Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid (GOFLEX)

D7.1 Report on Requirement and Prosumer Analysis – Use Case 1

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Imprint

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Executive Summary

This report D7.1 is the first deliverable of WP7. The target is to present in an analytical form the requirements of the prosumers concerning the Cyprus demonstration case. Two different cases are examined: the microgrid at the university campus and the dispersed prosumers within Cyprus.

Document History

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List of Acronyms and Abbreviations

Abbreviation	Definition
BRP	Balancing Responsible Person
BEMS	Building Energy Management System
CA	Consortium Agreement
CDEMS	Charging/Discharging Energy Management System
CDO	Campus Development Office
DSM	Demand Side Management
DSO	Distribution System Operator
EAC	Electricity Authority of Cyprus
EMS	Energy Management System
ENC	Energy Centre
ESS	Energy Storage System
EV	Electric Vehicle
GA	Grant Agreement
HE	Head-End
HEMS	Home Energy Management System
ITI	Intelligent Trading Interface
LV	Low Voltage
MV	Medium Voltage
PCC	Point of Common Coupling
PLC	Power Line Communication
PV	Photovoltaic
UCY	University of Cyprus

1 Introduction

1.1 Purpose

This report documents an initial approach for determining the requirements of both the university microgrid and the prosumers, spread within Cyprus.

1.2 Related Documents

This document is related with WP2 (Automatic Demand Response Trading), WP3 (Augmented Demand Response Ready Prosumer), WP4 (Distribution Observability and Management System), WP5 Cloud-based Service Platform and WP6 (System Integration & Technical Evaluation).

1.3 Document Structure

In Chapter 2, the work package with the respective tasks are described, as they have analytically presented in the main text of the proposal.

In Chapter 3, the demonstration sites of Cyprus are described. This Chapter is separated in two subsections, one for the microgrid at the University of Cyprus campus and the other regarding the dispersed prosumers within Cyprus.

In Chapter 4, the prosumers are analysed. For the Cyprus demonstration case, two different cases are examined. The first one corresponds to the university microgird, while the second one to the dispersed prosumers within Cyprus. For both cases, the current situation regarding the energy production and consumption is presented, while the most promising of this site is identified and the requirements for interaction are mentioned.

In Chapter 5, the demonstration requirements of the whole Cyprus testing case is analysed. The existing grid and ICT infrastructure of both the university microgrid and prosumers are presented. Finally, the technology infrastructure of the GOFLEX project is demonstrated.

In Chapter 6, the requirements of the Cyprus demonstration sites are summarized, while in Chapter 7 the References are presented.

2 Work Package Description

WP7 demonstrates the GOFLEX system in two pilot sites in Cyprus. The first one corresponds to the university microgrid demonstration case and the second case regards the prosumers spread within Cyprus.

The main objective of this WP is to develop and simulate a full utility-integrated campus microgrid that will incorporate all existing and future developed renewable technologies, energy storage systems (ESS), infrastructure, departments and facilities within the UCY. Specifically, the microgrid will operate the different prosumers / consumers embedded in the microgrid (e.g. administration offices, student dormitories, sport facilities, electric vehicle charging stations, etc.), by integrating in the most optimal manner the current and future distributed RES generation and storage though the use of DSM techniques. In this domain, all market activities will be emulated at a smaller and more controllable scale within the microgrid through simulations and actual measurements. Activities within the DSO control area can also be simulated using real data where possible from the DSO system and may be validated through further data from the university campus microgrid. This will be undertaken with the use of existing EMS that can control the operation of processes and devices and to extend it using new smart meters, sensors and a central management system to facilitate the operation of the mini market within the university campus.

This WP will also investigate the aggregated response of 20 prosumers spread throughout Cyprus for investigating the implementation of DSM strategies and aggregate the load flexibilities for offering ancillary services to the market.

The structure of the work package contains 5 tasks, which are briefly described as follows:

T7.1 Requirement Analysis; Participants: FOSS, EAC; Duration: M1-M6

The aim of the first task is the analytical description of the potential prosumers/consumers within the university campus and the dispersed prosumers within Cyprus. For this reason, the necessary equipment will be evaluated for both the university microgrid and the several prosumers.

T7.2 Conceptual Business Models & KPIs; Participants: FOSS, BAUM, EAC; Duration: M3-M12

This task will focus on the analysis of the conceptual business model related to the operation of the proposed microgrid and the effective integration of RES and storage for improved self-consumption through DSM. Furthermore, the associated risks will be identified in order to assess and benchmark the business model both qualitatively and quantitatively.

T7.3 Definition, Adaptation & Deployment; Participants: FOSS, EAC, INEA, AAU, ROB; Duration: M6-M26

Following the analysis of the previous tasks, the university campus microgrid will be adapted and deployed in order to reflect the targets of GOFLEX. For this reason, FOSS together with the Technical Services of the UCY will aim to achieve an optimal operation, including DSM strategies with all the resources. Furthermore, the designed business case of the prosumers will be defined in detail in full cooperation with them for preparing full deployment.

T7.4 Demonstration; Participants: FOSS, EAC; Duration: M24-M36

In this task the technical and economic functionality of the university campus microgrid will be assessed and demonstrated (through smart meters, sensors, controllers and EMS for the efficient operation of the microgrid in full coordination with the DSO), including advanced forecasting of RES generation and use of storage systems. The deployed business case of prosumers will be assessed and quantified through actual results, which will be presented in reports.

T7.5 Demonstration Results and Evaluation; Participants: FOSS, EAC; Duration: M27-M36

In this final task an in-depth economic evaluation will be performed, focusing on DSM techniques utilized for the load shaping and maximizing the self-consumption compared to established open-contracted tariff policies. This will also cover the economic effects of the aggregated use of prosumers for load flexibilities aiming to offer ancillary services to the market.

3 Demonstration Site Setting

3.1 University microgrid

The campus of University of Cyprus is participating in the GOFLEX project as a microgrid test case, taking into account the energy production and consumption mix. The campus of the University of Cyprus is located on the outskirts of east Nicosia, between Aglantzia and Athalassa and covers an area of approximately 1.2 square kilometers. After the finalization of the buildings that are currently under construction (such as the Faculty of Engineering, the Central Library, sport facilities, etc.), the campus will be able to accommodate up to 10,000 students annually and it is anticipated to include the teaching and research facilities, the amusement facilities, the administrative and supporting facilities, the library facilities, the centre for information and all the rest required facilities of the University of Cyprus. The Master Plan conceptualizes the Campus in four basic zones, as it appears in Figure 1:

- the zone of the Public Buildings
- the zone of the Academic Buildings
- the zone of the Sports Facilities and

- the zone of the Students Residents

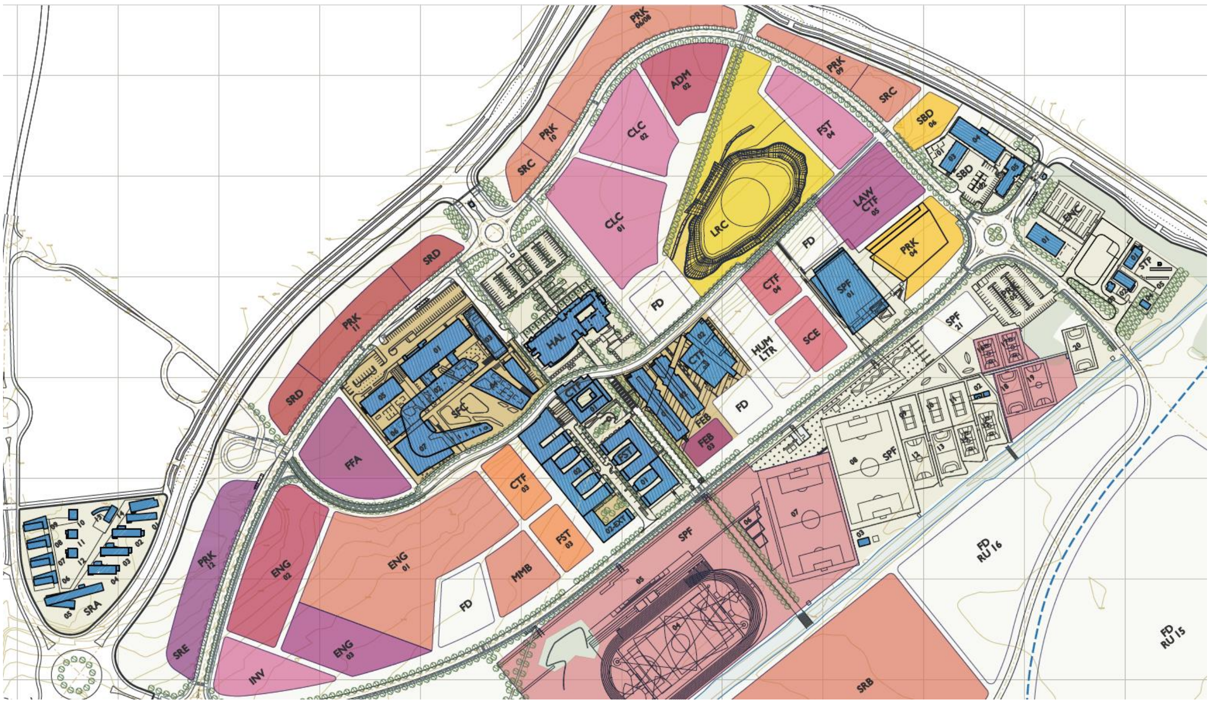

Figure 1 UCY master plan

The Campus Development Office (CDO) has overall responsibility for the administration, co-ordination, supervision and development of the project. To facilitate the coordination of the projects, the CDO has drawn up various schemata according to which the design and planning are undertaken. These schemata consider both urban and architectural parameters, energy management, mechanical and electrical issues, computer networks, etc. The access map to the University of Cyprus is shown in Figure 2.

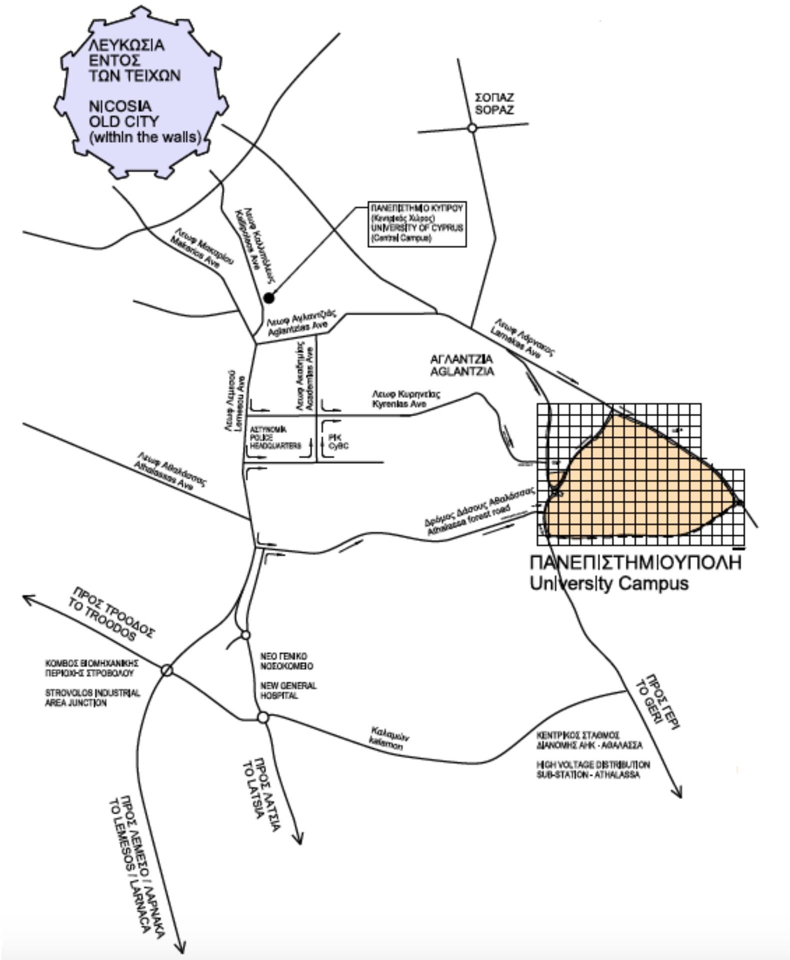

Figure 2 Access Map to University of Cyprus

Currently, the university area, as it appears in Google maps, is presented in Figure 3.

