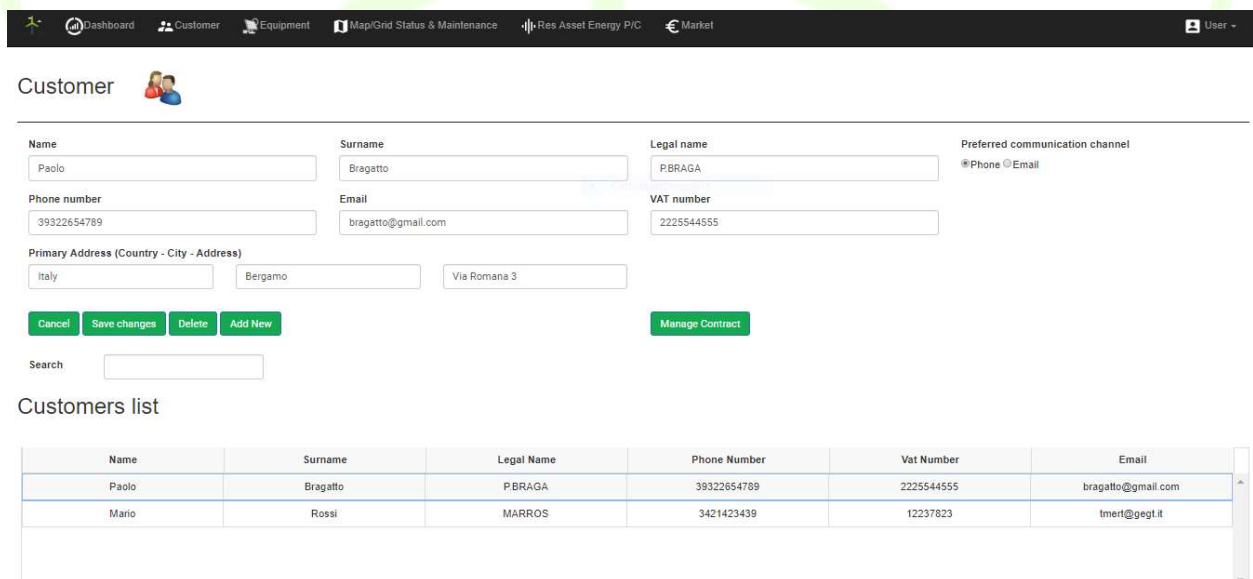
During the preliminary deployment phase the WG-RESCO tool within the Terni Pilot site has been installed and several tests have been performed to demonstrate the correct integration between WG RESCO and others WiseGRID tools, available assets and tool functionalities. In this regard, in agreement with the pilot site, some assets were considered to test the transmission of the measurements in real time and at the same time the saving of the same data in the database and subsequent reading. Below a list of the typology of assets that have been used to test a typical scenario for the WG RESCO tool (subsequently described), for each typology of asset a specific ID has been configured to identify the measures transmitted.

Storage System	72 kWh 2nd life Li-ion battery energy storage is the Block of Energy Unit (BoEU) providing the electric power storage and supply services. It is the BoEU that plays an important role in providing the district with the flexibility necessary to implement different services, especially ancillary services like Primary reserve, Dynamic reactive Power control and Reactive Power Compensation.
PV plant	The PV plant cover the Parking Surface (2000 m²) producing about 230 MWh yearly.
Building	ASM Terni buildings comprising a 4,050 m² three stories office building, a 2,790 m² single-floor building consisting of technical offices, a computer centre and an operation control centre and a 1,350 m² 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.

Primary Substation	It is the primary substation at which these facilities are normally connected. The energy drawn yearly is about 27 GWh, whilst Reverse Power Flow (RPF) produced by local Distributed Generators has a total amount equal to 5 GWh. The peak power is about 20 MW when it is absorbing energy from the TSO, while it is equal to 11.1 MW, in case of RPF.

The Resco signs a contract with a customer who lives in Terni and who makes available the roof of his home for the installation and maintenance of some photovoltaic panels in order to allow the production of green energy to be sold on the market. This type of contract requires that the Resco pays a fee to the customer to use the roof of his house and that it can exploit and sell to the market all the energy produced by the RES plant. The Resco will have to take charge of the installation and commissioning of all the assets, as well as ordinary and extraordinary maintenance. By using the WG RESCO the company will be able to verify in real time the production and possible consumption of energy from these assets and query a history for internal analysis; it will be able to manage invoicing with the customer either manually or automatically with a monthly billing deadline; the company will be able to manage both in a fully automatic way the ordinary maintenance of the installed assets and manually following a fault report due to, for example, a failure in data transmission or a fault report by the customer. The Resco can easily check the systems assets managed by him thanks to a special functionality that show into a map the different typology of assets and see immediately those running and those stopped. Resco will be able to calculate the daily amount of energy surplus that can be offered to the market and send energy offers. Below the steps that have been taken to demonstrate this scenario using a series of assets made available by the pilot site of Terni and previously mentioned in detail and connected through the WG IOP and all its micro services to the WiseGRID platform.

The first action that the Resco must do is to register the customer with whom it will sign the contract to the system. In order to do that, Resco will fill all the required fields presented in the "Customer" functionality and store these data into the database by the "Add new" button.

Figure 76 – WG RESCO Customer Info.

Resco registers a new contract with the customer and links all the installed assets of the customer supply point, in this case the asset IDs are the one mentioned above. By the Contract functionality Resco configures also the typology of assets that are predefined into the "Asset manager" functionality and fills all the required fields to sign a contract like the "Type of organization", the "Contract type", the "Supply point address", the "Contract validity period" and save the new contract in the system.

In this example the organization is a "Household", the contract type is "RESCO pays a fee" and the address of this customer is located to the Terni pilot site, this contract has also a validity of one year.

Figure 77 – WG RESCO Contract manager.

After signing the contract with the customer, the Resco is ready to operate its own renewable energy plant. Through the "Res Asset Energy P/C" function it can see in real time the trend of energy production and consumption or query the history of the data and if needed, for example for internal analysis, to view a forecast of energy production and consumption for the next day.

Figure 78 – WG RESCO Res Asset Energy P/C.

At any time, the Resco can use the "Map grid status" functionality to check the status of its plant, it can immediately see if any assets are running or not for maintenance, according the icon colours.

Figure 79 – WG RESCO Map/Grid status.

By the previous functionality the Resco can have access to the Maintenance manager functionalities to check and manage the maintenance of the assets through a smiley-shaped link.

Figure 80 – WG RESCO Maintenance manager

In this demo scenario the Resco signs a type of contract with the customer to be able to sell all the energy produced at its supply point paying an agreed fee. In order to sell this energy to the market Resco uses the "Market" feature through which on the basis of the type of contract, the tool calculates the energy that can be sold the day ahead. After the calculation, Resco can offer the available energy and send an Energy offer message to the market. The offer can be accepted or rejected by the actors who are interested in buying energy.

The Market Participation gives to the Resco, an energy Consumption and Production forecast for single contract/supply or for all the active ones.
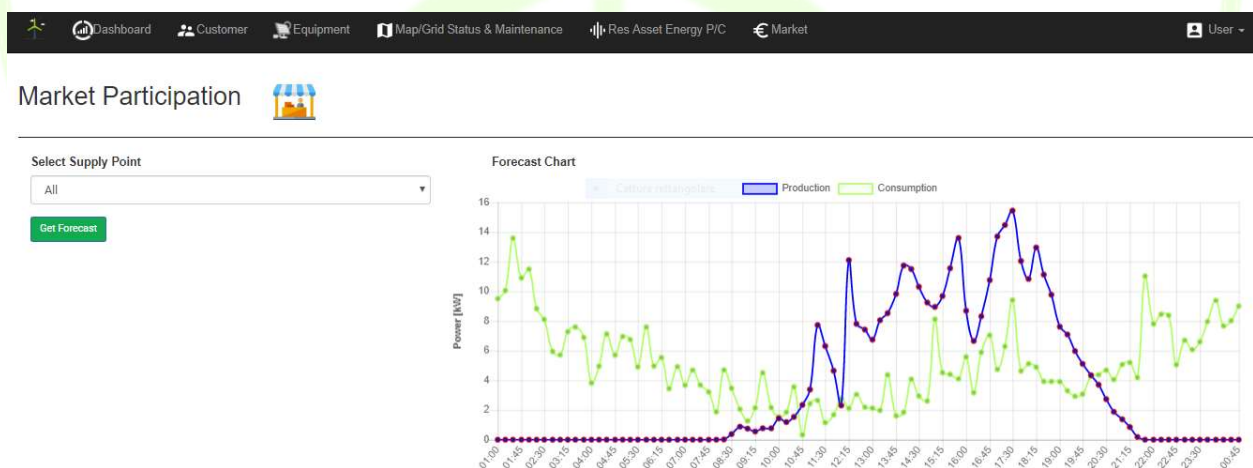
Figure 81 – Market Participation: Day ahead energy P/C forecast.

An algorithm calculates for the day ahead, when production will be greater than consumption and calculates the available surplus to be sold to the market. With a special button the Resco can manually send the offer to the market, otherwise the message with the offered energy is automatically sent to the Market every day.

Figure 82 – Market Participation : Res Energy surplus Available kW.

Resco has a dashboard that allows it to verify, in real time, various information relating to the aggregation of contracts and customers that it manages, the type of assets installed, the real time energy production and consumption and monitor the revenue for the current year derived from the sale of energy for the different contract typology.
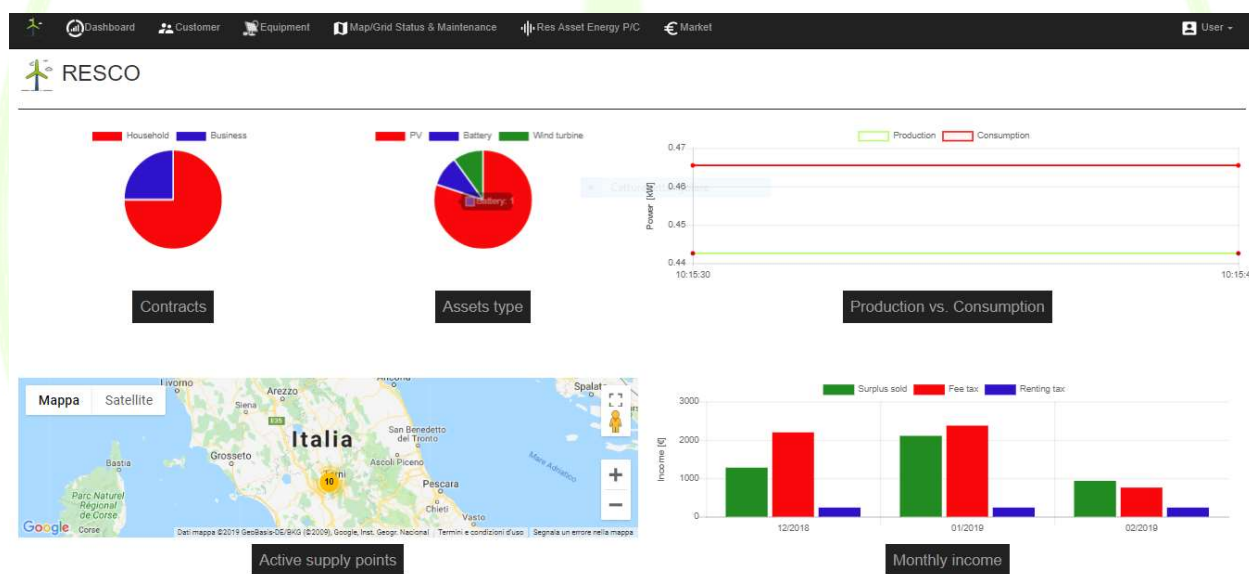
Figure 83 – WG RESCO dashboard
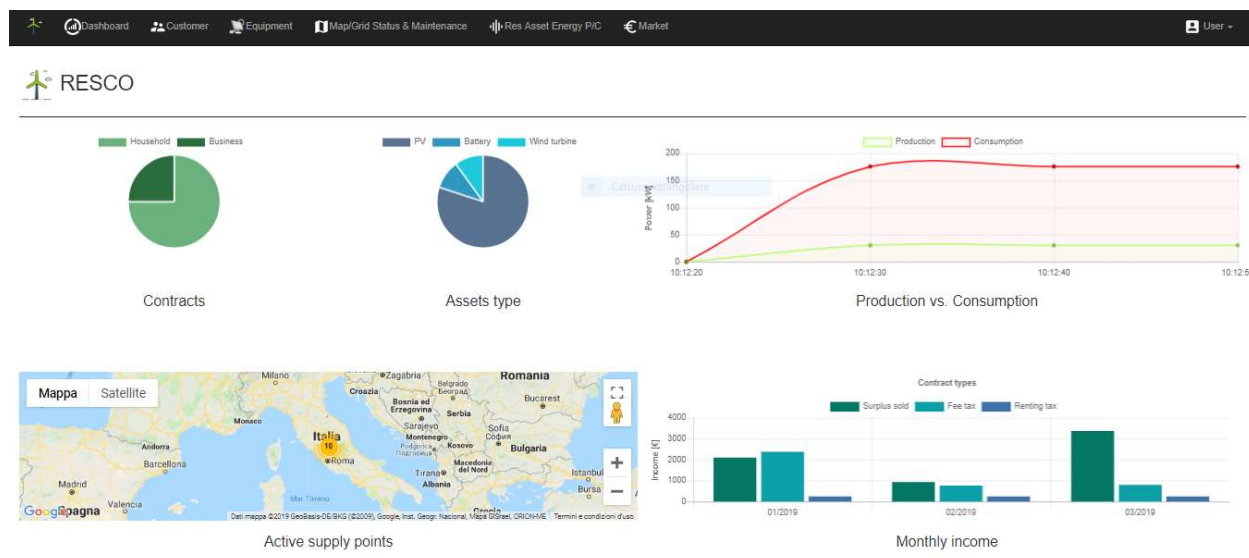
Figure 84 – WG RESCO Dashboard.

3.4.3.2 WG STaaS/VPP

Similar to the RESCO tool customer contracts can be managed within the WG STaaS/VPP as well. As illustrated in the figure below contracts and customer data can be created and managed within the tool. On the right side of the figure one can see that among others also a customer called ASM Terni was created and assigned to Pool 1. In general, each contract has its own ID.

Figure 85 - Customer manage section of WG STaaS/VPP.

Furthermore, equipment can be managed within the tool as well. For WG STaaS/VPP batteries, PV, load and Supply point SMX can be defined. For batteries and PV an advanced parameterisation the type and the most important system parameters can be defined. In Terni one battery is available with 66 kWh of capacity and a power output of 72 kW.

