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DELTA

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Pilot premises energy context analysis and end-users engagement/ training v1

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Executive Summary

This document reports on the technical and socioeconomic aspects of the pilot sites on the DELTA project.

Requirements (regulatory/RFP/timelines) for operation of DR in the pilots are discussed. Country specific information is given.

The pilot sites are surveyed in relation to the above and a review of the use cases specific to the pilot sites is presented.

This is the first version of the report, showing the initial analysis. This report will be substantiated and contextualise much further, presenting in more detail pilot planning, energy baselines, and specific equipment topologies will be presented in the second version (D7.6) of this report on M24.

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List of Acronyms and Abbreviations

Term	Description
CDO	Campus Development Office
DR	Demand Response
DVN	DELTA Virtual Node
FED	Finance Economics & Business
FEID	Fog Enabled Intelligent Device
IEEE	Institute of Electrical and Electronics Engineers
LV	Low Voltage
MV	Medium Voltage
PCC	Point of Common Coupling
PV	Photovoltaic

1. Introduction

1.1 Scope and objectives of the deliverable

To provide an initial report on the technical and socioeconomic context of the pilot sites as well an initial analysis of associated regulations and a review of the pilot use cases.

1.2 Structure of the deliverable

The technical parameters of the pilot sites are first described.

A socioeconomic review of the pilot sites is then presented.

Requirements for DR operation are discussed.

Assets to be integrated with the DELTA solution and FEIDs are reviewed.

Pilot-specific Use Cases are presented.

Initial end-user engagement is reported.

1.3 Relation to Other Tasks and Deliverables

This is an initial report that will be developed substantially in the full version (D7.6).

Related tasks are WP1 (Use Cases), T7.2 (end-users engagement and training) and WP6 (Customer training and innovative interaction tools).

2.1 UCY Pilot Infrastructure

The UCY pilot site comprises a selection of 4 buildings from the 17 tertiary buildings that make up the University of Cyprus campus in Nicosia, Cyprus. Coordinates are approximately 35.15° (lat.) and 33.41° (long).

The site plan illustrates the layout of the University of North Carolina at Chapel Hill campus. Key features include:

- Buildings and Facilities:** Labeled with abbreviations such as PK (Physical Education), CLC (Classroom), LAC (Lecture Hall), LAW (Law), CT (Counseling), MPM (Management), SCE (Student Center), SP (Student Plaza), PD (Physical Development), ENG (Engineering), FPA (Financial Planning), PFA (Physical Fitness), SRE (Student Recreation), and SRA (Student Recreation Area).
- Sports Facilities:** Includes a large yellow oval labeled LAC (Lecture Hall) and a large red oval labeled SRA (Student Recreation Area).
- Surrounding Areas:** The campus is bordered by a road on the left and a river on the right. The area to the right of the river is labeled PD RU 15 and PD RU 16.
- Color-Coding:** Buildings are color-coded: red for Physical Education (PK), yellow for Lecture Hall (LAC), purple for Law (LAW), blue for Counseling (CT), pink for Management (MPM), green for Student Center (SCE), orange for Student Plaza (SP), and brown for Physical Development (PD).

The electrical connection of the university campus with the distribution grid. 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. 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).

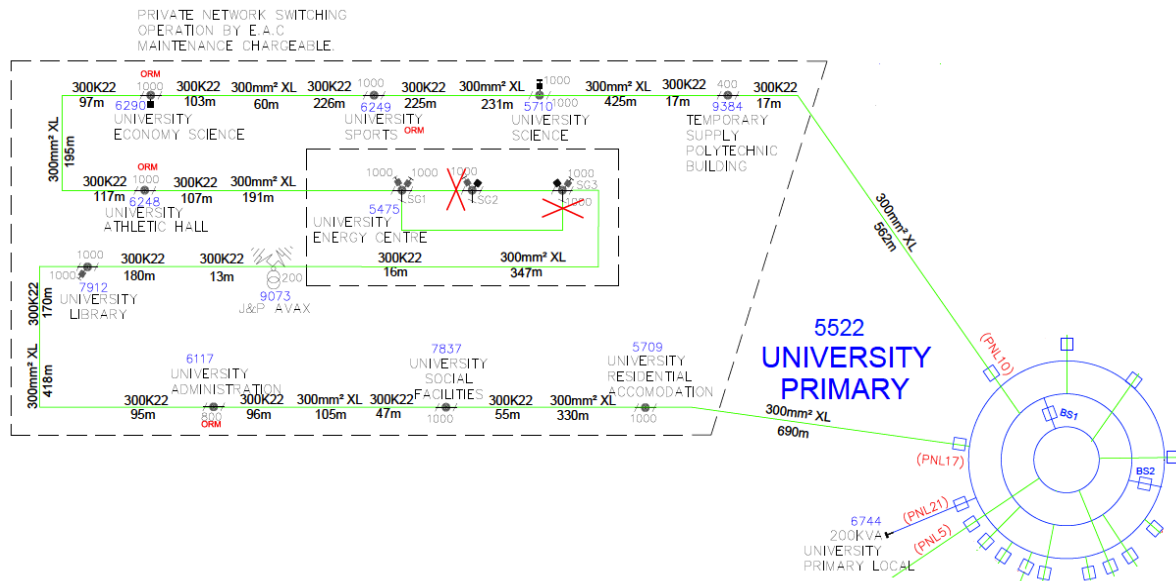


Figure 2: UCY Line Diagram

The Campus Development Office (CDO) has overall responsibility for the administration, coordination, supervision and development of the campus regarding: both urban and architectural parameters; energy management; mechanical and electrical issues; computer networks, etc. The Technical Services of the University have expressed interest in demand response concepts and are keen to be involved with the DRIMPAC project.

The road access map to the University of Cyprus campus is shown in Figure 3.



The climate is one of the warmest in the European union. Cyprus receives approximately 2 MWh/m² of solar energy per year (global horizontal), which is approximately double that of the UK. A significant amount of energy is spent on space cooling in the summer, with a typical average daily high temperature over 30 °C for four months of the year.

Of the 17 Tertiary buildings on the University of Cyprus campus, 4 have been selected for participation in the DRIMPAC project as part of the pilot deployment. The 4 buildings are:

- Library
- Administration
- Finance Economics & Business
- Residential

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2.1.1.1 The Library

The library at the University of Cyprus is a recent building with a modern and novel design. The building footprint is approximately 4200 m², 60 m by 70 m.

The building plan is shown in Figure 4.

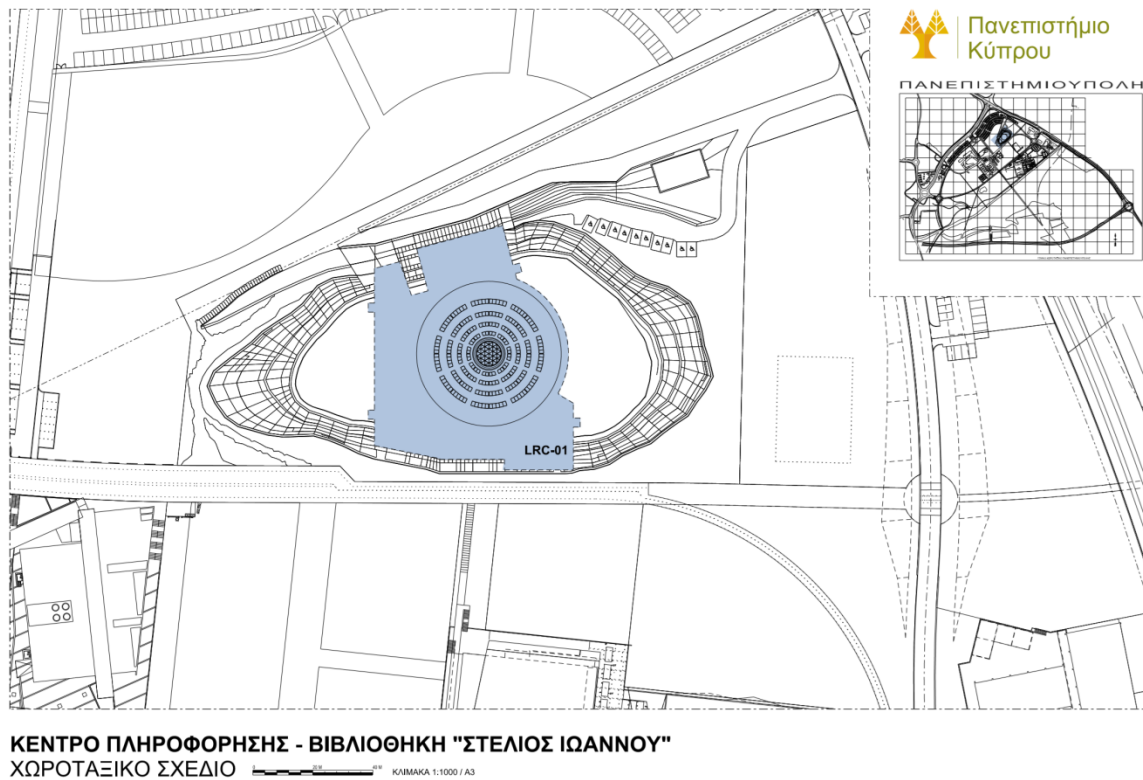


Figure 4. UCY Library building outline

The Library building consists of 4 floors and comprises approximately 80 offices (mostly double occupancy, 10 m² with some larger communal and some single occupancy), 40 study spaces (10 of which are large open spaces and 30 of which are designed for small groups and are bookable), 10 dedicated PC labs, 10 conference/meeting rooms, 2 lecture theatres, a cafeteria, a shop and 5 kitchen spaces for staff use. There are also several facilities rooms (storage/machine rooms/communication rooms/server rooms) distributed throughout the building, most of which are situated in the basement.

The first full month (April 2019) of available power metering data for the library is presented in Figure 5. There are two metering points for the library, as can be seen in Figure 5. Further investigation will be made throughout the course of the project to determine which loads are connected to which meter. The profiles of each metering point are generally similar with occasional substantial differences. For the example month, the baseline load for each meter is approximately 20 kW and the maximum load 200 kW. Weekday peak loads are around 165 kW with Saturday peaks dropping to around 140 kW and Sunday peaks to around 100 kW. The annual consumption of the library is not yet known but an approximation by extrapolation and comparison has been made at around 2 GWh.