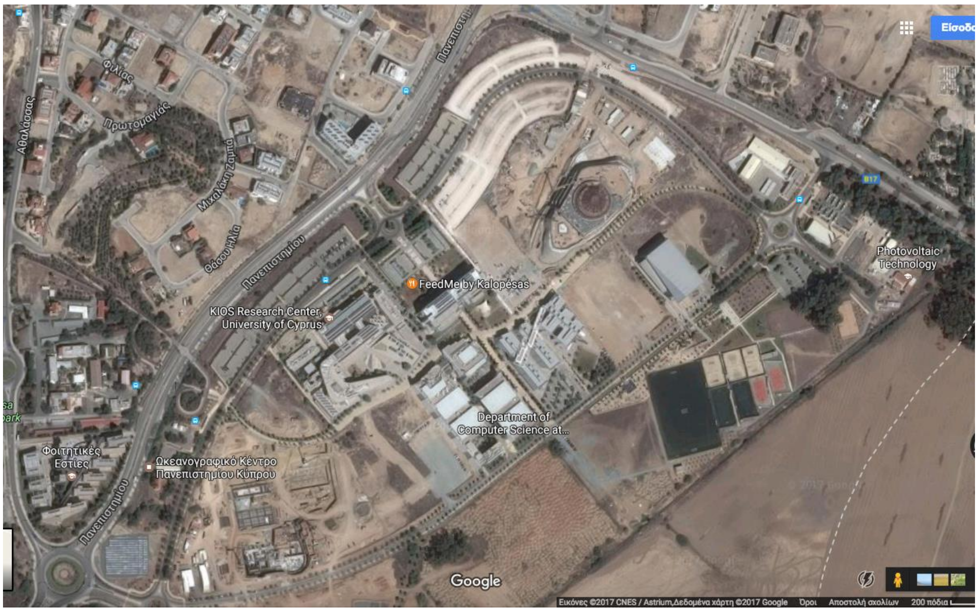

Figure 3 UCY current installations from Google maps

The future installations regarding the energy production and consumption are analysed below:

- 10MWp PV at the university campus
- 1MWh electrical energy storage system (both distributed and central) at university campus. The electrical energy storage will be conventional batteries (e.g. NiMh, li-ion, etc.), placed mainly centrally (e.g. 90% of the total battery capacity placed next to the 10MW PV installation) and distributed (e.g. 10% at 3-4 nodes within the campus, after conducting the proper electrical studies for identifying optimal siting)
- Smart infrastructure for managing charging facilities of electrical vehicles (EV)
- Heat pump installations for the planned extensions of the university campus
- smart meters within the university (for each separate building)
- installation of smart sensors and microgrid controllers for the efficient operation of the microgrid infrastructure
- new solar thermal systems for domestic hot water needs in some new buildings

3.2 Prosumers

Currently, 242 residential prosumers with rooftop PV installations are participating under the SmartPV project, in which FOSS is the coordinator. From this prosumer pool, 20 prosumers are selected by EAC in participate to GOFLEX project. The selected locations are the Municipality of Nicosia and the Municipality of Larnaca, as depicted in Figure 4. The existing equipment for these prosumers is the following:

- PV rooftop installation of 3kWp
- 2 smart meter infrastructure at prosumer premises (one for measuring the import and export energy from the grid and the other for measuring the energy production)

Figure 4 Island of Cyprus with Nicosia and Larnaca districts

4 Prosumers

4.1 Analysis

4.1.1 Analysis of university microgrid

The current and future infrastructure that is going to be utilized within the project is summarized in the following: Current installations (depicted in Figure 5):

- 70.08 kWp roof-mounted grid-connected PV at UCY administration offices (ADM)
- 176.4 kWp grid-connected PV park (Phaethon) (PVP-01)
- 148.32 kWp roof-mounted grid-connected PV at UCY social facilities building (SFC-01, SFC-02, SFC-04, SFC-07)
- 8 BEMS with different specifications
- Full broad band connectivity with EAC (local DSO) using fiber optic cables and PLC infrastructure allowing bidirectional flow of data

The specifications of the BEMS are summarized in Table 1.

Table 1 BEMS specifications

Building	BEMS type	Interfaces
Anastasios G. Leventis Building	Honeywell SymmetrE R410.2	Excel 5000 Direct, LonWorks
Building of Social Activities	Honeywell EBI R400.2	BACnet Client, LonWorks, Modicon PLC
Athletic Installations	Satchwell	Loytec, Lonworks
Faculty of Economics and Management	Siemens Desigo Insight	-
Faculty of Pure and Applied Sciences	Honeywell SymmetrE R410.2	Excel 5000 Direct, LonWorks, Modicon PLC
Faculty of Pure and Applied Sciences – Extension	Johnson Controls	-
Energy Centre	Honeywell Symmetre	BACnet Client, LonWorks, Modicon PLC, Excel 5000 Direct
Student Hall	Honeywell Symmetre R410.2	BACnet Client, Excel 5000 Direct, LonWorks

The energy production and consumption of each building are summarized in Table 2.

Table 2 Analytical list of energy production and consumption within the university campus

Id	Building	Type	Consumption (kWh/year)	Production (kWh/year)	Description
1	University Administration (ADM)	Commercial - Offices	729,776	102,786	UCY administration offices building includes a 70.08 kWp roof-mounted grid-connected PV system
2	Energy Centre (ENC)	Commercial - Heating / Cooling	Chillers: 2,221,073 Pumps: 1,275,045	-	Energy center of the UCY for heating/cooling (chillers and pumps) loads of the university
3	Services Buildings (SBD)	Commercial - Offices	296,924	-	Services buildings for management of the UCY
4	Faculty of Economics and Management (FEB)	Commercial - Offices	1,272,501	-	Department of Public & Business Administration. Department of Economics
5	Common Teaching Facilities (CTF) & Faculty of Pure and Applied Sciences (FST 01)	Commercial - Offices/ classrooms	1,198,966	-	Common Teaching Facilities of the UCY departments. Department of Mathematics & Statistics and Computer Science (FST 01)
6	Faculty of Pure and Applied Sciences (FST 02)	Commercial - Offices	2,621,332	-	Department of Physics and Chemistry (FST 02)
7	Sports Facilities (SPF)	Commercial - Sports Facilities	232,796	-	Indoor and outdoor sports facilities of the UCY
8	Residential (SR A-E)	Residential – Facilities	186,133	256,655	UCY residential blocks and communal facilities include a 176.4 kWp grid-connected PV park (Phaethon)
9	Campus Supplementary Offices (CSO)	Commercial - Offices	56,247	-	Office buildings of the UCY including a covered parking area

10	Social Facilities (SFC)	Commercial - Facilities	698,271	220,413	UCY social facilities building (kitchens, clubs, shops, health center etc.) includes a 148.32 kWp roof-mounted grid-connected PV system

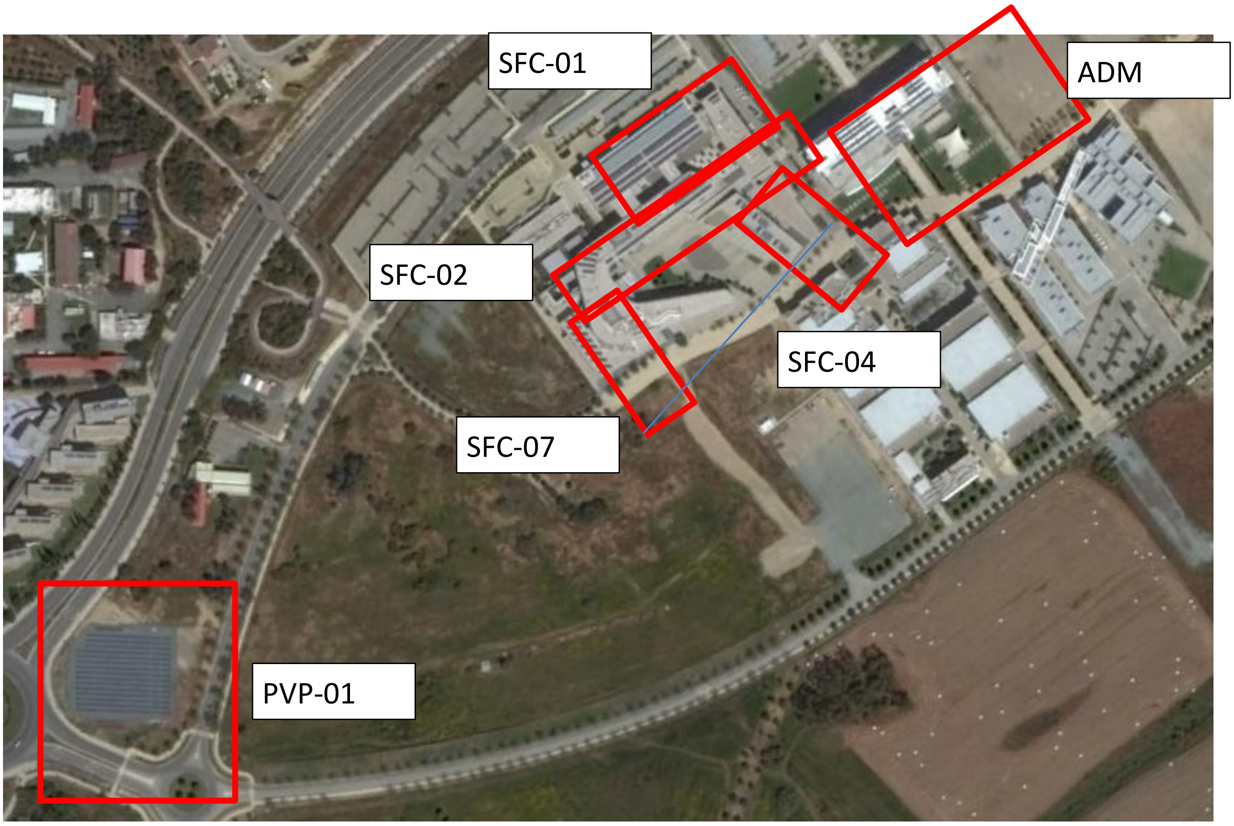

Figure 5 Current PV installations within the university campus

4.1.2 Analysis of dispersed prosumers

All the selected prosumers that will participate in the GOFLEX project will have a smart metering infrastructure and a rooftop PV installation. However, depending on the electrical connection with EAC, some prosumers have a three-phase connection with the electrical grid, and other are connected in a single-phase. For this reason, two different types of smart meters are installed, as presented in Figure 6 and Figure 7. The installation of the two meters at a prosumer premise can be depicted in Figure 8.

Figure 6 Three-phase meters: A1700 Programamble Polyphase Meter (Elster)

Figure 7 Single-phase smart meters: AMI AS230 Single Phase Meter

Figure 8 Double meter installation with import – export and generation meters

In order to select the prosumers that will participate in GOFLEX project, the following criteria have been set in close collaboration with EAC:

- Goegraphical dispersion. Two different districts have been selected (Nicosia and Larnaca), in order to identify the different habits, different weather conditions and different degree of adaptability
- Total energy consumption. 7 of the 20 prosumers have been selected following the criterion that the annual energy consumption meets the annual energy production from the PV installation. The rest 13 prosumers have been selected to have a larger energy consumption than energy production in annual terms.
- Degree of adaptability. The 20 prosumers have been carefully selected according to their previous participation to previous research programs and their response to the respective project requirements.

The details regarding a typical prosumer (with nominal PV installation of 3kWp) are presented in Table 3. The peak power corresponds to the maximum net power (power consumption minus power production) of the respective month.

Table 3 Details of the typical prosumer

Month	Peak Power [kW]	Consumption [kWh]	PV Production [kWh]
January	1.3024	20.106	8.1792
April	0.1919	13.926	16.2119
July	1.6798	25.544	16.0474

Concerning the electrical loads of this typical prosumer, the data are presented in the Table 4.

Table 4 Electrical loads of the typical prosumer

Load	Average working power [kW]	Percentage of working time [%]
Refrigerator	170 W	100
Dishwasher	1300 W	5
Washing Machine	500 W	4
Electric water heater	4000 W	4
Split-units (A/C)	2000 W	43
Hair Blow Dryer	2100 W	0.3
Clothes Dryer	2200 W	4
Clothes iron	1000 W	4
Fridge / Freezer	250 W	100
Electric Oven	2150 W	8
LED lights	20 * 8 W	15
TV	3 * 100 W	25
Desktop Computer	300 W	25
Electric Kettle	2000 W	0.5

4.2 Identification of most promising

4.2.1 University microgrid

In order to increase the overall efficiency of several production and consumption units within the university microgrid, the controllability of the microgrid should be enhanced. An integrated point of control is needed in order to centrally manage the energy flow within the university campus. For example, currently, the BEMS cannot cooperate with each other, since they use a different interface. Therefore, a system that will unify the different interfaces is required. Moreover, through the installation of smart meters at each building premises, additional energy management features will be identified in order to enhance the provided flexibility to the DSO.