For monitoring purposes, a real time monitor is considered in the tool. In the figure below monitoring

data of the battery storage system in Terni is illustrated. During the time the data was gathered the battery was in standby mode which is the reason why the active and reactive power is 0. However, the SOH of the 2ndlife battery as well as the SOC are shown.
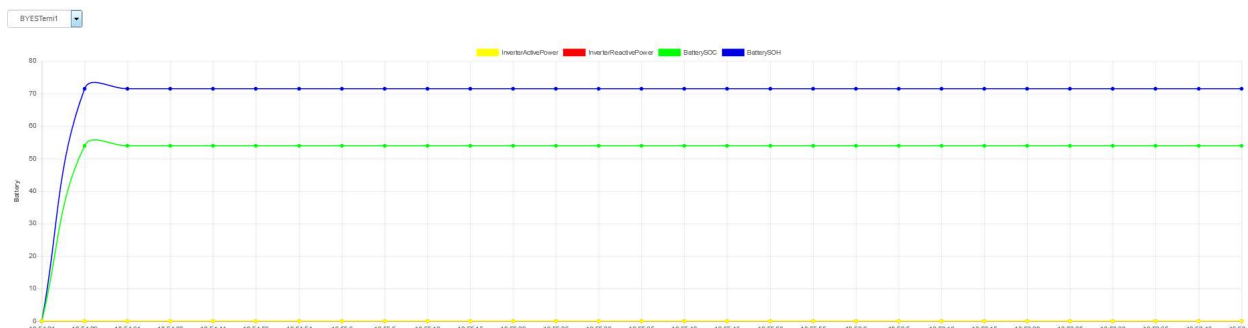
Figure 86 - Real time monitor of WG STaaS/VPP.

Beside real time also historical data can be illustrated. Here the same parameters as for real time monitoring are illustrated. In the figure below you can find historical data from the system.

Figure 87 – Historic data illustration.

In case an event occurs the WG STaaS/VPP tool is receiving requests from the DSO though WG Cockpit according to the defined Market Hub Spec. These requests are listed as campaigns in the WG STaaS/VPP tool

containing relevant information like the data and period of the request as well as the requested power.

For each campaign that is listed in the tool an offer can be provided by WG STaaS/VPP. The aggregator simulates if enough flexibility is available in order to meet the request and furthermore can manually set the price for each kWh provided. Based on that the expected income is calculated which is the basis for sending the offer to the DSO. After sending an offer the field in the column "Offered" in the respective campaign turns from "false" to "true". In case the DSO accepts the offer WG STaaS/VPP receives this information and the field in the column "Accepted" turns from "false" to "true" as well. Afterwards the WG STaaS/VPP will distribute the overall power that is requested in the campaign to the distributed batteries. Since in Terni just one battery is available the overall power is provided by that system. Below extracts from the page dealing with the handling of the DSO requests are illustrated.

Show requests   All ▾

Request				
Id Campaign	**Time Period of Request**	**PTU Start - End**	**PTU-Duration**	**Request power**
2019031113test-b94e-4f64-ba94-5daaad7a02af	2019-03-11	53-56	PT15M	1000
2019031115hplus-b94e-4f64-ba94-5daaad7a02af	2019-03-11	59-62	PT15M	1000
2019031116h-b94e-4f64-ba94-5daaad7a02af	2019-03-11	62-65	PT15M	1000

Offer for Campaign 2019031116h-b94e-4f64-ba94-5daaad7a02af						
Sequence Id	**Pool**	**Offered power**	**Offered price**	**Expected Income**	**Offered**	**Accepted**
2019021115242703040	Pool1	1000.00	10.00	10.00	true	true

Price for offer 10 **Pool** Pool1 ▾ Simulate Offer for

Figure 88 – Listing of DSO requests and generation of offers within WG STaaS/VPP.

3.5 KYTHNOS

3.5.1 REPORT OF THE DEPLOYMENT ACTIVITIES

The main goal of Kythnos pilot site is to increase the penetration of renewable energy sources (RES) in the island mix and reduce their curtailment. This will be achieved by deploying flexible loads such as the existing desalination plant, to which special automated operation will be implemented, battery storage systems in municipal buildings and electric vehicles and charging stations. With the implementation of the WiseGRID

tools, the local operator will be able to manage these flexible, dispatchable loads in order to provide their services in a cost-efficient and reliable manner.

To this end, an energy demand and production forecast for the island was developed by ITE, that will be used as an input to all tools at the desalination plant (WiseCORP), the battery storage systems (WG StaaS/VPP) and the EV charging stations (WiseEVP).

The forecast will be produced as follows:

1. WiseGRID Cockpit - Energy metering in the island

WiseGRID Cockpit will be in charge of receiving measurements from:

-   Significant energy production systems of the island (e.g. wind turbine)
-   Significant energy demand centers of the island (e.g. substations supplying important population centers)

Based on the aggregated energy demand and production measurements, a global estimation for the whole island will be computed in real time as follows:

$$Prod_{Kythn} = \sum_i Prod_i$$

$$Demand_{Kythnos} = \sum_i Demand_i$$

As a result of this step, WG Cockpit will generate information on a virtual smart meter (BBB0000) that corresponds to an estimation of the complete demand and production in the island. This information will be published to the IOP.

2. WiseGRID Cockpit – 24h demand and production forecast

WiseGRID Cockpit forecast module will use the historical information of the metrics calculated in step 1, together with weather-related information, to periodically (e.g. every 1 hour) calculate the next 24 hour demand and production forecast in 15 minutes slots. This information will be also published to the IOP.

3. The above information will be shared to WiseCORP, WG STaaS/VPP and WiseEVP.

3.5.1.1 WiseCORP

WiseCORP is the tool that was deployed at the existing desalination plant in Kythnos during preliminary deployment activities. The plant's operation during energy demand peak-periods (i.e. summertime) can be challenging. The new automation is expected to contribute to a smoother energy distribution to the island and pave the path for renewable energy sources exploitation for the plant's operation in the future.

An intervention in the plant's control panel (PLC) or even its complete replacement will provide a full and autonomous operation of the plant at variable load, based on the logic described in the next paragraphs.

Following, a timeline of the interventions at the desalination plant are presented.

-   **October and November 2018:** Development of operation optimization algorithm and plan for new operation of the desalination plant within WiseGRID
-   **December 2018:** Re-programming of existing PLC in the desalination plant at the pilot site
-   **January 2019:** Communication design and definition of equipment for metering – Procurement of smart metering equipment - Configuration of SMX and smart meter/power analyzer and communication test with ETRA's server
-   **February 2019:** Installation of SMX and smart meter at desalination plant in Kythnos and connection

to PLC - SMX and smart meter commissioning and communication test

- **March and April 2019:** Run test for optimization algorithm with island demand and production data

Status before WiseGRID deployment

Current operation description

A basic flowchart of the desalination plant operation is presented in the figure below:
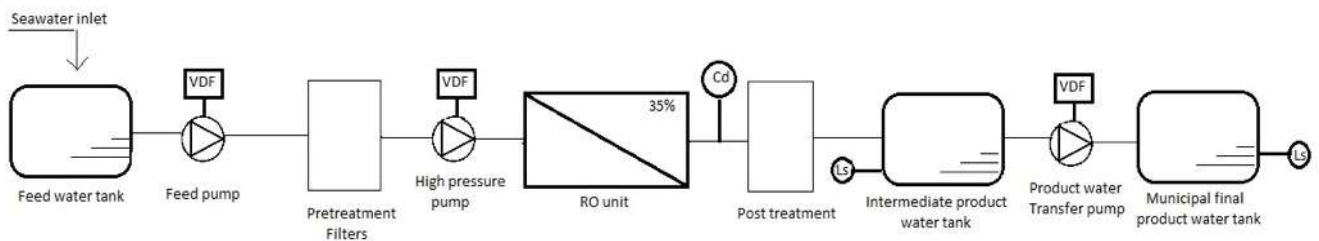
Figure 89 – The desalination plant operation scheme.

The control panels are placed on the system of the monitoring the pre & post treatment and the main treatment, from the feed water tank to the intermediate tank and a PLC controlling the product water transfer pump.

The main idea of the current operation is described in brief:

A level sensor (LS) at the final product water tank checks the level of water and gives an "ON/OFF" signal to the product water transfer pump (through the transfer pump's PLC) to start sending treated water from the intermediate storage tank. Another sensor placed on the intermediate tank sends an "ON/OFF" signal to the feed and high-pressure pumps to start operating in order to produce enough water to fill the tank. The plant starts operating at the design set point (product water flow rate: ~13 m³/h, recovery ~35%, feed water flow rate: ~ 37 m³/h), until the LS of the intermediate tank confirms the sufficiency of product water in the tank and gives the "OFF" signal. The plant then stops operating. During normal operation and especially at peak periods, the plant operates continuously producing 300 m3³/d and only stops for around 30'/ day in order for the pretreatment filters to be washed out.
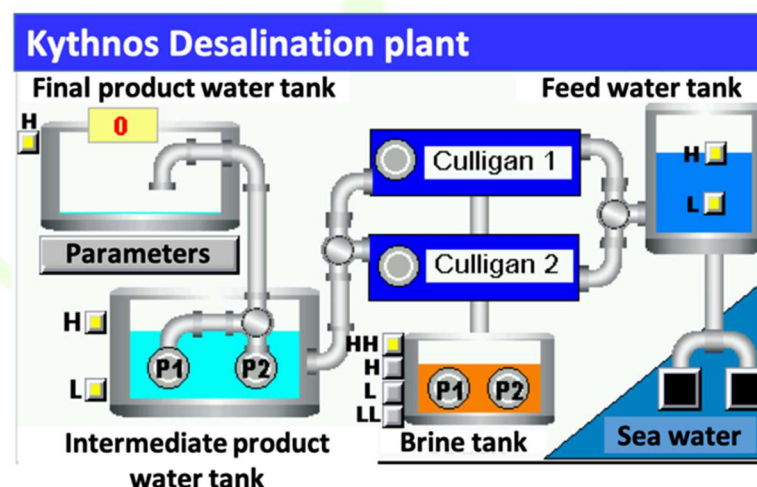
Figure 90 – The desalination plant basic modules.

Status after WiseGRID deployment

On the new operation mode, when there is available renewable energy, WG Cockpit will notify WiseCORP through which the plant's PLC will get the signal that the desalination plant <u>may</u> start operating. Starting from the municipal product water tank, the sensor will check water availability. If there is not enough water, the product water transfer pump will be put to operation to pump water from the intermediate water tank. If there is enough clean water available in the municipal tank for the island, then the sensor will check whether there is enough water in the intermediate water pump. If there is not enough water, then the pump will start operating and the plant will begin desalinating water. If there is enough water in the intermediate water tank, then the sensor will check whether there is enough seawater in the seawater tank. If not, the pumps will start operating to fill the tank with seawater.

The main idea is that the desalination plant will be asked to operate mostly when electricity demand in Kythnos is low in order to help shave peak loads. Additionally, the desalination plant will be asked to operate when there is renewable energy generation by the wind turbine in Kythnos.

The new operation mode will be achieved through WG Cockpit and WiseCORP. WG Cockpit will send a signal to WiseCORP, which will in turn send a signal of the kW available through a communication algorithm to the PLC, in order to start filling in the product tank with desalinated water when the wind turbine produces energy. Moreover, WiseCORP will send a signal to the PLC to halt operations when there is no more wind power available or when the electricity demand on the island from other electric loads rises. This automation mode will ensure that the product tank will be filled with water in time for the daily peak water demand to serve the island without adding burden to the grid and forcing diesel generators to run.

Design, configuration and deployment

Operation optimization algorithm

As explained in previous section, WiseCORP will receive forecast information from WG Cockpit via IOP. This section describes a proposal of how WiseGRID applications can collaborate to calculate a digital signal indicating the recommendation to keep the desalination plant ON or OFF.

1. WiseCORP – Optimum plan for the desalination plant

WiseCORP will implement an optimization algorithm that will be executed periodically (every 1 hour) with the latest forecasts available, in order to plan operation of the desalination plant for the next 24 hours, in slots of 15 minutes. The problem to be solved will be modelled as a linear optimization model, considering the following parameters, variables, constraints and objective:

- Input Parameters
    o 24-hour demand forecast (15 minutes slots)
    o 24-hour production forecast (15 minutes slots)
    o Nominal power of desalination plant
- Controllable variables
    o Desalination plant operation (ON/OFF, 15 minutes slots)
- Constraints
    o Desalination plant operation variables are Boolean (ON/OFF)
- Objective: minimize total surplus
- Intermediate variables:
    o Base surplus: energy surplus considering demand and production forecasts

o   Desalination plant demand: demand of the plant, considering its nominal power and its operation mode (ON/OFF)

o   Demand forecast after plant operation: demand forecast resulting of adding the planned demand for the desalination plant to the base demand forecast

o   Surplus after plant operation: forecast of the energy surplus resulting after the planned operation of the desalination plant.

The result of the algorithm will be a plan of ON/OFF values for the plant for the next 24 hours (15 minutes slots). By re-executing the algorithm periodically (e.g. every hour) with updated demand/production forecasts, we ensure that the plan adapts continuously to the last-minute changes.

Communication of ON/OFF signal to the plant

The desalination plant is controlled via TCP MODBUS. It was decided that a SMX provided by ETRA can be located in the same LAN as the plant, with access to the IOP (i.e. connection to the server where all applications will be deployed). The SMX also executes the necessary applications to trigger the signals via TCP MODBUS. An additional smart peter/power analyzer have been installed to provide readings of the electrical demand of the plant.

The following equipment was purchased in order to monitor the consumption of the desalination plant:

- Power supply P15
- Display D50
- Voltage module U30 – for voltage measurement for three lives phases and neutral, frequency, unbalance, THD, harmonics
- Current module I35 – for measurement of I, P, Q, S, PF, THDi, individual harmonics up to 63rd, kWh, kVarh on 4 quadrants, kVAh, load curves and history of average values.
- TR-32 600 A – current sensors
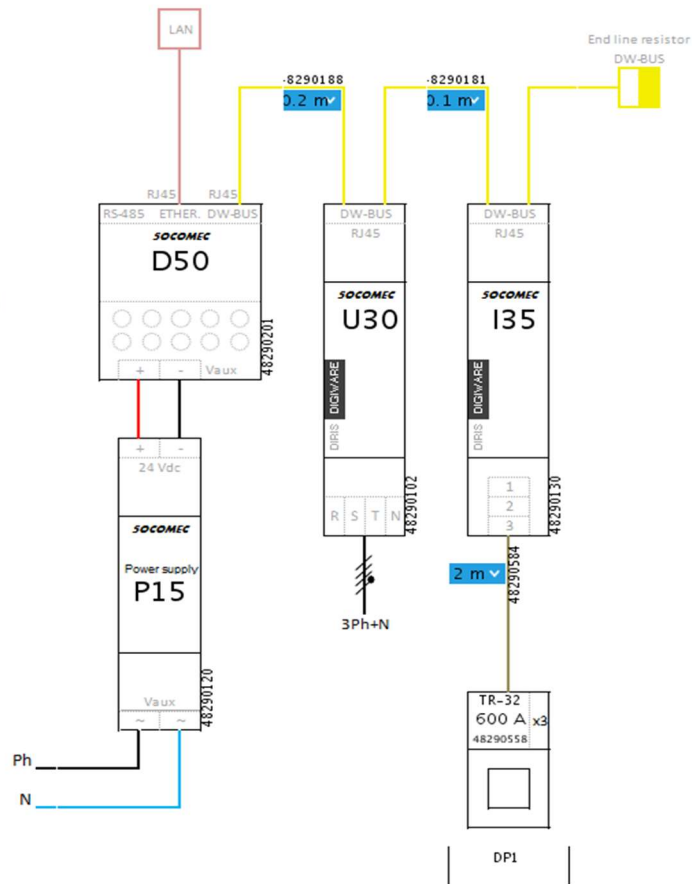
Figure 91 – The Socomec measuring equipment.

