Renaissance

RENEWABLE INTEGRATION & SUSTAINABILITY IN ENERGY COMMUNITIES

D5.1 – Output data framework

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RENAISSANCE Consortium

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Executive summary

RENAISSANCE aims to demonstrate an easily replicable approach to design and operate local integrated energy systems that have a high and stable level of social acceptability.

The project will demonstrate local energy systems that meet or exceed the EU target of 27% of RES across energy sources, at equal or lower cost of energy in comparison with current solutions and reach a critical mass of participation of 15-20% of citizens and businesses.

This report presents the Output Data Framework of the RENAISSANCE project, giving a description of the current Pilot Sites situation, post project implementation situation and data availability and communication with RENAISSANCE data platforms options.

This deliverable aims to be a general framework laying the groundwork for more technical deliverables that will detail technical implementation information. The main ones are:

- D1.4 Data management Plan [1]
- D2.3 KPI definition and selection [4]
- D2.2 Requirements, expectations and objectives for each demo site [5]
- D2.1 Report on ranking of technology-business designs for demo sites [6]
- D3.2 Smart-contracts detailed design and implementation [7]
- D4.1 Information Platform integrations [8]
- D4.2 Energy nodes integration report [9]
- D4.3 Blockchain network implementation [10]
- D5.2 Final implementation plan [11]
- D6.1 Data Platform [12]
- D7.1 RENAISSANCE visual identity, web site and social media [13]
- D7.2 RENAISSANCE dissemination [14]

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1. Introduction

This report contains the Data Output Framework for RENAISSANCE, compiling and analyzing all the available information as per M7 of the project lifetime. The report aims to collect all available information regarding the current and post-project situation of the Pilot Sites and describe the available data and communication options to feed the project platform.

D5.1 presents the Data Output Framework per Pilot Site, while it attempts to provide to also depict the current and future state of the Pilot Sites. The description of the PS is attempted to be as accurate as possible. However, due to major differences among them (function, purpose, use, data availability, different assets etc), each PS description is structured differently. Of course, this no way impacts the report itself, since it is not the objective.

The document has been structured as follows:

Pilot Sites Data output framework

- Data sets to be used within the project
- Data transfer information (protocols, communication HW, file formats, etc)

Pilot Sites current situation

- Pilot site description focused on the energy consumption (energy end users/stakeholders, seasonality, weather conditions and constrains to implement RES, etc)
- Energy assets by energy vector (Generation, transmission, end users/consumption and measurement)
- Energy contracts description

Objectives and Scenarios definition

- Stakeholders objectives
- MAMCA analysis (in Spanish and Holland Pilot Sites)
- Preferred scenario selection

Pilot Sites situation post project situation

- Description and technical justification of the new assets to be implemented

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* Integration with the current energy assets, benefits and expectations

Definitions and acronyms

ACRONYM	
DoA	Description of Action
FAIR	Findable, Accessible, Interoperable and Re-usable data
GA	Grant Agreement
GDPR	EU General Data Protection Regulation
GHG	Green House Gasses
IoT	Internet of Things
lRES	Local renewable energy sources
LES	Local energy system
LLCOE	Local levelised cost of energy
LCOE	Levelised Costs of Energy
LEC	Local energy community
SMT	Smart meter
TEM	Thermal energy meter
PV	Photovoltaic
SW	Software
PS	Pilot Site
RREE	Renewable Energy
PHEV	Plug-in Hybrid Electric Vehicle
BEV	Battery Electric Vehicle

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SLAB	Second Life Automotive Batteries
PPA	Power Purchase Agreement
CUPS	Código Universal de Punto de Suministro
TC	Transformation Centre
DB	Data Base
MV	Medium Voltage
DHW	Domestic Hot Water
DH	District Heating

Table 1- list of acronyms

2. Pilot Sites Data output framework

This section contains the data infrastructure framework in each PS describing the data sources, communication current equipment and protocols and where already available the solutions to exchange data with the Renaissance data platform.

Data sets are divided in electrical, thermal, mobility and transport and meteorological data to be consistent with the deliverable general structure.

2.1 Spanish pilot (Manzaneda)

Electrical energy data

Smart-meters data: Smart metering data system is based on PLC COSEM data protocol (data transferred between smart meters and Hubs) and PRIME protocol (data transferred between Hubs and data gathering platform). Data is sent stored in the platform in an FTP folder in xml format (Figure 1).

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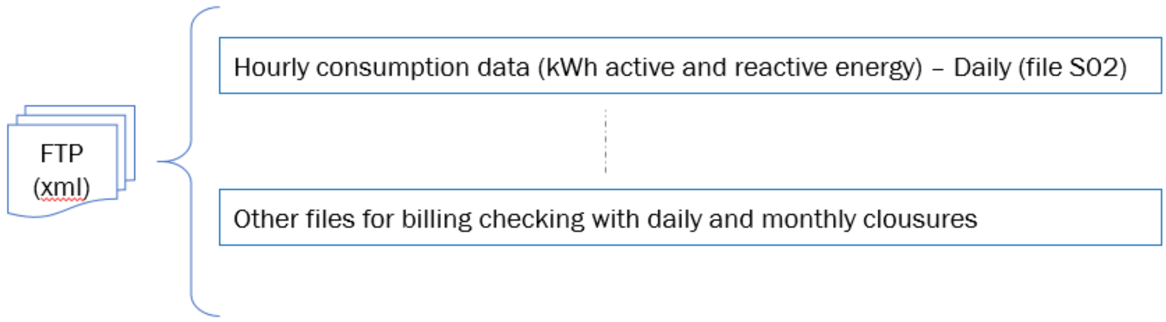

Figure 1- frequency of data sent

Circutor tertiary Hubs are able to create an alternative FTP folder to send the consumption files. This FTP service could be pointed to the ATOS platform thus get the files automatically daily.

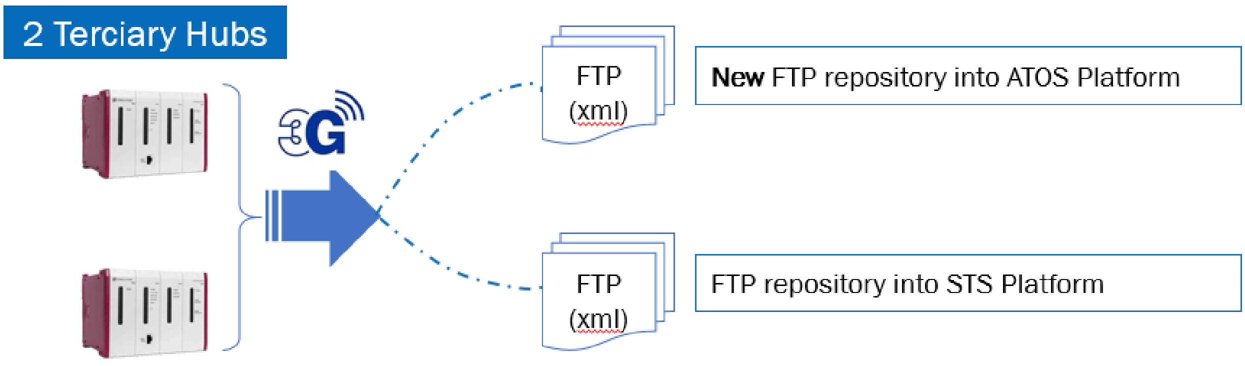

Figure 2- alternative folder for ATOS platform (source: Exeleria)

There are six consumption end users that are not integrated into the Telemanagement System. These CUPS has also smart meters, but the data acquisition is through a Telemetering System using IEC 870-5-102 protocol. The consumption is acquired by phone call to the modem installed in each smart meter.

MV Grid data: MV grid is being monitored and operated by a SCADA system. Each TC has metering and controlling devices connected by optic fibre with a central PC located at "Apartamentos Galicia" building.

Figure 3 shows the measures being gathered in each of the MV grid TCs.

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DeviceName	TagId	TagName	ElementName	TagClassDescription	Units
C.S. 0 - C.T. 0/ESCLAVO 2	1271	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30000	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Corriente Fase A	A
C.S. 0 - C.T. 0/ESCLAVO 2	1272	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30001	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (IA/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1273	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30002	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Corriente Fase B	A
C.S. 0 - C.T. 0/ESCLAVO 2	1274	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30003	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (IB/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1275	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30004	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Corriente Fase C	A
C.S. 0 - C.T. 0/ESCLAVO 2	1276	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30005	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (IC/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1277	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30006	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Corriente Fase N	A
C.S. 0 - C.T. 0/ESCLAVO 2	1278	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30007	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (IN/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1279	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30008	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Corriente Fase NS	A
C.S. 0 - C.T. 0/ESCLAVO 2	1280	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30009	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (INS/VA)	A
C.S. 0 - C.T. 0/ESCLAVO 2	1281	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30010	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Tensión Fase A	kV
C.S. 0 - C.T. 0/ESCLAVO 2	1282	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30011	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (VA/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1283	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30012	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Tensión Fase B	kV
C.S. 0 - C.T. 0/ESCLAVO 2	1284	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30013	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (VB/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1285	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30014	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Tensión Fase C	kV
C.S. 0 - C.T. 0/ESCLAVO 2	1286	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30015	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Ang (VC/VA)	º
C.S. 0 - C.T. 0/ESCLAVO 2	1287	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30016	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Activa Fase A	kW
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C.S. 0 - C.T. 0/ESCLAVO 2	1289	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30018	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Activa Fase C	kW
C.S. 0 - C.T. 0/ESCLAVO 2	1290	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30019	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Activa Total	kW
C.S. 0 - C.T. 0/ESCLAVO 2	1291	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30020	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Reactiva Fase A	kVAr
C.S. 0 - C.T. 0/ESCLAVO 2	1292	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30021	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Reactiva Fase B	kVAr
C.S. 0 - C.T. 0/ESCLAVO 2	1293	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30022	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Reactiva Fase C	kVAr
C.S. 0 - C.T. 0/ESCLAVO 2	1294	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30023	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	P. Reactiva Total	kVAr
C.S. 0 - C.T. 0/ESCLAVO 2	1295	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30024	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Energía importada	kWh
C.S. 0 - C.T. 0/ESCLAVO 2	1296	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30025	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Energía exportada	kWh
C.S. 0 - C.T. 0/ESCLAVO 2	1297	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30026	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Energía reactiva Q1	kVArh
C.S. 0 - C.T. 0/ESCLAVO 2	1298	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30027	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Energía reactiva Q2	kVArh
C.S. 0 - C.T. 0/ESCLAVO 2	1299	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30028	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Energía reactiva Q3	kVArh
C.S. 0 - C.T. 0/ESCLAVO 2	1300	C.S. 0 - C.T. 0/ESCLAVO 2/AI.30029	/Red Distribucion/PTO. 0 C. S. / C. T. 0/Celda 2/52-2:Int	Energía reactiva Q4	kVArh

Figure 3- MV grid measures by TC (source: Meisa)

These signals could be gathered in real time and up to 5 min sampling frequency.

SCADA system has a web service to allow external applications to read the current (real) value of any digital o analogic signal being gathered.

- Communication topology: Web Service WCF, using SOAP messaging
- URL: http://<hostname>/TedisNet.SystemExport.TagStateService
- Definition file WSDL: TedisNet.SystemExport.TagStateService.wsdl.

The WebService is designed to be called periodically in typical time frequencies ranged from 5 to 15 minutes. User and password are needed to access the service.

Detailed description of the WebService functions are provided in the "**Error! Reference source not found.**".

Thermal energy data

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There is no access to the computer where the consumption information is currently registered; therefore, a 3G router will be installed to send the M-Bus signal to the ATOS (FUSE) platform via internet.

Figure 4- thermal meter data exportation to FUSE (source: Exeleria)

Meteorological data

The API of MeteoSIX is a web service that gives access to the results of the different numerical prediction models executed daily by MeteoGalicia. In addition, it provides information on tides and sunrise and sunset times.

The objective of this API is to facilitate the consultation of the great quantity of existing meteorological and oceanographic prediction information presenting it in a structured and ordered way. The API can be useful both for those who wish to develop customized meteorological applications using these data, and for end users who need the information for different types of analysis and processing.

The numerical prediction variables that can be consulted through the API are the following:

- State of the sky
- Temperature
- Vento
- Precipitation
- Snow level
- Relative humidity

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- Cloud cover

- Sea level pressure

- Wave period*.

- Wave direction*

- Water temperature*.

- Salinity

- Wave height*.

* only in points on the sea

Atos has already successfully accessed to these data set.

2.2 Belgium Pilot (VUB health campus)

Data is collected through the PRIVA building management system, which gathers building usage and energy related data, including those coming from the smart meters.

The energy related data is copied to the ERBIS system, used for billing purposes in the hospital. Besides, the energy data is copied once every week to the server at the Green Energy Park. This server is property of the VUB, and the data is stored in a SQL database. The database (master) is copied to ensure that no data is lost in the process. RENAISSANCE partners, through VUB, have access to the data collected in the copy of the SQL database. The required datasets will be copied onto ATOS' FUSE platform for other partners' benefit. A graphical representation can be found in Figure 5.

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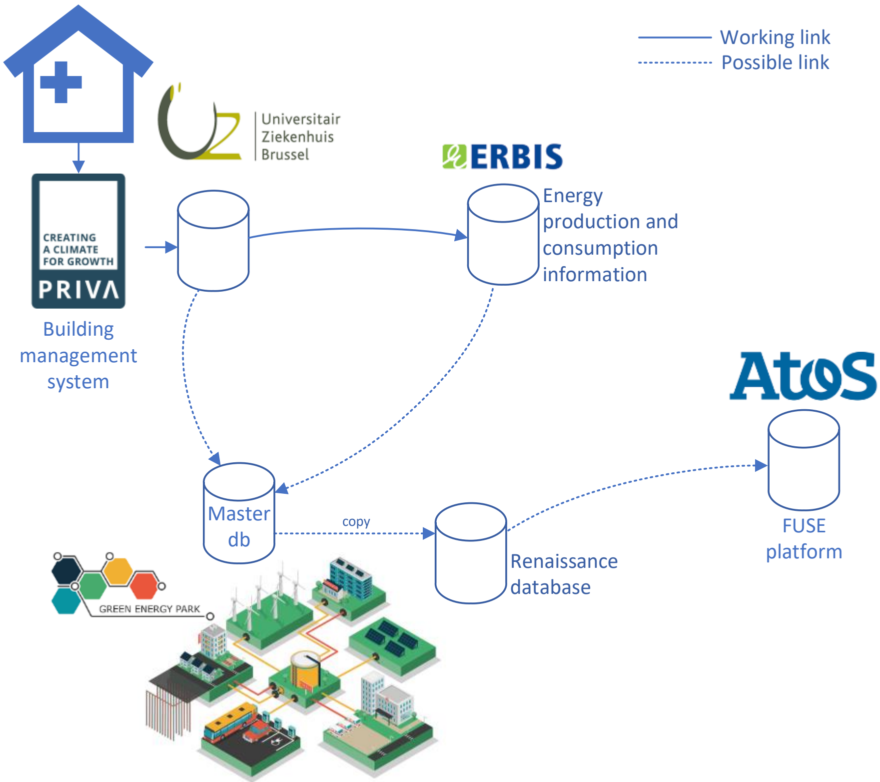

Figure 5-. Data output framework for VUB pilot site

2.3 Netherlands pilot (EEMNES)

<u>Electrical energy data</u>

Data is collected through the Bliq-vanger 1.0 gateway, which gathers energy related data. The bliq-vanger 1.0 will be connected to the existing smart meters through P1 portal. Exposure of the smart meter data via the i.LECO API which results in a 15min structure containing the EAN, the timestamp, the value and the type recorded using the Dutch smart meter conventions of the parameter (e.g. ; active energy injection2,54kWh). The data will be gathered locally via the DLMS version supported by the local smart meter connected to the gateway and then transfer it to i.LECO cloud, store and expose via i.LECO API to energy supplier license holder. For billing purposes, a mixed of Mongo, MySQL, Cosmo and a new fast time series

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DB is used which will be selected and implement for the overall i.LECO services in 2020 and thus also be used for this project.

The aggregated and anonymised database (master) is copied for the use RENAISSANCE partners. RENAISSANCE partners, through VUB, have access to the data collected in the copy of the SQL database. The interesting datasets will be copied onto ATOS' FUSE platform for other partners' benefit. A graphical representation can be found in Figure 6.

The data will be gathered locally via the DLMS version supported by the local smart meter connected to the gateway and then transfer it to i.LECO cloud, store and expose via i.LECO API to energy supplier license holder.

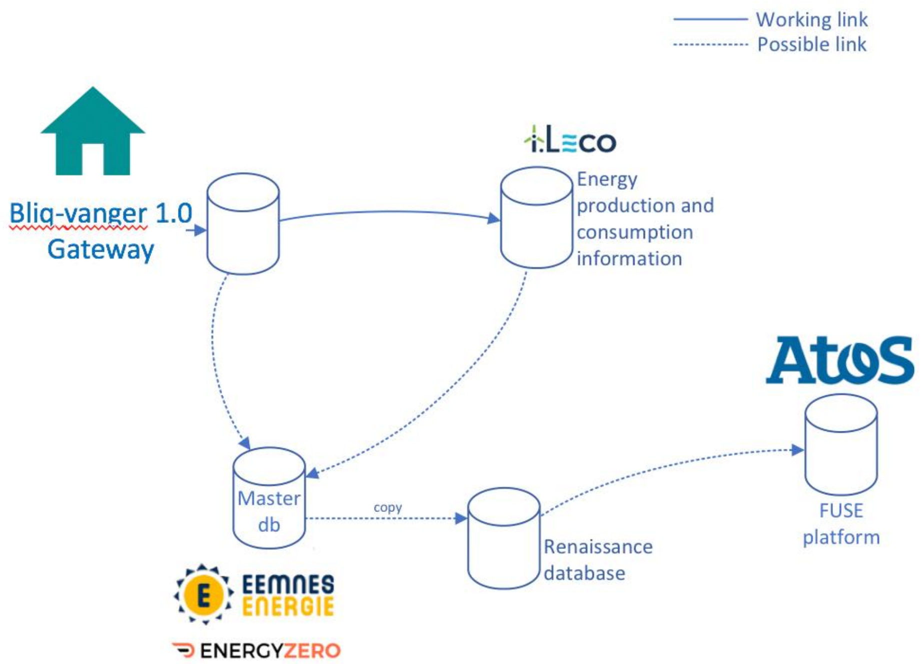

Figure 6 Indicative data collection and management scheme (November 2019)

2.4 Greek pilot (Kimmeria Campus)

Electrical energy data

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The available data regarding electrical energy include, the electricity generated by the autonomous PV system entailing information about the amount of electricity that is stored to the battery system and consumed by the building, the electricity consumption of the installed RES systems and the electricity consumption of specific loads of students' buildings (Table 2- Electrical Energy Smart Meters (Kimmeria's Pilot Site)

).

The new smart meters that are expected to be installed within RENAISSANCE project will provide information about the electricity consumption of specific student rooms, the total consumption of two students' buildings, as well as the electricity generation of the new ORC turbine.

The installed electricity smart meters of Kimmeria's PS are shown in Table 2- Electrical Energy Smart Meters (Kimmeria's Pilot Site)

. The type of the meters is "ABB-B23-111-10".

No	Building	Variable	Measuring Units	Time Interval
1	Restaurant	"Master" Geothermal Heat Pump consumption	kWh_e	15min
2	Restaurant	"Slave" Geothermal Heat Pump consumption	kWh_e	15min
3	G1	Groundfloor Communal Consumption	kWh_e	15min
4	G2	Boiler Consumption	kWh_e	15min
5	G2	Photovoltaic (PV) energy production	kWh_e	15min
6	G2	1st Floor Communal Consumption	kWh_e	15min

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7	D1A	2nd Floor Communal Consumption	kWh_e	15min
8	D1B	2nd Floor Communal Consumption	kWh_e	15min
9	Energy Centre	Absorption Chiller Consumption	kWh_e	15min
10	Energy Centre	Biomass Boiler's Primary Fan Consumption	kWh_e	15min
11	Energy Centre	Biomass Boiler's Draft Fan Consumption	kWh_e	15min

Table 2- Electrical Energy Smart Meters (Kimmeria's Pilot Site)

The data is temporarily stored into stand-alone dataloggers (Symmetron Stylitis-10) and then uploaded to a webserver, property of Symmetron S.A. (MyQSL database) (www.symmetron.gr/captum), as shown in section 2. The acquisition of the data can be performed using a tool provided by Symmetron S.A. that allows communication with the webserver.

New electricity smart meters will be installed within RENAISSANCE project in order to measure the electricity consumption of student rooms and the total electricity consumption of two student's residence buildings. Their data will be acquired through the installation of new BMS controllers that will include integrated webserver, where the data will be uploaded. The acquisition of the data from the webserver depends on the specific product that will be installed following the public tender procedure.

Thermal energy data

The available data regarding thermal energy include the thermal energy generated by installed RES systems, as shown in **Table 3- Thermal Energy Meters (Kimmeria's Pilot Site)**

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The new thermal energy meters that will be installed within RENAISSANCE project will provide information about the thermal energy consumption for heating and domestic hot water of specific student rooms, the total thermal energy consumption of two students' residence buildings, as well as the thermal energy consumption of the new ORC turbine. In addition, thermal energy data will be available from the two new SUNAMP thermal batteries that will provide domestic hot water.

The installed heat meters installed are presented in Table 3- Thermal Energy Meters (Kimmeria's Pilot Site)

. Two types heat meters are installed, "Madalena" and "B-Meters".

No	Building	Variable	Measuring Units	Time Interval
1	Restaurant	Thermal/Cooling Energy produced by GHPs	kWh_{th}	15min
2	Restaurant	Thermal/Cooling Energy given by the Geothermal Heat Excahnger	kWh_{th}	15min
3	Solar Thermal Field	Solar Loop 1 Thermal Energy	kWh_{th}	15min
4	Energy Centre	TES Thermal Energy	kWh_{th}	15min
5	Energy Centre	Hybrid System Thermal Energy	kWh_{th}	15min

Table 3- Thermal Energy Meters (Kimmeria's Pilot Site)

The data is temporarily stored into stand-alone dataloggers (Symmetron Stylitis-10) and then uploaded to a webserver, property of Symmetron S.A. (MyQSL database) (www.symmetron.gr/captum), as shown in section 2. The acquisition of the data can be performed using a tool provided by Symmetron S.A. that allows communication with the webserver.

New thermal energy meters will be installed within "RENAISSANCE" project in order to measure the thermal energy consumption for heating and domestic hot water of student rooms and the total thermal energy consumption of students' residence

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buildings. In addition, thermal energy meters will be installed for the collection of consumption data of the ORC turbine and thermal energy generation data of the SUNAMP thermal batteries. Their data will be acquired through the installation of new BMS local controllers that will include integrated webserver, where the data will be uploaded. The acquisition of the data from the webserver depends on the specific product that will be installed following the public tender procedure.

Meteorological data

The available data include solar irradiance (direct and diffuse), wind speed, ambient temperature, precipitation, relative humidity and air quality (particles).

The meteorological data of Kimmeria's Pilot Site are available through a locally installed meteorological station, property of Democritus University Thrace. Their acquisition can be performed only manually.

3. Pilot Sites Presentation

The definition of the current situation (**As is**), identification of objectives and scenarios for different and often with conflicting and competing interests' stakeholders (**To be**) and finally designing of a pathway to move towards the LEC implementation is a very complex process with deep implications not only from the energy and GHG emissions perspective but also regarding socio economic aspects.

This deliverable covers the work done in the first six month of the Renaissance project towards the definition of the LEC in the different PS.

The main findings and conclusions in the definition of the PS LEC data output framework are:

3.1 Current PS situation

1. Spanish Pilot (Manzaneda)

Being able to gather all the PS information has been more time-consuming than expected, mainly for the different actor involved. Nevertheless, having involved the local DSO (Electromanzaneda is owned by MEISA, the project partner) has proven to be critical when dealing with electrical energy infrastructure information gathering.

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Also, the fact that the Biomass DH provide, an external ESCO company having economical and operational problems during this project phase, has made it difficult to gather the thermal information.

2. Belgium Pilot (VUB health campus)

The VUB health campus together with the UZ-Brussel hospital is a well-advanced energy island owning and running a state-of-the-art microgrid that can work in island mode for 5 consecutive days. It includes a thermal and electricity grid, waste water recovery, a high-speed glass-fibre telecom network and a total of 33 HV transformers divided over HV 18 substations. Energy production and storage include photovoltaics (817 kWp), CHP 2.8MW, and 3 emergency generators (5.25 MVA), and a total capacity of 2,5 MWh in battery storage. The microgrid serves student dwellings, university (VUB), the Red Cross, Erasmus High School, a primary school (Theodoortje), a children day care (Kinderdagverblijf), the parksite operator (APCOA), Villa Samson and the Macdonalds House for taking care of young children with cancer.

3. Netherlands Pilot (EEMNES)

Eemnes has completed significant work during the first 8M of the project (December 2019). Eemnes has completed the key procurement process for kick-starting the pilot; including the procurement process for the key equipment such as gateways and energy management platform. Furthermore, significant advances were made in terms of engaging with the key stakeholder: citizens, local DSO, regulator and the tax authorities. In December 2019, first gateways were installed in prosumers houses and Eemnes has been able to start with the data collection. The aim is to present the business case for local citizens based on initial data already in May 2020.

4. Greek Pilot (Kimmeria campus)

The current situation mapping of the Kimmeria PS highlights the need to improve data acquisition in order to serve the objectives of RENAISSANCE project. The installed RES systems support the sustainability of the Kimmeria's LEC. The current situation of RES systems includes several operational issues, though of minor

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importance. Currently, end-users are not involved in any energy vector and all energy assets are owned by DUTh. It is important to mention that end-users (students) are not charged for the using the facilities of Kimmeria student's residences and are selected following socio-economic criteria.

3.2 Objectives and scenarios

1. Spanish Pilot (Manzaneda)

More time than expected was necessary to organize the first MAMCA meeting as it was difficult to reach stakeholders in summer period and to be able to bring them together. A good practice for next workshops would be to split it in different dates to avoid delays due stakeholders calendar matching.

In general, stakeholders were very collaborative during the workshop and gave a positive feedback.

2. Belgium Pilot (VUB health campus)

The objective of the Brussels pilot site within the RENAISSANCE project is to implement new intelligent scenarios in the control system. These algorithms will prioritize the important consumers, such as surgery rooms, over the other consumers. Besides, the potential of R1 trading with the local DSO, i.e. Sibelga, will be studied. The focus of the Brussels pilot site is reliability and energy efficiency over energy price.

3. Netherlands Pilot (EEMNES)

A MAMCA workshop took place on November 28th in Eemnes with key stakeholders, more on results in the document.

4. Greek Pilot (Kimmeria campus)

A MAMCA workshop has been scheduled for January 2020 with the participation of all stakeholders of Kimmeria pilot site.

3.3 Post project PS situation

1. Spanish Pilot (Manzaneda)

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Extensive and complete Manzaneda PS post-project situation information is included. Main reason is that an ESCO project partner (Exeleria) is involved in the technical and operational design of the implementations so detailed technical and economic analysis has been done. This has proven to be a critical aspect due to typical PS manager's lack of in-deep knowledge of innovative solutions and providers and how to implement them. In summary to have a technical experienced private company close collaborating with non-technical PS has proven to be a good solution.

2. Belgium Pilot (VUB health campus)

Brussels pilot site is planning to add new production and storage assets during and after the RENAISSANCE project. These are: 0.6MWh of battery-based energy storage, 1.2MWp of PV, 25MWh ice buffer storage and 1.6MWH borehole thermal storage.

3. Netherlands Pilot (EEMNES)

The expected output of Eemnes pilot is the validation of the local energy market based on flexible prices and with more than 200 households participating in the local market. The hope is to showcase lower energy prices for the participants of energy community compared to the current offering from traditional utilities.

4. Greek Pilot (Kimmeria campus)

The expected post project situation for Kimmeria PS includes the engagement of end-users and stakeholders in order to improve the efficiency of the RES systems and reduce primary energy and CO2 emissions. The study for installation of new energy assets has been concluded and their integration will facilitate the project objectives achievement. The installation of new smart meters will provide more valuable information regarding energy consumption profiles and will support the project implementation.

3.4 Data output framework

1. Spanish Pilot (Manzaneda)

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Further collaboration with other technical WP will be needed to define in detail the exchanging data solutions nevertheless the grounds of data infrastructure has been included in this document. Again, to have the close collaboration of the local DSO has been and will be critical for the project implementation success.

2. Belgium Pilot (VUB health campus)

The data gathering capabilities of the hospital will be able to supply broad kinds of usage and production data to the RENAISSANCE platform. These data will be gathered, stored and used on site, the useful datasets will be sent to ATOS's FUSE platform as well.

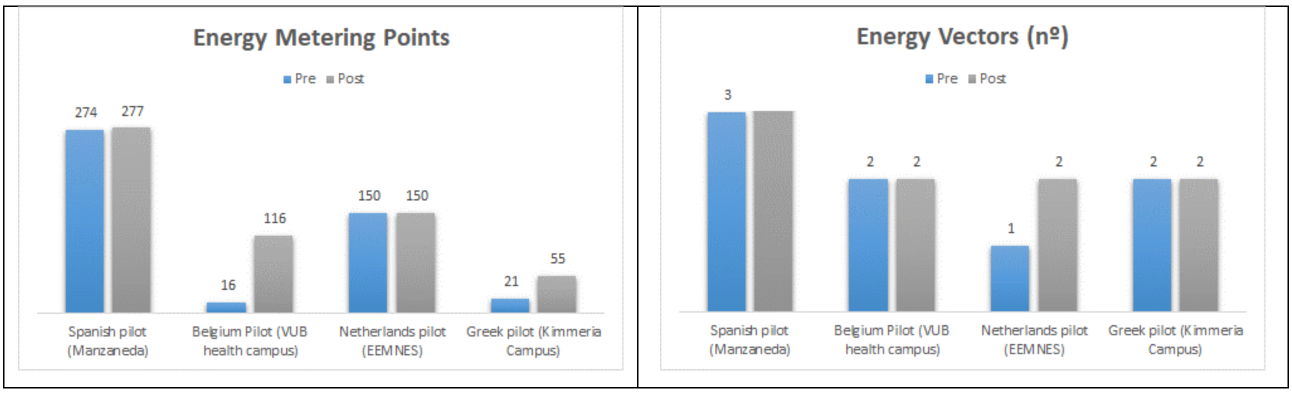
3. Netherlands Pilot (EEMNES)

The data acquisition infrastructure of the Eemnes pilot will have the capacity to transfer the data to the RENAISSANCE project use while respecting the GDPR requirements for end user's protection.

4. Greek Pilot (Kimmeria campus)

The data acquisition infrastructure of the current and post-project situation of Kimmeria campus have and will have the capacity to communicate with the RENAISSANCE platforms. The available data for collection has been identified from DUTh.

Finally, to summarize the different PS situation and LEC expectations, next figures (Figure 7) illustrate the different starting points and implementations within Renaissance project framework:



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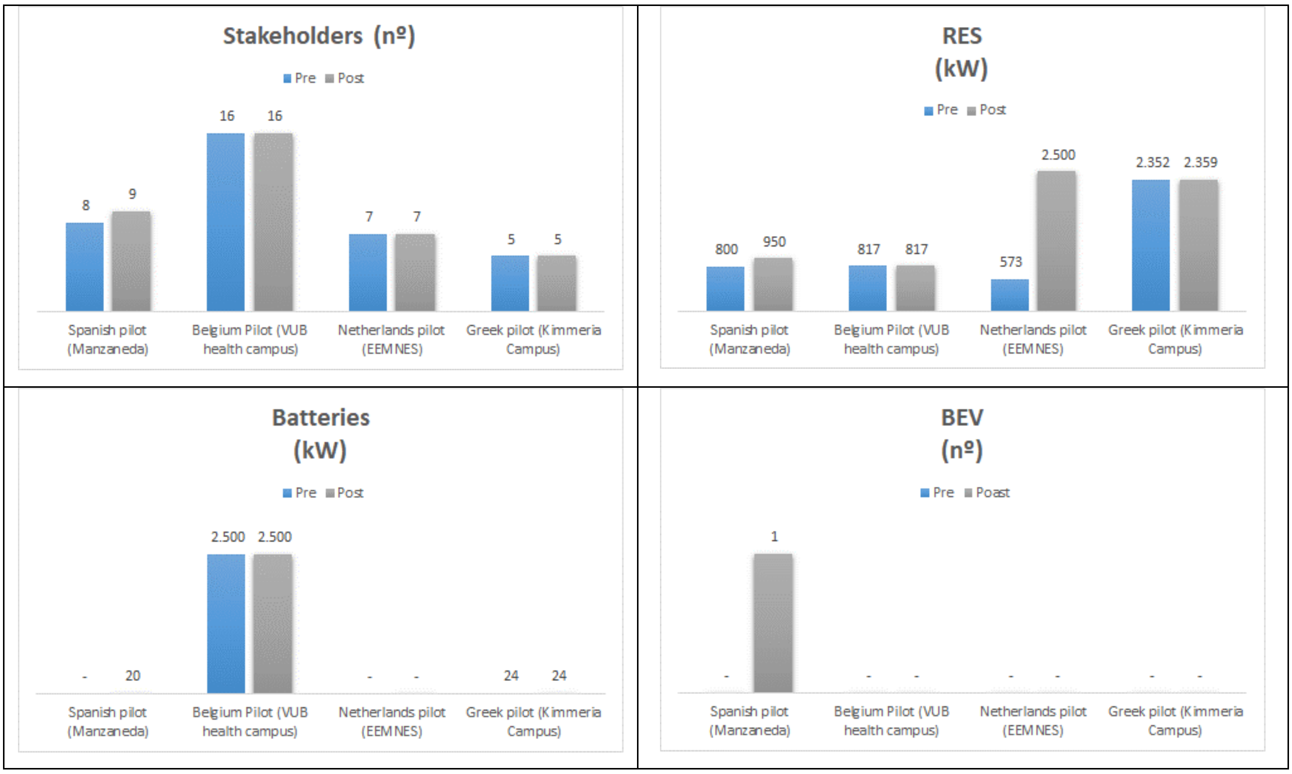
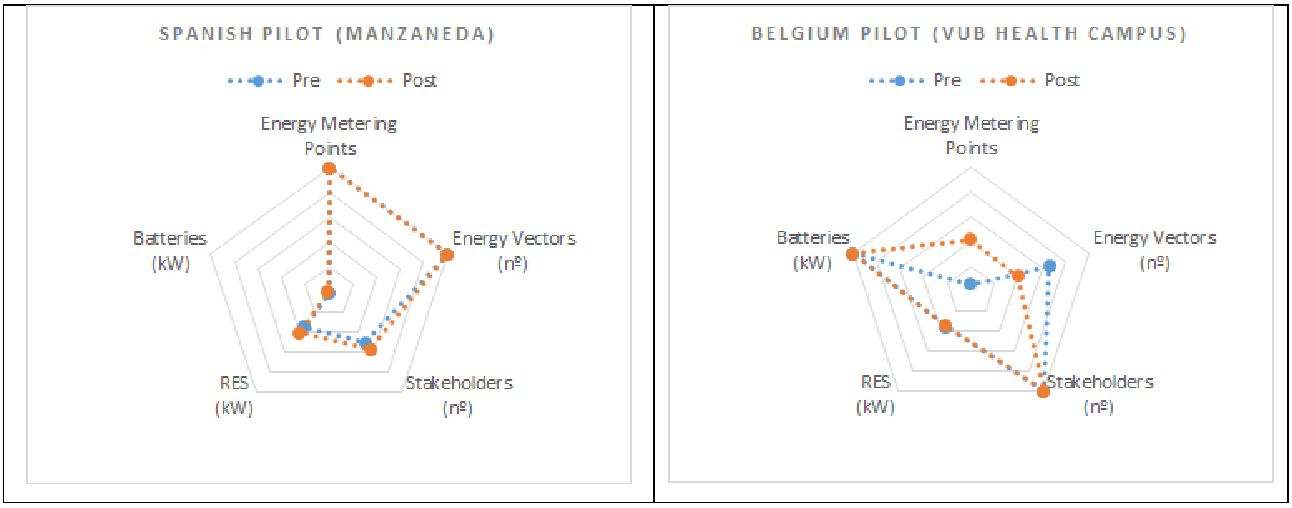


Figure 7 Pre and Post Renaissance PS situation

Figure 8 shows spider net diagrams per PS to analyse the weighing of the indicators and their Pre and Post project situation:



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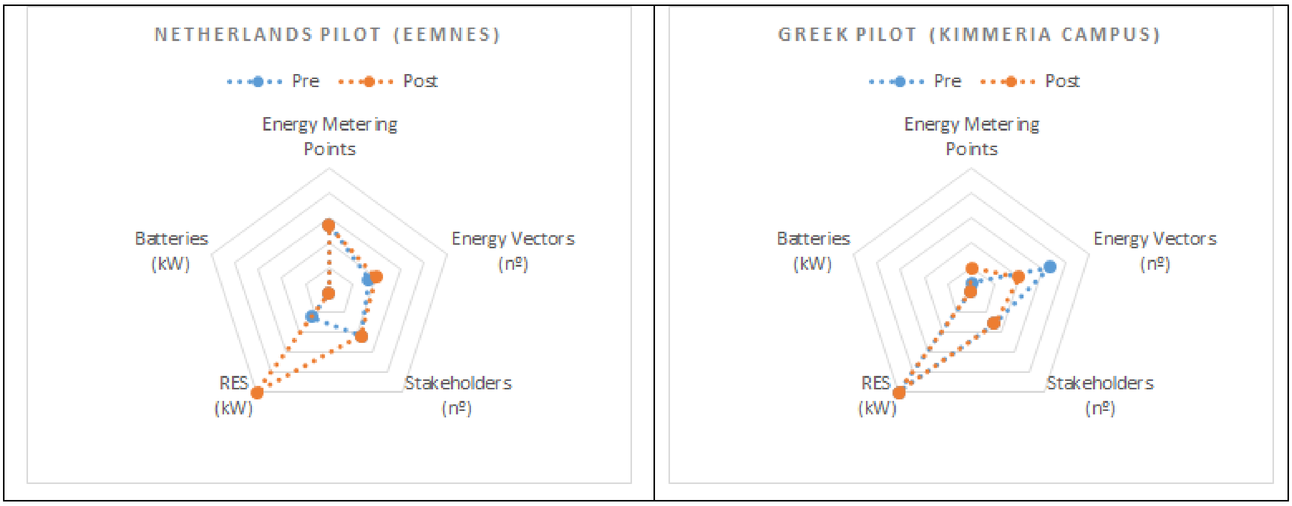

Figure 8 Pre and Post Renaissance PS situation (spider net diagrams)

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4. Conclusions

Due to many structural and functional differences and different needs and availabilities in the PS, specified targets and requirements are set. Each PS has its own targets and aims, and subsequently different plan of implementation and separate assets presentation, development and monitoring. However, a common data framework foresees the way of implementation in all cases, as presented in Section 1.

The broad nature of the pilot sites will serve to demonstrate different aspects of LECs and the advantages of the latter in all kinds of environments. This will demonstrate how LECs are flexible and capable of achieving different objectives, being a superior energy management structure that manages requirements efficiently and for a reduced cost.

This report is a living document, which will be updated if required, as new data might be obtained, and new information may become available as the Project progresses.

That said, the Output Data Framework presents the data sources, communication current equipment and protocols and where already available the solutions to exchange data with the Renaissance data platform.

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ANNEXES

Annex 1: Pilot Sites current situation

Spanish pilot (Manzaneda)

Overview

The pilot site is constituted by a rural ski village located in Manzaneda (Ourense), in the Galicia region of north-west Spain. It is based in a large pine forest of more than 2,000 hectares which gives it great beauty, especially in winter. Besides it has an extension of 17 km ski tracks, it offers beautiful itineraries outside tracks through the forest between pine trees to connoisseurs of the area.

The broad range of tourism/sporting activities available, allows for year-round opening. Besides skiing, there are grass football pitches, tennis courts, a go-karting circuit, horse riding, mountain biking, heated indoor swimming pool, multi-purpose sports centre with gym. There are also other sports available such as hiking, mountaineering, climbing (climbing wall), archery, golf on rustic course, etc.

Environment

The Oca Manzaneda ski village is located more than 1,500 meters high in the "Sierra de Queixa", in the middle of the Ourensano Eastern Massif.