Another important issue concerns the opportunity of trading ancillary services with the local DSO. Currently, the expansion of the university campus will demand an upgrade of the existing grid infrastructure. This is becoming more complicated, since a large PV park is planned to be installed in the same premises. As seen from the university feeder electrical diagram, the current grid and substation will need to be further reinforced. If the university microgrid could increase its efficiency by increasing the self-consumption and offering grid congestion relief ancillary services, a deferral of investments could be realized.

Another important component of the microgrid in respect to the offered flexibility is the electrical energy storage system. A large battery storage is going to be installed within the microgrid, being the energy buffer between the energy production and energy consumption. In order to fully exploit the storage, additional economic revenues can be applied in case of utilizing the battery in terms of providing the required flexibility to the DSO.

4.2.2 Dispersed prosumers

The selected prosumers have a separate smart metering infrastructure for measuring the electrical consumption and energy production from the PV rooftop installation. In this sense, the impact of the weather conditions and the energy habits of the prosumers can easily be identified. By having the generation data, the actual consumption profile can be extracted. Furthermore, its prosumer has almost the same rooftop PV installation (around 3kWp), which covers the energy consumption, in annual terms.

Since the distance within Cyprus are short, the weather conditions do not have a significant deviation. However, the microclimatic conditions of each territory should be taken into consideration for the energy production.

Regarding the energy consumption, since only domestic prosumers are regarded, the energy consumption profiles have many similarities, which should be taken into account during the analysis of the project results.

4.3 Requirements for Interaction

4.3.1 University microgrid

Through GOFLEX and by comparing the results of the Cyprus demonstration case with the results of the other two demonstration sites (Germany and Switzerland), useful information regarding the adaptability of the electrical loads to offer the required flexibility will be carried out. The different energy consumption habits of the university microgrid will also be compared with the respective energy consumption of the prosumers. This information will be very helpful for the DSO, in order to determine which prosumer or microgrid will have a better response to its need for flexibility. In this sense, the future actions will be identified for increasing the controllability of the university microgrid loads.

4.3.2 Dispersed prosumers

The different energy habits of the several prosumers will be gathered and analysed in respect to their location inside Cyprus. The different climatic conditions will also be taken into considerations. By this analysis, the willingness of the prosumers to participate to the required flexibility will be identified. Furthermore, the results will be compared with the respective results from the other two demonstration sites (Germany and Switzerland). The different energy habits will be analysed, taking into consideration the different climatic conditions and the requirements of the several DSOs. Thus, the islanded nature of the electricity grid in Cyprus and its particularity in respect to the interconnected electrical grids of the Central Europe will also be considered within this comparison.

5 Demonstration requirements

5.1 Existing grid infrastructure

5.1.1 Existing grid infrastructure of the university campus

The electrical connection of the university campus with the distribution grid appears in Figure 9. The voltage at the point of common coupling (PCC) of the university campus with the distribution grid is at Medium Voltage (MV) and more specifically at 11kV. As it is described in Figure 9, within the university campus exist several distribution transformers, which reduces the voltage level at 400V (three-phase voltage system). University of Cyprus has access to the data at the PCC, regarding the magnitude of the current at each feeder (two feeders totally). The time window of the data is every 30 minutes for the whole year.

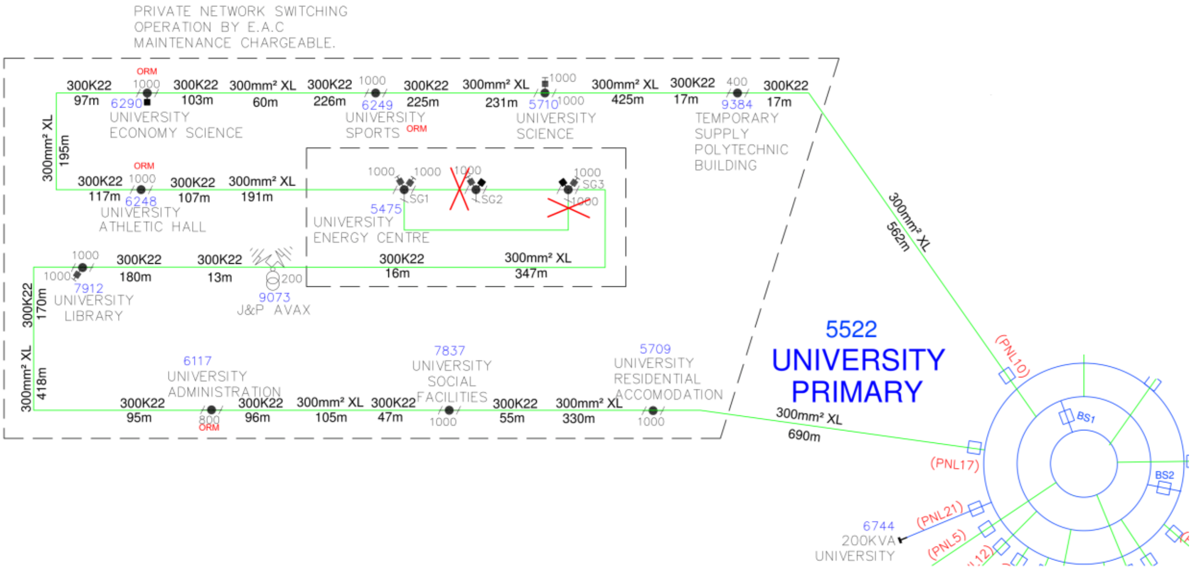

Figure 9 University feeder (provided by EAC)

The main electrical load of the university is the cooling system, which is placed centrally at the Energy Centre (ENC) building. The heating takes place by operating an oil heater, while the cooling is carried out by electrical chillers. However, taking into consideration the climatic conditions of Cyprus, both the heating and cooling are operating for a certain period of the year. Since during summer period the temperatures are quite high, the cooling needs are significant. For this reason, flexible load can be identified that can be smartly traded through effective control of this large load.

The control screen of the ENC is shown in Figure 10. As it can be seen, the specific equipment parameter can be presented, regarding both the cooling (chillers) and the heating (boilers). By selecting an equipment parameter, such as the ENC boiler, the specific control parameters are shown, as in Figure 11. In this screenshot, only two of the four boilers are operating.

Regarding the electrical consumption, two electric multi meters are used in order to measure analytically the several parameters, such as phase voltages and currents, frequency, output active, reactive and apparent power, etc. Figure 12 presents these parameters analytically. In case of an alarm, a red signal appears, indicating the faulty parameter.

