Strategy and planning for the energy performance monitoring

D.4.1.a

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no 680511. This document does not represent the opinion of the European Union, and the European Union is not responsible for any use that might be made of its content.

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PROJECT INFORMATION	
Project acronym	DREEAM
Grant agreement number	680511
Project title	Demonstration of an integrated Renovation approach for Energy Efficiency At the Multi building scale

DOCUMENT INFORMATION	
Title	Strategy and planning for the energy performance monitoring
Version	2.0
Release date	17/03/2017
Work package	4
Dissemination level	

DOCUMENT AUTHORS AND AUTHORISATION	
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DOCUMENT HISTORY			
Version	Date	Modified contents	Implemented by
1.0	12/2015	Methodology	SinCeO2
1.1	07/11/2016	Strategy for Monitoring In Pilot Sites	SinCeO2
2.0	17/03/2017	Including ECM´s Renovations Concepts	SinCeO2

Executive summary

In the following document, the monitoring programme of pilot buildings is established. Pilot buildings will be closely monitored in order to obtain a qualitative evaluation of the Dreeam approach.

This deliverable will be developed and updated in three stages:

V0. Methodology proposed to determine Energy Performance in pilot buildings. The methodology proposed is based on IPMVP International Performance Measurement and Verification Protocol developed by Efficiency Valuation Organization (EVO).

V1. Strategy and planning for the energy performance monitoring. This version is developed after collecting initial data and the data collected in the field visits. This document describes the core of the strategy for determining the energy performance in pilot Buildings. In this stage the plan of Measurement and Verification (M&V) will be established, according to the IPMVP protocol. This plan is recommended to be developed in parallel with the Energy Conservation Measurements (ECM) definition. ECM will be define in other different Work Package.

V2. Final Version. Strategy and planning for the energy performance monitoring. This document will include the last considerations regarding to the ECM and Renovation Works that would be implemented in each pilot case.

The main objective of this paper V0. is to describe the methodology proposed by SinCeO2 to define the energy performance of pilot buildings before and after renovations.

The description and the important points of the protocol IPMVP are presented below to have a working paper in order to collect feedback from the different partners involved in the definition of savings measures.

The core of the protocol set out in the Measurement and verification Plan. The key points within this M&V Plan will be described: the options that can be applied to each of the pilot cases, the variables that affect energy consumption as well as the reference time necessary for its characterization.

In addition, IPMVP Methodology for calculating the energy savings will be detailed. Finally this document include a briefly explanation about the outline on documents reporting savings.

Concluding this document, one first approach regarding to each pilot case is presented, in order to have a first starting point to face the process for defining the energy performance monitoring through IPMVP protocol.

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The following methodology is proposed to define the energy performance of Pilots before and after renovations. It is based on IPMVP International Performance Measurement and Verification Protocol Volume 1 Concepts and Options for Determining Energy and Water Savings Volume 1 (Ver. 2012).developed by Efficiency Valuation Organization (EVO).

This IPMVP, defines transparency in savings reports, while assembling best practice from all kind of projects in different countries.
IPMVP is flexible framework of M&V Options allows to craft the right M&V Plan for any building. This Protocol sets up the basis for a complete knowledge of energy efficiency in the current situation and the procedure for calculating the savings achieved after the renovation works.

1. Methodology (D4.1.a V0)

1.1 Measurement and Verification Plan.

"Measurement and Verification" (M&V) is the process of using measurement to reliably determine actual savings created within an individual facility by an energy management program. Savings cannot be directly measured, since they represent the absence of energy use. Instead, savings are determined by comparing measured use before and after implementation of a project, making appropriate adjustments for changes in conditions. Definition of terms, and heavy emphasis on consistent and transparent methods are the core precepts of the IPMVP. Though application details are unique to each project, IPMVP is flexible framework has been successfully applied to all types of energy efficiency techniques, projects and programs.

Measurement and Verification Plan is divided in three Phases:

- Phase 0. Determination of the sampling measure.

- Phase I. Developed the final Plan of Measurement and verification.

- Phase II. Savings Verifications

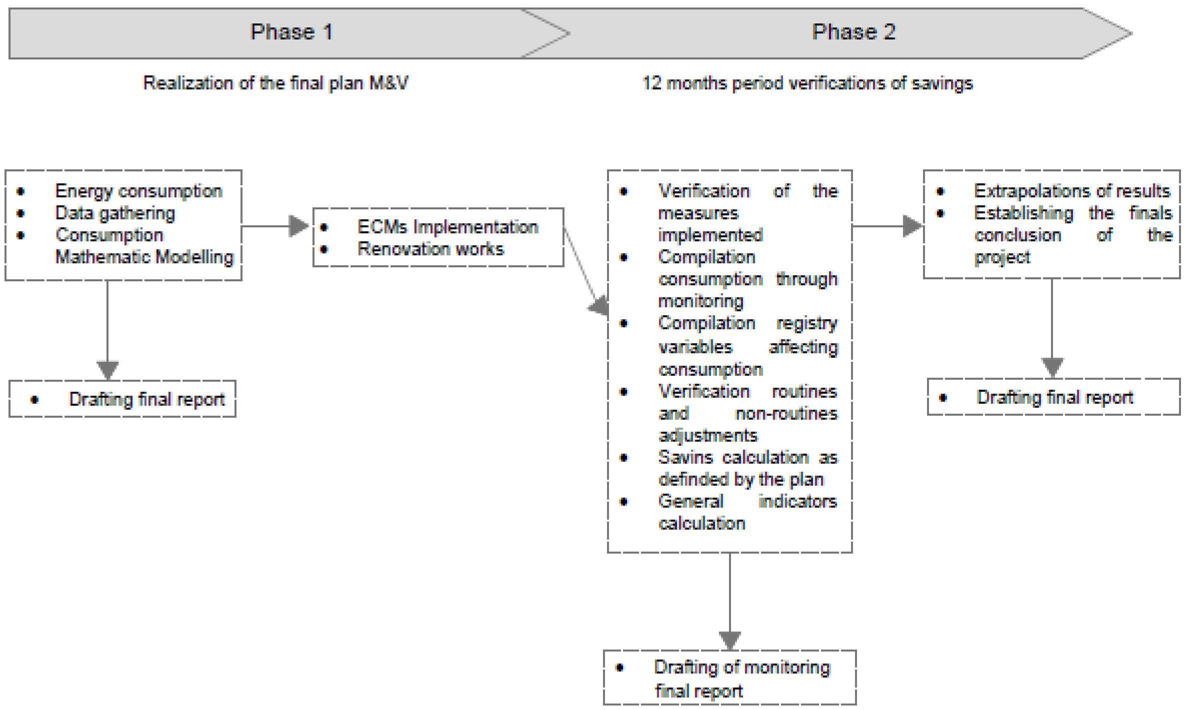


Fig. 1: Phases M&V Plan

1.2 PHASE 0

Determination of the sampling measure.

After gathering initial information, in each pilot case, the following points will be studied:

- Characteristics of buildings,
- Major systems or energy consuming facilities,
- Users and usage patterns of facilities.
- Energy Consumption Data

The analysis of all this initial information is performed on the M&V Plan and it will determine the common facilities needed to be monitored as well as the users units (houses).

For every Pilot Building, there will be defined a specific number of houses (archetypes), which will be used as reference to extrapolate the results of savings. This classification is especially important in Padiham (PFP) Pilot Case where energy consuming systems are individual for each house. For defining the referenced houses the following parameters will be considered:

1. Numbered list 1
2. Numbered list 2

Technical Characteristic

- Size, Number of Bedroom
- Orientation
- HAVC/ DHW Installations

Sociological Characteristic

- Number of resident
- Social Profile (Age, Family status, Working situation)

Analysing this parameters, Energy Performance Indicators EnPIs will be defined. This EnPIs allow to group housings depending on consumptions and characteristics and to select those that will be monitored.

EnPIs EXAMPLES:

- KWh/M2
- KWh/HDD (Heating Degree days)
- KWh/ User Number
- KWh/ User Type 1
- KWh/ User Type 2
- kWh/House 1
- Kwh/House 2.

The following scheme shows a basic Example for selecting archetypes in a building 5 floor building 2 orientation:

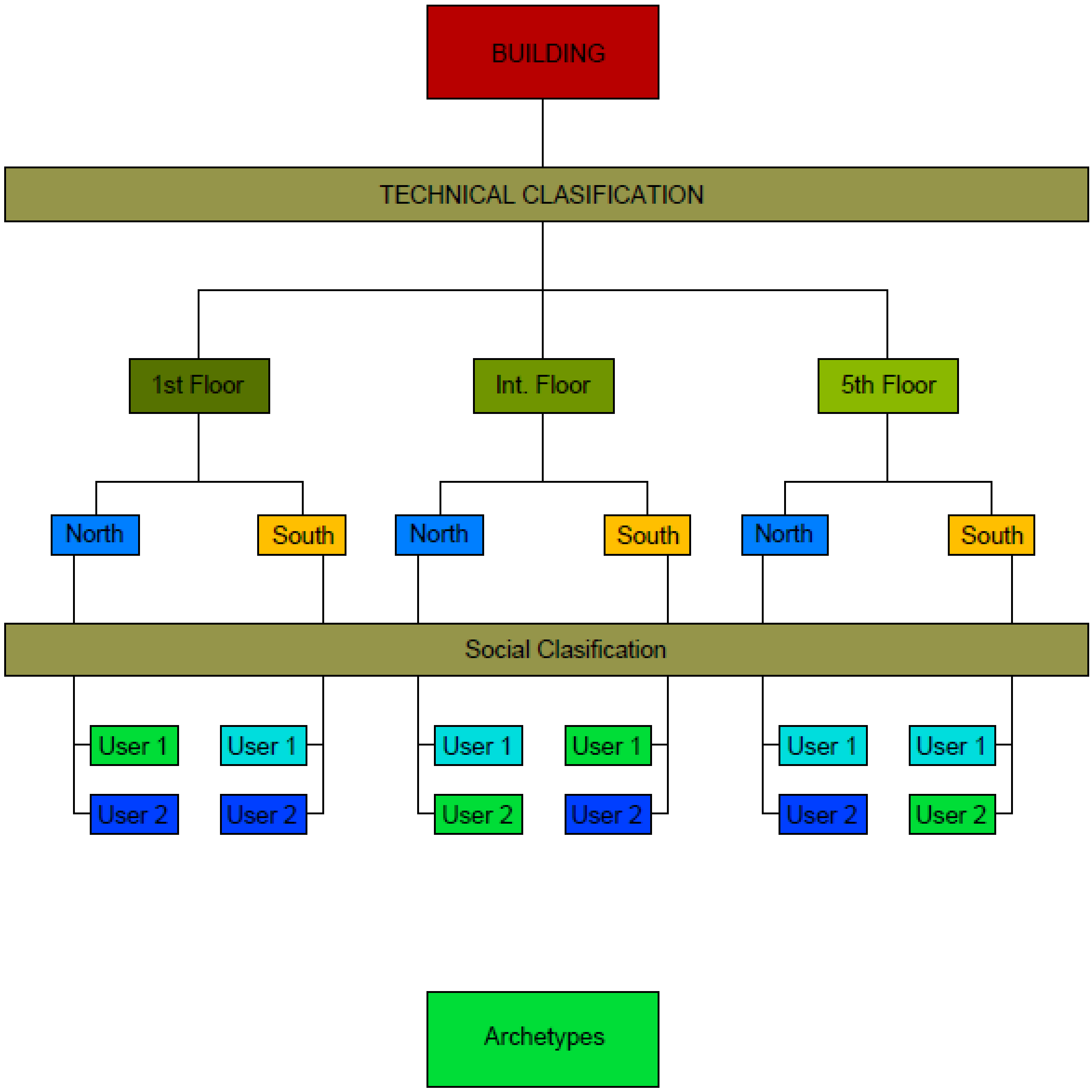


Fig. 2: schema definition of archetypes

1.3 PHASE I

Phase I. developed the final Plan of Measurement and Verification.

All the available information collected brings the characterizations of energetic consumptions including the conditions of use of the facilities, before the implantation of ECMs (period of reference).

- The energy consumptions will model mathematically depending on the variables that affect the same ones, on the basis of the methodology proposed in IPMVP and ISO 50006.

Within the final M&V Plan, the calculation of individual savings for each measuring point (dwelling consumption, Building HVAC system) will be held. Using the value of individual savings, it is possible to extrapolate the results to determine all the energy savings after the implementation of ECMs.

FRAMEWORK OF MEASUREMENT AND VERIFICATION PLAN.

1.3.1 INTRODUCTION.

Energy savings cannot be directly measured, since savings represent the absence of energy use or demand. Instead, savings are determined by comparing measured use or demand before and after implementation of a program, making suitable adjustments for changes in conditions.

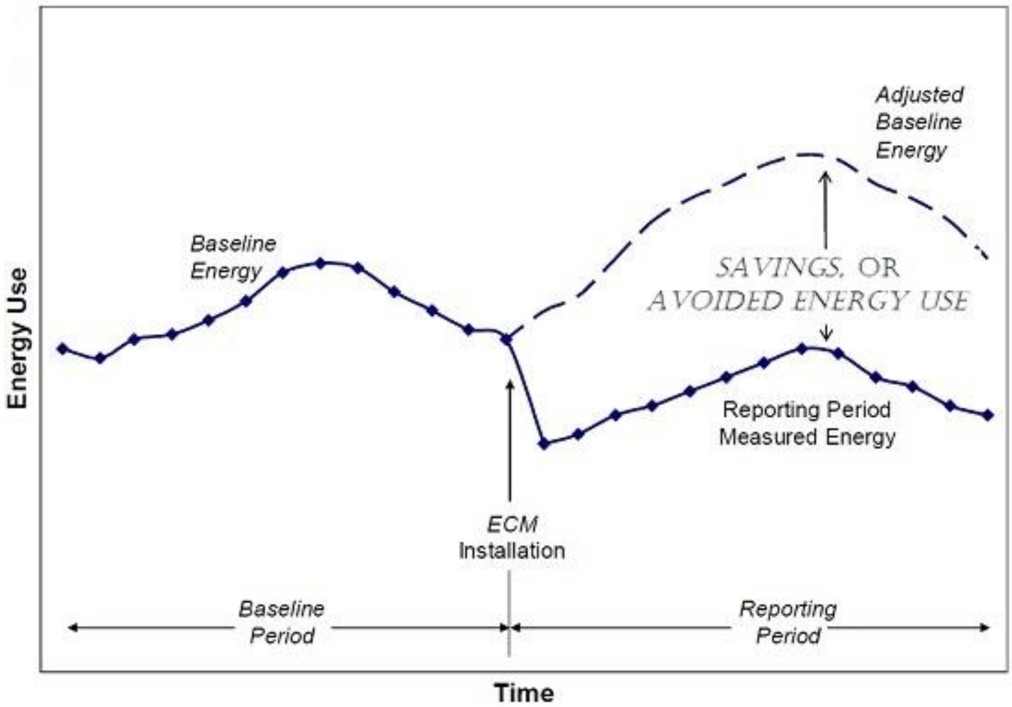


Fig. 3: "IPMVP Example Energy History"

It is necessary to segregate the energy effects of a savings program from the effects of other simultaneous changes affecting the energy using systems. The comparison of before and after energy use or demand should be made on a consistent basis, using the following **general Equation**:

Savings = (Baseline-Period Use or Demand - Reporting-Period Use or Demand)

± Adjustments

1.3.2 THE M&V DESIGN AND REPORTING PROCESS

The M&V design and reporting process parallels the ECM design and implementation process. The M&V processes should involve the following steps:

1. Consider the needs of the user of the planned M&V report. If the user is focused on overall cost control, Whole-Facility methods may be most suited. If user focus is on particular ECMs, Retrofit Isolation techniques may be most suited
2. While developing the ECM(s), select the IPMVP Option that best suits the ECM(s), the needs for accuracy and the budget for M&V. Decide whether adjustment of all energy quantities will be made to the reporting period conditions or to some other set of conditions. Decide the duration of the baseline period and the reporting period.
3. Gather relevant energy and operating data from the baseline period and record them in a way that can be accessed in the future.
4. Prepare an M&V Plan containing the results of steps 1 through 3 above. It should define the subsequent steps 5 through 9.
5. As part of the final ECM design and installation, also design, install, calibrate and commission any special measurement equipment that is needed under the M&V Plan.
6. After the ECM is installed, ensure it has the potential to perform and achieve savings by conducting operational verification. This may include inspecting the installed equipment and revising operating procedures as needed to conform to the design intent of the ECM.
7. Gather energy and operating data from the reporting period, as defined in the M&V Plan.
8. Compute savings in energy and monetary units in accordance with the M&V Plan.
9. Report savings in accordance with the M&V Plan.

1.3.3 SAVINGS VERIFICATION

The following sections add details about how to determine and report savings:

Measurement Boundary

Savings may be determined for an entire facility or simply for a portion of it, depending upon the purposes of the reporting.

- If the purpose of reporting is to help manage only the equipment affected by the savings program, a measurement boundary should be drawn around that equipment. Then all significant energy requirements of the equipment within the boundary can be determined.
- If the purpose of reporting is to help manage total facility energy performance, the meters measuring the supply of energy to the total facility can be used to assess performance and savings. The measurement boundary in this case encompasses the whole facility.
- If baseline or reporting period data are unreliable or unavailable, energy data from a calibrated simulation program can take the place of the missing data, for either part or all of the facility. The measurement boundary can be drawn accordingly
- Some of the energy requirements of the systems or equipment being assessed may arise outside a practical measurement boundary. Nevertheless, all energy effects of the ECM(s) should be considered. Those energy effects that are significant should be determined from measurements, the rest being estimated or ignored.
- Any energy effects occurring beyond the notional measurement boundary are called '**interactive effects'**. This point will be also analyse in the M&V Plan including the description of possible Interactive effects and its likely magnitude.