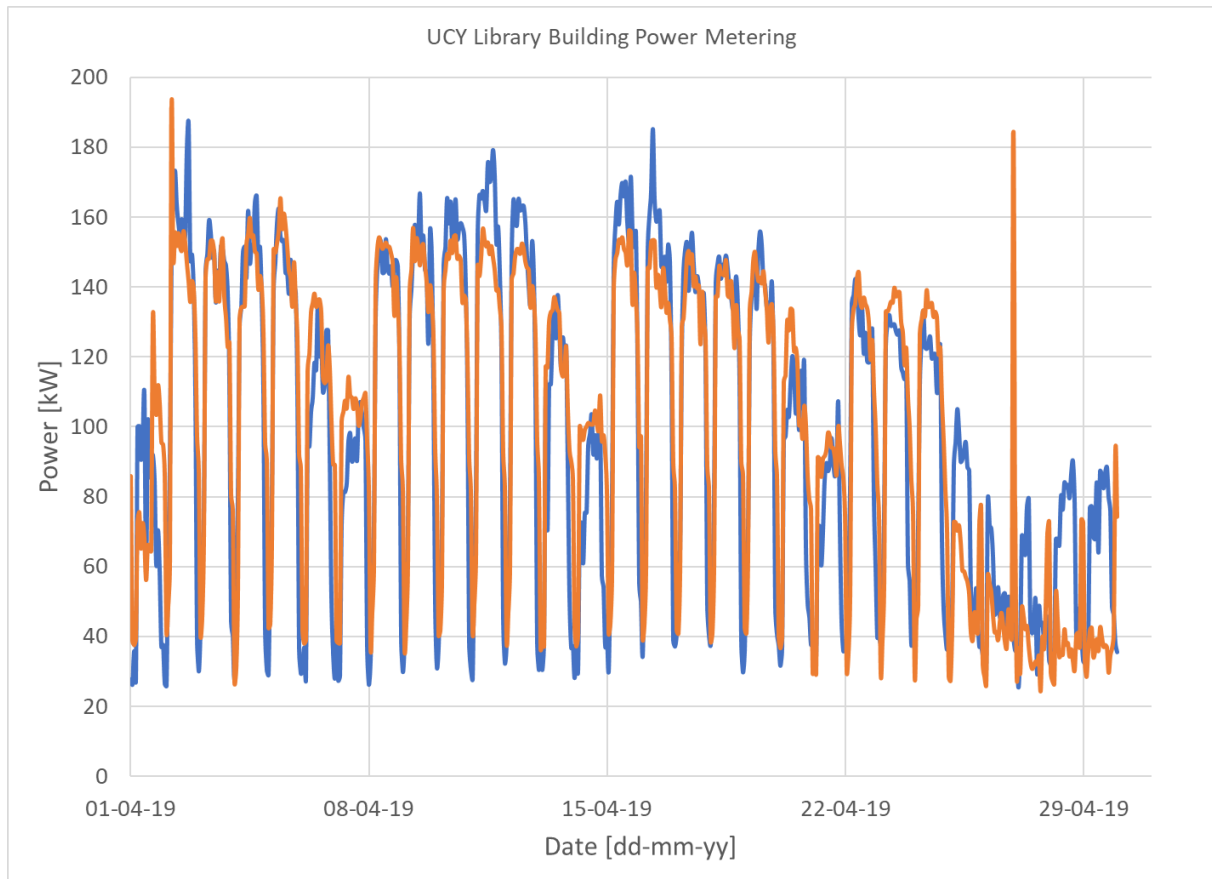


Figure 5. Power metering example for UCY Library, April 2019

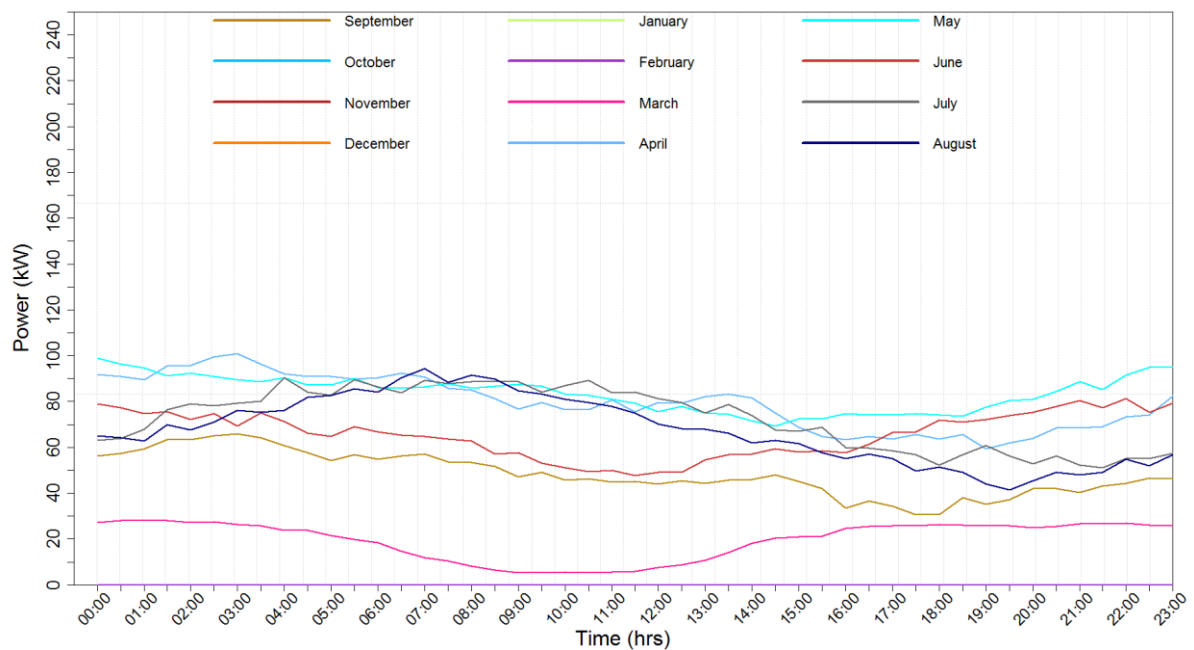


Figure 6. Average load Profile per month for the Library (Income 1) building.

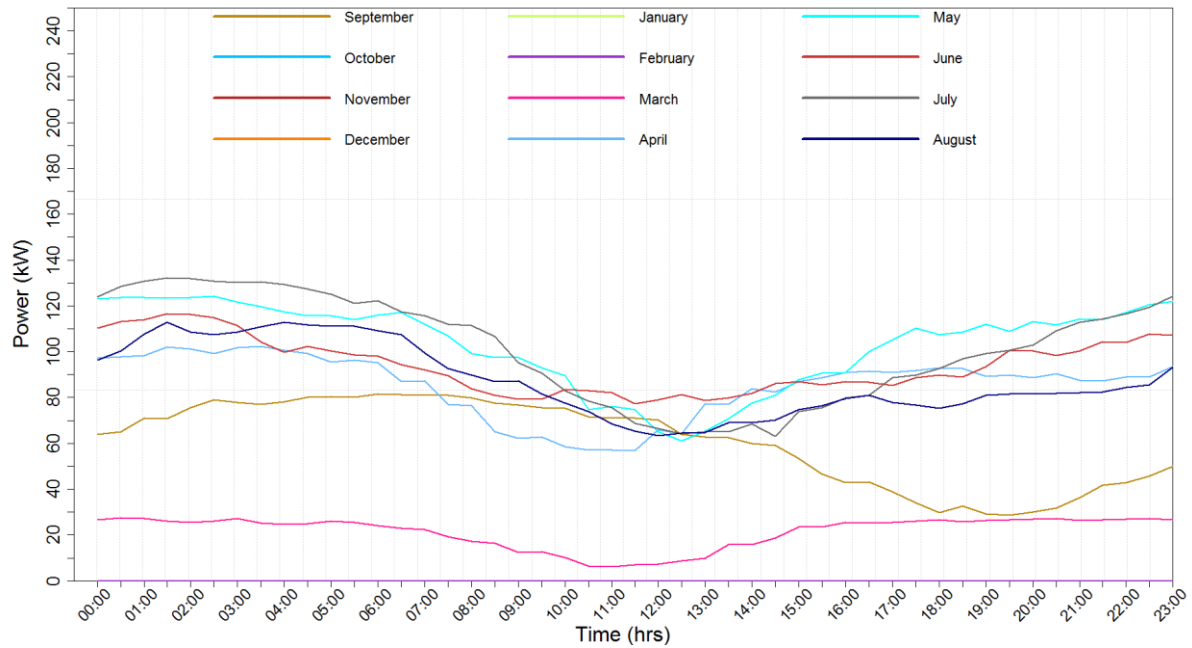


Figure 7. Average load Profile per month for the Library (Income 2) building.

2.1.1.2 Administration Building

The administration building is a single building of approximately 30 m by 80 m corresponding to a footprint of approximately 2400 m².

The building plan is shown in Figure 8.



Figure 8. UCY Administration building outline

The Administration building houses the central services of the University and comprises approximately

165 offices, 10 conference/meetings rooms, 5 kitchen spaces, 1 large cafeteria (approximately 200 m²) and 1 large lecture theatre (approximately 200 m²) typically used for large conference events. These are distributed over 5 floors. There are also several facilities rooms (storage/machine rooms/communication rooms/server rooms) distributed throughout the building, most of which are situated in the basement. The office spaces are typically around 10 m², single occupancy with some communal office spaces throughout the building.

Power metering for the month of March 2019 of the Administration building is presented in Figure 9. There is a single metering point for the administration building and this metering point encompasses not only the building load but also the rooftop photovoltaic system output, which is mostly self-consumed by the building. This can be seen in Figure 9 as there are only 2 negative readings throughout the example month of March 2019. March was chosen as a representative example regarding the PV generation profile as the month of March encompasses the Spring equinox. The contribution of solar output to the profile can be expected to increase in the summer and decrease in the winter. It should be noted that heating/cooling load is not accounted for in this profile as the University campus operates a centralised district heating system. For the example month, the baseline load for the building is approximately 50 kW and the maximum weekday load 175 kW. Weekend days are approximately equivalent in terms of load, operating at around the baseline. The 70 kWp PV system on the roof of the Administration building generates approximately 100 MWh per year and the annual consumption of the building is approximately 730 MWh.