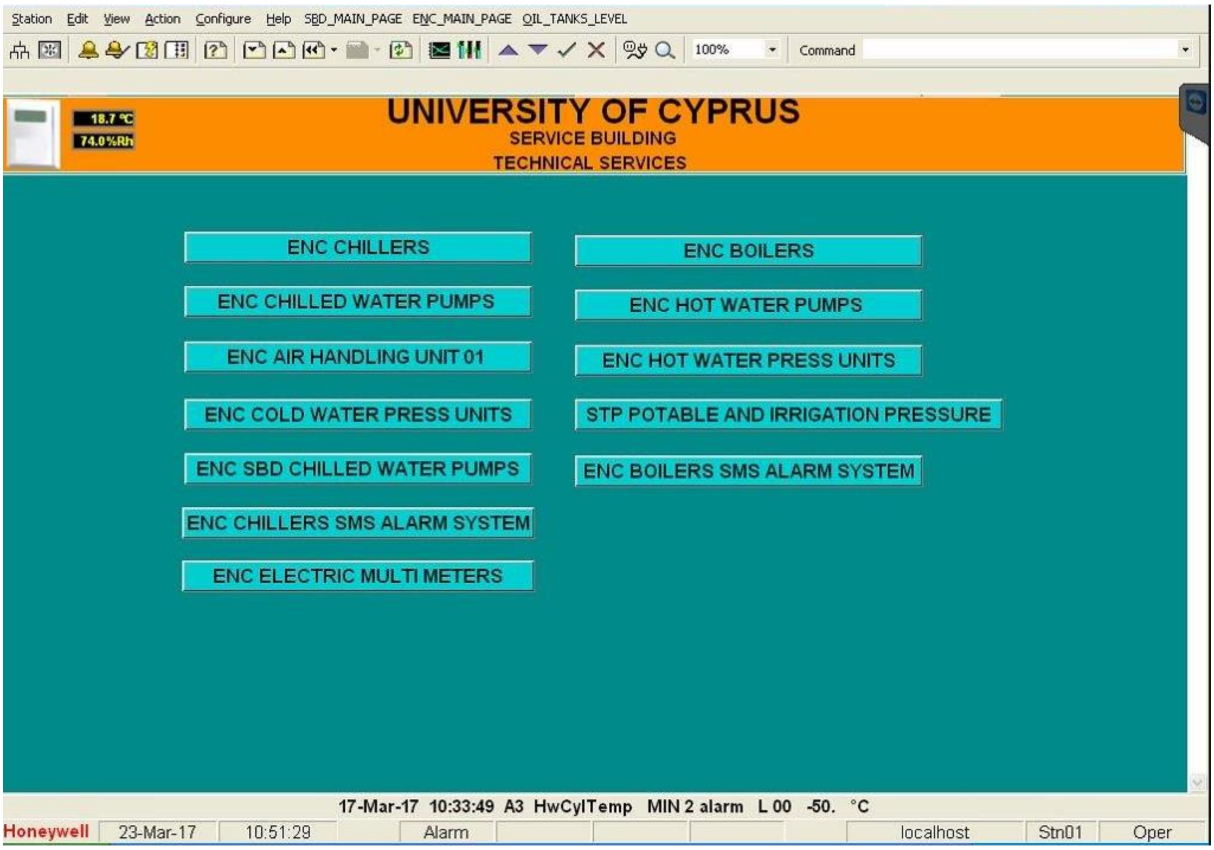

Figure 10 Display of the energy centre

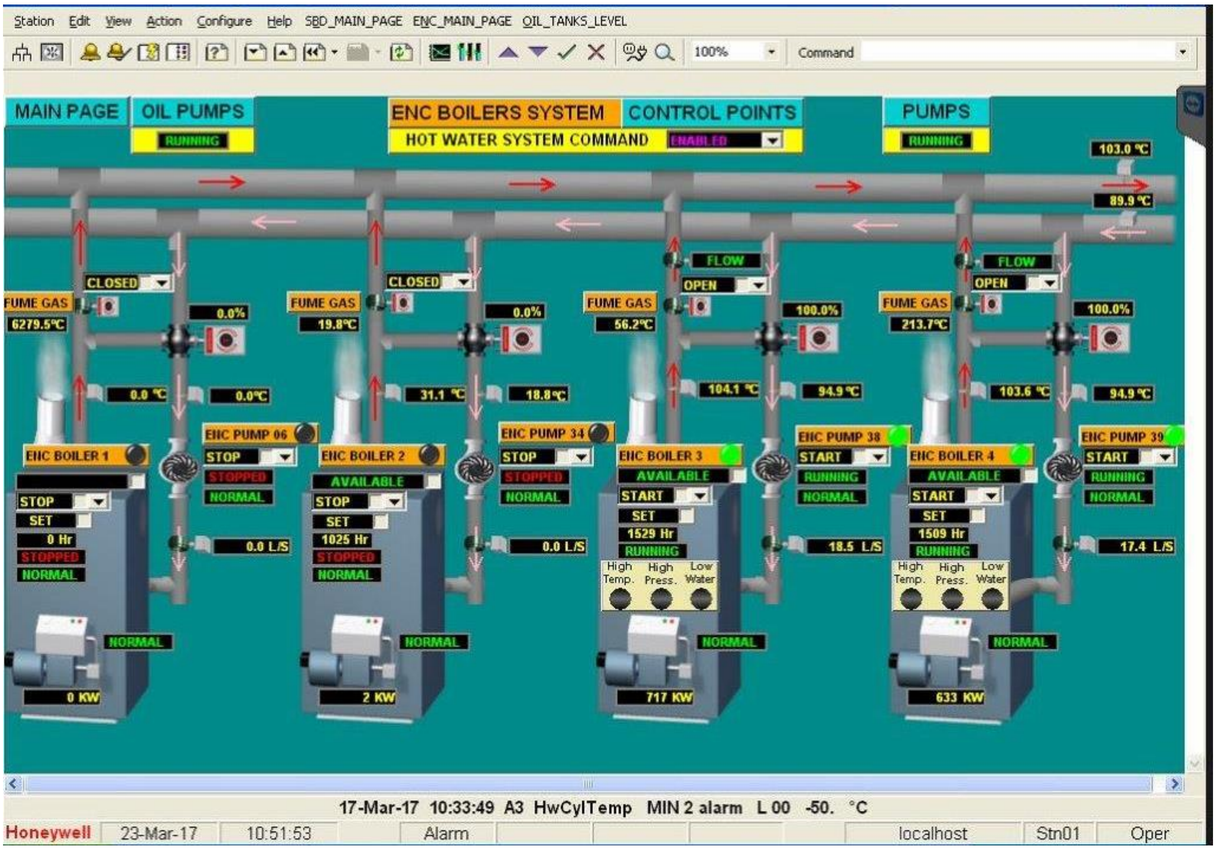

Figure 11 Display of ENC boilers

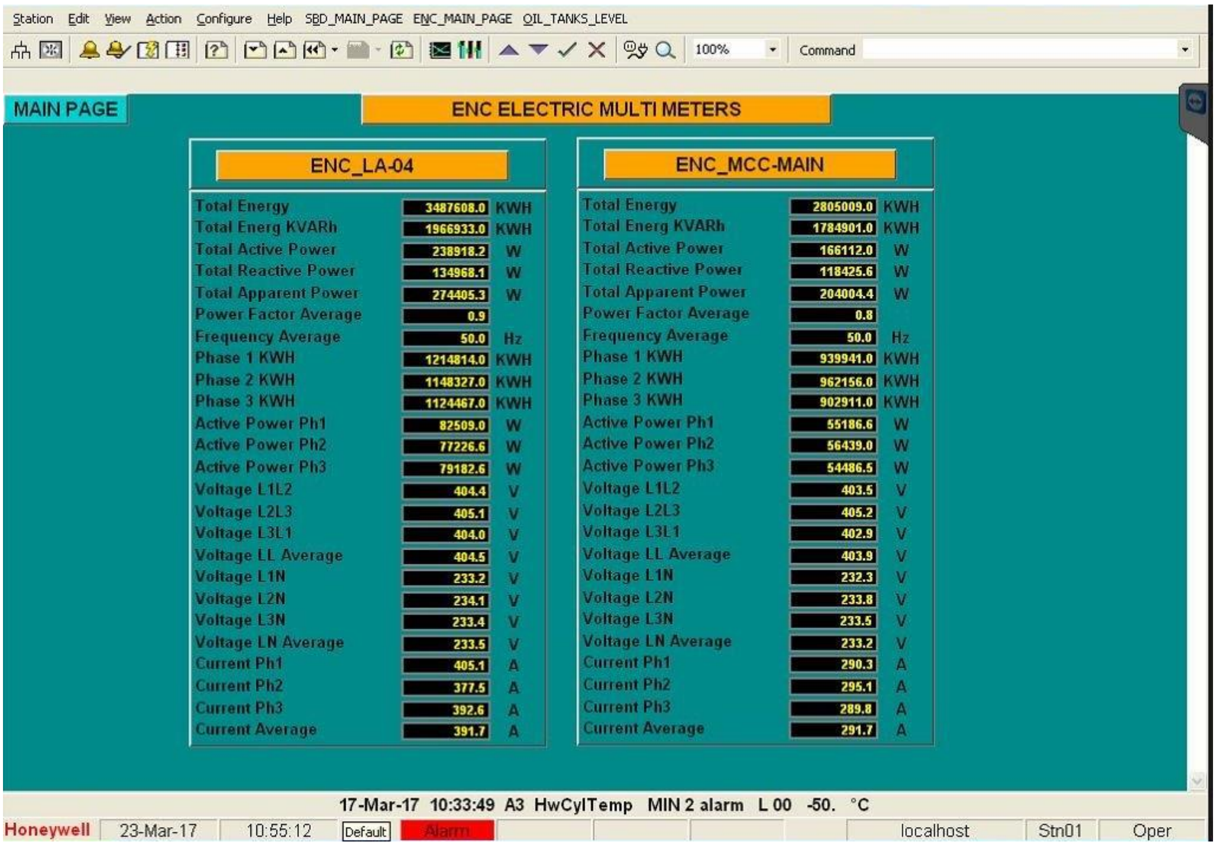

Figure 12 ENC Electric multi-meters

Downstream of the central ENC system, central heating and cooling pipes transfer the hot/cold water to each building. As it has been already presented, each building is equipped with its own BEMS, with the respective ICT infrastructure. A server PC gathers the data and measurements from each control point (e.g. pump, heater, boiler, chiller, etc.) of each BEMS. Consequently, the Ethernet local area network is used in order to have access to this server PC and control each parameter remotely. The controllers of the heating/cooling machine sends the information to a network adapter, which is also connected with the PC server. In case that the controller has a separate unique IP address, a remote access and control can also be implemented. However, this opportunity is not available for each BEMS. The structure of the BEMS located at Administrative Building - ADM (Anastasios G. Leventis Building) is presented in Figure 13. The indicative BEMS architecture of the School of Economics and Management is presented in Figure 14.

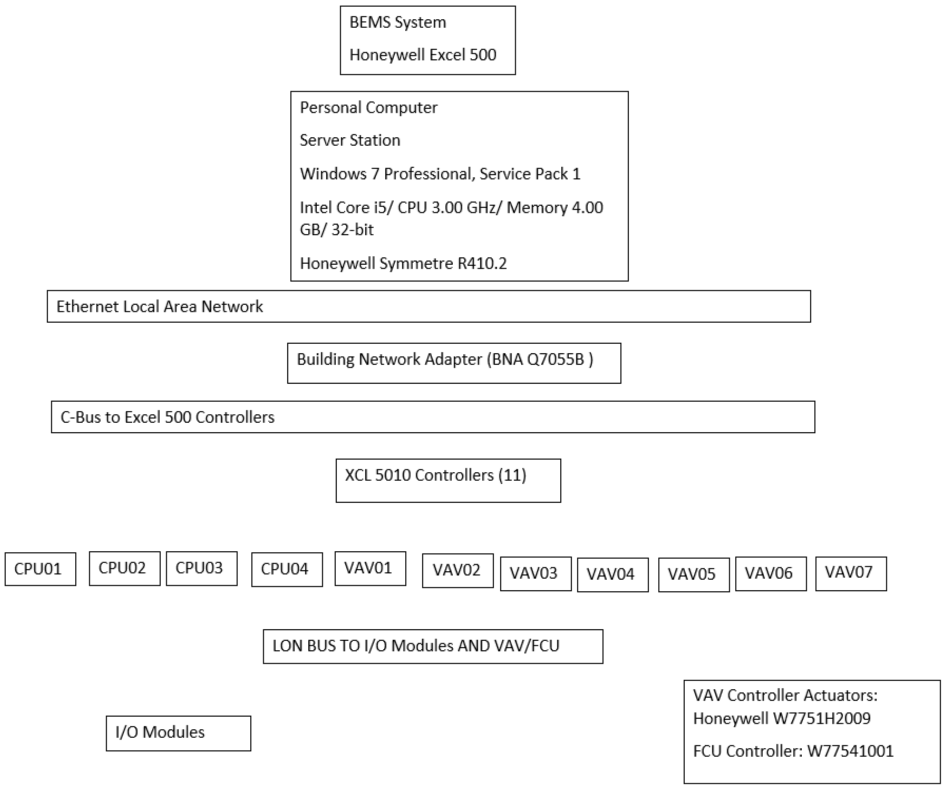

Figure 13 Overview of BEMS at Administrative Building

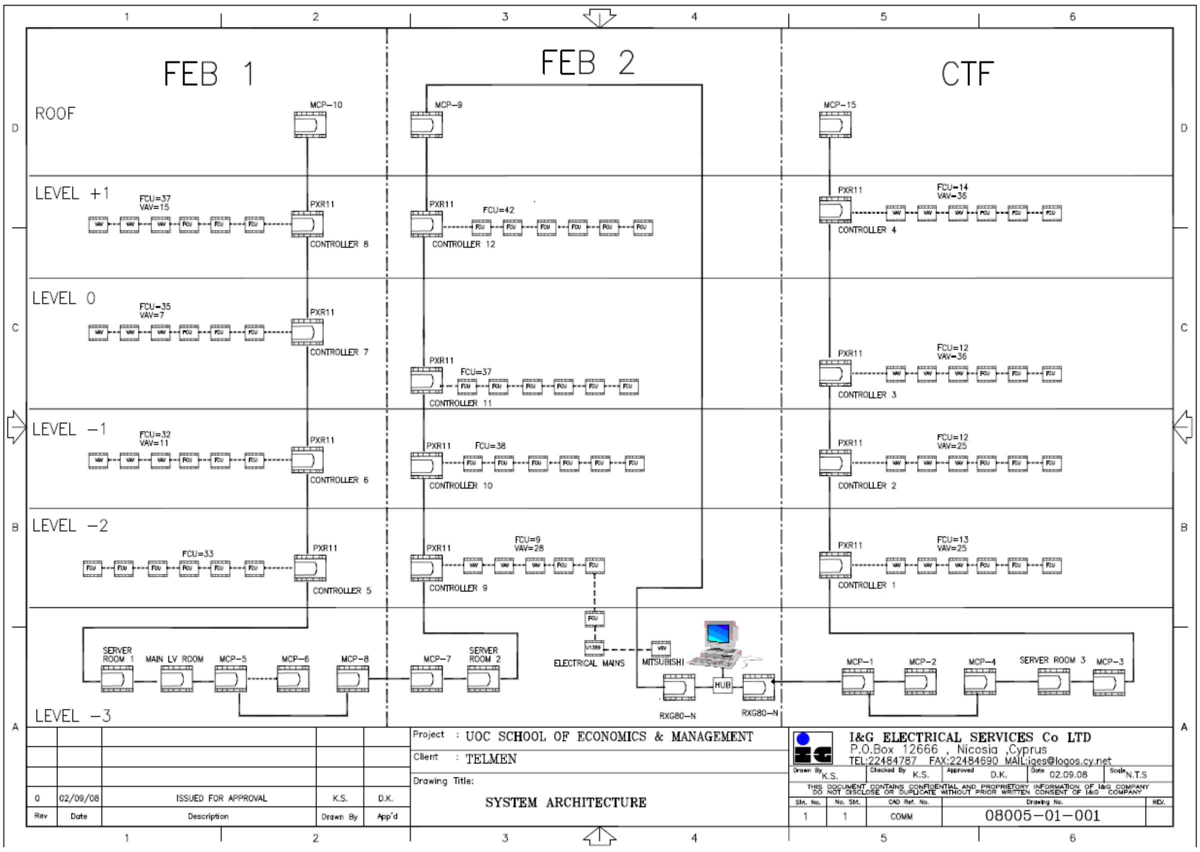

Figure 14 BEMS architecture for the School of Economics and Management

The screen display with all features is presented in Figure 15. The temperature of the supply and return of water pipes with the respective pressure are also shown. More details can be found in Figure 16.