Measurement Boundary will be defined choosing one of the options proposed on IPMVP.

1.3.4 IPMVP OPTIONS. MEASUREMENT BOUNDARY

The Protocol of Measurement and Verification IPMVP provides different options to calculate the savings:

Option A. Retrofit Isolation: Key Parameter Measurement

Savings are determined by field measurement of the key performance parameter(s) which define the energy use of the ECM's affected system(s) and/or the success of the project.

Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the reporting period.

Parameters not selected for field measurement are estimated. Estimates can based on historical data or engineering judgment. Documentation of the source or justification of the estimated parameter is required. The plausible savings error arising from estimation rather than measurement is evaluated.

How Savings Are Calculated in Option A.

Engineering calculation of baseline and reporting period energy from:

- Short-term or continuous measurements of key operating parameter(s); and
- Estimated values.
- Routine and non-routine adjustments as required.

Option B. Retrofit Isolation: All Parameter Measurement

Savings are determined by field measurement of the energy use of the ECM-affected system.

Measurement frequency ranges from short-term to continuous, depending on the expected variations in the savings and the length of the reporting period.

How Savings Are Calculated in Option B.

- Short-term or continuous measurements of baseline and reporting-period energy, and/or engineering computations using measurements of proxies of energy use.
- Routine and non-routine adjustments as required.

Option C. Whole Facility.

Savings are determined by measuring energy use at the whole facility or sub-facility level.

Continuous measurements of the entire facility's energy use are taken throughout the reporting period.

How Savings are Calculated In option C:

- Analysis of whole facility baseline and reporting period (utility) meter data.
- Routine adjustments as required, using techniques such as simple comparison orregression analysis.
- Non-routine adjustments as required.

D. Calibrated Simulation

Simulation routines are demonstrated to adequately model actual energy performance measured in the facility.

Savings are determined through simulation of the energy use of the whole facility, or of a sub-facility.

This Option usually requires considerable skill in calibrated simulation.

How Savings Are Calculated in Option D:

- Energy use simulation, calibrated with hourly or monthly utility billing data. (Energy end use metering may be used to help refine input data.)

Option Selection

It is impossible to generalize on the best IPMVP Option for any type of situation. However IPMVP suggest the Table below as commonly favoured Options according to some key project characteristics.

ECM Project Characteristic	Suggested Option			
	A	B	C	D
Need to assess *ECMs* individually	X	X		X
Need to assess only total facility performance			X	X
Expected *savings* less than 10% of utility meter	X	X		X
Significance of some *energy* driving variables is unclear		X	X	X
Interactive effects of ECM are signficant or unmeasurable			X	X
Many future changes expected within *measurement boundary*	X			X
Long term performance assessment needed	X		X	
Baseline data not available				X
Non-technical persons must understand reports	X	X	X	
Metering skill available	X	X		
Computer simulation skill available				X
Experience reading utility bills and performing regression analysis available			X	

Fig. 4: "IPMVP TABLE 3. SUGGESTED OPTIONS"

Options for pilots cases.

The different options will be analysed in the M&V Plan, however as first approach, for those cases in which monitoring consumption on the systems of heating is available, one will proceed to use an Option B, whereas the supplies in which only the total consumption is available, then Option C will be in use.

1.3.5 Measurement Period Selection.

Baseline Period

Care should be taken in selecting the period of time to be used as the baseline period and the reporting period. Strategies for each are discussed below.

The baseline period represents all modes of use of the facility. This period should span a full operating cycle from maximum energy use to minimum.

Include only time periods for which all fixed and variable energy-governing facts are known about the facility. Those will be gathering through the monitoring time before renovations.

Coincide with the period immediately before commitment to undertake the retrofit.

Baseline documentation should include:

- Identification of the baseline period.
- Baseline energy consumption and demand data
- All independent variable data coinciding with the energy data (e.g. ambient temperature)
- All static factors coinciding with the energy data:
    - Occupancy type,
    - Operating conditions (space temperature humidity and ventilation levels)
- Description of any baseline conditions that fall short of required conditions. For example, the space is under-heated during the baseline, but the ECM will restore the desired temperature. Details of all adjustments that are necessary to the baseline.
- Energy data to reflect the energy-management program's expected improvement from baseline conditions.
- Equipment inventory: nameplate data, location, condition. Photographs or videotapes are effective ways to record equipment condition.
- Equipment operating practices (schedules and set points, actual temperatures and pressures).

Whole-building energy use can be significantly affected by weather conditions. Typically, a whole year of baseline data is needed to define a full operating cycle.

For the pilot sites, the minimum measurement period is the winter season because the majority of ECMs affect the heating system. Nevertheless it would be recommended to have measurements, from 6 months (including winter season) to 12 month.

1.3.6 Reporting Period

The reporting period should encompass at least one normal operating cycle of the equipment or facility, in order to fully characterize the savings effectiveness in all normal operating modes.

The reporting period after ECMs Implementation for the pilot cases it is fixed in 12 months.

The length of any reporting period should be determined with due consideration of the life of the ECM and the likelihood of degradation of originally achieved savings over time.

Regardless of the length of the reporting period, metering may be left in place to provide feedback of operating data for routine management purposes and specifically to detect subsequent adverse changes in performance.

1.3.7 Basis for Adjustments:

The adjustments term shown in general Equation:

Savings = (Baseline-Period Use or Demand - Reporting-Period Use or Demand)

± Adjustments

Should be computed from identifiable physical facts about the energy governing characteristics of equipment within the measurement boundary. Two types of adjustments are possible:

- **Routine Adjustments** – for any energy-governing factors, expected to change routinely during the reporting period, such as weather conditions. A variety of techniques can be used to define the adjustment methodology. Techniques may be as simple as a constant value (no adjustment) or as complex as a several multiple parameter non-linear equations each correlating energy with one or more independent variables. Valid mathematical techniques must be used to derive the adjustment method for each M&V Plan.

- **Non-Routine Adjustments** – for those energy-governing factors which are not usually expected to change, such as: the facility size, the design and operation of installed equipment, the type of occupants. *<u>These static factors must be monitored for change throughout the reporting period</u>*.

    - **Static factor proposed (INITIAL APPROACH) in pilot cases:**

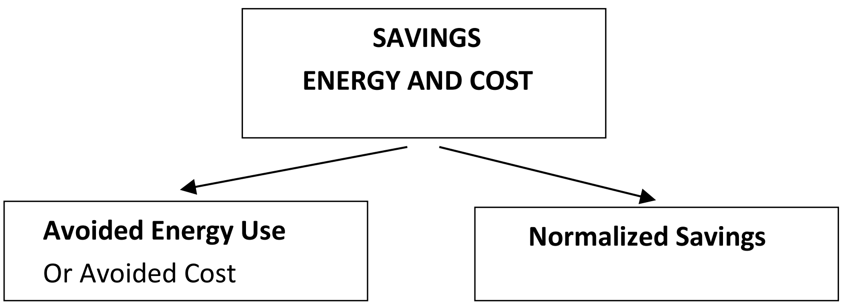
        - **Social characteristics**: *number and type of occupants*
        - *Pattern of use from tenants. Set points. Running time.*
        - *Individual home equipment*
        - *amount of space being heated or air conditioned*
        - *indoor environmental standard (e.g. light levels, temperature, ventilation rate),*

Therefore General Equation can be expressed more fully as:

Savings = (Baseline Energy – Reporting-Period Energy) **± Routine Adjustments ± Non-Routine Adjustments**

The adjustments terms in General Equation are used to express both pieces of measured energy data under the same set of conditions. The mechanism of the adjustments depends upon whether savings are to be reported on the basis of the conditions of the reporting period, or normalized to some other fixed set of conditions.

<u>Two types of savings.</u>



Reporting-Period Basis or Avoided Energy Use

When savings are reported under the conditions of the reporting period, they can also be called avoided energy use of the reporting period. Avoided energy use quantifies savings in the reporting period relative to what energy use would have been without the ECM(s).

When reporting savings under reporting-period conditions, baseline-period energy needs to be adjusted to reporting-period conditions.

For this common style of savings reporting General Equation can be restated as:

1.3.7.1 Avoided Energy Use (or Savings) (2 a) =

(Baseline Energy ± Routine Adjustments to reporting-period conditions
± Non-Routine Adjustments to reporting-period conditions) - Reporting-Period Energy

Simplified to the following:

1.3.7.2 Avoided Energy Use (or Savings) (2 b) =

Adjusted-Baseline Energy – Reporting-Period Energy
± Non-Routine Adjustments of baseline energy to reporting-period conditions

Where Adjusted-Baseline Energy is defined as the baseline energy plus any routine adjustments needed to adjust it to the conditions of the reporting period.

The adjusted-baseline energy is normally found by first developing a mathematical model which correlates actual baseline energy data with appropriate independent variable(s) in the baseline period. Each reporting period’s independent variable(s) are then inserted into this baseline mathematical model to produce the adjusted-baseline energy use.

General Baseline Mathematical Model:

$$Q\,(kWh) = X \times C_1 + Y \times C_2 + N \times C_N + C_F + M_i$$

Q ≡Adjusted base consumption (kWh)

C_1 ≡Constant associated with the variable X considered

C_2 C_1 ≡Constant associated with the variable Y considered

C_N ≡Constant associated with the variable N considered

C_F ≡ Constant related to non-variable part of consumption

M_i≡ Constant related to non-variable part of consumption

Independent Variables

An independent variable is a parameter that is expected to change regularly and have a measurable impact on the energy use of a system or facility. For example, a common independent variable governing building energy use is outdoor temperature, referenced as Heating Degree Day.

Fixed Conditions Basis or Normalized Savings

Conditions other than those of the reporting period may be used as the basis for adjustment. The conditions may be those of the baseline period, some other arbitrary period, or a typical, average or 'normal' set of conditions.

Adjustment to a fixed set of conditions reports a style of savings which could be called "normalized savings" of the reporting period. In this method energy of the reporting period and possibly of the baseline period are adjusted from their actual conditions to the common fixed (or 'normal') set of conditions selected.

Equation 3) restates the more General Equation for such normalized savings reports:

1.3.7.3 Normalized Savings (3) =

(Baseline Energy ± Routine Adjustments to fixed conditions

± Non-Routine Adjustments to fixed conditions)

- (Reporting Period Energy ± Routine Adjustments to fixed conditions ± Non-Routine Adjustments to fixed conditions)

The calculation of the reporting period routine-adjustments term usually involves the development of a mathematical model correlating reporting-period energy with the independent variables of the reporting period. This model is then used to adjust reporting-period energy to the chosen fixed conditions. Further, if the fixed set of conditions is not from the baseline period, a mathematical model of baseline energy is also used to adjust baseline energy to the chosen fixed conditions.

What Basis for Adjustment, or Which Type of 'Savings?'

Factors to consider when choosing between avoided energy use and normalized savings:

"Avoided Energy Use" style of savings (Equation 2):

- Are dependent upon the reporting period's operating conditions. Even though savings can be properly adjusted for phenomena such as weather, the level of reported savings depends upon the actual weather.
- Cannot be directly compared with savings predicted under baseline conditions

"Normalized savings" style of savings (Equation 3):

- Are unaffected by reporting-period conditions since the fixed set of conditions are established once and not changed.
- Can be directly compared with savings predicted under the same set of fixed conditions.
- Can only be reported after a full cycle of reporting-period energy use, so that the mathematical correlation between reporting-period energy and operating conditions can be derived.

According to Dream project objectives, it is necessary the development of Normalized savings calculations, in order to extrapolate the final savings results to similar facilities under construction but under other weather conditions.

1.3.8 M&V PLAN CONTENTS

A complete M&V Plan should include discussion of the following 13 topics:

- ECM Intent.
- Selected IPMVP Option and Measurement Boundary.
- Baseline: Period, Energy and Conditions.
- Reporting Period.
- Basis for Adjustment.
- Analysis Procedure.
- Energy Prices.
- Meter Specifications.
- Monitoring Responsibilities.
- Expected Accuracy.
- Budget and the resources required for the savings determination.
- Report Format   Specify how results will be reported and documented.
- Quality Assurance   Specify quality-assurance procedures that will be used for savings reports and any interim steps in preparing the reports.

1.4 PHASE II SAVINGS REPORTING

1.4.1 M&V REPORTING

Once the ECMS are implemented, energy consumption and variables will be measured during 12 months. The savings will be calculated as established in the final M&V plan and the final savings report will be developed.

Complete M&V reports should include at least:

- Observed data of the reporting period: the measurement period start and end points in time, the energy data, and the values of the independent variables.
- Description and justification for any corrections made to observed data
- For Option A the agreed estimated values.
- Energy price schedule used.
- All details of any baseline non-routine adjustment performed. Details should include an explanation of the change in conditions since the baseline period, all observed facts and assumptions, and the engineering calculations leading to the adjustment.
- Computed savings in energy and monetary units.

The report presents the energetic savings really obtained according to the proposed formulation in M&V plan

The report conclude with a detailed energy saving report on the Dwellings or facilities considered for the measurements. These savings will be extrapolated to the rest of the building.

1.5 INITIAL APPROACH OF IPMVP IN THE DIFFERENTS PILOTS CASES.

The following tables show a summary as a starting point for the application of IPMVP in different pilot cases.

The information collected refers to the broad proposals outlined in the project Dreeam bases.

All information collected in the tables below are subject to change as the different parts of the project Dreeam are developed.

Table 1: Tresviso Pilot Case

Treviso Pilot Case (Ater, Italy)		
	M&V Plan	**SAVINGS REPORTING**
Sampling measure	5-7 dwelling and Building common services electric consumption will be considered: -Technical Characteristic (size, number of bedroom, orientation, HAVC/ DHW installations) -Sociological Characteristic (Number of resident, social profile, age, family status, working situation)	
ECMs	**Initial proposal** Roof mounted solar thermal system and storage Solar photovoltaic electricity supply Heat pumps and underground storage	Final ECMs
Measurement period selection	Min. 6 months	12 months
Energy consumption measurement	-Building common services electric consumption -Natural Gas general consumption -Heat Cost Allocators installed in the radiators.	-Building common services electric consumption - Gas Natural general consumption - Heat Cost Allocators -PV Energy Production -Geotermarl supply

Independent Variables monitoriced	-Room temperature -Outside temperature (HDD)
Static factor	- Social characterization: number and type of occupants - House heating equipment - Amount of space being heated or air conditioned
IPMVP Option	Option C
Types of Savings calculated	Normalized Savings
Note	It could be necessary to have the information of the all Heat Cost Allocators installed in the radiators.

Table 2: Padiham Pilot Case

Padiham Pilot Case(PFP, UK)		
	M&V Plan	**SAVINGS REPORTING**
Sampling measure	5 dwelling Will be considered: -Technical Characteristic (size, number of bedroom, orientation, HAVC/ DHW installations) -Sociological Characteristic (Number of resident, social profile, age, family status, working situation)	
ECMs	**Initial proposal** Wall insulations Meseaurements Solar photovoltaic electricity supply POD solar thermal Heat storage from POD	Final ECMs

Measurement period select.	Min. 6 months	12 months
Energy consumption measurement	- Heating system electric consumption of 4 dwellings, and general electric consumption. - Natural Gas consumption in 1 dwelling	- Heating system electric consumption of 4 dwellings - Natural Gas consumption in 1 dwelling - Energy production in 5 dwelling
Independent Variables monitoriced	-Room temperature -Outside temperature	
Static factor	- Social characterizes: number and type of occupants - House heating equipment - Amount of space being heated or air conditioned	
IPMVP Option	Option B	
Types of savigs calculated	Normalized Savings	
Note		

Table 3: Koppargården, (Lands SWEDEN)

Koppargården, (Lands SWEDEN)		
	M&V Plan	**SAVINGS REPORTING**
Sampling measure	5-7 dwelling Will be considered: -Technical Characteristic (size, number of bedroom, orientation, HAVC/ DHW installations) -Sociological Characteristic (Number of resident, social profile, age, family status, working situation)	
ECMs	**Initial proposal** Close loop heat pump for waste-water heat recovery Photovoltaic renewable energy Individual sub-metering (and billing) of hot water use	Final ECMs
Measurement period	Min. 6 months	12 months
Energy consumption measurement	- Hot water energy suply (general connection) - Electric consumption of 5 dwellings - Pump system Electric consumption	- Hot water energy suply (general connection) - Electric consumption of 5 dwellings - Pump Electric consumption - Energy production in 5 dwelling
Independent Variables monitoriced	- Hot water flow -Room temperature -Outside temperature	
Static factor	- Hot water distribution system equipment - Social characterizes: number and type of occupants - House heating equipment - Amount of space being heated or air conditioned	
IPMVP Option	Option B for pump System ECMs and Option C for building ECMs	
Types of Savings calculated	Normalized Savings	

2. STRATEGY FOR MONITORING IN PILOTS SITES.D.4.1.a (v1)

In order to define the strategy for Monitoring in each Pilot site, the following content is going to be analysed:

- INITIAL INFORMATION NEEDED.
  - HISTORIC ENERGY CONSUMPTION DATA:

    In order to calculate the energy Base line, is needed to collect the energy consumption of one year from all the energy suppliers. There are different agents involved for getting this information.