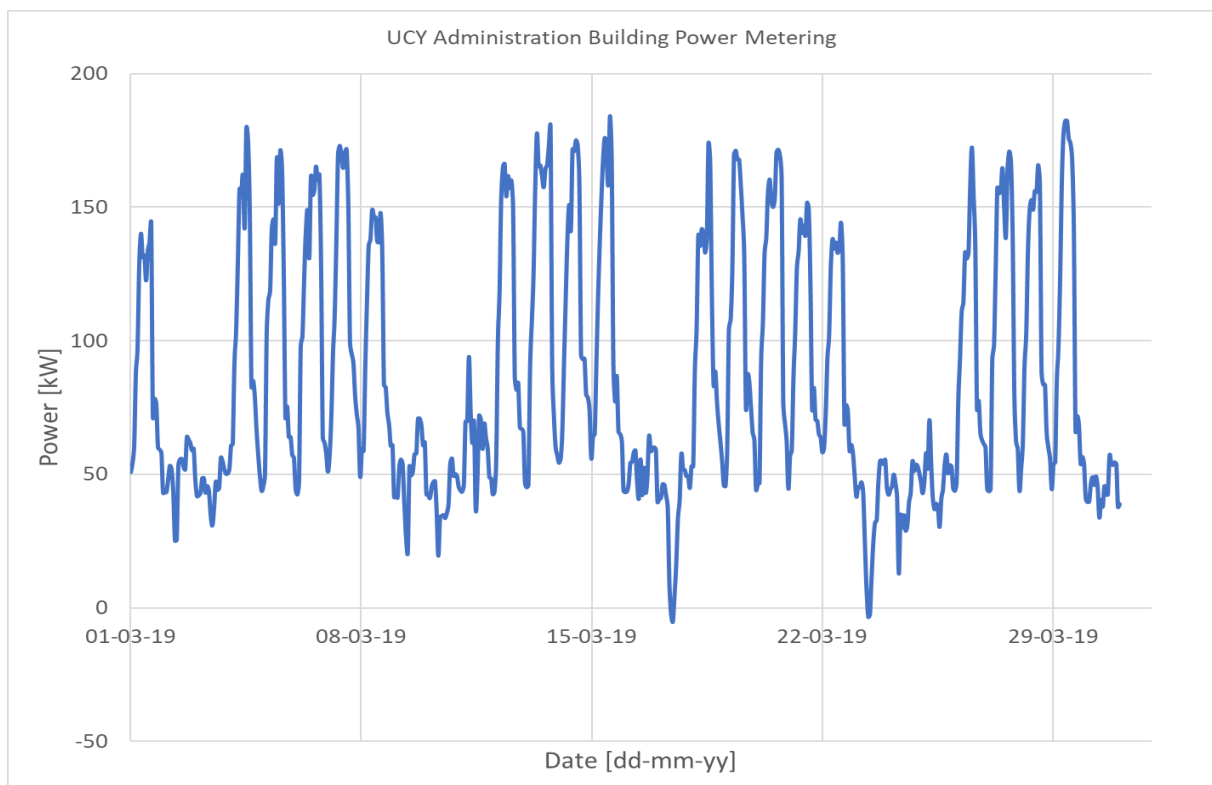


Figure 9. Power metering example for UCY Administration building, March 2019

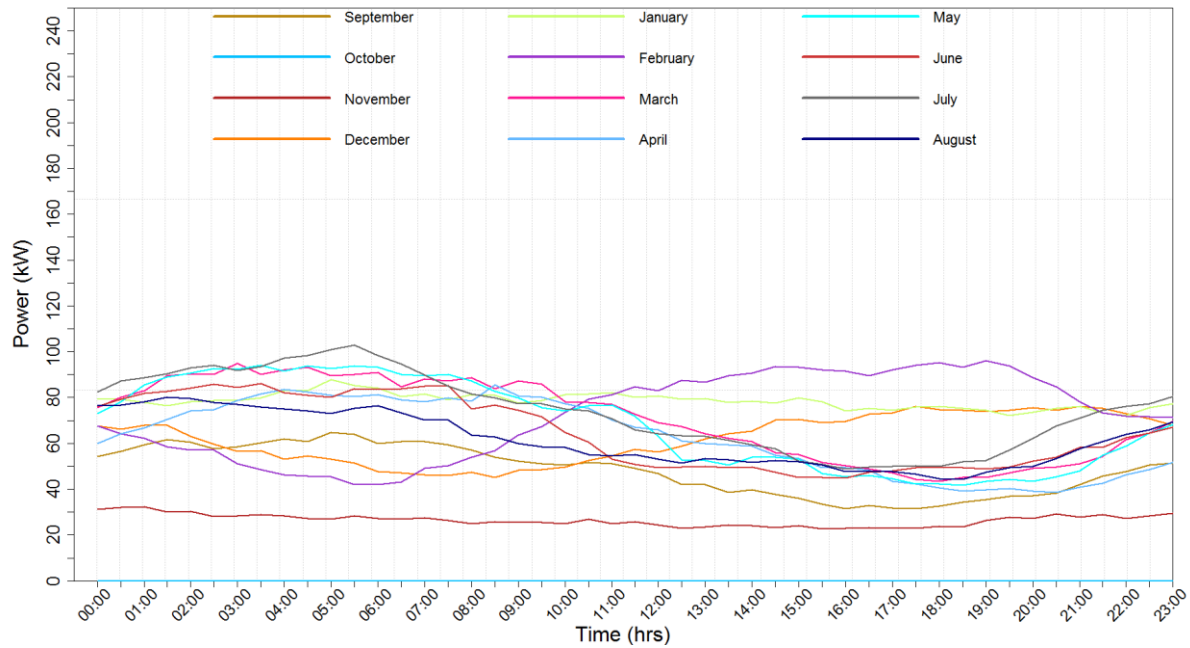
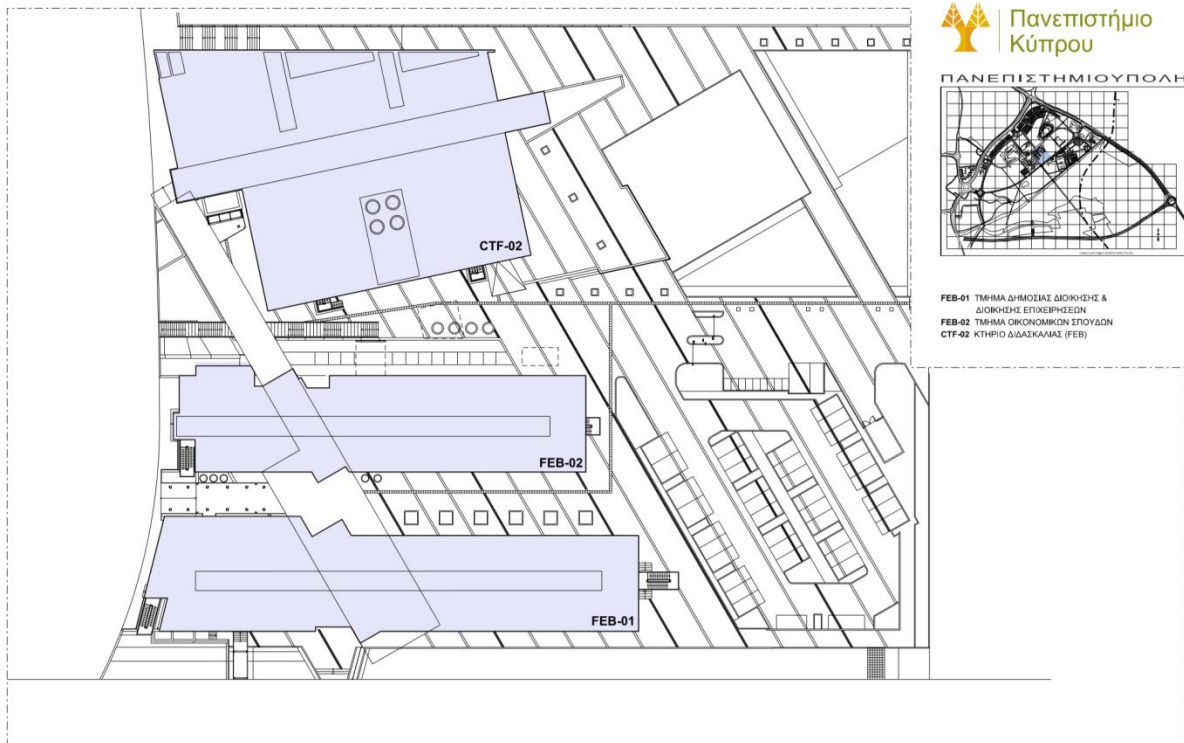


Figure 10. Average load Profile per month for the University Administration (ADM) building.

2.1.1.3 Finance Economics & Business (FEB)

The FEB building set comprises 2 buildings, one of 15 m by 65 m corresponding to a footprint of approximately 975 m² and one of 15 m by 85 m corresponding to a footprint of approximately 1125 m². The total footprint for the FEB building set is thus approximately 2100 m².

The building plan is shown in Figure 11.



ΣΧΟΛΗ ΟΙΚΟΝΟΜΙΚΩΝ ΕΠΙΣΤΗΜΩΝ ΚΑΙ ΔΙΟΙΚΗΣΗΣ

ΧΩΡΟΤΑΞΙΚΟ ΣΧΕΔΙΟ  ΚΑΙΜΑΚΑ 1:500 / A3

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Figure 11. UCY FEB building outline

The FEB building set comprises around 200 offices, 10 conference/meetings rooms, 10 kitchen spaces, 10 lecture theatres, 5 computer labs and a water pumping unit. These are distributed over 4 floors. There are also several facilities rooms (storage/machine rooms/communication rooms/server rooms), most of which are situated in the basement. The office spaces are typically around 15 m².

Power metering data for the month of March 2019 of the FEB buildings is shown in Figure 12. There is a single metering point for the FEB buildings. The FEB buildings consume approximately 1.25 GWh of electricity per year. It should be noted that heating/cooling load is not accounted for in this profile as the University campus operates a centralised district heating system to which the FEB buildings are connected. For the example month, the baseline load for the building is approximately 100 kW and the maximum weekday load 300 kW. Saturday load peaks are around 200 kW and Sunday load peaks around 150 kW.

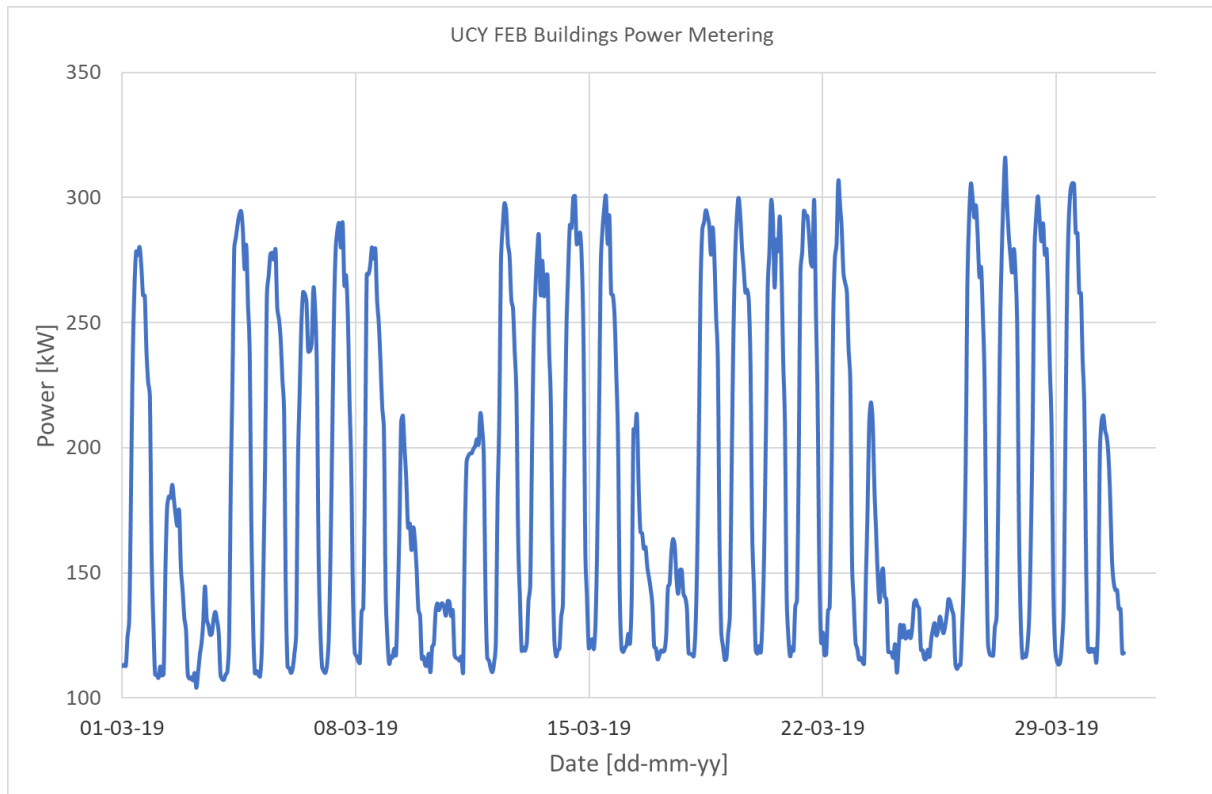


Figure 12. Power metering example for UCY FEB buildings, March 2019

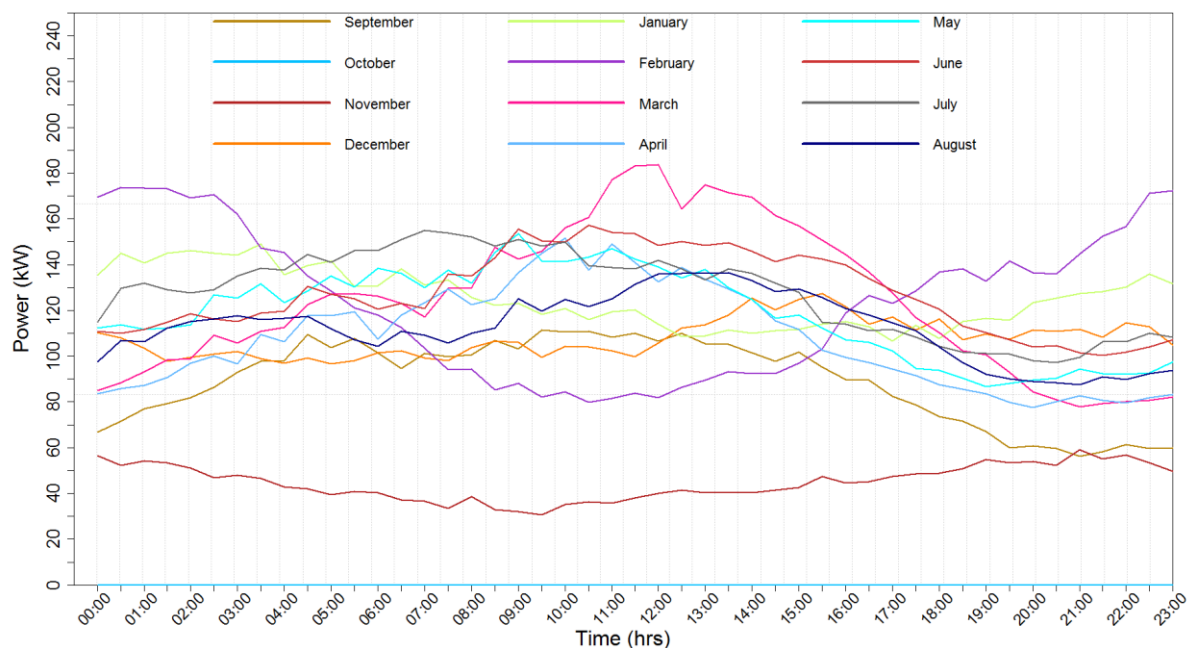


Figure 13. Average load Profile per month for the Faculty of Finance Economics & Business (FEB) building.

2.1.1.4 Resident Blocks

The residential blocks building set comprises 14 individual buildings each of approximately 25 m by 10 m corresponding to a footprint of 250 m². The total footprint of the Residential Blocks building set is thus roughly 3500 m².

The building plan is shown in Figure 14.