PLC re-programming

Two pilot site visits took place in December 2018 and in February 2019. During the December pilot site visit, a team of engineers from AEGEA with a programmer visited the desalination plant to perform the re=programming of the existing PLC.

The existing PLC as well as the monitor illustrating the equipment of the desalination plant (seawater pumps, product water tank and saline water tank) were reprogrammed so as the desalination plant will be able to operate in a demand response pilot mode based on the energy surplus on the island. At this pilot mode, the desalination plant will be able to use any energy surplus on the island coming from renewable energy production (wind turbine, PV plants), helping reduce its curtailment.

In order to enable the pilot operation mode described above, the PLC was programmed so that the remote operation center of the plant will receive commands to absorb surplus energy at times when the energy demand from the island consumers is low, especially during winter months.

At normal operation, the desalination plant operates in a way ensuring that the final product water tank is always full. The intermediate water product tank send water to the final water product tank as soon as the water level at the final product water tank falls slightly below the highest water level tank. This is regulated

by a start/stop set of parameters at the product water transfer pumps according to the current level at the final water product tank.

Normal operation of the desalination plant ensures full capacity of the final product water tank for the island but there is no free storage space available in order to absorb energy when there is surplus energy at the island. That is the reason that the PLC was reprogrammed so that the operator can select between normal and pilot mode operation. Pilot mode operation also ensures necessary water capacity for the island at the final product water tank, but at the same time allows for free storage space in the tank in order to absorb surplus energy whenever possible according to the island's operator and production and demand forecast.

The graphs below show the monitor at the plant with the reprogrammed functions.
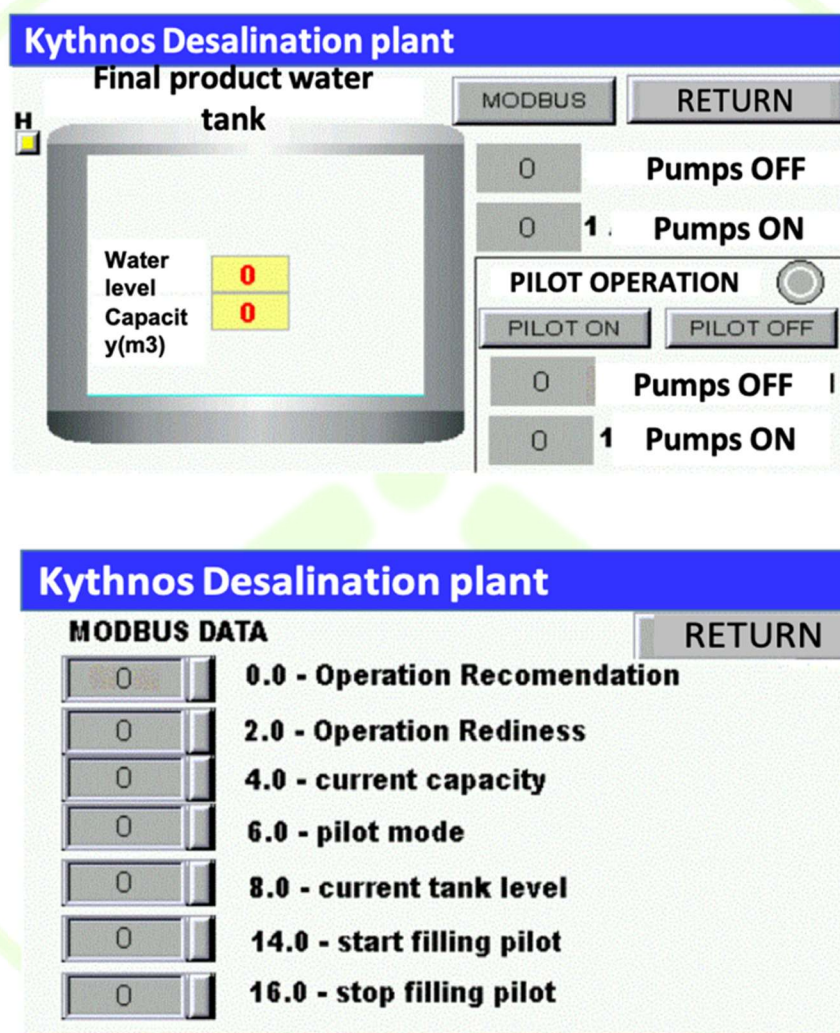
Figure 92 - The reprogrammed functions of the plant.

In order to achieve remote management of the desalination plant, an open industrial data transmission protocol (Modbus TCP/IP) interface was developed. Thanks to this interface, the operator can know the state of the plant at any time and can also execute the necessary operation commands of the plant when required.

The pictures below showing the monitor were taken on site after the PLC was reprogrammed.
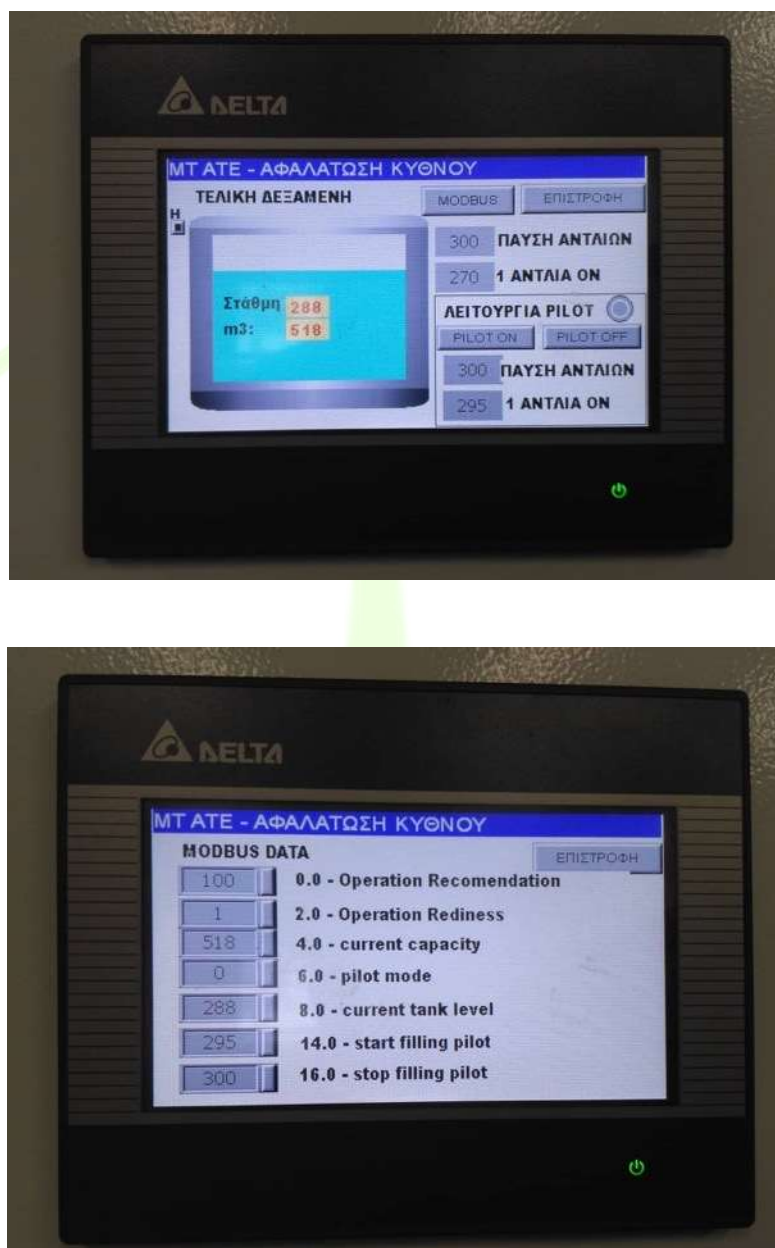
Figure 93 – PLC monitor after reprogramming the plant.

The following table illustrates the MODBUS map at the PLC with the new parameters that were added for pilot mode operation with WiseCORP.

	SIGNAL	ADD RESS	NUMBER OF POSITIONS (word – 16bit)	TYPE (Discrete Output Coils /Discrete Input Contacts /Analog Input Registers/Analog Output Holding Registers)	OPERATION	DATA TYPE (Integer/IEE Float/ASCII)
MANDATORY	OPERATION RECOMMENDATION	100	1	Holding Register	WRITE	INTEGER (0=OFF, 1=ON)
OPTIONAL	PRODUCTION READINESS	101	2	Holding Register	READ	INTEGER (0=NO, 1=YES)
OPTIONAL	REMAINING CAPACITY (m³)	102	3	Holding Register	READ	m3
OPTIONAL	PILOT MODE	103	4	Holding Register	WRITE	INTEGER (0=CLASSIC, 1=PILOT)
OPTIONAL	CURRENT TANK LEVEL (m)	104	5	Holding Register	READ	m
OPTIONAL	START FILLING TANK LEVEL	105	6	Holding Register	WRITE/READ	m
OPTIONAL	STOP FILLING TANK LEVEL	106	7	Holding Register	WRITE/READ	m
OPTIONAL	START FILLING TANK LEVEL PILOT MODE	107	8	Holding Register	WRITE/READ	m

DEVICE	IP CONFIGURATION
Desalination plant PLC	IP: 192.168.1.4 MASK: 255.255.255.0 GATEWAY ADDRESS: 192.168.1.1

After the procurement of the smart meter, the SMX and the smart meter were configured by ETRA and ICCS and communication tests with ETRA's server were conducted to ensure seamless communication.

During the second site visit in February 2019, the SMX and the smart meter were installed at the desalination plant and successful remote communication tests were run.

Below pictures from the installation of the metering units and the SMX at the desalination plant are shown:

Figure 94 – Pictures from the installation of the metering units and the SMX.

3.5.1.2 WG STaaS/VPP

The batteries as well as the charging stations to be deployed in Kythnos will be installed in municipal buildings. To that end, AEGEA worked with the Municipality of Kythnos in order to collect data on electricity meters, contracted electricity supply, installed capacity etc.

The timeline of the interventions required for the host of WG STaaS/VPP

- **October 2018:** Municipal buildings analysis and data collection

- **December 2018:** On-site evaluation of municipal buildings regarding spatial and electrical requirements (e.g grounding) and selection of two buildings (Town Hall and Health Center at Dry-opida)

- **January 2019:** Order initiation for VARTA batteries

- **February 2019:** Installation of smart meters in municipal buildings to collect load data

- **April 2019:** Installation of smart meters at the two buildings of the Port Authority in Merichas and Loutra

- **April 2019:** Electrical configuration of municipal buildings

By May 2019 the batteries are expected to be delivered and installed and its installation will be properly explained in the deliverable related to the final deployment activities (D15.2)

Status before WiseGRID deployment

The municipal buildings simply got their electricity directly from the grid. No battery storage system or PV panels are installed in any of the buildings.

Status after WiseGRID deployment

The buildings where the batteries will be installed will be able to operate in a demand response pilot mode. The batteries will charge from the grid at times of energy surplus on the island coming from renewable energy production or from low energy demand by the consumers in order to reduce RES curtailment. The batteries then will cover some of the building loads.

Pricing schemes (double tariff) could be simulated to understand potential cost benefits.

Design, configuration and deployment

The information collected with the help of the Municipality is shown at the table below:

Table 7 – Data collection from the Municipality

Municipal buildings	Location	Electrical supply	Contracted power (kVA)	Installed power (kVA)	Current per phase (A)
Town Hall	Chora	3 -phase	25	17	29
Primary School	Chora	1 -phase	8	1	4
Kindergarten	Chora	3 - phase	25	25	43
Munical Center	Chora	1 - phase	8	1	4

Municipal Center	Dryopida	3 - phase	25	25	43
Primary School	Dryopida	1 - phase	8	1	4
Health Center	Dryopida	3 - phase	85	67	114
High School	Merichas	1 -phase	8	1	4
Port Authority	Merichas				
Port Authority	Loutra				

During the first pilot visit, three municipal buildings were evaluated in terms of suitability for battery deployment. The buildings were evaluated with regards to the following:

- Electrical grounding
- Spatial requirements
- Ventilation
- Electrical installation

It was decided that the Town Hall and the Health Centre in Dryopida were more suitable for battery deployment. Both feature electrical grounding and suitable space with ventilation (windows).

Figure 95 – The town hall of Kythnos.

Batteries will be installed at the basement of the Town Hall for which AEGEA has also collected a plan, where the location of the batteries is shown.
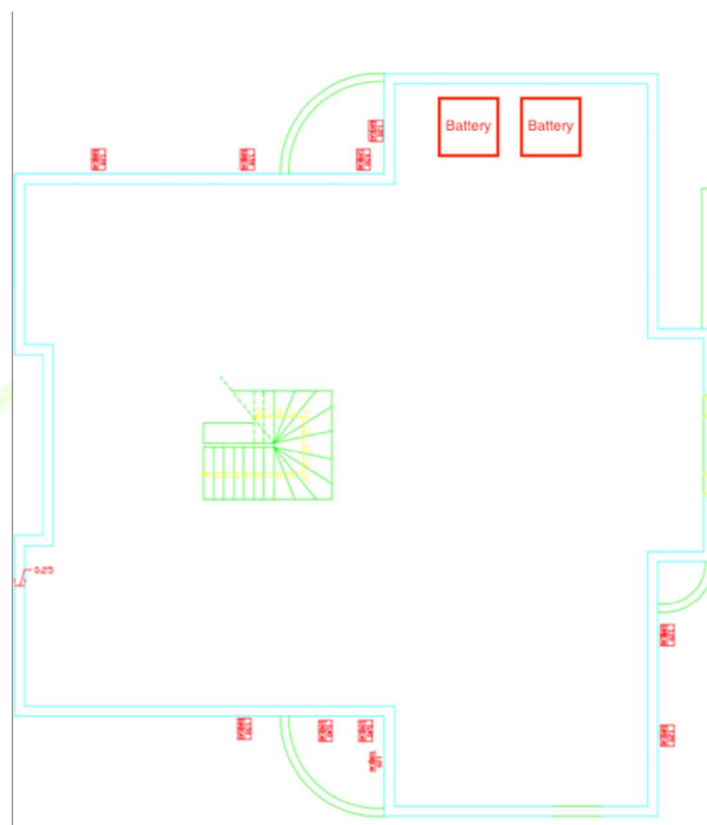
Figure 96 – Location at Town Hall where the storage system will be installed.
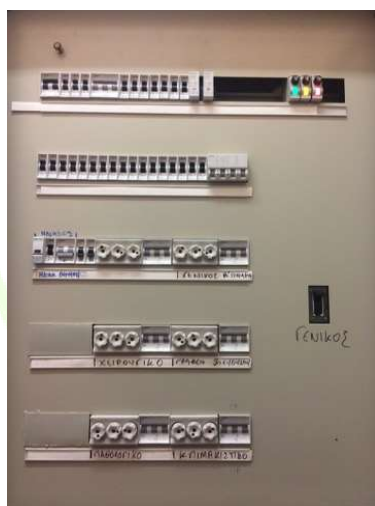
Figure 97 – Health Center of Dryopida.