    1. Information Provided by Building owners.
       a. Energy consumptions Bills.
       b. Current monitoriced services.
    2. Information provided by Utilities, this information could be provided once the utility have the permission from the client (BO, Tenant)
    3. Information provided by tenants.
       a. Electric Bills.
       b. Bills from heating system.
  - BUILDING DESCRIPTION.
    1. Architectonical Drawings.
    2. Installations drawings. Heating scheme, electric
  - SOCIOLOGICAL CHARACTERISTIC.
    1. Number of tenants/dwelling
    2. Family status.
    3. Social Profile/age/ energy pattern of use.
    4. This information will be collected in coordination with Savills an Building owners.
- ANALISYS OF INFORMATION AVAILABLE AND COLLECTED FOR PLANING THE STRATEGY FOR ENERGY MONITORING.
- BUILDING AND INSTALLATIONS DESCRIPTION.
- MEASUREMENT AND VERIFICATION PLAN.
  a. Determination of sampling Measures.
  b. Selection IPMVP OPTION. Measurement boundary
  c. Baseline Period and Conditions.
  d. Timetable activities and reporting period.
  e. Monitoring equipment options.
  f. Detailed plan for monitoring equipment.

3. STRATEGY FOR MONITORING IN ATER TREVISO 1st Pilot Building.

3.1 INFORMATION AVAILABLE AND COLLECTED FOR PLANING THE STRATEGY FOR ENERGY MONITORING.

The three pilot sites have the same singularity regarding to information available: there are very few information that describes the buildings in detail. Whereas the three pilot sites are from 70´s, it shows a usually characteristic for this type of buildings. In the case of Ater Building the following table shows the information available.

Table 4: ATER TREVISO PILOT INITIAL INFORMATION REQUESTED

ATER TREVISO PILOT INITIAL INFORMATION REQUESTED.				
Information	**Initial Availability**	**Agent involved**	**Other Agent requested**	**Information Provided**
ENERGY CONSUMPTIONS				
Electric consumptions comunal Areas	NO	Ater/building manager	Eon (utility) Without no results	1 year
Electric consumptions tenants	NO	Ater/	Aggregate consumptions requested to Eon (utility) Without no results.	8 Tenants 1 year
Gas consumptions Central Heating.	NO	Ater/ Syram (Esco)		3Years
Gas consumptions Central Heating.	NO	Ater/ Syram (Esco)		3 Years
Tenants heating bills (from electronic allocators)	NO	Ater/Syram/tenants		1 Year (7 tenants)
BUILDING DESCRIPTION. (drawings technical description)				
Arquitectonical	YES			Basic description.
Electric installation	NO			Information collected in field visit.
HAVC installation.	YES			Basic description
SOCIOLOGICAL CHARACTERISITC				
Number of tenants per dwelling	NO	Ater/Savills		Ater/
Family status.	NO	Ater/Savills		Savills Interviews

3.2 BUILDING AND INSTALLATIONS DESCRIPTION. (BISCIONE BUILDING INITIAL SELECTION)

The building is a line-type building with an "L stretched" shape and it's divided into three parts slightly similar. The whole Building is approximately about 200m in length, 9.50in depth and21.90m height (h conventional, for the urban purposes) with the pitched roof. Originally the ground floor was used as a commercial space with a portico of longitudinal distribution, after the 1975 (year of construction) the portico was closed to enlarge the eleven shops. In the basement there are garages served by rampson the back side, while in the attic there is a common area for laundry. The building have 102 apartments of different size (from 64.83 sq m to 109 sq m), consisting of a living room, kitchen, bathrooms and from two to four bedrooms. All the units are served by eight stairwells with lift that define eight blocks characterized in four typologies (T1, T2, T3, and T4).

Fig. 5: BISCIONE BULDING

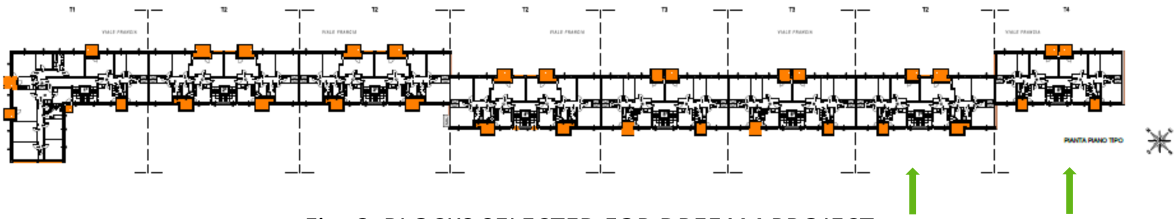


Fig. 6: BLOCKS SELECTED FOR DREEAM PROJECT

.

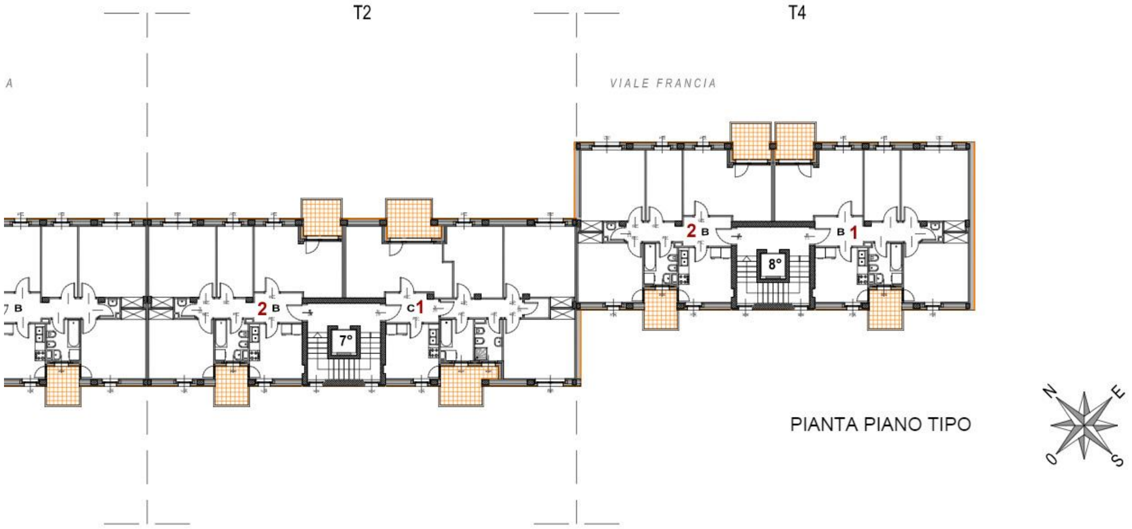


Fig. 7: Blocks selected for Dreeam project.

Number of Floors: 6 residential Floor + Ground floor (commercial)

Apartments: 102 Units (from 64.83 sq m to 109 sq m)

Table 5: Apartment net area

APARTMENT NET AREA (Relacione tecnicaBloccoabitativo)			
TIPOLOGY	**QUANT.**	**M2**	
T1	1	1558,44	1558,44
T2	4	1156,98	4627,92
T3	2	977,04	1954,08
T4	1	960,49	960,49
TOTAL			**9100,93**
T2+T4			**2117,47**

APARTMENT DESCRIPTION BY TIPOLOGY.

Table 6: Apartment description by tipology

TIPOLOGY	UNITS	Kitchen	Dryingterrace	Bathroom	Livingroom	Terrace	Bedrooms
T1							
A	6	1	1	1	1	1	3
B	6	1	1	1	1	0	2
D	6	1	1	2	1	1	4
T2A							
C	6	1	1	2	1	1	3
C	6	1	1	2	1	1	3
T2B							
C	6	1	1	2	1	1	3
C	6	1	1	2	1	1	3
T2C							
C	6	1	1	2	1	1	3
C	6	1	1	2	1	1	3
T3							
B	6	1	1	2	1	1	3
B	6	1	1	2	1	1	3
T3							
B	6	1	1	2	1	1	3
B	6	1	1	2	1	1	3
T2D							
B	6	1	1	2	1	1	3
C	6	1	1	2	1	1	3
T4							
B	6	1	1	1	1	1	3
B	6	1	1	1	1	1	3
TOTAL	**102**						

HEATING SYSTEM.

The apartments are equipped with a natural gas centralized system for the production of heating and domestic hot water(consisting of 3 boilers), while the ground-floor shops have gas boilers of stand-alone type, as not using the heating and hot water of the centralized system. The Heating of housing is the radiator type, while the summer cooling, if any, is made with conditioners single type.

Centralized natural gas thermal power station having total capacity of 1.050 kW consisting of:

- n.1 thermal unit, potential 420 kW Ecoflam NC- 420
- n.1 thermal unit, potential 630 kw Ecoflam NC- 630

Fig. 8: Heating Boilers characteristic plate

Fig. 9: Radiator/electronic heat allocator/thermostatic valve

COOLING SYSTEM.

Some flats are equipped with single conditioners.

Fig. 10: AC EQUIPMENT (Only some flats)

DOMESTIC HOT WATER.

Centralized natural gas thermal power station having total capacity of 282 kW consisting of:

- N.2 thermal unit, potential 141 kW each.

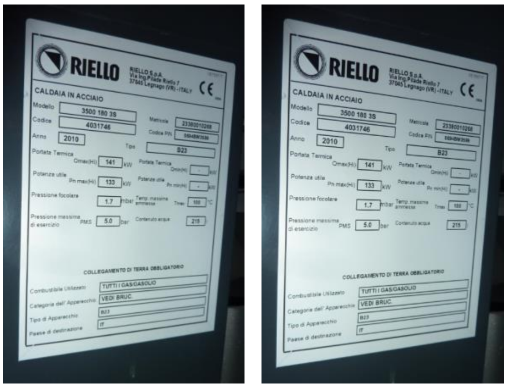


Fig. 11: DHW Boilers characteristic plate

PUMPING SYSTEM.

Table 7: Pumping system

PUMPING SYSTEM			
SYSTEM	**LOCATION**	**QUANT.**	**P(kW)**
HEATING	BOILER 1	2	0.58
HEATING	BOILER 2	2	0.45
HEATING	Forw. Pipe	3	5,3
DHW	Boilers	2	0.10
DHW	1St/2nd	4	1,5
WATER SUP	W SYST.	2	4

Fig. 12: Characteristic pump plates

ELEVATORS.

1 Elevator for each Block equipped with an engine 3.3 kW.

SMS SISTEMI E MICROSISTEMI

SCHEDA PRODOTTO ARGANO

NUMERO DI SERIE ARGANO: 06A01294/7

CODICE ARGANO: F GK0 145 S 033 400 004

RAPPORTO DI TRASMISSIONE: 1:45 MANO: SX TIPO: GEKO

MOTORE: 3,3kW 400V MOTORE VVVF 4 POLI COLLEGAMENTO: STELLA

VOLANO: VOLANO D.382 L.24 GHISA BOBINA: BOBINA FRENO 54VDC (48-60V +\- 10%

GUARDAFUNI: GUARDAFUNI TIRO 360

PULEGGIA: CODICE APGK480311TI3508018 FORNITA : MONTATA

DIAMETRO 480 GOLE 3 GOLE D.FUNI D.11 FORMA GOLA trapezoidale con intaglio

ANGOLO GOLA gamma di 35° ANGOLO INTAGLIO intaglio di 80° PASSO TRA GOLE 18

NOTA: PULEGGE CON 3 GOLE 11mm ANGOLO γ 35° INTAGLIO 80° = 3 GOLE 9mm ANG. γ 35° INT. 104° = 3 GOLE 10mm ANG. γ 35° INT. 90° = 3 GOLE 12mm ANG. γ 35° INT. 73°

Fig. 13: Elevators Characteristics.

LIGTHING SYSTEM.

- Flats light system. (according with tenants interviews)

Most of tenants have low energy bulbs or a mix between normal with low energy bulbs (and a progressive replacement)

- Communal Areas.

The stairways and communal areas are mostly equipped with fluorescence system.

Fig. 14: Fluorescence system

Table 8: Major energy consuming system

MAJOR ENERGY CONSUMING SYSTEM.	SOURCE	SCOOPE
HEATING		**BUILDING**
BOILERS	GAS	
PUMPING SYSTEM	ELECTRIC	
DOMESTIC HOT WATER		**BUILDING**
BOILERS	GAS	
PUMPING SYSTEM	ELECTRIC	
COMMUNAL LIGHTING	**ELECTRIC**	**BUILDING**
ELEVATORS	**ELECTRIC**	**BUILDING**
TENANTS COOLING SYSTEM	**ELECTRIC**	**APARTMENT**
TENANTS LIGHTING	**ELECTRIC**	**APARTMENT**
COOKING SYSTEM	**GAS**	**APARTMENT**
APPLIANCES	**ELECTRIC**	**APARTMENT**

3.3 MEASUREMENT AND VERIFICATION PLAN.

3.3.1 DETERMINATION OF SAMPLING MEASURES FOR APARTMENT SCOOPE.

Biscione Building is distributed in 8 blocks and this 8 blocks are aggregated in 4 different typologies (T1, T2, T3 and T4) in terms of similar indoor distribution and facades design.

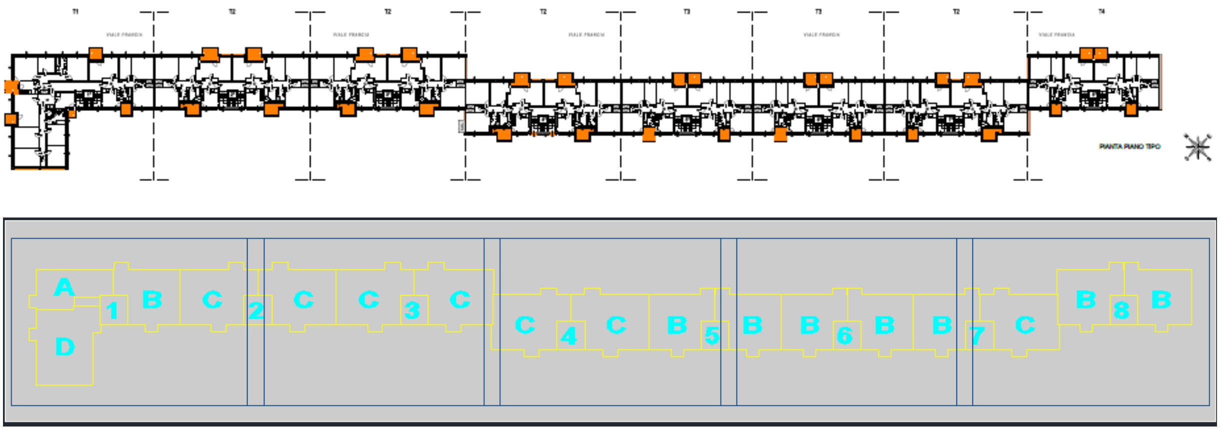


Fig. 15: Building distribution

(TI: Block 1, T2: Block2, 3, 4, 7 T3: block 5, 6 T4: block 8)

Regarding with the area of each apartment there are 4 typology: A,B,C,D

The Blocks initially selected for renovations within Dreeam project are typology T2 (7) and T4 (8)

After taking into consideration the following variables:

- Facade orientation. T2, T3, T4, T1 (B), (88,23%) have the same main orientation.
- Flats area and room distribution.

BLOCK T2 (7) is the block selected for sampling measures, because it has the standard orientation of the building, and it has the two more common typology of flats, (B and C)

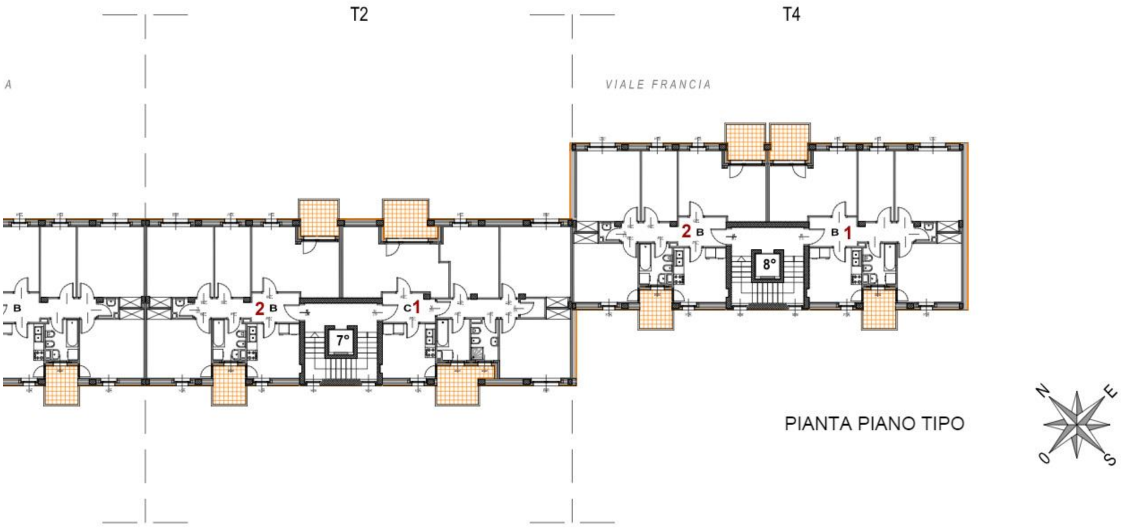


Fig. 16: *Blocks Selected for Dreeam Project.*

Analysing another variables it is possible to perform a second group of samples between the 24 flats that composed T2 and T4

- FLOOR, three different floors considering three different flats envelopes: 1st, intermediate,6th
- Number of tenants.
- Social characteristics: Age, Family Status.