This mountainous environment and great landscape beauty is part of what is known as Red Natura (nature conservation programme). One of the natural jewels of Galicia both for the diverse flora that populates its forests and for the fauna that inhabits them. Located a few kilometres away from the borders with the province of León, Manzaneda has become a perfect natural enclave for lovers of mountain sports, not only during the winter season, but also during the rest of the year. The trails that cross the station, as well as the ski slopes, are perfect for hiking or mountain biking. Wildlife includes squirrels, roe deer, badgers, foxes, wild boars and even the Iberian wolf that is sometimes seen in our lands.

As part of the Natura network environmental, and flora and fauna impacts are very restricted therefore requirement for energy assets implementation, (design and installation) are very demanding and should fulfil specific regulatory criteria.

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Figure 9-location of Manzaneda Skii resort (or Manzaneda Pilot site) in Spain (Google maps)

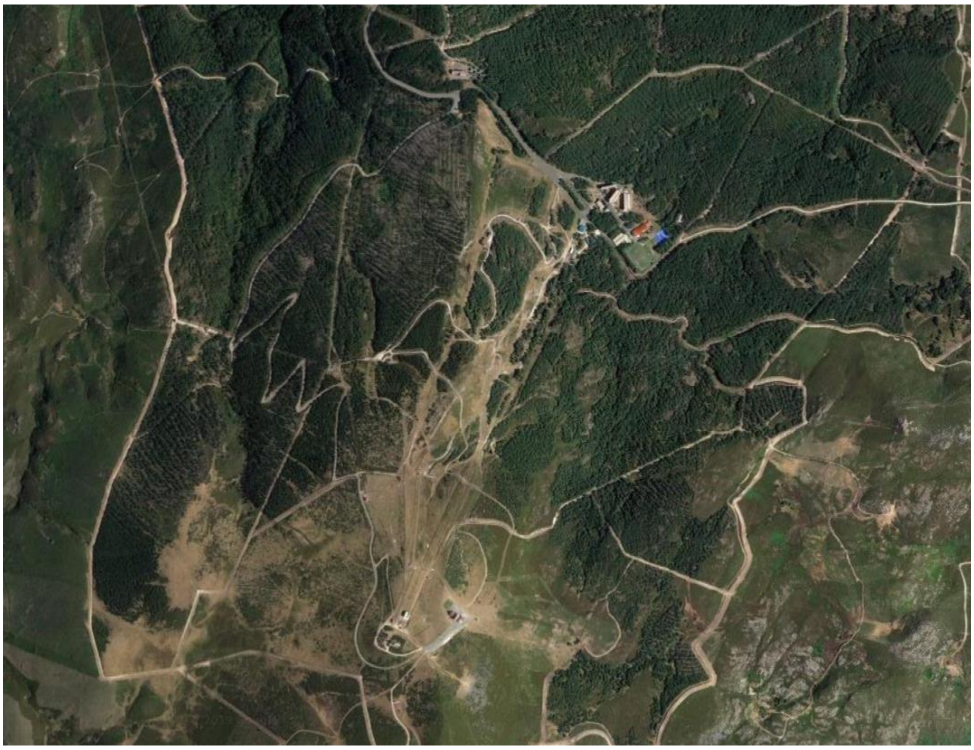

Figure 10- aerial view of Manzaneda ski resort (or Manzaneda pilot site) (Google maps)

Different end users form the energy community: private residential, commercial and industrial. The ski resort hosts throughout the year over 100,000 visitors in addition to be the home of around 900 permanent inhabitants. Apart from this, restaurant, shops, laundry, ski lift, artificial snow guns, and more installations are part of this energy community.

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Figure 11-Manzaneda landscape view (MEISA)

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Social aspects and stakeholders' description

Social aspects

The ski village of Manzaneda is located in the area of influence of two small local villages (A Pobra de Trives and Manzaneda) playing a crucial economic and social role for them.

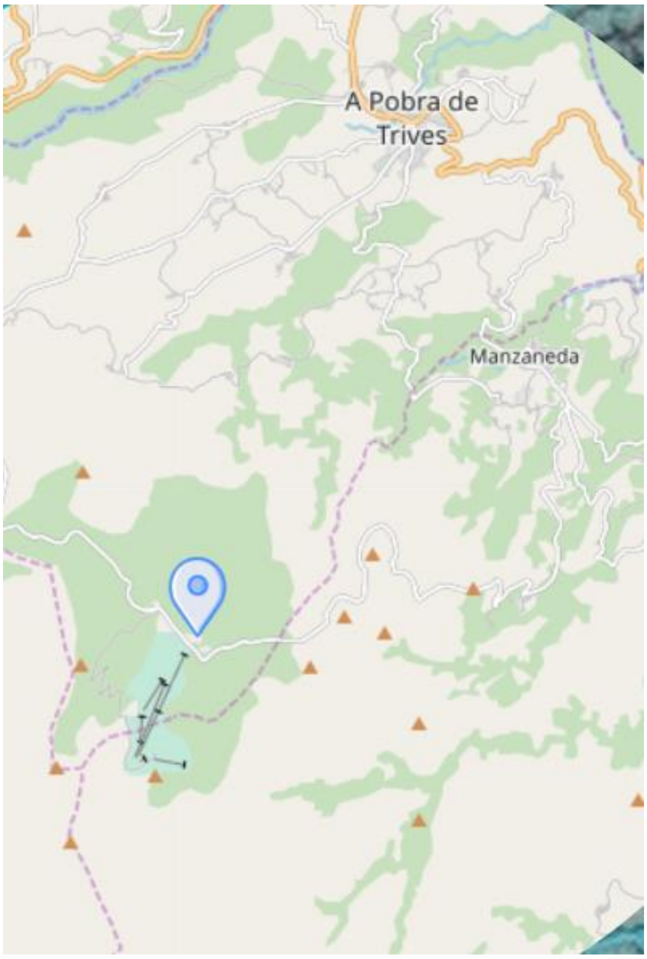

Figure 12-Ski village location and surrounding villages

The rural area surrounding the ski village is an economically underdeveloped area as the GDP (% based on national mean) shows (around 85% of the national mean by 2016):

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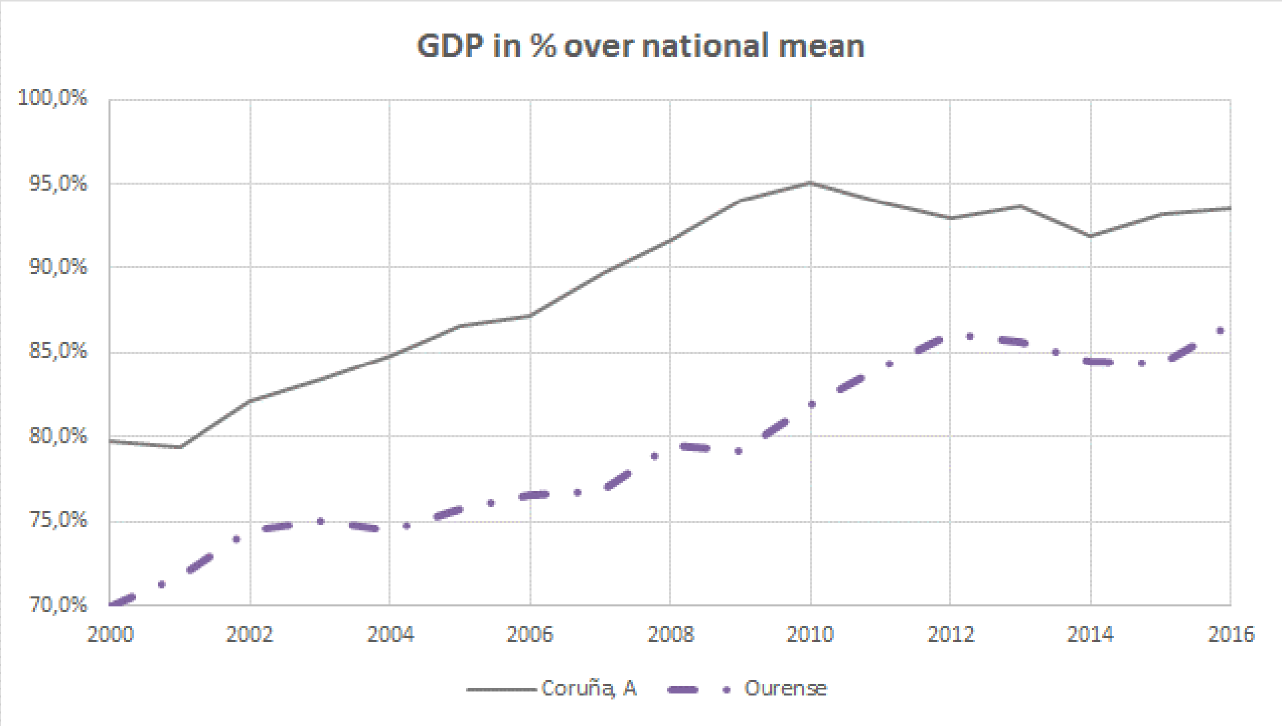

Figure 13-Galicia and Ourense GDP evolution

That is why the development of innovative actions that could lead to tourism attraction to the area and "green-energy-jobs" are so important and relevant to the public stakeholders of the LEC of Manzaneda.

In addition, around 100,000 students from different ages visit the Ski resort every year for educational and leisure activities therefore the educational and environment awareness aspects of the project are especially relevant in the Pilot Site of Manzaneda.

Stakeholders:

- MEISA **(Estación de Invierno Manzaneda S.A.)**
  Founded in 1972, is a public ownership company established in order to operate the Manzaneda Ski Resort. The company owns and operates different facilities within the Ski resort.
  MEISA is a private company owned by public bodies:
- **Xunta de Galicia**
  Owns almost 50%. It is the collective decision-making body of the government of the autonomous community of Galicia, composed of the

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President, the Vice-President and the specialized ministers. Xunta de Galicia regulates its own taxes, prepares the rules for managing state taxes and prepares and applies the budget of Galicia.

- **Diputación de Orense**
  Owns almost 50%. The Provincial Council of Orense is a public institution that provides direct services to citizens and provides technical, economic and technological support to the 92 municipalities of the province of Orense, in the autonomous community of Galicia, Spain. In addition, it coordinates some municipal services and organizes supramunicipal services and its headquarters are located in the city of Orense.
- **Local councils of nearest towns (Puebla de Trives and Manzaneda)**
  Owns Minority shareholdings but contributes with local employment to the resort operations and as a collateral effect are benefited by tourism attraction to the area.
- **Electromanzaneda**
  Electromanzaned is a utility company (DSO) in charge of distribution, maintenance and operation of Manzaneda electrical MV grid. It is owned by MEISA and operates the electricity network that supplies all the consumers in the ski resort.
- **Educational Stakeholders**
  The ski resort hosts around 8,000 students over the year from around 170 different groups:

	Winter		Summer		Total	
	Groups	Visitors	Groups	Visitors	Groups	Visitors
2015-2016	59	3.393	116	4.473	175	7.866
2016-2017	34	2.116	127	5.056	161	7.172
2017-2018	45	3.119	124	5.130	169	8.249
2018-2019	40	2.553	101	4.160	141	6.713

Table 4-Student visitors (source: MEISA)

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Climatic conditions and seasonal demand

Due to the geographical conditions of the area, the climate corresponding to Manzaneda is high mountain climate. This climate takes place in areas located at more than 1,200 m altitude and is characterized by cold and long winters with below zero temperatures, and cool and short summers. It has a thermal oscillation (difference between maximum and minimum temperature) of 10.5 degrees Celsius. It has also abundant rainfall that increases with altitude, that are usually in the form of snow.

These weather specific conditions lead to some issues regarding the energy assets:

- High thermal stress due to extremely low temperatures and high daily gradient
- Corrosion due to the salt used to melt the ice
- More glycol % in heating and DHW systems to avoid freezing
- PV systems should be installed with more tilt than optimum to avoid snow accumulation
- Strong winds make it necessary to reinforce structures

All the above leads to lower assets lifetime.

Manzaneda has its own open data weather station, accessible through METEOGALICIA service, to obtain climatic data:

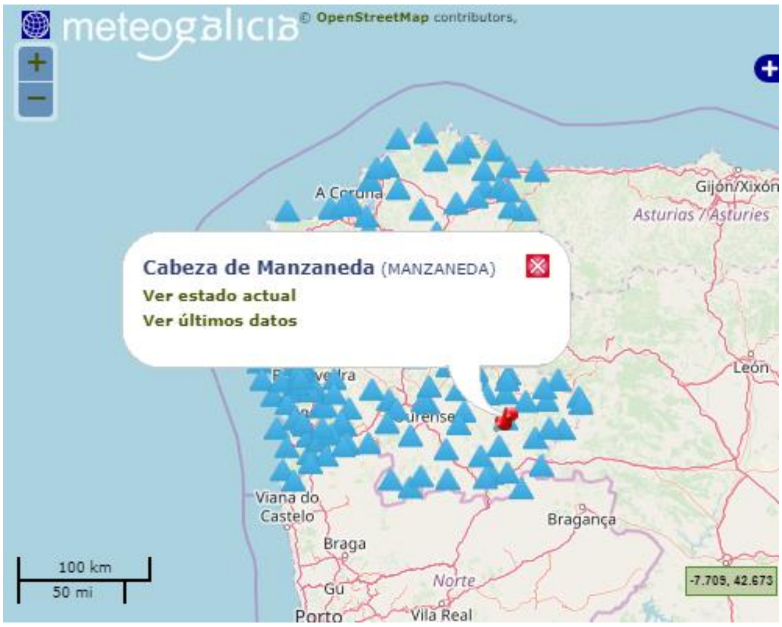

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Figure 14-Meteogalicia weather stations network (source: Meteogalicia)

Table 5 show relevant data for the last 12 months in Manzaneda:

Manzaneda 2018-2019			
	Maximum	Average	Minimum
Tª max (ºC)	25,3	10,2	-3,6
Tª min (ºC)	18,0	3,7	-8,8
Tª av (ºC)	21,2	6,8	-6,0
R. Humidity max (%)	100	89,6	16,0
R. Humidity min (%)	100	51,4	2,0
R. Humidity av (%)	100	72,5	9,0
Wind speed (km/h)	61,5	21,14	6,84
Rain (l/m^2)	60,3	3,2	0,0
Daily Irradiation (10kJ/m^{2}day)	3.388	1.705	143
Pressure (hPa)	838,3	826,4	798,3

Table 5-Relevant climatic variables for the last 12 months (source: Meteogalicia)

Due to the main activity of the season, that is to say skiing, the higher energy consumption occurs during the winter, when the station has maximum occupancy and all its facilities are fully operating. However, this does not mean that the rest of the year there is no consumption due to the various available activities, although that involves lower energy consumption.

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Electrical energy

Production assets

There are currently no electrical production assets installed in this Pilot Site.

Distribution network

Manzaneda has its own electrical grid (Figure 15) which is connected to main Grid through an overhead power line. It is a ring topology MV grid and it has six control points with TCs in major end use consumers:

- Pto 0 -> Main Grid border point
- CS1-2 & TC1 -> Galicia Building
- CS3 & TC3 -> Workshop/Ski Lift Manzaneda, restaurant, sport facilities. etc
- CS4 & TC4 -> Ski Lift Fonte Fría
- CS5 & TC5 -> Snow Production
- CS6 & TC6 -> Pena das Veigas

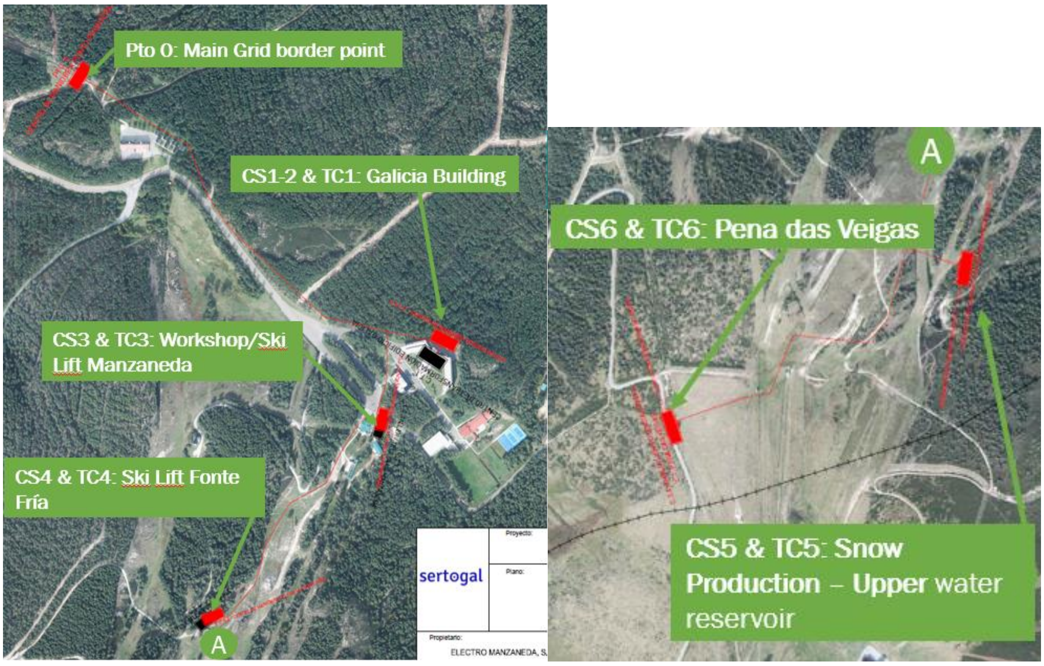

Figure 15- map of the electrical grid of Manzaneda (source: MEISA)

The total length of the grid is approximately 5,5 km, with 11 transformation centres (CSs & TCs) and 5,96 MVA of total installed capacity (Figure 16) in order to fulfil the electrical energy needs of around 290 customers.

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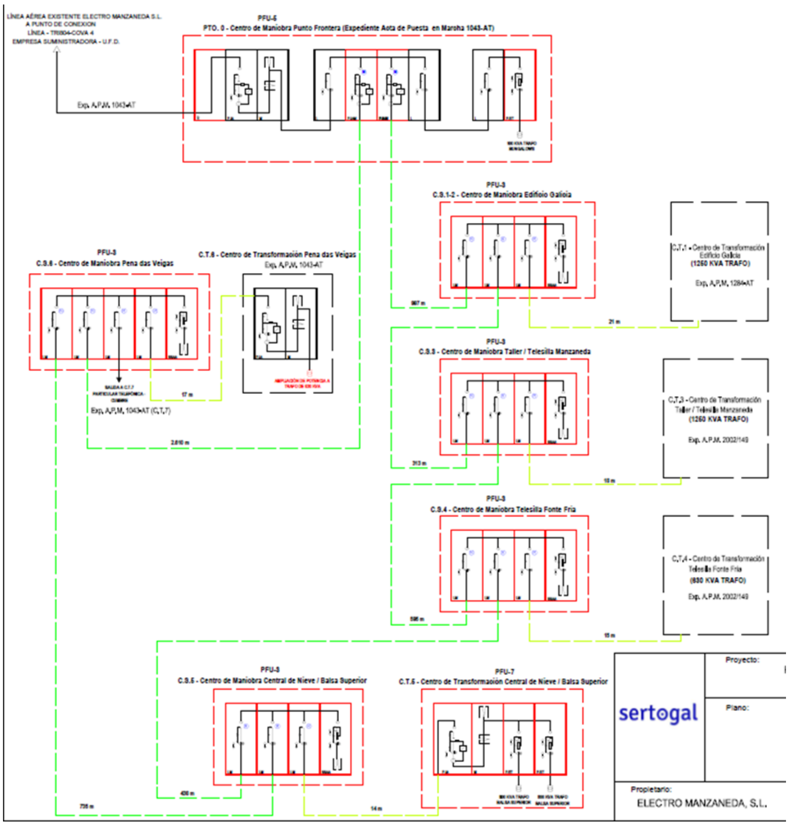

Figure 16- Manzaneda's grid scheme (source: MEISA)

Finally, a grid-balancing graph is shown in the Figure 17.

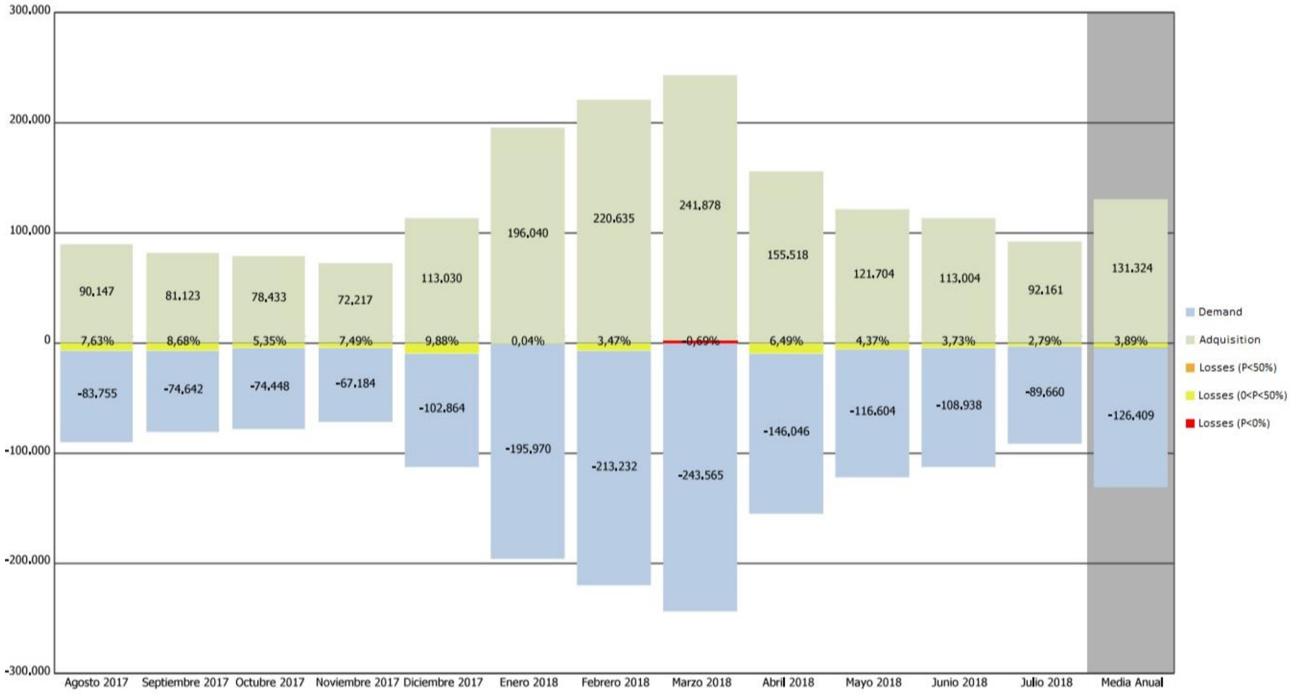

Figure 17- Manzaneda grid balancing (source: MEISA) Consumption

Consumption

The end users of electricity are dwellings, street lighting, some industrial equipment and a hotel with its sport and commercial facilities:

- **Residential:** 220 end users, 53 owned by MEISA
- **Hotel**
  - Laundry
  - Classrooms and educational facilities
  - Recepcion and shop
  - shelter
- **Industrial**
  - 460 KVA for ski lift 1, commercial area, shops
  - 500 KVA for coffee shop, restaurant, swimming pool, multi sports hall, water treatment plant,
  - 630 KVA for ski lift 2 y other smaller ski lifts
  - 5 services users (TELEFONICA, VODAFONE, RETEGAL, ETC)
  - 1600 KVA for artificial snow guns

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The following consumptions has been obtained from the monthly invoices for each of the consumers. Table 6 shows the results obtained for the year 2018 (complete) grouped for each of the existing tariffs on the pilot site:

Tariff	Number of users	Annual Energy Consumption (kWh)
2.0 A	230	354,984.00
2.0 DHA	34	101.270,00
2.1 A	1	21.108,00
3.0 A	6	246.499,00
3.1 A	2	59.145,00
6.1 A	1	721.958,00

Table 6-Manzaneda´s Annual energy consumption (source: MEISA

Measurement infrastructure

Grid monitorisation

A SCADA System (TEDISNET) recently installed by ORMAZABAL is monitoring Manzaneda's grid. The SCADA gathers the following measurements in each cell of the TCs:

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TagClassDescription	Units
Corriente Fase A	A
Ang (IA/VA)	º
Corriente Fase B	A
Ang (IB/VA)	º
Corriente Fase C	A
Ang (IC/VA)	º
Corriente Fase N	A
Ang (IN/VA)	º
Corriente Fase NS	A
Ang (INS/VA)	A
Tensión Fase A	kV
Ang (VA/VA)	º
Tensión Fase B	kV
Ang (VB/VA)	º
Tensión Fase C	kV
Ang (VC/VA)	º
P. Activa Fase A	kW
P. Activa Fase B	kW
P. Activa Fase C	kW
P. Activa Total	kW
P. Reactiva Fase A	kVAr
P. Reactiva Fase B	kVAr
P. Reactiva Fase C	kVAr
P. Reactiva Total	kVAr
Energía importada	kWh
Energía exportada	kWh
Energía reactiva Q1	kVArh
Energía reactiva Q2	kVArh
Energía reactiva Q3	kVArh
Energía reactiva Q4	kVArh

Table 7- measurements gathered in each cell of the TCs (source: MEISA)

Following figures show the graphic interface of the SCADA System:

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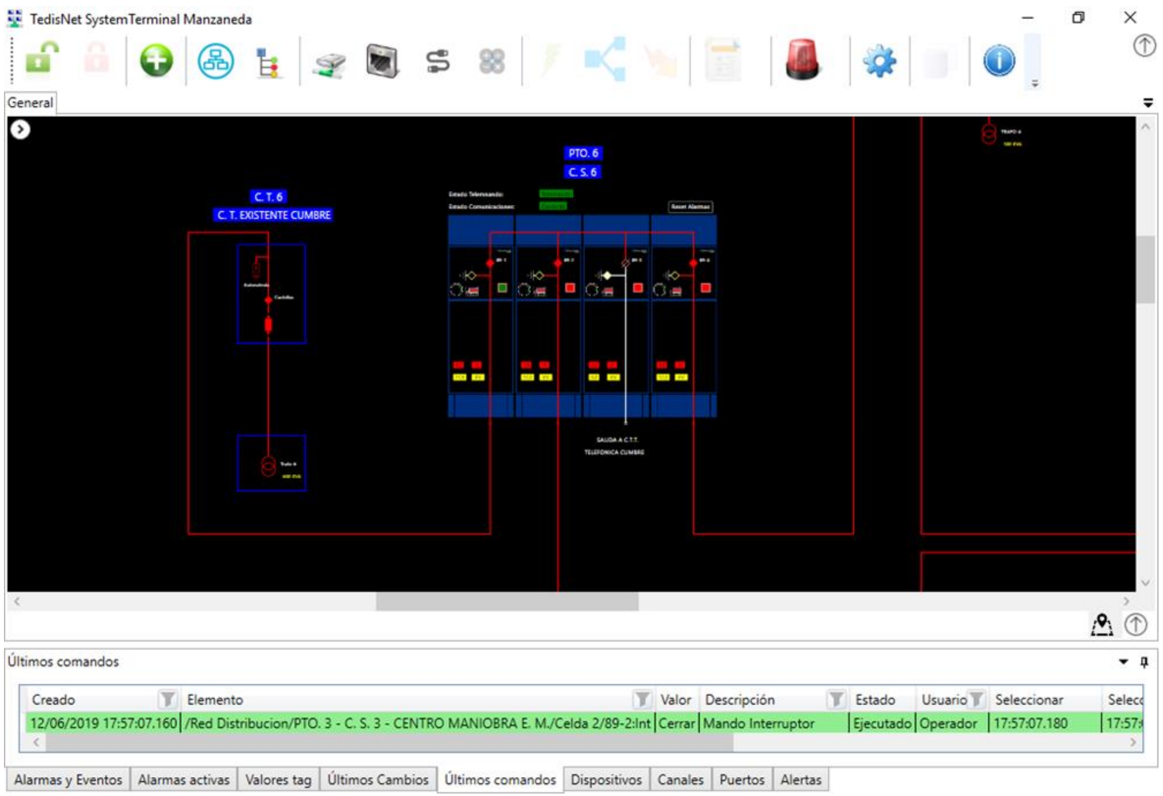

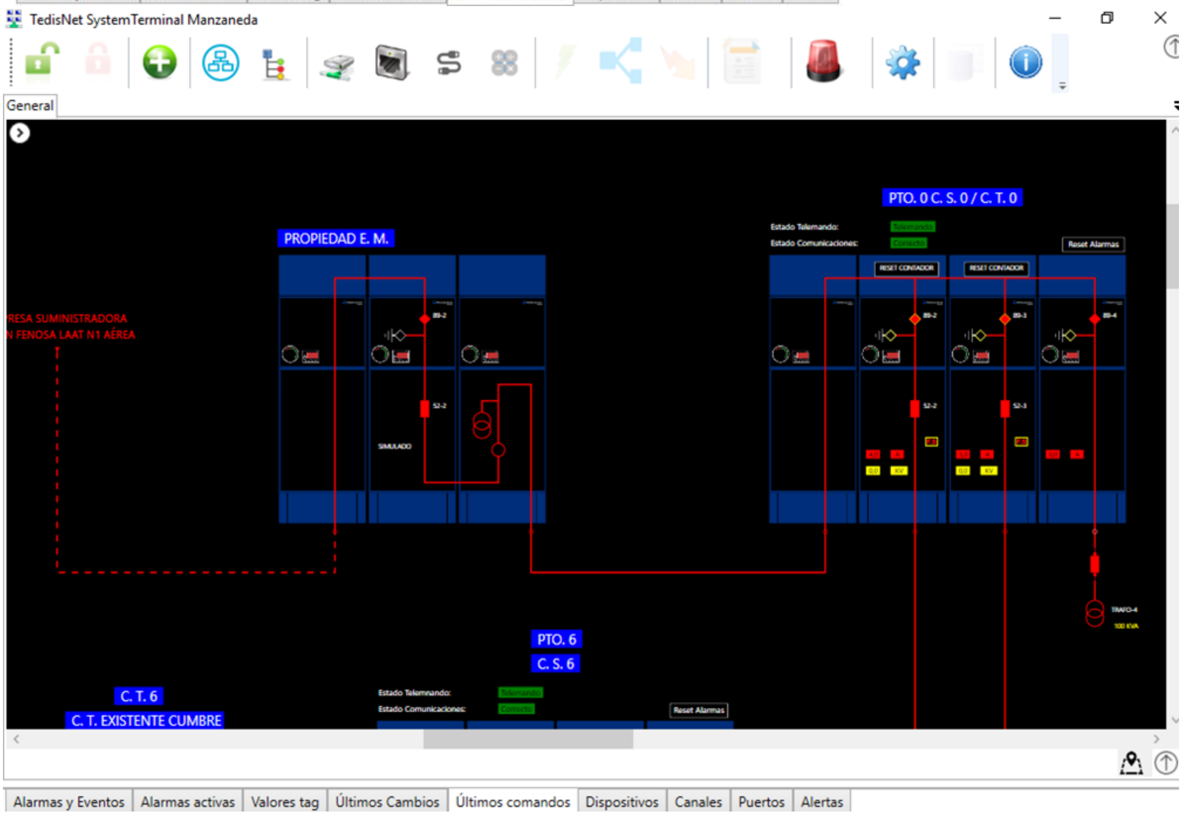

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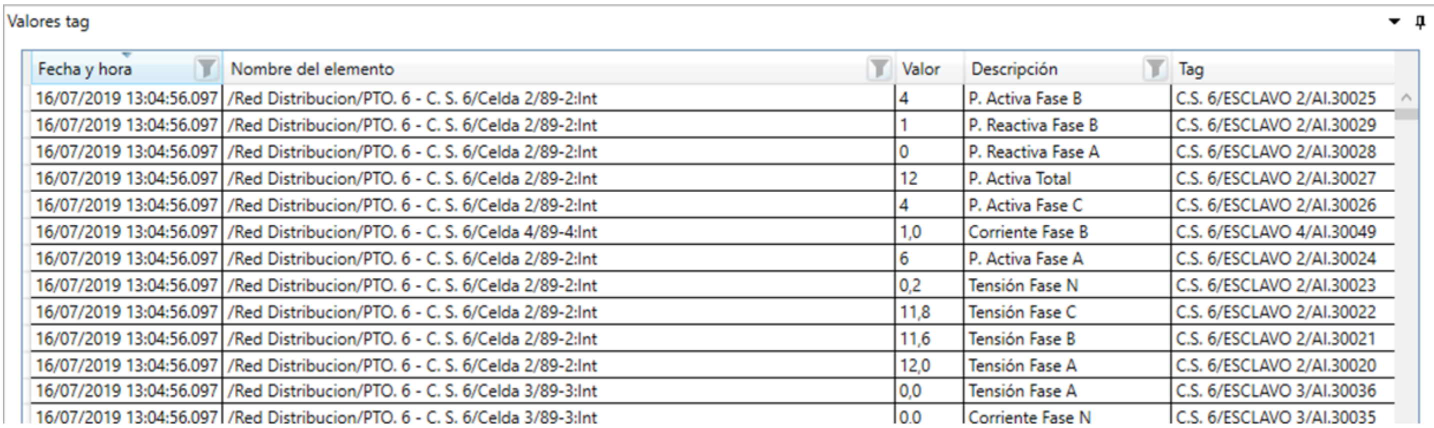

Valores tag

Fecha y hora	Nombre del elemento	Valor	Descripción	Tag
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	4	P. Activa Fase B	C.S. 6/ESCLAVO 2/AI.30025
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	1	P. Reactiva Fase B	C.S. 6/ESCLAVO 2/AI.30029
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	0	P. Reactiva Fase A	C.S. 6/ESCLAVO 2/AI.30028
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	12	P. Activa Total	C.S. 6/ESCLAVO 2/AI.30027
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	4	P. Activa Fase C	C.S. 6/ESCLAVO 2/AI.30026
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 4/89-4:Int	1,0	Corriente Fase B	C.S. 6/ESCLAVO 4/AI.30049
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	6	P. Activa Fase A	C.S. 6/ESCLAVO 2/AI.30024
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	0,2	Tensión Fase N	C.S. 6/ESCLAVO 2/AI.30023
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	11,8	Tensión Fase C	C.S. 6/ESCLAVO 2/AI.30022
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	11,6	Tensión Fase B	C.S. 6/ESCLAVO 2/AI.30021
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 2/89-2:Int	12,0	Tensión Fase A	C.S. 6/ESCLAVO 2/AI.30020
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 3/89-3:Int	0,0	Tensión Fase A	C.S. 6/ESCLAVO 3/AI.30036
16/07/2019 13:04:56.097	/Red Distribucion/PTO. 6 - C. S. 6/Celda 3/89-3:Int	0,0	Corriente Fase N	C.S. 6/ESCLAVO 3/AI.30035

Figure 18- SCADA System interface (source: MEISA)

Consumers metering system

End Users' energy consumption data is stored and measured by smartmeters. Data is locally stored in the secondary HUB (data concentrator) with the content and format defined by the Spanish TSO [19] using PRIME and TCP:IP communication protocols.

Table 8 shows the smart meters installed in the Pilot Site:

PROTOCOL	BRAND	MODEL	UNITS
PRIME	SAGEMCOM	BT	250
PRIME	SOGECAM	BK	1
PRIME	CIRCUTOR	CIRWATT	1
PRIME	CIRCUTOR	GB	16
TCP_IP	ACTARIS	GENERICO	1
TCP_IP	CIRCUTOR	GENERICO	1
TCP_IP	ACTARIS	SL762D	1
TCP_IP	ACTARIS	SL762B	1
TCP_IP	ITRON	ACE 6000	1
GSM	ACTARIS	GENERICO	1

Table 8- smart meters (source: MEISA)

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There is a total of 274 smart meters, 263 of which correspond to dwellings. Besides that, there are 2 tertiary Hubs (CIRCUTOR PLC1000) which cluster the smart meters into 2 groups.

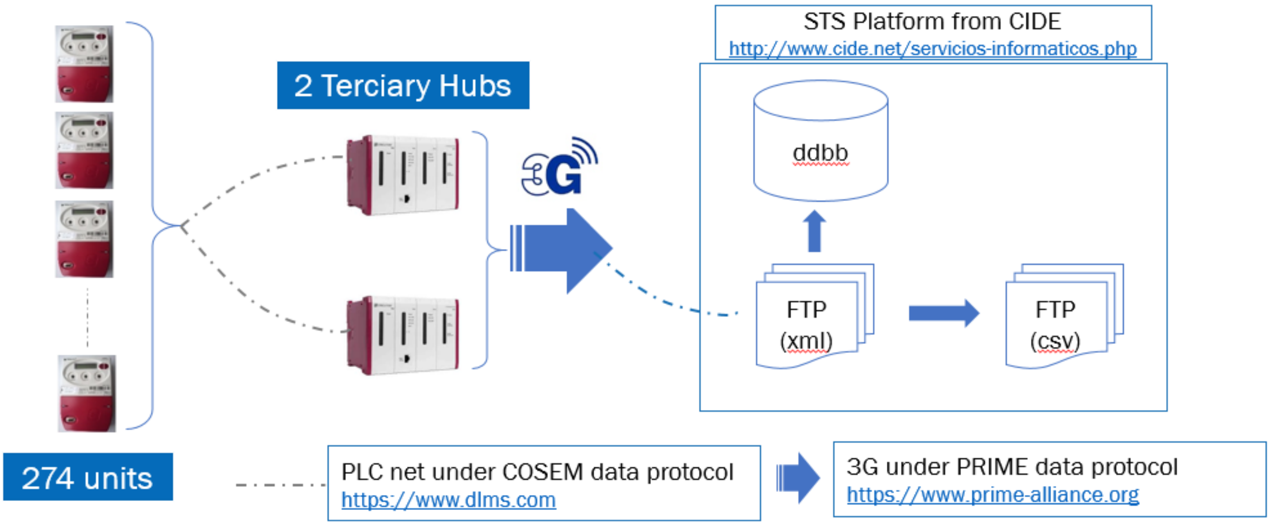

Figure 19- Smartmetering system overview (Source: MEISA)

Thus, it is possible to have hourly data sent at the end of the day. For shorter timesteps and/or transmission frequencies, additional equipment should be installed.

Contractual framework

After the release of the Spanish electricity market, the sector was fragmented into four activities: production, transport, distribution and commercialization. Electricity trading companies are responsible for purchasing electricity for their consumers. The purchase of electricity is carried out in the Electricity Market, which is managed by an independent operator (OMIE) that performs the economic management of the daily and intraday market of the production of electric energy in Spain. This activity is carried out under a regime of free competition so that consumers can choose their company in the market.

Customers can access electricity offers through two markets that are within the energy sector and are specified below:

- **Regulated market**: it is the part of the sector in which prices are marked by the Government.

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- **Free market:** companies that set their own electricity prices and offer fixed or variable rates

There is a wide variety of electricity rates whose characteristics are shown in the table 9:

Voltage	Tariff	Contracted Power	Measure	Hours
Low	2.0A	<10 kW	Flat	24h
Low	2.1°	10<X<15 kW	Flat	24h
Low	2.0HD	<10 kW	Hourly discrimination (2p)	P1: 12-22h T P2: 22-12h F/V
Low	2.1HD	10<X<15 kW	Hourly discrimination (2p)	P1: 13-23h T P2: 23-13h F/V
Low	2.0HDS	<10 kW	Hourly discrimination (3p)	P1: 13-23h T P2: 23-1+ 7-13 V P3: 1-7 SV
Low	2.1HDS	10<X<15 kW	Hourly discrimination (3p)	P1: 13-23h T P2: 23-1+ 7-13 V P3: 1-7 SV
Low	3.0A	15<X<50 kW	Hourly discrimination (6p)	Winter: P1: 18-22h T WD P2: 8-18h + 22-24h F WD P3 0-8h V WD P4: 18-22h T P5: 8-18h + 22-24h F P6 0-8h V Summer: P1: 11-15h T WD P2: 8-11h + 15-24h F WD

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				P3 0-8h V WD P4: 11-15h T P5: 8-11h + 15-24h F P6 0-8h V
Low	3.0A	>50 kW	Hourly discrimination (3p)	Winter: P1: 18-22h T P2: 8-18h + 22-24h F WD P3 0-8h V Summer: P1: 11-15h T P2: 8-11h + 15-24h F P3 0-8h V
High	3.1°A	1<X<450 kW	Hourly discrimination (3p)	Winter WD: P1: 17-23h T P2: 8-17h + 23-24h F P3 0-8h V Summer WD: P1: 10-16h T P2: 8-10h + 16-24h F P3 0-8h V Winter: P1:- T P2: 18-24h F P3 0-18h V Summer: P1: - T P2: 18-24h F P3 0-18h V

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High	3.1°A	1<X<450 kW	Hourly discrimination (6p)	Winter: P1: 17-23h T WD P2: 8-17h + 23-24h F WD P3 0-8h V WD P4: - T P5: 18-24h F P6 0-8h V Summer: P1: 10-16h T WD P2: 8-10h + 16-24h F WD P3 0-8h V WD P4: - T P5: 18-24h F P6 0-8h V
High	6.X	X>450 kW	TA6	See ITC/2794/2007

Table 9- Spanish electrical network access tariffs (source: own production)

The following tariffs can be found in Manzaneda:

- 226 tariffs 2.0A
- 38 tariffs 2.0HDA
- 1 tariff 2.1
- 6 tariffs 3.0A
- 2 tariffs 3.1A
- 1 tariff 6.1A

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Thermal energy

Production assets

Thermal energy production is carried out by an 800kW biomass boiler that supplies heat to a district heating system of 1,85 km length. This DH fulfils the necessities of heating and DHW of all the resort facilities but from some dwelling (private and MEISA owned) with electrical heating systems.