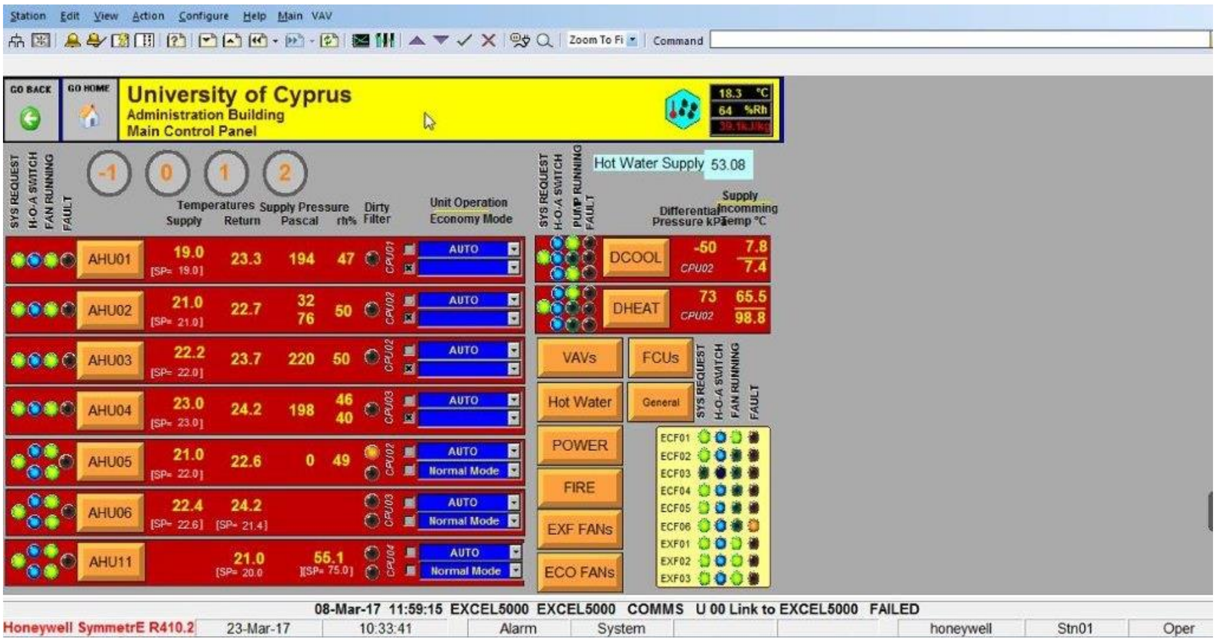

Figure 15 BEMS screen of the BEMS of Administrative building

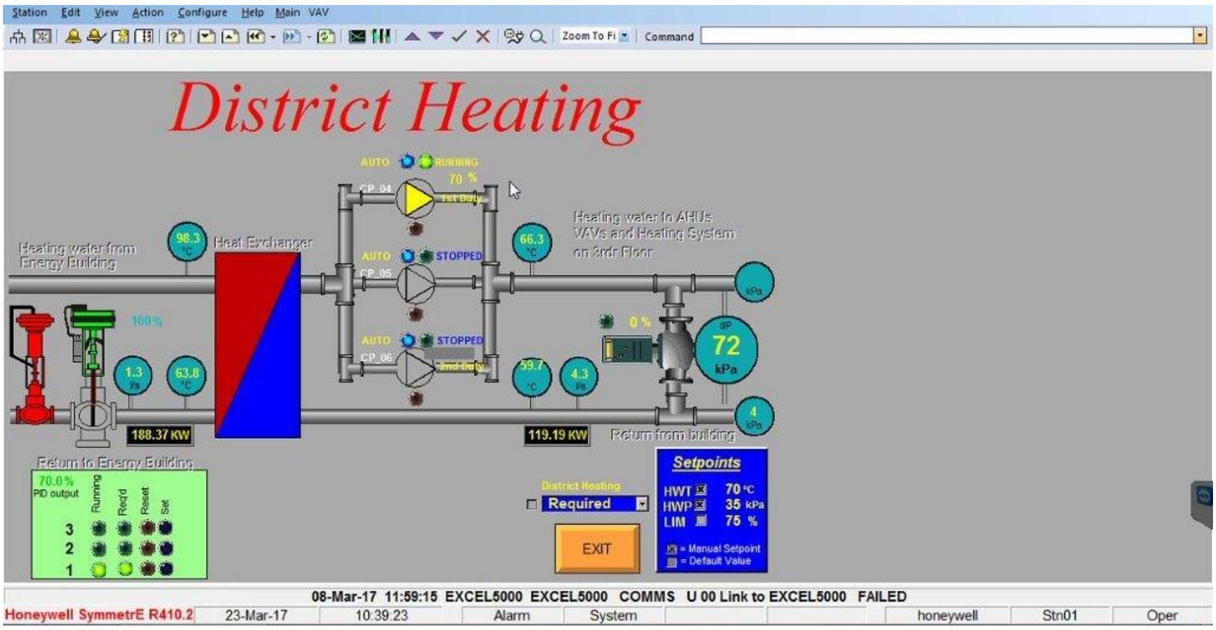

Figure 16 Details from district heating of ADM

Concerning the PV generation, the Solaredge web application is used for collecting the measurements from the PV system and each measuring infrastructure (temperature sensors, wind sensors, irradiance sensors, etc.). The whole PV installations are currently monitored by utilizing the panoramic view presented in Figure 18. If the PV modules are operating normally, the modules are painted in blue, while in case of an issue they are painted with black colour. Indicatively, due to a communication failure, a two PV strings are in black colour in Figure 18. Figure 19 and Figure 19 present the produced energy and the performance ratio (PR) of the total PV installations. The output curves from the sensors are shown in Figure 20, Figure 21 and Figure 22.

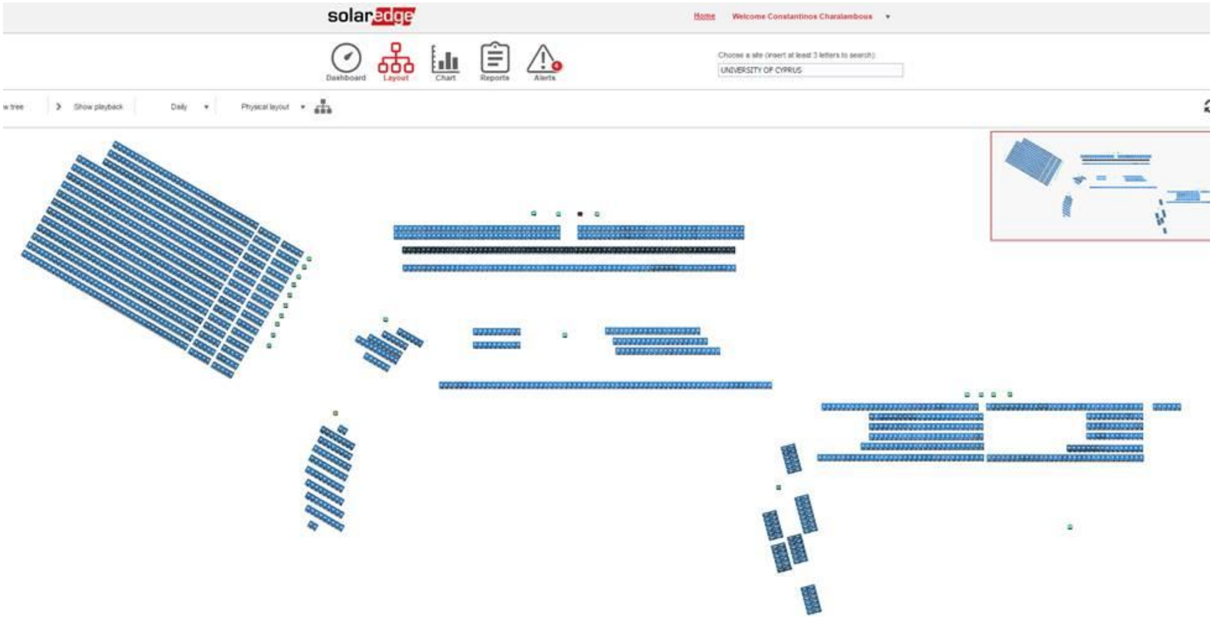

Figure 17 Panoramic view of the PV installations within the university campus

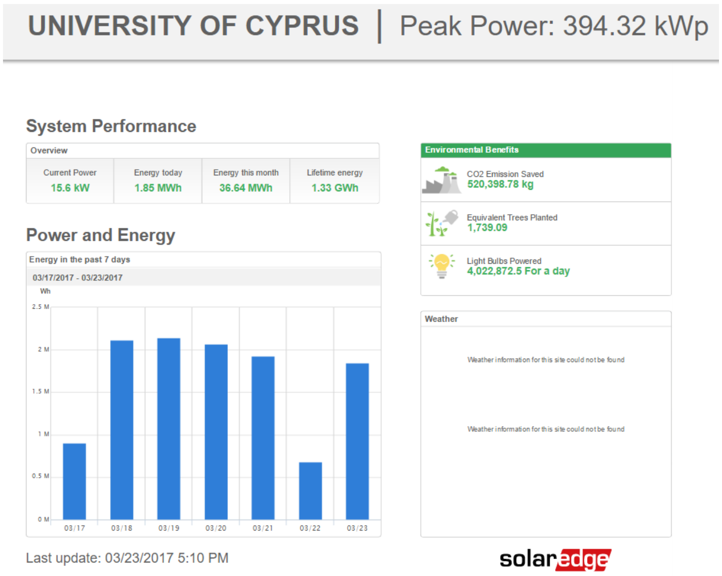

Figure 18 Energy and power production from the PV installations within the UCY

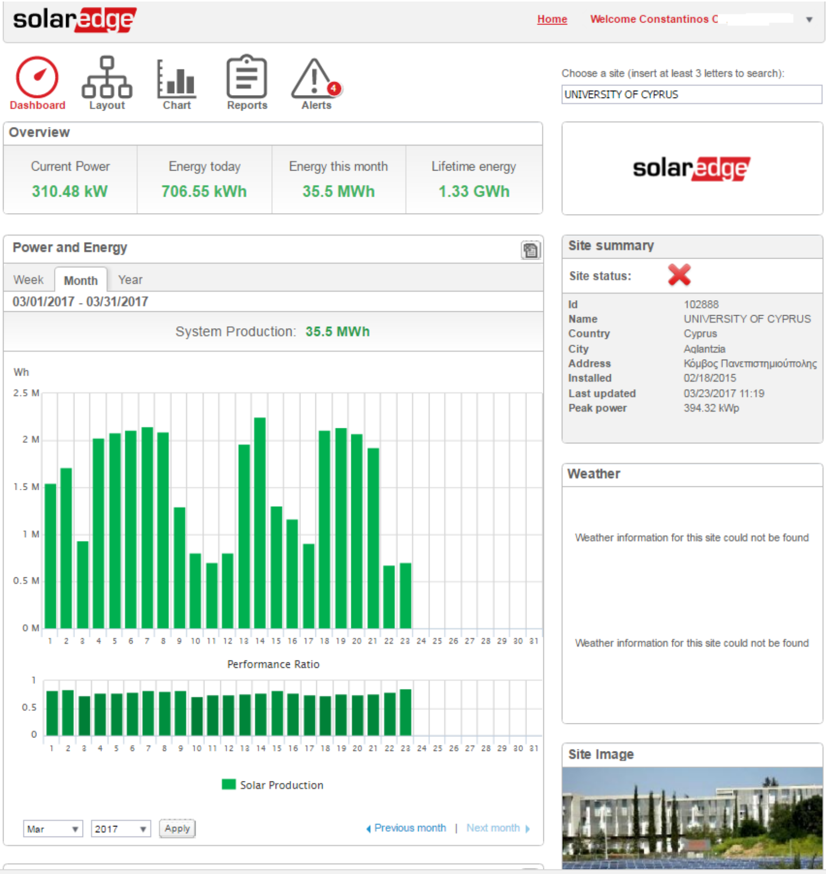

Figure 19 Energy and performance ratio (PR) from the PV installations within the UCY