Table 9: Tenants per flat

TENANTS PER FLAT.							
	T2 (7)				T4 (8)		
	C	B	BEDROOMS		B	B	BEDROOMS
P6	6	2	3	P6	4	3	3
P5	3	2	3	P5	3	6	3
P4	4	2	3	P4	2	4	3
P3	2	4	3	P3	1	4	3
P2	1	2	3	P2	2	2	3
P1	4	2	3	P1	3	2	3
Average	2,91	P/flat					
Sum	70						

Table 10: Flats units per occupancy

FLATS UNITS PER OCCUPANCY (TENANTS)							
TENANTS	1 PERS.	2 PERS.	3 PERS.	4 PERS.	5 PERS.	6 PERS.	TOTAL
FLOOR							
P6		1	1	1		1	
INTERM	2	7	2	4		1	
P1		2	1	1			
TOT. FLATS	2	10	4	6	0	2	24
TOT. PERS	**2**	**20**	**12**	**24**	**0**	**12**	**70**

Searching the minimum quantity of groups that could be a representative sample for extrapolate the results; the flats selected are shown in the following table.

For tenant's interviews selection, T2 is the first Typology option but in case that there is not collaboration from this typology, T4 would be the alternative option.

Table 11: Standard flats for closely monitoring and tenants interviews

STANDARD FLATS FOR CLOSELY MONITORING AND TENANTS INTERVIEWS			
UNIT	**PLANT**	**OCUPANCY**	**TYPOLOGY**
1 ud	P6.	2 PERS	T2/T4 First option T2
1 ud	interm	2 pers	T2/T4 First option T2
1 ud	interm	4 pers	T2/T4 First option T2
1 ud	P1	2 PERS	T2/T4 First option T2

This selection also represents the two key types of householders, confirmed during the tenant's interviews.

- Retired tenants. Normally two persons.
- Families, More than two tenants.

3.3.2 SELECTED IPMVP OPTION.

For Ater Treviso building two kinds of analysis will be developed:

Option C. Whole Building, In order to compare the energy performance before and after renovations.

Savings are determined by measuring energy use at the whole facility. See the variables that are going to be measured are:

Table 12: Measurements – Option C

MEASURE	SOURCE	FRECUENCY.
M3 Gas Consumption for heating	Supplier bills	Monthly
M3 Gas consumption for DHW	Supplier bills	Monthly
kWh electric consumption Heating and DHW System	Supplier Bills/ Monitoring equipment.	Monthly/Each 15 min.
kWh electric consumption communal services	Supplier bills 8 blocks/ monitoring equipment 1 block (T2)	Monthly 8 Blocks/ each 15 min Block T2 (7)
kWh electric consumptions tenants.	Supplier bills 3 tenants/ Monitoring equipment 12 tenants.	Monthly 3 Tenants/ each 15 min 12 tenants.

There is only one measure that is not going to be measured at 100%: Electric consumption of tenants.

- It is going to be measured the 50% of the tenants affected by renovation plan (T2) Block (see Options for monitoring Plan). They represent 11,76% of the whole building. To extrapolate results it will be calculated by comparison or regression analysis.

Continuous measurements of the entire facility's energy use are taken throughout the reporting period by the monitoring equipment.

Option B for Heating and Domestic hot water ECM.

Savings are determined by field measurement of the energy use of the ECM-affected system. Measurement frequency are described in the following table:

Table 13: Measurements – Option B

MEASURE	SOURCE	FRECUENCY.
kWh Boiler produced for heating	ESCO/Monit. Equipment.	Monthly/Each 15 min.
kWh Boiler produced for DHW	ESCO/Monit. Equipment.	Monthly/Each 15 min.
kWh electric consumption Heating and DHW System	BILLS/ Monit. Equipment.	Monthly/Each 15 min.
kWh Energy consumption of New System after renovations.	BILLS/Monit. Equipment.	Monthly/Each 15 min

3.3.3 BASELINE PERIOD AND CONDITIONS.

Once the main subjects for energy analysis are identified:

- Major energy consumptions systems.
- Data availability for energy analysis.

It is possible to define:

- The energy Base line for each system
- The strategy for monitoring additional monitoring equipment, that will provide detailed complementary data to the available data.

Energy base-lines, the following baselines will be calculated.

- Heating baseline. The independent variable commonly used for this model is Heating Degree days HDD, several regression analysis with different HDD will be performed.
- Domestic hot water-baseline. The influence of weather conditions will be considered in this calculations.
- Communal electric Services. This consumption will be breakdown in consumption affected by weather conditions (i.e pumping system for heating) and other consumptions not affected by weather conditions (Lighting system and elevators)
- Tenants consumption baseline.
  - The information initially provided is one year consumption for 7 tenants (monthly data). This information should have to be complemented with more data provided from new monitoring equipment.

- According with the Monitoring Plan for the pilot Site, It is feasible to collect the electric consumption from 12 tenants in the same Block on real time, each 15 min. After one year of monitoring, there will be a great amount of data that will allow to develop a complete analysis. The block selected is the Typology T2 because it represent the more standard block.
    - Additional base lines for tenants could be developed for Block T4 but in this case the cooperation from tenants is needed providing electric bills and the amount of data will be very few (monthly consumption).
- There will be twelve tenants baseline energy consumption.
    - It represents sample of 11,65%
    - The samples contains almost all the tipologies considering all the factors:
    - Flat typology and social characterization:

Table 14: Number of tenants per flat – T2

T2 (7) NUMBER OF TENANTS PER FLAT		
FLOOR	Flat Type B	Flat Type C
P6	6	2
P5	3	2
P4	4	2
P3	2	4
P2	1	2
P1	4	2

The selected period for baseline is the year 2015.

<u>HEATING SYSTEM CONDITIONS.</u>

- The heating Schedule for the year is fixed and programmed from mid October to mid April. During this period the central heating system is switched off two hours in the morning every day.
- The temperature set point of water production for the boilers is 80C. The indoor temperature during heating system can be selected by the tenant through the position of the thermostatic Valve.

<u>DOMESTIC HOT WATER.</u>

The temperature set point of water production for the boilers is 65C.

COOLING SYSTEMS.

(Only tenants with individual equipment). Each tenant selects their own user conditions set points and hours of use.

3.3.4 INDEPENDENT VARIABLES and STATIC FACTORS

Ambient temperature is selected as the main variable that allows to define a mathematical relation to represents the energy performance. In the energy performance report will be described the different mathematical models that represent the consumption after perform the analysis with the data available for Heating Degree Days.

The static Factors considered for this pilot are

- Occupancy data and social Characterization. (I.E. Tenants that leave the flats, or new tenants with different family Typology)
- Operating conditions: heated and cooling areas, (I.E. tenants that install a new cooling system)

This static factor has to be monitored by Ater-Treviso and the variations of these conditions will be calculated in the Non-routine Adjustments.

In the following Tables are showed the initial values for STATIC FACTORS, regarding with Occupancy Data, Cooling systems and heated and cooling areas.

BISCIONE BUILDING.

Table 15: Initial values of Biscione building

Block/ Num	TYPE	FLOOR	SIDE	n Persons	BOW WINDOW	air cond
B1/2	T1	1	B	2		
B1/2	T1	1	C	1		
B1/2	T1	1	A	3	x	x
B1/2	T1	2	B	3		
B1/2	T1	2	C	2		
B1/2	T1	2	A	1		
B1/2	T1	3	B	2		x
B1/2	T1	3	C	1		

B1/2	T1	3	A	1		x
B1/2	T1	4	B	6		
B1/2	T1	4	C	2		
B1/2	T1	4	A	2		
B1/2	T1	5	B	3		
B1/2	T1	5	C	0		
B1/2	T1	5	A	2		x
B1/2	T1	6	B	2		
B1/2	T1	6	C	5		
B1/2	T1	6	A	1		
B2/4	T2	1	L	1		
B2/4	T2	1	R	4		
B2/4	T2	2	L	3		
B2/4	T2	2	R	1		
B2/4	T2	3	L	1		
B2/4	T2	3	R	3	x	
B2/4	T2	4	L	4		
B2/4	T2	4	R	1		
B2/4	T2	5	L	1		
B2/4	T2	5	R	1		
B2/4	T2	6	L	0		
B2/4	T2	6	R	2		
B3/6	T2	1	L	2		
B3/6	T2	1	R	2		
B3/6	T2	2	L	1		
B3/6	T2	2	R	2	X	x
B3/6	T2	3	L	2		
B3/6	T2	3	R	7		
B3/6	T2	4	L	1		
B3/6	T2	4	R	1	X	x
B3/6	T2	5	L	2	X	x
B3/6	T2	5	R	6		
B3/6	T2	6	L	2	X	x
B3/6	T2	6	R	2	x	
B4/10	T2	1	L	6		X
B4/10	T2	1	R	2	X	
B4/10	T2	2	L	4	X	
B4/10	T2	2	R	4		
B4/10	T2	3	L	2		
B4/10	T2	3	R	1		
B4/10	T2	4	L	2	X	
B4/10	T2	4	R	2	X	
B4/10	T2	5	L	3		
B4/10	T2	5	R	5		
B4/10	T2	6	L	3		
B4/10	T2	6	R	3		

B5/16	T3	1	L	5		
B5/16	T3	1	R	2		
B5/16	T3	2	L	2		
B5/16	T3	2	R	3		
B5/16	T3	3	L	1		
B5/16	T3	3	R	1		
B5/16	T3	4	L	2		
B5/16	T3	4	R	2		
B5/16	T3	5	L	2	X	
B5/16	T3	5	R	1		
B5/16	T3	6	L	3		
B5/16	T3	6	R	1		
B6/22	T3	1	L	4		
B6/22	T3	1	R	2		
B6/22	T3	2	L	2		
B6/22	T3	2	R	0		
B6/22	T3	3	L	3		
B6/22	T3	3	R	1	X	
B6/22	T3	4	L	0		
B6/22	T3	4	R	1		
B6/22	T3	5	L	2	X	
B6/22	T3	5	R	2	X	
B6/22	T3	6	L	2		
B6/22	T3	6	R	1		X
B7/24	T2	1	R	4		
B7/24	T2	1	L	2		x
B7/24	T2	2	R	2		x
B7/24	T2	2	L	6		
B7/24	T2	3	L	1	x	
B7/24	T2	3	R	3		
B7/24	T2	4	R	4		
B7/24	T2	4	L	2		
B7/24	T2	5	R	2		
B7/24	T2	5	L	4		
B7/24	T2	6	R	2		
B7/24	T2	6	L	2		
B8/26	T4	1	R	3		
B8/26	T4	1	L	2	x	
B8/26	T4	2	R	2		
B8/26	T4	2	L	2		
B8/26	T4	3	R	1	x	
B8/26	T4	3	L	4	x	x
B8/26	T4	4	R	3		
B8/26	T4	4	L	3		

B8/26	T4	5	R	4		
B8/26	T4	5	L	6		
B8/26	T4	6	R	2		
B8/26	T4	6	L	4		

Table 16: Quantity of apartments per typology and tenants

QUANTITY OF APARTEMENTS PER TYPOLOGY AND TENANTS									
	0 PERS	**1 PERS**	**2 PERS**	**3 PERS**	**4 PERS**	**5 PERS**	**6 PERS**	**7 PERS**	**TOTAL**
T1	1	5	7	3		1	1	0	**18**
T2	1	11	18	6	7	1	3	1	**48**
T3	2	7	10	3	1	1	0	0	**24**
T4	0	1	4	3	3	0	1	0	**12**
TOTAL	**4**	**24**	**39**	**15**	**11**	**3**	**5**	**1**	**102**

Table 17: Quantity of apartments with bow window

QUANTITY OF APARTMENTS WITH BOW WINDOW		
T1	1	5,56%
T2	11	22,92%
T3	4	16,67%
T4	3	25,00%
TOTAL	**19**	**18,63%**

Table 18: Quantity of apartments with air conditioner

QUANTITY OF APARTMENTS WITH AIR COND.		
T1	4	22,22%
T2	7	14,58%
T3	1	4,17%
T4	1	8,33%
TOTAL	13	12,75%

3.3.5 TIMETABLE ACTIVITIES AND REPORTING PERIOD.

Table 19: Treviso monitoring planning

TREVISO MONITORING PLANING and Reporting Period.																					
		2015				2016				2017				2018				2019			
		1 Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	31-04	07-11	14-18	21-25
0	**INITIAL INFORMATION**																				
1	COLLECTING INFORMATION																				
2	FIELD VISITS																				
I	**MONITORING EQUIPMENT DEFINITION**																				
2	TENANTS INTERVIEWS																				
3	MONITORING EQUIPMENT INSTALLATION																				
II	**BASELINE PERIOD**																				
3	Period with detailed information from monitoring equipment																				
	Period for monitor static Factors (PFP)																				
III	**ESTIMATED PERIOD FOR RENOVATIONS WORKS**																				
IV	**REPORTING PERIOD**																				

This plan of activities was temporally suspended in April 2016, the idea is to continue the project with a New Pilot Building

3.4 OPTIONS FOR MONITORING EQUIPMENT.

This section describe the possible options analysed for installed monitoring equipment that add valuable energy consumption data needed to define the energy baseline. The objective for this monitoring proposal is collect as much and technically possible information from Heating system, Domestic hot water System and electric consumption from tenants.

In order to verify indoor comfort conditions some temperature sensors are proposed to be installed in some selected flats, at least (1st floor, intermediate floor and 6th floor)

3.4.1 Options For Monitoring Heating and DHW.

The Scheme below shows the distribution of the Heating and DHW Central System of Biscione Building.

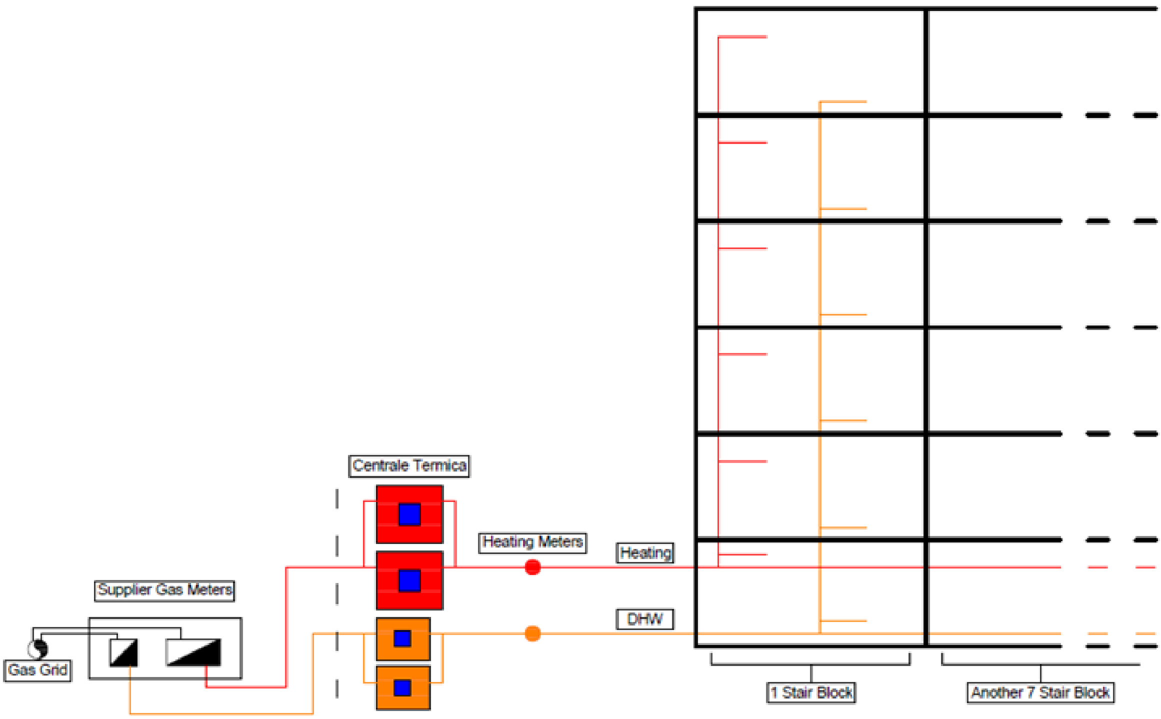


Fig. 17: Scheme of heating and DHW distribution

Option	Installation	Description	Comments

1	**SUPPLIER GAS METER** 	Measure: Gas m^3 (Heating and DHW) Gas meters: Elster BK-G25 M (DHW) and Elster BK-G100 M (Heating). Equipped with pulser IN-Z61. Conversion devices: CPL Concordia ECOR4 (DHW) and KamstrupUnigas 300. (Heating)	Both devices belong to the supplier company and they are sealed. It is not possible to manipulate them or connect any other devices without supplier permission.
2	**HEATING METERS** 	Measure: MWh. (Heating and DHW) Energy meters: • DanfossSonometer 1000. • DanfossSonometer 1100. (Condenser) • KundoCaroli. (Boiler) Communication: Optical interface with the M-Bus protocol.	It is possible to collect the data from the Current Energy meters trough optical interface and pulser device. Through this energy meter we would get the data on real time.