Figure 20 shows the buildings connected to the DH network:

Figure 20- Buildings connected to DH network (Source: MEISA)

1. Residential building “TRIDENTE”
2. Restaurant
3. Indoor heated swimming pool
4. Sports complex

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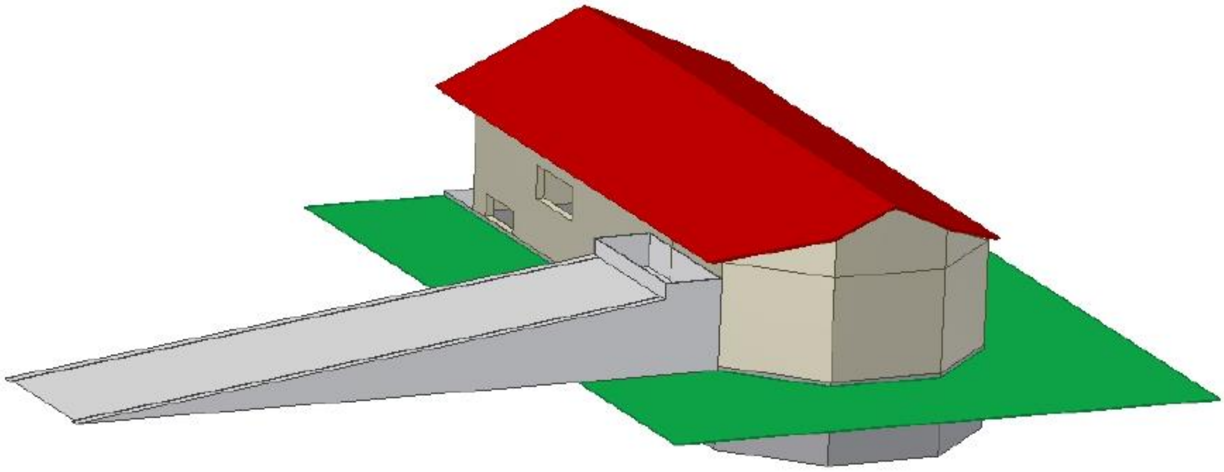

Figure 21- Boiler room and biomass storage (Source: MEISA)

On top of that, a solar thermal system covers part of the DHW demand of the swimming pool & SPA.

Distribution network

The DH network is divided into two circuits (Figure 22):

- Heated swimming pool
- Rest of buildings

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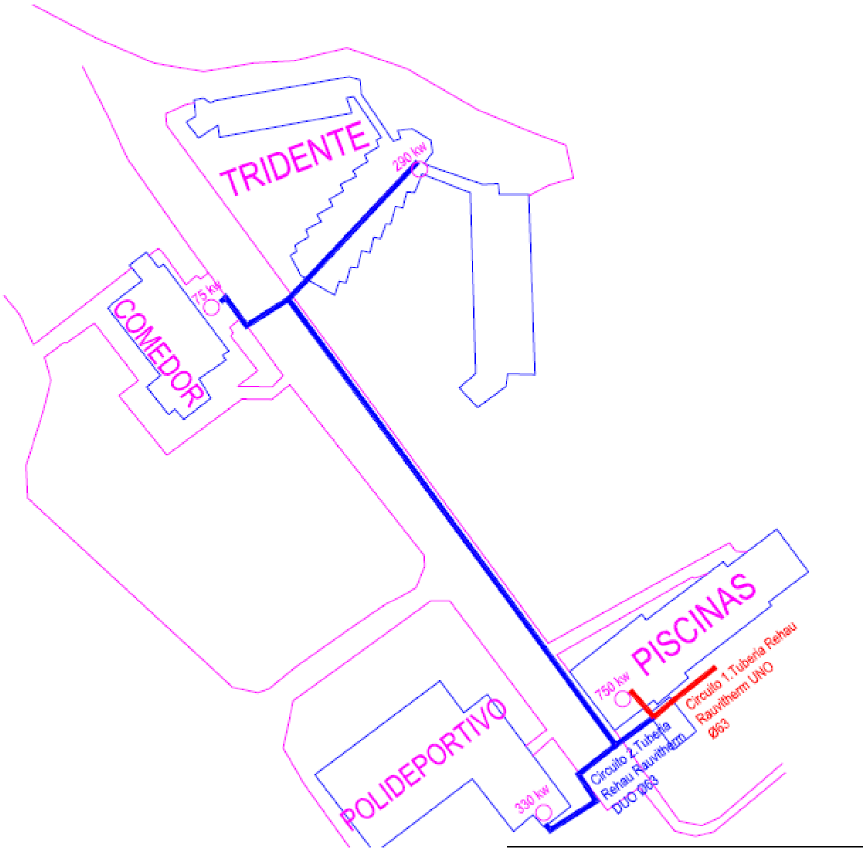

Figure 22- DH network (Source: MEISA)

Thermal energy produced in the Biomass boiler is supply around 90ºC and returns at 75ªC at peak demand conditions. At lower demand control systems automatically reduces de supply temperature in order to cut energy distribution losses.

Each building has a buffer hot water storage tank from which energy is distributes to terminal units (radiators and heat exchangers)

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Piping system consists in pre-insulated PEX pipes.

Figure 23- Pre-insulated pipes (Source: MEISA)

Consumption

Average thermal yearly consumption is around 1.400.000 kWh/year which mean a biomass Consumption (woodchips) of 320 tn/year.

Measurement infrastructure

MEISA is the only client of the installation, so only the total energy generated is measured. This information is measured by a meter Multical 602 together with an airflow-meter Ultraflow 54 M-Bus and transmitted wirelessly to a PC, where the data is stored.

Figure 24- DH energy meter (Source: MEISA)

Contractual framework

The heating service is provided by:

- Electrical heated dwellings: Electrical retailer, within a price scheme bases on the electrical tariffs. Costumers are private owners and Meisa
- DH heated buildings: ESCO Company who provides thermal kWh at a flat price. The only costumer is Meisa.

Mobility and transport

Assets

Table 10 shows the vehicles owned by MEISA:

QUARDS	E0018BFD
QUARDS	E0021BFD
QUARDS	E0024BFD
QUARDS	E0014BFD
QUARDS	E0015BFD
TRACTOR - ESCABADORA	E6300BDJ
LAND ROVER	7476FKC
UNIMOG	OR 8666 A
CAMION	OU 8501 U
NISSAN	1953 BNJ
LAND ROVER	OU 9687 V
FIAT DUCATO	9914 DSM
MOTO POLARIS	4XASB5BSSYCOZ1684
MORO WIDE TRACK	4XASU4BU21C152390
MOTO POLARIS	SN1SU4BS26C625118

Table 10- List of vehicles (source: MEISA)

Apart from these vehicles, MEISA has a renting for the General Manager car.

Consumption

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Last year (2.018) fuel consumption was around 26.000 l.

Measurement infrastructure

Local retailers that fill the storage tanks on demand are responsible for the fuel supply. Fuel trucks have their own measurement devices to generate the bills.

Due to that fuel consumption data is only available for periods between refilling.

Contractual framework

MEISA negotiates with local suppliers the fuel supply conditions and prices.

Belgium Pilot (VUB health campus)

Overview

The Brussels Health Campus containing the university Hospital (Universitair Ziekenhuis Brussel UZB-VUB) and part of the Vrije Universiteit Brussel (VUB), is a well-advanced energy island owning and running a state-of-the-art microgrid that can work in island mode for 5 consecutive days. It includes a thermal and electricity grid, waste water recovery, a high-speed glass-fibre telecom network and a total of 33 HV transformers divided over HV 18 substations. Energy production and storage includes solar PV, CHP, 3 emergency generators, and a total capacity of 2,5 MWh in battery storage, mainly under the form of UPS.

Figure 25- Energy assets layout (Source: VUB)

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The microgrid serves the hospital complex, 250 student dwellings, the faculty of health sciences, a primary school and a fitness center. The microgrid system is conceived to go in island mode with complete automatic transition in max. 15s to critical need and 3 min to comfort need. The financial bookkeeping and billing to the different consumers in the microgrid is carried out by means of ERBIS software platform. Cutting edge control technology and maximal reliability are the focus points of this demonstration site.

Social aspects and stakeholders' description

The hospital, founded in 1977, has almost 4,000 employees, 721 beds and welcomes more than 30,000 admissions every year, as well as 360,000 consultations. It offers full medical care including specialized care to patients and training to students. Besides, they have a strong focus on scientific research.

The hospital makes an effort to offer affordable care to anyone that steps in. This includes a multi-lingual approach and acceptance of anyone that comes in regardless of their background.

Located in Jette, the hospital serves the Brussels capital region, with a population of 1,192 million inhabitants (Jan 1, 2017) and an area of 161.4 km^2, and part of Flanders. The Brussels capital region comprises 10 general hospitals (UZ Brussel among them) and 8 specialized hospitals.

Among the stakeholders of the Brussels pilot site are: the hospital (UZB) , the users of the hospital, the students in the Brussels Health campus dwellings, university (VUB), the Red Cross, Erasmus High School, a primary school (Theodoortje), a children day care (Kinderdagverblijf) , the parksite operator (APCOA), Villa Samson and the Macdonalds House for taking care of young children with cancer. In addition, some departments in VUB are considered separate units such as the dentistry department (Tandheelkundig Instituut), Cyclotron, Faculty of Medicine (Geneeskunde en Farmacie) and the student restaurant (see Figure 26). The relation between the stakeholders has been fixed and is not going to change thus no MAMCA methodology will be applied to this pilot site. UZB acts as the local DSO as well as energy supplier. Whatever UZB cannot deliver from its own generation (solar, cogeneration), it will buy from the grid and retail it to all stakeholders.

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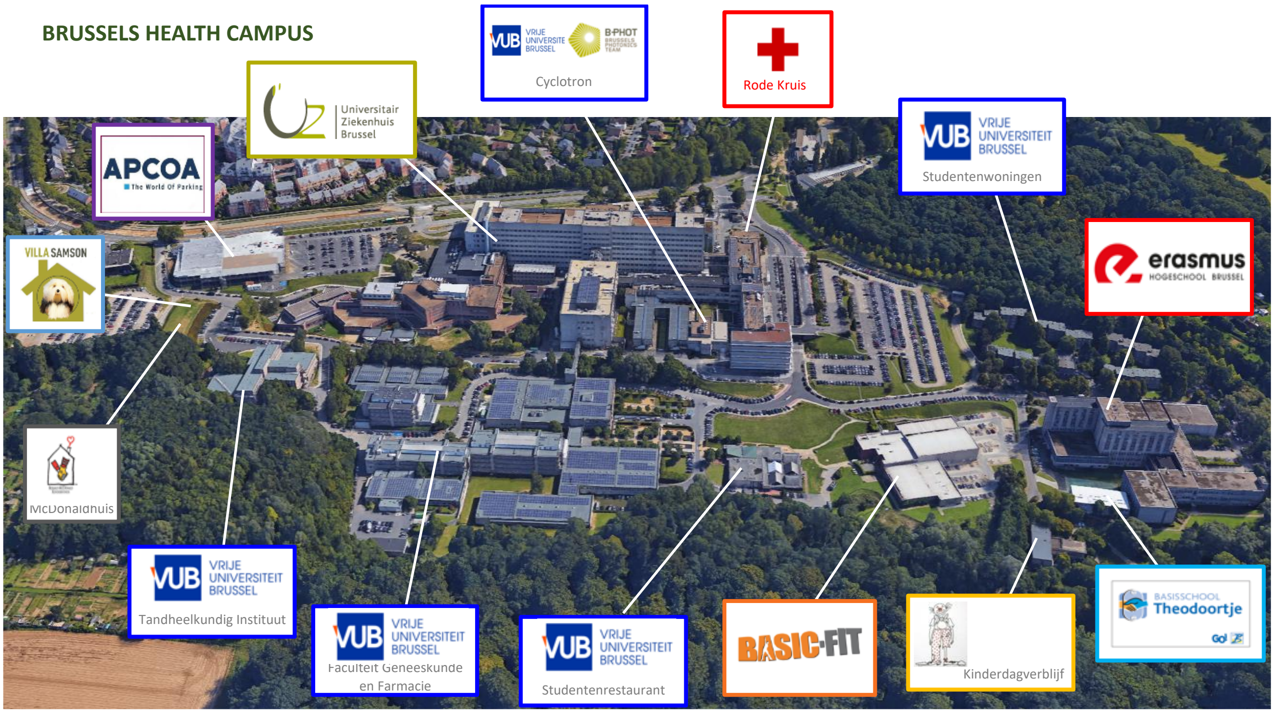

Figure 26- Health Campus stakeholders (Source: VUB)

Climatic conditions and seasonal demand

Belgium has a temperate, maritime climate predominantly influenced by air masses from the Atlantic. Rapid and frequent alternation of different air masses separated by fronts gives Belgium considerable variability in weather. Frontal conditions moving from the west produce heavy and frequent rainfall, averaging 750 to 1,000 mm a year. Winters are damp and cool with frequent fogs; summers are rather mild. The annual mean temperature is around 10 °C. Brussels, which is roughly in the middle of the country, has a mean minimum temperature of just below 0 °C in January and a mean maximum of about 22 °C in July (Britannica, 2019).

The climate introduces a cyclic component to the consumption of gas as shown in Figure 27. This supplies the heating needs of the hospital.

The electricity consumption does not show any cyclical behaviour, but due to the effect of the CHP (see Figure 30), which generates electricity as a by-product, the electricity bought by the hospital (Figure 28) is reduced during winter, when the CHP is used to heat the buildings in the hospital. Figure 29 shows the PV generation on site, which although presents cyclical behaviour is negligible when compared to the total electricity consumption and purchase of the hospital.

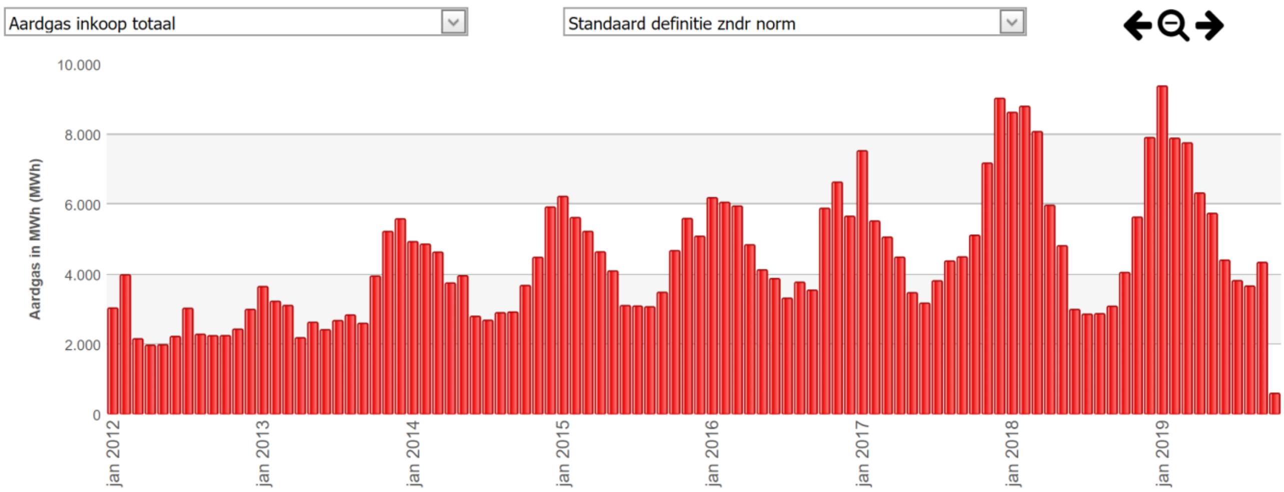

Figure 27. Monthly natural gas purchase in MWh.

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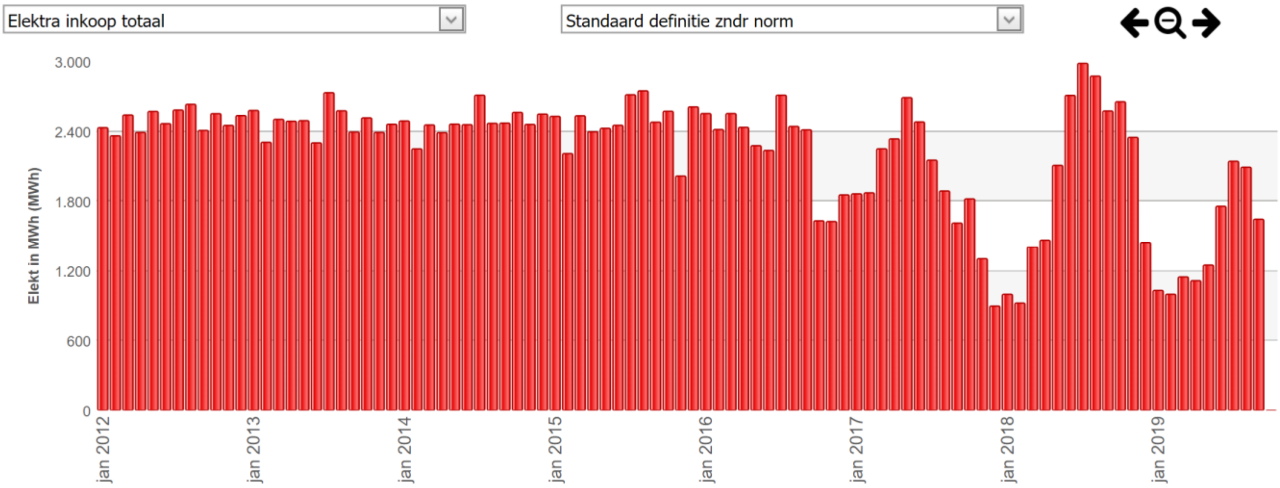

Figure 28. Monthly electricity purchase in MWh.

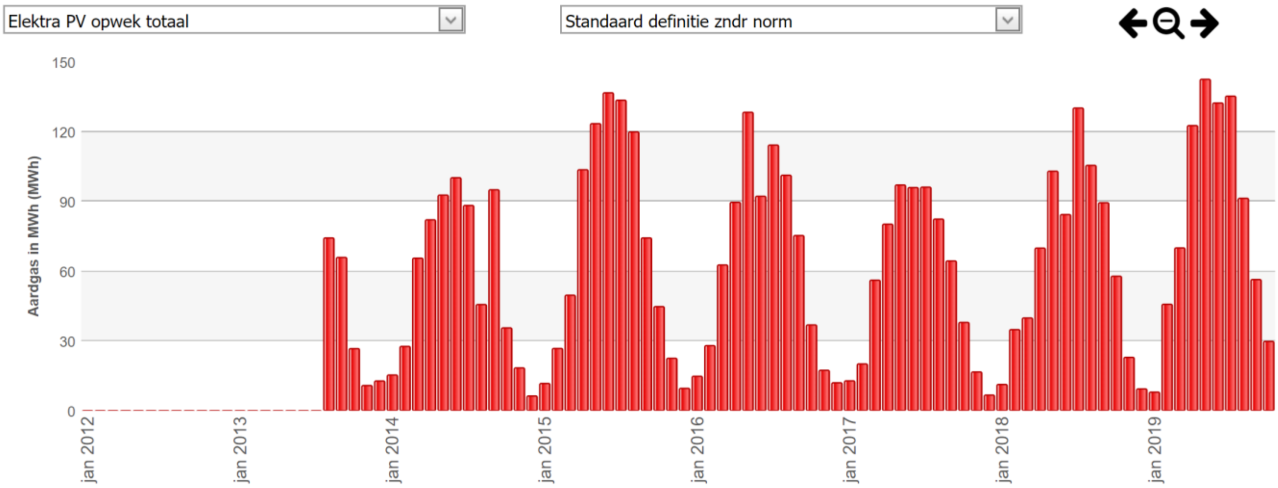

Figure 29. Monthly PV generation of the site in MWh.

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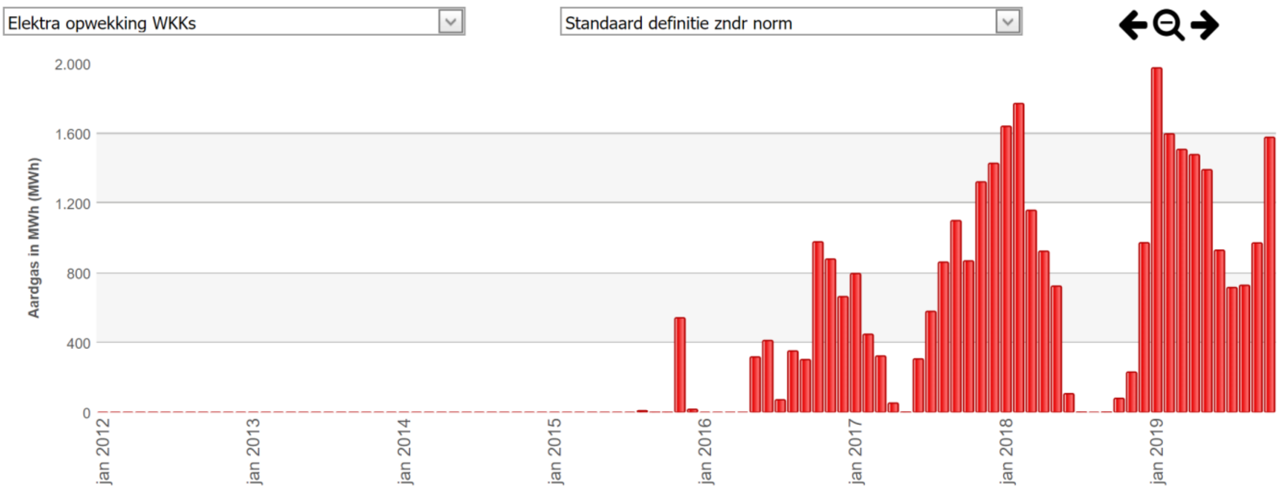

Figure 30. Monthly electricity generation of the CHP in MWh.

Electrical energy

Production assets

The hospital's energy system comprises the electrical and thermal vectors. Both vectors have a distribution system owned by the hospital.

The yearly amount of electricity bought from the grid is shown in Figure 31. There, an electricity purchase of about 30GWh per year is shown for the early years of 2010's decade, with a clear decreasing trend starting in 2016. Note that year 2019 is not representative as the last months of the year are missing at the time of the snapshot.

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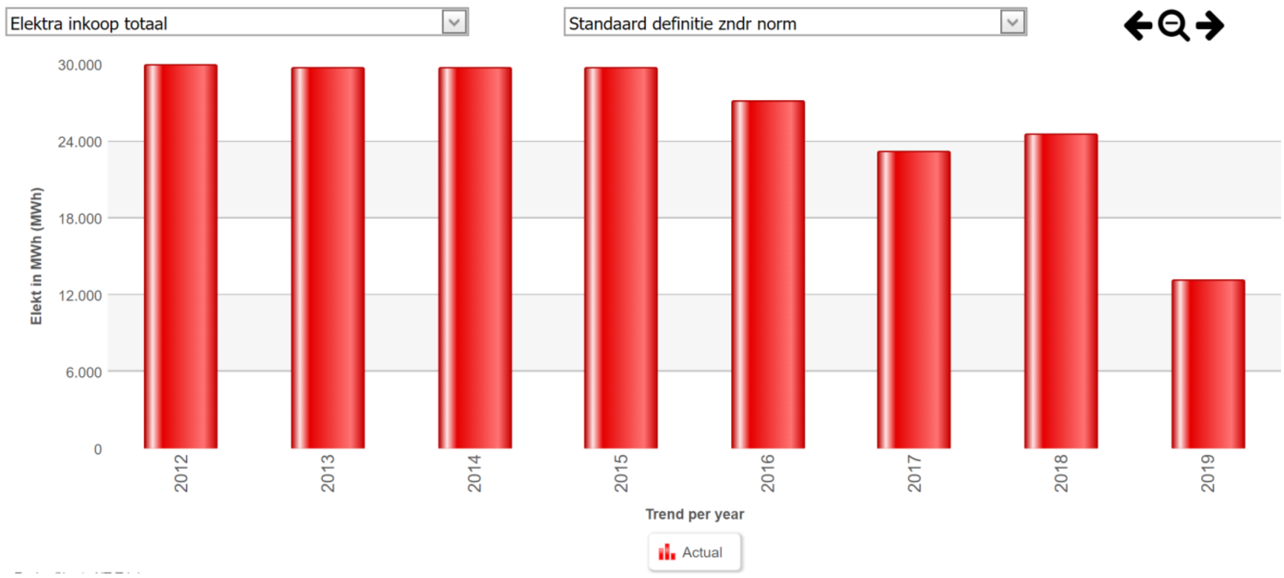

Figure 31. Electricity purchase in MWh per year.

Next table list the PS electrical production assets:

Installation type	Power (electric)
Emergency generators (diesel)	4.4MW/5.5MVA
Solar PV	817kWp
CHP	2.8MVA

Table 11-VUB Health Campus Electrical production assets (Source: VUB)

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Distribution network

The hospital has its own distribution network, shown in Figure 32. The topology of the network presents a closed-ring shape for increased reliability. The network is connected to the grid through two links C1A and C1B, located at the same place.

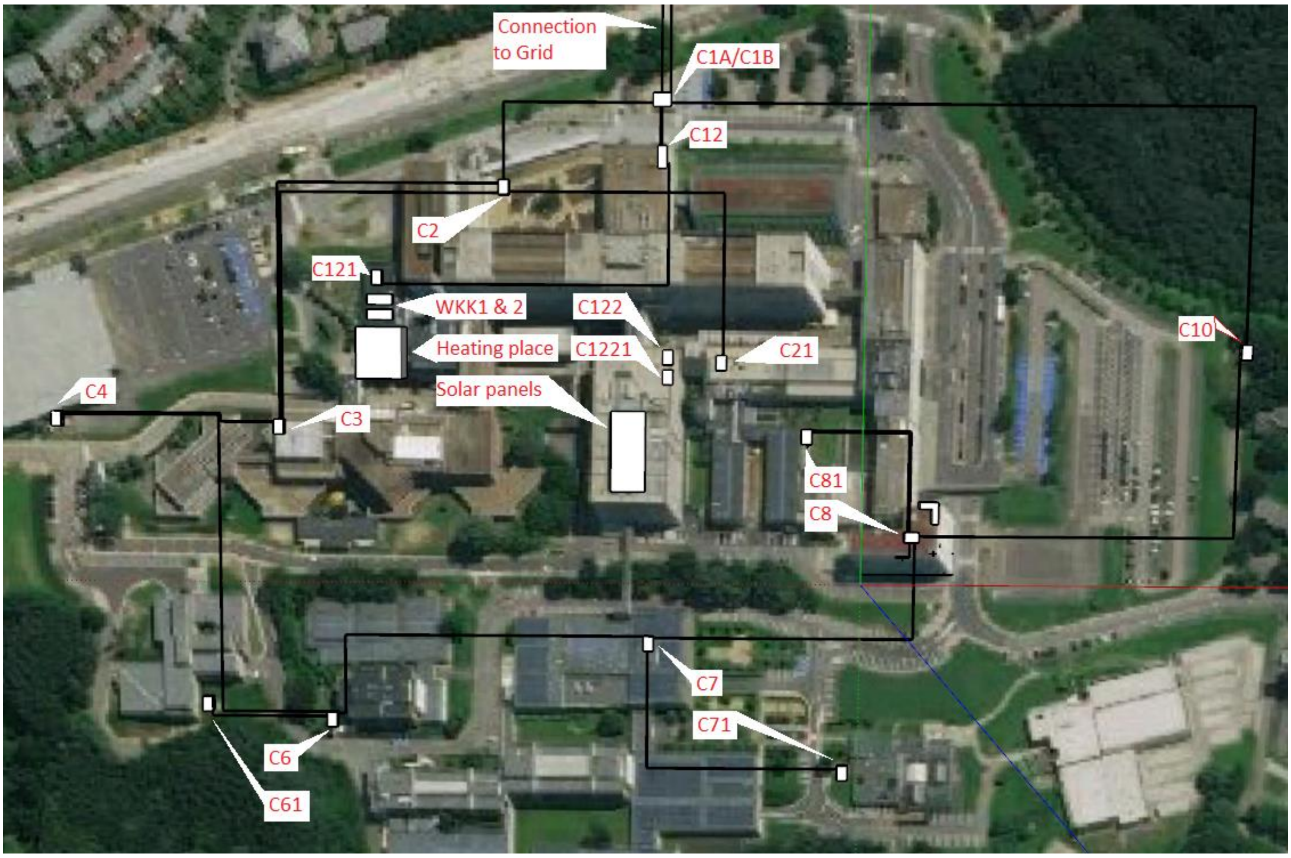

Figure 32. UZB electricity distribution network.

Consumption

Electric consumption data is available for the following

High voltage cabin		Power [kVA]	Number of transformers	Connected stakeholder
C1	Head cabin (grid connection)			UZB
C2	Emergency stream production	2000	2	UZB

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		2500	2	UZB
C2.1	Temporary ophthalmology	630	1	UZB
C3	Children's hospital	800	3	UZB
		1250	1	UZB
C4	Parking 1	630	1	• UZB • Parksite • MacDonaldH • Villa Samson
C6	Animalarium	+/- 1600		VUB
C6.1	Dentistry	320	1	VUB
C7	Faculty Medicine	630	2	VUB
C7.1	Student's restaurant	320	1	VUB
C8	PR4	630	2	UZB
C10	Student's houses	630	1	VUB
C12	hospitalization building (main entrance)	800	8	UZB
C12.1	CHP	1250	2	UZB+ VUB
C12.2	Operational Services	800	2	UZ
C122.1	PV installation	800	1	UZ +VUB + third investor

Table 12-VUB Health Campus Electric consumption data (Source: VUB)

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In Figure 33, the composition of the sources supplying the electrical consumption of the last year is shown.

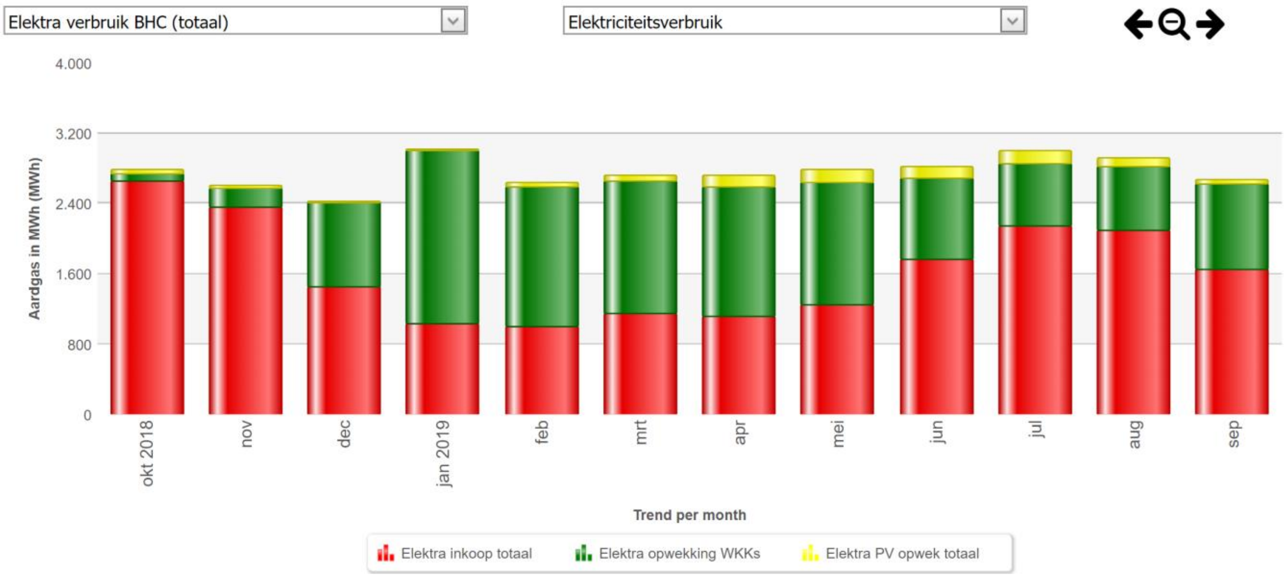

Figure 33. Monthly electricity consumption of the hospital: bought from the grid (red), CHP on site production (green) and PV on site production (yellow).

Measurement infrastructure

Measurements are taken on the secondary (LV) terminals of the transformers. See deliverable D1.4 Data Management Plan [3] for extended information.

Contractual framework

Billing is done internally following the consumption of the different actors for UZB and VUB. Other stakeholders are sent 12 bills a year, for delivered electricity (in kWh). Distribution and transformation losses are distributed according to the energy consumed. Accounting and billing are managed through ERBIS software.

Stakeholders are free to co-invest in generation, but currently only VUB and UZB jointly invested in CHP. Solar panels are obtained through a third investor. Roof space is given for free in return for free electricity for 10 years. After 10 years the panels become property of UZB. The third part creates revenue through green energy certificates.

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Thermal energy

Production assets

The natural gas consumption shows an increasing consumption trend over the years, as shown in Figure 34. This is due to the increasing energy demand of the hospital, where part of the electricity consumption is generated in place, thus is not bought to the DSO, but the natural gas consumed is always bought.

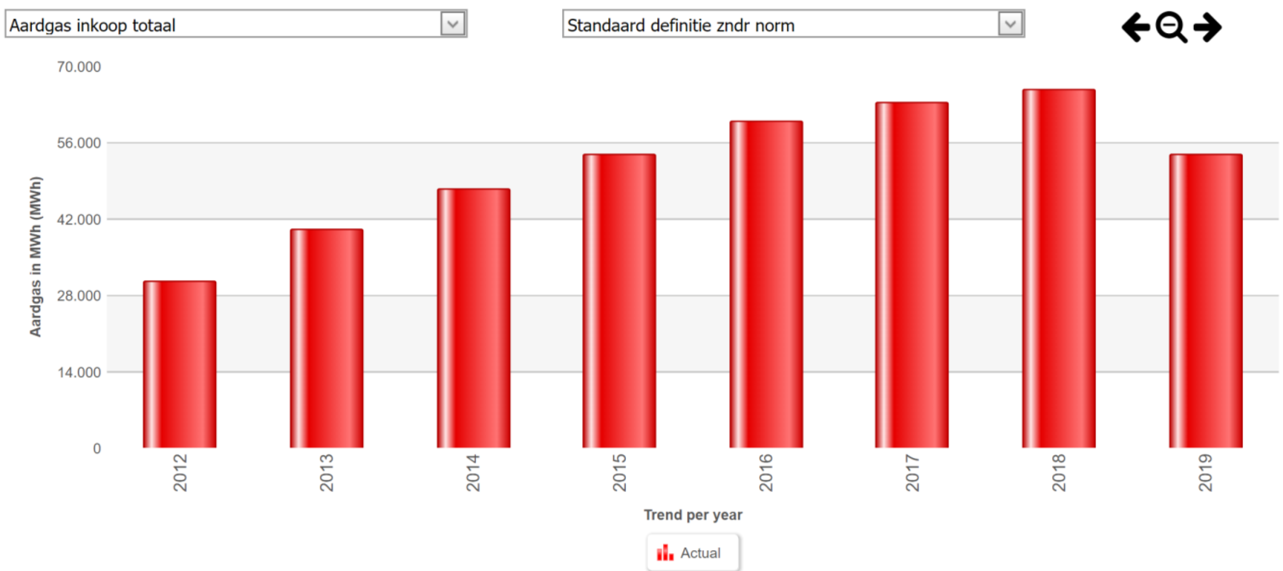

Figure 34. Natural gas purchase in MWh per year.

Next table list the PS thermal production assets:

Installation type	Power
Central heating boilers (Gas fueled) (12+6+3)	21MW
CHP (2x1.5MW)	3.0MW

Table 13-VUB Health Campus Thermal production assets (Source: VUB)

Distribution network

There is a high-temperature heat distribution network in place. 11 heat circuits are connected to the distribution network.

Consumption

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Information about the fuel consumption and the consumption of certain parts of the hospital can be retrieved from the PRIVA building management system if needed. The gas consumption since 2012 is shown in Figure 27.

Measurement infrastructure

A PRIVA building management system gathers part of the consumption and production of heat, as well as the information on fuel consumption.

Contractual framework

No information about the contractual framework has been obtained.

Mobility and transport

Out of project scope.

Netherlands pilot (EEMNES)

Overview

The town of Eemnes is Located in the province of Utrecht, 35 km from Amsterdam, with roughly 3 600 households. Eemnes seeks to be energy neutral by 2030. In order to achieve this goal, CO_2 emissions in Eemnes must be reduced. Eemnes will implement and validate of a block-chain enabled, peer2peer energy market environment. The municipality has also been granted an exemption from the Dutch Electricity Laws by the Ministry of Economic Affairs for a period of ten years.

Figure 35. Map of municipality of Eemnes (google maps).

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Social aspects and stakeholders' description

Social aspect:

The Eemnes peer-to-peer energy trading project will include a smart grid with renewable energy generation, landlords, homeowners and businesses that will be able to become prosumers and take ownership of their energy production and distribution.

Eemnes is going to take advantage of the granted exemptions from the Dutch government. The project will involve around 100 or 150 participants during the RENAISSANCE project, and within the next 10 years it will aim to involve approximately 1,000 participants.

Stakeholders:

- **Municipality of Eemnes (Gemeente Eemnes)**

A public body in the province of Utrecht that provides direct services to citizens. It coordinates some municipal services and organizes supra municipal services. In the project they act as a project promoter. Their main ambition is to 2-fold:

i. Encourage homeowners to install more PV panels on their roofs, directly reducing CO_2 emissions and helping Eemnes get one step closer to its goal of being energy-neutral by 2030.

ii. Support the Validation of the business case for a local flexible energy market connecting prosumers and consumers and larger industry players.

- **Eemnes Energie**

Eemnes Energie, a cooperative partnership focused on generating sustainable energy and helping to save on energy consumption. In the project with Eemnes Energie is a cooperative that distributes electricity in the Eemnes town, it will together with a white label energy supplier (EnergyZero) take the role of the Distribution System Operator (DSO) and of the energy supplier roles.

- **i.LECO**

i.LECO enables the next generation energy markets by using advanced energy management combined with novel strategies. Technologies that they use include blockchain fundamentals, distributed computing and AI.

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The i.LECO platform enables the Eemnes smart local energy trading community and delivers this towards the LEC SP (Local Energy Community Service Provider), Eemnes Energie, who deals with the end customers interaction.

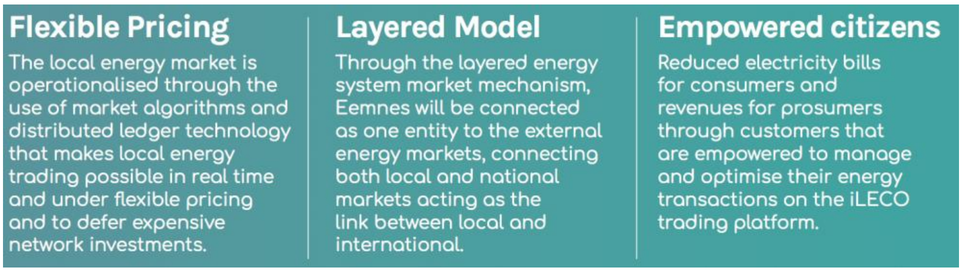

Figure 36: Innovative features of the local energy market enabled by i.LECO

- **Province of Utrecht**

The Province of Utrecht spans 144,915 hectares and consists of 26 municipalities with a joint population of 1,200,000. Utrecht is the oldest and smallest province in the Netherlands and is also one of the most densely populated. The provinces of the Netherlands represent the country's middle level of government and as such work in close co-operation both with municipalities and with the State. The local governments in the province will be observing the pilot development for further enrolment in the region.