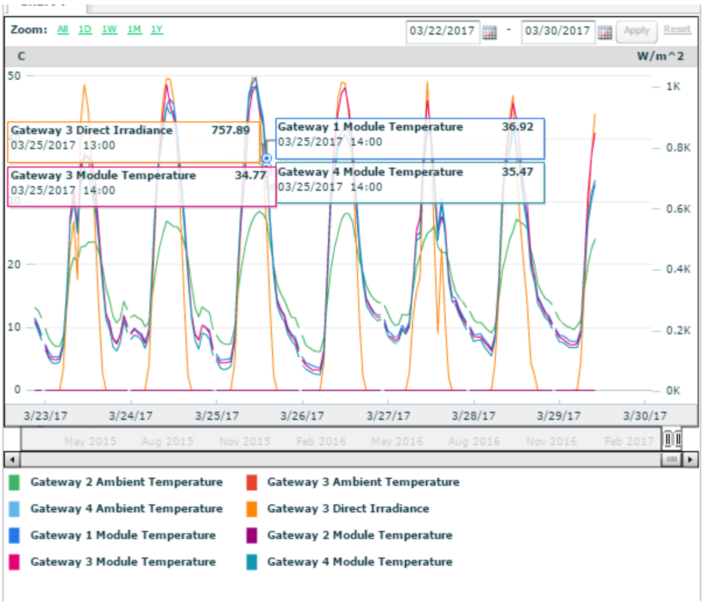

Figure 20 Temperature curves form the ambient and PV module temperature sensors

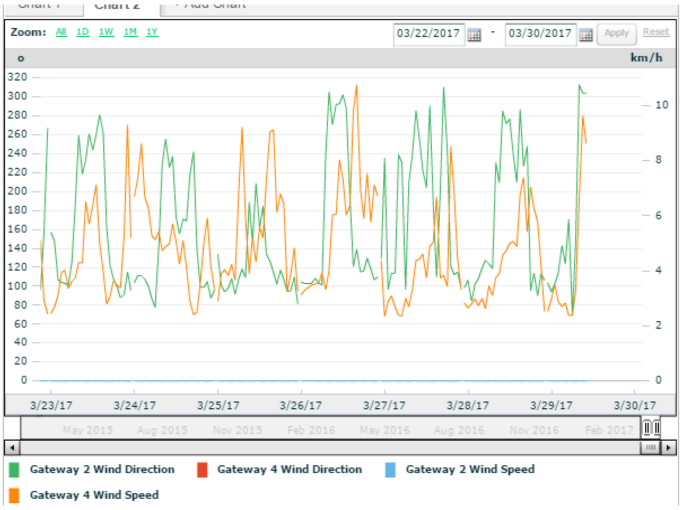

Figure 21 Wind speed and direction curves from the wind sensors

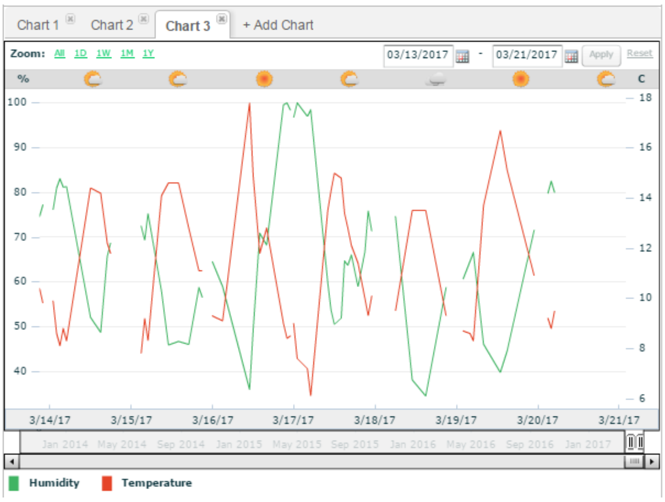

Figure 22 Humidity and ambient temperature curves from the weather station

5.1.2 Existing grid infrastructure regarding the prosumers

The prosumers are connected with the distribution grid at 400V for three-phase systems and 230V for single-phase systems. The selection among three-phase or single-phase systems depends on the nominal power of the domestic installation. Each prosumers that participates to GOFLEX project is single phase and has two smart meters, as it has been already presented. The graphical figure of the connection of the meter is presented in Figure 23.

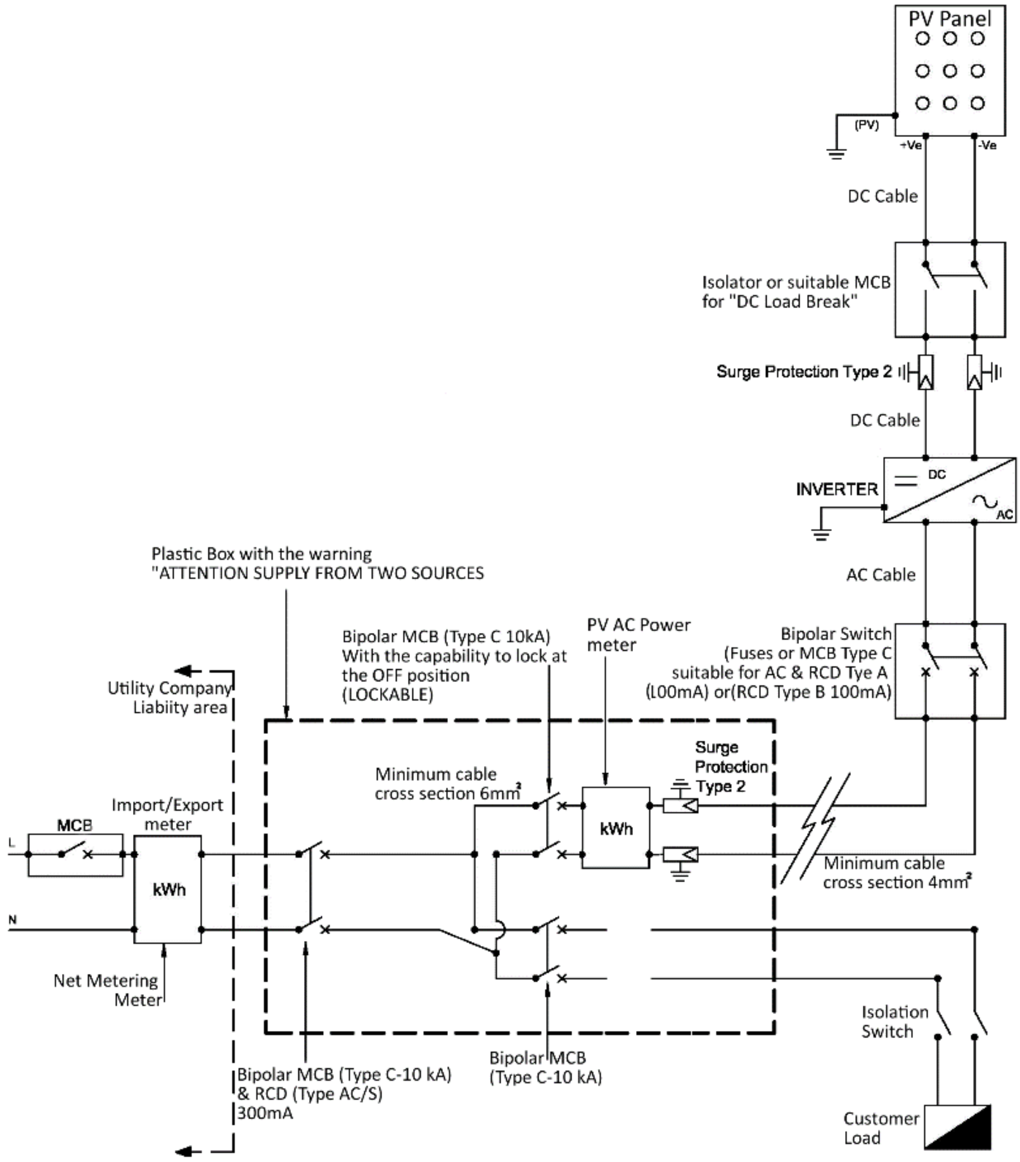

Figure 23 Detail of the connection of the consumption and production of each prosumer

5.2 Existing ICT infrastructure

5.2.1 Existing and Future ICT infrastructure of the university microgrid

The existing ICT infrastructure includes optical fibers to each building of the university. Therefore, broadband connectivity is available throughout the campus. A wireless internet connectivity is also available within the campus, which is freely available for any academic person.

Regarding the control of the consumption, the Technical Services have a remote access to each BEMS, by using the Ethernet broadband connectivity. The monitoring of the energy production from the PV installations takes place through the Solaredge website. The data are from the metering and sensor infrastructure are uploaded to the Solaredge server by using the available broadband grid of the university.

When the whole university will be transformed to an operating microgrid, the tiered architecture will be featured. At the top tier will reside the controller responsible for balancing the energy demand and production by coordinating the second-tier controllers. The controllers on the second tier will be the BMS controllers of each building. They will be responsible for coordinating the electromechanical systems of each building to achieve the goals set by the top tier controller. To achieve their goals the second-tier controllers will use an array of sensors throughout each building in order to get information about the state of the building. In parallel to the second-tier controllers there will be data acquisition devices at each substation, serving the campus that will record and transmit data regarding energy consumption and quality to the main controller.

Regarding the substations of the university grid, a BPL network is implemented in the current MV/LV substations, as shown in Figure 24. Therefore, the top tier controller will communicate with the data acquisition devices at each substation via a BPL network that will be implemented on top of the 11kV wires connecting each substation to the other. At the controller end the BPL connection will have to be transferred to the low voltage (230V) network in order to reach the location where the controller will be hosted. The second-tier controllers will communicate with the top tier via Ethernet that will be implemented either via copper wiring (Cat5e or Cat6a) or via optical fibers. The wires/fibers that will be used will be the existing network cabling used for the University network, where possible, and the traffic will be segregated at the switch level via VLAN tagging. The application level protocol used in the communication between the controllers will have to be compatible with the Ethernet protocol or protocol converters will have to be used. This is necessary in order to avoid laying new infrastructure that will increase the cost of the implementation. Also the application layer protocol will preferably be an open protocol in order to avoid being locked in a particular manufacturers controllers.

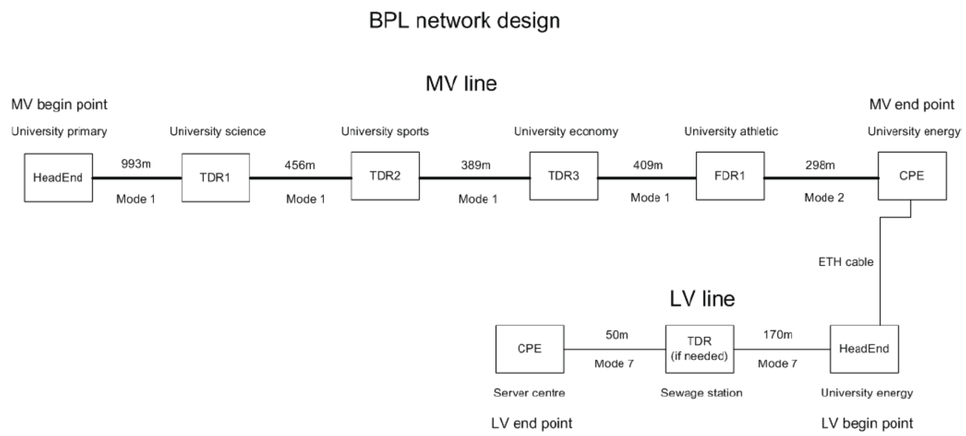

Figure 24 BPL network design

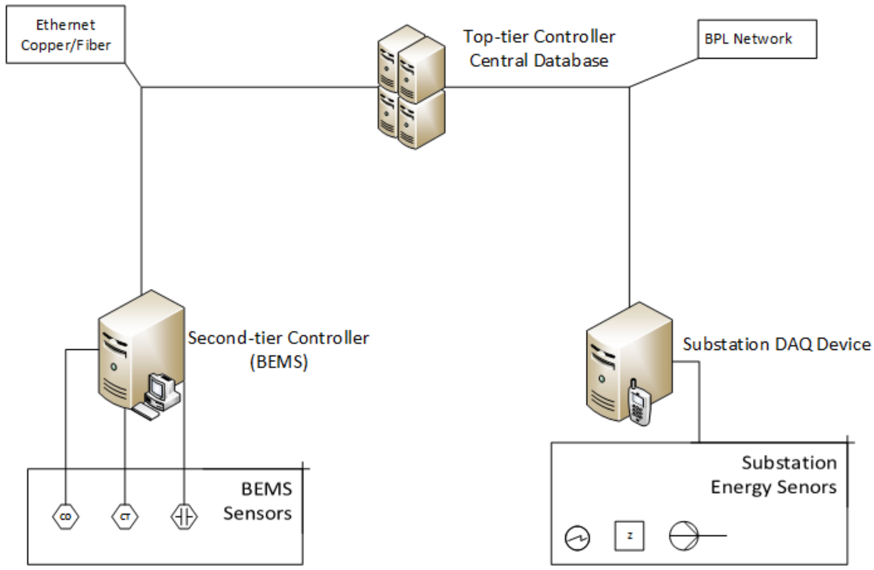

Figure 25 ICT analytic description

5.2.2 Existing ICT infrastructure of the prosumers

The data from the smart meters located at prosumer premises are gathered centrally in order to be further analysed. The daily consumption profile is needed in order to investigate and analyse the ability of different prosumers to take advantage of the installed equipment and provide the required flexibility to the DSO. The communication of the smart meters with EAC is proceeded with GPRS communication and a head-end system. The system design in illustrated in Figure 26.