3.4.2 Options for monitoring Electric Consumption

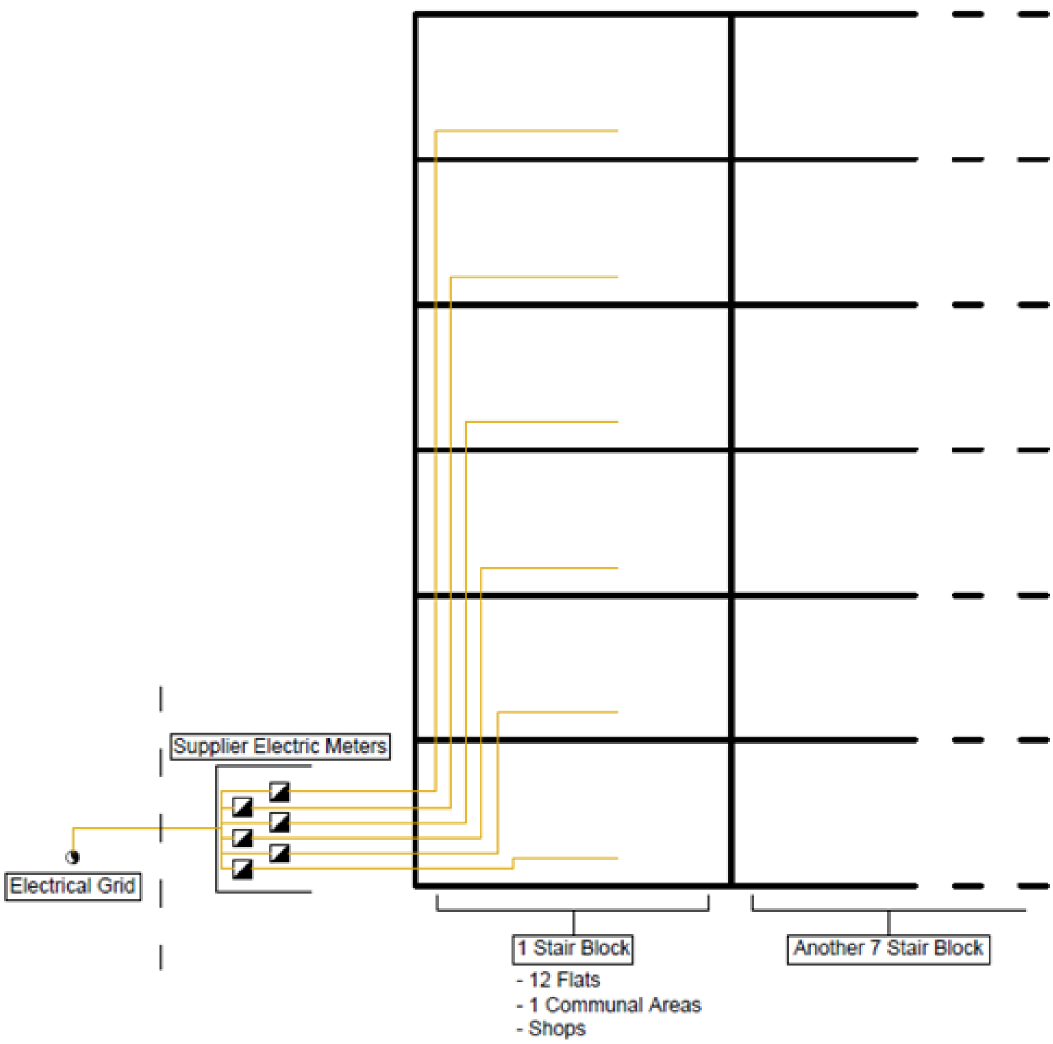


Fig. 18: Scheme of electric consumption

Table 20: Monitoring installation description

Option	Installation	Description	Comments
1	**IN SUPPLIER ELECTRIC BOARD** 	Measure: kWh Equipment: Electric Three phase meter (ODEnergy) Electrical connection in supplier electrical board (bus bar located below meters. Need to verify).	Advantages: -Total electricity metering stair block (communal áreas and flats) Disadvantages: -Supplier electrical board could be sealed (need to be verified), it is required permission from the supplier. Others: -Temperature measurement would be installed in selected flats. -Modem GPRS with internet Access should be installed
2	**AFTER SUPPLIER ELECTRIC METERS.** **SELECTED OPTION** 	Measure: kWh Equipment: Electric Three phasic and Monophasic meter (ODEnergy) Electrical connection in general electrical board after supplier meter: - 1 Threephasic meter to lift - 1 Threephasic meter for two local - 1 Threephasic meter for 3 flats - 3 Threephasic meter for 9 flats	Advantages: -Individual measurement of each flats and communal areas. Others: -Temperature measurement would be installed in selected flats -Modem GPRS with internet Access should be installed

3	**SUPPLIER ELECTRIC METER/OPTICAL DEVICE** 	Measure: kWh EQUIPMENT: Optical meter/datalogger modem Meter Reading Company ENEL with the optical port.	Disadvantages: - The meter is produced by the electrical supplier (ENEL) we probably need the supplier permission to collect the data from the optical port Others: -Temperature measurement would be installed in selected flats -Modem GPRS req.
4	**ELECTRIC METERS AT ELECTRIC BOARD IN FLAT.** 	Measure: kWh Electric Monophasic meter (ODEnergy) in flat board Electrical connection in the electrical board in selected flats.	Advantages - Easy installation (electric and temperature devices are installed together) Disadvantages: - Only archetypes flats - The electrical boards of the flats are very small and need use auxiliary electrical boards. - Need of anchoring to the wall in Flats - The flats need internet. Others: -Temperature measurement would be installed in selected flats.

3.5 DETAILED MONITORING PLAN.

This section describes in detail the option selected for the installation of monitoring equipment. In this case the option selected includes monitoriced Thermal meters of Heating and Domestic hot Water, the electric consumption of flats and common facilities in Block T2 and 6 flats indoor Temperature

3.5.1 ELECTRIC CONSUMPTION FLATS AND COMMON FACILITIES.

The photo below shows the utility meters and the electric board of common service, the monitoring equipment will be installed in the same electric distribution room.

Fig. 19: Utility meters and electric board

To measure all the electric consumption of Block T2 have been considered the installation of Electric Meters: ODEnergy provided by Opendomo with the following distribution.

FLATS: 4 ODEnergy three phasic measure 12 flats. 1 Current Transformer after each supplier meter (monophasic measure)

SHOPS: 1 Unit ODENERGY Threephasic measure 2 shops. 1 Current Transformer after each supplier meter (monophasic measure)

COMMON FACILITIES: 1 Unit OD ENERGY Three phasic. 3 Current Transformer after each supplier meter (Threephasic measure)

- ELECTRIC CONNECTIONS.

The elevator main switch will be used for connecting the measure voltage for all the meters (OD energy).

Fig. 20: Elevator main switch

One current sensor (open core) will be installed in each measurement point.

Fig. 21: Current sensor installation

The photo below show an example of monitoring equipment board developed as prototype to test the one proposed for the pilot building.

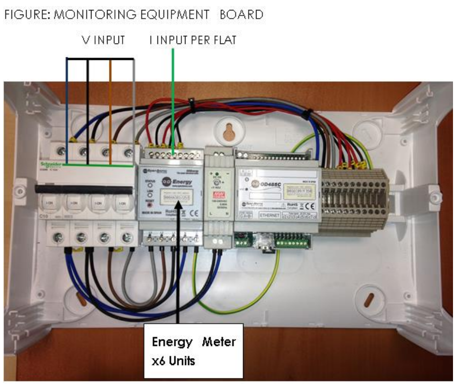


Fig. 22: Monitoring equipment board example

TEMPERATURE AND HUMIDITY MEASURE IN FLATS.

6 unit temperature and humidity sensors in 6 selected flats. 1 unit datalogger, 1 datalogger per stairblock.

3.5.2 THERMALMETERS INTEGRATION, HEATING ROOM ELECTRIC CONSUMPTION.

For thermal meters installations the following equipment is needed:

3 Pulse sensor.

1 dataloger device OD485. (Supplied By Opendomo)

1 Electric threephase energy meter.

3.5.3 MONITORING EQUIPMENT LIST.

Table 21: Monitoring equipment list

TREVISO MONITORING EQUIPMENT BEFORE RENOV.		QTY
CAP.1	**MONITORING EQUIPMENT**	
1,1	**ELECTRIC CONSUMPTION (1 BLOCK)**	
	COMMUNAL FACILITIES/ELEVATOR	
1.1.1	OD Energy Trifásico ETH	1,00
1.1.2	Current Transducer Open core Z90/80A	3,00
	FLATS	
1.1.3	OD Energy Trifásico ETH	4,00
1.1.4	Current transducer Open core Z90/80A	12,00
	SHOPS	
1.1.5	OD Energy Trifásico ETH	1,00
	Current transducer Open core Z90/80A	3,00
1.2	**TEMPERATURE SENSORS. (1 block)**	
	OPTION A. Radio Frecuency	
1.2.1	Temperature and humidity sensor Produal TEFL	6,00
1.2.2	Datalogger OD485.C	1,00
1.2.3	Power Suplly AC/DC	1,00
1.2.4	Repeater RF	5,00
1.2.5	BASE RF FLTA PRODUAL	1,00
1.2.6	RF Configuration	1,00
1.3	**CENTRALE TÉRMICA. (HEAT METERS&ELECTRIC CONSUMP)**	
1.3.1	Datalogger OD485.C	1,00
1.3.2	Power Supply AC/DC	1,00
1.3.3	OD ENERGY TRIFÁSICO.	1,00
1.3.4	Transformador de corriente nucleo abierto Z90/200A	3,00
1.3.5	Ethernet cable (100M), (using current cable duct)	1,00
1,3,6	Sennet RF Gateway (Optional)	1,00
	Sonda optica ZVEI Izar OptoHead BT para SONOMETER (DANFOSS) + Gateway Mbus-Modbus	3,00
1,4	**COMMUNICATIONS (1 Block)**	
1.4.1	ROUTER GPRS	2,00
1.4.2	Antenna	2,00
1.4.3	Power supply AC/DC	2,00
1.4.5	Data comunication sim card.	2,00

4. STRATEGY FOR MONITORING IN ATER TREVISO 2st Pilot Building.

4.1 INFORMATION AVAILABLE AND COLLECTED FOR PLANING THE STRATEGY FOR ENERGY MONITORING.

Table 22: ATER Treviso 2nd pilot initial information requested

ATER TREVISO 2nd PILOT INITIAL INFORMATION REQUESTED.				
Information	Initial Availability	Agent involved	Other Agent requested	information Provided
ENERGY CONSUMPTIONS				
Electric consumptions comunal Areas	NO	Ater/building manager	NA	1 year
Electric consumptions tenants	NO	Ater	NA	11 Tenants 1 year
Gas consumptions tenants	NO	Ater	NA	10 Tenants 1 year
BUILDING DESCRIPTION. (drawings technical description)				
Arquitectonical	YES			Basic description.
Electric installation	NO			Information collected in field visit.
HAVC installation.	YES			Basic description
SOCIOLOGICAL CHARACTERISITC				
Number of tenants per dwelling	NO	Ater/Savills		Ater/
Family status.	NO	Ater/Savills		Savills Interviews

4.2 BUILDING AND INSTALLATIONS DESCRIPTION.

The buildings were built in Treviso in the year 1970. There are two buildings included in Dreeam Project; A Tower, placed in Viale Borgo Furo 35, and B Tower, placed in Viale Francia 1.

Fig. 23: A and B Tower air picture

Both Towers have an useful area of 1540,5 m2 and 6 floors. The towers have 3 apartments per floor, therefore 18 apartments per building.

The 2 buildings have the following characterization:

Table 23: A, B Towers description

BUILDING	ADDRESS	FLOORS	APARTMENTS	STAIRWELLS	TENANTS
A Tower	Viale BORGO FURO 35/A	6	18	1	42
B Tower	Viale FRANCIA 1	6	18	1	45

A TOWER:

Table 24: Tower A

ADDRESS	TENANTS	TYPE	FLOOR	BOW WINDOW	SQM	AIR COND.
Via BORGO FURO 35/A	1	A1	1	X	79,44	
Via BORGO FURO 35/A	3	A2	1	X	94,35	
Via BORGO FURO 35/A	2	A3	1	X	82,97	1
Via BORGO FURO 35/A	1	A1	2	X	79,44	1
Via BORGO FURO 35/A	4	A2	2	X	94,35	
Via BORGO FURO 35/A	1	A3	2	X	82,97	
Via BORGO FURO 35/A	1	A1	3		79,44	1
Via BORGO FURO 35/A	3	A2	3	X	94,35	1
Via BORGO FURO 35/A	4	A3	3	X	82,97	
Via BORGO FURO 35/A	3	A1	4	X	79,44	
Via BORGO FURO 35/A	2	A2	4	X	94,35	
Via BORGO FURO 35/A	2	A3	4	X	82,97	
Via BORGO FURO 35/A	1	A1	5	X	79,44	1
Via BORGO FURO 35/A	2	A2	5	X	94,35	
Via BORGO FURO 35/A	2	A3	5	X	82,97	1
Via BORGO FURO 35/A	2	A1	6		79,44	1
Via BORGO FURO 35/A	2	A2	6	X	94,35	1
Via BORGO FURO 35/A	6	A3	6		82,97	

B TOWER:

Table 25: Tower B

ADDRESS	TENANTS	TYPE	FLOOR	OW WINDOV	air cond	SQM	AIR COND.
V.le FRANCIA 1		B1	1	X		79,44	
V.le FRANCIA 1	4	B2	1	X	1	94,35	1
V.le FRANCIA 1	3	B3	1			82,97	
V.le FRANCIA 1	5	B1	2		1	79,44	1
V.le FRANCIA 1	1	B2	2	X	1	94,35	1
V.le FRANCIA 1	2	B3	2	X	1	82,97	1
V.le FRANCIA 1	2	B1	3	X		79,44	
V.le FRANCIA 1	3	B2	3		1	94,35	1
V.le FRANCIA 1	2	B3	3		1	82,97	1
V.le FRANCIA 1	1	B1	4	X		79,44	
V.le FRANCIA 1	5	B2	4	X	1	94,35	1
V.le FRANCIA 1	2	B3	4	X	1	82,97	1
V.le FRANCIA 1	3	B1	5			79,44	
V.le FRANCIA 1	3	B2	5	X	1	94,35	1
V.le FRANCIA 1	2	B3	5		1	82,97	1
V.le FRANCIA 1	1	B1	6	X	1	79,44	1
V.le FRANCIA 1	2	B2	6	X		94,35	
V.le FRANCIA 1	4	B3	6	X	1	82,97	1

GROUND FLOOR:

Fig. 24: Ground floor

1 TO 6 FLOORS:

Fig. 25: 1 to 6 floor

The building envelope is characterized by the following:

- Facade: Brick (13 cm) / Polystyrene (2 cm) / Cavity (4,5-5 cm) / Drilled brick (8cm)

Fig. 26: Facade

- Roof: The roofs are made from ceramic tiles.

Fig. 27: Roof

- Windows: Upvc windows with simple glazing.

Fig. 28: Windows

HEATING SYSTEM.

Each apartment has an independent heating system for the production of water for heating a DHW. Autonomous boiler running with gas natural and 25 kW of thermal power.

Fig. 29: Autonomous boiler

The distribution of heat in the rooms of the apartment is made by radiators. These radiators let adjust the flow rate depending on the internal temperature.

Fig. 30: Radiators

LIGHTING SYSTEM APARTMENT AND COMMUNAL AREAS.

The lighting system depend of the tenants, and there are several types of bulbs.

Fig. 31: Bulbs lights

In the communal areas the majority of the bulbs are incandescence typology.

Fig. 32: Bulbs with incandescence light

In both buildings the communal energy consumption is due to the elevator and the lighting system. There is no other active system that have influence in the energy performance of the building.

4.3 MEASUREMENT AND VERIFICATION PLAN.

4.3.1 DETERMINATION OF SAMPLING MEASURES FOR APARTMENT SCOOPE.

The pilot site buildings are two six floor towers called A Tower (access by 35 Borgo Furo Street) and B Tower (access by 1 Francia Street) has a different orientation.

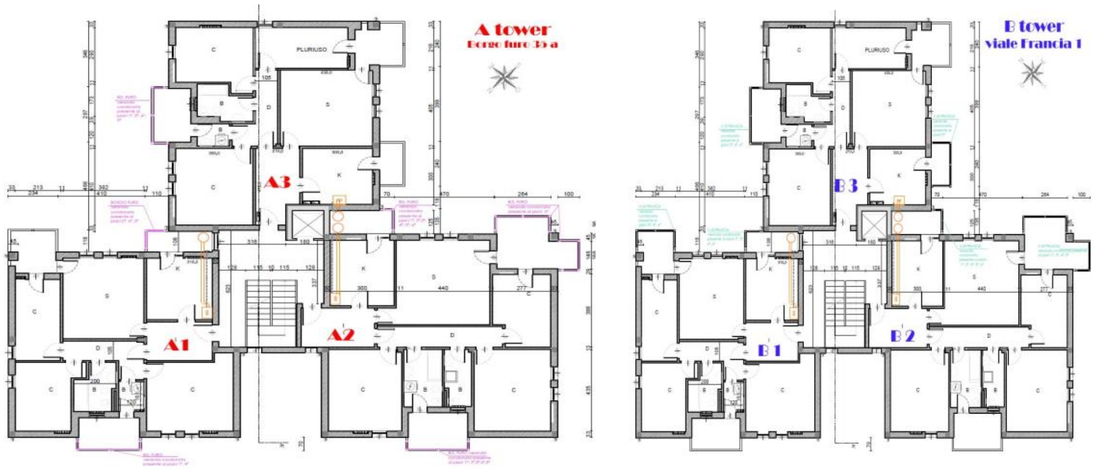


Fig. 33: A and B towers maps

Regarding with the area of each apartment there are 3 different typologies: 1, 2 or 3. The "1" typology has 79,44 m² area, the "2" typology has 94,35 m² and finally, the "3" typology has 82,97 m².