- **de Alliantie**

A social housing company that repairs, renovates and improves homes in the Amsterdam, Almere, Amersfoort, Eemnes and Gooi and Vechtstreek regions and could be the potential replicators of Eemnes solution.

- **EnergieVan**

Will be acting as the energy transition expert stimulating action for the Energy transition in the region.

- **Stedin**

Stedin, regional distribution system operator looking for new solutions to reduce the costs of network upgrades.

Climatic conditions and seasonal demand

Due to the geographical conditions of the area, the climate corresponding to Eemnes is a moderate marine climate and, as such, enjoys fairly mild winters and

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not-too-hot summers. A secondary effect of the coastal climate is the fact that rain may fall throughout the year. There is no real rainy season and certainly no long dry periods. It has a thermal oscillation (difference between maximum and minimum temperature) of 10.5 degrees Celsius.

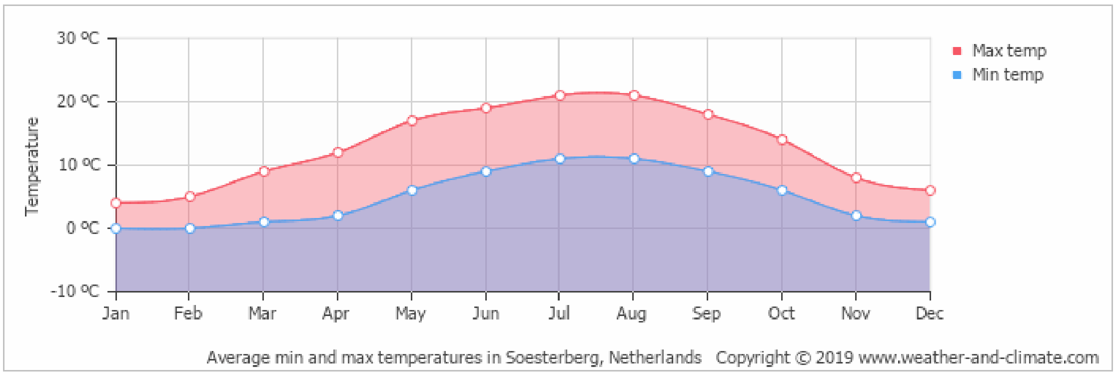

Figure 37: Eemnes weather conditions (source: weather-and-climate.com)

Electrical energy

Production assets

There are currently no electrical production assets installed in this Pilot Site, as each individual household joining the pilot will bring along their own generation assets, mainly PV panels. A typical household has 8 PV panels with 25 kWh production capacity, thus if we foresee 50-150 participants the total capacity could reach up to 2,500 kWh. Furthermore, there is a 183,255 Wp of size PV park in vicinity that potentially could be connected to the system.

Distribution network

Eemnes has its own electrical grid. Energie cooperative has contemplated the energy trading project plan. The grid system will localise energy usage through a smart grid, enabling local households and businesses to become 'prosumers'. In addition, due to the nature of block-chain software, all data from the municipality is safe and secure (more details D1.4 [3] and D6.1 [12]).

Consumption

Eemnes, a small municipality with a strong interest in sustainability and already high rate of personal-use solar panels, is the first place in Europe to test an energy trading in real life conditions under flexible pricing model.

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The use of a block-chain solution and trading is hoped to bring down the prices of energy in Eemnes by between 5% and 10%, due to efficient energy use, highlighting the economic value of such innovation. The system will track how consumer behaviour and energy bills have changed in Eemnes.

Measurement infrastructure

The proposed measurement infrastructure will let the connection between the local energy market and the national energy market by creating a gateway connection that complies with the locally supported DSO flexibility market in Eemnes. The i.LECO platform enables overall the Eemnes smart local energy community and delivers this towards the LEC SP (Local Energy Community Service Provider) which deals with the end customers both in digital as in human interaction.

Eemnes's grid will be monitored with the i.EcoSCADA System, a robust agent based system enabling various decentralized services with unlimited scalability. The core of all the products is a hardware-agnostic SaaS middleware platform that has 3 main functions:

- Monitors all the available energy resources like solar, wind, energy storage (batteries), demand side agents (HVAC, lighting, electric vehicles, etc.)
- Predicts future supply and demand using weather forecasts, user inputs, big data and automated self-learning algorithms
- Controls energy flexibility in the system to optimize pre-defined strategies, e.g maximize green energy usage, lowest cost, energy efficiency, security, etc.

Some basic services/APPs will be implemented for this specific market approach:

- Market Service App: the service to provide local matching and basic link with Dutch level energy markets.

- Grid Safety App: the service to assess possible local grid problems and call flexibility to resolve this in case needed.

- Billing Service App: the service to provide the data-set required for billing towards each participant of the local market.

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- Prosumer App: the service for the end-customer to participate towards the LES market inclusive the end-user graphic user interface.

The figure below shows all the block-chain based Apps for the local market services:

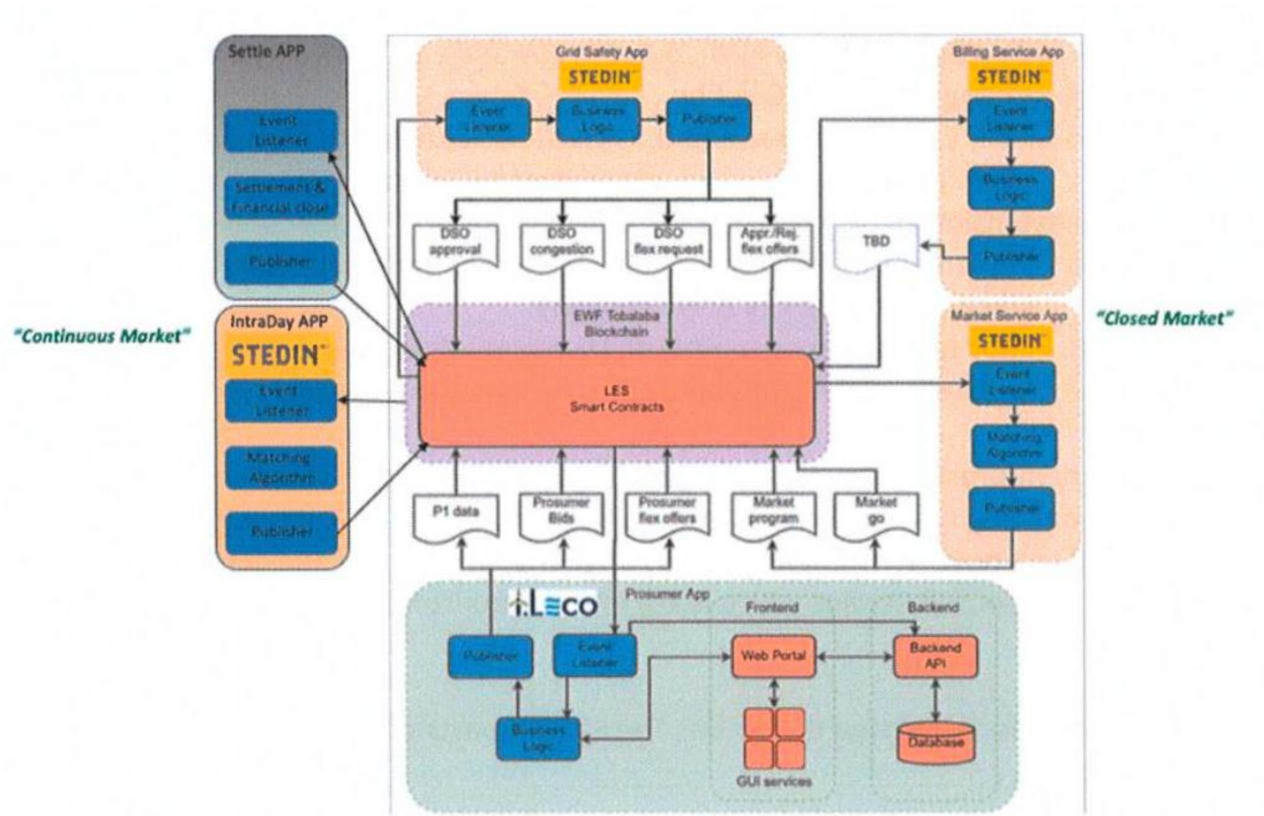

Figure 38 Local market services (source: i.LECO)

i.LECO uses a microservice architecture which uses internal webservice APIs which are now in the process of being partially and differently exposed for external usage. In order to develop the project, complementary to the tender for a Local Energy Trading solution in Eemnes, there is also the need for gateways to enable this software trading solution:

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- **R1 “smart meter interoperable”**: be able to read the Dutch smart meter P1 port at the maximal frequency available (2-10sec based on the model installed;

- **R2 “multi-sensor interoperable”**: be able to interface with other sensor points: electrical, thermal, other (e.g. CO2, relative humidity, occupancy) and this via minimally RS485/MODBus;

- **R3 “multi-IO interoperable”**: be able to interface with different I/O controllable devices via RS485/MODBus (e.g. heat-pump, EV, battery);

- **R4 “software upgradable”**: support R2 and R3 by means of remote upgradeability to thus support new devices, but also other maintenance/upgrades and bug-fixing should be possible remotely;

- **R5 “secure and GDPR compliant”**: be support data-interaction and possibly storage of data in a GDPR compliant manner;

- **R6 “multi-WAN connectable”:** be able to connect to the public internet either via the home internet gateway (via ethernet, WiFi) or via a WWAN connection (min 2G);

- **R7 “modern-age interaction protocol”:** be able to connect to the trading solution platform via modern-age communication protocols (e.g. MQTT, WebService) with a known, open and proven API;

- **R8 “ease of operations”**: be installed easily and low in maintenance;

- **R9 “Cost-effective”**: have a good cost-effective price/quality/capabilities ratio;

The selected gateway that met the preferred criteria for the project is:

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Technische aspecten	Bliq-vanger 1.0
Energie manager	
Max. aantal apparaten	4
Geschikt voor volgende type meters	DSMR 2.2/4.0/4.2/5.0
Communicatie interfaces	3x Serieel 2x Ethernet 1x MBus 1x 2G (Optioneel: 4G) 1x RF868 (Optioneel: LoRa)
Communicatieprotocol	Modbus RTU via RS485/422/232 Modbus TCP/IP via Ethernet
Omgevingscondities	
Omgevingstemperatuur in bedrijf	-10°C tot 60°C
Omgevingstemperatuur tijdens opslag	-40°C tot 80°C
Relatieve vochtigheidsgraad	10-90%, niet condenserend
Beschermingsgraad (volgens IEC 60529)	IP21
Algemene data	
Afmetingen (l*b*h)	146mm/81mm/25mm
Gewicht	0,2 kg
Plaatsingsmethode	Staand en hangend
Certificaten en goedkeuringen	CE
Energieverbruik	< 3W
Voeding	5V DC
Status display	8 x LED
Features	
Werking en visualisatie	Bliq installateursportaal, Bliq app
Update functie	Automatische updates
Garantie	2 jaar
GSM data abonnement	2 jaar inbegrepen, verlenging mogelijk

Figure 39 Gateway used in Eemnes (source:Bliq-vanger)

This selected gateway will be interconnected into a Measurement Electric Grid and also other measurement points/sensors (Mx) to enrich the customer's data with real time data about the electrical consumption. Also, the DSO will be interconnected via a P4 service provider with real time energy meters (See Figure 40 below).

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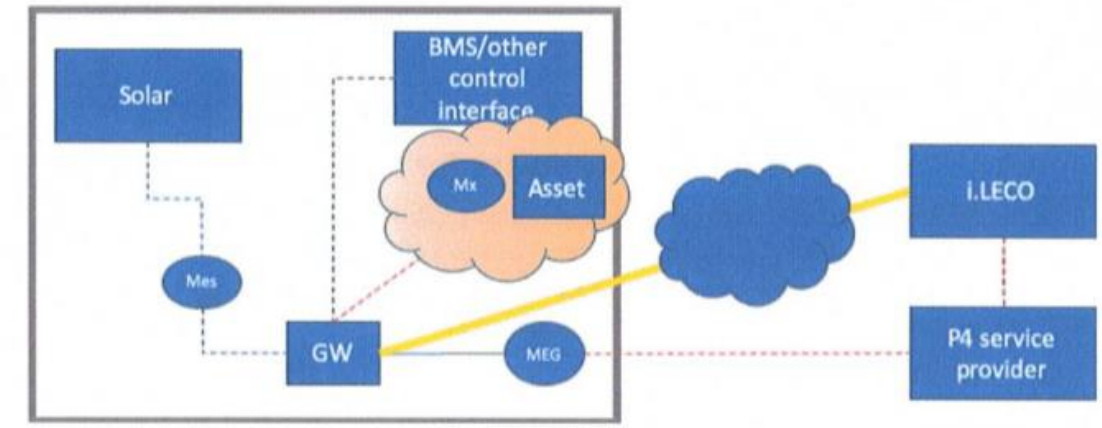

Figure 40 Measurement Electric Grid (source: i.LECO)

Contractual framework

The Dutch power generation market is moderately concentrated, with four major players. Also, the Dutch electricity market has been fully open to competition since 2004 (2002 for industrial consumers). The liberalization of the market led to the entry of large European vertically integrated companies, which purchased assets from former national generation and distribution companies.

The Netherlands opted for a system of full ownership unbundling, which is designed to completely split power generators from network owners. TenneT is the single national electricity TSO. It is controlled and owned by the Dutch state. The electricity (low voltage electricity) distribution network is operated by eight distribution companies, through concession agreements.

The contractual agreements within the stakeholder in the pilot are being determined during the time of submission of the deliverable (November 29th, 2019) and are thus not yet available.

Thermal energy

There are no thermal energy generation assets within the project scope

Mobility and transport

In the current phase of the project, no e-Vechicle connections have been foreseen. Could be that once the pilot has been launched, some EV charging stations will be connected to the pilot.

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Greek pilot (Kimmeria Campus)

Overview

The Greek Pilot Site (PS) comprises a building complex of students' residences located near Kimmeria, northeast of the city of Xanthi, Northeastern Greece (Figure 41 and Figure 42). The building complex is owned by Democritus University of Thrace. The total built area is 14,819.09 m^2 and consists of eight (8) students' residence buildings, one (1) amphitheatre, one (1) restaurant and one (1) building used for housing electromechanical equipment. The buildings of Greek PS were constructed chronologically in two phases, the first completed in 1990 and the second completed in 1999.

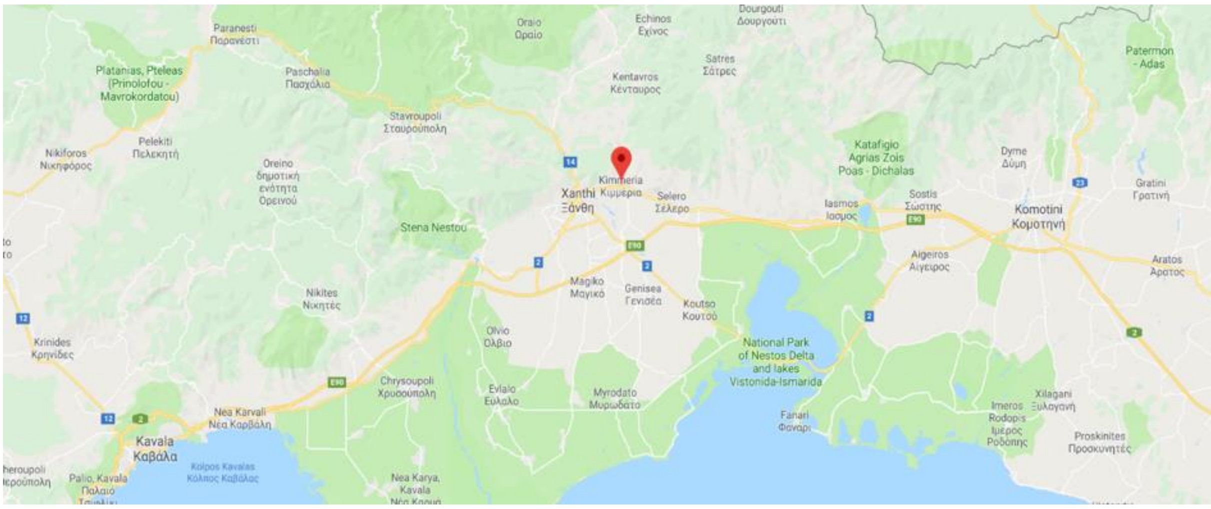

Figure 41- Location of the Kimmeria Pilot Site, Xanthi, Greece (google maps)

The energy community of Kimmeria's PS has a social character, since its end users are students, which are selected through low-income and other socio-economic criteria, following relative national laws. The total occupants of the students' residences are on average 630 and are renewed every year. The thermal energy demand of the students' residences is covered by locally generated renewable energy. The thermal and cooling energy demand of the restaurant and the amphitheatre are also covered by Renewable Energy Systems.

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Figure 42- Satellite view of Kimmeria, Xanthi, Greece (google maps)

Social aspects and stakeholders' description

Kimmeria's PS is owned by Democritus University of Thrace, a public university of Greece. The building complex is used for the accommodation of DUTh's students (Figure 43). The selection of the students follows strict socio-economic criteria (low-income, single parent families, etc), since the accommodation services (to students) is provided without charge.

Stakeholders:

- **DUTh** (Democritus University of Thrace): The University owns 100% of the campus. DUTh was founded in 1973 and is developed in four cities of Thrace, Greece, including Xanthi, operating 8 Schools with 18 Departments.
- **YLLF** (Youth and Lifelong Learning Foundation): YLLF is responsible for the management of Kimmeria's students' residences. YLLF was found in 1947, is an entity governed by private law and it is supervised by the Ministry of Education, Research and Religious Affairs. YLLF's mission is to implement lifelong learning programmes/projects, implement youth programmes/projects, emphasising youth innovation, mobility, transitions and career growth, manage all issues regarding student care services, catering and accommodation facilities.
- **Municipality of Xanthi**: Municipality of Xanthi is the local authority where Kimmeria campus belongs administratively and geographically. The main city of the municipality is the city of Xanthi. The municipality of Xanthi was formed

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in 2011 following the merge of two former municipality, Xanthi and Stavroupoli.

- **Techni S.A (Pantelos).**: An aluminium industry located near Kimmeria's PS and it was established in 1988 by Aristides Pantelos. With a steady upwards course, the company managed to extend its activities by establishing facilities with a total area of 20.000 square meters, where today takes place the construction of Doors, Panels from Aluminum and PVC, and Anti-mosquito systems.
- **Students and visitors**. Kimmeria's PS accommodates approximately 630 students. In addition, the PS is visited by non-tenant students and other visitors of several events that are hosted in the amphitheater of the building complex.

Figure 43- Aerial photo of Kimmeria Pilot Site, Xanthi, Greece

Climatic conditions and seasonal demand

Energy demand is directly correlated with the climatic conditions, e.g. the increase electricity demand during periods of high temperature for cooling, or the increase of thermal energy demand during periods of low temperature. At the same time, the generation of energy from Renewable Energy Sources is directly related to the climatic conditions, e.g. wind, solar, hydroelectric.

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Region of Eastern Macedonia and Thrace, where Kimmeria's PS is located, has relatively strong wind potential (5-7m/s average wind speed), as show in Figure 44. In addition, the region is considered as the most important region in terms of the low-enthalpy geothermal energy potential. As far as the solar irradiation is concerned, the PS's region presents lower solar potential (approx. 1600 kWh/m^2) in respect to the rest of Greece, however, it is considered as important as compared to the rest of Europe (Figure 44).

In general. the climatic conditions of Kimmeria's PS are characterised by cold winters, with durations over 5 months, and hot summers (average winter temperature ~ -4 ^oC and in summer ~ 34 ^oC).

The local climate conditions are responsible for issues related to energy production of installed RES systems, which include:

- Increased demand for biomass consumption due to lower solar refraction during winter
- Increased glycol % in water (heat transfer fluid) of solar thermal systems for freezing protection
- Increased temperatures in water of the solar thermal systems due to high solar radiation due to summer period resulting in stagnation issues.

Kimmeria's pilot site has its own meteorological station, which is located less than 200m southwest from the complex of building. More information about the availability of the meteorological data will be included in future reference.

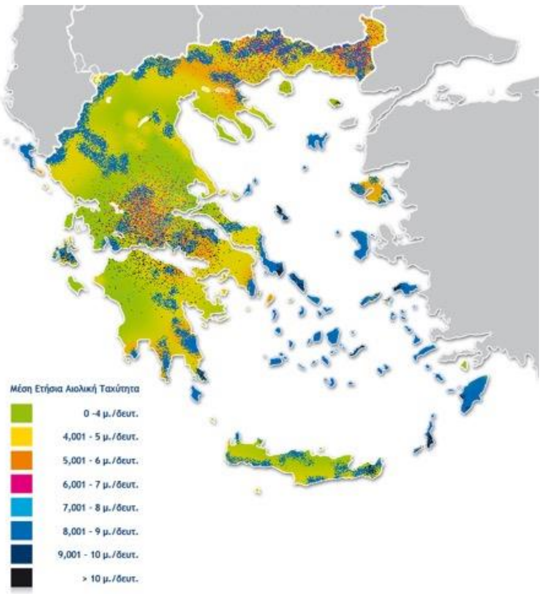

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Figure 44- Wind speed in Greece

The energy demand of the PS follows directly the local climate conditions. Thus, the building complex requires increased thermal energy demand during cold winter period, which in general is between 15th October and 30th April. Although the summer period is characterised by high ambient temperatures, the absence of installed cooling systems results in low cooling consumption. Nevertheless, the cooling demand exists and cannot be neglected. However, during summer period and particularly between end of July and beginning of September, buildings are unoccupied due to vacations of students. Students vacations during Christmas and Easter also influence the energy demand of the pilot site.

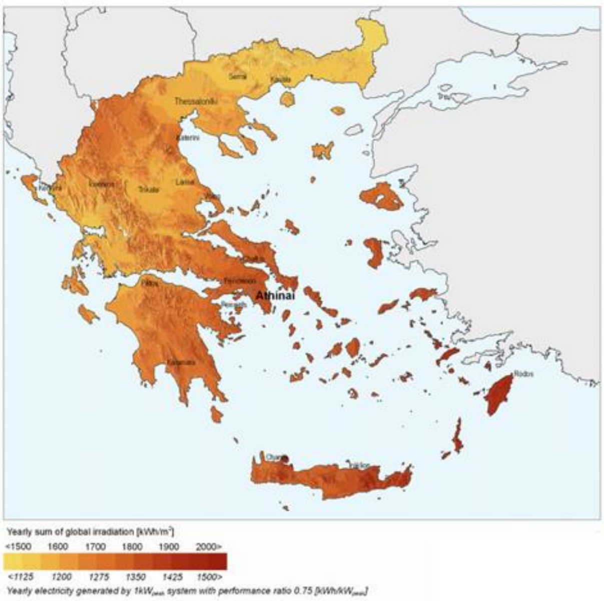

Figure 45- Solar irradiation map of Greece

Electrical energy

Production assets

Local electrical energy is generated by an installed autonomous rooftop PV system. Additional local electrical energy is expected to be generated by the ORC turbine that will be implemented within RENAISSANCE project.

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The autonomous PV system covers part of the electrical demand of building “G2” of the building complex. It comprises 198 polycrystalline photovoltaic panels of 260Wp each, installed on the roof of “G2” and “D1” buildings using aluminium support system. PV panels (by SUNTECH) are connected to an electrical energy storage system that constitutes of 72 OPzS 2V batteries of 3,780Ah each, comprising a battery system of capacity of approximately 500 kWh. The PV system includes also three off-grid inverters of 8kW (SMA sunny island 8.0H) each and two grid inverters (SMA STP-25000TL) of 25kW each. Figure 46 presents the simplified one-line diagram of the autonomous photovoltaic system.

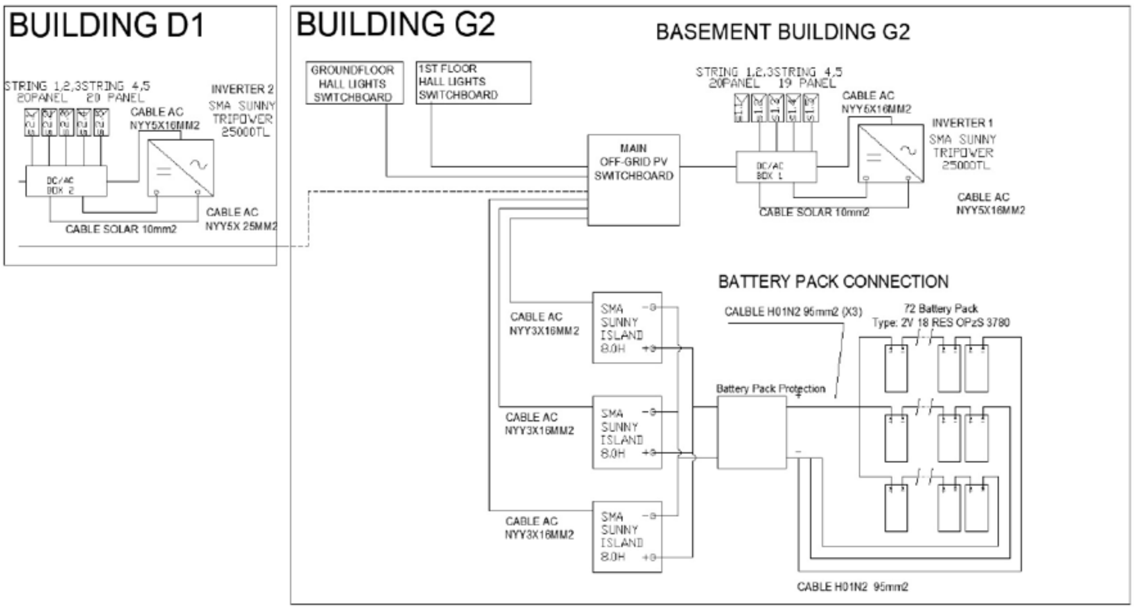

Figure 46- Simplified one-line diagram of autonomous PV system

Distribution network

Kimmeria’s PS has its own connection to the Main (National) Grid through an overhead power line and a LV/MV transformer. Figure 47 depicts the connection of the PS to national Main Grid. Within the PS, a star connection low voltage grid exists to distribute the electricity to the buildings of the complex.

An independent electrical network serves the distribution of the electricity generated by the autonomous PV system. This network will be updated within

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RENAISSANCE project in order to integrate the electricity generated by the ORC turbine and increase the utilization of renewable energy by the PV system.

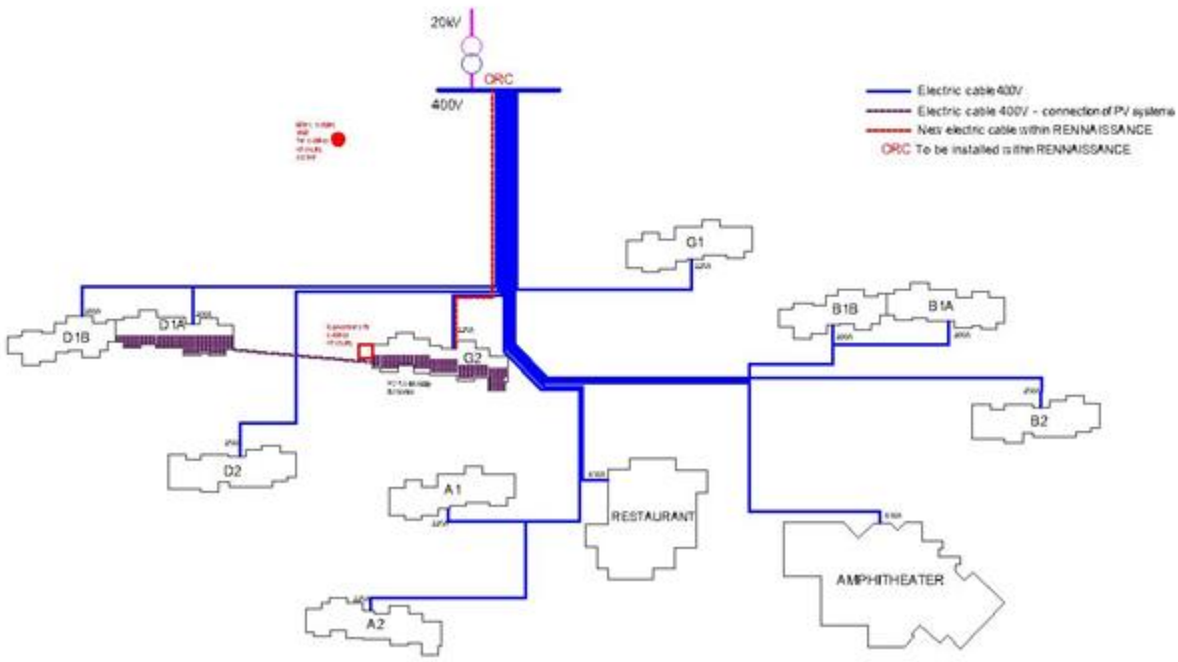

Figure 47- The electrical grid of Kimmeria PS including ORC integration

Consumption

The end-users of electricity are student rooms and common spaces of students' dorms, the restaurant, the amphitheatre, the outdoor lighting and the central heating and cooling facilities of the buildings complex. The total average electricity consumption of the eight buildings for student's residence is estimated 1,500 MWh/y. The electricity consumption per room (double) is approximately 6,320 kWhe/y. Common areas (corridors, entrance etc.) of each building, consume about 1,220 kWhe/y. It should be noted that electricity consumption of the PS is significantly higher than the electricity generated locally by the installed RES systems.

Measurement infrastructure

The consumption of electrical energy at Kimmeria is selectively measured through installed measurement infrastructure that includes smart electricity meters and data loggers, which record, store for a short period of time (~15min) and upload

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the data collected to a webserver (www.symmetron.gr/captum). The installed data loggers presented in Figure 48, collect the electricity of specific consumptions at the PS.

Building	Data Logger	Serial Number	Mac Address	Units
G2	Symmetron Stylitis-10	045E0444	00409D:8A07B0	kWhe
G2	Symmetron Stylitis-10	045E0440	00409D:8C97C7	kWhe
D1B	Symmetron Stylitis-10	045E0445	00409D:780008	kWhe
D1A	Symmetron Stylitis-10	045E0443	00409D:88EFF6	kWhe
G1	Symmetron Stylitis-10	045E0441	00409D:8A0889	kWhe
Boiler Room	Symmetron Stylitis-10	045E0399	00409D:8A0889	kWhe
Boiler Room	Symmetron Stylitis-10	045E0164	00409D:88F016	kWhe
Restaurant	Symmetron Stylitis-10	037E0222	00409D:243C0E	kWhe

Figure 48- Measurement infrastructure for electricity consumption of Kimmeria's PS

In Figure 49, the electrical data collection, logging and uploading is shown.

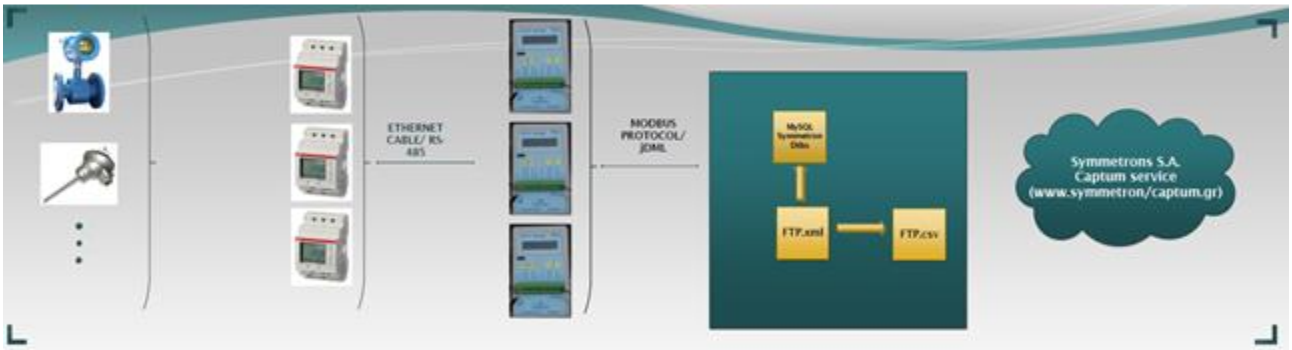

Figure 49- - Measuring, data collection and upload of the electricity consumption in Kimmeria's PS

Besides, the symmetron's data loggers, data collection of electricity is also performed by the installed equipment of the autonomous PV system. This refers to the electricity generated by the PV system, as well as the electricity stored to the battery system. This information is uploaded to SMA's webserver (www.sunnyportal.com).

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Contractual framework

The electricity sector of Greece is fragmented into four activities: production, transport, distribution and commercialization. Electricity trading companies are responsible for purchasing electricity for their customers/consumers. The purchase of electricity is carried out in the Electricity Market, which is managed by an independent operator (RAE – www.rae.gr) that performs the economic management of the daily and intraday market of the production of electric energy in Greece. This activity is carried out under a regime of free competition so that consumers can choose their company in the market.

Independent customers can now choose between private entities to provide them with electricity (the prices depend on the provider). There is a wide range of prices. Figure 50 and Figure 51 show the low voltage tariffs currently in force in Greece by Public Power Corporation (PPC). Kimmeria's PS is currently under medium voltage tariff ("BC") contract with PPC.

	A.C.- "Agreed Consumption"	Power (Fixed Price) (€/kVA*A.C./year)	Energy (Varying Price) (€/kWh)	Power (Fixed Price) (€/kVA*A.C./year)	Energy (Varying Price) (€/kWh)	Reamining fees	Special Fee For CO2 Emissions	Community Services
G21		0.53	0.0047	1.47	0.0190	0.00007	0.017	0.01824
G22	Reac. Power Measured	0.53	0.0047	3.17	0.0190	0.00007	0.017	0.01824
	Reac. Power not Measured	0.53	0.0047	3.78	0.0167	0.00007	0.017	0.01824
G23	MAX 25kVA	0.53	0.0047	1.47	0.0190	0.00007	0.017	0.01824
	>25kVA			3.17	0.0190			
	Night Charge (kWh)			3.78	0.0167			

Figure 50– Low voltage electricity tariffs for domestic use in Greece

	Transportation System	Distribution System		Reamining fees	Special Fee For CO2 Emissions	Community Services
	Charge of Power (€/kW/month)	Charge of Power (Fixed Charge) (€/kW/month)	Charge of Energy Consumption (€/kWh)			
Commercial	1.329	1.179	0.0029	0.00007	0.00878	0.01790
Industrial	1.329	1.179	0.0029	0.00007	0.00878	0.00691

Figure 51– Low voltage electricity tariffs for commercial use in Greece

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Thermal energy

Production assets

Hybrids biomass/solar thermal system:

The main RES system installed in DUTh's students' residences is a hybrid system that utilizes a biomass boiler and a solar thermal system for the heating, cooling and domestic hot water of the buildings' complex. Figure 53 presents the simplified one-line diagram of the hybrid system. The main components of the system include 740 selective flat plate solar collectors of 2.58 m^2 each, 4 solar stations with plate heat exchangers, one biomass boiler of 1.15 MW_{th}, an underground metallic biomass storage tank of 35 m^3, an absorption chiller of 316.52 KW_c coupled with cooling tower of 720.5 KW and 4 outdoor hot water tanks of 10 m^3 each. The solar field consists of 4 identical solar collectors' loops. Each loop consists of 40 parallel solar strings with 4 or 5 collectors each. A "reverse-return" connection is selected in order to achieve hydraulic balance.

Solar collectors are supported on an aluminium system utilizing trembling. Each loop is controlled by a specific solar station that utilizes speed variation in order to maintain a stable ΔT between the solar collectors and the thermal energy storage (TES) system. Water/glycol mixture is used as heat transfer medium in order to prevent freezing conditions.

Figure 52- Aerial photo of RES systems installed at Kimmeria's PS

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The biomass boiler is accompanied with an economizer of 50kW, a multicyclonic ash filter, a bag filter (<10mg/Nm^3) and a chimney with diameter of 640mm and height of 12m. The biomass boiler is installed in parallel with the existing oil boilers, which are used as a back-up heating system. As shown in Figure 53, thermal energy produced in solar field is transmitted to TES system. The external plate heat exchangers included in the solar stations are used to transfer the heat for the water/glycol mixture to the water stored within the tanks. TES system is inline connected with the biomass boiler. During thermal energy demand, the water stored in TES is circulated to the consumptions (buildings) after is heated up to 90°C – if required – in biomass boiler. During summer, solar energy is utilized to satisfy the demand for domestic hot water of the students' buildings and for the cooling demand of amphitheatre. Cooling is produced by the absorption chiller by using the available heat of the solar thermal. In case the temperature of the water stored is below 80°C, biomass boiler is used to raise the temperature to 90°C.

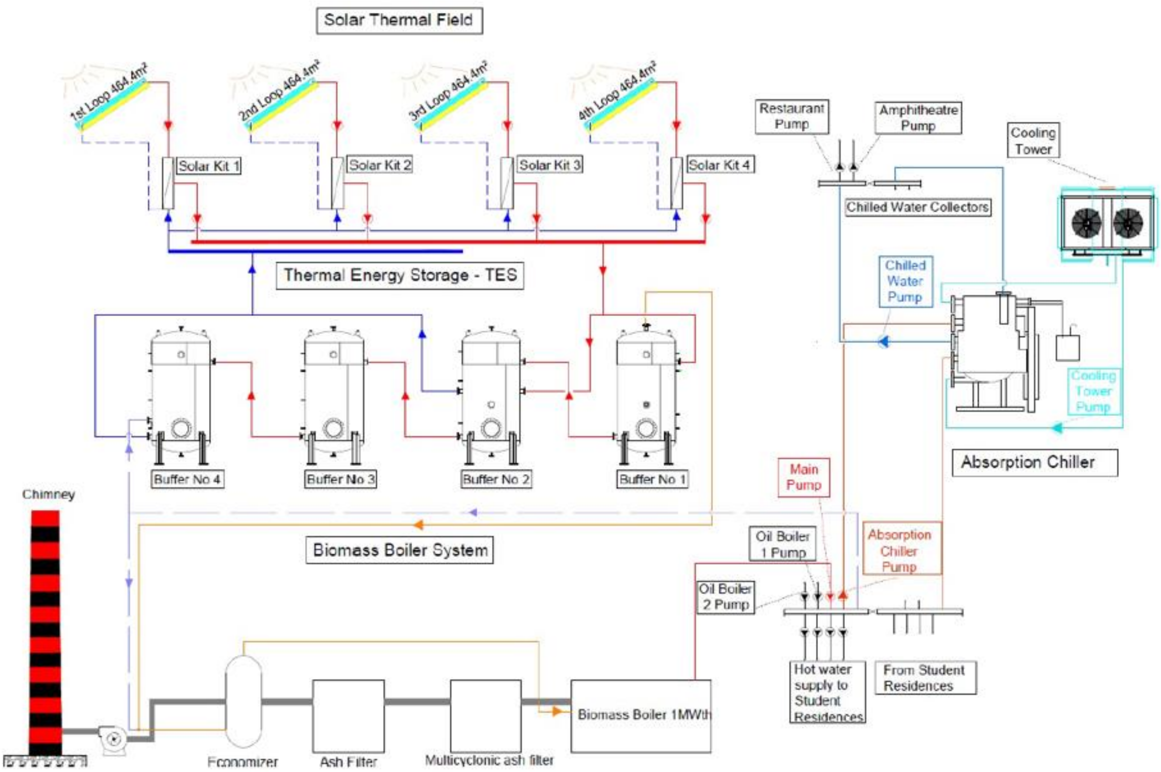

Figure 53– Simplified one-line diagram of biomass/solar thermal system of Kimmeria's PS

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Geothermal heat pumps:

Geothermal heat pumps have been installed for heating and cooling of the restaurant building of Kimmeria's PS. The geothermal heat pumps are coupled with a geothermal heat exchanger of 34 vertical wells of 94m each, located near the restaurant. The capacity of the two geothermal heat pumps is 135KW_{th}, 94.6KW_c each. The system includes also a buffer tank of 1m^3. The geothermal heat pumps are installed in parallel with the existing heating oil boiler, which is used as a back-up heating system. Figure 53 presents the simplified one-line diagram of the geothermal heat pumps. The geothermal heat exchanger is constructed with polyethylene pipes (PE-HD 16) in U-tube formation.

Distribution network

Heating and domestic hot water (DHW) is produced centrally and delivered through an extensive non-insulated piping network to each building of the complex. This network serves all students' residences and the amphitheatre, while restaurant has a specific heating and domestic hot water system, as mentioned above. The piping network consists of 5 branches that utilize a specific circulation pump. Each student's residences building have a hot water storage tank of 2,500 lt in order to cover the domestic hot water demand. Amphitheatre is the only building that is covered in terms of cooling from the central cooling system (absorption chiller).