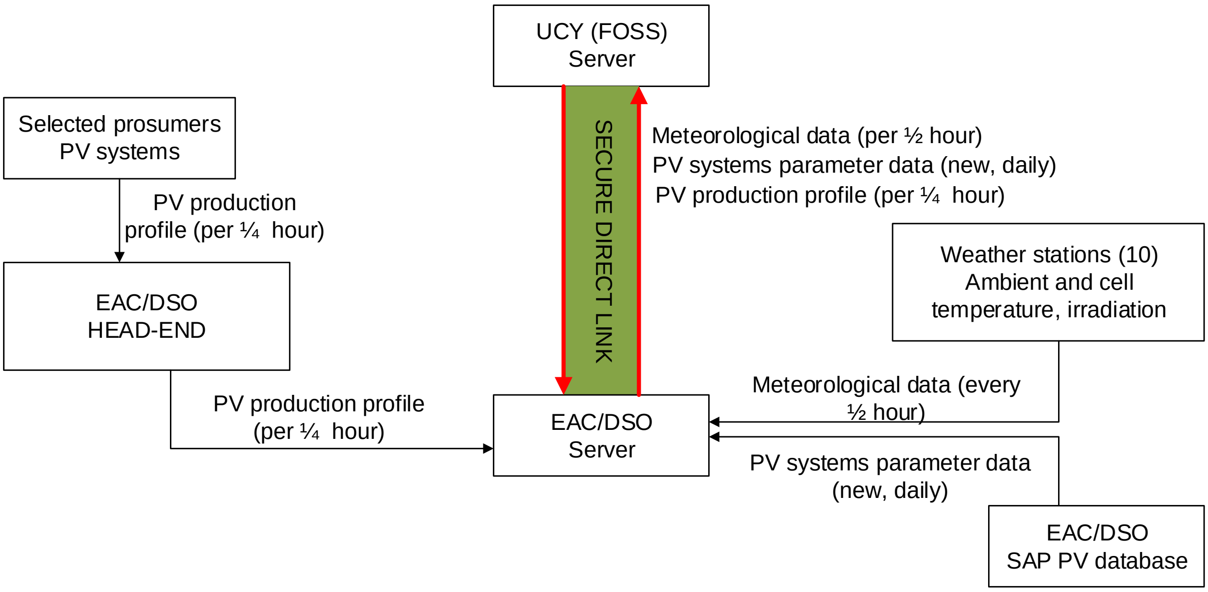

Figure 26 Communication link between the weather station, prosumers and EAC

In this figure, the two servers of EAC and UCY are presented. The measuring parameters from the weather stations and the PV production profiles are served as input data to the EAC/DSP server. Consequently, the data are transferred in an anonymized way to the UCY server, which is located at FOSS premises.

More analytically, the import/export metering data from all prosumers are transmitted wirelessly to the Head-End (HE) system to be installed at EAC. Further, meteorological data from 10 weather stations already installed in diverse locations in Cyprus are transmitted via Ethernet link to an EAC server. Meteorological data to be measured by these stations are ambient temperature and irradiation. This meteorological data will be exploited to accurately measure regional solar irradiation and relate meteorological parameters to total PV production. This relationship will help understand variations of system power demand due to PV production variation because of weather conditions variations and will provide a tool for conventional generation economic dispatch design in the presence of significant PV capacity penetration.

5.3 Testing and acceptance of components to install

Table 5 presents the technological components that will be installed at the Cyprus demonstration cases. The overview of the installed equipment is presented in Figure 27. The procedure will be carried out in three steps, as it is described in [1].

Table 5 Components installed at university campus

Use Case 1: Cyprus		
O1: Trading		Microgrid + BRP level
O2: Storage	Virtual	6 BEMS, 10 HEMS
	Explicit	1 CDEMS (EV in garage)
O3: DR ready xESM		6 BEMS (campus) 20 residential EMS
O4: EVs		4 Public (only charge) 1 Private (charge/discharge)
O5: Distribution Observability		Microgrid monitoring: 20+ Buses/branches DR effect on HV distribution Cyprus: 50+ buses/branches
O6: Cloud data services		SCADA: 10-50 points AMI: 20 points Weather: 10 points 50+ Forecasting models

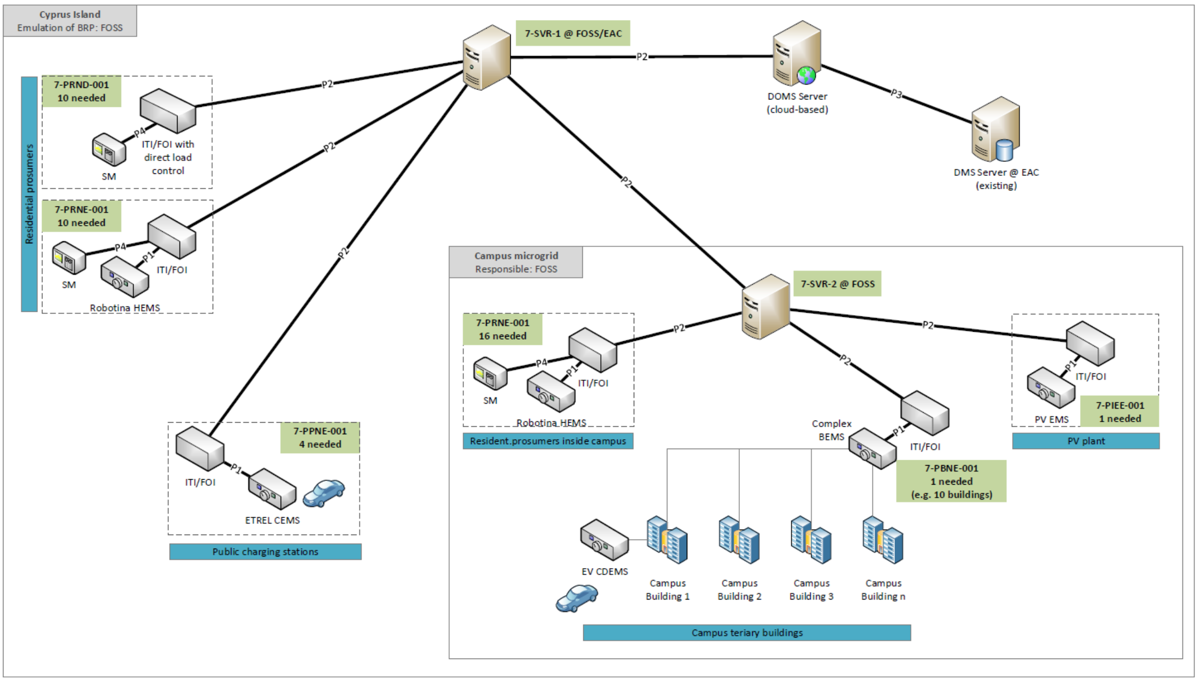

Figure 27 Installed equipment at Cyprus demonstration case

5.3.1 Installations at the university microgrid

Regarding the university campus, a smart metering infrastructure will be installed at each separate building. The target is to measure the energy production from the rooftop PV and consumption. Furthermore, the complex BEMS of each buildings will be unified in a single point of control. The KIBERnetFLEX solution will be utilized in order to generate flex-offers, which will be delivered by the Aggregator of the microgrid. FOSS will play the Aggregator role within the microgrid. The KIBERnetFLEX solution is developed by INEA and allows trading of energy flexibilities, based on the two-sided pool concept, where consumption and production (including DSM offers) are constantly matched. It uses an Intelligent Trading Interface (ITI) for generating flex-offers at the microgrid side. Through Cyprus demonstration case of the university microgrid, the KIBERnet family solutions will be extended to be able to address the large PV installation and the several smaller rooftop PV, the large energy storage and the energy consumption of each building.

Regarding the Electric Vehicle Charging Discharging Energy Management System (EV CDEMS), the solution provided by Robotina will be utilized. The target is to use the stored energy in a smart way, providing the flexibility needed by the DSO. The charging/discharging station will be located within the university microgrid. Since currently the EV manufacturer do not allow the discharging of the battery, there is an intention to locate a conventional battery in the charging/discharging station in order to test the discharging operation.

5.3.2 Installations at prosumer premises

The Home Energy Management System (HEMS) provided by Robotina will be utilized at each selected prosumer. The target is to manage the energy behaviour of the prosumers and control the respective energy by collecting the local production, consumption and several environmental parameters. Through the HEMS, the prosumers will have the opportunity to control their loads by using the web-based application and provide the required flexibility to the DSO. The details of the installation are presented in Figure 28.

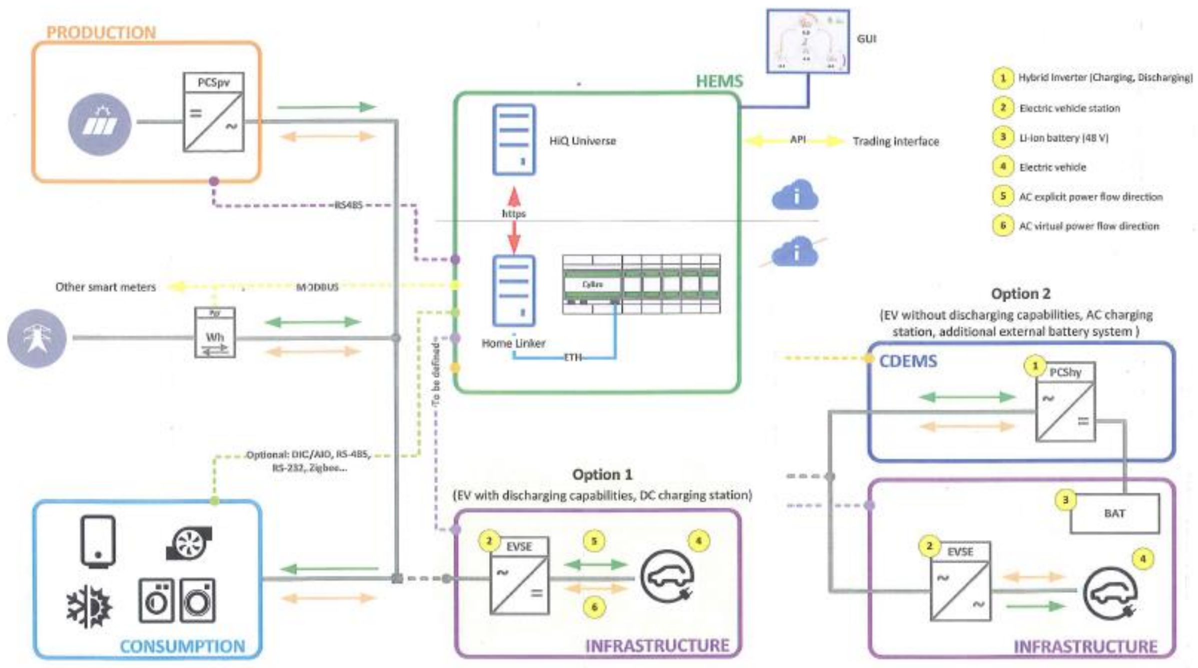

Figure 28 HEMS details regarding the prosumer in Cyprus

In each case, the target of the installed equipment is not to provoke discomfort to the energy habits of the prosumer, but give incentives to adopt a more grid-friendly consumption curve. Therefore, the prosumer will have the capability to monitor the energy production and consumption and response to the DSO's needs accordingly.

6 Conclusion

This deliverable is focused on the requirements of the demonstration case in Cyprus. The current infrastructure and the future installations are analysed concerning both the microgrid at the university campus and the prosumers. From this deliverable, the GOFLEX specific requirements are identified, while a presentation of new infrastructure of GOFLEX technology advancements is carried out. Therefore, the specifications of the Cyprus demonstration case are recognized, aiming at providing the necessary input to the technology providers of GOFLEX project.

7 References

—. (2017). GOFLEX Deliverable D 9.1: SWW Demo Site Requirements

Attachments

A.1 Prosumer Consent Agreement (in Greek):

ΣΥΜΦΩΝΙΑ ΣΥΝΕΡΓΑΣΙΑΣ ΓΙΑ ΤΟ ΕΡΕΥΝΗΤΙΚΟ ΠΡΟΓΡΑΜΜΑ GOFLEX

Σήμερα, στις ../../…. η Αρχή Ηλεκτρισμού Κύπρου (Διαχειριστής Συστήματος Διανομής, εφεξής «ΑΗΚ (ΔΣΔ)») η οποία για το συμβόλαιο αυτό εκπροσωπείται νόμιμα από τον/την ……………………… και ο/η ……………………… κάτοικος …………………….. οδός αριθμ. ……………………………………… (θα λέγεται εφεξής «Παραγωγός/Καταναλωτής») συμφώνησαν τα ακόλουθα:

Θα τοποθετηθεί ο αναγκαίος επιπρόσθετος εξοπλισμός στα κατάντη του σημείου διασύνδεσης του Παραγωγού/Καταναλωτή με το Δίκτυο στο πλαίσιο διεκπεραίωσης του ερευνητικού έργου GOFLEX. Ο επιπρόσθετος εξοπλισμός θα αποστέλλει τα δεδομένα στην ΑΗΚ και μετά από τη διαδικασία ανωνυμοποίησης θα αποστέλλονται στο Συνεργαζόμενο Φορέα, ο οποίος θα έχει τη δυνατότητα αποθήκευσης, επεξεργασίας και δημοσίευσης τους στη βάση της Συμφωνίας Εμπιστευτικότητας ΑΗΚ(ΔΣΔ)-Συνεργαζόμενου Φορέα για το παρόν ερευνητικό έργο.