During the second pilot visit in February, smart meters were installed in both buildings to monitor their electricity consumption. This was necessary in order to decide whether an upgrade of the building's electrical supply would be required to ensure that the building's supply could cover a battery and/or a charging station.

Figure 98 – Town Hall and Health Center Switchboards.

3.5.1.3 WiseEVP

The timeline of the activities related to the hosting of WiseEVP in Kythnos Pilot Site is the following:

- **October 2018:** Stakeholder mapping regarding charging stations and EVs

- **November 2018:** Market analysis and offers from different EV providers (leasing, used, new EVs)

- **December 2018:** On-site evaluation of municipal buildings

- **January 2019**: Market analysis and offers from different EV charging station suppliers for wall-mounted EV charging stations

- **February 2019**: Installation of smart meters in municipal buildings to collect load data

- **April 2019**: Installation of smart meters at the two buildings of the Port Authority in Merichas and Loutra

- **April 2019:** Evaluation of locations and collection of civil engineering plans and electrical plans in order to design parking spots and to decide on exact charging station points in the buildings

  By June 2019 the EV charging stations procurement and installation is expected and its installation will be properly explained in the deliverable related to the final deployment activities (D15.2)

Status before WiseGRID deployment

There are no EVs nor any EV charging stations in Kythnos.

Status after WiseGRID deployment

The electric vehicles will be able to operate in a demand response pilot mode. The charging of the vehicles from the grid will be scheduled at times of energy surplus on the island coming from renewable energy production or from low energy demand by the consumers in order to reduce RE curtailment.

Design, configuration and deployment

Extensive market research and several contacts with EV and EV charging station providers has been made and AEGEA has been informed on all available options: offers for leasing EVs, offers for new and used EVs, offers for wall-mounted or on-street EV charging stations.

HEDNO has launched a tender to install 150 EV charging stations in the Greek islands starting in January 2019. It is expected that HEDNO will install one on-ground for shared use EV charging station in Kythnos, but the initial time plan provided is delayed due to court appeals for the decision on the final award. Therefore, AEGEA will proceed with the procurement of wall-mounted charging stations that can be placed in municipal buildings.

Apart from the Town Hall and the Health Center, which have been identified as suitable locations for charging stations as well, smart meters were installed in three additional buildings (Primary School in Chora, High School in Merichas and Municipal Center in Dryopida).
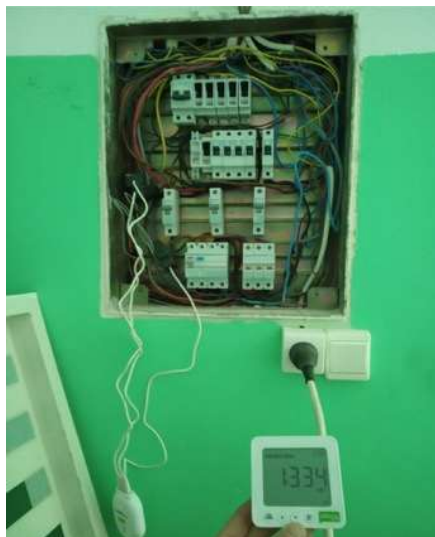
Figure 99 – Merichas High School, Chora Primary School and Municiapl Center of Dryopida.

3.5.1.4 Other activities

In order to develop a forecast for production and demand in Kythnos, real data from the actual production (thermal and PV) as well as the demand will be needed.

To this end, AEGEA has made a request to HEDNO to receive data from the PV plants on Kythnos, which has been granted, AEGEA has also made official request to the local power station to install smart meters at the diesel generators in order to have access to real-time production data and waits for a response.

3.5.2 LESSONS LEARNED AND POSSIBLE RISKS

3.5.2.1 Lessons Learned

Installation of the SMX and smart meter at the desalination plant has been challenging because the main distribution panel was more than 50m away from the PLC. The Ethernet cable was partially passed underground and partially above ground.

Physical damage in the desalination plant caused by water leakage (electrical wiring and equipment damaged), interrupted data transmission from the installed SMX to ETRA's server. The damage was fixed on March 22nd. However, frequency and phase-to-phase voltage data are being transmitted with negative values. This is an issue to be fixed.

The installation of smart meters at the municipal buildings was often challenging because some distribution panels were old or the wires were difficult to reach inside the panel, so clamping the sensors had to be done with special care.

3.5.2.2 Risks

Table 8 – Risk Table

Risks	Mitigation plan
Access to real island production data is not granted	Historical data will be used for the demos

Desalination plant is not protected against lightning	A suitable anti-lightning system will be deployed
Delay on battery and EV charging station deployment depending on requirement to upgrade or not the existing electrical supply of some buildings	Strict planning and execution

3.5.3 DEMO OF THE TOOL

3.5.3.1 WiseCORP

The following graph shows data from the main PLC at the desalination plant as seen in WiseCORP tool.

The data pictured here span 16 hours and show the current level of water at the final product water tank measured in meters (m) as well as the remaining available capacity of the final water product tank measured in cubic meters (m³).
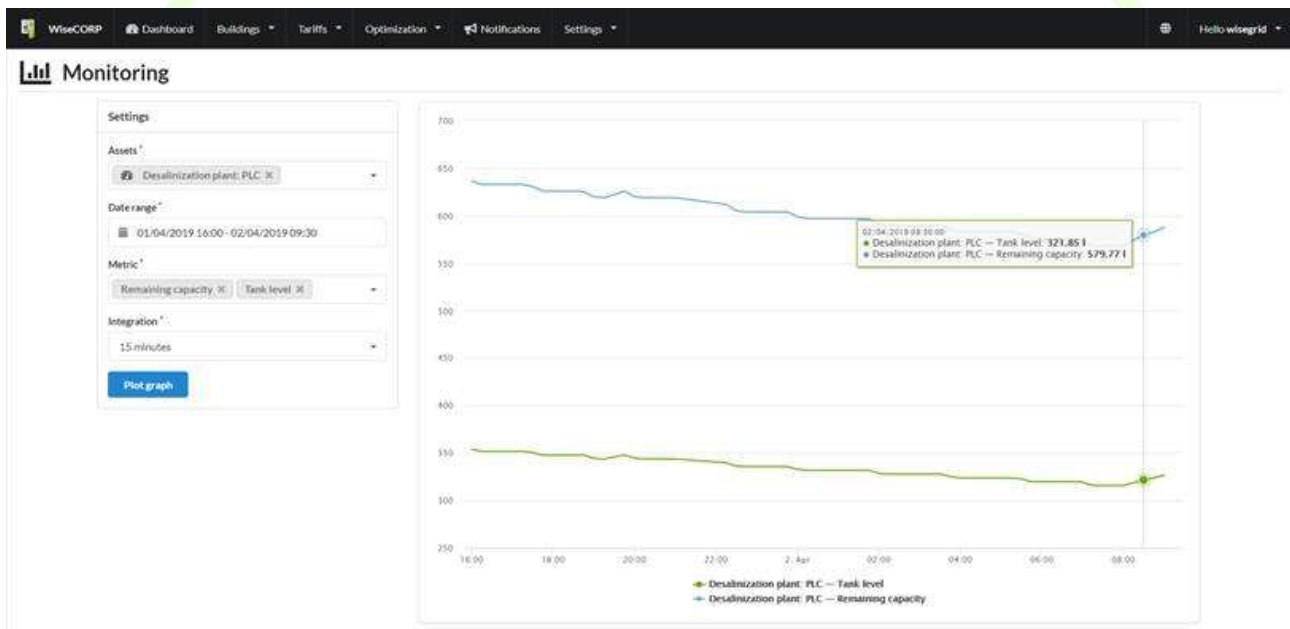
Figure 100 – Current level of water and remaining available water capacity of desalination plant as depicted in WiseCORP.

As explained in the previous sections, the desalination plant has been damaged for some time and was fixed end of March 2019. Additionally, once tests are run with real demand and production data, with cooperation with WG Cockpit, the actual pilot mode operation will be demonstrated.

4 REVIEW OF THE USE CASES

4.1 FLANDERS

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID (CRE)			
1 **HL-UC 1_PUC_1_Network monitoring**	**High**	-	N
2 HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections	High	-	N
3 HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections	High	-	N
4 HL-UC 1_SUC_1.3_KPI management	High	-	N
5 HL-UC 1_SUC_1.4_Big data storage analysis	High	-	N
6 **HL-UC 1_PUC_2_Control strategies for reducing RES curtailment**	**High**	-	N
7 HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption	High	-	N
8 HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means	High	-	N
9 HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies	High	-	N
10 HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode	Low	-	N
11 **HL-UC 1_PUC_3_Voltage support and congestion management**	**High**	-	N
12 HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (Centralized)	High	-	N
13 HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (Decentralized)	Medium	-	N
14 HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases	Low	-	N
15 **HL-UC 1_PUC_4_Grid planning analysis**	**Low**	-	N
16 HL-UC 1_SUC_4.1_EV charge points planning analysis	Low	-	N
17 HL-UC 1_SUC_4.2_Grid storage planning analysis	Low	-	N
18 **HL-UC 1_PUC_5_Promote RES via RESCO companies**	**Medium**	5	Y
19 HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance	Medium	5	Y
20 HL-UC 1_SUC_5.2_Monitor domestic RES production	Medium	3	Y
21 HL-UC 1_SUC_5.3_Monitor domestic clients consumption	Medium	3	Y
22 HL-UC 1_SUC_5.4_Manage energy selling	Medium	5	Y
23 HL-UC 1_SUC_5.5_Energy cost management	Medium	5	Y

Figure 101 – Flanders' interests in HL-UC 1.

Concerning HL-UC 1, ECO applies the same level of engagement as expressed in D2.1. No changes have arisen. ECO is still interested in testing SUC's 5.1 to 5.5 in order to promote RES via RESCO companies.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION (ICCS)			
24 HL-UC 2_PUC_1_Distribution network real-time monitoring	High	-	N
25 HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters	High	-	N
26 HL-UC 2_SUC_1.2_Data concentration	High	-	N
27 HL-UC 2_SUC_1.3_Monitoring power quality in the grid	High	-	N
28 HL-UC 2_SUC_1.4_Fault detection and identification	High	-	N
29 HL-UC 2_SUC_1.5_Asset management	High	-	N
30 HL-UC 2_PUC_2_Real-time distribution system awareness	High	-	N
31 HL-UC 2_SUC_2.1_RES and load forecasting	High	-	N
32 HL-UC 2_SUC_2.2_Topology processor	Medium	-	N
33 HL-UC 2_SUC_2.3_Network observability analysis	High	-	N
34 HL-UC 2_SUC_2.4_Load flow calculation	High	-	N
35 HL-UC 2_SUC_2.5_State estimation	High	-	N
36 HL-UC 2_SUC_2.6_Bad data detection, identification and replacement	High	-	N
37 HL-UC 2_PUC_3_Grid control	High	-	N
38 HL-UC 2_SUC_3.1_Load control	High	-	N
39 HL-UC 2_SUC_3.2_DR as a service to the grid	High	-	N
40 HL-UC 2_SUC_3.3_Optimization algorithm	High	-	N
41 HL-UC 2_SUC_3.4_Reconfiguration	Medium	-	N
42 HL-UC 2_SUC_3.5_Islanding procedures for the local grid	Low	-	N
43 HL-UC 2_SUC_3.6_Cold ironing	Medium	-	N

Figure 102 – Flanders' interests in HL-UC 2.

With regard to HL-UC 2, no modifications have occurred in the prioritisation of use cases. In the Flanders pilot site, DSO is not involved in the WiseGRID project. Therefore, it is not possible to test these use cases.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
HL-UC 3 e-MOBILITY INTEGRATION IN THE GRID WITH V2G (ITE)			
44 HL-UC 3_PUC_1_EVSE and EV fleet monitoring	High	5	Y
45 HL-UC 3_SUC_1.1_Data collection from EVSE	High	5	Y
46 HL-UC 3_SUC_1.2_Data collection from EVs	High	5	Y
47 HL-UC 3_PUC_2_Interaction of the user with EVSE	Medium	3	Y
48 HL-UC 3_SUC_2.1_Users' authentication	Medium	-	N
49 HL-UC 3_SUC_2.2_Charging session request	Medium	5	Y
50 HL-UC 3_SUC_2.3_Charging session booking	Medium	3	Y
51 HL-UC 3_PUC_3_EV charging management	Medium	1	Y
52 HL-UC 3_SUC_3.1_EVSE network configuration	Medium	1	Y
53 HL-UC 3_SUC_3.2_EV load forecasting	Medium	3	Y
54 HL-UC 3_SUC_3.3_EV flexibility estimation	Medium	1	Y
55 HL-UC 3_SUC_3.4_Reference charging load profile calculation	Medium	-	N
56 HL-UC 3_SUC_3.5_Charging session schedule	High	1	Y
57 HL-UC 3_PUC_4_Interaction with the energy infrastructure	Medium	2	Y
58 HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests	Medium	-	N
59 HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration	High	3	Y
60 HL-UC 3_SUC_4.3_EV providing V2H services	Medium	-	N

Figure 103 – Flanders' interests in HL-UC 3.