Consumption

The thermal energy is generated locally by the installed RES systems that include a hybrid biomass/solar system and a geothermal heat pumps system. These systems are in operation for approximately two years. According to the results of the two years operation, the solar field was able to provide with an average yearly thermal energy of 532 MWh. According the collected data, during summer period, there was significant number of times where the return temperature of the primary loop of the heat exchangers was close to the supply temperature, resulting in stoppage of the energy transfer and consequently resulting in wasted solar energy. The wasted solar energy is due to the limited thermal storage capacity and it is estimated at approximately of 100 MWh/y. The yearly average biomass pellet consumption during the first two years of operation was approx. 300t. Within the first two years of operation, there were significant issues mainly related to the biomass supply

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system that resulted in unavailability of the biomass boiler. The biomass pellet that is expected to be consumed by the building complex in normal yearly operation is estimated at approx. 380t. The average yearly thermal energy delivered to the building complex is approx. 1,900 MWh.

As far as the geothermal heat pumps system is concerned, the thermal energy generated was in average 135 MWh/y. At the same time, the average electricity consumption of the geothermal heat pumps was 26 MWh/y, resulting in renewable thermal energy generation of 95 MWh/y.

Thermal energy is also consumed for the operation of the absorption chiller that cover the cooling demand of the amphitheater of Kimmeria's PS. The average thermal energy consumption is 45 MWh/y.

Measurement infrastructure

The data collection of thermal energy consumption is performed using smart heat meters and symmetron data loggers. The installed heat meters measure the thermal energy generated by the solar field, the thermal energy delivered by storage tanks to the biomass boiler and the thermal energy consumed by the eight buildings of students' residences. In addition, smart heat meters are collecting data from the thermal energy produced by the geothermal heat exchanger and by the geothermal heat pumps.

Building	Data Logger	Serial Number	Mac Address	Units
Boiler Room	Symmetron Stylitis-10	045E0399	00409D:8A0889	kWhth
Boiler Room	Symmetron Stylitis-10	045E0164	00409D:88F016	kWhth
Restaurant	Symmetron Stylitis-10	037E0222	00409D:243C0E	kWhth

Figure 54- Measurement infrastructure for thermal energy consumption of Kimmeria's PS

Contractual framework

Thermal energy is generated locally at the PS. As mentioned above, students of Kimmeria's campus are not charged for the use of student's residences. Therefore, no contractual framework exists for the use of thermal energy. Regarding the use of biomass pellets for the production of thermal energy, the procurement follows market prices of pellets, which are usually about 250 EUR/t.

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In general, the national contractual framework for thermal energy comprises the market prices of heating oil, biomass pellets and other fossil fuels (e.g. LPG) used for heating and domestic hot water. District heating systems are operating in only few cities of Greece and each of the system operates with a specific contractual framework mainly depending on the origin of the heat (e.g. waste heat from power plants, natural gas CHP, etc) and the owner of the system (e.g. public or private entity).

Mobility and transport

Out of project scope.

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Annex 2: Objectives and scenarios definition

This section describes how the Pilot sites has or will define their objectives and scenarios for the development of their LEC.

Within the DoW scope, two Pilot Sites has already defined it, Belgium PS and Greek PS, both are university campus with mainly educational stakeholders. Therefore, in this section just and explanation of their objectives and scenarios is included. Then during the first months of project, Greek PS decides that MAMCA methodology could help them to define objectives and future scenarios, so they decided to ask VUB to join the MAMCA process in their PS. This works will start beginning 2020.

Spanish PS and Netherlands PS have joined the project with some predefined implementations, but their stakeholder's structure and less developed RES infrastructures makes them ideal candidates to test MAMCA methodology in order to analyse and help to define objectives and scenarios. This methodology compromises several workshops and exchanges with the stakeholders so this report will be updated once the process has ended. By now, this section includes the first MAMCA workshop held in both PS to explain the process to the stakeholders and gather their objectives.

MAMCA methodology

Within the RENAISSANCE project, a Multi-Actor Multi-Criteria Analysis (MAMCA, more information in [4]) is conducted for the two pilot sites in Manzaneda, Spain and Eemnes, the Netherlands.

This tool serves different purposes; as a facilitating tool for decision-making, co-creation or for consensus building. The methodology was already used in various large-scale mobility and logistics projects (Macharis, Turcksin, & Lebeau, 2012). Using the MAMCA, affected parties are involved in the process of the project from an early stage on which allows an adaptation according to the needs of the most affected. A MAMCA is applicable, when various actors, e.g., the government, citizens and companies, are influencing and are influenced by a decision. Therefore, the MAMCA is specifically interesting for the pilot sites at Eemnes and Manzaneda, as more than one stakeholder is involved.

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At the other pilot sites in Greece and Belgium, the university hospital and the Kimmeria University Campus respectively, are the sole decision-maker for the site, so the MAMCA is less relevant. On the other hand, MAMCA is a powerful for future potential scenario's a track that is currently being explored for the Greek site (a workshop to discuss it more deeply will be held in January 2020).

A MAMCA follows seven steps (Macharis, Turcksin, & Lebeau, 2012) (see Figure 55):

1 **Problem definition and identification of alternatives**

Scenarios encompass visions or possibilities for the development of a EC. Within RENAISSANCE these scenarios differ in their respective community set - up that is characterized by, e.g., size, production or storage capacity, trading approaches, actors involved and/or business models employed. One of these scenarios is usually the present situation called "business-as-usual"-scenario.

2 **Stakeholder analysis and communication of their objectives**

Through a stakeholder analysis based on a literature study, a survey and the snowball method, affected parties are assessed and then asked to share their objectives, needs and wants for the EC. In the given figure, the local government communicates green environment, economic growth, inclusiveness and affordability as their key objectives for the EC.

3 **Key criteria are identified and are assigned with weights according to their attributed importance**

To assess the communicated objectives, the objectives are translated to measurable criteria, e.g., climate change, local employment, participation, and the energy price. During a first participative workshop, the criteria is weighted by the stakeholders. In the example, the local government sees local employment with 36 out of 100 % as most important.

4 **Indicators**

Specific indicators like CO_2-emissions, jobs, number of households and tariffs are used to assess the criteria. RENAISSANCE addresses all pillars of sustainability for the assessment: Social, economic and environmental while focusing on technical feasibility.

5 **Evaluation**

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The performance of the different scenarios is then evaluated according to the defined criteria. Combining the expert knowledge about the performance of the indicators and the objective of the stakeholders, the scenarios are scored.

6 Multi-Actor View

A comparative overview of the scored scenarios is given, and a sensitivity analysis is conducted. The scoring for all actors is displayed and allows a direct and participative comparison of the performance of all scenarios for all participants.

7 Implementation

The selected scenario is implemented. The steps can be followed in an iterating manner.

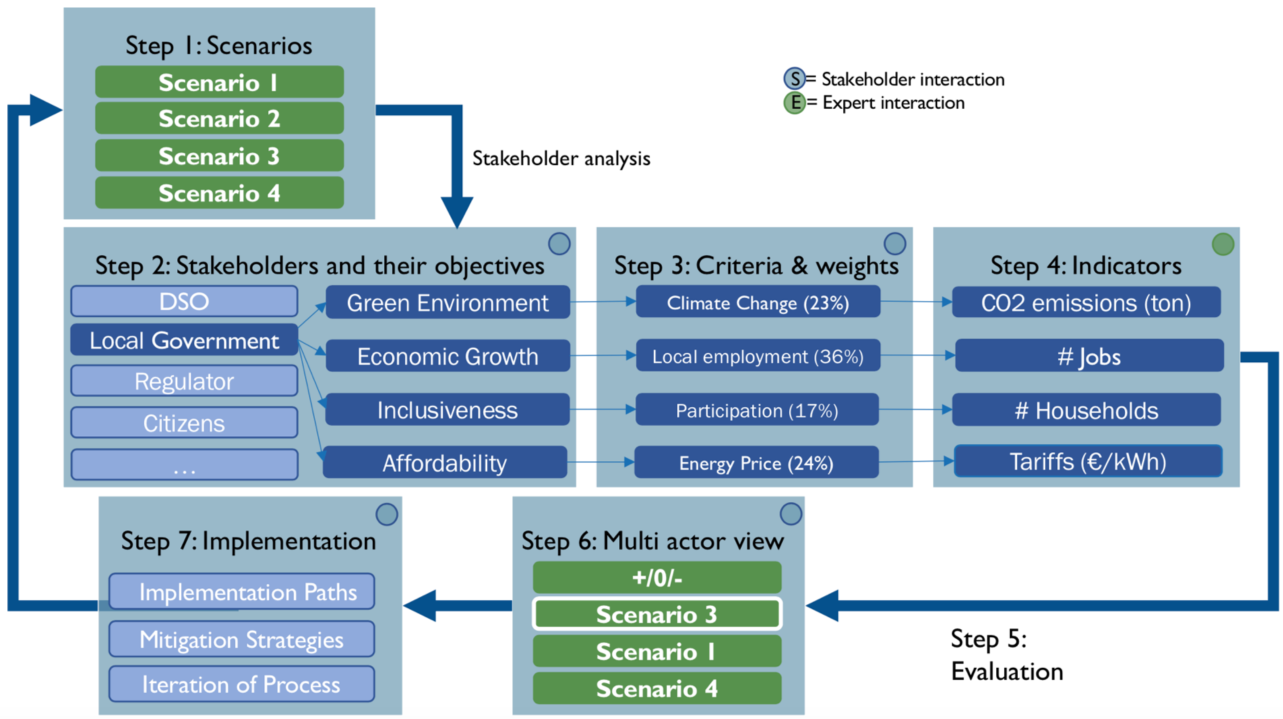

Figure 55: MAMCA Methodology

The mentioned objectives of the stakeholders are important to take into consideration to develop and roll-out a community that fits the unique requirement of each site. The translated indicators also show which KPIs should be compared among the different sites to guarantee that the goals of the project are achieved.

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MAMCA Implementation Plan at Eemnes and Manzaneda

Following the introduced trajectory, the MAMCA methodology will be applied at Eemnes and Manzaneda using the same approach:

The pilot site owners are contacted to assess all the stakeholders at site to facilitate the communication with them. As a preparation for the participatory part, possible scenarios are developed together with the site owners. The first contact with the stakeholders is the communication about the project itself and entails a first exploration of the objectives. This is done sharing an online survey where participants can rank pre-selected objectives and add objectives to the list. This serves as an input for the first participatory workshop where, using the MAMCA software provided by the VUB, the criteria are further defined.

With an example about urban freight mitigation in the Brussels region, the application of the software is shown:

1. **Scenario definition**
   - Business as Usual
   - Crowdsourced Deliveries
   - Lockers during the night
   - Mobile Depot and cargo bikes
   - Electric Vehicles
2. **Stakeholder Analysis**
   - Authorities (Brussels Capital Region, Ixelles, Municipality)
   - Citizens (Anna, Raoul), Ixelles and Brussels Residents
   - Companies (DPD, Amazon, Coolblue, Parcelforce)
3. **Criteria Assessment (Survey) and Weighting**
   - This step is partially conducted via the online survey and a first workshop. The first workshop in Manzaneda takes place at the end of October 2019, and the first workshop at Eemnes is scheduled at the end of November 2019
   - Each of the criteria will be compared to each other by a pairwise comparison, see Figure 56

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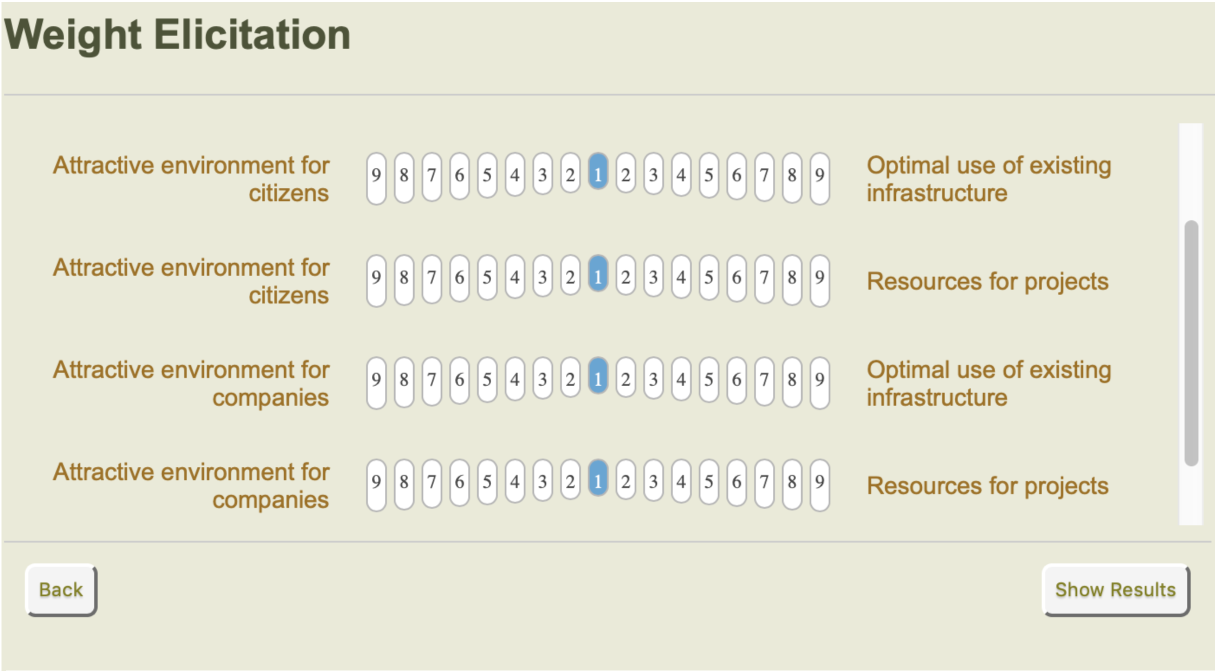

Figure 56: Pairwise Comparison

- In Figure 57 you can see the different attributed weights to the criteria for the stakeholder group authorities “Brussels Capital Region”. In this example, network optimization scores as the most important criteria for this stakeholder

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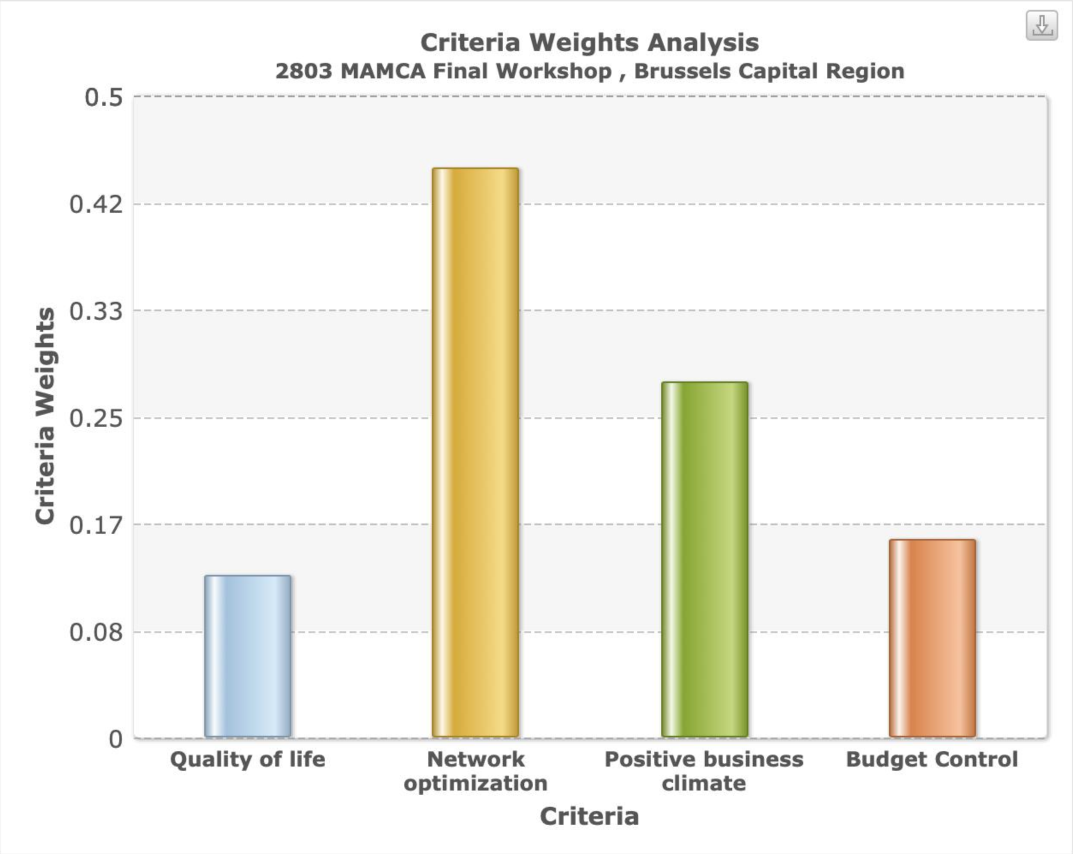

Figure 57: Weighting of Criteria

4. & 5. Indicators and Evaluation
   - Experts are involved for the indicator assessment and KPI measurement

6. One Actor and Multi-Actor View
   - This step will take place at a second workshop on site, these workshops take place before March 2020
   - The scenarios that perform well on the objectives/criteria are now displayable for each stakeholder. In Figure 58, you see the performance of the criteria for each scenario for the Brussels Capital Region

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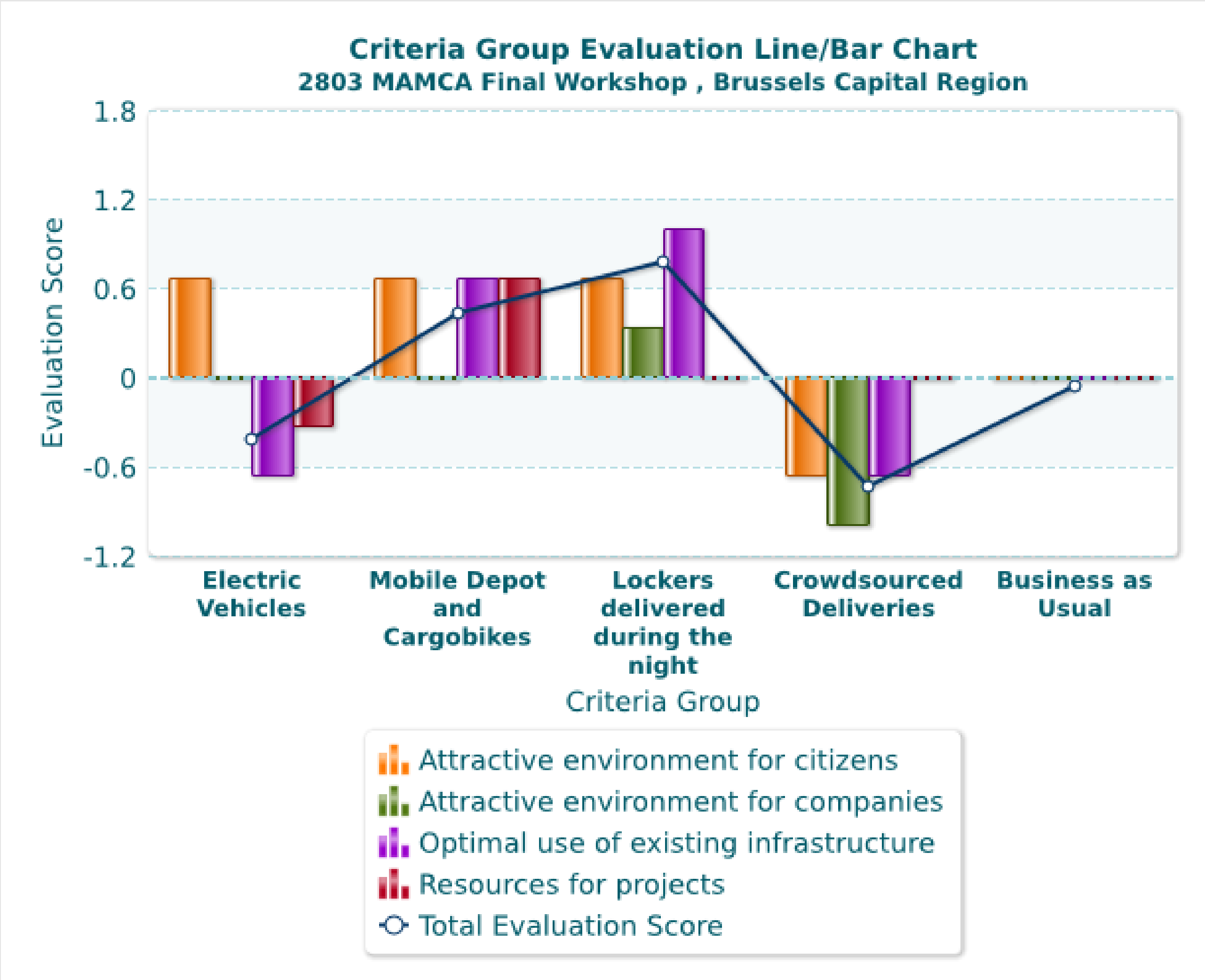

Figure 58: Criteria Performance for one Actor

- In Figure 59, all the stakeholder views are shown. It can be seen that the scenario "lockers during the night" (green) performs well for all actors, except of the Brussels Residents. In such a situation, the workshop creates an open space for discussion and for co-creating a solution that reduces the negative impacts on the affected stakeholder group

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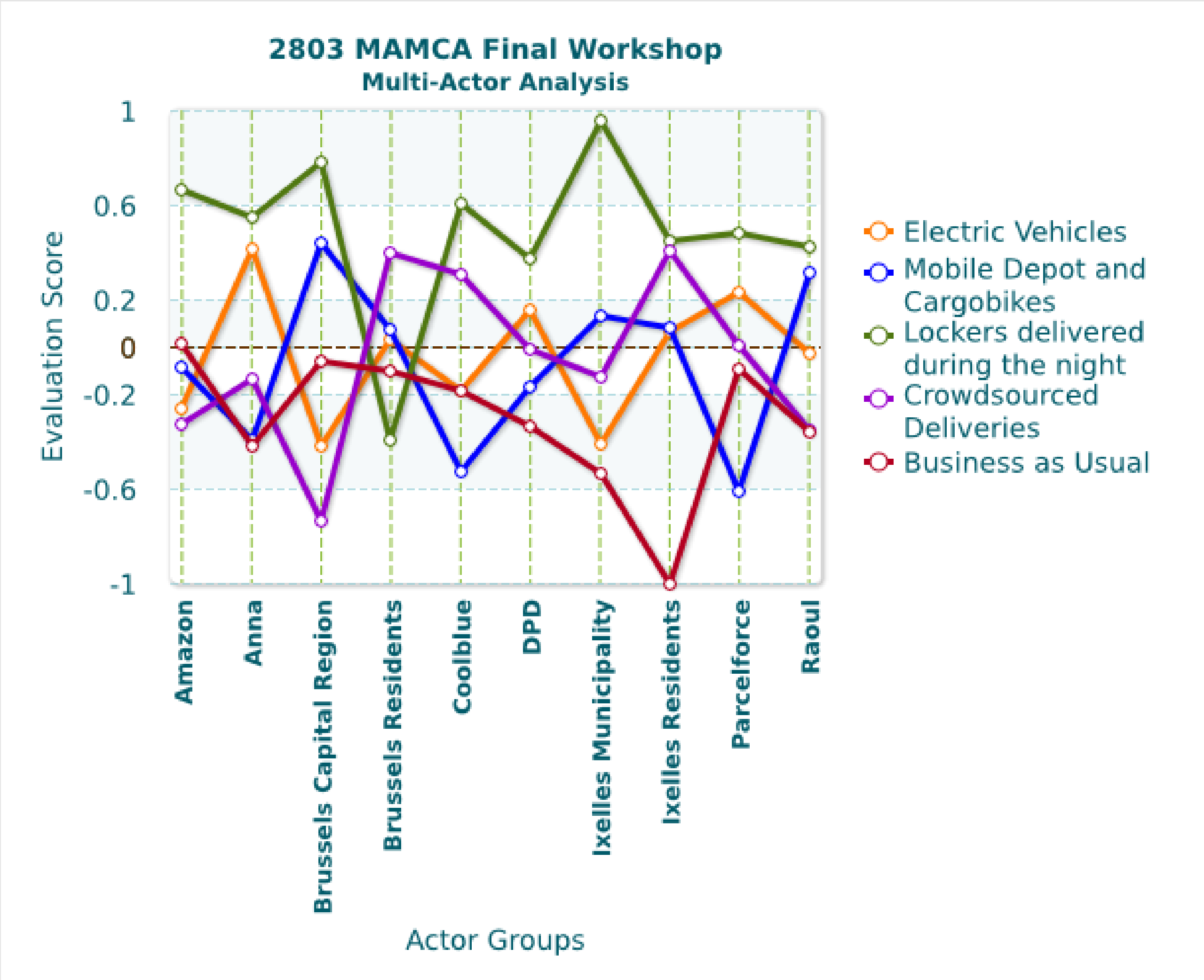

Figure 59: Multi-Actor View

7. Implementation and follow-up

- The ideal scenario or elements of them are implemented
- The same channels can be used to assess and improve the decision over time

Spanish pilot (Manzaneda)

On October 18th, the first MAMCA stakeholder meeting took place in Manzaneda, where a presentation of the RENAISSANCE Project was made including the

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implementations to be done in Manzaneda pilot site and a presentation of the MAMCA tool. Then a workshop for the definition of objectives and its prioritization was held.

Table 14 contains the participants of the workshop:

Assistant	Partner / Stakeholder
Miguel Fontela	Exeleria (Partner & Stakeholder)
Gustavo San Martín	Xunta Galicia (Partner & Stakeholder)
Ignacio Pereira	Dip. Orense (Partner & Stakeholder)
Jon Gonzalez	Meisa (Partner & Stakeholder)
Alberto Rodriguez	Comunidad de propietarios (Stakeholder)
Thierry Cooseman	VUB (Partner)
Maarja Meitern	BaxCo (Partner)

Table 14-Stakeholders at 1st Manzaneda MAMCA workshop

Stakeholders Objectives

Each stakeholder participating in the workshop has selected a list of criteria and given weight to each of them.

The list of criteria for all the partners:

- Innovation
- ECO image
- RREE share
- Operation
- Noise, emissions,etc.
- Social aspects
- ROI
- Replicability
- Commercial validation
- Economic savings

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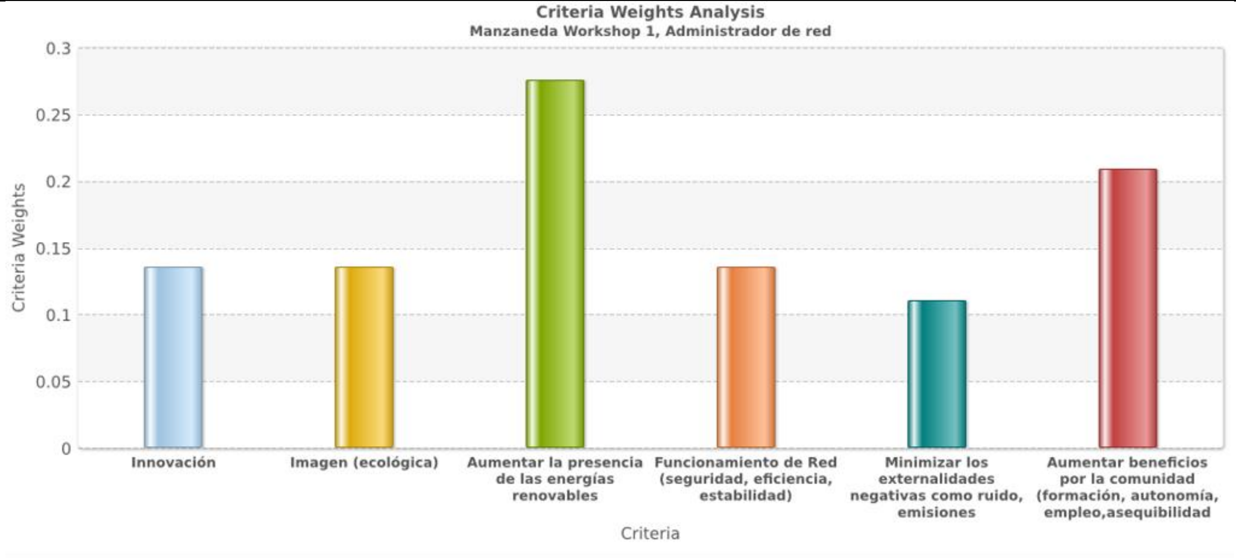
- Sustainability
- Autonomy and self-management

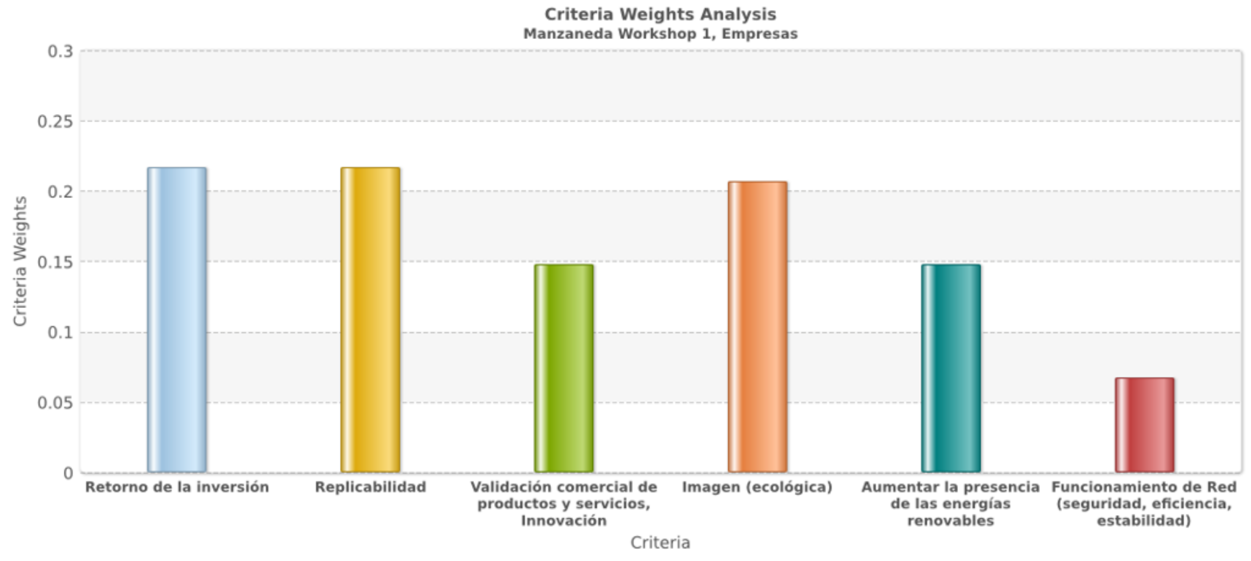
MAMCA tool analysis

As result of the MAMCA tool use (data were sent to VUB systems, they analyse it and sent back the results within 30 min), the following diagrams are shown with the results giving prioritization criteria for each partner:

MEISA



EXELERIA



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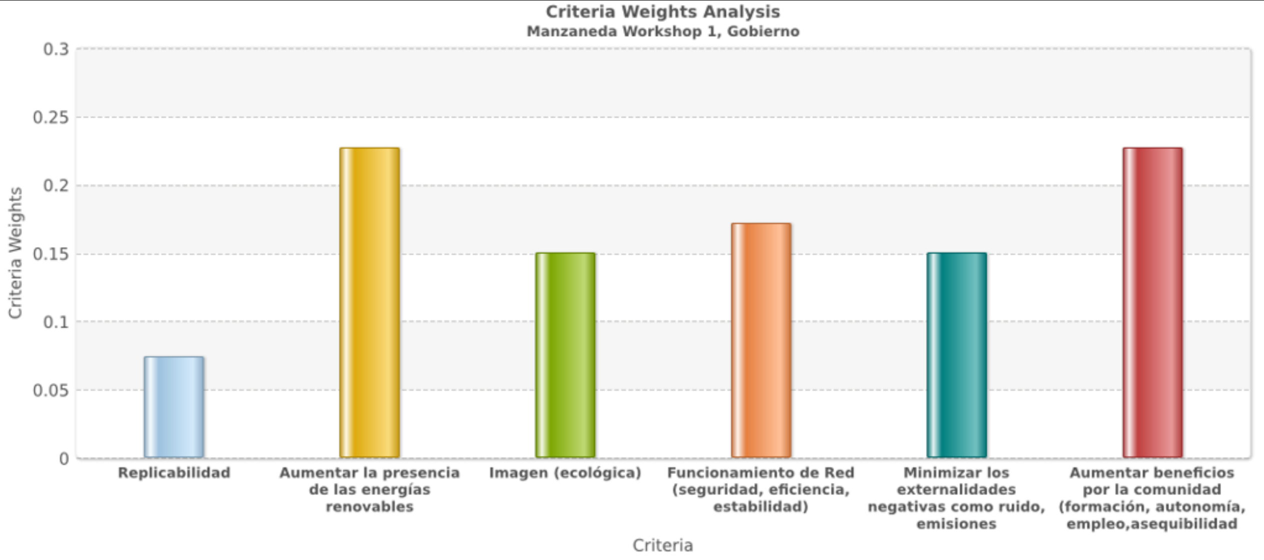
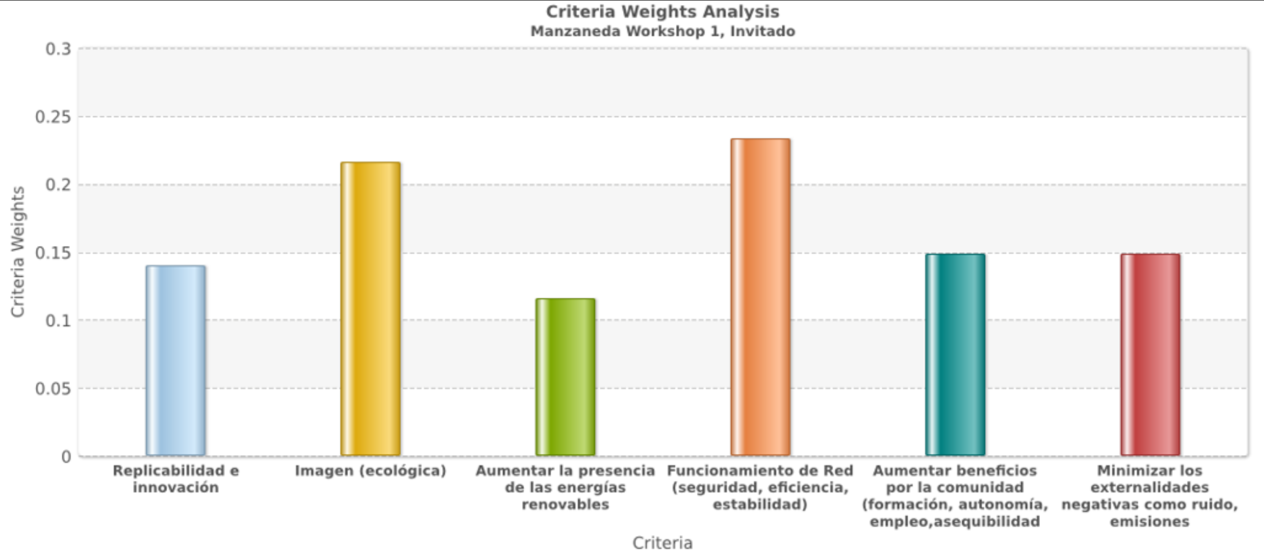
XUNTA DE GALICIA

DIPUTACIÓN DE ORENSE

COMMUNITY OF OWNERS

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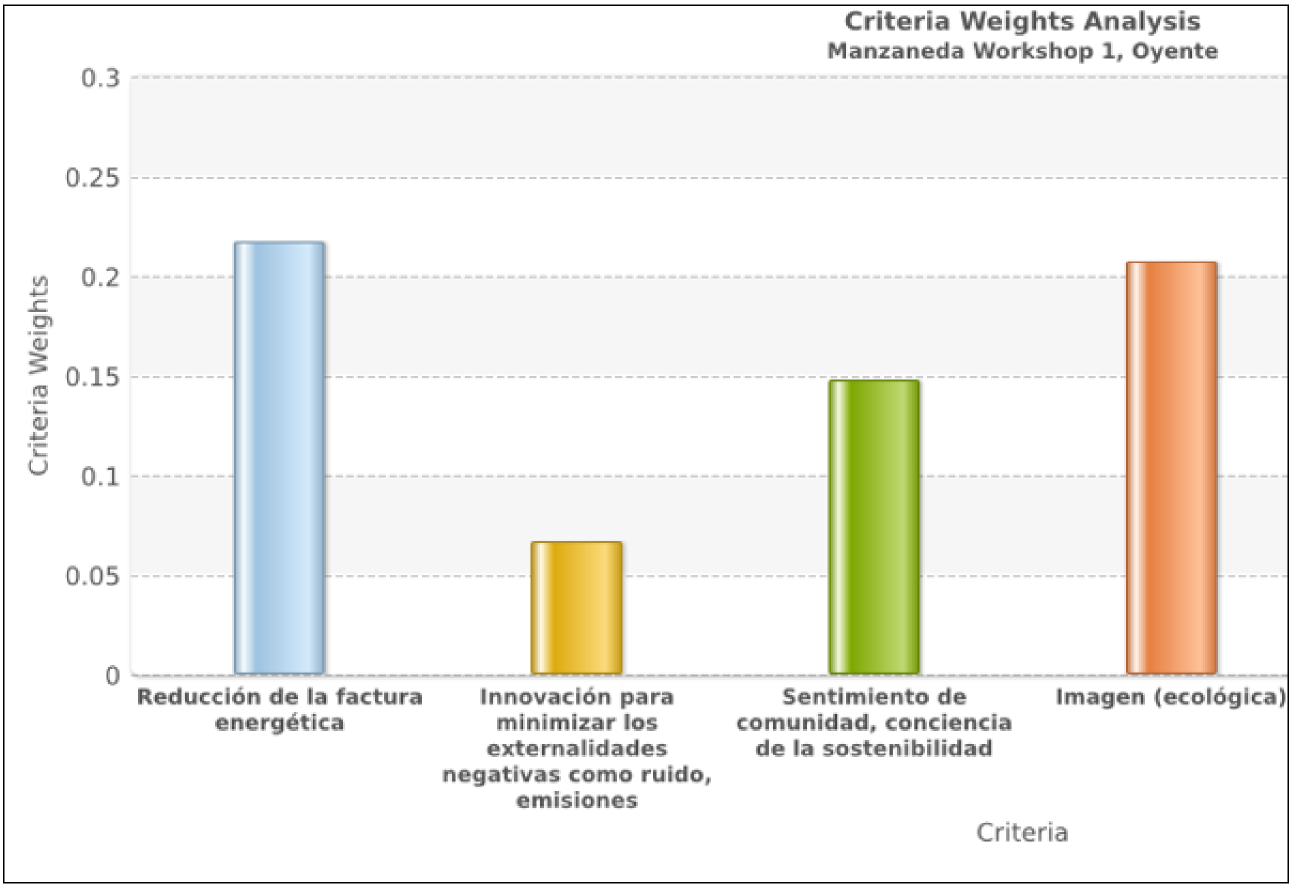

Figure 60: MAMCA Manzaneda´s workshop Criteria Weighting

Selected scenario

Exeleria and VUB will work together to define the scenarios which will cover the different stakeholders most weighted objectives, then another workshop will be held to present the results and discuss the most feasible scenario.

Belgium Pilot (VUB health campus)

Stakeholders Objectives

Objective: Demand/supply balancing under islanded mode in the LV distribution network.

Thanks to the addition of ABB's digital motorized switch, and SDM's control strategy, the dispatchable load control that is currently done at HV distribution level is going to be tested in the LV distribution network. This means that when loads are turned off in order to lower the consumption of the hospital to match the

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available power, instead of turning on and off whole sets of buildings, the same is done at room level.

This represents an increase in the control of the dispatchable power, being able to match the demand and supply with smaller power steps. This increases the dynamic response of the system, increases safety, security of supply and comfort of the users.

Besides the switches will be able to collect information about the current state of the grid, allowing for preventive maintenance and spotting faults in case of occurrence.

Selected scenario

The site will be further extended with 20MWh ice buffer, additionally in 2022 a Borehole Thermal Energy Storage (BTES) of 1.6MWh system will be installed. The microgrid contains about a 1000 smart-meters that are included in a PRIVA Building Management System. These decisions have been taken on beforehand and no access to the details has been granted.