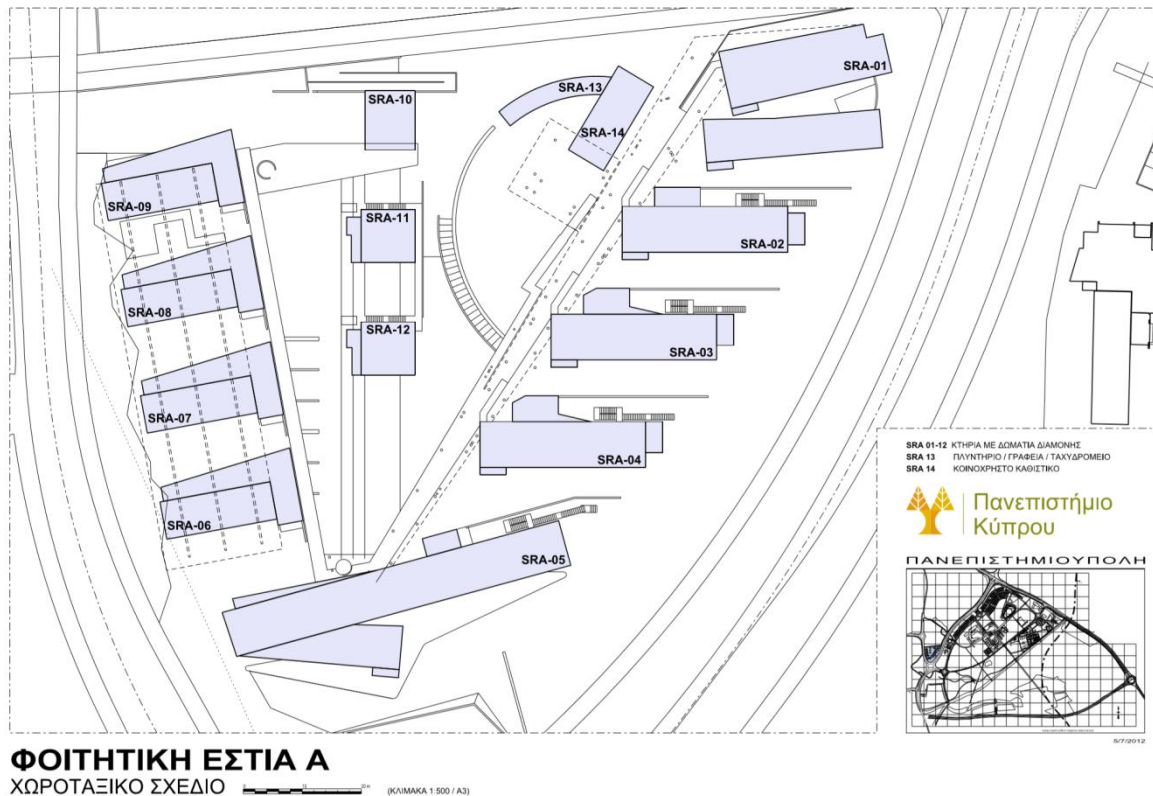


Figure 14. UCY Residential Blocks building outline

A typical building in the Residential Blocks building set has 4 floors with facilities rooms (storage/machine rooms/communication rooms) in the lowest floor (basement level 2); and 8 individual dormitories and 1 communal kitchen on each of the 3 floors above. There is typically 1 occupant per dormitory thus approximately 25 occupants per building and around 300 residents across the building set.

Power metering data for the month of March 2019 of the Residential Blocks is presented in Figure 15. There is a single metering point for the Residential Blocks and this metering point encompasses not only the buildings load but also the nearby photovoltaic system output, which is preferentially self-consumed by the buildings. This can be seen in Figure 15 as there are significant negative readings throughout the example month of March 2019. The reason for these negative readings is that the 175 kWp PV system generates approximately 255 MWh per year whereas the Residential Blocks buildings consume approximately 185 MWh per year. March was chosen as a representative example regarding the PV generation profile as the month of March encompasses the Spring equinox. The contribution of solar output to the profile can be expected to increase in the summer and decrease in the winter. It should be noted that heating/cooling load is accounted for in this profile as the residential blocks are not controlled by the district heating system but the individual dormitories have user-controlled air conditioning systems. For the example month, the baseline load for the building is approximately 50 kW and the maximum weekday load 175 kW. There is no immediately obvious difference between weekdays and weekends in terms of load but this will be further investigated throughout the course of the project.

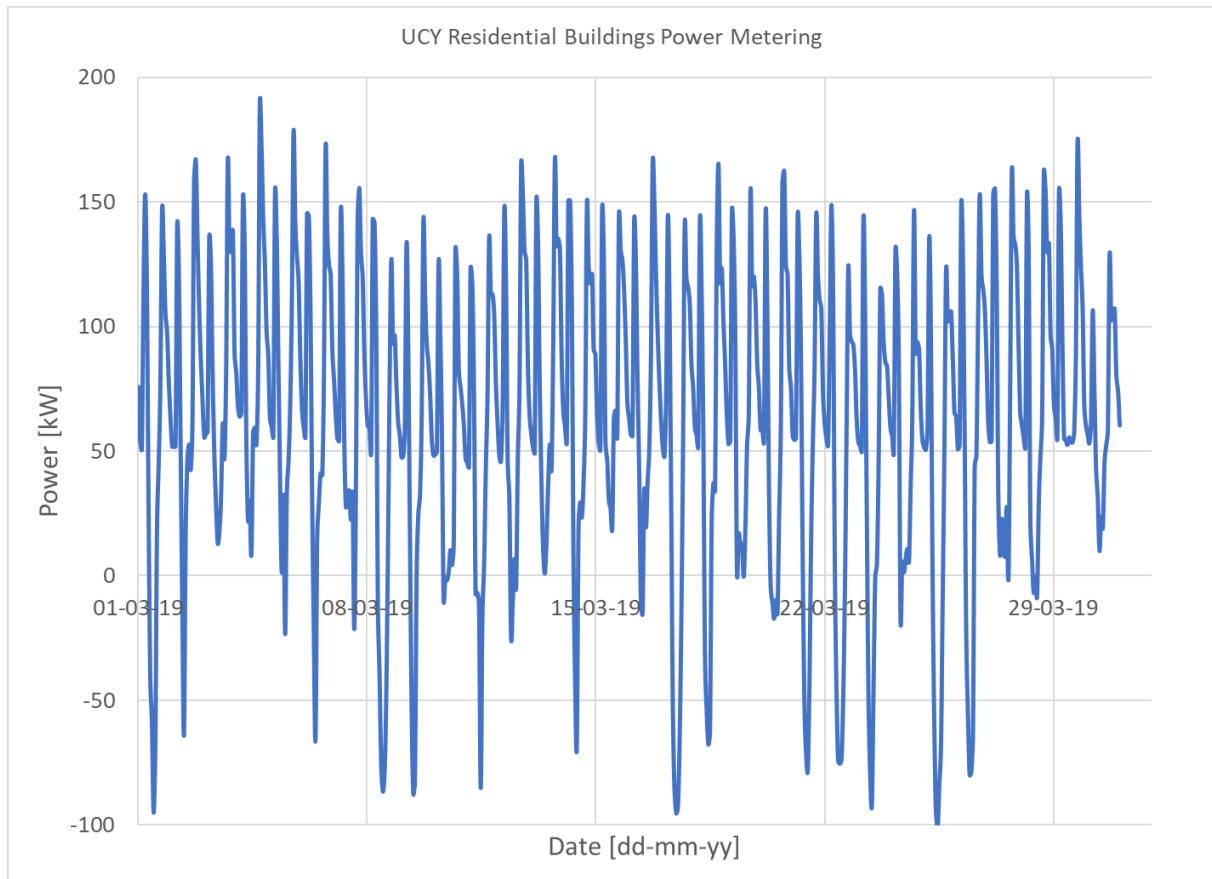


Figure 15. Power metering example for UCY Residential Blocks, March 2019

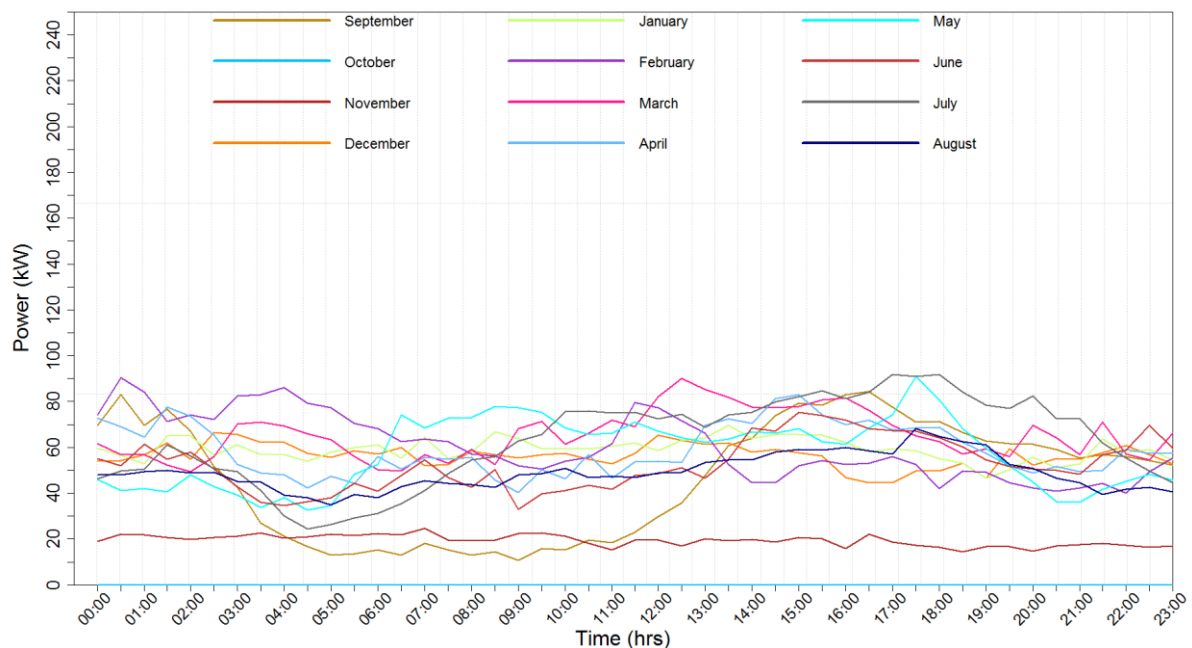


Figure 16. Average load Profile per month for the Residential Student Halls building.

Some of the Residential block buildings and the connected PV plant are shown in Figure 17.



Figure 17. UCY Residential Blocks (background) and connected PV system (foreground)

2.1.2 Service Description

To review, across the four buildings in the UCY pilot site described above the key services are:

- Office spaces
Used by staff during work hours. Most of the office spaces included in the UCY pilot are single occupancy offices although some are shared.
- Lecture theatres
- Typically used for public facing events and conferences, from 100 to 250 people
- Lecture rooms
- Mostly used to deliver course material to the students of UCY, typically host up to 50 people
- Meeting/conference rooms
- Used for internal staff and/or student meetings as well as small public facing events. Bookable.
- PC labs
- Dedicated facilities with up to 50 PCs installed with various software used in course delivery to UCY students
- Study spaces
- Areas dedicated to private or group study, some open quiet spaces, many bookable rooms.
- Dormitories

- Individual living spaces
- Cafeterias
- Serving refreshments and catering for breakfast and lunch
- Kitchen spaces
- Facilities used by staff for the preparation of hot beverages and food

An overview of the distribution of these services across the UCY pilot is given in Table 1.

Table 1. UCY Pilot services overview

	Library	Administration	FEB	Residential	Total
Office	80	165	200		445
Lecture Theatres	2	1			445
Lecture Rooms			10		13
Meeting Rooms	10	10			20
PC Labs	10		5		15
Study Space	40				40
Dormitories				300	300
Cafeteria	1	1			2
Kitchen Spaces	5	5	2	15	12

The energy requirements associated with these services are detailed in section 4.

2.1.3 Energy Requirements Description

The annual energy consumption and associated PV system generation for each of the 4 UCY pilot buildings are shown in Table 2.

Table 2. UCY Pilot buildings annual energy consumption and generation values

Building	Approximate Consumption (kWh/year)	Approximate Production (kWh/year)
Administration	750,000	100,000
FEB	1,300,000	0
Residential Blocks	200,000	250,000
Library (extrapolated from 1 month of data and similarities with other campus buildings)	2,000,000	0

The total annual energy consumption across the four buildings of the UCY pilot site is thus approximately 4 GWh.

The energy usage across the 4 buildings is associated with the services offered in the buildings, as detailed above in section 2.1.2. The energy requirements per service are described below in Table 3.