Concerning HL-UC 3, the same level of engagement as expressed in D2.1 has been followed by PARTA for the Flanders test site.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL (AMP / VS)			
61 **HL-UC 4_PUC_1_Batteries management at prosumer level**	High	5	Y
62 HL-UC 4_SUC_1.1_Increase of self-consumption	High	5	Y
63 HL-UC 4_SUC_1.2_Time-of-use management	Medium	5	Y
64 HL-UC 4_SUC_1.3_Peak Shaving	Medium	5	Y
65 **HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)**	**Medium**	4	Y
66 HL-UC 4_SUC_2.1_Batteries dispatch management	High	4	Y
67 HL-UC 4_SUC_2.2_Black start capabilities	Low	4	N
68 HL-UC 4_SUC_2.3_Power management for peak-shaving and load harmonization	Medium	4	Y
69 HL-UC 4_SUC_2.4_Backup power for residential area	Low	-	N
70 **HL-UC 4_PUC_3_Ancillary services**	**Medium**	3	Y
71 HL-UC 4_SUC_3.1_Market scheduling	High	3	Y
72 HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system	Medium	3	Y
73 HL-UC 4_SUC_3.3_Batteries automatic dispatch	Medium	3	Y
74 **HL-UC 4_PUC_4_Combination of battery storage systems**	**Medium**	4	Y
75 HL-UC 4_SUC_4.1_Parameter configuration of storage systems	Medium	4	Y
76 HL-UC 4_SUC_4.2_Priority list of units running	Medium	4	Y

Figure 104 – Flanders' interests in HL-UC 4.

For HL-UC 4, in the beginning of the project there was some interest in Flanders pilot site to investigate whether SUC 2.2 Black start capabilities could be tested by ECO. In the meantime it has become clear that the Flanders test site does not dispose of suitable infrastructure to test SUC 2.2. Priority of all the other use cases remain unchanged compared to D2.1. Side note for SUC 4.1, where ECO will only be able to showcase the parameter configuration on a simplistic level. Regarding SUC 4.2, ECO is specifically interested in what kind of reward is allocated to end-users and/or batteries that deliver flexibility.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING (ICCS / EPA)			
77 **HL-UC 5_PUC_1_Thermal monitoring**	**Medium**	-	N
78 HL-UC 5_SUC_1.1_Monitoring gas meters	Low	-	N
79 HL-UC 5_SUC_1.2_Monitoring CHP	Medium	-	N
80 HL-UC 5_SUC_1.3_Monitoring buildings	Medium	-	N
81 **HL-UC 5_PUC_2_Cogeneration and HVAC management**	**Medium**	-	N
82 HL-UC 5_SUC_2.1_Forecasting thermal needs	Medium	-	N
83 HL-UC 5_SUC_2.2_Real time control set-points	Medium	-	N
84 HL-UC 5_SUC_2.3_Control devices	Medium	-	N
85 HL-UC 5_SUC_2.4_Alarm management	Medium	-	N
86 **HL-UC 5_PUC_3_Comfort-based demand flexibility models**	**Medium**	-	N
87 HL-UC 5_SUC_3.1_Thermal model of households	Medium	-	N
88 HL-UC 5_SUC_3.2_Thermal model of building	Medium	-	N
89 HL-UC 5_SUC_3.3_Thermal flexibility modeling	Medium	-	N
90 **HL-UC 5_PUC_4_Cogeneration and HVAC optimisation**	**Medium**	-	N
91 HL-UC 5_SUC_4.1_VPP participation	Low	-	N
92 HL-UC 5_SUC_4.2_Provision of ancillary services	Medium	-	N
93 HL-UC 5_SUC_4.3_System optimisation	Medium	-	N

Figure 105 – Flanders' interests in HL-UC 5.

Concerning HL-UC 5, no modifications have occurred in the prioritisation of use cases. In the Flanders pilot site, suitable infrastructure to test these use cases are not present.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY (ENG)			
94 **HL-UC 6_PUC_1_VPP monitoring and management**	**High**	5	Y
95 HL-UC 6_SUC_1.1_Resource metering	High	5	Y
96 HL-UC 6_SUC_1.2_VPP RES forecast	High	5	Y
97 HL-UC 6_SUC_1.3_VPP flexibility forecast	High	5	Y
98 HL-UC 6_SUC_1.4_Strategies definition	Medium	5	Y
99 **HL-UC 6_PUC_2_VPP market participation**	**Medium**	5	Y
100 HL-UC 6_SUC_2.1_VPP market participation and bid calculation	Medium	5	Y
101 HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation	Medium	5	Y
102 HL-UC 6_SUC_2.3_VPP unit scheduling	Medium	5	Y
103 **HL-UC 6_PUC_3_VPP Real time control**	**High**	5	Y
104 HL-UC 6_SUC_3.1_Real time flexibility calculation	Medium	5	Y
105 HL-UC 6_SUC_3.2_VPP implementation of ancillary services	Medium	5	Y
106 HL-UC 6_SUC_3.3_Real time decision making	High	5	Y
107 **HL-UC 6_PUC_4_VPP users relationship management**	**Low**	5	Y
108 HL-UC 6_SUC_4.1_Manage contractual issues	Low	5	Y
109 HL-UC 6_SUC_4.2_Define and manage member compensation	Low	5	Y
110 HL-UC 6_SUC_4.3_DSM and DR mechanisms	High	5	Y

Figure 106 - Flanders' interests in HL-UC 6.

With regard to HL-UC 6, ECO has some remarks on SUC 1.4, 2.1 and 4.3. During the project meeting in Paris, VS has expressed some preoccupations whether these use cases will be technically feasible. For SUC 1.4 it is most important for ECO to have a proof of concept to show. For SUC 2.1, VS declared no interface with wholesale market is possible, disabling the testing of this SUC. For SUC 4.3, ECO emphasizes that it can test this use case when these mechanisms are showed in the reward section of WiseHOME.

To conclude, ECO hereby declares that it is still willing to test these use cases in the Flanders pilot site if they are technically feasible.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION FLANDERS pilot site	
		D 2.1	D 15.1
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**	**High**	4	Y
112 HL-UC 7_SUC_1.1_Monitor energy demand	High	4	Y
113 HL-UC 7_SUC_1.2_Enriched information visualization	High	4	Y
114 HL-UC 7_SUC_1.3_Integration with DR mechanisms	High	4	Y
115 HL-UC 7_SUC_1.4_Net metering & self consumption	Medium	4	Y
116 HL-UC 7_SUC_1.5_Energy cost management for large infrastructures	Medium	4	Y
117 **HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market**	**High**	5	Y
118 HL-UC 7_SUC_2.1_Enriched information visualization	High	5	Y
119 HL-UC 7_SUC_2.2_Portfolio profiling & analytics	High	5	Y
120 HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading	High	5	Y
121 HL-UC 7_SUC_2.4_Billing services	Medium	5	Y
122 HL-UC 7_SUC_2.5_Energy cost management and optimization	Medium	5	Y
123 HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control	Medium	5	Y
124 HL-UC 7_SUC_2.7_Manual DSM strategies activation	High	5	Y
125 **HL-UC 7_PUC_3_Clients engagement for active market participation**	**High**	5	Y
126 HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring	High	5	Y
127 HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers	Low	5	Y
128 HL-UC 7_SUC_3.3_Participation in DR programs	High	5	Y
129 HL-UC 7_SUC_3.4_Residential net metering & self consumption	Medium	5	Y

Figure 107 – Flanders' interests in HL-UC 7.

Concerning HL-UC 7, the level of engagement for the use cases remains unchanged. For ECO as a RESCoop, the empowerment of citizens in the energy market is a core value to strive for. New insights during the project urge ECO to only virtually test SUC 2.4. Also, a remark to SUC 3.2 can be expressed. This SUC, social network collaboration and comparisons with peers, will be linked to the Buurzame Stroom project that collaborates with WiseGRID in the Flanders pilot site. In this SUC, a comparison will be made between the individual (household) level and the collective (neighbourhood) level. This will be tested via the WiseHOME tool.

4.2 MESOGIA

Upon reviewing the use cases after the deliverable D14.1, the Use Cases which are planned to be implemented at Mesogia pilot site with the collaboration of EDA, ICCS and the respective tools developers (ETRA, ENG, HYP) are given in Figure 108.

There may be differences between the D2.1 planning and the current one, due to equipment or technical restrictions, legislation limitations or swift of DSO's interests etc.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES IMPLEMENTATION	
		HEDNO (Mesogia)	
HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID		D2.1	D15.1
1 HL-UC 1_PUC_1_Network monitoring	High		
2 HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections	High	4	Y
3 HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections	High	4	Y
4 HL-UC 1_SUC_1.3_KPI management	High	4	Y
5 HL-UC 1_SUC_1.4_Big data storage analysis	High	3	Y
6 HL-UC 1_PUC_2_Control strategies for reducing RES curtailment	High		
7 HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption	High	3	Y
8 HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means	High	3	N
9 HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies	High	3	Y
10 HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode	Low	3	N
11 HL-UC 1_PUC_3_Voltage support and congestion management	High		
12 HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (Centralized)	High	3	Y
13 HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (Decentralized)	Medium	3	N
14 HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases	Low	3	N
15 HL-UC 1_PUC_4_Grid planning analysis	Low		
16 HL-UC 1_SUC_4.1_EV charge points planning analysis	Low	-	N
17 HL-UC 1_SUC_4.2_Grid storage planning analysis	Low	-	N
18 HL-UC 1_PUC_5_Promote RES via RESCO companies	Medium		
19 HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance	Medium	2	N
20 HL-UC 1_SUC_5.2_Monitor domestic RES production	Medium	2	N

			PILOT SITES IMPLEMENTATION	
21	HL-UC 1_SUC_5.3_Monitor domestic clients consumption	Medium	2	N
22	HL-UC 1_SUC_5.4_Manage energy selling	Medium	2	N
23	HL-UC 1_SUC_5.5_Energy cost management	Medium	2	N

Figure 108 – Mesogia's interests in HL-UC 1.

There are no significant changes, as most of the Use Cases with higher priority for Mesogia pilot site will be tested. In order to achieve this, the data used for WG tests will not be real-time, but real data using a predefined short-time sliding window. The data from section of the grid will come from the HV/MV substation and maybe the MV/LV substation feeding Meltemi LV Network. Also, since there is no real ESCO involved in Mesogia pilot site, this will be emulated. The length of the period covered by historical data has not been determined yet. Because of lack of RTUs on the MV lines included in the demo, the collected network data mentioned above will be used. Regarding big data storage analysis, HEDNO will provide the infrastructure and this SUC will be realised provided the designed platform works as needed. Regarding, HLUC1-PUC 2, since the penetration of RES in not very high in the lines under consideration, there is the risk that the curtailment may not occur. Considering that there is not a PRB involved in Mesogia pilot project, market price will come from a Market Price Provider wrapper. HL-UC 1 – PUC 3.1 can be tested during summer at Meltemi, using the batteries there as dynamic loads to increase the range of load variation during demand response.

	WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES IMPLEMENTATION	
			HEDNO (Mesogia)	
			D2.1	D15.1
	HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION			
24	**HL-UC 2_PUC_1_Distribution network real-time monitoring**	**High**		
25	HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters	High	4	Y
26	HL-UC 2_SUC_1.2_Data concentration	High	4	Y
27	HL-UC 2_SUC_1.3_Monitoring power quality in the grid	High	4	Y
28	HL-UC 2_SUC_1.4_Fault detection and identification	High	3	Y
29	HL-UC 2_SUC_1.5_Asset management	High	4	Y
30	**HL-UC 2_PUC_2_Real-time distribution system awareness**	**High**		
31	HL-UC 2_SUC_2.1_RES and load forecasting	High	5	Y
32	HL-UC 2_SUC_2.2_Topology processor	Medium	4	Y
33	HL-UC 2_SUC_2.3_Network observability analysis	High	5	Y
34	HL-UC 2_SUC_2.4_Load flow calculation	High	5	Y
35	HL-UC 2_SUC_2.5_State estimation	High	5	Y
36	HL-UC 2_SUC_2.6_Bad data detection, identification and replacement	High	4	Y
37	**HL-UC 2_PUC_3_Grid control**	**High**		
38	HL-UC 2_SUC_3.1_Load control	High	3	Y
39	HL-UC 2_SUC_3.2_DR as a service to the grid	High	3	Y

40	HL-UC 2_SUC_3.3_Optimization algorithm	High	4	Y
41	HL-UC 2_SUC_3.4_Reconfiguration	Medium	3	Y
42	HL-UC 2_SUC_3.5_Islanding procedures for the local grid	Low	3	N
43	HL-UC 2_SUC_3.6_Cold ironing	Medium	-	N

Figure 109 – Mesogia's interests in HL-UC 2.

As far as HLUC 2 is concerned, there is a consistent approach from D2.1 to D15.1 and there is no outstanding change in the inventory. Regarding SUC 1.4, the first part of automatic detection of faults can be performed using data from SCADA/DMS, AMI and SLAM/SMX. Due to the specific number of monitoring and metering devices, while the network observability algorithm will be tested, the result of it (meaning the observability of the network) cannot be guaranteed and the execution of state estimation (SUC 2.5), as well as of SUC 2.6 depends on the outcome of SUC 2.3. SUC 3.1, and SUC 3.2 can be tested during summer at Meltemi using the batteries there as dynamic loads to increase the possible range of load variation. Testing SUC 3.3 depends on the realisation of the Algorithmic Framework for optimizing multi-objective energy systems, which is a technical matter. SUC 3.4 could be performed offline.

	WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES IMPLEMENTATION	
			HEDNO (Mesogia)	
			D2.1	D15.1
	HL-UC 3 e-MOBILITY INTEGRATION IN THE GRID WITH V2G			
44	HL-UC 3_PUC_1_EVSE and EV fleet monitoring	High		
45	HL-UC 3_SUC_1.1_Data collection from EVSE	High	2	N
46	HL-UC 3_SUC_1.2_Data collection from EVs	High	2	N
47	HL-UC 3_PUC_2_Interaction of the user with EVSE	Medium		
48	HL-UC 3_SUC_2.1_Users' authentication	Medium	2	N
49	HL-UC 3_SUC_2.2_Charging session request	Medium	2	N
50	HL-UC 3_SUC_2.3_Charging session booking	Medium	2	N
51	HL-UC 3_PUC_3_EV charging management	Medium		
52	HL-UC 3_SUC_3.1_EVSE network configuration	Medium	2	N
53	HL-UC 3_SUC_3.2_EV load forecasting	Medium	2	N
54	HL-UC 3_SUC_3.3_EV flexibility estimation	Medium	2	N
55	HL-UC 3_SUC_3.4_Reference charging load profile calculation	Medium	2	N
56	HL-UC 3_SUC_3.5_Charging session schedule	High	2	N
57	HL-UC 3_PUC_4_Interaction with the energy infrastructure	Medium		
58	HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests	Medium	2	N
59	HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration	High	2	N
60	HL-UC 3_SUC_4.3_EV providing V2H services	Medium	2	N

Figure 110 – Mesogia's interests in HL-UC 3.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES IMPLEMENTATION

			HEDNO (Mesogia)	
	HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL		D2.1	D15.1
61	**HL-UC 4_PUC_1_Batteries management at prosumer level**	**High**		
62	HL-UC 4_SUC_1.1_Increase of self-consumption	High	2	N
63	HL-UC 4_SUC_1.2_Time-of-use management	Medium	2	N
64	HL-UC 4_SUC_1.3_Peak Shaving	Medium	2	N
65	**HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)**	**Medium**		
66	HL-UC 4_SUC_2.1_Batteries dispatch management	High	2	N
67	HL-UC 4_SUC_2.2_Black start capabilities	Low	2	N
68	HL-UC 4_SUC_2.3_Power management for peak-shaving and load harmonization	Medium	2	N
69	HL-UC 4_SUC_2.4_Backup power for residential area	Low	2	N
70	**HL-UC 4_PUC_3_Ancillary services**	**Medium**		
71	HL-UC 4_SUC_3.1_Market scheduling	High	2	N
72	HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system	Medium	2	N
73	HL-UC 4_SUC_3.3_Batteries automatic dispatch	Medium	2	N
74	**HL-UC 4_PUC_4_Combination of battery storage systems**	**Medium**		
75	HL-UC 4_SUC_4.1_Parameter configuration of storage systems	Medium	2	N
76	HL-UC 4_SUC_4.2_Priority list of units running	Medium	2	N

Figure 111 – Mesogia's interests in HL-UC 4.