Netherlands pilot (EEMNES)

On November 29th, the first participatory MAMCA workshop took place at Eemnes, the Netherlands. In Table 15-, the participating parties are summarized.

Attendee	Partner / Stakeholder
Thierry Coosemans	VUB (Partner)
Shary Heuninckx	VUB (Parner)
Maarja Meitern	BaxCo (Partner)
Sven Lankreijer	Eemnes Municipality (Partner and Local Authority)
1 representative (name confidential)	DSO (Stakeholder)

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1 representative of I.LECO (name confidential)	Platform Provider (Stakeholder)
Representative of Eemnes Energie (name confidential)	Local Company (Stakeholder)
Two representatives of EnergieVanNu (name confidential)	EnergieVanNu (Stakeholder)

Table 15- Participants first MAMCA workshop (Eemnes)

Stakeholders Objectives

Each participating stakeholder group has communicated their most important objectives regarding LECs before the workshop. A list of the selected objectives for each stakeholder group is provided below.

Local government:

- Economic advantages
- User Participation
- Increase in Renewable Energy Penetration
- Grid Functionality (including security issues)
- Reduction of Emissions

DSO:

- Grid functionality (including security issues)
- Economic benefits for all
- Replication and validation of energy services
- Energy independence
- Increase in Renewable Energy Penetration

Platform Provider:

- Grid functionality (including security issues)
- Economic benefits for all
- Participation of the Community
- Reduction of Fossil Fuels
- Increase in Renewable Energy Penetration

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Local Company:

- Grid functionality (including security issues)
- Economic advantages
- Replication and validation of energy services
- Participation of the Community
- Increase in Renewable Energy Penetration
- Transparency of Pricing

EnergieVanNu:

- Grid functionality (including security issues)
- Economic advantages
- Environmental advantages
- Replication and validation of energy services
- Participation of the Community

MAMCA tool analysis

Based on the described pairwise comparison approach, the weight of the selected objectives was allocated for each stakeholder differently (Figure 61,

Figure 62, Figure 63, Figure 64, Figure 65):

Criteria Name	Criteria Indicator	Weight
Economic Advantages		0.043
User Participation		0.042
Increase of Renewable Energy Penetration		0.380
Grid Functionality (including security issues)		0.135
Reductions of Emissions		0.400

Figure 61: Local Government Criteria Weighting

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Criteria Name	Criteria Indicator	Weight
Grid functionality (energy security)		0.361
Economic profits for everyone		0.166
Replication and Validation of energy services		0.138
Energy Independence		0.086
Increase of Renewable Energy Penetration		0.249

Figure 62: DSO Criteria Weighting

Criteria Name	Criteria Indicator	Weight
Grid functionality (including energy security)		0.093
Economic benefits for all		0.139
Participation of the community		0.059
Reduction of fossil fuels		0.194
Increase of Renewable Energy		0.515

Figure 63: Platform Provider Criteria Weighting

Criteria Name	Criteria Indicator	Weight
Grid functionality (including energy security issues)		0.102
Economic advantages		0.117
Replication and Validation of energy services		0.089
Community Participation		0.281
Increase of Renewable Energy Penetration		0.229
Transparency of Pricing		0.182

Figure 64: Local Company Criteria Weighting

Criteria Name	Criteria Indicator	Weight
Grid functionality (including security issues)		0.056
Economic advantages		0.123
Environmental advantages through the increase of renewable energy and fossil fuel reduction		0.245
Replicability and Validation of Energy Services		0.200
Community Participation		0.375

Figure 65: EnergieVanNu Criteria Weighting

Selected scenario

To obtain information about the general acceptance of the scenarios that shall be implemented at Eemnes. Three generic scenarios were formulated which are based on a selection of key elements provided in Table 16.

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Key Elements	Description
Renewable Resource Penetration	Respective % for renewable energy resource In the energy mix
Size of Community **Number of Participating Members**	Size of the community and percentage (%) of participating members
Energy Trading Mechanism	Peer-2-Peer Community-2-Community Prosumer to the grid Virtual Power Plant (Aggregation of production) Prosumer with storage capacity to the grid Community with storage capacity to the grid
Energy Market Regulation	Day-Ahead, Intra-day (such as in the EU, USA) Other market regulations
Legal Entity	Local Energy Community Cooperative Energy Service Contracting Company
Storage Capacity	Single User Storage (2-6kWh) Community Storage (accumulated storage) Company Storage Electric Vehicle (full electric around 60kWh)
Tariff Structures	Dynamic Pricing Fixed-rate tariffs Variable tariffs

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	Capped tariffs Pre-payment tariffs Time of use- tariffs Fixed-feed-in tariffs Legal Framework: Self-consumption, community self-consumption
Energy Services	Ancillary Services Performance Contracting Maintenance / Engineering Services Asset Provision
Time Horizon	Now, 20 years (PV lifetime), 50 years as a communication tool?

Table 16- Key Elements for Scenario Building (VUB)

The first scenario is the "Business-As-Usual"-model which represents the current state of Eemnes.

Business as Usual – Model:

Currently at Eemnes, prosumers are not trading their energy with each other. The remuneration of energy production is based on the ownership of own PVs that feed surplus energy directly into the grid. Energy production assets are small-scale and are distributed per prosumer. Prosumers and energy end-users have no decision-making power.

Elements selected:

- Prosumer feed energy directly to the grid
- Central supply of energy → End-user focused
- Fixed tariffs for consumers and fixed feed-in-tariffs for prosumers
- No direct energy trading is happening

Energy community model:

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An energy community is characterized with peer-to- peer trading mechanisms that can be joined by everyone. Energy demand and supply is managed through demand-respond mechanisms and different, mostly new energy services are offered to the community but also by the community itself. The community has decision-making power on how the energy should be sold. A battery capacity is available for the community facilitating the increased energy independence from the central grid

Elements used:

- P2P, Dynamic Pricing
- Increase in local technology
- Storage possibility as shared investment
- Community oriented
- Self-organized

Aggregation Model

In this model, prosumers from different localities unite as a prosumer network selling and trading energy similar to the current power utility model. Only prosumers can join this model and economic advantage is created for prosumers.

Elements Used:

- Prosumer Network, aggregation of energy production
- Dynamic pricing

Based on the weighted criteria, the three generic scenarios were performing as following:

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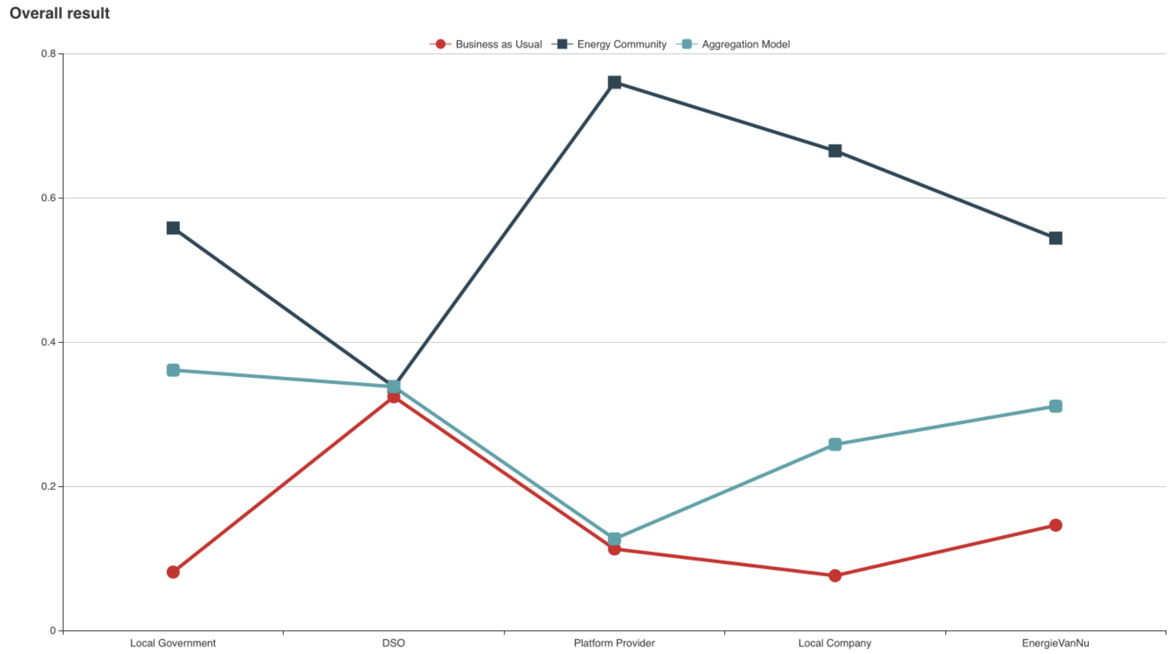

Figure 66: EEMNES Scenario Ranking

The red line represents the "Business-as-Usual" scenario, the dark blue represents the "Energy-Community" scenario and the light blue represent the "Aggregation"-model. On the x-axis the different stakeholders are presented, on the y-axis, the score of the pairwise comparison is shown.[1] The scenario "Energy Community" is performing for all stakeholders better than the "Business-as-Usual" scenario. Only for the DSO, all of the models are performing equally the same. The "Business-as-Usual" model is the least preferred while the "Aggregation" model is perceived as less favorable than the "Energy Community" model.

Greek pilot (Kimmeria Campus)

Stakeholders Objectives

[1] For more information on pairwise comparison and the AHP method used, read: [1]
L. Turcksin, A. Bernardini, and C. Macharis, "A combined AHP-PROMETHEE approach for selecting the most appropriate policy scenario to stimulate a clean vehicle fleet," *Procedia - Soc. Behav. Sci.*, vol. 20, pp. 954–965, Jan. 2011.

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The stakeholders of Kimmeria's PS comprise the students staying at residences and staff of the university, The Democritus University of Thrace, as the owner of the facilities and the Youth and Lifelong Learning Foundation (YLLF), a non-profit, public benefit institution, which is supervised by the Ministry of Education, Research and Religious Affairs, that is responsible for the management of the students' residences. Other stakeholders include the city of Xanthi and a near located industry.

In general, the following objectives apply to Kimmeria's PS:

- Monitor energy consumption patterns
- Optimize energy consumption behavior
- Reduce primary energy consumption and CO_2 emissions
- Promote social innovation in student housing
- Reduce cost of energy

Specific objectives may apply to students, such as improvement of thermal comfort, benefits/rewards (as a non-financial support) for optimized energy consumption behavior. Regarding out of situ stakeholders, city of Xanthi and local industry, specific objectives may include the identification of opportunities for energy efficiency improvement through energy exchange and the encouragement to install RES technologies for increase of local renewable energy generation.

MAMCA tool analysis

To be done during first half of 2020, first workshop planned in January.

Selected scenario

MAMCA tool analysis is expected to be performed within RENAISSANCE project for Kimmeria PS. DUTh and VUB will work together to define the scenarios which will cover the different stakeholders most weighted objectives and through workshop present the results and discuss the most feasible scenario.

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Annex 3: Pilot Sites post project situation

This section aims to give a proper view and technical justification of the different assets, systems and services to be implemented and tested within Renaissance project scope. Some of them are already included in the DoW (new energy assets mainly) while others are being designed and defined in collaboration with another technical WP (WP2, WP3 and WP4).

Section is structured in two subsection per PS:

- **New energy assets**, including production equipment and HW/SW for communications between project data platform and PS.
- **New energy contracts**, including new contracts and smart-contracts.

Spanish pilot (Manzaneda)

New energy assets

Electrical energy

PV systems design:

Two meters installed by Exeleria read the consumptions of points TC1 (Dwellings of Galicia Building) (Figure 67) and TC3 (Restaurant, Pool, workshop & other facilities) (Figure 68) since March 2019.

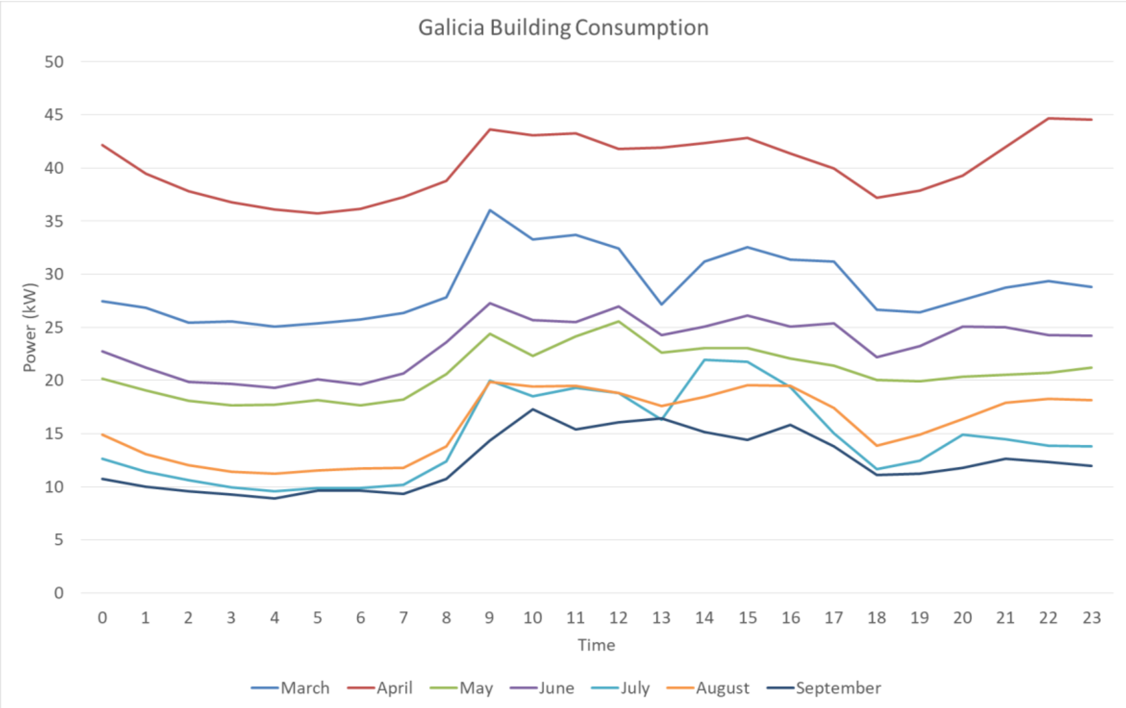

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Figure 67- Galicia Building Hourly Consumption (TC1)

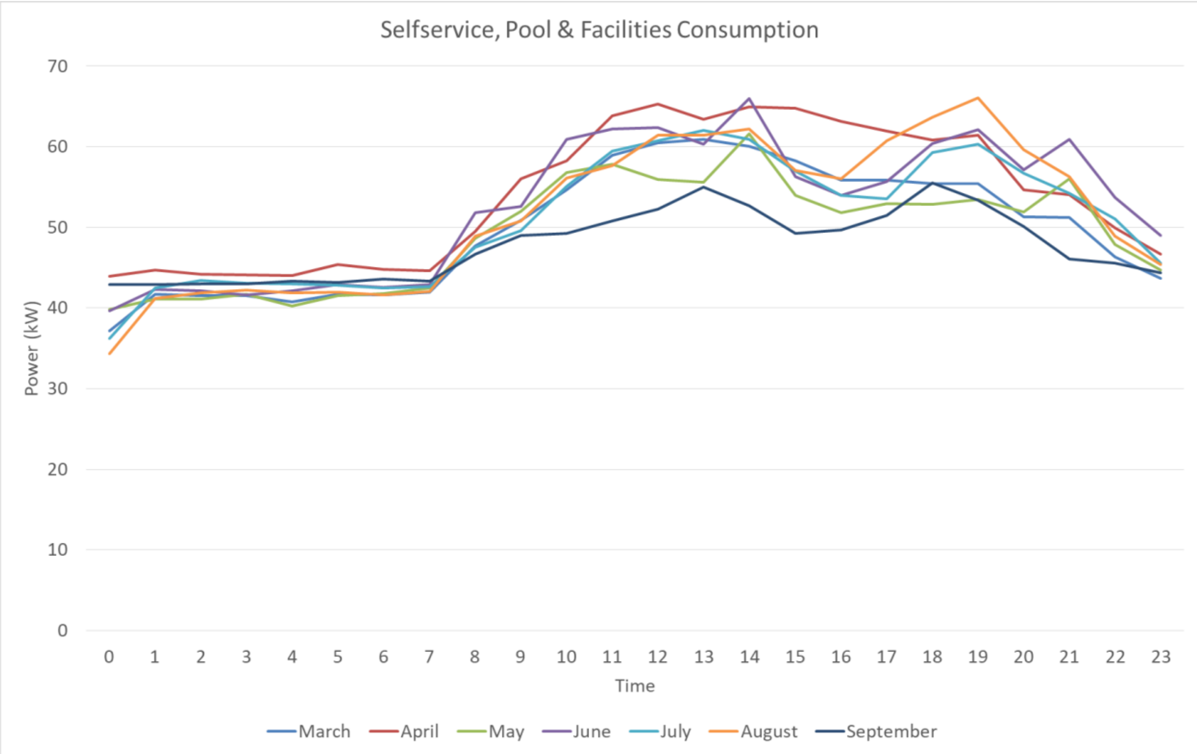

Figure 68- Self-service, Pool & Facilities Hourly Consumption (TC3)

Based on this data, a grid connected PV System with self-consumption has been designed using the PVsyst Software which is a PC software package for the study, sizing and data analysis of complete PV systems (PVsyst main features [15]).

See "**Error! Reference source not found.**" for PVsyst simulation report data.

PV systems design

The LEC PV energy production will be divided in three different installations, two of them for TC3 (Selfservice, Pool & Facilities) of 80+20 kWp and one for TC1 (Galicia Building) of 50 kWp.

- **TC 3 Selfservice, Pool & Facilities**:
  The total power of this installation is 100 kWp, divided in two (80+20). It is expected to have a second life battery, provided by Nissan, in order to test it. The battery pack has a nominal capacity of 20 kWh and a discharge power of 20 kW. This battery pack will be coupled to the 20 kWp PV installation during

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a 3-year period. According to calculations, this installation should self-consume more or less the 87 % of the produced energy; this means that a 29 % of the total consumption will be covered with the PV system. The surplus energy will be sold to the Power Grid signing a contract with an electricity retailer accordingly with the current PV Spanish regulations.

Figure 69 shows the expected average daily production vs average daily consumption. Grey shade profile show shading generated by orography, this is a specific functionality using PVGIS (https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html) data imported to PVsyst which allows to improve calculation reliability.

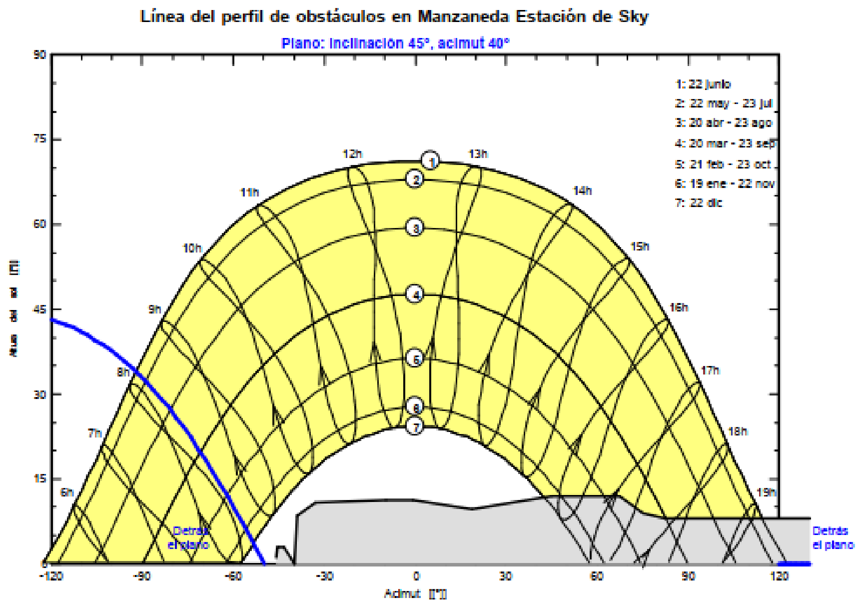

Figure 69- shading calculations (Selfservice, Pool & Facilities)

Following graphs shows monthly production and efficiency:

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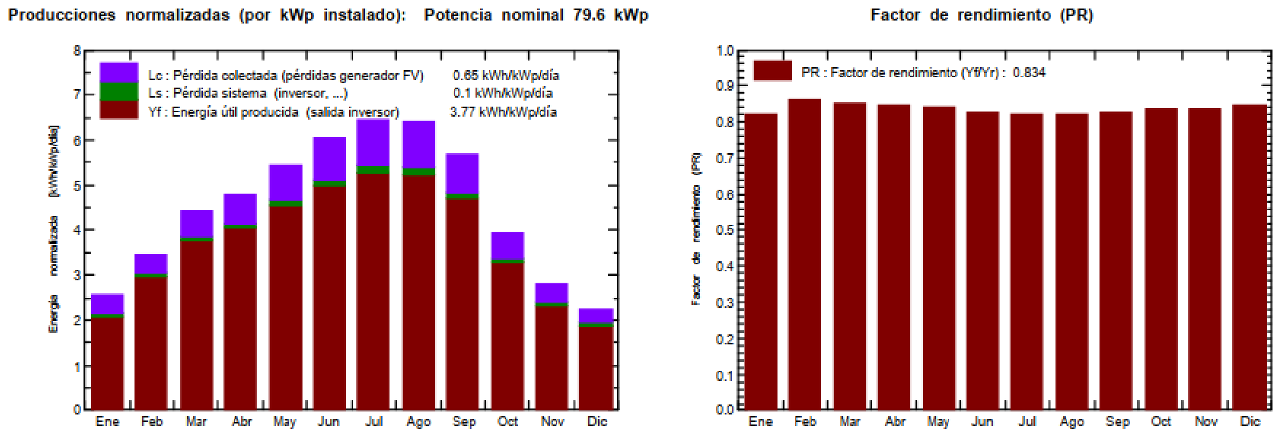

Figure 70- Energy production with losses and performance by month (Selfservice, Pool & Facilities)

Then, taking into account the demand profiles an hourly demand-production calculation was made to assess energy self-consumed and surpluses, a graph for the average consumption-production profiles is shown in Figure 71:

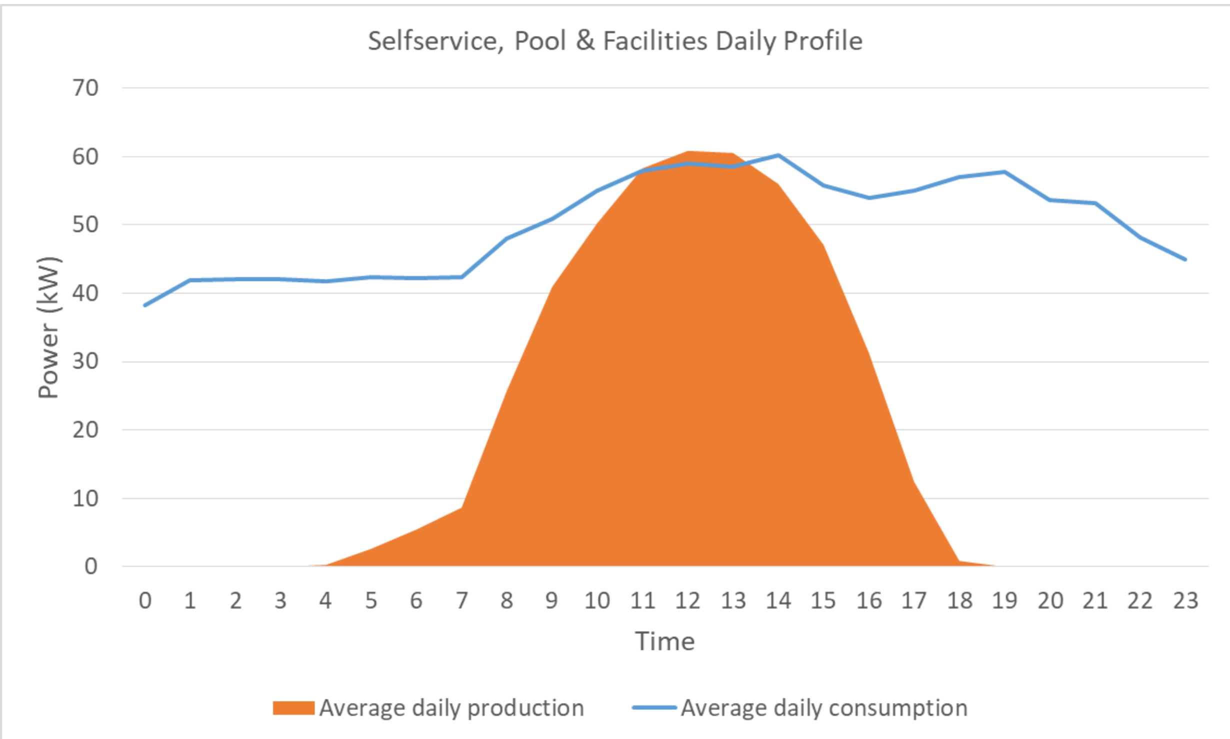

Figure 71- average daily PV production (TC3)

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Physically PV systems will be located in two locations as shown in Figure 72

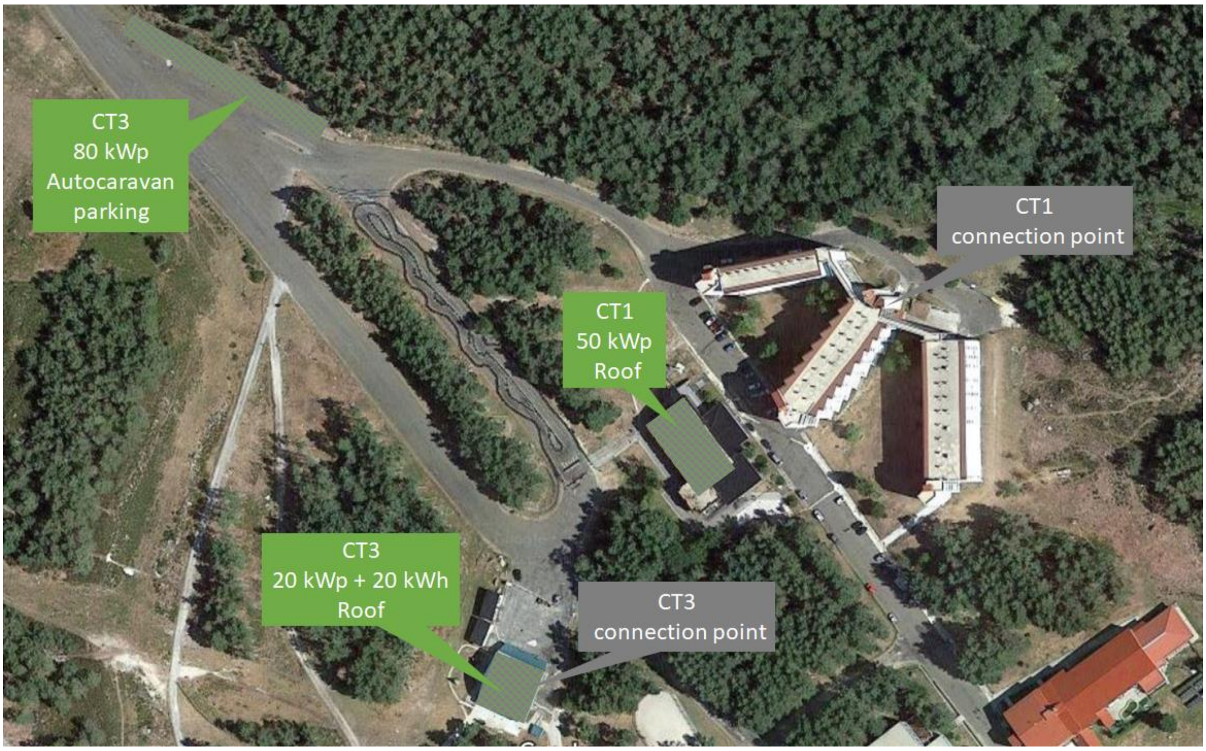

Figure 72- PV systems general layout

Ski village entrance: Taking advantage of the necessity of MEISA to build a campervan parking to enhance summer resort tourism, a metallic parking pergola structure has been built. As a roof PV panels will be installed as presented in Figure 73:

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Figure 73- Parking pergola structure installation

Inverters and electrical security devices will be installed into a shed and charger point to feed campervan will be located at each parking place.

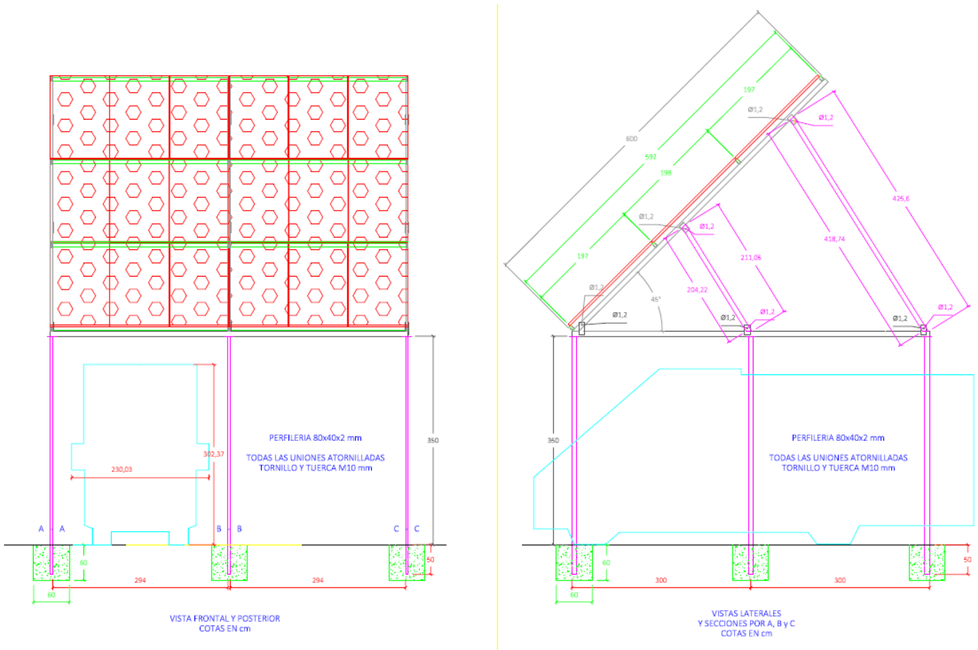

Figure 74- Parking pergola structure design

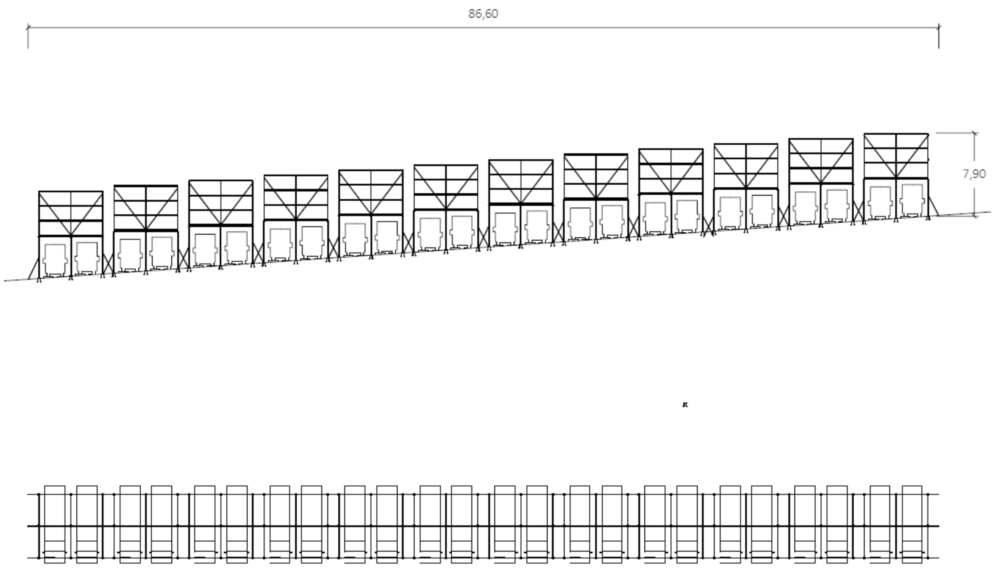

Figure 75- Parking 80 kWp PV layout drawing

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To connect this PV system to the TC3 connection point located at the TC3 building buried cabling is being installed (Figure 76).

Figure 76- CT3 PV wiring in trench

TC3 building (storeroom) roof: The TC3 building roof will be used to install 20 kWp of PV whereas inside the building a 20 kW – 20 kWh battery system will be installed. The TC3 PV + batteries connection point is also located in the site.

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TC 1 Galicia Building:

The total power of this installation is 50 kWp. According to calculations, this installation should self-consume approximately 71 % of the energy produced, this means that a 29 % of the total consumption is covered with the PV system. The surplus energy will be sold to the Power Grid. The following graph shows the expected average daily production vs average daily consumption.

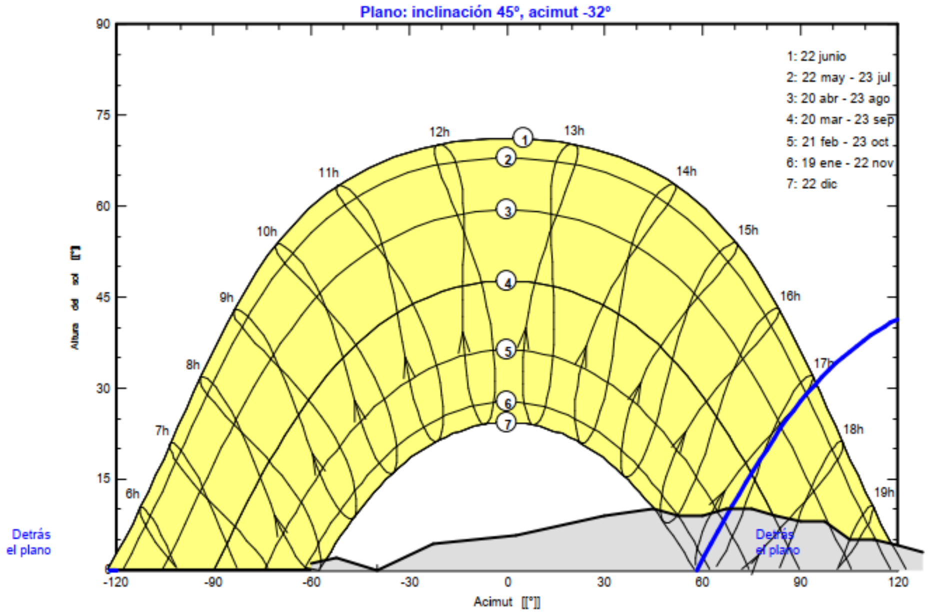

Figure 77- shading calculations (Galicia Building)

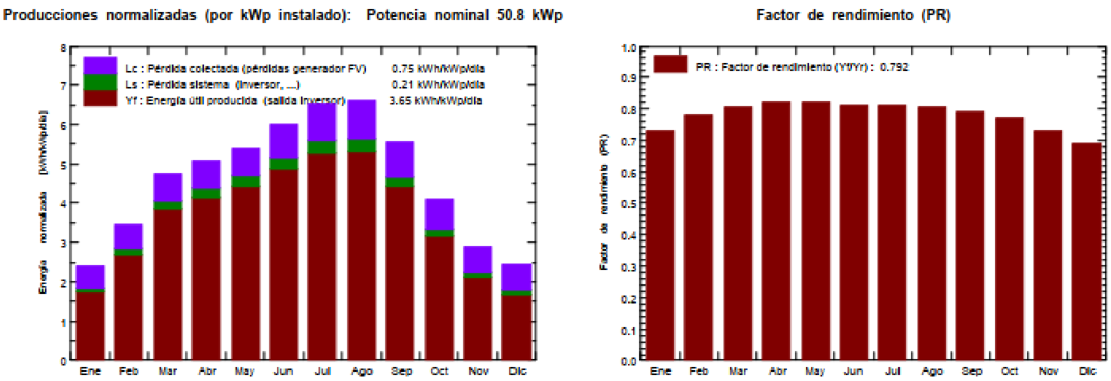

Figure 78- Energy production with losses and performance by month (Galicia Building)

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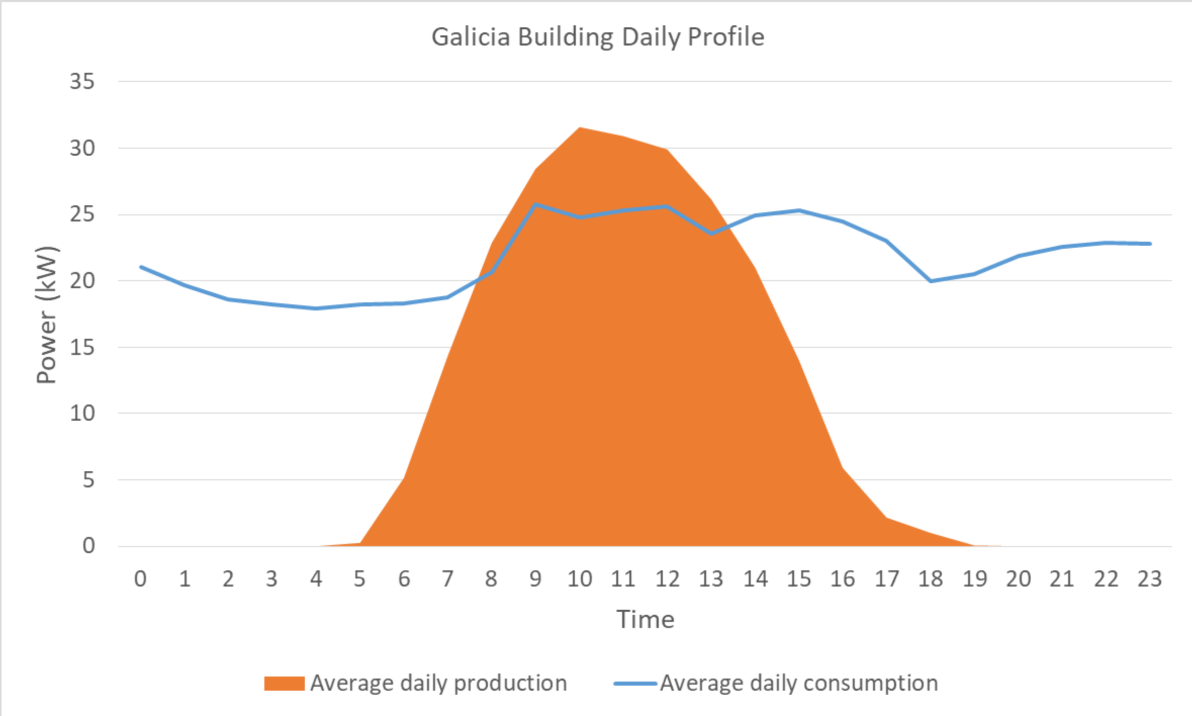

Figure 79- average daily PV production (TC1)

TC3 battery system (second life batteries)

According to the IEA market analysis and forecast from 2018 to 2023 [4], it is expected a growth of the renewable electricity up to 30% by 2023.