Table 3. Energy requirements for provision of services at UCY pilot site

Service	Principle Energy Requirements	Considerations for Flexibility
Office	Mostly personal computers, some printing facilities, lighting	Tied to office hours, can be predicted to some extent from calendar entries.
Lecture Theatres	Audio & Visual (AV) services, theatre lighting, local sockets often used by attendees for personal laptops	As these are linked public facing events, they would not be considered flexible, although events are booked in advance so usage is known.
Lecture Rooms	Projection, lighting	Generally booked in advance, unlikely to be considered flexible after booking due to the emphasis placed on student satisfaction. Flexible prior to booking.
Meeting Rooms	Projection, often many attendees will have personal computers, lighting	Generally booked in advance, flexible prior to booking.
PC Labs	Desktop PCs often running specific software, some of which is power intensive, lighting.	Generally booked in advance, unlikely to be considered flexible after booking due to the emphasis placed on student satisfaction. Flexible prior to booking.
Study Space	Power for personal PCs, lighting.	Generally booked in advance, unlikely to be considered flexible after booking due to the emphasis placed on student satisfaction. Flexible prior to booking.
Dormitories	Heating/cooling, local power requirements, lighting	User controlled, could be considered flexible with sufficient incentives passed to individual users, especially regarding heating/cooling.
Cafeteria	Industrial catering equipment (heating/cooling)	Tend to use energy according to service demands and thus have timeframes for operation that may be difficult to change. However, financial incentives such as time of use tariffs employed by the University may influence energy usage.
Kitchen Spaces	Appliances for cooling and heating food/beverages	Many of the heating appliances tend to be high energy devices that see a lot of use within a specific time interval (lunchtime). This interval may be spread across a few hours depending on staff preferences. It may be possible to incentivise pre/postponing the use

		of this equipment.
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Further work will be done on the project to disaggregate the energy usage in the buildings throughout the pilot site and identify flexibilities.

2.2 KiWi Pilot Infrastructure

2.2.1 KiWi Pilot– infrastructure

The KiWi pilot site comprises two focused pilots representing the commercial and residential sectors. These pilot sites are Moor House (Central London, UK) and Ernest Dence Estate (Greenwich, UK), respectively.

2.2.1.1 Moor House

Overview

Moor House is an office building located in Central London hosting approximately 4,100 employees and covering a total area of 43,300 m². Energy consumption is split between electricity (total annual consumption of 9,636 MWh) and gas (total annual consumption of 3,883 MWh).

Each floor has a North and South zone of fan coils with individual temperature set points. KiWi Power controls the Air Handling Units (AHU) via propitiatory technology so that they can participate in the Static Frequency Response (SFR) programme, described in more detail later in this document.

Demand Response at Moor House

In accordance with the requirements of the SFR programme, whereby 1 MW of assets is required for participation, Moor House is part of a larger contract with other assets of similar technical characteristics comprising a 1 MW of turndown contract with the UK National Grid. Moor House gets monthly payments for availability (each month the availability payment prices are different due to the nature of the monthly procurement cycle for this product from National Grid). There are penalties that can be issued if the asset does not deliver the agreed turndown volume.

For the purpose of the pilot site, Kiwi Power and partners will install the FEID to replace the existing proprietary KiWi technology (called the Fruit) that is currently managing these operations. The benefits of the FEID and the DELTA solution over the KiWi Fruit are detailed in the DELTA deliverable D2.1. The FEID will be preconfigured to respond to the UK National Grid Frequency and if the frequency goes above 50.2Hz then the FEID needs to give the action to the Moor House chillers to turn down to the agreed capacity. As the site is part of an existing contract under the Framework agreement of Kiwi, any technological means to supply the necessary turndown value can be implemented without any issues around RFP regulations. The technology that is used to deliver the service is natural to National Grid.

2.2.1.2 Ernest Dence Estate-Greenwich

The Ernest Dence Estate is a residential estate comprising 3 buildings.

1. Aylmer House with 64 flats
2. Jennings House with 20 flats
3. Gifford House with 20 flats.

A monitoring device (a smart meter) is installed with the target of interacting with the installed smart meters to provide TRIAD avoidance notifications so that the residents of these houses can reduce their energy consumption and avoid significant incurred charges for the energy usage at these times.

A TRIAD is one of the three highest electricity consumption peaks in the UK peak usage season, winter. These typically occur on in the evening ‘shoulder’ of the daily usage profile. The determination of TRIADs is subject to the further specification that there must be a minimum of 10 days between TRIAD points, this leads to difficulty in the prediction of TRIAD events and generally a widespread concerted effort for those entities on half-hourly electricity tariffs to minimise energy usage at potential TRIAD points to avoid significant costs.

The number of houses at the Ernest Dence Estate that will participate is not yet confirmed as residents have to sign up to the scheme, due to the data protection laws currently in place. Upon acceptance, DELTA FEIDs will be installed that will communicate with and via the installed smart meters and mobile phone applications, email and SMS to provide turndown notifications. KiWi wants to issue payment vouchers for the duration of the trial via Horizon 2020 to incentivise the residents to respond to the trial. The installed smart meters are parasitic and are installed to each house electrical board.

3. Socioeconomic Parameters

3.1 UCY Pilot

The users of these services differ in many contexts. Users of the same services may be from many different demographics and differ greatly in their comprehensions of and attitudes to demand response initiatives.

The occupants of the Residential Blocks are all University students, some of whom reside in the dormitories for the full year and some of whom make frequent visits to families at weekends. Time spent in the dwellings is dependent on their individual schedules and influenced significantly by University timetabling of courses. The kitchen spaces in these residential blocks differ to those in the other pilot site buildings in that they are used in the evenings for food preparation.

Office staff are a large part of the UCY pilot site as there are many offices distributed throughout the Administration, FEB and Library buildings. Office staff generally work inflexible hours and have routine set times for breaks, during which they are more likely to use the kitchen facilities and the services of the cafeterias throughout the campus.

The lecture rooms, PC labs and study spaces will be used primarily by University students at times predetermined by timetabling. There may be some flexibility at the point of the timetabling but these services are generally considered inflexible after this point, primarily in relation to the satisfaction of students. In this context the students are considered service users. Service users tend to utilise facilities with expectations of service provision at given times and their levels of satisfaction has commercial ramifications on the service providers. In this sense the lecture theatres and meeting rooms can be considered services provided to both internal and external persons by the University and the cafeteria can be considered similarly.

Commercial staff responsible for the provision of services (such as the cafeteria) may have somewhat different incentives regarding demand response as companies are often tasked with energy cost reduction strategies. The timing of industrial processes may be flexible although this is not something that be dictated by the University directly – incentives must be passed to these persons through an electricity billing system which is currently simple and linked directly to the University's tariff with the electricity provider, EAC.

Each of the four buildings in the UCY pilot site is managed by personnel from University technical services. These technical staff will require executive control over any settings of building energy management systems. They are tasked with the provision of services to the satisfaction of building tenants whilst minimising cost.

An overview of the service Users at the UCY pilot site is presented in Table 4.

Table 4. UCY Pilot site Service Users Overview

Technical Staff	Office Staff	Residents	Commercial Staff	Service Users (some overlap)
5	500	300	25	1000

Table below summarises the annual energy usage of each one of the buildings along with the respective electricity cost.

No	Building	Type	Annual Consumption [kWh/year]	Annual Peak Consumption [kWh/year]	Annual Off-Peak Consumption [kWh/year]	Annual Peak Consumption on Weekends [kWh/year]	Annual Off-Peak Consumption on Weekends [kWh/year]	Annual Electricity cost [€/year]
1	University Administration (ADM)	Commercial - Offices	1,352,034.95	474,733.99	545,345.74	146,245.45	185,709.77	254,592.88
2	Athletic Centre Sport	Commercial - Sports Facilities	26,079.72	9,157.26	10,519.30	2,820.96	3,582.20	4,910.90
3	Athletic Hall	Commercial - Sports Facilities	317,482.14	111,476.08	128,056.99	34,341.06	43,608.00	59,782.99
4	Energy Centre – Chillers 1&2	Commercial – Heating / Cooling	997,303.07	350,178.57	402,264.00	107,875.20	136,985.31	187,795.64
5	Energy Centre – Chillers_3&4	Commercial – Heating / Cooling	1,227,904.08	431,148.47	495,277.33	132,818.59	168,659.69	231,218.61
6	Energy Centre – Chillers 5&6	Commercial – Heating / Cooling	816,722.27	286,772.04	329,426.40	88,342.33	112,181.50	153,791.64
7	Energy Centre – Chillers 7&8	Commercial – Heating / Cooling	304,947.75	107,074.94	123,001.22	32,985.26	41,886.33	57,422.72
8	Energy Centre	Commercial - Offices	1,581,973.59	555,471.32	638,091.90	171,117.20	217,293.17	297,891.13
9	Faculty of Finance Economics & Business (FEB)	Commercial - Offices	1,054,308.01	370,194.46	425,257.04	114,041.24	144,815.27	198,529.86
10	Faculty of Pure and Applied Sciences (FST 01)	Commercial - Offices/ classrooms	2,664,764.83	935,666.97	1,074,837.71	288,239.39	366,020.77	501,784.48
11	Faculty of Pure and Applied Sciences (FST 02)	Commercial - Offices	1,044,136.88	366,623.12	421,154.49	112,941.06	143,418.20	196,614.60
12	Library – Incomer 1	Commercial - Library	377,085.34	132,404.29	152,098.05	40,788.16	51,794.84	71,006.48
13	Library – Incomer 2	Commercial - Library	483,643.88	169,819.71	195,078.63	52,314.27	66,431.27	91,071.82
14	PV Lab: Chillers-Climatic	Commercial – Heating / Cooling / Offices	6,916.20	2,428.45	2,789.66	748.10	949.98	1,302.34
15	PV Lab	Commercial -	26,122.34	9,172.22	10,536.49	2,825.57	3,588.05	4,918.93

		Offices						
16	Social Facilities Building	Commercial – Facilities	1,352,034.95	474,733.99	545,345.74	146,245.45	185,709.77	254,592.88
17	Residential Student Halls	Residential – Facilities	223,550.00	78,494.11	90,169.30	24,180.71	30,705.88	42,095.24
Total			13,857,010.00	4,865,550.00	5,589,250.00	1,498,870.00	1,903,340.00	2,609,323.17

3.2 KiWi Pilots

Moor House

Moor House will continue to enjoy the revenue for the participation to SFFR via DELTA under the Kiwis Framework agreement with National Grid. Via this service (SFFR) we will ensure the frequency of the National Grid remains within secure limits. Moor House will benefit about £2,10/MWh for the 0.345MW they have under contract for each month Kiwi secures capacity via the tender National Grid holds once a month.

Ernest Dence Estate-Greenwich

The residents of the flats will benefit by turning down unnecessary devices they might consume electricity and via the notifications they will receive from DELTA they will reduce the carbon foot print, get reduced energy bill and benefit via the cash coupons we proposing having in place.

4. Requirements

4.1 UCY Pilot

UCY site will simulate a market for operation in collaboration with EAC and some simulated requirements will be justified following EU market rules. The previous directive for DR and the Clean Energy package will be reviewed contextually alongside physical constraints and safety measure in the CY grid to ensure that market rules are well simulated in the project and a justified consideration for future market operation in Cyprus is presented.

4.2 KiWi Pilots

Requirements for operation in the UK related predominantly to Article 8 and Article 10.

- Depending on the type of asset a potential client we might get under our management we have to procure a certain set of information and site visits to determine the programme.
 - Half-Hourly Data to analyse and see what is the average consumption/use of the asset so we can see what is the flexibility of the asset. In case the asset has an export agreement with the local DNO then we know what is the export capacity and makes things more simple.
 - Response time of the asset (1 second is Dynamic Frequency, from 10 seconds-30 seconds is Static Frequency and anything more than a minute and up to 15 minutes is STOR and Constraint Management.
- Once we do the initial site visit and get all the data then we sign a contract (between Kiwi Power and the client) and we send an Appendix 8 form (please see attached an example). Once the client has sign the apex.8 we send it to National Grid for approval.