Each apartment has an individual gas heater, to produce heat and DHW. Natural Gas is also used as cooking system.

The Towers initially selected for renovations within Dreeam project are A and B. After taking into consideration the following variables:

- Facade orientation.
- Flats area and room distribution.

Analysing another variables it is possible to perform a second group of samples between the 36 flats that composed A Tower and B Tower

  - Floor
  - Number of tenants.
  - Social characteristics: Age, Family Status.

Table 26: A Tower Characteristics

ADDRESS	TENANTS	TYPE	FLOOR	BOW WINDOW	SQM	AIR COND.
Via BORGO FURO 35/A	1	A1	1	X	79,44	
Via BORGO FURO 35/A	3	A2	1	X	94,35	
Via BORGO FURO 35/A	2	A3	1	X	82,97	1
Via BORGO FURO 35/A	1	A1	2	X	79,44	1
Via BORGO FURO 35/A	4	A2	2	X	94,35	
Via BORGO FURO 35/A	1	A3	2	X	82,97	
Via BORGO FURO 35/A	1	A1	3		79,44	1
Via BORGO FURO 35/A	3	A2	3	X	94,35	1
Via BORGO FURO 35/A	4	A3	3	X	82,97	
Via BORGO FURO 35/A	3	A1	4	X	79,44	
Via BORGO FURO 35/A	2	A2	4	X	94,35	
Via BORGO FURO 35/A	2	A3	4	X	82,97	
Via BORGO FURO 35/A	1	A1	5	X	79,44	1
Via BORGO FURO 35/A	2	A2	5	X	94,35	
Via BORGO FURO 35/A	2	A3	5	X	82,97	1
Via BORGO FURO 35/A	2	A1	6		79,44	1
Via BORGO FURO 35/A	2	A2	6	X	94,35	1
Via BORGO FURO 35/A	6	A3	6		82,97	

Table 27: B Tower Characteristics

ADDRESS	TENANTS	TYPE	FLOOR	OW WINDOV	air cond	SQM	AIR COND.
V.le FRANCIA 1		B1	1	X		79,44	
V.le FRANCIA 1	4	B2	1	X	1	94,35	1
V.le FRANCIA 1	3	B3	1			82,97	
V.le FRANCIA 1	5	B1	2		1	79,44	1
V.le FRANCIA 1	1	B2	2	X	1	94,35	1
V.le FRANCIA 1	2	B3	2	X	1	82,97	1
V.le FRANCIA 1	2	B1	3	X		79,44	
V.le FRANCIA 1	3	B2	3		1	94,35	1
V.le FRANCIA 1	2	B3	3		1	82,97	1
V.le FRANCIA 1	1	B1	4	X		79,44	
V.le FRANCIA 1	5	B2	4	X	1	94,35	1
V.le FRANCIA 1	2	B3	4	X	1	82,97	1
V.le FRANCIA 1	3	B1	5			79,44	
V.le FRANCIA 1	3	B2	5	X	1	94,35	1
V.le FRANCIA 1	2	B3	5		1	82,97	1
V.le FRANCIA 1	1	B1	6	X	1	79,44	1
V.le FRANCIA 1	2	B2	6	X		94,35	
V.le FRANCIA 1	4	B3	6	X	1	82,97	1

Searching the minimum quantity of groups that could be a representative sample for extrapolate the results; the flats selected are shown in the following table.

Table 28: Apartment typologies selected for Monitoring

A TOWER		TYPE	N tenants
1St. Floor	2	A2,A3	2,3
INTERM. Floor	4	A1,A2,A3	1,2,3,4
6th. Floor	1	ANY	
TOTAL	7	(at least two of them with AC)	

B TOWER		TYPE	N tenants
1St. Floor	2	B1, B2,B3	4,3
INTERM. Floor	4	B1,B2,B3	1,2,3,5
6th. Floor	1	ANY	
TOTAL.	7	(at least two of them with AC)	

This selection also represents the two key types of householders, confirmed during the tenant's interviews.

- Retired tenants. Normally two persons.
- Families, More than two tenants.

Table 29: Tenants interviewed

A TOWER		TYPE	N tenants
1 St. Floor	1	A3	2
2nd Floor	2	A2,A3	1,4
3 th floor	1	A3	4
4th floor	0		
5th floor	3	A1,A2.A3	1,2
6 Th floor	2	A1,A2.	2
	9	(5 FLATS with AC)	

B TOWER		TYPE	N tenants
1 St. Floor	1	B2	4
2nd Floor	2	B2,B3	1,2
3 th floor	1	B1	2
4th floor	2	B2,B3	2,5
5th floor	2	B2,B3	2,3
6 Th floor			
	8	(7 FLATS with AC)	

4.3.2 SELECTED IPMVP OPTION.

For Treviso building two kinds of analysis will be developed:

Option C. Whole Building, In order to compare the energy performance before and after renovations.

Savings are determined by measuring energy use at the whole facility. See the variables that are going to be measured are:

Table 30: Whole building measurements

MEASURE	SOURCE	FRECUENCY.
M3 Gas Consumption for heating, DHW and Cooking gas	Gas Meters	Monthly
kWh electric consumption communal services	Supplier bills 2 Towers/ monitoring equipment 2 Towers (A and B)	Monthly 2 Towers / each 15 min 2 Towers (A and B)
kWh electric consumptions tenants.	Supplier bills minimum 18 tenants/ Monitoring equipment 18 tenants.	Monthly 18 Tenants/ each 15 min 18 tenants.

At least, It is going to be measured the 50% of the tenants. To extrapolate results it will be calculated by comparison or regression analysis.

Continuous measurements of the entire facility's energy use are taken throughout the reporting period by the monitoring equipment.

Option B for Heating and Domestic hot water ECM.

Savings are determined by field measurement of the energy use of the ECM-affected system. Measurement frequency are describe in the following table:

Table 31: Heating and domestic hot water measurements

MEASURE	SOURCE	FRECUENCY.
kWh Energy consumption of New System after renovations.	BILLS/Monit. Equipment.	Monthly/Each 15 min

4.3.3 BASELINE PERIOD AND CONDITIONS.

Once the main subjects for energy analysis are identified:

- Major energy consumptions systems.
- Data availability for energy analysis.

It is possible to define:

- The energy Base line for each system
- The strategy for monitoring additional monitoring equipment, that will provide detailed complementary data to the available data.

Tenants Energy base-lines, the following baselines will be calculated.

- Gas consumption baseline. The independent variable commonly used for this model is Heating Degree days HDD, several regression analysis with different HDD will be performed.
- Communal electric Services. This consumption will be breakdown in consumption affected by lighting system and elevators
- Tenants electric consumption baseline
    - The information initially provided is one year consumption for 6 tenants (monthly data). This information should have to be complemented with more data provided from new monitoring equipment.
    - According with the Monitoring Plan for the pilot Site, It is feasible to collect the electric consumption from 18 tenants in the two Towers on real time, each 15

min. After one year of monitoring, there will be a wide amount of data that will allow to develop a complete analysis.

- There will be 18 tenants baseline energy consumption.
    - It represents sample of 50%
    - The samples contains almost all the typologies considering all the factors:
        - Flat typology and social characterization:

The selected period for baseline is the year 2017.

<u>HEATING SYSTEM AND HOT WATER CONDITIONS.</u>

- The heating Schedule for the year is normally from mid October to mid April.
- The temperature set point and the hour of operation will be collected from the information provided during the tenants interviews

<u>COOLING SYSTEMS.</u>

(Only tenants with individual equipment). Each tenant select their own user conditions set points and hours of use. This Information will be collected through the tenant's interviews.

4.3.4 INDEPENDENT VARIABLES and STATIC FACTORS

Ambient temperature is selected as the main variable that allows to define a mathematical relation to represents the energy performance. In the energy performance report will be described the different mathematical models that represent the consumption after perform the analysis with the data available for Heating Degree Days.

The static Factors considered for this pilot are

- Occupancy data and social Characterization. (I.E. Tenants that leave the flats, or new tenants with different family Typology)
- Operating conditions: heated and cooling areas, (I.E. tenants that install a new cooling system)

This static factor has to be monitored by Ater-Treviso and the variations of these conditions will be calculated in the Non-routine Adjustments.

In the Tables 26 and 27 are shown the initial values for STATIC FACTORS, regarding with Occupancy Data, Cooling systems and heated and cooling areas.

In order to identify the values for the static factors of each tenant the following questionnaire have been included in the tenant's interviews performed by Savills.

Table 32: Questions for tenants in Treviso

QUESTIONS FOR TENANTS IN TREVISO	TYPE	VALUE	DESCRIPTION
HEATING SYSTEM			
Average use (hours/working day) in coldest months (Dec, Jan,Feb)	hours		
Average use (hours/workin day) in other months (oct, nov,march, april)	hours		
Average use (hours/no working day) in general	hours		
Set Point Temperature	C		
Programmable thermostat	Y/N		
Any Radiators normally off? Rooms?	Y/N		
Any auxliar equipment for extra heating with very cold weather?	Indicate		
(only in case with Air Conditioning) Do you normally use heat pump system for Heating?	hours		
Humidifier/Air Dryer	Y/N		
Average use for humidifier (hours/day)			
COOLING SYSTEM			
Cooling system available?	Y/N		
Rooms with AC?	indicate		
Months of use	indicate		
Average use (hours/working day)	hours		
Average use (hours/no working day)	hours		
Set Point Temperature	C		
Electric Power of outside AC Equipment. (In case it is possible)	kW		
COOKING SYSTEM (in order to identify gas consumption for cooking)			
Gas cooker	Y/N		
Average use (Hours/day)	hours/day		
Gas oven	Y/N		
Average use (Hours/week)	hours/day		
Electric cooker	Y/N		
Average use (Hours/day)	hours/day		
Electric oven			
Average use (Hours/week)	hours/day		
OTHER APPLIANCES			
Do you have any special appliance different from normal Ones: (Fridge, freezer, Microwave,Washing Machine, Dish washing Machine, kettle, Ironing)	Indicate		

4.4 OPTIONS FOR MONITORING EQUIPMENT.

4.4.1 ELECTRIC MONITORING EQUIPMENT.

The electric consumptions that are going to be monitored during the project are shown in the next table.

Table 33: Monitored electric consumptions

BEFORE RENOVATIONS.		AFTER RENOVATIONS.	
DESCRIPTION		**DESCRIPTION**	
ELECTRIC CONSUMPTION COMMUNAL AREAS	Mon.Equip.	ELECTRIC CONSUMPTION COMMUNAL AREAS	Mon.Equip.
ELEVATOR ELECTRIC CONSUMPTION	Mon.Equip.	ELEVATOR ELECTRIC CONSUMPTION	Bills
Global FLAT Electric Consumption (36 units)	Mon.Equip.	Global FLAT Electric Consumption (36 units)	Mon.Equip.
Flats Air Conditioning consumption.	Will be estimated through the analisys of data from Global Consumption.	Flats Air Conditioning consumption.	Will be estimated through the analisys of data from Global Consumption.
Flats lighting Consumption	Will be estimated through the analisys of data from Global Consumption.	Flats lighting Consumption	Will be estimated through the analisys of data from Global Consumption.
		Electric consumption from ventilation system.	Included in flat consumption. Will be estimated through the analisys of data from Global Consumption.
		ELECTRIC CONSUMPTION FROM SOLAR THERMAL (Pumps)	Mon.Equip.
		Energy production from PV panels	Mon.equip.

4.4.2 HEATING AND DOMESTIC HOT WATER MONITORING.

The energy consumption from heating, domestic hot water and cooking is supplied by Gas.

Table 34: Gas Supply

GAS SUPPLY
HEATING
DOMESTIC HOT WATER
COOKING

Initially there was a proposal for monitoring the gas consumption through the Opendomo Platform but there has not been collaboration from Gas Supplier giving permission to the installation of the monitoring equipment.

Alternatively, there has been designed a campaign to capture the gas meters readings manually, with Ater's collaboration. There is a plan for readings according with the weather conditions in order to have a wide range of temperatures

Table 35: Gas consumption breakdown

GAS CONSUMPTION BREAKDOWN	
BEFORE RENOVATIONS	AFTER RENOVATIONS
HEATING	HEATING
During winter there will be captured readings of the daily gas consumptions in weekly intervals and with different ranges of outside temperature	readings of the daily consumptions in weekly intervals and with different ranges of outside temperature
DOMESTIC HOT WATER	DOMESTIC HOT WATER
During NO WINTER TIME there will be captured readings of the MONTHLY Gas consumptions. The consumption for winter time there will be extrapolated with the data collected	captured readings of the MONTHLY Gas consumptions. The consumption for winter time there will be extrapolated with the data collected
COOKING	COOKING
Fixed Daily estimation according with the number of tenants and information collected during Interviews.	Fixed Daily estimation according with the number of tenants and information collected during Interviews.

4.5 DETAILED MONITORING PLAN.

4.5.1 MONITORING EQUIPMENT SOLUTION

Minimum selection for electric and gas consumption monitoring

Table 36: Minimum selection for consumption monitoring

A TOWER		TYPE	N tenants
1St. Floor	2	A2,A3	2,3
INTERM. Floor	4	A1,A2,A3	1,2,3,4
6th. Floor	1	ANY	
TOTAL	7	(at least two of them with AC)	

B TOWER		TYPE	N tenants
1St. Floor	2	B1, B2,B3	4,3
INTERM. Floor	4	B1,B2,B3	1,2,3,5
6th. Floor	1	ANY	
TOTAL.	7	(at least two of them with AC)	

According to the criteria for having cost effective monitoring equipment with the major scope available the following solution have been developed:

4.5.1.1 ELECTRIC CONSUMPTION.

- Flats: 18 units/tower. 6 Electric Meter/tower. 18 Mono-phase measured.
- Common facilities: 2 electric meters.

Fig. 34: Electric meters

The electrics meters are placed in a little room on the ground floor.

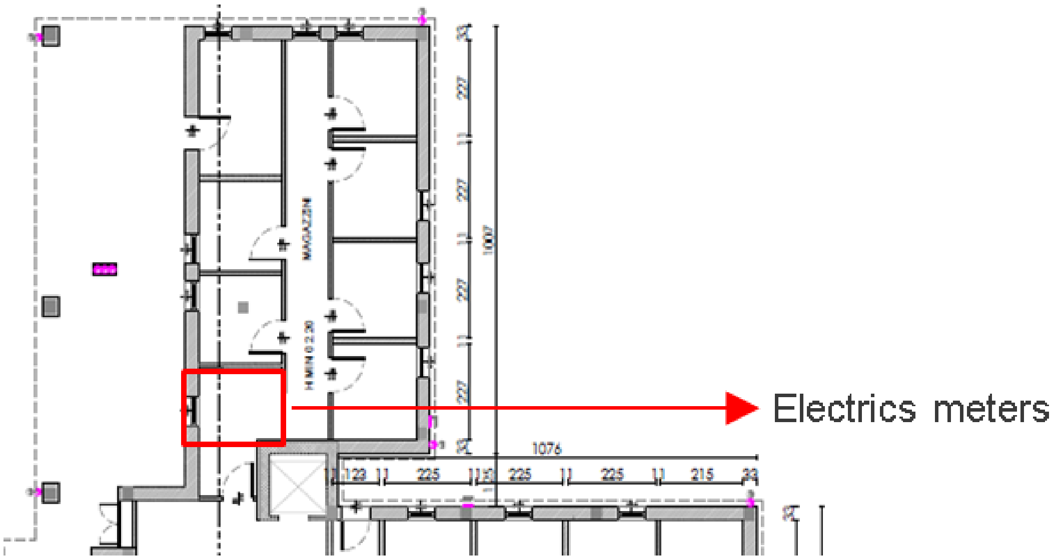


Fig. 35: Electric meters installation place

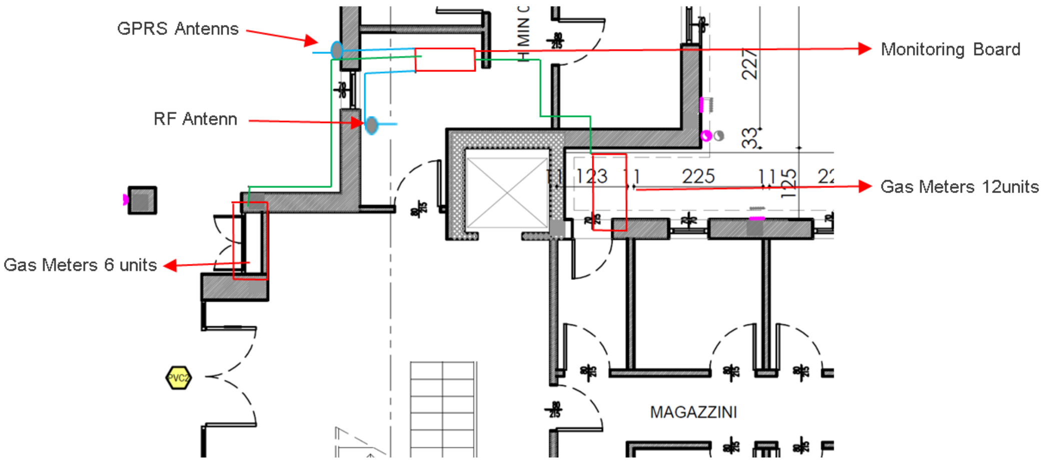


Fig. 36: Equipment place map

1 Measurement in each Meter; 1 Current sensor per flat.

The sensor will be positioned as follows:

Fig. 37: Sensor position

V measurement point from a Three phase circuit.