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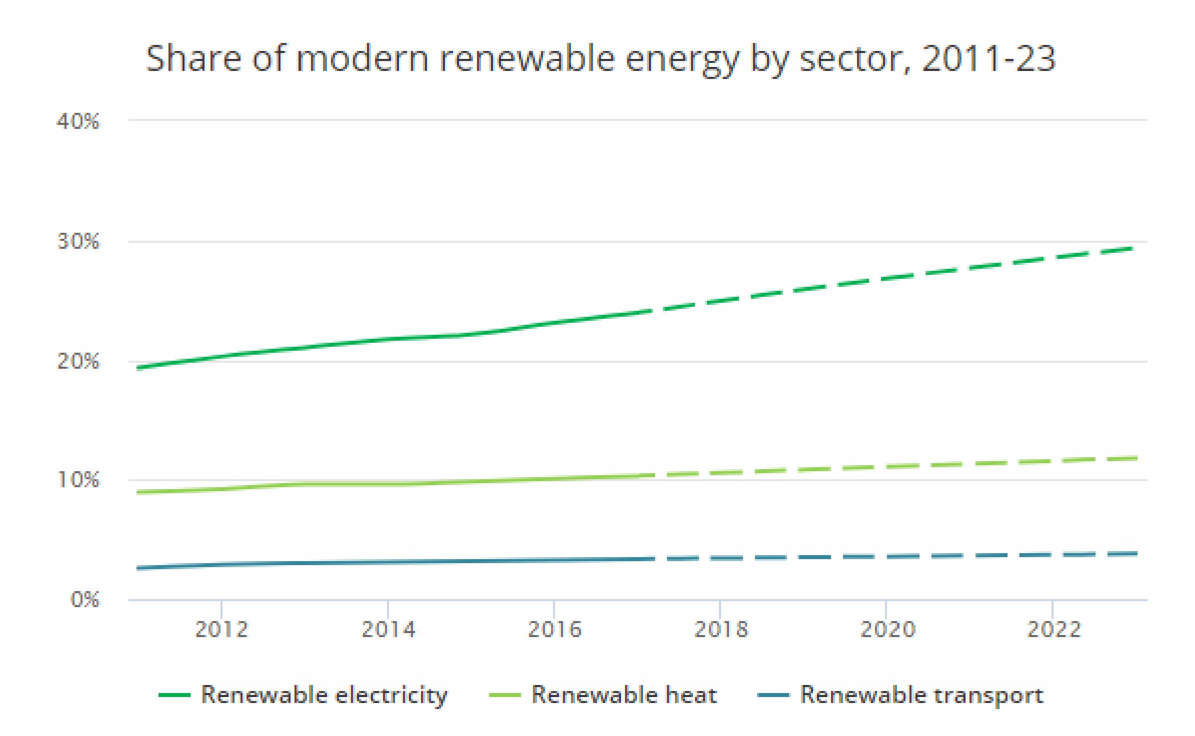

Figure 80- share of modern renewable energy by sector, 2011-23 (source: IEA)

This fact entails some issues in terms of matching electrical power supply to customer demand due to the inability to store electricity in large quantities. Nowadays, it is not a problem, but it is indeed a future challenge, especially taking into account the current trend of growth.

Besides electric vehicles (PHEV + BEV) growth expected rates (see Figure 81) predict a huge second life batteries market. This market will be driven by two factors:

- LCC of SLAB systems which implies to test the performance and lifetime of SLAB systems in real stationary application conditions
- Environmental and circular economy related issues that push governments and costumers to use these systems due to carbon footprint reductions.

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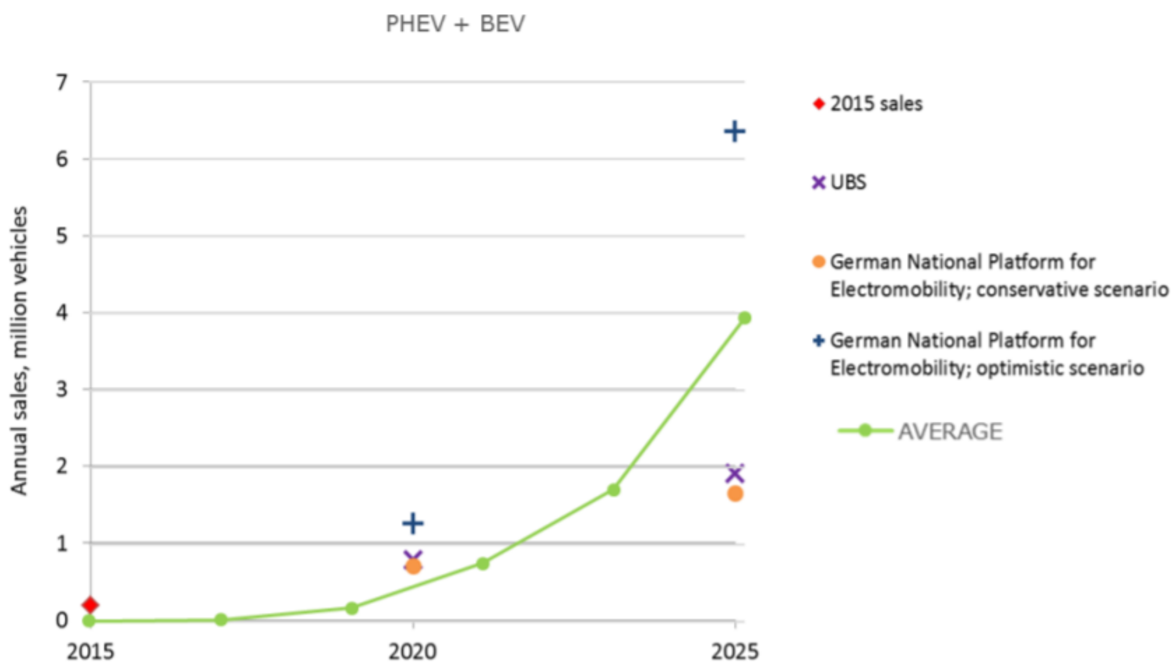

Figure 81- Projected European sales of new PHEV and BEV vehicles for 2015-2025 (source: EU JRC Technical report [16])

Next figure (Figure 82) shows an illustrative scheme of the global lifecycle use of SLAB batteries:

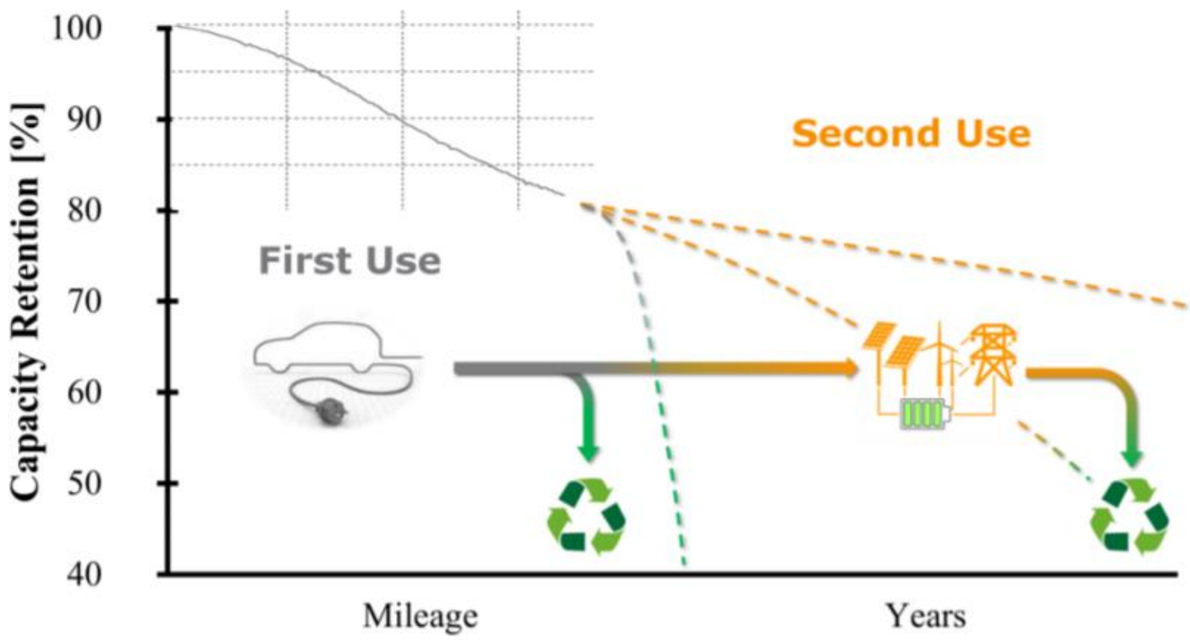

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Figure 82- Capacity retention with First Use mileage and Second Use duration (source: EU JRC Technical report [16])

In Manzaneda Pilot Site a SLAB system will be installed and tested in TC 3 (Selfservice, Pool & Facilities) consumption point. Therefore, different services provided by the SLAB system could be tested (see Figure 83):

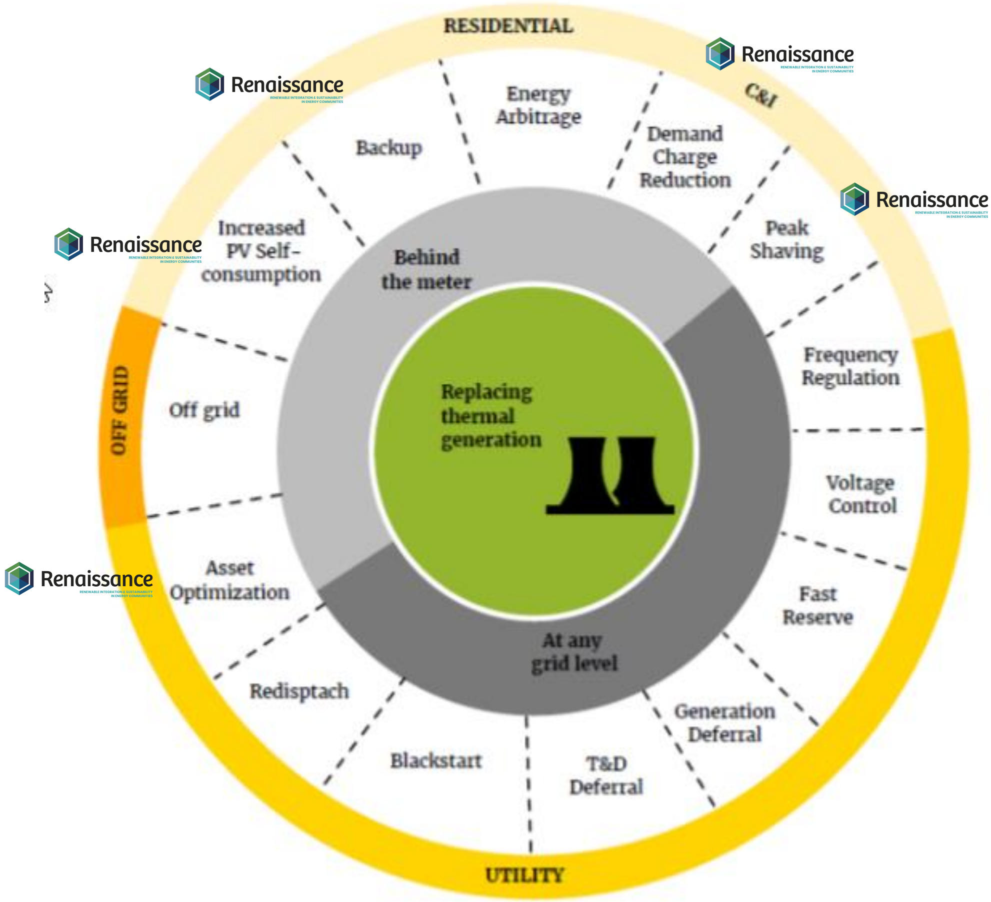

Figure 83- Services batteries can provide to stakeholders at two levels (behind the meter and all levels) (source: EU JRC Technical report [16])

In order to test this kind of batteries, Nissan granted second life batteries to the project for a 3-year term, otherwise it would be difficult to test due to new batterie systems cost (it may double the cost of the whole 20 kW PV System itself based on quotations from providers for 20 kW – 20 Kwh systems). The batteries granted are

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5 Li-Ion battery packs EATON-NISSAN GEN1 2nd life batteries with the following characteristics:

- Nominal DC battery pack capacity: 20 kWh
- Initial usable DC capacity: 17 kWh
- Initial usable DC capacity: 16 kWh
- Expected capacity loss: <4%/year (depending on use)
- Expected lifetime = 5 years
- Each pack includes own BMS (communication through CAN-bus)
- IP30 protection
- Temperature 0-30°C
- Relative humidity 5-95%, non-condensing
- Dimensions (per pack): W440 x D736 x H175 mm
- Weight (per pack): 85 kg

The whole storage system will be composed by:

- Converter 20 kW:
- Bi-directional converter based on Eaton UPS technology (93 PS)
- Rated AC discharging power 20 kW
- Rated AC charging power 10 W
- AC voltage 3x400 V + N + PE
- IP20 protection
- Temperature 0-40°C
- Relative humidity 5-95% (non-condensing)
- Dimensions W335 x D750 x H646 mm
- Weight 101 kg

Storage C&I Battery Rack – 42 U:

- Standard 19", 42U form factor, no front or rear doors, levelling feet
- Mounting rails for battery packs
- Isolation contactors for up to two battery strings

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- Dimensions: W600 x D1040 x H2022 mm
- Weight without battery packs approx. 10 kg

Storage C&I System Controller:

- Controller communicates between BMSs of battery packs and inverter
- Controller provides external customer control over Modbus/TCP with 8 signals

Mode	No.	Signal Name	Logical Direction		Valid Range	Unit	Scaling
			Source	Destination			
Slave (Modbus)	1	System Status	Ext	ESS	0-1000	-	-
Slave (Modbus)	2	Power Request (active Power) (Big-Endian)	Ext	ESS	-1000000...1000000	W	1
Slave (Modbus)	4	Power Request (reactive Power) (Big-Endian)	Ext	ESS	-1000000...1000000	Var	1
Slave (Modbus)	6	Ext Error	Ext	ESS	0=no Error, 1=Error	-	-
Slave (Modbus)	7	General Error Reset	Ext	ESS	trigger on flank	-	-
Slave (Modbus)	8	Alive Counter	Ext	ESS	0-65553	-	-

Register Type	Datatype	Modbus Address	Description
Holding (FC03)	UINT16	0	Command ID# Description 100 GRID-TIE Go / Stay grid-tied. When system is grid-tied you can send power setpoints. 346 AUTONOMOUS Go / Stay to autonomous mode 175 ISLAND Go / Stay to islanding mode 358 STARTUP Startup system 0 OFF Shutdown system.
Holding (FC03)	INT32	1	Power setpoint. By default, positive is discharging and negative charging.
Holding (FC03)	INT32	3	(not implemented)
Holding (FC03)	UINT16	5	Error in external contol unit. Not used for now - you can write what you want into this register.
Holding (FC03)	UINT16	6	Error reset of ESS error. Writing 1 into this register will ack the current "Storage System Error", possibly displaying a new one or eventually the same if same fault condition is still present/occurs again.
Holding (FC03)	UINT16	7	Alive value, upcounting, to check if connection is alive, counting up until 65535 and restarts with 0. If you choose to write something into this register, writing at least twice the same value consecutively will start a timeout. If the timeout expires, the system will be put into idle. Writing another new value will stop and reset it.

Figure 84- storage system modbus control signals (source: NISSAN)

During this period of time, the battery will be operating coupled with the PV System and battery system performance data will be provided to Nissan in return.

Inverter/storage coupling topologies:

Two topologies have been considered for the PV system; AC coupling or DC coupling. Each topology has its advantages over the other.

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- DC-coupled systems have one inverter, which reduces the cost of the installation and equipment. It is, in terms of capital expenditure, more efficient than AC-coupling.

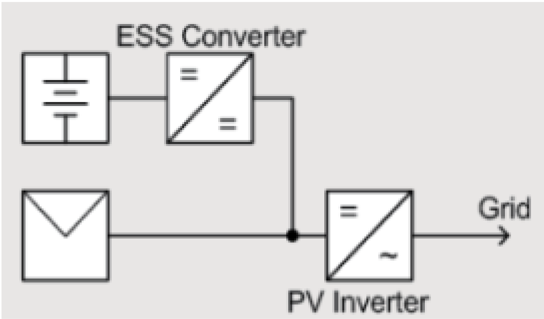


Figure 85- DC-coupling (source: https://www.dynapower.com)

- AC-coupled systems have two inverters and with this configuration, the power to the grid can be maximized by discharging both, the battery and PV at max. power. The main strength is that they can be dispatched independently or together, which is interesting in our installation, due to the temporary availability of the battery.

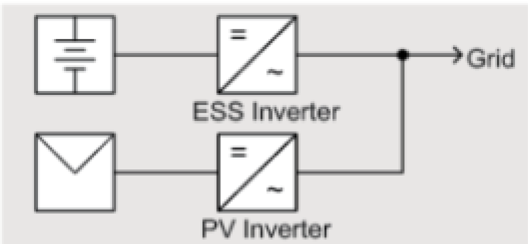


Figure 86- AC-coupling scheme (source: https://www.dynapower.com)

Considering the donation of the battery by Nissan, the chosen solution is AC-coupling, this way it will be possible to remove the battery after the 3-year period, leaving the system unaltered.

The chosen inverters are Huawei SUN2000. Those inverters gather operating information including:

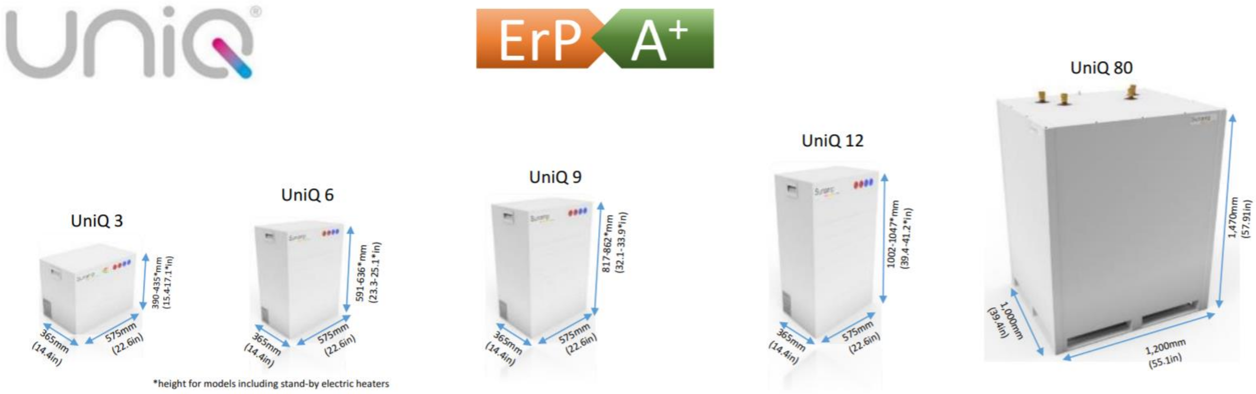
- Daily, monthly, yearly, historical, and total energy yields

- Insulation resistance
- Input data
- Output data
- Internal temperature
- RS485 communications parameters such as the address, protocol, baud rate, and check mode can be set on the monitoring panel.

Thermal energy

Sunamp domestic batteries will be installed in some ski resort workers apartments, so all season use will be granted.

Definition and design of the concrete solutions will be done beginning of 2020.



Model Example	Measured kWh	Equivalent cylinder (L)	Heat Loss (kWh/24h)	Comments	ErP Rating
UniQ HW 3	3.5	71	0.449		A+
UniQ Heat 6	7	140	0.649	Stackable two high	A+
UniQ HW 9	10.5	210	0.738	for larger storage	A+
UniQ Dual 12	14	280	0.809		A+
UniQ Heat 80	90	1800	2.2 (provisional)	Palletised, <1.5 Tonnes	Non ErP

Figure 87-Heat storage PCM batteries (source: SUNAMP)

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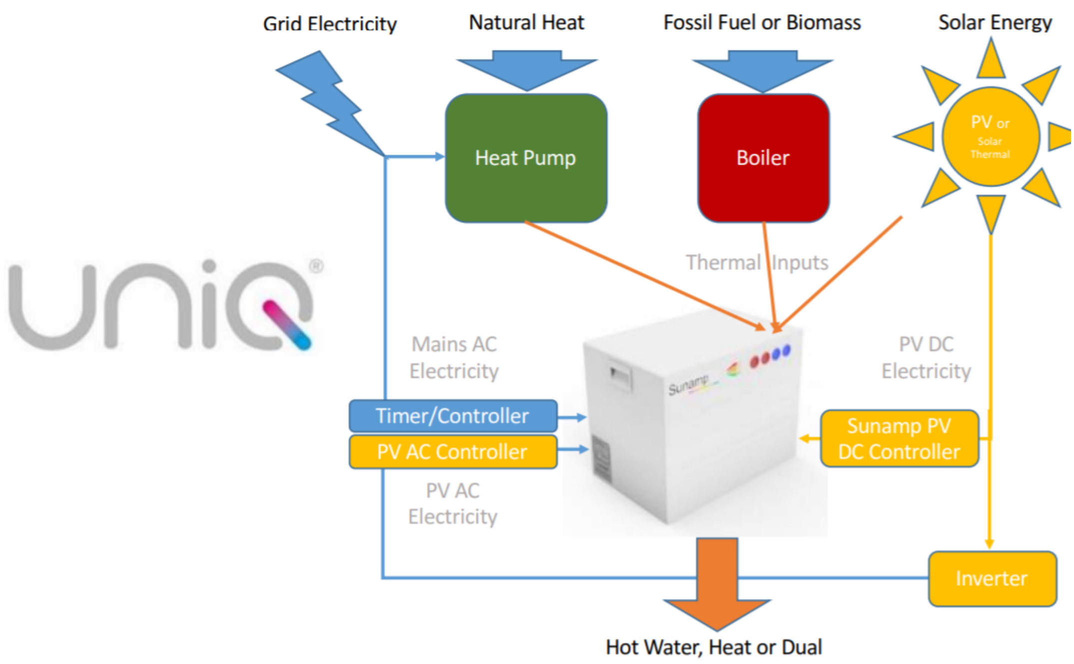

Figure 88-Heat storage PCM batteries energy flows (source: SUNAMP)

Mobility and transport

In order to integrate an important share from a non-dispatchable renewable energy source as solar PV, it has been considered purchasing an EV and study how charge/discharge cycles affect the whole system. The chosen vehicle is a BMW i3.

This is a plug-in vehicle with an underfloor 120 Ah & 42,2 kWh Li-ion battery pack.

A 22 kW wallbox charger has been purchased for charging purposes.

New energy contracts

Electrical energy

Real and virtual contracts (for project demonstration purposes) should be differentiated.

Some new contracts will be signed between MEISA and new service providers such as for the PV self-consumed energy.

Besides that, some virtual contracts (smart-contracts) will be designed and virtually tested in the PS to allow P2P and surpluses energy trading and balancing. This new kind of energy contracts are not allowed by Spanish energy sector regulations so,

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testing and comparing them versus current contracts will allow public regional Manzaneda stakeholders to disseminate the benefits of this new contracts and business models.

A new contract (PPA) will be signed to allow Exeleria to get revenue from the PV production in an ESCO model.

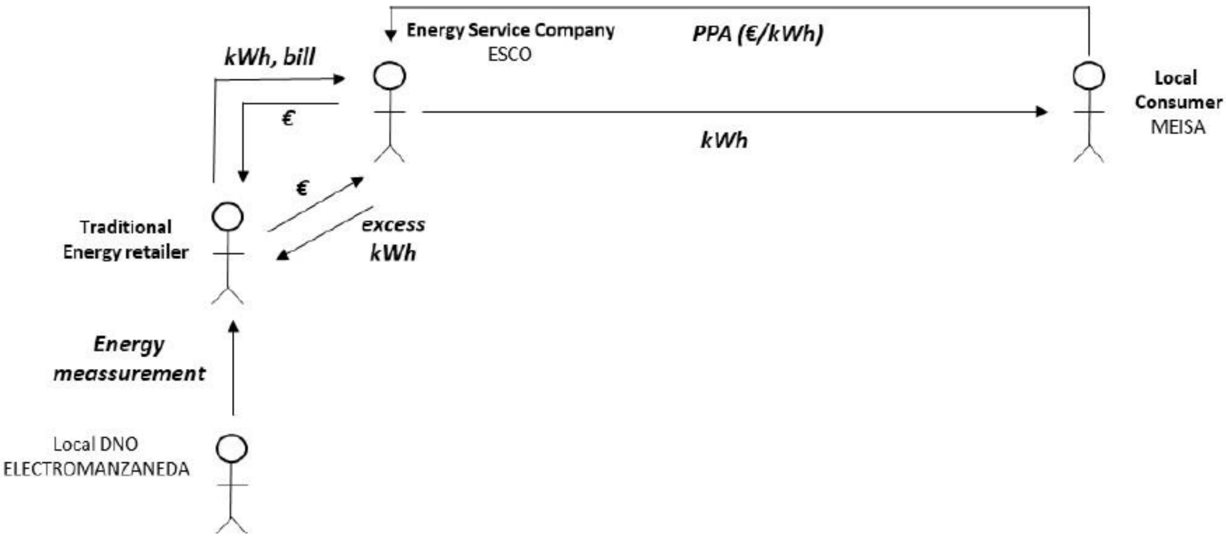

Figure 89- Market as usual agents and energy and economic flows (source: Ikerlan)

For testing and demonstrating purposes, using RENAISSANCE platform and real data coming from the Pilot Site energy assets, a new virtual energy market will be designed and operated. This market (Figure 90) will be based on PV energy surpluses trading which nowadays must be sold to a traditional energy retailer at pool spot market conditions, penalizing profitability of these PV projects.

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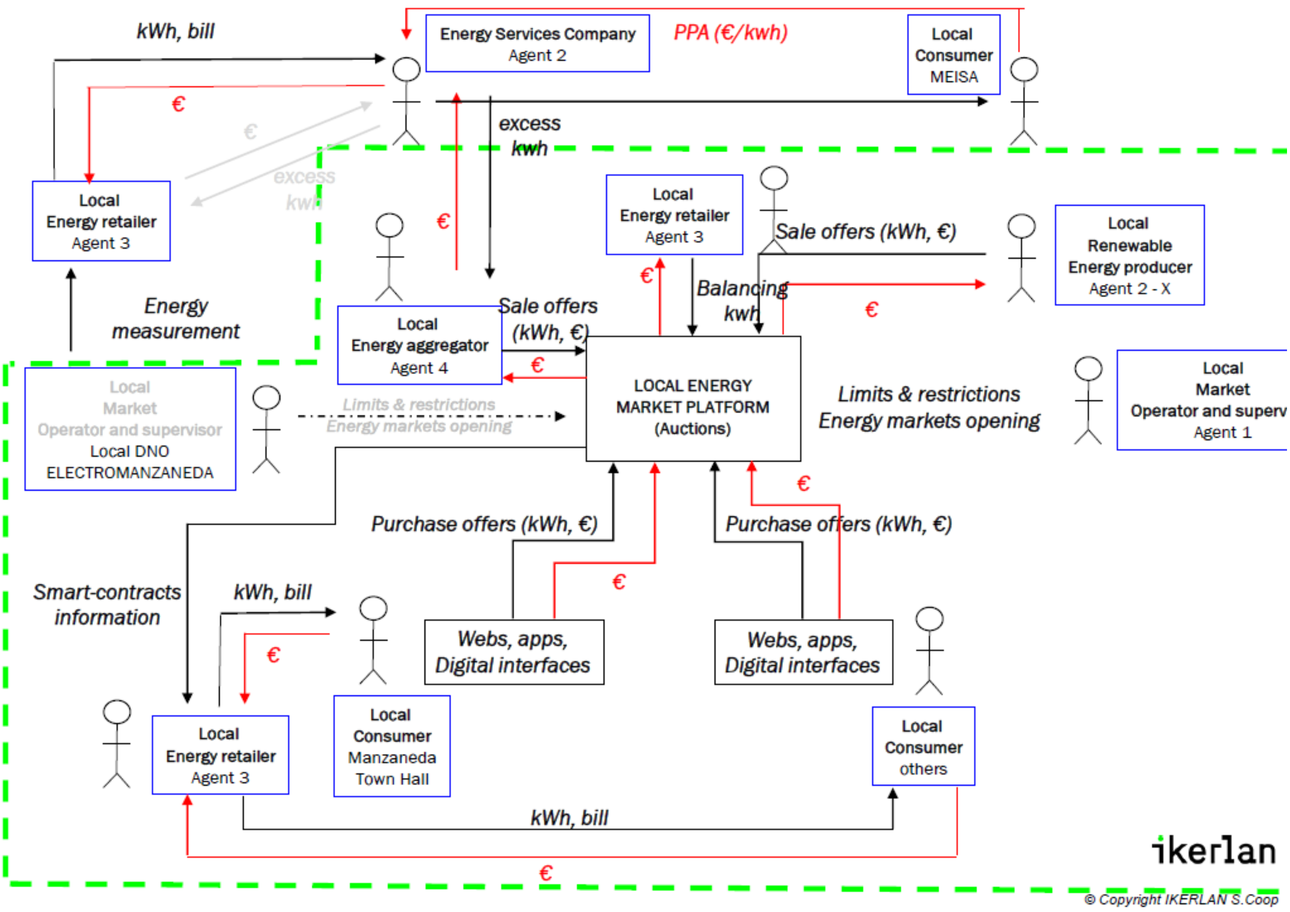

Figure 90- Smartcontract agents, energy and economic flows (source: Ikerlan)

Market will be based on the following roles/agents:

- Agent 1 – Local market Operator and supervisor
- Agent 2 – Energy service company (exeleria): Is the RE producer which will virtually sell energy surpluses in the market
- Agent 3 – Local energy retailer: In charge of real contracts and payment for surpluses under current Spanish legal conditions
- Agent 4 – Local energy aggregator: In charge of compensating energy interchange balances between surpluses and demand forecast and real ones
- Local consumers

Thermal energy

No new contracts are expected to be implemented.

Mobility and transport

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No new contracts are expected to be implemented.

Belgium Pilot (VUB health campus)

New energy assets

Electrical energy

Leap in knowledge for this demonstration site:

Improvement of the building energy management and the microgrid control, optimized energy consumption. Currently the load balancing is mainly carried out by balancing the loads and production at HV level. In such scenario it is possible that certain substations need to be shut down resulting in partial shut-down of subsystems. In order to avoid such situations a smarter management of the consumption at the various departments of the hospital may consistently help in sustaining the balance within the microgrid. For that purpose, intelligent scenario's need to be implemented in the controllers of the energy management of the buildings, prioritizing the most important consumers (e.g. surgery rooms), delaying and adapting/reducing consumption for less important components systems. Several scenario's need to be programmed in order to ensure fast response on various levels of balancing needs.

This methodology will be implemented and tested out in large scale on the site. This methodology/intelligence is an enabler for the deployment of microgrids in a broad sense, it not only increases efficiency of the microgrid but is also an enabler in a more rural area or less complex system. The design of the Brussels Health Campus microgrid for abundant redundancy minimizes the effect of shutting down a substation, however in a simple constellation with a limited number of substations the impact is far more important and implementing this intelligence will mitigate this issue.

VUB will develop and introduce the scenarios in the controllers of the Priva Building Management System in collaboration with SDME.

Inclusion of student rooms in the energy community and improved energy consumption

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100 ABB Smart meters will be installed in the adjacent student houses owned by the VUB, monitoring the electricity consumption of each student room. The students will have access to a data platform developed by Proximus that shows their behavior as and give suggestions for an improved consumption behavior, they will be incentivized through e.g. reduction of house rent. A such customer sensitivity to incentivizing measures is monitored. In addition, the different services of the VUB will be separately billed in order to incentivize their behavior towards a more efficient use pattern, e.g. carrying out energy intensive operations on moments electricity is cheap/abundant. Finally, the UZVUB personnel will be engaged in a crowd funding exercise for purchasing the new photovoltaics in the hospital, as such investigating methodologies for citizen engagement in the capex participation.

Thermal energy

The site will be further extended with 20MWh ice buffer, additionally in 2022 a Borehole Thermal Energy Storage (BTES) of 1.6MWh system will be installed.

New energy contracts

As the hospital is the only actor taking part in the production and consumption of energy in the pilot site, this is out of the scope and there will not be new energy contracts.

Netherlands pilot (EEMNES)

New energy assets

Electrical energy

Currently (October 2019) Eemnes is planning to install a battery system for energy storage. The size of the battery is yet to be known, as negotiations with the provider are still ongoing. This storage facility fits in the municipality's vision to become carbon neutral by 2030, as it will help balance the energy demand and supply even more. With the degasification of the Netherlands, renewables will provide a bigger portion of the energy supply. Aside from the benefits, this will also pose difficulties due to the intermittency of the renewable energy production. Energy storage is needed to reduce the imbalance between demand and supply.

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Another step will be connecting the municipal building and their installed PV. This will strengthen the local energy supply and is also expected to serve as an incentive for the current consumers to install more PV themselves.

Thermal energy

Currently no thermal installation is connected to the smart grid. Plans for a new thermal plant are being discussed. This plant will reach up to 2km deep and will provide heat storage. Multiple reports (TNO, McKinsey, CE Delft [18]) show enormous potential for smart heat storage in the Netherlands. Underground heat storage will provide a long-term, climate-friendly option to reduce gas-fuelled water heating. An underground thermal storage facility fits perfectly in the vision to make Eemnes carbon neutral. However, it is likely that the construction of such facility falls out of the RENAISSANCE project period.

Mobility and transport

The rise of electric vehicles (EV) will pose new challenges for both municipalities (installing the required infrastructure) and energy suppliers (increase in demand due to charging of the EV).

Smart charging however shows potential to not only solve this energy demand problem but can also help balancing the grid demand. This is shown by McKinsey in the Figure 91.

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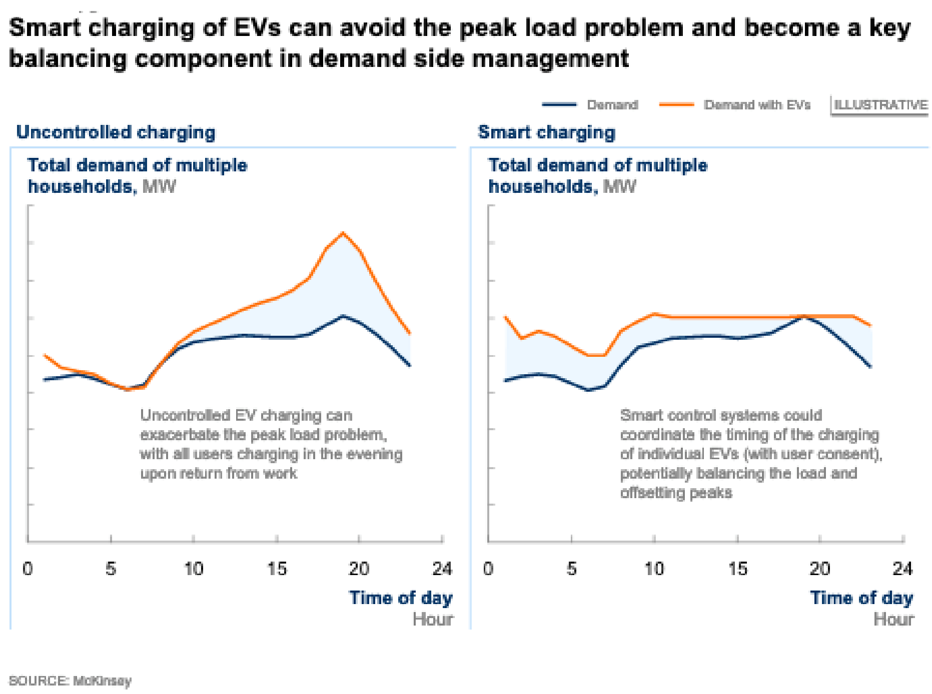

Figure 91- EV smart charging potential (source: McKinsey)

The International Energy Agency and Forbes show in a report (see Figure 92) that the Netherlands is a clear frontrunner in EV charging infrastructure, with over 19 charging points per 100km of paved road. The municipality of Eemnes itself has already installed EV charging points, although they are not yet connected to the smart grid. It is foreseen that this connection will take place in the future, as smart charging will become vital in balancing the local energy demand in Eemnes, however such developments might fall out of the RENAISSANCE project timeframe.

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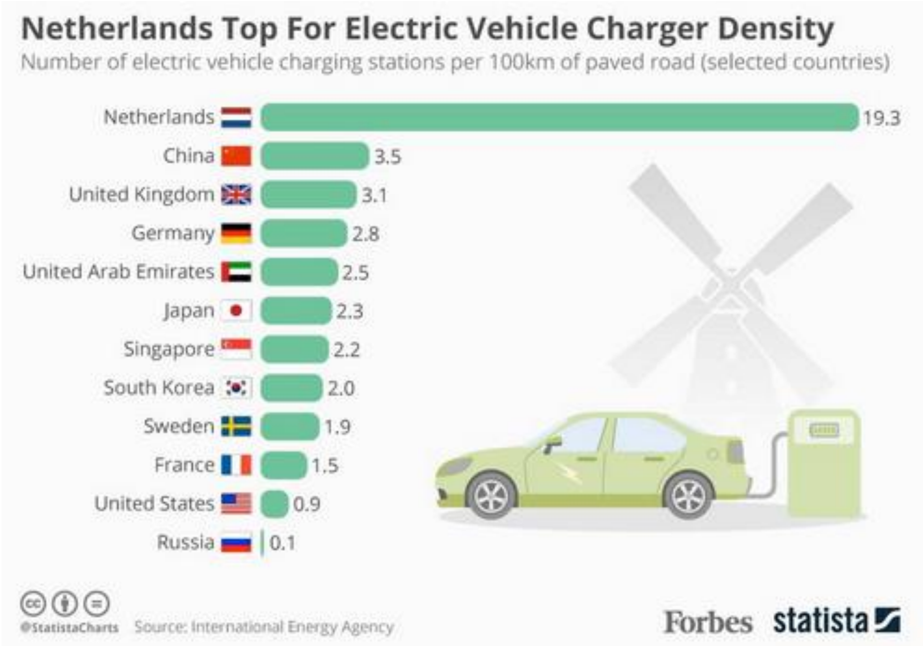

Figure 92- EV charging infrastructure (source: International Energy Agency and Forbes)

New energy contracts

Electrical energy

New types of contracts are necessary due to new smart cooperation and trading systems based on blockchain. For Eemnes, these are developed by i.LECO and Eemne Energie. The structure of these contracts is not yet decided but will be known by summer 2020.

Thermal energy

Out of project scope

Mobility and transport

Out of project scope

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Greek pilot (Kimmeria Campus)

New energy assets

Electrical energy

ORC (Organic Rankine Cycle) turbine:

The ORC turbine is expected to be integrated in the existing electrical system within the first year of RENAISSANCE project. DUTh has studied the integration of the ORC turbine, as shown in Figure 93. The ORC will be connected as an off-grid generator.

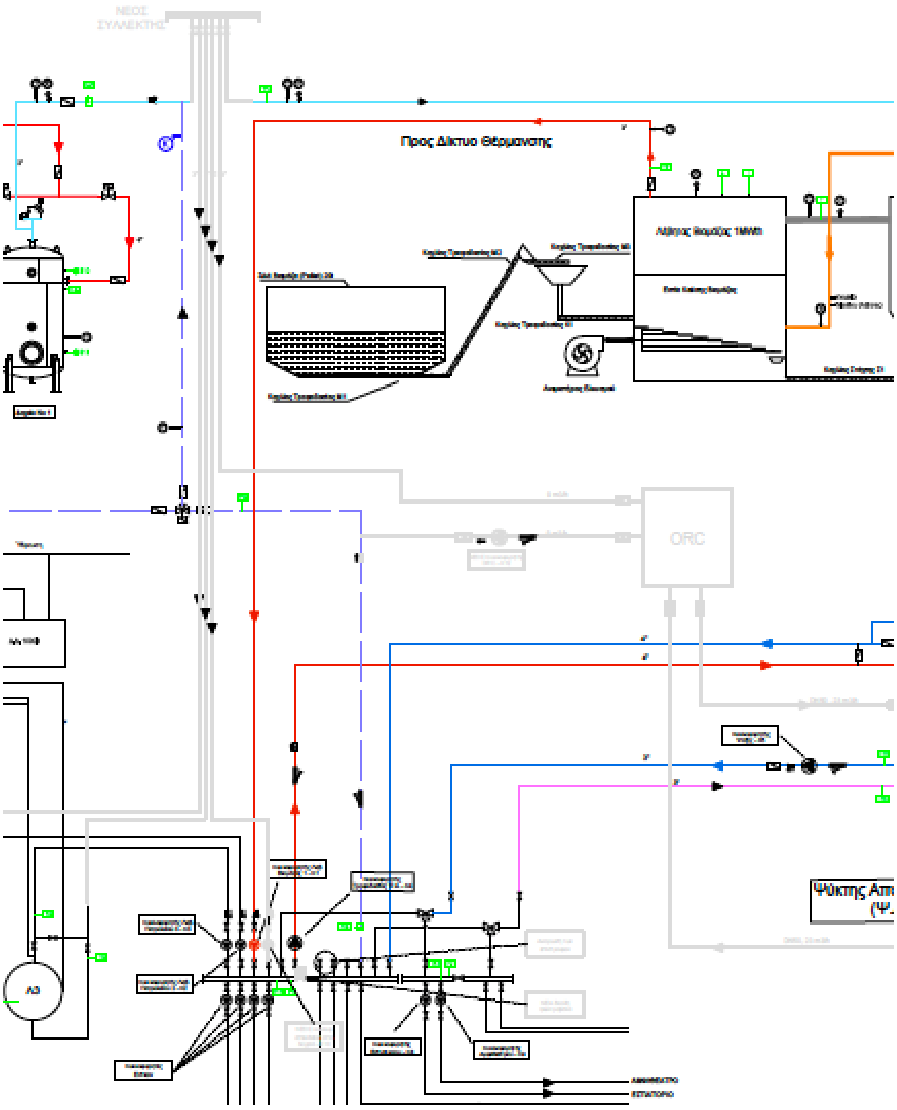

Figure 93- View of the simplified one-line diagram of ORC integration

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Autonomous PV system update:

As mentioned before, the installed autonomous PV system covers only part of the electrical demand of building “G2” of the building complex. The operation results highlight the potential to increase the penetration of electricity generated by the PV system. Therefore, within RENAISSANCE it is expected to increase the electrical loads connected to the autonomous PV system, in order to increase the use of renewable electricity that is locally produced. The PV system is expected to be connected with the new installation of the ORC turbine.