- Once we get approval (up to-10 days) then we are allowed to upload the asset to our platform and be able to declare it to the aggregation buckets.
- We have aggregation buckets for all of the programmes and we determine in which bucket an asset will go depending of the size of the asset, the weekly availability declaration the client has to provide us with and response time. For STOR, for example, we always try to balance the buckets with several small assets (0,5MW-3MW) with larger assets (40MW) so in case 1 customer doesn't deliver the agreed capacity the aggregation bucket can overdeliver so we won't fail in case of an event. When a client is not performing according to the agreed capacity we pass on the penalties that National Grid might apply.
- National Grid doesn't allow an asset to participate in 2 different ancillary services at the same time (FFR services & STOR), however, they are allowed to participate to STOR and Capacity Market and STOR and Constraint Management.
- STOR+ CM is allowed as CM is a backup service which will only happen in case of National emergency and all the ancillary services have failed to maintain electricity to the country.
- STOR +Constraint Management is allowed because the one looks after the National level and the CMZ looks at the local level. However, in case you are utilising an asset at CMZ and there is a call for STOR(or any other TSO programme) and your asset participates in CMZ then the asset gets financial penalties. If you are responding to a TSO event and you are not responding to a DNO event the are no penalties.

For a client to participate into the ancillary services under the framework agreement of Kiwi Power Ltd we need to demonstrate a test (start and stop signal from our Operations department) so we can prove in paper that the client can response within the time requirements of the programme and submit a document issued by National Grid called Appendix 8. The document alongside with the test results are send to National Grid for approval (within 10 days). Once the document gets approval Kiwi Power sends a User Acceptance Manual (UAT) to the contracted customer so the know the programme requirements and know how to operate the mobile app and desktop programme for demand response. For the purpose of Moor House all the above have been done and we don't need to repeat the process as the Pilot site will be under the current framework contract. Currently no specific agreement is required by the regulatory body for case of the Ernce Dence estate.

For the Ernce Dence Estate, we will be seeking written approval by the Greenwich council and the residents.

5. Distributed Energy Resources & Systems to be integrated with FEIDS

5.1 UCY Pilot

The current and future infrastructure that is going to be utilized within the project is summarized in the following: Current installations (depicted in Figure 18):

- 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



Figure 18 Current PV installations within the university campus

The specifications of the BEMS are summarized in Table 5.

Table 5 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 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.

Explicit DR can be performed in buildings with Siemens BEMSs (FEB01, Library) as we have direct control through a custom central EMS, while for the rest of the buildings (Administration, Residential) only implicit DR can be implemented as we have no control over the Honeywell BEMSs. The only major available source of flexibility of the UCY campus are the chillers units located at the Energy Centre.

- 8 chillers are installed with total capacity 8 MW (8X1000 kW). Two chillers are installed per transformer => 4 transformers in total.

The following figures show the average monthly energy profiles of the chiller units currently installed at the University of Cyprus.

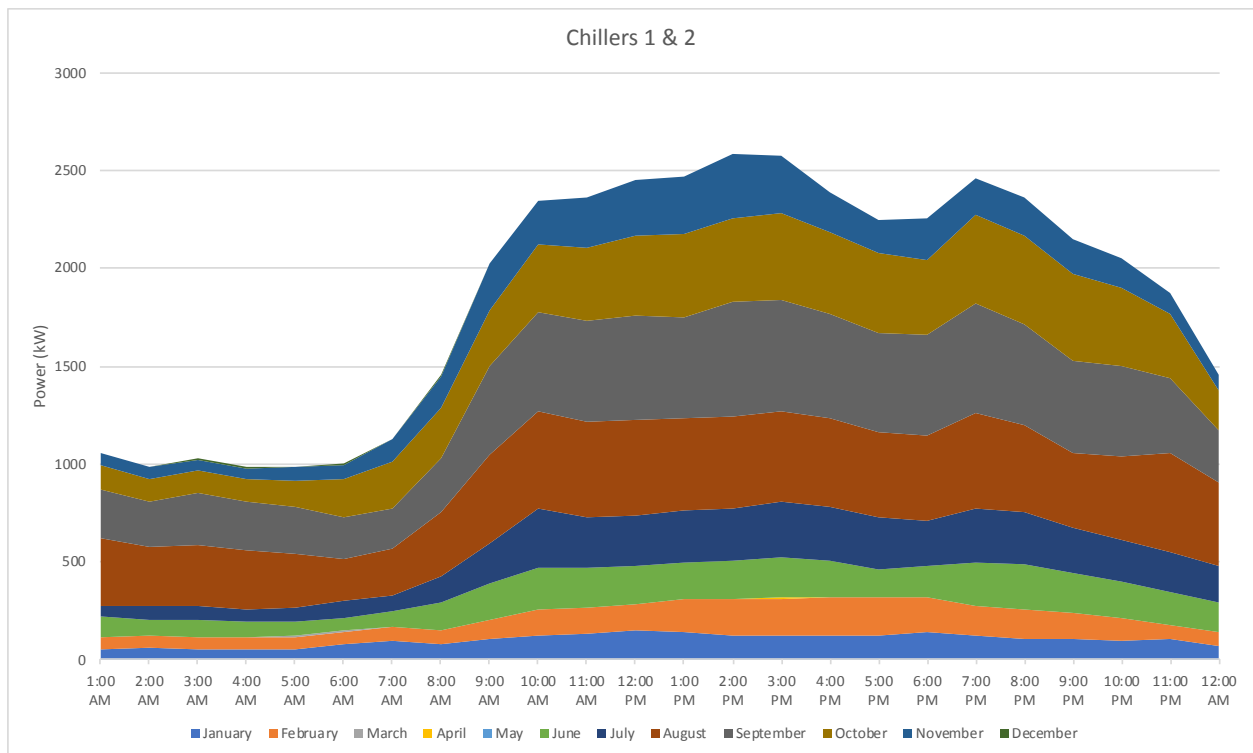


Figure 19. Average Load Profile of the chiller units 1 & 2 installed at UCY.

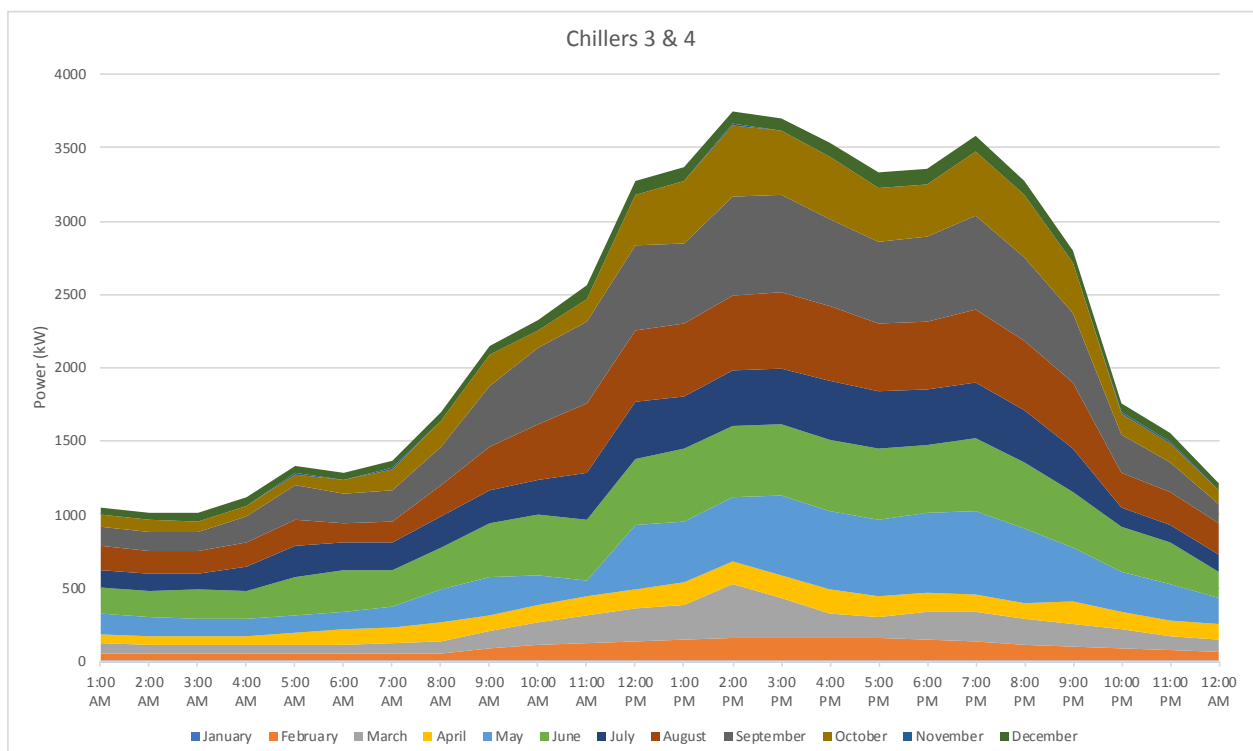


Figure 20. Average Load Profile of the chiller units 3 & 4 installed at UCY.

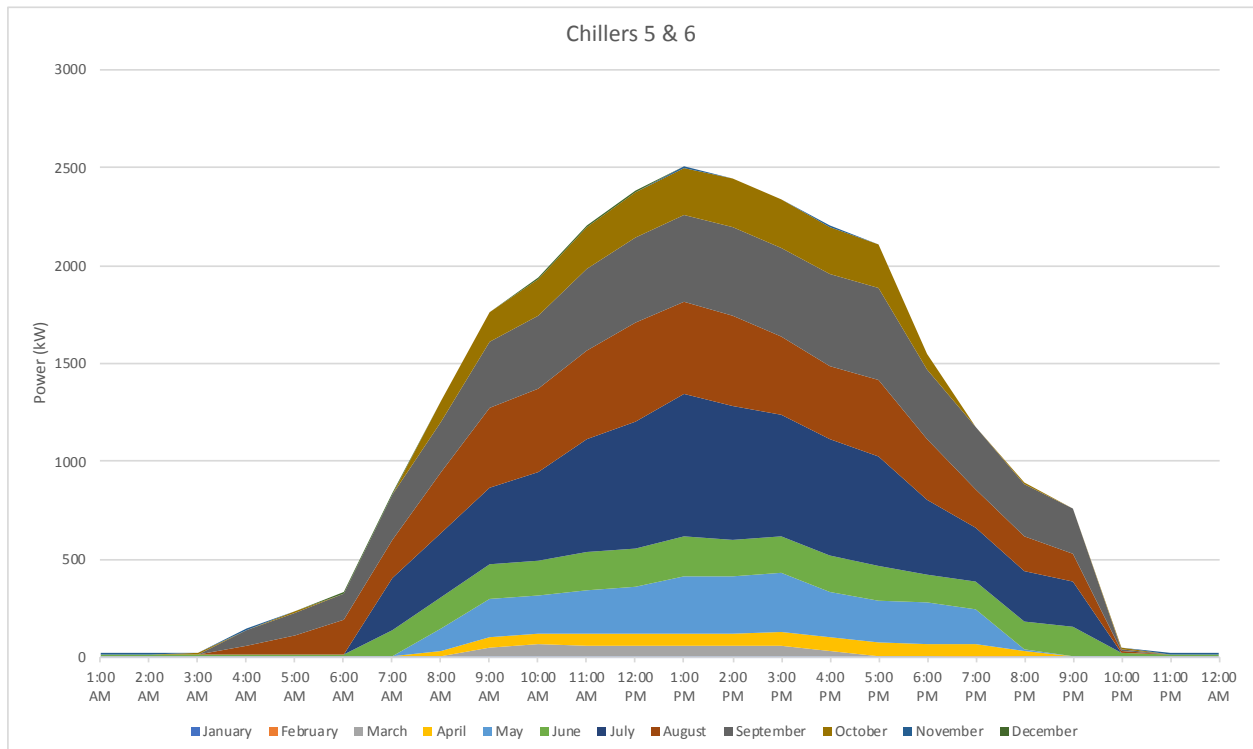


Figure 21. Average Load Profile of the chiller units 5 & 6 installed at UCY.