Options:

- From Elevator Switch (side picture)
- From Elevator electric meter (outline)

Fig. 38: Elevator switch

The final monitoring board includes the following devices:

	Power Max.
Energy Meter ODEnergy (X 8 UNITS):	<5VA
Datalogger OD485: (x1 unit for air quality sensors) (x1 unit for gas meters)	<65 mA (24v)
router:	7 W
Base RF Produal:	<2VA

Fig. 39: Monitorin board

4.5.1.2 GAS CONSUMPTION

Option 1:

Pending to have permission from supplier.

1 Pulse probe/meter.

Fig. 40: Gas meters

Option 2:

Collect Gas bills for monitoring gas consumption in case of option 1 could not be possible

4.5.1.3 AIR QUALITY.

The monitoring board includes the hardware device for gas meters and Air quality sensors Base. This devices will be included in the electric monitoring board.

Table 37: Initial flats selection for air quality sensors

INITAL FLATS SELECTION FOR AIR QUALITY SENSORS		
TOWER A		TYPE
1St. Floor	3	A1,A2,A3
2nd Floor	3	A1,A2,A3
6th. Floor	1	ANY
TOTAL	7	

Temperature and Humidity Sensors to be installed in: 1 Unit in Living Room and 1 Unit in Bedroom:

Flats Initial Selection: Tower A Borgo Furo;

- 3 Flats 1st Floor.
- 3 Flats 2nd Floor.
- 1 Flat 6th Floor.
- Alternative Itcould be selected other flats in 3,4,5 th Floor.

Fig. 41: Temperature and humidity sensors

Wireless repeater device to be installed in: Communal Areas near stairs hall. Close to an electric Box with Power Supply.

Fig. 42: Wireless repeater device

Temperature, Humidity and CO2 Sensor:

- To be installed in two selected flats Instead of normal ones.
- To be installed in the Living room this sensor needs power supply.
- This sensor measures the influence of the new ventilation system.
- The cost of this sensor is high, so there are only two units.
- Máx consumption of this sensor: 17,52 kWh/ year / 4,38 €/year.

Fig. 43: Temperature, humidity and CO2 sensor

4.6 ENERGY CONSERVATION MEASURMETS (ECM´s) MONITORING

This section includes the procedure for measuring the different renovations concepts that have been analysed by Exeleria, Chalmers and Ater Treviso.

Table 38: Systems considered in renovations concepts

Passive Systems considered in Renovations Concepts related with Global energy Consumption and Comfort	Active Systems considered in Renovations Concepts related with electric supply	Active Systems considered in Renovations Concepts related with Thermal energy
ENVELOP RENOVATIONS:	Ventilation system	Condensing Boiler
Outer Insulation	Pumping system for Solar thermal panels	Solar thermal
New Windows	PV System	
	NIGHT STORAGE UNIT	
	PV System	

Envelop renovation.

Savings due to the influence from envelop renovation, will be considered by the data registered through the monitoring equipment in the main switch. This equipment is already planned in the monitoring equipment to be installed (April 2017). In addition a deeper analysis will be performed by the comparison of the air-quality indoor temperature and humidity before and after renovations. This Air quality parameters are planned to be measured by the air-quality sensors.

New Active Systems supplied by electric energy.

The Monitoring Equipment planned to be installed at least in 18 apartments and in all the communal services, is a scalable solution that allows to integrate the energy consumptions readings for any of the new system considered in this section. The monitoring kit is equipped with electric meters that can be readjust to the new equipment or it is possible to install additional meters for the new installations depending on the final solution for the different system. The Opendomo Platform is perfectly adaptable to integrate this new meters.

Regarding with the energy produced by the PV system, Opendomo will integrate this data in a specific application for this system.

New Active systems for Heating and Domestic Hot Water.

The energy consumption of the current gas Boiler and the new one have to be registered by the Gas Meter. Currently it is not possible to measure directly with monitoring equipment, therefore the energy consumption of this system have to be analysed through the data collected from bills or Gas Meters.
The energy produced by the solar panels will be measured by a thermic meter that have to be installed during the renovations implementation. The readings from this meter will be integrated into Opendomo platform. In addition the individual tenant´s consumption from solar panels will be measured by another energy meter that is expected to being integrated into Opendomo platform as well.

5. STRATEGY FOR MONITORING IN PFP PADIHAM PILOT SITE

5.1 ANALYSIS OF INFORMATION AVAILABLE AND COLLECTED FOR PLANING THE STRATEGY FOR ENERGY MONITORING.

Table 39: PFP Padiham pilot initial information requested

PFP PADIHAM PILOT INITIAL INFORMATION REQUESTED.				
Information	Initial Availability	Agent involved	Other Agent requested	information Provided
ENERGY CONSUMPTIONS				
Electric consumptions tenants	NO	PFP	Aggregate consumptions requested to GRID OPERATOR Without no results.	4 Tenants /some months
GAS Consumption tenants	NO	PFP		1 Year
BUILDING DESCRIPTION. (drawings technical description)				
Arquitectonical	YES	PFP		Basic description of tipologies.
Electric installation	NO	PFP/SinCeO2		Information collected in field visit.
Heating system	NO	PFP/SinCeO2		Information collected in field visit.
SOCIOLOGICAL CHARACTERISITC				
Number of tenants per dwelling	NO	PFP		
Family status.	NO	PFP/Savills		during interviews with tenants.

5.2 BUILDING AND INSTALLATIONS DESCRIPTION.

The Neighbourhood of Whitegate Close, Whitegate Gardens and Victoria Court are placed in Padiham (England), on the outskirts of Burnley. The scheme is made up of 109 properties all built in the mid 1970's.

Fig. 44: Neighbourhood of White Close

The building envelope is characterized by the following:

- Facade: Traditional brick cavity with no fill of insulation.

Fig. 45: Facade

- Roof: The roofs are gabeled and made from ceramic tiles.

Fig. 46: Roof

- Windows: windows with double glazing. 3,5/23/4,5 mm.

Fig. 47:Windows

Within Dreeam Project there are 103 properties of which 23 were equipped with gas and the other 80 remain with their initial electrical storage heating from 70´S.

Fig. 48: Scheme of Neighbourhood of Whitegate

- End-Terrace, 2 Bedrooms.
- End-Terrace, 3 Bedrooms.
- Mid Terrace, 2 Bedrooms.
- Mid Terrace, 3 Bedrooms.
- Ground Floor Flat (1 bed)/First Floor Flat (2 bed)
- Ground Floor Flat (1 bed)/First Floor Flat (1 bed)
- First Floor Flat (1 bed)
- Ground Floor Flat (1 bed)
- Electric
- Electric and Gas Sold

The Following scheme shows the two types of dwellings according with their energy source: “all Electric” and “Gas&electric”

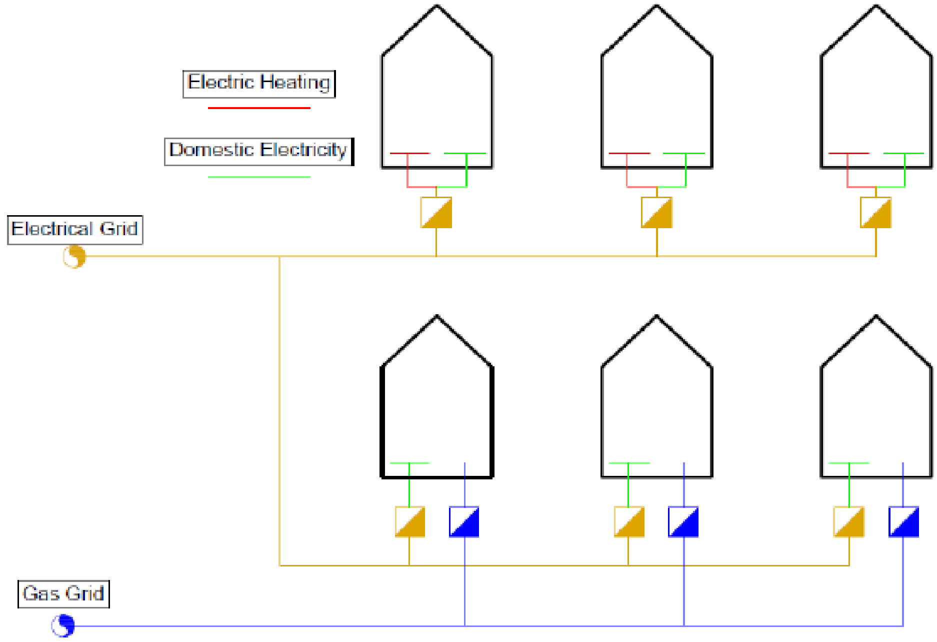


Fig. 49: Scheme of dwelling types

In “all electric Houses” the dwellings are equipped with utility meters and electric distribution that allow hourly discrimination for two different tariffs:

Normal Tariff, Same price for all the day.

Off-peak Tarif, Reduced priced for seven hours during night.

The facilities initially plan to be connected on Off-peak Tariff are: electric Storage Heating System and electric heater water tank.

DWELLINGS CLASIFICATION

Table 40: Dwelling clasification

Archetype	UNITS
End-Terraced House	29
First Floor Flat	18
Ground Floor Flat	16
Mid-Terraced House	40
Total	103

Bedrooms	DWELLINGS
1 Bedroom	32
2 Bedrooms	47
3 Bedrooms	24
Total	103

<u>HEATING AND DWH SYSTEM.</u>

Electric House

All the production of energy comes from electricity. The dwellings are equipped with electric storage heaters that store heat overnight during seven hours benefiting the off-peak tariff.

Fig. 50: Electric storage heaters

The terminal unit is working like a radiators for heating. There are one per room. The radiators have a manual regulation system which regulates the temperature of the room and the overnight charge.

For the DHW production, a small electric heater tank is installed in each house. The shower has its own electric resistance heater, the power is 8 kW.

Fig. 51: Electric heater tanks

Gas and Electric House

These houses are equipped with a Gas boiler for the production of heating and DWH. One example of gas boiler, registered during field visit is BAX: FS 601 OF with a output power of 17,58 kW.

Fig. 52: Gas boiler

The terminal unit is a radiator. There are one per room. All the radiator have valve for open or close the flow of water.

Fig. 53: Radiator

Extra heating and humidity regulator Systems.

Some properties have an extra heating like extra panels or dehumidifier.

Fig. 54: Extra heating and humidifier

LIGHTING

The lighting system depend of the tenants, and there are several types of bulbs.

Halogen: Some Bedrooms.

Fig. 55: Halogens

Incandescent: Livings rooms and bedrooms.

Fluorescent: Kitchen and toilet.

Low consumption lamp: Different stances.

Fig. 56: Low consumption lamp

5.3 MEASUREMENT AND VERIFICATION PLAN.

5.3.1 DETERMINATION OF SAMPLING MEASURES.

The below Table shows the classification of the dwellings according with 4 criteria: Indoor distribution, Energy source, orientation, number of tenants per dwelling. The figures represent the quantity of dwellings in each type.

Table 41: Dwellings classification

DWELLINGS TYPOLOGIES											
		ENERGY SOURCE		ORIENTATION		DWELLINGS UNITS BY OCCUPANCY					
	UNITS	ALL ELECTRIC	GAS&ELECTRIC	NW	NE	1 PERS	2 PERS	3 PERS	4 PERS	5 PERS.	NO DATA
End-Terraced House 2 Bedroom	14	14		6	8	2	2	3	1		6
End-Terraced House 3 Bedroom	15	13	2	6	9	1		3		2	9
Mid-Terraced House 2 Bedroom	31	28	3	11	20	3	15	7			6
Mid-Terraced House 3 Bedroom	9	6	3	1	8		1		2	1	5
Ground floor flat 1 bedroom	16	13	3		16	7	1				8
First floor flat 1 bedroom	16	13	3		16	5	1				10
First floor flat 2 bedroom	2	1	1		2		1				1
Total	**103**	**88**	**15**	**24**	**79**	**18**	**21**	**13**	**3**	**3**	**45**

SELECTED AS SAMPLING MEASURED					
DWELLING D1		Ground floor flat 1 bedroom	GAS&ELECTRIC	NE	1 TENANT
DWELLING D2		Mid-Terraced House 2 Bedroom	ALL ELECTRIC	NE	2 TENANTS
DWELLING D3		Mid-Terraced House 2 Bedroom	ALL ELECTRIC	NW	1 TENANT
DWELLING D4		Ground floor flat 1 bedroom	ALL ELECTRIC	NE	1 TENANT
DWELLING D5		End-Terraced House 3 Bedr.	GAS&ELECTRIC	NE	1 TENANT
DWELLING D6		First floor flat 1 bedr.	ALL ELECTRIC	NE	1 TENANT
DWELLING D7		End-Terraced House 2 Bedr.	ALL ELECTRIC	NE	3 TENANTS
DWELLING D8		End-Terraced House 2 Bedr.	ALL ELECTRIC	NW	3 TENANTS
DWELLING D9		Mid-Terraced House 3 Bedroom	ALL ELECTRIC	NW	2 TENANTS

Initially, the available energy consumption information from tenant's bills is not enough for a basic description of energy consumption. For that reason, there has been a selection of 9 dwellings to be monitored by installing electric meters. (See Table above) For this selection the following criteria has been taking into account:

- Select each type of indoor distribution and orientation.
- Select same typology but different energy source (gas and electric) for compare two typologies.
- Select different occupancy rates.
- Select some tenants in energy poverty situation.
- The final selection has been realized between those tenants that are willing to collaborate with Dreeam Project.

The data collected from this 9 typologies will allow to extrapolate the results to the whole group of Dwellings.

5.3.2 SELECTED IPMVP OPTION.

For PFP Dwellings two kinds of analysis will be developed:

Option C. Whole dwelling, In order to compare the energy performance before and after renovations.

Savings are determined by measuring energy use at the whole facility. See the variables that are going to be measured are:

Table 42: Whole facility measuring

MEASURE	TYPE	SOURCE	FRECUENCY.
kWh Total Electric consumption	"All electric"	Monitoring equipment.	Each 15 min.
M3 Gas Consumption for heating	**"Gas&Electric"**	Tenantsbills	Monthly

To measure Total electric consumption two electric meters will measure the consumption in the main switch and the off-peak circuit. (see monitoring detailed plan)

Option B for Heating and Domestic hot water ECM.

Savings are determined by field measurement of the energy use. Three electric meters will be installed for measuring:

Table 43: Heating and domestic hot water ECM measuring

MEASURE	SOURCE	FRECUENCY.
kWh, electric storage heaters.	Monit. Equipment.	Each 15 min.
kWh, DHW Electric Tank.	Monit. Equipment.	Each 15 min.
kWh, DHW, Shower Heater.	Monit. Equipment.	Each 15 min.

5.3.3 BASELINE PERIOD AND CONDITIONS.

In Padiham Pilot the energy data will be collected from the monitoring equipment installed in the 9 dwellings selected. The monitoring equipment installation is planned to be installed in September 2016 consequently the Energy Baseline Period will cover winter 2016-2017 and some months during 2017 until the beginning of the renovation works. Once the renovation works start, it will be necessary to review if renovation works affects in the use of the different installations.

Energy base-lines, the following baselines will be calculated.

- Tenants energy consumption baseline for the 9 dwellings selected. They represent the different typologies that will be used to extrapolate the results to the all dwellings. The independent variable that normally represent this consumption is Heating Degree Days.
- Heating system baseline. The independent variable commonly used for this model is Heating Degree days HDD, several regression analysis with different HDD will be performed.
- Domestic hot water-baseline. The influence of weather conditions will be considered in this calculations.

<u>HEATING SYSTEM CONDITIONS.</u>

- Each tenant decide the heating period during the year, normally from mid-September to mid-April.
- The electric storage heater are very old and with very low effieciency. They were design to be charged overnight, but normally they are not available to provide heat at evening hours.
- Most of the tenants use auxiliary electric panels on winter time.
- Budget restrictions. Some tenants cannot afford the cost of the heating.

In order to identify the influence of these conditions, some temperature and humidity sensors will be installed at the dwellings (see monitoring plan). These temperature sensors also will be used to compare the temperature comfort before and after renovations.

<u>DOMESTIC HOT WATER.</u>

The hot water is produced by the electric heater tank. There is a programmer that allow to select the heating period during off-peak tariff. There is an optional function “Boost” to heat the water at any time.

The shower has its own electric heater.