Thermal energy

The thermal energy vector of Kimmeria pilot site is currently supported 100% by renewable energy systems. Nevertheless, the increase of thermal energy storage has been identified by the pilot site operators as an important update of the installed hybrid biomass/solar system. Therefore, within RENAISSANCE project it is expected to proceed with alternations on the hydraulic network of the hybrid system that will increase the storage capacity by 5,000 lt of water. Moreover, a procurement of two hot water tanks of 2,000 lt each, will also support the increase of thermal energy storage.

Additionally, two student’s buildings of the pilot site will be equipped with a new thermal battery, provided by the project partner SUNAMP. The specific type of SUNAMP battery is UniQ heat 80 – SU58 standard and its integration in the existing heating network of the buildings is presented in Figure 94. The SUNAMP battery will be connected in series with the installed hot water tank and provide with domestic hot water of the building as a complementary source. The integration of SUNAMP battery is expected to increase the thermal energy storage capacity and therefore support the increase of solar fraction to the final thermal energy consumption.

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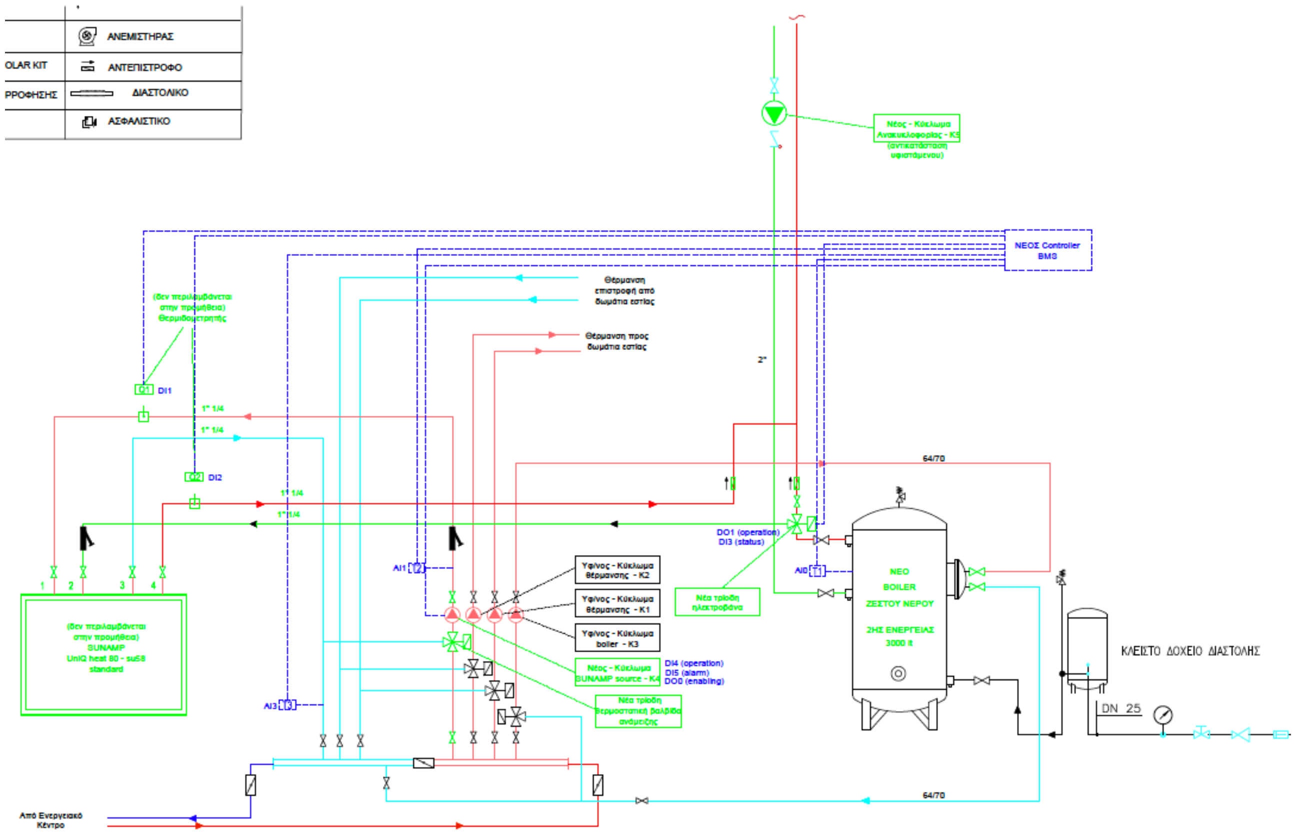

Figure 94-- Simplified one-line diagram for the integration of SUNAMP thermal battery

Mobility and transport

Out of scope.

New energy contracts

Electrical energy

Kimmeria's campus is connected to the national Grid (medium voltage) and has a conventional energy contract with Public Power Corporation (PPC). In addition, the accommodation services, including the energy bills, are provided without charge to the students following socio-economic selection criteria. Therefore, the introduction of new smart contracts which capture the elements needed for shared control of energy units at the student housing facilities of Kimmeria is proposed. The structure of the new smart contracts is not yet decided; however, their objective is to optimize the use of electricity while providing opportunities for trading energy

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among stakeholders. Different smart contracts are expected to be developed for DUTh pilot site including student energy coin (EC) management (Figure 95).

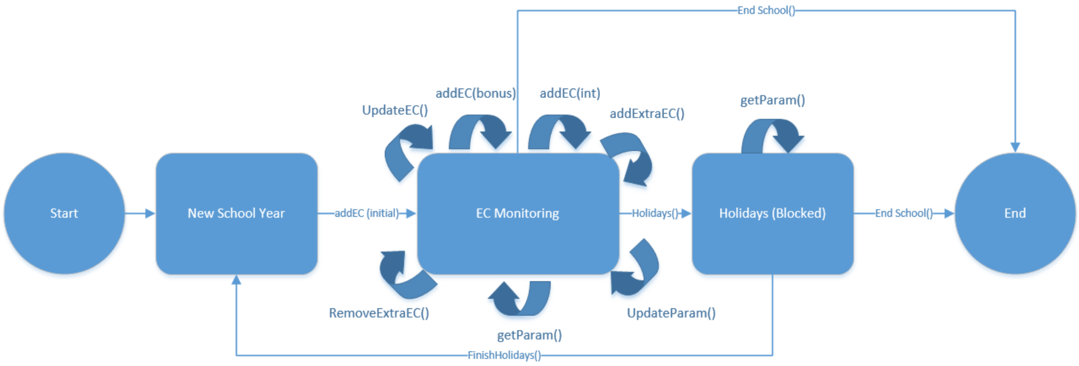

Figure 95-– Student Energy Coins Management Smart Contract state machine

Thermal energy

The thermal energy demand of Kimmeria's campus is covered by a central hybrid biomass/solar system with an extensive distribution network, forming a type of small-scale district heating system. Additionally, the accommodation services, including the energy bills, are provided without charge to the students following socio-economic selection criteria. Therefore, the introduction of new smart contracts which capture the elements needed for shared control of energy units at the student housing facilities of Kimmeria is proposed. The structure of the new smart contracts is not yet decided, however their objective is to optimize the use of thermal energy and particularly the increase of solar fraction, while providing opportunities for trading energy among stakeholders. Different smart contracts are expected to be developed for DUTh pilot site including excess energy trade management (Figure 96).

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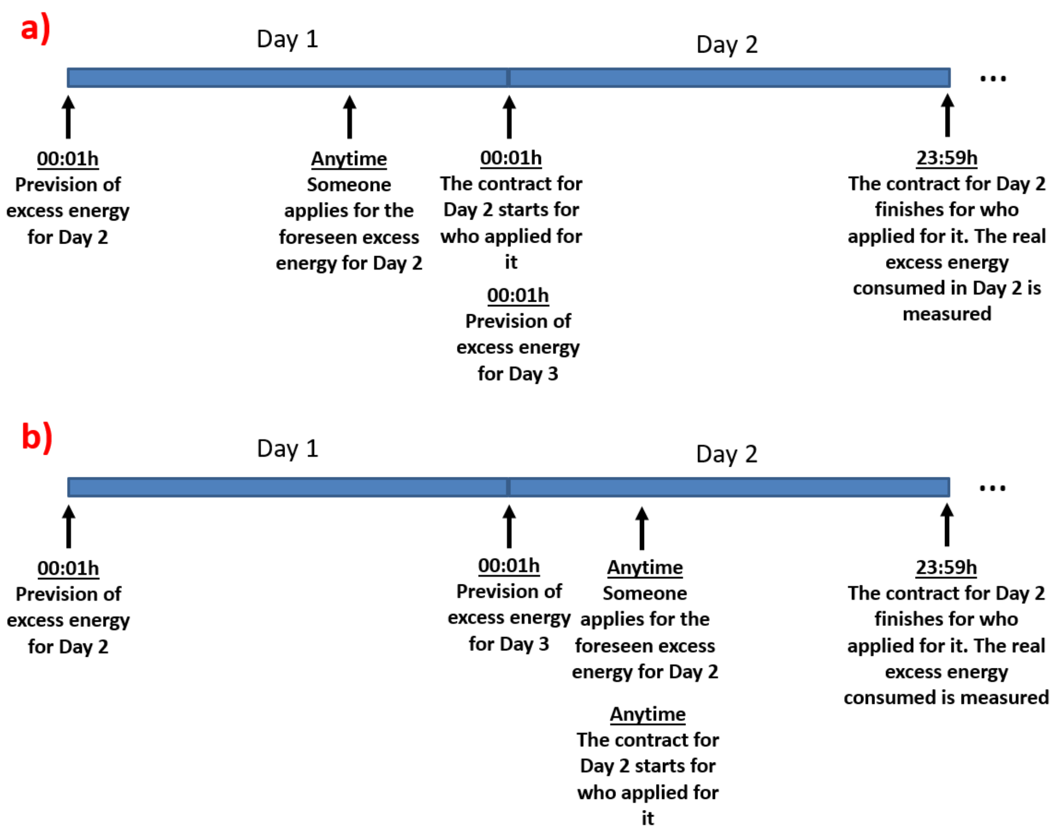

Figure 96-- Excess Energy Trade Definition

Mobility and transport

Out of scope.

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Renaissance
RENEWABLE INTEGRATION & SUSTAINABILITY IN ENERGY COMMUNITIES

Annex 4: Manzaneda PVsyst simulation report

PVSYST V6.73	Everis ingenieria slu (esb85746089) (Spain)	31/05/19	Página 1/5

Sistema Conectado a la Red: Parámetros de la simulación

Proyecto :	Manzaneda FV				
Lugar geográfico	**Manzaneda Estación de Sky**			País	**España**
Ubicación		Latitud	42.27° N	Longitud	-7.28° W
Hora definido como		Hora Legal	Huso hor. UT	Altitud	1483 m
		Albedo	0.20		
Datos climatológicos:	**Manzaneda Estación de Sky**		Síntesis		

Variante de simulación :	5m separacion 2 subgrupos		
		Fecha de simulación	31/05/19 09h32

Parámetros de la simulación	Tipo de sistema	**Sheds, single array**		
2 orientations	tilts/azimuths	45°/-15° y 45°/48°		
Modelos empleados	Transposición	Perez	Difuso	Perez, Meteonorm
Perfil obstáculos	Sin perfil de obstáculos			
Sombras cercanas	Sombreado lineal			

Características generadores FV	**(2 Tipo de generador definido)**				
Módulo FV	Si-mono	Modelo	**JKM 370M-72**		
Original PVsyst database		Fabricante	Jinkosolar		
Sub-generador "Sub-generador #1"		Orientación	#1	Inclinación/Acimut	45°/-15°
Número de módulos FV		En serie	13 módulos	En paralelo	7 cadenas
N° total de módulos FV		N° módulos	91	Pnom unitaria	370 Wp
Potencia global generador		Nominal (STC)	**33.7 kWp**	En cond. funciona.	30.5 kWp (50°C)
Caract. funcionamiento del generador (50°C)		V mpp	475 V	I mpp	64 A
Sub-generador "Sub-generador #2"		Orientación	#2	Inclinación/Acimut	45°/48°
Número de módulos FV		En serie	13 módulos	En paralelo	24 cadenas
N° total de módulos FV		N° módulos	312	Pnom unitaria	370 Wp
Potencia global generador		Nominal (STC)	**115 kWp**	En cond. funciona.	105 kWp (50°C)
Caract. funcionamiento del generador (50°C)		V mpp	475 V	I mpp	220 A
Total	Potencia global generadores	Nominal (STC)	**149 kWp**	Total	403 módulos
		Superficie módulos	**782 m²**	Superf. célula	689 m²

Sub-generador "Sub-generador #1" : Inversor	Modelo	**FreeSun FS0030 LVT**		
Original PVsyst database	Fabricante	Power Electronics		
Características	Tensión Funciona.	450-820 V	Pnom unitaria	30.0 kWac
Banco de inversores	N° de inversores	1 unidades	Potencia total	30 kWac
			Relación Pnom	1.12
Sub-generador "Sub-generador #2" : Inversor	Modelo	**FreeSun FS0035 LVT**		
Original PVsyst database	Fabricante	Power Electronics		
Características	Tensión Funciona.	450-820 V	Pnom unitaria	35.0 kWac
Banco de inversores	N° de inversores	3 unidades	Potencia total	105 kWac
			Relación Pnom	1.10
Total	N° de inversores	4	Potencia total	135 kWac

Factores de pérdida Generador FV				
Factor de pérdidas térmicas	Uc (const)	20.0 W/m²K	Uv (viento)	0.0 W/m²K / m/s
Pérdida Óhmica en el Cableado	Generador#1	124 mOhm	Fracción de Pérdidas	1.5 % en STC
	Generador#2	36 mOhm	Fracción de Pérdidas	1.5 % en STC
	Global		Fracción de Pérdidas	1.5 % en STC
Pérdida Calidad Módulo			Fracción de Pérdidas	-0.8 %
Pérdidas Mismatch Módulos			Fracción de Pérdidas	1.0 % en MPP
Strings Mismatch loss			Fracción de Pérdidas	0.10 %

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Sistema Conectado a la Red: Definición del sombreado cercano

Proyecto : **Manzaneda FV**

Variante de simulación : **5m separacion 2 subgrupos**

Parámetros principales del sistema	Tipo de sistema	**Sheds, single array**		
Sombras cercanas	Sombreado lineal			
Orientación Campos FV	2 orientations	Inclinación/Acimut = 45°/-15° y 45°/48°		
Módulos FV	Modelo	JKM 370M-72	Pnom	370 Wp
Generador FV	N° de módulos	403	Pnom total	**149 kWp**
Inversor	Modelo	FreeSun FS0030 LVT	Pnom	30.0 kW ac
Inversor	Modelo	FreeSun FS0035 LVT	Pnom	35.0 kW ac
Banco de inversores	N° de unidades	4.0	Pnom total	**135 kW ac**
Necesidades de los usuarios	Carga ilimitada (red)			

Perspectiva del campo FV y situación del sombreado cercano

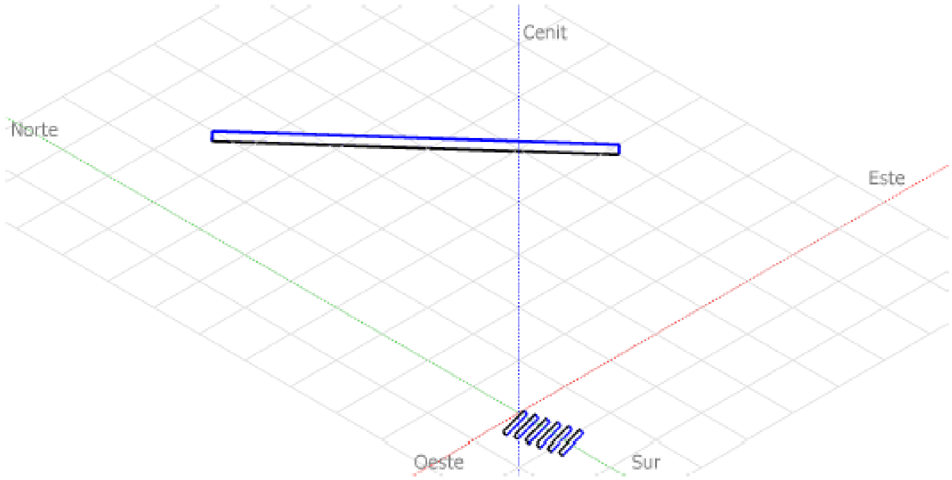
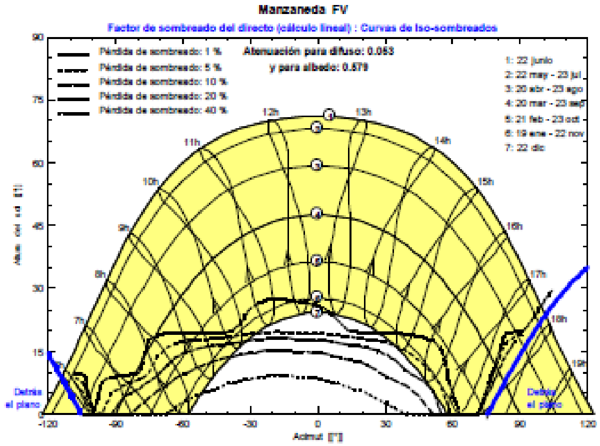


Diagrama de Iso-sombreados



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Sistema Conectado a la Red: Resultados principales

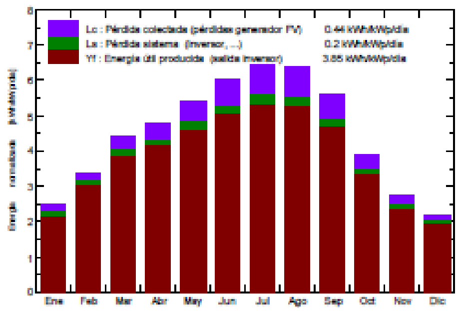
Proyecto : **Manzaneda FV**

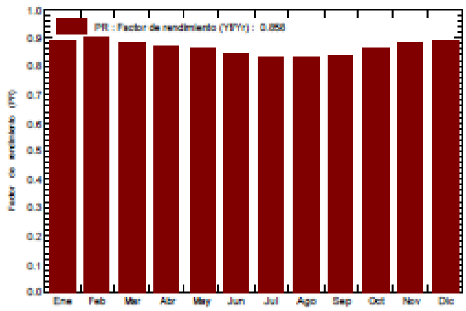
Variante de simulación : **5m separacion 2 subgrupos**

Parámetros principales del sistema	Tipo de sistema	**Sheds, single array**		
Sombras cercanas	Sombreado lineal			
Orientación Campos FV	2 orientations	Inclinación/Acimut = 45°/-15° y 45°/48°		
Módulos FV	Modelo	JKM 370M-72	Pnom	370 Wp
Generador FV	N° de módulos	403	Pnom total	**149 kWp**
Inversor	Modelo	FreeSun FS0030 LVT	Pnom	30.0 kW ac
Inversor	Modelo	FreeSun FS0035 LVT	Pnom	35.0 kW ac
Banco de inversores	N° de unidades	4.0	Pnom total	**135 kW ac**
Necesidades de los usuarios	Carga ilimitada (red)			

Resultados principales de la simulación

Producción del Sistema	**Energía producida**	**209.3 MWh/año**	Produc. específico	1404 kWh/kWp/año
	Factor de rendimiento (PR)	85.76 %		





5m separacion 2 subgrupos

Balances y resultados principales

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
Enero	49.0	26.45	0.90	76.8	73.9	10.80	10.21	0.892
Febrero	69.2	33.89	-1.10	94.8	91.2	13.39	12.72	0.901
Marzo	120.9	58.03	2.60	137.1	132.1	18.92	17.99	0.880
Abril	141.6	65.14	5.20	143.4	138.0	19.65	18.68	0.873
Mayo	180.7	75.91	7.60	167.2	160.6	22.56	21.45	0.861
Junio	205.8	69.97	11.30	180.8	173.8	23.80	22.61	0.839
Julio	221.7	62.06	14.60	199.2	192.0	25.96	24.70	0.831
Agosto	199.6	55.90	14.20	197.9	191.3	25.71	24.48	0.830
Septiembre	144.9	46.37	12.10	168.2	163.0	22.09	21.02	0.838
Octubre	94.9	41.74	8.20	120.8	116.7	16.39	15.57	0.865
Noviembre	55.8	28.46	3.20	82.1	78.8	11.41	10.81	0.884
Diciembre	44.3	23.94	1.80	68.5	65.3	9.57	9.04	0.885
Año	1528.4	587.84	6.77	1636.7	1576.7	220.23	209.29	0.858

Leyendas:	GlobHor	Irradiación global horizontal	GlobEff	Global efectivo, corr. para IAM y sombreados
	DiffHor	Irradiación difusa horizontal	EArray	Energía efectiva en la salida del generador
	T Amb	Temperatura Ambiente	E_Grid	Energía reinyectada en la red
	GlobInc	Global incidente plano receptor	PR	Factor de rendimiento

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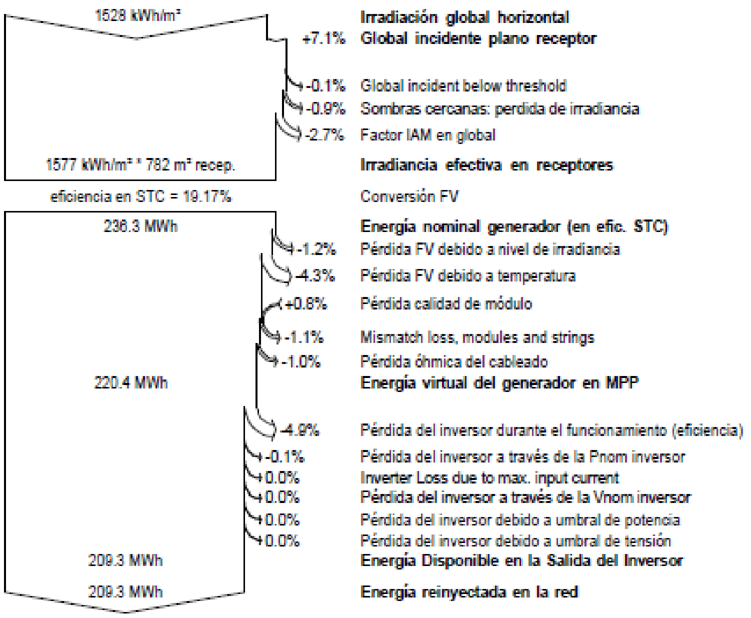
Sistema Conectado a la Red: Diagrama de pérdidas

Proyecto : **Manzaneda FV**

Variante de simulación : **5m separacion 2 subgrupos**

Parámetros principales del sistema	Tipo de sistema	**Sheds, single array**		
Sombras cercanas	Sombreado lineal			
Orientación Campos FV	2 orientations	Inclinación/Acimut = 45°/-15° y 45°/48°		
Módulos FV	Modelo	JKM 370M-72	Pnom	370 Wp
Generador FV	N° de módulos	403	Pnom total	**149 kWp**
Inversor	Modelo	FreeSun FS0030 LVT	Pnom	30.0 kW ac
Inversor	Modelo	FreeSun FS0035 LVT	Pnom	35.0 kW ac
Banco de inversores	N° de unidades	4.0	Pnom total	**135 kW ac**
Necesidades de los usuarios	Carga ilimitada (red)			

Diagrama de pérdida durante todo el año



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Annex 5: TedisNet SystemExport TagStateService - Especificación – Revisión 8

	TedisNet SystemExport TagStateService	21/05/2019
SITEL	Especificación – Revisión 8	Pág. 1 de 10

REVISIÓN	FECHA	CAMBIOS
6	27/02/2019	Primera versión validada
7	02/05/2019	Se añade detalle y origen de calidad a métodos de estados. Se añade nombre de clase, dispositivo y unidades a métodos de información de tags .
8	21/05/2019	Se añade acceso a librería de clases y de enumerados

1. INTRODUCCIÓN

En este documento se describe el servicio web de acceso a estados de tag, para poder leer el estado actual (real) de cualquier señal digital o analógica del sistema.

2. CARACTERÍSTICAS SERVICIO WEB

Tipo de comunicación: Web Service WCF, con uso de mensajería SOAP.

Dirección URL: http://<hostname>/TedisNet.SystemExport.TagStateService

Archivo de definición WSDL: TedisNet.SystemExport.TagStateService.wsdl.

El servicio está pensado para ser llamado de forma periódica. Se estima que el intervalo típico de llamada será de entre 5 y 15 minutos.

Se añade un control de acceso por usuario y contraseña utilizada en todos los métodos del servicio.

3. MÉTODOS WEB SERVICE

Los métodos y parámetros definidos son:

1. bool GetTagCount(string user, string password, out int? minTagId, out int? maxTagId, out int tagCount, out string message)

   Devuelve el total de tags, y los Ids de los tags mínimo y máximo. Nos permite saber sobre qué tags puedo realizar consultas.

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio

   Argumentos de salida:

   - minTagId: identificador mínimo del tag
   - maxTagId: identificador máximo del tag
   - tagCount: número total de tags que tienen estado
   - message: texto del mensaje de error si se produce durante la llamada al método

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- Resultado: verdadero si se devuelven datos. Falso si se produjo error.

2. bool GetTagInformation(string user, string password, int? lastRequestMaxTagId, int maxTagCount, out List<SDTag> tags, out string message)

   Devuelve un listado de tags que contienen información básica sobre los elementos existentes. Permite realizar un inventario de los tags disponibles.

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - lastRequestMaxTagId: identificador a partir del cual buscar tag Id. Se devolverán los tags con valor superior a este Id. Orientado a peticiones sucesivas de todos los tags en varios mensajes. Si se pasa valor nulo, se devuelven a partir del primer tag.
   - maxTagCount: número máximo de tags a obtener en la respuesta desde servicio. Aplicar para partir una consulta en varias, útil si hay muchos tags (número total de los elementos es posible obtener con el método GetTagCount)

   Argumentos de salida:

   - tags – listado de objetos SDTag, que contiene información básica sobre el tag.
     - SDTag:
       - Id: identificador de tag
       - Name: nombre completo de tag
       - ElementId: identificador de elemento asociado. Es posible obtener el listado completo de ids usando web service de elementos. Puede ser nulo.
       - ElementName: nombre completo del elemento asociado. Puede ser nulo.
       - TagValueTypeId: identificador de tipo. Indicará que campo de valor he de consultar en SDTagState. Valores posibles son:
         - 1: booleano (leer ValueBool)
         - 2: flotante doble (leer ValueFloat)
         - 11: int 32 bits con signo (leer ValueInt)
         - 12: string (leer ValueStr)
         - Otro valor: enumerado (leer ValueInt)
       - TagClassName: nombre de la clase de tag.
       - Units: unidades de la medida (opcional)
       - DeviceName: nombre del dispositivo que contiene el tag
   - message: texto del mensaje de error si se produce durante la llamada al método
   - Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

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3. bool GetTagStatesByTagId(string user, string password, int? lastRequestMaxTagId, int maxTagCount, out List<SDTagState> tagStates, out string message)

   Devuelve un listado de estados de tags, a partir de un tag id, con un máximo de valores devueltos.

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - lastRequestMaxTagId: identificador de tag (TagId) a partir del cual se buscan tags. Se devolverán los tags con valor superior a este Id. Orientado a peticiones sucesivas de todos los tags en varios mensajes. Si se pasa valor nulo, se devuelven a partir del primer tag.
   - maxTagCount: número máximo tags a obtener en la respuesta.

   Argumentos de salida:

   - tagStates: lista de objetos SDTagState, que contiene información sobre estados actuales de cada tag:
     - SDTagState:
       - TagId: identificador de tag
       - ValueInt: estado del elemento en formato de un entero 32 bits con signo, posibles valores:
         - 0: Estado desconocido
         - 1: Estado abierto / off / desconectado
         - 2: Estado cerrado / on / conectado
         - 3: Estado desconocido
       - ValueStr: valor cadena. Este campo también tendrá valor para los demás tipos.
       - ValueBool: valor booleano
       - ValueFloat: valor flotante (precisión doble, 64 bits).
       - QualityId: calidad del estado en formato digital:
         - (Nulo): desconocido
         - 1: OK / Buena
         - 2: Mala
         - 3: Desconocida
         - 4: Mantenida
       - QualityDetailId: detalle de calidad del estado, en formato:
         - Nnulo): No detallado
         - 1 No conectado
         - 2 Error configuración
         - 3 Fallo dispositivo
         - 4 Fallo sensor

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- 5 Fallo comunicaciones
- 6 Último conocido
- 7 Fuera de servicio
- 8 En espera valores iniciales
- 9 Último utilizable
- 10 Sensor calibrando
- 11 Excedido
- 12 Insuficiente
- 13 Local
- 14 Copiado
- 15 Iniciando
- 16 Detenido
- 17 Activando
- 18 No válido
- 19 Bloqueado
- 20 No relevante

▪ QualitySourceId: origen del valor, en formato:
  - (Nulo): desconocido
  - 1: Telemedido
  - 2: Calculado
  - 3: Manual
  - 4: Estimado

▪ SourceTimestamp: fecha de último cambio de estado del valor de tag. Fecha estampada por dispositivo origen

▪ UpdateTimestamp: fecha recepción de último cambio de estado del valor de tag. Fecha estampada por Centro de Control.

- message: texto del mensaje sobre el error si se produce durante la llamada al método
- Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

4. bool GetTagStatesByTagIds(string user, string password, int[] tagIds, out List<SDTagState> tagStates, out string message)

   Devuelve un listado de estados de tags, a partir de una lista de tag id.

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - tagIds: Lista de identificadores de tag (TagId)

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Argumentos de salida:

- tagStates: lista de objetos SDTagState, que contiene información sobre estados actuales de cada tag. Estructura idéntica a mensaje anterior.
- message: texto del mensaje sobre el error si se produce durante la llamada al método
- Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

5. bool GetTagStatesByTimestamp(string user, string password, DateTime? minTimestamp, DateTime? maxTimestamp, int? lastRequestMaxTagId, int maxTagCount, out List<SDTagState> tagStates, out bool hasMoreValuesWithLastTimestamp, out string message)

   Devuelve un listado de estados de tags, a partir de una fecha, con un máximo de valores devueltos. Si se indica, también filtra a partir de un Id de tag.

   Argumentos de entrada:

   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - minTimestamp: fecha a partir de la cual se buscan tags (no incluida). Se devolverán todos los que tengan fecha de cambio posterior a esta fecha. La fecha considerada es la de cambio en Centro de Control (UpdateTimestamp). Si se pasa valor nulo, se devuelven todos.
   - maxTimestamp: fecha máxima de los tags a devolver (incluida). Se devolverán todos los que tengan fecha inferior a esta (incluida). Si se pasa valor nulo, se devolverán todos.
   - lastRequestMaxTagId: si es nulo, no tiene efecto. Si es diferente de nulo, y fecha no maxTimestamp no es nula, devolverá los que tengan esa fecha, pero superior a este TagId. Utilizado para el caso que hayan quedado algunos valores sin enviar (por tamaño de mensaje), con misma fecha que último valor enviado.
   - maxTagCount: número máximo tags a obtener en la respuesta.

   Argumentos de salida:

   - tagStates: lista de objetos SDTagState, que contiene información sobre estados actuales de cada tag. Tipo SDTagState definido anteriormente. Orden en que se reciben es 1-Timestamp y 2-TagId.
   - hasMoreValuesWithLastTimestamp: booleano que si cierto, indica que han quedado valores pendientes por devolver con misma fecha (exacta) que último valor. Esto será útil para poder detectar que en un mensaje no se han podido

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devolver todos los valores. Se deberán pedir de nuevo, indicando además el TagId del último valor.

- message: texto del mensaje sobre el error si se produce durante la llamada al método.
- Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

6. bool GetStateByTagName(string user, string password, string tagName, out SDTagState tagState, out string message)
   Devuelve el estado del tag con el nombre único pasado.

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - name: nombre único del tag

   Argumentos de salida:

   - tagState: Estado del tag, en formato SDTagState.
   - message: texto del mensaje sobre el error si se produce durante la llamada al método
   - Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

7. bool GetTagChangesById(string user, string password, int? lastRequestMaxChangeId, int maxChangeCount, out List<SDTagState> tagStates, out string message)

   Devuelve un listado de cambios de estados digitales (o discretos), a partir de un id de evento (Id), con un máximo de valores devueltos.

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - lastRequestMaxChangeId: identificador de evento (ChangeId) a partir del cual se devolverán cambios. Se devolverán los cambios con valor superior a este Id. Orientado a peticiones sucesivas de todos los eventos en varios mensajes. Si se pasa valor nulo, se devuelven a partir del primer evento.
   - maxChangeCount: número máximo de cambios a devolver en la respuesta. Si se indica valor 0, se devuelven todos los cambios encontrados.

   Argumentos de salida:

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- tagStates: listado de objetos SDTagStateChange, que contiene información sobre cambio de cada tag.
    - SDTagStateChange:
        - Id: Identificador del cambio (id evento)
        - TagId: identificador de tag
        - ValueInt: estado del elemento en formato de un entero 32 bits con signo. Mismos valores que en estructura SDTagState.
        - ValueStr: valor cadena. Este campo también tendrá valor para los demás tipos.
        - ValueBool: valor booleano
        - ValueFloat: valor flotante (precisión doble, 64 bits).
        - QualityId: calidad del estado en formato entero. Mismos valores que en estructura SDTagState.
        - QualityDetailId: detalle de calidad del estado (opcional). Mismos valores que en estructura SDTagState.
        - QualitySourceId: origen del estado. Mismos valores que en estructura SDTagState.
        - SourceTimestamp: fecha de último cambio de estado del valor de tag. Fecha estampada por dispositivo origen
        - UpdateTimestamp: fecha recepción de último cambio de estado del valor de tag. Fecha estampada por Centro de Control.
- message: texto del mensaje sobre el error si se produce durante la llamada al método
- Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

8. bool GetTagChangesByTimestamp(string user, string password, DateTime? minTimestamp, DateTime? maxTimestamp, int maxChangeCount, out List<SDTagState> tagStates, out bool hasMoreValuesWithLastTimestamp, out string message)

   Devuelve un listado de cambios de estados digitales (o discretos), entre las 2 fechas indicadas (incluida la final).

   Argumentos de entrada:
   - user: usuario del servicio
   - password: contraseña del usuario del servicio
   - minTimestamp: mínima fecha a consultar, no incluida. Se usa fecha de guardado (UpdateTimestamp). Si no se indica, se piden todas.
   - maxTimestamp: máxima fecha a consultar, incluida. Se usa fecha de guardado (UpdateTimestamp). Si no se indica, se piden todas.

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- maxChangeCount: número máximo de cambios a devolver en la respuesta. Si se indica valor 0, se devuelven todos los cambios encontrados.

Argumentos de salida:

- tagStates: listado de objetos SDTagStateChange, que contiene información sobre cambio de cada tag. Estructura idéntica a mensajes anteriores que usan SDTagStateChange.
- hasMoreValuesWithLastTimestamp: si devuelve verdadero, indica que hay más cambios pendientes con la misma fecha que último evento enviado.
- message: texto del mensaje sobre el error si se produce durante la llamada al método
- Resultado: verdadero si se devuelven datos correctamente. Falso si se produjo error.

9. bool GetTagClasses(string user, string password, out List<SDTagClass> tagClasses, out string message)

   Devuelve lista de clases de tag disponibles.

   Argumentos de entrada:

- user: usuario del servicio
- password: contraseña del usuario del servicio
- lastRequestMaxTagClassId (opcional): id a partir del cual se piden clases. Si es nulo, se piden todas.
- maxTagClassCount: máximo número de clases a pedir. Si es 0, se piden todas.

Argumentos de salida:

- tagClasses: listado de objetos SDTagClass.
  - SDTagClass:
    - Id: Identificador numérico (único) de la clase.
    - Name: Nombre alfanumérico (único) de la clase. Este nombre será el que encontremos al pedir el listado de tags con GetTagInformation.
    - Description: Descripción de la clase.
    - ParentTagClassName: Clase superior (agrupación de clases). Algunos valores pueden ser:
      - (nulo): Clase de nivel superior
      - "DI"/"CDI": Entradas Digitales (simples/dobles)
      - "DO"/"CDO": Salidas Digitales (simples/dobles)
      - "AI": Entradas Analógicas.

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- ValueTypeId (opcional): Identificador de tipo de valor. Es el mismo valor que se obtiene al pedir listado de tags, en TagValueTypeId, o al pedir tipos de valores de tag con GetTagValueTypes.
- message: mensaje de error.
- Resultado: Verdadero si se devuelven datos correctamente. Falso si se produjo error, con mensaje en argumento message.

10. bool GetTagValueTypes(string user, string password, out List<SDTagValueType> tagValueTypes, out string message)

    Devuelve lista de tipos de datos y enumerados disponibles para los tags de estados digitales.

    Argumentos de entrada:
    - user: usuario del servicio
    - password: contraseña del usuario del servicio

    Argumentos de salida:

    - tagValueTypes: listado de objetos SDTagValueTypes.
      - SDTagValueType:
        - Id: identificador único de tipo. Este valor será el que se use en TagValueTypeId para cada Tag.
        - Name: Nombre de tipo. Algunos ejemplos de valores son "Flotante", "Entero", "Cadena", o el nombre de un enumerado específico como "Posición", "Estado reenganchador".
        - List<SDEnumValue> (opcional, nulo para valores no enumerados como "Float"): listado de valores enumerados.
          - SDEnumValue:
            - Id: identificador único del valor en el sistema.
            - Value: Valor numérico.
            - Name: Valor de texto (por ejemplo "ABIERTO", "CERRADO", "EN SERVICIO", "ON")
    - message: mensaje de error si se ha producido al llamar.
    - Resultado: Verdadero si se devuelven datos correctamente. Falso si se produjo error, con mensaje en argumento message

4. SECUENCIA HABITUAL DE LLAMADAS

La secuencia que se estima habitual de llamadas al servicio web será la siguiente, según los datos que se quieren obtener:

- Inventario de tags:

- 1 Llamada a GetTagCount para obtener el total de tags del sistema
- N Llamadas a GetTagInformation, pasando el último (máximo) Id obtenido en la anterior llamada, hasta obtener todos los tags.
- Esto permite al sistema externo tener un listado de todos los tags disponibles y sus tipos.

- Todos los estados de tag:
  - Primera llamada a GetTagStatesByTagId con argumento nulo:
    - lastRequestMaxTagId= nulo
  - N llamadas a GetTagStatesByTagId, hasta recibir lista vacía:
    - lastRequestMaxTagId= máximo (último) TagId recibido en mensaje anterior.

- Conjunto de estados de tags:
  - 1 llamada a GetTagStatesByTagIds con la lista de tags a consultar. Si la lista de tags es muy grande se deberá de partir en varias peticiones.

- Todos los estados, a partir de una fecha:
  - Primera llamada a GetTagStatesByTimestampById, con argumentos nulos:
    - minTimestamp= nulo
    - maxTimestamp=nulo
    - lastRequestMaxTagId= nulo.
  - N llamadas a GetTagStatesByTimestampById, hasta recibir lista vacía:
    - minTimestamp= máxima (última) fecha recibida (UpdateTimestamp) en mensaje anterior
    - maxTimestamp=nulo
    - lastRequestMaxTagId= nulo.
  - Caso de recibir un flag activo "hasMoreValuesWithLastTimestamp", se enviará un mensaje indicando tag id, para obtener resto de valores con misma fecha:
    - minTimestamp=nulo
    - maxTimestamp= máxima (última) fecha recibida (UpdateTimestamp) en mensaje anterior
    - lastRequestMaxTagId= tag id máximo de último mensaje

- Cambios digitales (eventos):
  - Primera llamada a GetTagChangesById, con argumento nulos:
    - lastRequestMaxChangeId= nulo.
  - N llamadas a GetTagChangesById, hasta recibir lista vacía:
    - lastRequestMaxChangeId= máximo ChangeId recibido en mensaje anterior.

- Un estado de tag por nombre:
  - 1 llamada a GetTagStatesByName, indicando nombre único de tag.

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5. References

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[9] RENAISSANCE Project, D4.2 Energy nodes integration report

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