HLUC3 and HLUC4 were never of high priority for HEDNO, as e-mobility has not been widely spread yet and there are legislative limitations regarding storage (not allowing batteries connected on LV level, e.g. to increase self-consumption, to inject energy to the LV or MV network, but only absorb energy from it).

WiseGRID USE CASES INVENTORY	**UC priority**	**PILOT SITES IMPLEMENTATION**	
		HEDNO (Mesogia)	
HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING		D2.1	D15.1
77 **HL-UC 5_PUC_1_Thermal monitoring**	**Medium**		
78 HL-UC 5_SUC_1.1_Monitoring gas meters	Low	5	Y
79 HL-UC 5_SUC_1.2_Monitoring CHP	Medium	5	Y
80 HL-UC 5_SUC_1.3_Monitoring buildings	Medium	5	Y
81 **HL-UC 5_PUC_2_Cogeneration and HVAC management**	**Medium**		
82 HL-UC 5_SUC_2.1_Forecasting thermal needs	Medium	5	Y
83 HL-UC 5_SUC_2.2_Real time control set-points	Medium	2	Y
84 HL-UC 5_SUC_2.3_Control devices	Medium	2	Y
85 HL-UC 5_SUC_2.4_Alarm management	Medium	3	N
86 **HL-UC 5_PUC_3_Comfort-based demand flexibility models**	**Medium**		
87 HL-UC 5_SUC_3.1_Thermal model of households	Medium	5	Y
88 HL-UC 5_SUC_3.2_Thermal model of building	Medium	5	Y
89 HL-UC 5_SUC_3.3_Thermal flexibility modeling	Medium	5	Y

		UC priority	PILOT SITES IMPLEMENTATION HEDNO (Mesogia)
90	**HL-UC 5_PUC_4_Cogeneration and HVAC optimization**	**Medium**	
91	HL-UC 5_SUC_4.1_VPP participation	Low	3 N
92	HL-UC 5_SUC_4.2_Provision of ancillary services	Medium	4 N
93	HL-UC 5_SUC_4.3_System optimization	Medium	4 N

<p align="center">Figure 112 – Mesogia's interests in HL-UC 5.</p>

At HLUC5, there have been several changes since D2.1, because of the difficulty to finalize the installation site/building, safety concerns of the owners and limitations imposed by them and by the systems themselves. However, many SUCs will be implemented, under certain considerations and involving the two buildings where the CHPs will be installed. SUC 1.3 will be tested if the BMS planned to be installed at NTUA sports centre is installed early enough to be used for the needs of WiseGRID project too. SUC 2.1, SUC 3.2 and SUC3.3 will be focused mainly on the needs for hot water usage, while for SUC 2.2 and SUC 2.3 there will be ON/OFF control possibility.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES IMPLEMENTATION	
		HEDNO (Mesogia)	
HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY (ENG)		**D2.1**	**D15.1**
94 **HL-UC 6_PUC_1_VPP monitoring and management**	**High**		
95 HL-UC 6_SUC_1.1_Resource metering	High	1	N
96 HL-UC 6_SUC_1.2_VPP RES forecast	High	1	N
97 HL-UC 6_SUC_1.3_VPP flexibility forecast	High	1	N
98 HL-UC 6_SUC_1.4_Strategies definition	Medium	1	N
99 **HL-UC 6_PUC_2_VPP market participation**	**Medium**		
100 HL-UC 6_SUC_2.1_VPP market participation and bid calculation	Medium	1	N
101 HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation	Medium	1	N
102 HL-UC 6_SUC_2.3_VPP unit scheduling	Medium	1	N
103 **HL-UC 6_PUC_3_VPP Real time control**	**High**		
104 HL-UC 6_SUC_3.1_Real time flexibility calculation	Medium	1	N
105 HL-UC 6_SUC_3.2_VPP implementation of ancillary services	Medium	1	N
106 HL-UC 6_SUC_3.3_Real time decision making	High	1	N
107 **HL-UC 6_PUC_4_VPP users relationship management**	**Low**		
108 HL-UC 6_SUC_4.1_Manage contractual issues	Low	1	N
109 HL-UC 6_SUC_4.2_Define and manage member compensation	Low	1	N
110 HL-UC 6_SUC_4.3_DSM and DR mechanisms	High	1	N

<p align="center">Figure 113 – Mesogia's interests in HL-UC 6.</p>

HLUC 6 was not of high priority for HEDNO and this has not been changed.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES IMPLEMENTATION
		HEDNO (Mesogia)

	HL-UC 7 CITIZENS EMPOWERMENT IN ENERGY MARKET AND REDUCTION OF ENERGY POVERTY (HYP)		D2.1	D15.1
111	**HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector**	**High**		
112	HL-UC 7_SUC_1.1_Monitor energy demand	High	5	Y
113	HL-UC 7_SUC_1.2_Enriched information visualization	High	5	Y
114	HL-UC 7_SUC_1.3_Integration with DR mechanisms	High	3	Y
115	HL-UC 7_SUC_1.4_Net metering & self consumption	Medium	3	N
116	HL-UC 7_SUC_1.5_Energy cost management for large infrastructures	Medium	3	Y
117	**HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market**	**High**		
118	HL-UC 7_SUC_2.1_Enriched information visualization	High	5	Y
119	HL-UC 7_SUC_2.2_Portfolio profiling & analytics	High	5	N
120	HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading	High	5	Y
121	HL-UC 7_SUC_2.4_Billing services	Medium	5	Y
122	HL-UC 7_SUC_2.5_Energy cost management and optimization	Medium	3	Y
123	HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control	Medium	2	Y
124	HL-UC 7_SUC_2.7_Manual DSM strategies activation	High	3	Y
125	**HL-UC 7_PUC_3_Clients engagement for active market participation**	**High**		
126	HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring	High	5	Y
127	HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers	Low	5	Y
128	HL-UC 7_SUC_3.3_Participation in DR programs	High	3	Y
129	HL-UC 7_SUC_3.4_Residential net metering & self consumption	Medium	3	Y

Figure 114 – Mesogia's interests in HL-UC 7.

Although HLUC7 is not adjacent to a DSOs core business, HEDNO intends to implement the most of it at the best possible level under possible constraints or with simplifications, since the importance of citizens' participation in the energy market is highly acknowledged.

4.3 CREVILLENT

After having reviewed (including an intermediate one in May 2018 described in D14.1 "Analysis of the Demo Sites technical data and integration and demonstration planning") the list of Use Cases, the local partner decided the final list of Use Cases that will test based on its capabilities and interests. In this section will be explained the differences between the different interests shown in D2.1 (ranked from 1 to 5) and the final list of Use Cases to be tested in Crevillent.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
		D2.1	D15.1
HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID	**High**		
1 **HL-UC 1_PUC_1_Network monitoring**	**High**	**4**	**Y**
2 HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections	High	4	Y
3 HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections	High	4	Y
4 HL-UC 1_SUC_1.3_KPI management	High	4	Y
5 HL-UC 1_SUC_1.4_Big data storage analysis	High	4	Y
6 **HL-UC 1_PUC_2_Control strategies for reducing RES curtailment**	**High**	**4**	**Y**
7 HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumpt	High	3	N
8 HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means	High	2	N
9 HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies	High	4	Y
10 HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode	Low	4	N
11 **HL-UC 1_PUC_3_Voltage support and congestion management**	**High**	**4**	**N**
12 HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (Centralized)	High	4	N
13 HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (Decentralized)	Medium	4	N
14 HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases	Low	4	N
15 **HL-UC 1_PUC_4_Grid planning analysis**	**Low**	**4**	**Y**
16 HL-UC 1_SUC_4.1_EV charge points planning analysis	Low	3	Y
17 HL-UC 1_SUC_4.2_Grid storage planning analysis	Low	4	Y
18 **HL-UC 1_PUC_5_Promote RES via RESCO companies**	**Medium**	**2**	**N**
19 HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance	Medium	2	N
20 HL-UC 1_SUC_5.2_Monitor domestic RES production	Medium	2	N
21 HL-UC 1_SUC_5.3_Monitor domestic clients consumption	Medium	2	N
22 HL-UC 1_SUC_5.4_Manage energy selling	Medium	2	N
23 HL-UC 1_SUC_5.5_Energy cost management	Medium	3	N

Figure 115 – Crevillent's interests in HL-UC 1.

Concerning HL-UC 1, ENER has been coherent with its the degree of interest and the Use Cases that will finally test. The main change aroused in PUC 1.3 when they finally concluded that they not have the required communication capabilities with the inverters to perform these demonstrations.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
		D2.1	D15.1
HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION			
24 **HL-UC 2_PUC_1_Distribution network real-time monitoring**	**High**	**4**	**Y**
25 HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters	High	4	Y
26 HL-UC 2_SUC_1.2_Data concentration	High	4	Y
27 HL-UC 2_SUC_1.3_Monitoring power quality in the grid	High	4	Y
28 HL-UC 2_SUC_1.4_Fault detection and identification	High	5	Y
29 HL-UC 2_SUC_1.5_Asset management	High	5	Y
30 **HL-UC 2_PUC_2_Real-time distribution system awareness**	**High**	**4**	**Y**
31 HL-UC 2_SUC_2.1_RES and load forecasting	High	4	Y
32 HL-UC 2_SUC_2.2_Topology processor	Medium	4	Y
33 HL-UC 2_SUC_2.3_Network observability analysis	High	4	Y
34 HL-UC 2_SUC_2.4_Load flow calculation	High	4	Y
35 HL-UC 2_SUC_2.5_State estimation	High	4	Y
36 HL-UC 2_SUC_2.6_Bad data detection, identification and replacement	High	4	Y
37 **HL-UC 2_PUC_3_Grid control**	**High**	**4**	**Y**
38 HL-UC 2_SUC_3.1_Load control	High	4	Y
39 HL-UC 2_SUC_3.2_DR as a service to the grid	High	4	Y
40 HL-UC 2_SUC_3.3_Optimization algorithm	High	4	Y
41 HL-UC 2_SUC_3.4_Reconfiguration	Medium	4	Y
42 HL-UC 2_SUC_3.5_Islanding procedures for the local grid	Low	4	N
43 HL-UC 2_SUC_3.6_Cold ironing	Medium	-	N

Figure 116 – Crevillent's interests in HL-UC 2.

With regards to *HL-UC2*, no significant modifications have been performed. ENER had a lot of interest in this HL-UC and they are willing to test it almost complete.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
		D2.1	D15.1
HL-UC 3 e-MOBILITY INTEGRATION IN THE GRID WITH V2G		D2.1	D15.1
44 HL-UC 3_PUC_1_EVSE and EV fleet monitoring	High	2	Y
45 HL-UC 3_SUC_1.1_Data collection from EVSE	High	2	Y
46 HL-UC 3_SUC_1.2_Data collection from EVs	High	2	Y
47 HL-UC 3_PUC_2_Interaction of the user with EVSE	Medium	1	Y
48 HL-UC 3_SUC_2.1_Users' authentication	Medium	1	Y
49 HL-UC 3_SUC_2.2_Charging session request	Medium	1	Y
50 HL-UC 3_SUC_2.3_Charging session booking	Medium	2	Y
51 HL-UC 3_PUC_3_EV charging management	Medium	1	Y
52 HL-UC 3_SUC_3.1_EVSE network configuration	Medium	1	Y
53 HL-UC 3_SUC_3.2_EV load forecasting	Medium	1	Y
54 HL-UC 3_SUC_3.3_EV flexibility estimation	Medium	1	Y
55 HL-UC 3_SUC_3.4_Reference charging load profile calculation	Medium	1	Y
56 HL-UC 3_SUC_3.5_Charging session schedule	High	1	Y
57 HL-UC 3_PUC_4_Interaction with the energy infrastructure	Medium	3	Y
58 HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests	Medium	1	Y
59 HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration	High	1	Y
60 HL-UC 3_SUC_4.3_EV providing V2H services	Medium	3	Y

Figure 117 – Crevillent's interests in HL-UC 3.

At the beginning of the project, the interest in *HL-UC 3* were not especially high, but during the project development, the local partners realized about the potential of the WiseEVP and WG FastV2G in its small electromobility infrastructure and decided to test all the PUCs.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
		D2.1	D15.1
HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL		D2.1	D15.1
61 HL-UC 4_PUC_1_Batteries management at prosumer level	High	2	Y
62 HL-UC 4_SUC_1.1_Increase of self-consumption	High	2	Y
63 HL-UC 4_SUC_1.2_Time-of-use management	Medium	2	Y
64 HL-UC 4_SUC_1.3_Peak Shaving	Medium	2	Y
65 HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)	Medium	-	N
66 HL-UC 4_SUC_2.1_Batteries dispatch management	High	-	N
67 HL-UC 4_SUC_2.2_Black start capabilities	Low	-	N
68 HL-UC 4_SUC_2.3_Power management for peak-shaving and load harmonization	Medium	2	N
69 HL-UC 4_SUC_2.4_Backup power for residential area	Low	2	N
70 HL-UC 4_PUC_3_Ancillary services	Medium	-	N
71 HL-UC 4_SUC_3.1_Market scheduling	High	-	N
72 HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system	Medium	-	N
73 HL-UC 4_SUC_3.3_Batteries automatic dispatch	Medium	-	N
74 HL-UC 4_PUC_4_Combination of battery storage systems	Medium	-	N
75 HL-UC 4_SUC_4.1_Parameter configuration of storage systems	Medium	-	N
76 HL-UC 4_SUC_4.2_Priority list of units running	Medium	-	N

Figure 118 – Crevillent's interests in HL-UC 4.