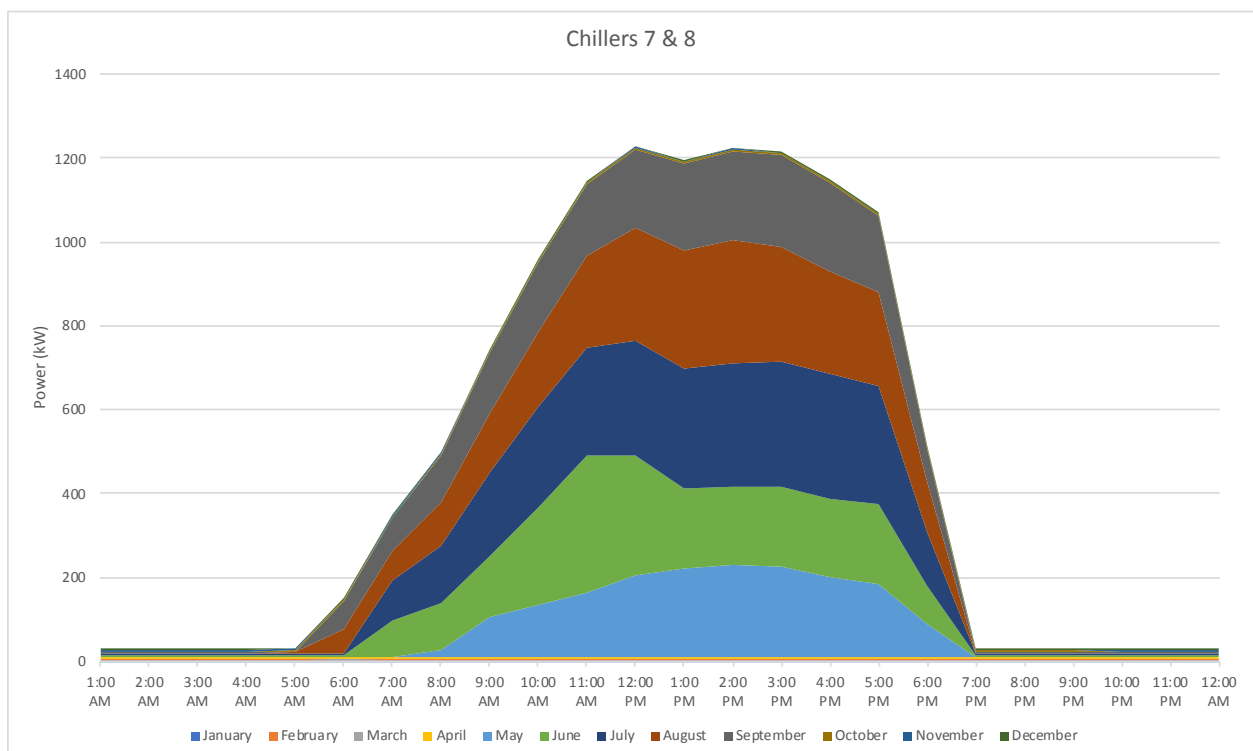


Figure 22. Average Load Profile of the chiller units 7 & 8 installed at UCY.

Temperature control at the Faculty of Finance Economics & Business (FEB) building can be applied separately on each floor and in three different levels:

- economy (peak shaving/load shifting)
- normal

- boost (increase consumption/valley filling)

Temperature control in the Library building is applied in a similar manner but without the floor division control as the ceiling of the building is common for all floors.

The following figure illustrates the average temperature levels per month for the location of the UCY campus.

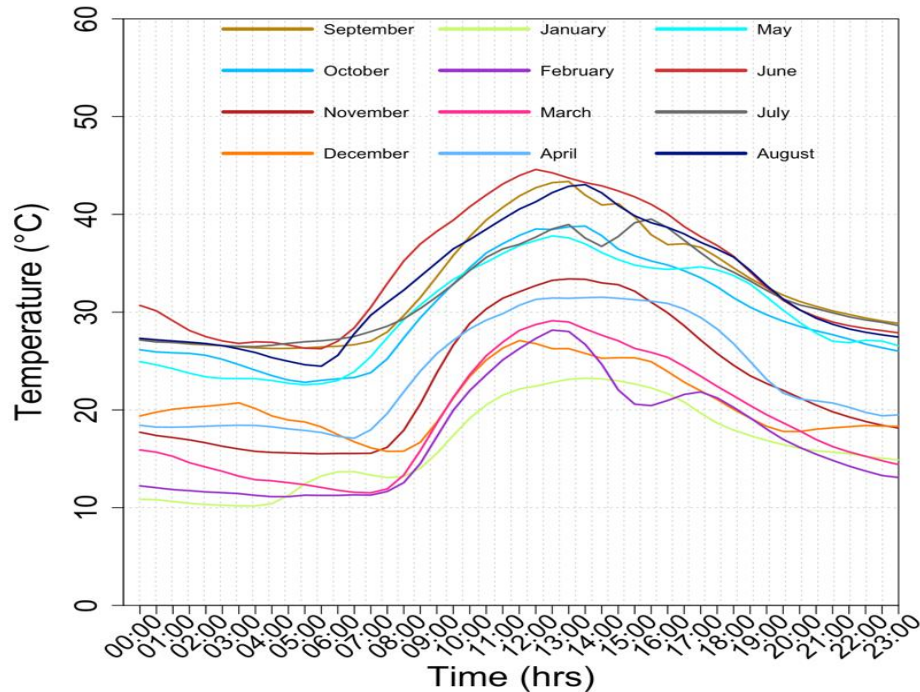


Figure 23. Average Temperature levels per month.

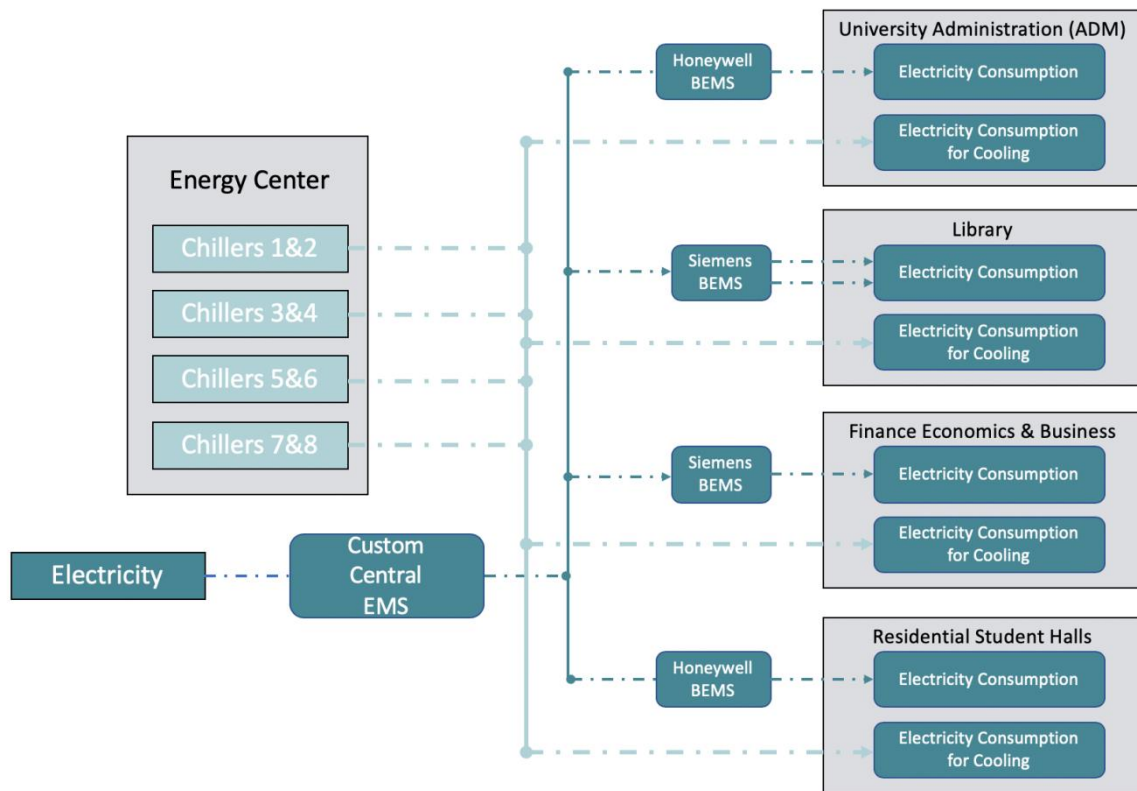


Figure 24. Energy schematic of the pilot buildings located within the UCY campus.

The control screen of the ENC. 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 above. In this screenshot, only two of the four boilers are operating.

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). The indicative BEMS architecture of the School of Economics and Management.

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 Broadband over power lines (BPL) network is implemented in the current MV/LV substations, as shown in Figure 25. 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.

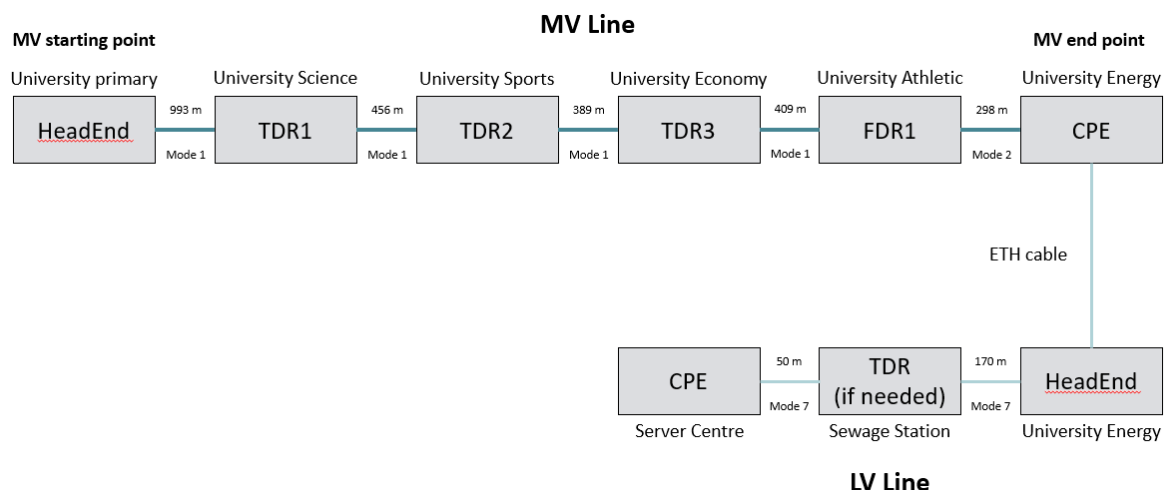


Figure 25 BPL network design

5.2 KiWi Pilots

Moor House

KiWi device operation has to be taken over by FEID.

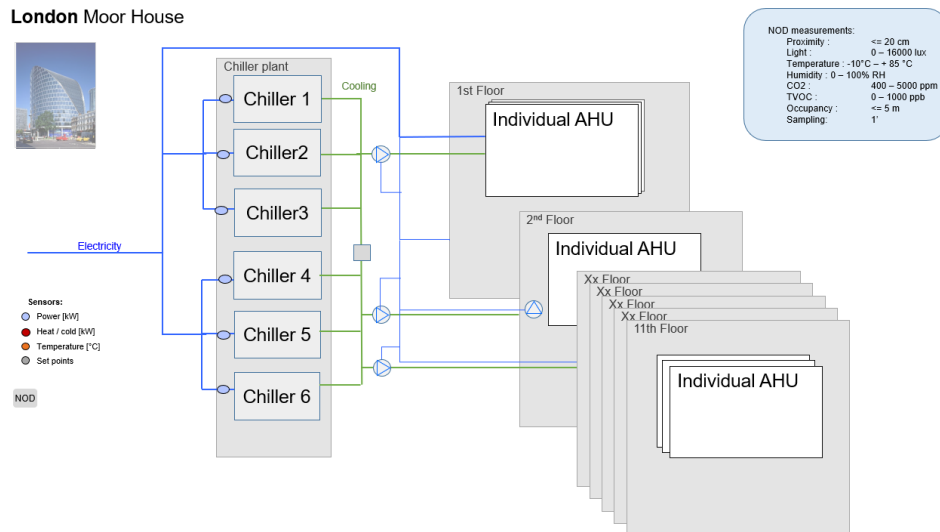


Figure 26 KiWi Moor House Chillers Scenario.

Kiwi residential:

Parasitic smart meters that (<https://shop.glowmarkt.com/products/glow-sensor-transmitter>) relate to the electrical box of each individual resident and provides power consumption.