Τα δύο αντισυμβαλλόμενα μέρη συμφώνησαν στους ακόλουθους όρους:

ΓΕΝΙΚΟΙ ΟΡΟΙ

ΑΡΘΡΟ 1 – ΟΡΙΣΜΟΙ

«**ΑΗΚ**» σημαίνει την Αρχή Ηλεκτρισμού Κύπρου που έχει ιδρυθεί βάσει του άρθρου 3 του περί Ανάπτυξης Ηλεκτρισμού Νόμου, Κεφ. 171, ως έχει τροποποιηθεί μέχρι σήμερα και όπως αυτός εκάστοτε τροποποιείται ή αντικαθίσταται και είναι νομικό πρόσωπο με διαρκή διαδοχή και κοινή σφραγίδα και με εξουσία να αποκτά, κατέχει και διαθέτει ιδιοκτησία, να συνάπτει συμβάσεις, να ενάγει και ενάγεται στο όνομα της και να κάνει οτιδήποτε είναι απαραίτητο για τους σκοπούς του Νόμου αυτού.

«**Δίκτυο**» ή «**Σύστημα**» σημαίνει το Δίκτυο Διανομής της ΑΗΚ.

Ως «**Συνεργαζόμενος Φορέας**» ορίζεται οποιοσδήποτε φορέας είναι ενεργός εταίρος στο παραπάνω ερευνητικό έργο και συμβάλλεται με την ΑΗΚ (ΔΣΔ) με Συμφωνία Εμπιστευτικότητας.

ΑΡΘΡΟ 2 – ΑΝΑΛΥΤΙΚΗ ΠΕΡΙΓΡΑΦΗ ΕΡΓΩΝ

2.1 Για την επίτευξη των ερευνητικών σκοπών του έργου, δυνατό να απαιτηθεί η ακόλουθη υλοποίηση:

1. Αντικατάσταση της υφιστάμενης μετρητικής διάταξης ή προσθήκη νέας,

2. Προσθήκη του αναγκαίου ηλεκτρολογικού ή τηλεπικοινωνιακού εξοπλισμού κατόπιν συνεννόησης με τον Παραγωγό/Καταναλωτή για τη θέση και το χώρο εγκατάστασης.

Ο Παραγωγός/Καταναλωτής δύναται να έχει πρόσβαση στις μετρήσεις που λαμβάνονται, ωστόσο δεν επιτρέπεται καμία παρέμβαση στον εξοπλισμό που θα εγκατασταθεί.

2.2 Η ΑΗΚ (ΔΣΔ) μαζί με το Συνεργαζόμενο Φορέα δεσμεύονται για την εγκατάσταση του απαιτούμενου εξοπλισμού, την ομαλή λειτουργία και την ασφάλεια του ανθρώπου και του συστήματος.

ΑΡΘΡΟ 3 – ΔΑΠΑΝΕΣ ΠΑΡΑΓΩΓΟΥ/ΚΑΤΑΝΑΛΩΤΗ

3.1 Δεν θα υπάρξει καμία επιπρόσθετη χρηματική επιβάρυνση για τον Παραγωγό/ Καταναλωτή, τόσο σε ζητήματα προμήθειας και εγκατάστασης εξοπλισμού, όσο και στην προμήθεια του ηλεκτρικού ρεύματος κατά τη διάρκεια διεξαγωγής του ερευνητικού έργου.

3.2 Ο επιπρόσθετος εξοπλισμός θα παραμείνει στην ιδιοκτησία του Παραγωγού/Καταναλωτή μετά το πέρας διεξαγωγής του ερευνητικού έργου χωρίς καμία οικονομική επιβάρυνση για τον Παραγωγό/Καταναλωτή.

ΑΡΘΡΟ 4 - ΑΠΑΙΤΗΣΕΙΣ ΕΛΕΓΧΟΥ ΤΟΥ ΕΓΚΑΤΕΣΤΗΜΕΝΟΥ ΕΞΟΠΛΙΣΜΟΥ

4.1 Η ΑΗΚ (ΔΣΔ) θα έχει το δικαίωμα να απαιτήσει από τον Παραγωγό / Καταναλωτή να διακόψει την παραγωγή και κατανάλωση ηλεκτρικής ενέργειας όταν είναι απαραίτητο, προκειμένου να συντελεστούν εργασίες εγκατάστασης, επισκευής, αντικατάστασης, συντήρησης, επίβλεψης ή αφαίρεσης του εξοπλισμού. Όποτε είναι δυνατόν, θα δίδεται από την ΑΗΚ (ΔΣΔ) εκ των προτέρων ειδοποίηση, εντός εύλογου χρονικού διαστήματος, για την πιθανότητα διακοπής παραγωγής και κατανάλωσης ηλεκτρικής ενέργειας.

4.2 Η ΑΗΚ (ΔΣΔ) θα έχει το δικαίωμα να διενεργεί οποιοδήποτε έλεγχο ή δοκιμή θεωρεί αναγκαία, στο αντιστροφέα τάσης (inverter), στα Φωτοβολταϊκά πλαίσια και γενικότερα στον ηλεκτρικό, τηλεπικοινωνιακό και μετρητικό εξοπλισμό του Παραγωγού/Καταναλωτή.

ΑΡΘΡΟ 5 – ΔΙΑΣΦΑΛΙΣΗ ΑΠΟΡΡΗΤΟΥ / ΠΡΟΣΤΑΣΙΑ ΠΡΟΣΩΠΙΚΩΝ ΔΕΔΟΜΕΝΩΝ

5.1. Κατά τη διάρκεια του έργου και όση χρονική περίοδο απαιτηθεί μετά τη λήξη του, οι Συνεργαζόμενοι Φορείς θα μεταχειρίζονται ως απόρρητες/εμπιστευτικές, οποιεσδήποτε πληροφορίες, οι οποίες τους αποκαλύφθηκαν κατά τη διάρκεια του έργου από τον Παραγωγό/Καταναλωτή, και οι οποίες χαρακτηρίζονται ως ιδιόκτητες από τον τελευταίο.

5.2. Σε περίπτωση που οι Συνεργαζόμενοι Φορείς ανταλλάσσουν προσωπικά δεδομένα, δεσμεύονται για την προστασία των δεδομένων αυτών. Μεταξύ άλλων, έχουν υποχρέωση να σέβονται το απόρρητο και την ασφάλεια των δεδομένων που μπορούν να λάβουν καθώς και να μην τα χρησιμοποιούν παρά μόνο για το σκοπό της αποστολής που τους έχει ανατεθεί.

5.3. Η ΑΗΚ (ΔΣΔ) είναι υπεύθυνοι για τη διαδικασία ανωνυμοποίησης όλων των πληροφοριών, οι οποίες αποκαλύφθηκαν κατά τη διάρκεια του έργου από τον Παραγωγό/Καταναλωτή και οι οποίες χαρακτηρίζονται ως ιδιόκτητες από τον τελευταίο. Οι Συνεργαζόμενοι Φορείς δύναται να έχουν πρόσβαση ύστερα από τη διαδικασία ανωνυμοποίησης σε όλες τις πληροφορίες και μετρητικά δεδομένα, που είναι απαραίτητα για τη διεξαγωγή του ερευνητικού προγράμματος.

5.4. Καμία ευθύνη δεν καταλογίζεται για την προστασία οποιωνδήποτε τέτοιων πληροφοριών και μετρητικών δεδομένων αν:

- **i.** έχουν δημοσιοποιηθεί πριν από, ή μετά από την κοινοποίησή τους χωρίς την επέμβαση αδικαιολόγητης πράξης εκ μέρους του λαμβάνοντος Φορέα,
- **ii.** είναι ήδη γνωστές στον λαμβάνοντα Φορέα, όπως αποδεικνύεται από γραπτά τεκμήρια στα αρχεία του εν λόγω Φορέα,
- **iii.** έχουν νομότυπα ληφθεί, χωρίς παραβίαση της παρούσας Συμφωνίας, από τρίτο, ο οποίος δεν δεσμεύεται από τους όρους της παρούσας Συμφωνίας,
- **iv.** έχουν δημοσιοποιηθεί χωρίς παραβίαση της παρούσας Συμφωνίας,
- **v.** έχουν αναπτυχθεί καλοπροαίρετα από υπαλλήλους του λαμβάνοντος Φορέα, οι οποίοι δεν είχαν πρόσβαση στις εμπιστευτικές πληροφορίες,
- **vi.** δεν υποδείχθηκαν επαρκώς ως εμπιστευτικές.

5.5. Ο κάθε Φορέας θα επιβάλει τις ίδιες υποχρεώσεις στους υπαλλήλους του, οι οποίοι λαμβάνουν γνώση των εμπιστευτικών πληροφοριών, ακόμη και για την περίοδο μετά από το τέλος του έργου ή μετά τη λήξη της απασχόλησής τους.

A.2 Prosumer Consent Agreement (in English):

COLLABORATION AGREEMENT FOR GOFLEX EU RESEARCH PROJECT

This collaboration agreement, effective as of …/…/…, is signed between Electricity Authority of Cyprus (Distribution System Operator, hereinafter called "EAC (DSO)"), which is legally represented by ……………, and ……………., resident of ……… with a registered address located at …………. (hereinafter called "Prosumer"), who have agreed the following:

Additional necessary equipment will be installed downstream of the interconnection point between the Network and the Prosumer within the framework of **GOFLEX** research project. The installed equipment will send the data to EAC (DSO) and after the anonymisation process the data will be sent to the Co-operating Organization, which will be able to store, edit and publish anonymously according to the confidentiality agreement between the Co-operating Organization and EAC (DSO) for the current research project.

The two contracting parties agreed to the following conditions:

GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS

"EAC (DSO)" is the Electricity Authority of Cyprus, which was established under the Electricity Development Law Cap.171, Article 3, in order to exercise and perform functions relating to the generation and supply of electric energy in Cyprus, operating within its own legal framework. Under this law, EAC (DSO) has the authority to enter into contracts and own property for the purposes of generation, distribution, transmission and supply of electricity.

"Network" is the Distribution Network of EAC (DSO).

A **"Co-operating Organisation"** is any organisation that actively participates in this research project.

ARTICLE 2 - WORK DESCRIPTION

2.1 In support of the objective of this research project, the following actions shall be implemented:

1. Replacement of the current metering infrastructure or placement of a new one.
2. Installation of the necessary electrical and communication equipment. The location of the installation will be specified after a consent with the Prosumer.

The Prosumer shall have access to the data, without being able to interfere with the installed equipment.

2.2 EAC (DSO), in consultation with the Co-operating Organisation, is committed to install any necessary equipment, to ensure its smooth functioning and to guarantee system's security and safety of the Prosumer.

ARTICLE 3 - PROSUMER EXPENSES

3.1 This agreement shall not involve any additional costs for the Prosumer, both for equipment supply and electricity supply, within the research project duration.

3.2 Once the research work has been completed, ownership of all additional equipment shall remain with the Prosumer, for no additional costs.

ARTICLE 4 - MONITORING AND CONTROL OF INSTALLED EQUIPMENT

4.1 EAC (DSO) shall retain the right to disconnect the Prosumer's electricity, when necessary, in order to carry out installation, repairs, replacement or maintenance work, as well as surveillance or removal of equipment. EAC (DSO) will provide, whenever possible, advanced notification of these disruptions to the Prosumer.

4.2 EAC (DSO) shall carry out, when necessary, inspections or tests of operation of PV module(s), inverter(s) and metering equipment of the Prosumer.

ARTICLE 5 - CONFIDENTIALITY / PERSONAL DATA PROTECTION

5.1 During the project implementation and for the required period following the end of the project, the Co-Operating Organisations will treat all information that have been obtained directly from the Prosumer as confidential. Moreover, the Co-Operating Organisation should use the data only for the purpose for which it was collected and not for some secondary purposes.

5.2 In case that the Co-Operating Organizations exchange personal data, they are committed for the respective protection. The Co-Operating Organizations are responsible for respecting the data privacy and protection, while they will able to use this data only for this certain purpose.

5.3 EAC is responsible for the anonymisation of all information that were obtained in the course of this research project from the Prosumer. Co-operating Organisations shall have access, after the data anonymisation process, to any information related to the electrical relation of the Prosumer with the grid.

5.4 No liability is imputed for such information if:

i. it has already been published, before the project start,
ii. it is already known to the Co-operating Organisation,

iii. it has been legally obtained by a third party, without breaching the rules of this agreement,
iv. it has been published without breaching the rules of this agreement,
v. it has been developed without any other intention by employees of the Co-operation Organisation, who did not have access to confidential data,
vi. it has not been properly indicated as confidential.

5.5 Each Organisation shall impose these confidentiality obligations to all employees who may have access to this information, during the project implementation and after the end of the project, or after they have ceased employment with the organisation.