ENER received a couple of AMP batteries from activities not related to WiseGRID. This allowed WiseGRID to at least testing the PUC 4.1 and include also storage capabilities in the pilot site of Crevillent.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING		D2.1	D15.1
77 HL-UC 5_PUC_1_Thermal monitoring	Medium	-	N
78 HL-UC 5_SUC_1.1_Monitoring gas meters	Low	-	N
79 HL-UC 5_SUC_1.2_Monitoring CHP	Medium	-	N
80 HL-UC 5_SUC_1.3_Monitoring buildings	Medium	-	N
81 HL-UC 5_PUC_2_Cogeneration and HVAC management	Medium	-	Y
82 HL-UC 5_SUC_2.1_Forecasting thermal needs	Medium	-	N
83 HL-UC 5_SUC_2.2_Real time control set-points	Medium	-	Y
84 HL-UC 5_SUC_2.3_Control devices	Medium	-	Y
85 HL-UC 5_SUC_2.4_Alarm management	Medium	-	Y
86 HL-UC 5_PUC_3_Comfort-based demand flexibility models	Medium	-	N
87 HL-UC 5_SUC_3.1_Thermal model of households	Medium	-	N
88 HL-UC 5_SUC_3.2_Thermal model of building	Medium	-	N
89 HL-UC 5_SUC_3.3_Thermal flexibility modeling	Medium	-	N
90 HL-UC 5_PUC_4_Cogeneration and HVAC optimisation	Medium	-	Y
91 HL-UC 5_SUC_4.1_VPP participation	Low	-	N
92 HL-UC 5_SUC_4.2_Provision of ancillary services	Medium	-	Y
93 HL-UC 5_SUC_4.3_System optimisation	Medium	-	Y

Figure 119 – Crevillent's interests in HL-UC 5.

Although ENER is not able to monitor gas consumption or test CHP units, in Crevillent is possible to monitor and control the HVACs of its Headquarters and its industrial plant, allowing WiseGRID to test PUCs 5.2 and 5.4.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY		D2.1	D15.1
94 HL-UC 6_PUC_1_VPP monitoring and management	High	-	N
95 HL-UC 6_SUC_1.1_Resource metering	High	-	N
96 HL-UC 6_SUC_1.2_VPP RES forecast	High	-	N
97 HL-UC 6_SUC_1.3_VPP flexibility forecast	High	-	N
98 HL-UC 6_SUC_1.4_Strategies definition	Medium	-	N
99 HL-UC 6_PUC_2_VPP market participation	Medium	-	N
100 HL-UC 6_SUC_2.1_VPP market participation and bid calculation	Medium	-	N
101 HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation	Medium	-	N
102 HL-UC 6_SUC_2.3_VPP unit scheduling	Medium	-	N
103 HL-UC 6_PUC_3_VPP Real time control	High	-	N
104 HL-UC 6_SUC_3.1_Real time flexibility calculation	Medium	-	N
105 HL-UC 6_SUC_3.2_VPP implementation of ancillary services	Medium	-	N
106 HL-UC 6_SUC_3.3_Real time decision making	High	-	N
107 HL-UC 6_PUC_4_VPP users relationship management	Low	-	N
108 HL-UC 6_SUC_4.1_Manage contractual issues	Low	-	N
109 HL-UC 6_SUC_4.2_Define and manage member compensation	Low	-	N
110 HL-UC 6_SUC_4.3_DSM and DR mechanisms	High	-	N

Figure 120 – Crevillent's interests in HL-UC 6.

Nothing has changed with regards to HL-UC 6.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITE DEMONSTRATIONS	
		ENER (Crevillent)	
		D2.1	D15.1
HL-UC 7 CITIZENS EMPOWERMENT IN ENERGY MARKET AND REDUCTION OF ENERGY POVERTY			
111 HL-UC 7_PUC_1_Dynamic management of demand side assets in tertiary sector	High	3	Y
112 HL-UC 7_SUC_1.1_Monitor energy demand	High	3	Y
113 HL-UC 7_SUC_1.2_Enriched information visualization	High	3	Y
114 HL-UC 7_SUC_1.3_Integration with DR mechanisms	High	2	Y
115 HL-UC 7_SUC_1.4_Net metering & self consumption	Medium	2	Y
116 HL-UC 7_SUC_1.5_Energy cost management for large infrastructures	Medium	3	Y
117 HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market	High	2	Y
118 HL-UC 7_SUC_2.1_Enriched information visualization	High	3	Y
119 HL-UC 7_SUC_2.2_Portfolio profiling & analytics	High	3	Y
120 HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading	High	3	Y
121 HL-UC 7_SUC_2.4_Billing services	Medium	3	Y
122 HL-UC 7_SUC_2.5_Energy cost management and optimization	Medium	3	Y
123 HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control	Medium	-	Y
124 HL-UC 7_SUC_2.7_Manual DSM strategies activation	High	2	N
125 HL-UC 7_PUC_3_Clients engagement for active market participation	High	3	Y
126 HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring	High	3	Y
127 HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers	Low	3	Y
128 HL-UC 7_SUC_3.3_Participation in DR programs	High	2	N
129 HL-UC 7_SUC_3.4_Residential net metering & self consumption	Medium	3	N

Figure 121 – Crevillent's interests in HL-UC 7.

At the beginning of the project, ENER had medium interest in the *HL-UC 7*. During the project development, this interest turned on a firm willingness to test it and finally all the PUCs of HL-UC 7 will be tested in the Pilot Site of Crevillent.

4.4 TERNI

After an intermediate review in May 2018 described in D14.1, [2], this section reports the list of Use Cases reviewed by the partners of the pilot site. It explains the differences between the interests reported in D2.1, [4] (i.e., interest on UCs ranked from 1 to 5) and the final list of Use Cases that will test based on its capabilities and interests.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION TERNI PILOT SITE	
		D 2.1	D 15.1
HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID (CRE)			
1 **HL-UC 1_PUC_1_Network monitoring**	**High**	5	Y
2 HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections	High	5	Y
3 HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections	High	5	Y
4 HL-UC 1_SUC_1.3_KPI management	High	5	Y
5 HL-UC 1_SUC_1.4_Big data storage analysis	High	5	Y
6 **HL-UC 1_PUC_2_Control strategies for reducing RES curtailment**	**High**	4	Y
7 HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consum	High	4	Y
8 HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means	High	4	Y
9 HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies	High	4	Y
10 HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode	Low	4	N
11 **HL-UC 1_PUC_3_Voltage support and congestion management**	**High**	5	Y
12 HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (Centralized)	High	4	Y
13 HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (Decentralized)	Medium	4	Y
14 HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases	Low	5	Y
15 **HL-UC 1_PUC_4_Grid planning analysis**	**Low**	5	Y
16 HL-UC 1_SUC_4.1_EV charge points planning analysis	Low	5	Y
17 HL-UC 1_SUC_4.2_Grid storage planning analysis	Low	5	Y
18 **HL-UC 1_PUC_5_Promote RES via RESCO companies**	**Medium**	4	Y
19 HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance	Medium	4	Y
20 HL-UC 1_SUC_5.2_Monitor domestic RES production	Medium	4	Y
21 HL-UC 1_SUC_5.3_Monitor domestic clients consumption	Medium	4	Y
22 HL-UC 1_SUC_5.4_Manage energy selling	Medium	4	Y
23 HL-UC 1_SUC_5.5_Energy cost management	Medium	4	Y

Figure 122 – Terni's interests in HL-UC 1

With respect to HL-UC 1, ASM Terni is aligned with the interests provided in [4], since these UCs are well suited with the main goals of the company. Nevertheless, SUC_4 will not be tested because of a lack of equipment enabling the island mode in real life.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION TERNI PILOT SITE	
		D 2.1	D 15.1
HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION (ICCS)			
24 **HL-UC 2_PUC_1_Distribution network real-time monitoring**	**High**	5	Y
25 HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters	High	5	Y
26 HL-UC 2_SUC_1.2_Data concentration	High	5	Y
27 HL-UC 2_SUC_1.3_Monitoring power quality in the grid	High	5	Y
28 HL-UC 2_SUC_1.4_Fault detection and identification	High	5	Y
29 HL-UC 2_SUC_1.5_Asset management	High	5	Y
30 **HL-UC 2_PUC_2_Real-time distribution system awareness**	**High**	5	Y
31 HL-UC 2_SUC_2.1_RES and load forecasting	High	5	Y
32 HL-UC 2_SUC_2.2_Topology processor	Medium	5	Y
33 HL-UC 2_SUC_2.3_Network observability analysis	High	5	Y
34 HL-UC 2_SUC_2.4_Load flow calculation	High	5	Y
35 HL-UC 2_SUC_2.5_State estimation	High	5	Y
36 HL-UC 2_SUC_2.6_Bad data detection, identification and replacement	High	5	Y
37 **HL-UC 2_PUC_3_Grid control**	**High**	5	Y
38 HL-UC 2_SUC_3.1_Load control	High	5	Y
39 HL-UC 2_SUC_3.2_DR as a service to the grid	High	5	Y
40 HL-UC 2_SUC_3.3_Optimization algorithm	High	4	Y
41 HL-UC 2_SUC_3.4_Reconfiguration	Medium	5	Y
42 HL-UC 2_SUC_3.5_Islanding procedures for the local grid	Low	4	N
43 HL-UC 2_SUC_3.6_Cold ironing	Medium	4	N

Figure 123 – Terni's interests in HL-UC 2

As described for HL-UC 1, ASM Terni has great interest on the demonstration of this HL-UC, even if the SUC_3.5 and SUC_3.6 cannot be tested; the former needs equipment enabling islanded mode (e.g., inverters

allowing island mode of PV and generators with rotating inertia), the latter is not suitable with the location of the pilot.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION	
		TERNI PILOT SITE	
		D 2.1	D 15.1
HL-UC 3 e-MOBILITY INTEGRATION IN THE GRID WITH V2G (ITE)			
44 HL-UC 3_PUC_1_EVSE and EV fleet monitoring	High	5	Y
45 HL-UC 3_SUC_1.1_Data collection from EVSE	High	5	Y
46 HL-UC 3_SUC_1.2_Data collection from EVs	High	5	Y
47 HL-UC 3_PUC_2_Interaction of the user with EVSE	Medium	4	Y
48 HL-UC 3_SUC_2.1_Users' authentication	Medium	4	Y
49 HL-UC 3_SUC_2.2_Charging session request	Medium	4	Y
50 HL-UC 3_SUC_2.3_Charging session booking	Medium	4	Y
51 HL-UC 3_PUC_3_EV charging management	Medium	5	Y
52 HL-UC 3_SUC_3.1_EVSE network configuration	Medium	5	Y
53 HL-UC 3_SUC_3.2_EV load forecasting	Medium	5	Y
54 HL-UC 3_SUC_3.3_EV flexibility estimation	Medium	5	Y
55 HL-UC 3_SUC_3.4_Reference charging load profile calculation	Medium	4	Y
56 HL-UC 3_SUC_3.5_Charging session schedule	High	4	Y
57 HL-UC 3_PUC_4_Interaction with the energy infrastructure	Medium	5	Y
58 HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests	Medium	5	Y
59 HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration	High	5	Y
60 HL-UC 3_SUC_4.3_EV providing V2H services	Medium	4	N

Figure 124 – Terni's interests in HL-UC 3

Regarding HL-UC 3, ASM in conjunction with EMOTION aims to get results on these UCs, partners generally confirmed their interests already provided in [4]. SUC_4.3 is not applicable on the pilot site because of lack of infrastructure allowing V2G.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION	
		TERNI PILOT SITE	
		D 2.1	D 15.1
HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL (AMP / VS)			
61 HL-UC 4_PUC_1_Batteries management at prosumer level	High	3	Y
62 HL-UC 4_SUC_1.1_Increase of self-consumption	High	3	Y
63 HL-UC 4_SUC_1.2_Time-of-use management	Medium	3	Y
64 HL-UC 4_SUC_1.3_Peak Shaving	Medium	3	Y
65 HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)	Medium	5	N
66 HL-UC 4_SUC_2.1_Batteries dispatch management	High	4	N
67 HL-UC 4_SUC_2.2_Black start capabilities	Low	4	N
68 HL-UC 4_SUC_2.3_Power management for peak-shaving and load harmonization	Medium	5	N
69 HL-UC 4_SUC_2.4_Backup power for residential area	Low	4	N
70 HL-UC 4_PUC_3_Ancillary services	Medium	5	Y
71 HL-UC 4_SUC_3.1_Market scheduling	High	3	Y
72 HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system	Medium	4	Y
73 HL-UC 4_SUC_3.3_Batteries automatic dispatch	Medium	4	Y
74 HL-UC 4_PUC_4_Combination of battery storage systems	Medium	3	N
75 HL-UC 4_SUC_4.1_Parameter configuration of storage systems	Medium	3	N
76 HL-UC 4_SUC_4.2_Priority list of units running	Medium	3	N

Figure 125 – Terni's interests in HL-UC 4

With respect to the HL-UC 4, storage system providing services to the DSO is already in operation. As described in the previous sections, only one equipment is working in the pilot site, implying that only some of the UCs can be tested, as foreseen in [2].