6. Pilot Use Cases

Overview of Pilot-specific Use Cases from D1.5. Expand on the below:

ID	Use Case Description	Demo Partners
5.1.1	Flexibility forecast to improve assets availability declaration and maximise DR revenues	UCY/EAC, CERTH, KiWi
5.3.1	Optimise prosumer RES self-consumption and increase flexibility	UCY/EAC
5.5.1	Prosumer admission in the Aggregator's Portfolio	CERTH, UCY
5.5.2	Prosumer admission in DELTA	CERTH, UCY
5.5.3	Prosumer renunciation from DELTA	CERTH, UCY

ID	Use Case Description	Demo Partners
5.1.1	Flexibility forecast to improve assets availability declaration and maximise DR revenues	UCY/EAC, CERTH, KiWi
5.1.2	Improving DSR revenues by trading flexibility in the Imbalance Market based on energy market price forecasts.	CERTH/ITI, KiWi
5.3.1	Optimise prosumer RES self-consumption and increase flexibility.	KiWi
5.3.2	Provision of ancillary services for network constraint management.	KiWi
5.4.1	Securing communication between smart meters and DVN agents.	KiWi
ID	Use Case Description	Demo Partners
	Demand response through self-configured, self-optimized and collaborative virtual distributed energy nodes_Static Frequency response and TRIAD warnings notifications	KiWi
	Zoned control and DR participation for Library assuming booked operations can be spatially confined	UCY
		UCY
	Incentivised DR Activities for Residential Users for whom bills are inclusive in rental agreements	

7. User Engagement Activities to Date

UCY and KiWi have both expended time on educating users about Demand Response programmes in general. More specific information relating to the DELTA solution will be developed in T7.2 and reported on in the second version of this deliverable, D7.6. A review of the material used by UCY and KiWi to educate Users of Demand Response in general is given here.

7.1 UCY User Engagement

As a University, UCY has developed and delivered course material to students that address the energy transition requirements and the technologies involved in the future energy systems. Furthermore, as a research entity involved in many future energy systems projects, UCY has delivered a number of pamphlets and workshops on the energy transition.

The next workshop is planned for mid-November and will take the approximate form shown below:

Cyprus Pilot DR Workshop

Invitations

Core SE representatives by personal emails

Wider stakeholders by group email

Internal stakeholders & key personnel by personal emails

UG Representatives by personal emails

Wider UG by informational posters in pilot site buildings with a contact email address

Note that invitation emails out to persons will ask if there are any key points that the recipient would like to be addressed in the workshop and this will inform the workshop presentations and perhaps lead to changes in the agenda.

Agenda

Session Title	Presenter	Time
Welcome & Refreshments	N/A	08:30 – 09:00
Emerging Energy Systems & Demand Response	UCY	09:00 – 09:30 (20 Minutes & 10 Questions)
Introduction to UCY's DR projects including: DELTA/DRIMPAC/FLEXGRID/GOFLEX	UCY	09:30 – 10:00 (20 Minutes & 10 Questions)
UCY Campus as a DR Pilot Site – DR possibilities – DR possibilities – DR possibilities	UCY	10:00 – 10:30 (20 Minutes & 10 Questions)
Refreshments	N/A	10:30 – 10:45
Discussion Session with Panel Interaction	Panel-led session:	10:45 – 12:00
Key Points: <ul style="list-style-type: none"> Forthcoming changes in energy 	UCY/EAC/Technical Staff/Aggregator?	

<p>system through the clean package for all Europeans through the clean package for all Europeans that must be addressed</p> <ul style="list-style-type: none"> • Challenges in implementation • Requirements & concerns <p>Key outcomes: documentation of system and user requirements deriving</p>		
Closing remarks & open session for questions	UCY	12:00 – 12:30

7.2 KiWi User Engagement

KiWi have developed an ‘Introduction to Demand Response’ document that is used to explain to potential clients the need for Demand Response and how they could potentially participate in DR programmes and benefit financially for doing so:

“Demand Response” means reducing electricity consumption from the distribution network for short periods when the national electricity system is under stress.

At certain times of day National Grid needs access to sources of extra power in the form of either generation or demand reduction, to be able to deal with actual demand being greater than forecast demand and/or generation unavailability.

Traditionally, National Grid procured this requirement from peaking power stations and other, older, less efficient and more expensive power stations.

Most of these old, inefficient, polluted power stations are in process of decommissioned for environmental reasons, and also they were too expensive to be kept operational.

This creates the need of having DSR.

The established narrative here is that the existing methods for dealing with peak power periods are expensive and dirty power stations and that DR brings and opportunity to clean up the supply and reduce peak consumption.

An overview of available DR programmes is presented in

Table 6:

Table 6: DR Programs in UK Overview

Type of Programs	DFFR (Dynamic Firm Frequency Response)	SFFR(Static Firm Frequency response)	Constraint Management (DNO programme)	STOR (Short Term Operating Reserve)	Capacity Market
------------------	--	--------------------------------------	---------------------------------------	-------------------------------------	-----------------

Response Time	1 second	1-30 seconds	15 minutes	15 minutes	4 hours
Duration of the event	Continuous	30 Minutes Fixed	2-4hours	Max 2 hours	4 hours
Payments	Availability	Availability	Availability & utilization	Availability & utilization	Availability
Types	Dynamic – Any Variance from 50 Hz	Static – 50.2 Hz- 49.7 Hz	Demand Turn Up Demand turn Down	Static	1. Existing Generation 2. DSR A. Proven B. Un Proven
Availability Window	24/7	24/7	Summer/Winter	06:00-14:00 16:30-22:00	24/7

And a review of the typical assets used to participate in DR by industry in Figure 27:

Assets Used in Demand Response



Figure 27: Typical DR Assets by Industry

After the commitment of clients to participate, KiWi offers a User Acceptance Training. Events are described and the technology used by KiWi to automate this process (both software and hardware) is reviewed. Example material from this training is presented in Figure 28 and Figure 29.

Frequency event - Start

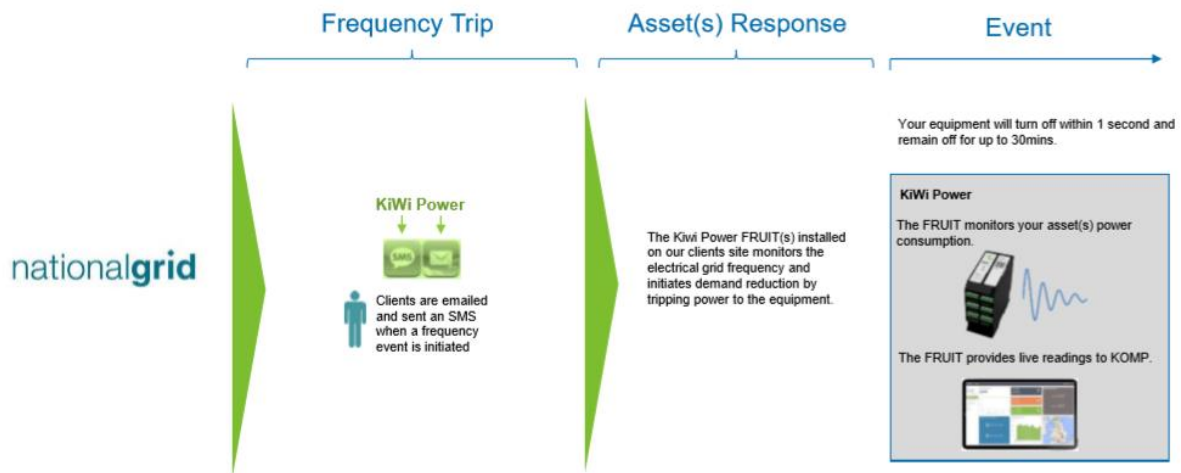


Figure 28: KiWi Training Example – Event Description

Our Equipment

KiWi Power processing station: FRUIT

- Our FRUIT has been installed on your site to monitor your asset(s) power consumption and trigger a frequency event when the trip point is reached.



KiWi Operational Management Platform: KOMP

- Our Operations team communicates with the FRUIT via KOMP which provides dashboard information on energy consumption as well as control options.



Note: our FRUIT will never override critical system limits, only operate within them.

Figure 29: KiWi Training Example – Equipment Description

Training is given on asset availability requirements and the methods used to declare assets unavailable:

Asset(s) Availability

Weekly email

- Every Monday morning the Operations team will send an email to your chosen contacts requesting your asset(s) availability for the following week and confirmation of your chosen contacts.
- Please ensure that you respond to this email by Wednesday CoB.

Reasons to declare your asset(s) unavailable

- Asset maintenance/testing
- Asset issues/faults
- Onsite electrical issues
- The asset has been decommissioned

8. Initial Pilot Plan

In order to be able to meet the DELTA objectives in terms of pilot deployment, it is essential to draft a very detailed and technically robust pilot plan that incorporates all the requirements and technical objectives that were presented in previous reports. In general, and based on the DELTA Gantt diagram, the overview of the pilot planning, deployment and reporting is presented in the following flow.

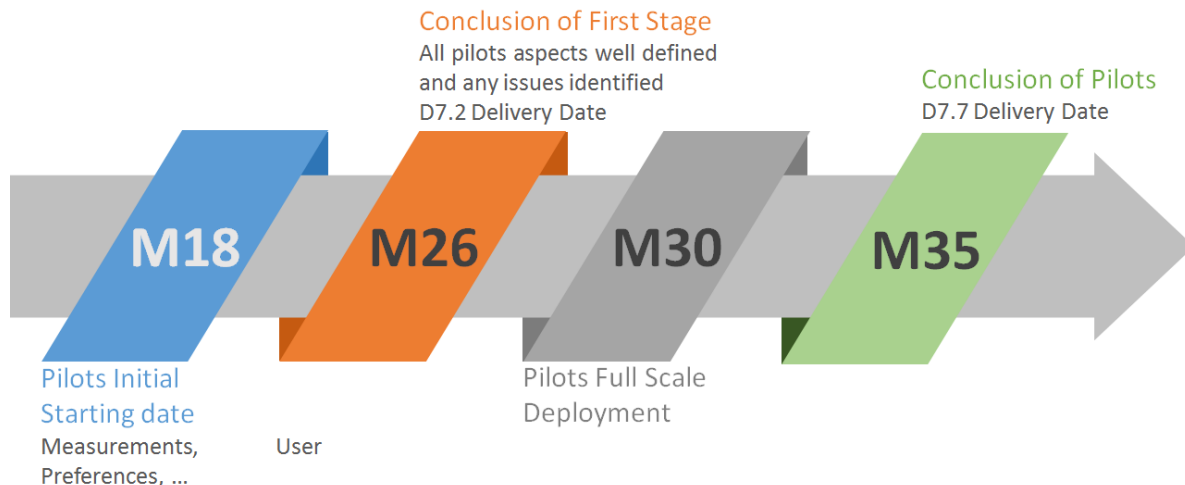


Figure 30 Overview of the pilot deployment plan

The main focus for the first stage of the pilots is the establishment of the necessary equipment towards ensuring data retrieval and creation of an initial baseline. As such, in the first two months (M18-M19) there will be deployment of metering and actuation equipment (mainly in KiWi pilot sites) along with interfaces (both pilots) for data exchange between the onsite assets and the FEIDs. Within M19-M20 (November/December 2019), the first FEIDs will be sent to the pilots for initial integration and testing of the various hardware and software aspects.

By M21-M22 (taking into consideration winter holidays) all pilot assets are expected to be fully integrated with the DELTA FEIDs and all necessary measurements will be collected by the end of M21. Beyond this date (i.e. M23) initial testing of the DELTA use cases will be initiated, up until M26. Full deployment of all scenarios at pilot premises is expected to take place in the period M29-M35, following the initial plan of the T7.3 Pilot realization and Integrated DELTA framework Deployment.

It is worth mentioning that the FEIDs have already been deployed and tested at the pre-pilot test lab at CERN premises. Most technologies are applied within this controlled environment before deployment at the pilot premises.

A detailed plan, focused on the DELTA business scenarios and use cases has been initiated and will be delivered within the second version of this report (D7.6).

9. Conclusions

The UCY and KiWi pilots offer substantially different test cases, not only as the market is already developed in the UK and the regulations are known (whereas there is currently no market for DR in Cyprus), but also due to substantial differences in the technical and socioeconomic contexts of the two pilot sites. To this end, future engagement with users and any developed material should bare these differences in mind.

The responses of the users to future engagement activities will be included in v2 of this report and attention will be paid to any impact that these may have on the implementation of use cases at the respective sites.

Further auditing of the specifics of technical interfaces and communications requirements for integration with/substitution for the DELTA FEIDs for operations is required and forthcoming requirements for market operation in Cyprus and likely regulation in the marketplace will be analysed for inclusion in v2 of this report so that the operation of resources and demonstration activities of the DELTA solution will at least be in consideration of likely future restrictions/operational requirements.

10. References

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- [2] Modelio, The open source modeling environment, <https://www.modelio.org>
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- [4] M. Bucur, D. Kolajo, I. Moschos, D. Papageorgiou, C. Patsonakis, D1.1 DELTA Requirements, Business Scenarios and Use Cases, 31 January 2019