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION TERNI PILOT SITE	
		D 2.1	D 15.1
HL-UC 5 COGENERATION INTEGRATION IN PUBLIC BUILDINGS/HOUSING (ICCS / EPA)			
77 HL-UC 5_PUC_1_Thermal monitoring	Medium	-	Y
78 HL-UC 5_SUC_1.1_Monitoring gas meters	Low	-	N
79 HL-UC 5_SUC_1.2_Monitoring CHP	Medium	-	N
80 HL-UC 5_SUC_1.3_Monitoring buildings	Medium	-	Y
81 HL-UC 5_PUC_2_Cogeneration and HVAC management	Medium	-	Y
82 HL-UC 5_SUC_2.1_Forecasting thermal needs	Medium	-	N
83 HL-UC 5_SUC_2.2_Real time control set-points	Medium	-	N
84 HL-UC 5_SUC_2.3_Control devices	Medium	-	Y
85 HL-UC 5_SUC_2.4_Alarm management	Medium	-	N
86 HL-UC 5_PUC_3_Comfort-based demand flexibility models	Medium	-	N
87 HL-UC 5_SUC_3.1_Thermal model of households	Medium	-	N
88 HL-UC 5_SUC_3.2_Thermal model of building	Medium	-	N
89 HL-UC 5_SUC_3.3_Thermal flexibility modeling	Medium	-	N
90 HL-UC 5_PUC_4_Cogeneration and HVAC optimisation	Medium	-	N
91 HL-UC 5_SUC_4.1_VPP participation	Low	-	N
92 HL-UC 5_SUC_4.2_Provision of ancillary services	Medium	-	N
93 HL-UC 5_SUC_4.3_System optimisation	Medium	-	N

Figure 126 – Terni's interests in HL-UC 5

Regarding HL-UC 5, ASM Terni has not provided interests in [4] since the deployment of the proper equipment was still not planned. As explained in the previous sections, a BEMS has been installed in the headquarters of ASM to monitor and control HVAC; in this respect, SUC_1.3 and SUC_2.3 can be properly evaluated in the context of WiseCORP.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION TERNI PILOT SITE	
		D 2.1	D 15.1
HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY (ENG)			
94 HL-UC 6_PUC_1_VPP monitoring and management	High	3	Y
95 HL-UC 6_SUC_1.1_Resource metering	High	3	Y
96 HL-UC 6_SUC_1.2_VPP RES forecast	High	3	Y
97 HL-UC 6_SUC_1.3_VPP flexibility forecast	High	3	Y
98 HL-UC 6_SUC_1.4_Strategies definition	Medium	3	Y
99 HL-UC 6_PUC_2_VPP market participation	Medium	2	Y
100 HL-UC 6_SUC_2.1_VPP market participation and bid calculation	Medium	2	Y
101 HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation	Medium	2	Y
102 HL-UC 6_SUC_2.3_VPP unit scheduling	Medium	2	Y
103 HL-UC 6_PUC_3_VPP Real time control	High	3	Y
104 HL-UC 6_SUC_3.1_Real time flexibility calculation	Medium	3	Y
105 HL-UC 6_SUC_3.2_VPP implementation of ancillary services	Medium	3	Y
106 HL-UC 6_SUC_3.3_Real time decision making	High	3	Y
107 HL-UC 6_PUC_4_VPP users relationship management	Low	2	Y
108 HL-UC 6_SUC_4.1_Manage contractual issues	Low	1	Y
109 HL-UC 6_SUC_4.2_Define and manage member compensation	Low	1	Y
110 HL-UC 6_SUC_4.3_DSM and DR mechanisms	High	2	Y

Figure 127 – Terni's interests in HL-UC 6

With respect to the HL-UC 6, the usage of VPP, as an aggregation of the PV plants, will be leveraged to get these results.

WiseGRID USE CASES INVENTORY	UC priority	PILOT SITES DEMONSTRATION	
		TERNI PILOT SITE	
		D 2.1	D 15.1
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	High	1	N
112 HL-UC 7_SUC_1.1_Monitor energy demand	High	1	N
113 HL-UC 7_SUC_1.2_Enriched information visualization	High	1	N
114 HL-UC 7_SUC_1.3_Integration with DR mechanisms	High	1	N
115 HL-UC 7_SUC_1.4_Net metering & self consumption	Medium	1	N
116 HL-UC 7_SUC_1.5_Energy cost management for large infrastructures	Medium	1	N
117 HL-UC 7_PUC_2_Dynamic aggregation of distributed energy assets and active participation into energy market	High	1	Y
118 HL-UC 7_SUC_2.1_Enriched information visualization	High	1	Y
119 HL-UC 7_SUC_2.2_Portfolio profiling & analytics	High	1	Y
120 HL-UC 7_SUC_2.3_Portfolio demand forecasting for wholesale energy trading	High	1	Y
121 HL-UC 7_SUC_2.4_Billing services	Medium	1	Y
122 HL-UC 7_SUC_2.5_Energy cost management and optimization	Medium	1	Y
123 HL-UC 7_SUC_2.6_Automated DSM strategies activation through direct load control	Medium	1	Y
124 HL-UC 7_SUC_2.7_Manual DSM strategies activation	High	1	N
125 HL-UC 7_PUC_3_Clients engagement for active market participation	**High**	1	Y
126 HL-UC 7_SUC_3.1_Enriched information visualization for energy monitoring	High	1	Y
127 HL-UC 7_SUC_3.2_Social network collaboration and comparisons with peers	Low	1	Y
128 HL-UC 7_SUC_3.3_Participation in DR programs	High	1	Y
129 HL-UC 7_SUC_3.4_Residential net metering & self consumption	Medium	1	Y

Figure 128 – Terni's interests in HL-UC 7

Regarding HL-UC 7, the interests collected in [4] has not been confirmed since a notable amount of customers have been involved during the follow-up of the project. In this respect, the usage of WiseHOME and WiseCORP is a key to get a real involvement of the citizen and to increase their awareness about energy utilization.

4.5 KYTHNOS

WiseGRID USE CASES INVENTORY	AEA (Kythnos)
HL-UC 1 DISTRIBUTED RES INTEGRATION IN THE GRID (CRE)	
1 HL-UC 1_PUC_1_Network monitoring	Yes
2 HL-UC 1_SUC_1.1_Data collection from the RES and critical network sections	Yes
3 HL-UC 1_SUC_1.2_Forecast of RES production, consumption and of total power flow in critical sections	Yes
4 HL-UC 1_SUC_1.3_KPI management	Yes
5 HL-UC 1_SUC_1.4_Big data storage analysis	Yes
6 HL-UC 1_PUC_2_Control strategies for reducing RES curtailment	
7 HL-UC 1_SUC_2.1_Reduce RES curtailment by encouraging neighbourhood transactions and real-time consumption	No
8 HL-UC 1_SUC_2.2_Reduce RES curtailment by using grid storage distributed means	Yes
9 HL-UC 1_SUC_2.3_Providing DSO curtailment warnings service to allow RES strategies	Yes
10 HL-UC 1_SUC_2.4_Methods for reducing RES curtailment in island mode	No
11 HL-UC 1_PUC_3_Voltage support and congestion management	
12 HL-UC 1_SUC_3.1_Provide local U control through P-Q flexibility of RES inverters (Centralized)	No
13 HL-UC 1_SUC_3.2_Provide local U control through P-Q flexibility of RES inverters (Decentralized)	No
14 HL-UC 1_SUC_3.3_Improve voltage symmetry between the phases	No
15 HL-UC 1_PUC_4_Grid planning analysis	
16 HL-UC 1_SUC_4.1_EV charge points planning analysis	No
17 HL-UC 1_SUC_4.2_Grid storage planning analysis	No
18 HL-UC 1_PUC_5_Promote RES via RESCO companies	
19 HL-UC 1_SUC_5.1_RESCO asset inventory, control and maintenance	No
20 HL-UC 1_SUC_5.2_Monitor domestic RES production	No
21 HL-UC 1_SUC_5.3_Monitor domestic clients consumption	No
22 HL-UC 1_SUC_5.4_Manage energy selling	No
23 HL-UC 1_SUC_5.5_Energy cost management	No

Figure 129 – Kythnos' interest in HL-UC 1.

The Use Cases of HL-UC 1 will be tested as initially described in D2.1.

	HL-UC 2 DECENTRALIZED GRID CONTROL AUTOMATION (ICCS)	
24	HL-UC 2_PUC_1_Distribution network real-time monitoring	
25	HL-UC 2_SUC_1.1_Monitoring grid through Unbundled Smart Meters	No
26	HL-UC 2_SUC_1.2_Data concentration	No
27	HL-UC 2_SUC_1.3_Monitoring power quality in the grid	Yes
28	HL-UC 2_SUC_1.4_Fault detection and identification	No
29	HL-UC 2_SUC_1.5_Asset management	Yes
30	HL-UC 2_PUC_2_Real-time distribution system awareness	
31	HL-UC 2_SUC_2.1_RES and load forecasting	Yes
32	HL-UC 2_SUC_2.2_Topology processor	Yes
33	HL-UC 2_SUC_2.3_Network observability analysis	Yes
34	HL-UC 2_SUC_2.4_Load flow calculation	Yes
35	HL-UC 2_SUC_2.5_State estimation	Yes
36	HL-UC 2_SUC_2.6_Bad data detection, identification and replacement	Yes
37	HL-UC 2_PUC_3_Grid control	
38	HL-UC 2_SUC_3.1_Load control	Yes
39	HL-UC 2_SUC_3.2_DR as a service to the grid	Yes
40	HL-UC 2_SUC_3.3_Optimization algorithm	Yes
41	HL-UC 2_SUC_3.4_Reconfiguration	No
42	HL-UC 2_SUC_3.5_Islanding procedures for the local grid	No
43	HL-UC 2_SUC_3.6_Cold ironing	Yes (simulation)

Figure 130 – Kythnos' interest in HL-UC 2.

The Use Cases of HL-UC 2 will be tested as initially described in D2.1.

	HL-UC 3 e-MOBILITY INTEGRATION IN THE GRID WITH V2G (ITE)	
44	HL-UC 3_PUC_1_EVSE and EV fleet monitoring	
45	HL-UC 3_SUC_1.1_Data collection from EVSE	Yes
46	HL-UC 3_SUC_1.2_Data collection from EVs	Yes
47	HL-UC 3_PUC_2_Interaction of the user with EVSE	
48	HL-UC 3_SUC_2.1_Users' authentication	Yes
49	HL-UC 3_SUC_2.2_Charging session request	Yes
50	HL-UC 3_SUC_2.3_Charging session booking	Yes
51	HL-UC 3_PUC_3_EV charging management	
52	HL-UC 3_SUC_3.1_EVSE network configuration	Yes
53	HL-UC 3_SUC_3.2_EV load forecasting	Yes
54	HL-UC 3_SUC_3.3_EV flexibility estimation	Yes
55	HL-UC 3_SUC_3.4_Reference charging load profile calculation	Yes
56	HL-UC 3_SUC_3.5_Charging session schedule	Yes
57	HL-UC 3_PUC_4_Interaction with the energy infrastructure	
58	HL-UC 3_SUC_4.1_Charging reschedule to follow grid requests	Yes
59	HL-UC 3_SUC_4.2_Charging reschedule to maximise RES integration	No
60	HL-UC 3_SUC_4.3_EV providing V2H services	No

Figure 131 – Kythnos' interest in HL-UC 3.

The Use Cases of HL-UC 3 will be tested as initially described in D2.1.

HL-UC 4 BATTERY STORAGE INTEGRATION AT SUBSTATION AND PROSUMER LEVEL (AMP / VS)	
61	HL-UC 4_PUC_1_Batteries management at prosumer level	
62	HL-UC 4_SUC_1.1_Increase of self-consumption	Yes
63	HL-UC 4_SUC_1.2_Time-of-use management	Yes
64	HL-UC 4_SUC_1.3_Peak Shaving	Yes
65	HL-UC 4_PUC_2_Batteries management at aggregator level (grid support)	
66	HL-UC 4_SUC_2.1_Batteries dispatch management	Yes
67	HL-UC 4_SUC_2.2_Black start capabilities	No
68	HL-UC 4_SUC_2.3_Power management for peak-shaving and load harmonization	No
69	HL-UC 4_SUC_2.4_Backup power for residential area	No
70	HL-UC 4_PUC_3_Ancillary services	
71	HL-UC 4_SUC_3.1_Market scheduling	Yes
72	HL-UC 4_SUC_3.2_Combination of applications/services in the same storage system	Yes
73	HL-UC 4_SUC_3.3_Batteries automatic dispatch	Yes
74	HL-UC 4_PUC_4_Combination of battery storage systems	
75	HL-UC 4_SUC_4.1_Parameter configuration of storage systems	Yes
76	HL-UC 4_SUC_4.2_Priority list of units running	Yes

Figure 132 – Kythnos' interest in HL-UC 4.

The Use Cases of HL-UC 4 will be tested as initially described in D2.1.

HL-UC 5 is not tested in Kythnos.

HL-UC 6 VPP TECHNICAL AND ECONOMIC FEASIBILITY (ENG)	
94	HL-UC 6_PUC_1_VPP monitoring and management	
95	HL-UC 6_SUC_1.1_Resource metering	No
96	HL-UC 6_SUC_1.2_VPP RES forecast	No
97	HL-UC 6_SUC_1.3_VPP flexibility forecast	No
98	HL-UC 6_SUC_1.4_Strategies definition	No
99	HL-UC 6_PUC_2_VPP market participation	
100	HL-UC 6_SUC_2.1_VPP market participation and bid calculation	No
101	HL-UC 6_SUC_2.2_VPP ancillary market participation and bid calculation	No
102	HL-UC 6_SUC_2.3_VPP unit scheduling	No
103	HL-UC 6_PUC_3_VPP Real time control	
104	HL-UC 6_SUC_3.1_Real time flexibility calculation	Yes
105	HL-UC 6_SUC_3.2_VPP implementation of ancillary services	Yes
106	HL-UC 6_SUC_3.3_Real time decision making	Yes
107	HL-UC 6_PUC_4_VPP users relationship management	
108	HL-UC 6_SUC_4.1_Manage contractual issues	No
109	HL-UC 6_SUC_4.2_Define and manage member compensation	No
110	HL-UC 6_SUC_4.3_DSM and DR mechanisms	No

Figure 133 – Kythnos' interest in HL-UC 6.

The Use Cases of HL-UC 6 will be tested as initially described in D2.1.

HL-UC 7 is not tested in Kythnos.

5 CONCLUSIONS

This report presented the work that was carried out by the WiseGRID partners, and mainly the Pilot Site leaders and the Tool Developers, in the frame of the tasks T14.3 "WiseGRID integrated ecosystem preliminary deployment" and T15.2 "WiseGRID integrated ecosystem preliminary demonstration", for the period between August 2018, M22 – the first month of Preliminary Deployment activities -, and April 2019, M30 – the last month of Preliminary Demonstration activities -. The adopted approach, according to which Pilot Site leaders and Tool Developers formed collaboration and coordination teams in order to focus on the deployment and demonstration of the tools per Pilot Site, proved to be useful and sufficient. Despite the difficulties, which are expected during the implementation phase of any project, all the tools have been partially deployed and demonstrated by the end of the period, which means that the primary goal of the Tasks has been succeeded.

Most importantly, already by the end of the Preliminary Deployment and Demonstration period, all the pilot sites are heading towards the full deployment of the WG Tools and, eventually, the demonstration of them and the evaluation of their impact. The activities of the complete deployment and demonstration are defined at the tasks T14.4 and T15.3, the timeline of which has been presented in D14.1 and D14.2, and will be presented at deliverable D15.2.

6 REFERENCES AND ACRONYMS

6.1 REFERENCES

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6.2 ACRONYMS

Table 9 – Acronyms list

Acronyms List	
BD	Big Data
BEMS	Building Energy Management System
BoEU	Block of Energy Unit
CAN	Control Area Network (standard)
CIM	Common Information Model
CPU	Central Processing Unit
DMS	Distribution Management System
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HD	Hard Disk
HL-UC	High Level Use Case
HVAC	Heating, Ventilating and Air Conditioning
HW	Hardware
IP	Internet Protocol
LV	Low Voltage
MV	Medium Voltage
OCPP	Open Charge Point Protocol
PLC	Programmable Logic Unit
PUC	Primary Use Case
PV	Photovoltaics
RES	Renewable Energy Sources
RFID	Radio Frequency IDentification
RPF	Reverse Power Flow
SCADA	Supervisory Control And Data Acquisition
SMX	Smart Meter eXtension
SOC	State of Charge
SOH	State of Health
VM	Virtual machine
VPN	Virtual Private Network