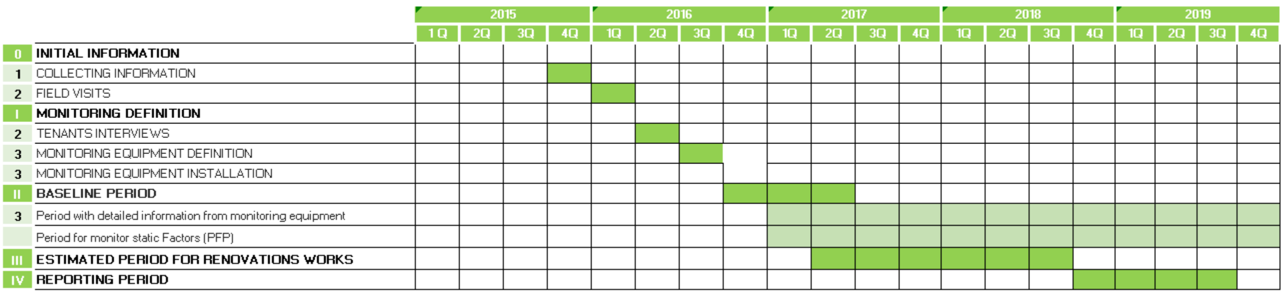
5.3.4 INDEPENDENT VARIABLES and STATIC FACTORS

Ambient temperature is selected as the main variable that allows to define a mathematical relation to represents the energy performance. In the energy performance report will be described the different mathematical models that represent the consumption after perform the analysis with the data available for Heating Degree Days.

The static Factors considered for this pilot are

- Occupancy data and social Characterization. The tenants who live in the dwellings selected have to be closely monitored by PFP, in order to identify changes in number of tenants that live in the house.
- Operating conditions: heated areas, (I.E modifications in the heating system)

5.3.5 TIMETABLE ACTIVITIES AND REPORTING PERIOD.



5.4 OPTIONS FOR MONITORING.

This section describes the possible options analysed for installed monitoring equipment. Due to the lack of significant information about energy consumption of dwellings it is essential to collect the data to define the energy consumption for each system. The objective for this monitoring proposal is collect as much and technically possible information from Heating system, Domestic hot water System and electric consumption from tenants.

In order to verify indoor comfort conditions two temperature and humidity sensors are proposed to be installed, one in the living room, and other in one bedroom.

5.4.1 Options for Monitoring "All Electric House"

Table 44: Options for monitoring "All electric house"

Option	Instalation	DESCRIPTION	Comments
1	*SUPPLIER ELECTRIC METER (OUTSIDE HOUSE)* 	Measure: kWh Meters: Electric Meter ODEnergy Electrical connection in main switch. Not optical probe option in Supplier meter	Disadvantages: - Supplier main switch is sealed, it is required permission from the supplier. - Temperature measurement need be installed indoors.
2	*ELECTRICAL BOARD*   Main elec. Board heating	Measure: kWh Meters: Electric Meter ODEnergyTriphase (3 monophase) Electrical connection in the two electric boards. (heating/ other consumption)	Advantages: - All the devices can be placed in the same box. - We will have measurements for electric heating (main heating switch) and Other electric consumptions (Other main switch) OTHER: Temperature measurement need be installed. Internet access req.

5.4.2 Options for Monitoring "Gas&electric" Dwelling.

Table 45: Options for monitoring "Gas&electric" dwelling

Option	Instalation	DESCRIPTION	Comments
1	*SUPPLIER ELECTRIC METER* 	Measure: kWh Meters: Electric Meter ODEnergy. Electrical connection in main switch. Not optical probe option in Supplier meter	Disadvantages: - Supplier main switch is sealed, it is required permission from the supplier. - Temperature measurement need be installed indoors.
2	*ELECTRICAL BOARD* 	Measure: kWh Meters: Electric Meter ODEnergy Electrical connection in electrical board.	Advantages: - All the devices can be placed in the same box. - We will have measurements for electric heating (main heating switch) and Other electric consumptions (Other main switch) - OTHER: Temperature measurement need be installed. Internet access req.

5.4.3 Options For Monitoring Gas and Electric House) <u>Gas Consumption</u>

Table 46: Options for monitoring gas and electric house

Option	Instalation	DESCRIPTION	Comments
1	*SUPPLIER GAS METER/SMART METER*  	Measure: m3 Meters: Supplier Gas Meter and Smart Meter.	We recommended using bills for monitoring gas consumption in these houses. (The options for monitoring are already used for the utility. It is necessary to ask for permission to the utility to connect with their meter, and normally it takes long to have it)

5.5 DETAILED MONITORING PLAN.

The followings schemes and descriptions have been developed to explain the monitoring solution to PFP.

Electric scheme: (House with electric heating)

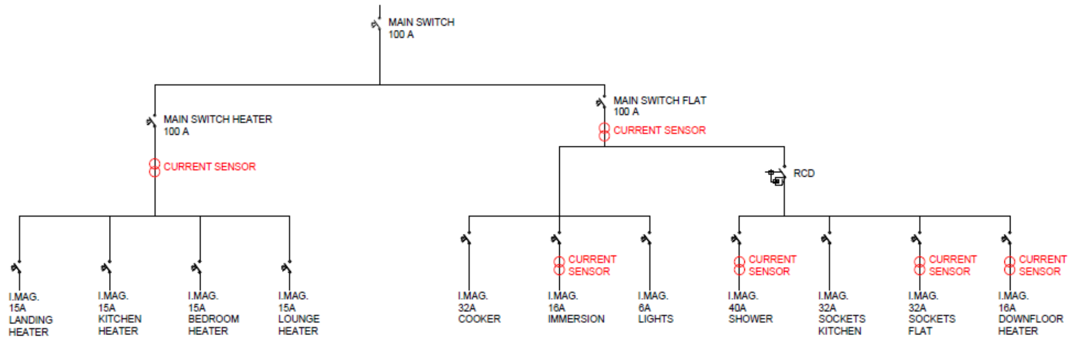


Fig. 57: Electric scheme (House with electric heating)

Electric scheme: (House with electric heating), electric meters connections.

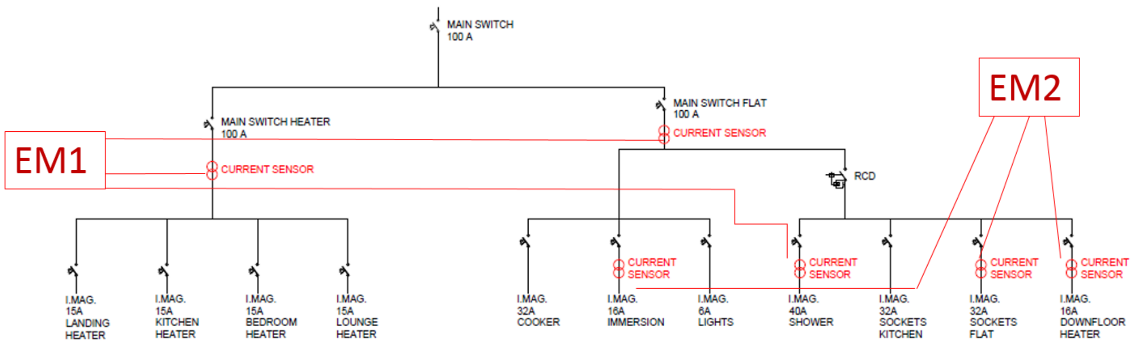


Fig. 58: Electric scheme: (House with electric heating), electric meters connections

Electric scheme: (House gas heated), electric meters conections.

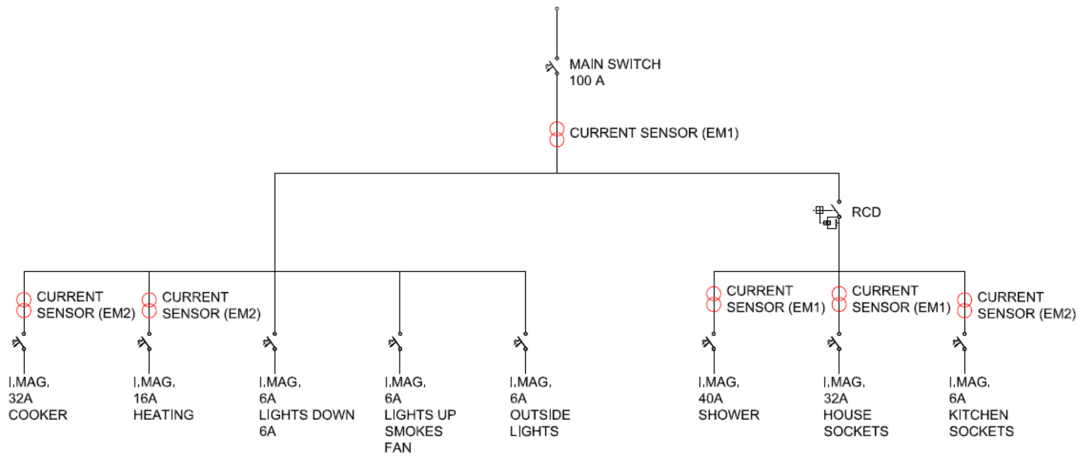


Fig. 59: Electric scheme: (House gas heated), electric meters conections.

DESCRIPTION:

Energy Meter. EM1. (ODenergy, Opendomo)

1 current sensor main heating circuit. MEASURE: TOTAL ELECTRIC HEATING CONSUMPTION.

1 current sensor main switch circuit. MEASURE: DWELLING ELECTRIC CONSUMPTION

1 current sensor main sockets flat. MEASURE: Socket electric consumption, to identify auxiliary heating systems.

Energy Meter EM2. (ODenergy, Opendomo)MEASURE.ELECTRIC CONSUMPTION FOR DHW.

1 current sensor Shower Heater.

1 current sensor Water Heater.

1 current sensor Bathroom Heater (heating)

Temperature and humidity sensors. MEASURE INDOOR COMFORT. (1 Unit Livingroom/ 1 Unit Bedroom)

MONITORING BOARD: (30X38X10CM)

An initial prototype was developed and tested before the production of the nine monitoring boards.

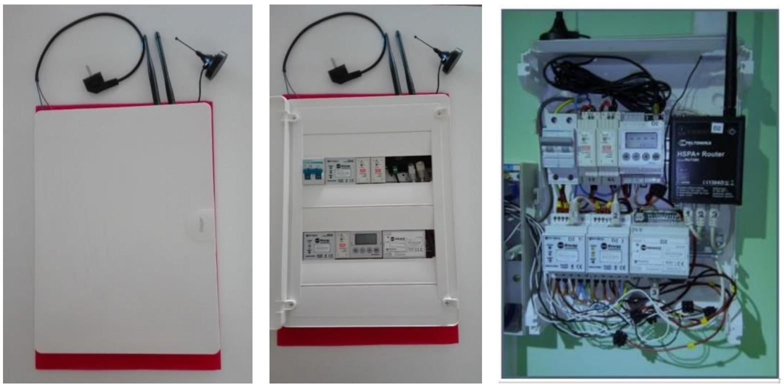


Fig. 60: Monitoring board

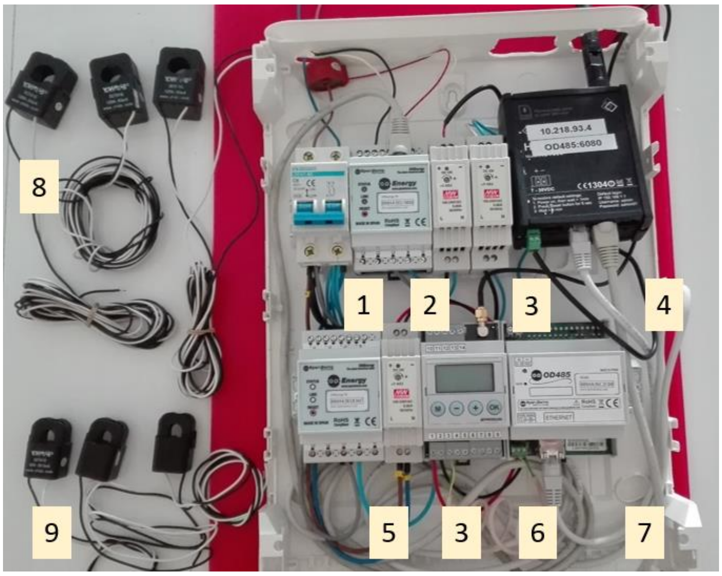


Fig. 61: Scheme of monitoring board

1. Switch.
2. EM1 (Electric meter).
3. AC-DC Transformer.
4. Router.
5. EM2 (electric meter).
6. RF base. Temp Sensor.
7. Datalogger.
8. Current sensor 120 A.
9. Current sensor 80 A .

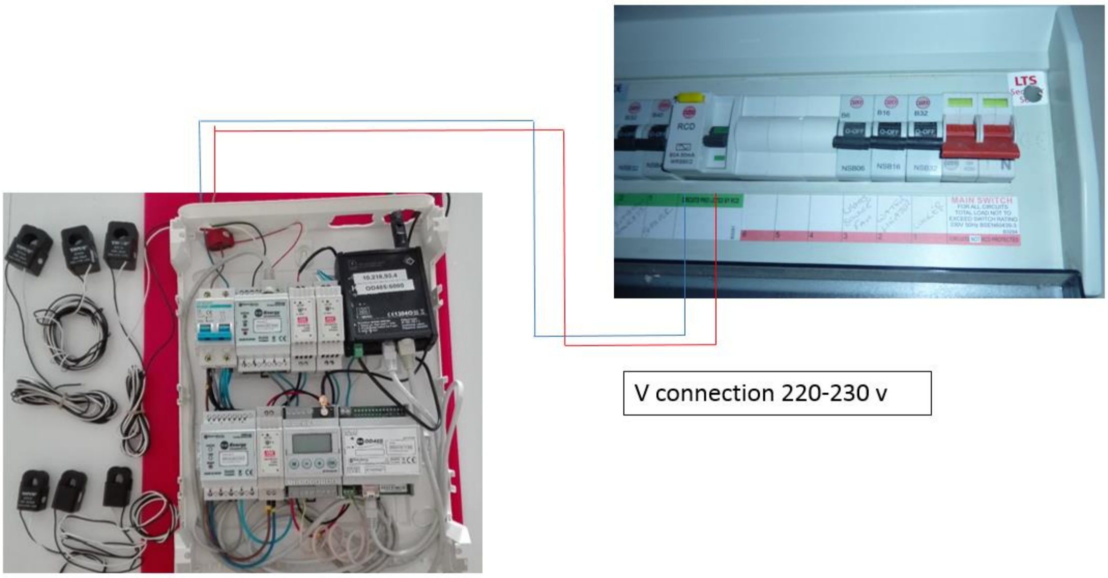


Fig. 62: Monitoring board connection

ACTIVITIES FROM PROPOSAL APPROVEMENT TO EQUIPMENT INSTALLATION

Table 47: Monitoring equipment installation PFP (Padiham)

	MONITORING EQUIPMENT INSTALLATION PFP (PADIHAM)	Weeks 0	1	2	3	4	5	6	7	8	9	10	11	12	13
I	**APPROVAL OF PROPOSAL. (PFP AND PARTNERS)**														
1	RECEIPT OF EQUIPMENT														
2															
II	**EQUIPMENT ASSEMBLY.CONFIGURATION.TEST**														
1	EQUIPMENT ASSEMPBLY														
2	CONFIGURATION AND TEST.														
3	SHIPMENT														
III	**INSTALLATION**														
1	Mechanic Equipment Installation, (Local company support needed)														
2	SinCeO2 installation.														

The energy consumption of the monitoring equipment is being calculated, in order to inform adequately to the tenants.

	Power Max.	Power (Average W)	HOURS/YEAR	kWh/year
ODEnergy (X 2 UNITS):	<5VA	8		
OD485:	<65 mA (24v)	1,25		
router:	7 W	7		
Base RF Produal:	<2VA	1,6		
TOTAL.		**17,85**	**8760**	**156,35**

Table 48: Monitoring equipment

MONITORING EQUIPMENT	UNITS
Per DWELLING	
ELECTRIC CONSUMPTION	
OD Energy Trifásico ETH	2,00
OD Current Transducer Open core Z90/120A	3,00
OD Current Transducer Open core Z90/80A	3,00
TEMPERATURE SENSORS.	
OPTION A. Radio Frecuency	
Temperature and humidity sensor Produal TEFL	2,00
Datalogger OD485.C	1,00
PowerSuplly AC/DC	1,00
Repeater RF	-
BASE RF FLTA PRODUAL	1,00
RF Configuration	1,00
COMMUNICATIONS	
ROUTER GPRS	1,00
Antenna	1,00
Powersupply AC/DC	1,00
DATA COMMUNICATIONS SIM CARD (GPRS/3G)	1,00

5.6 ENERGY CONSERVATION MEASURMETS (ECM´s) MONITORING

This section includes the procedure for measuring the different renovations concepts that have been analysed by Exeleria, Chalmers and PFP.

Table 49: Systems considered in renovations concepts

Passive Systems considered in Renovations Concepts related with Global energy Consumption and Comfort	Active Systems considered in Renovations Concepts related with electric supply	Active Systems considered in Renovations Concepts related with Thermal energy
ENVELOP RENOVATIONS:	Air water Heat Pump	Condensing Boiler
Outer Insulation	Air-air heat pump	Solar thermal
Roof	Ventilation system	
Ground Floor	Night storage unit	
New Windows	PV system	

Envelop renovation. The savings due to envelop renovation will be considered by the measurements registered by the monitoring equipment in the main switch and in the heating consumption. In addition a deeper analysis will be performed by the comparison of the air-quality indoor temperature and humidity before and after renovations.

New Active Systems supplied by electric energy. The Monitoring Equipment already install in 9 Dwellings, is a scalable solution that allows to integrate the energy consumptions readings for any of the new system considered in this section. The monitoring kit is equipped with electric meters that can be readjust to the new equipment or it is possible to install additional meters for the new installations depending on the final solution for the different system. The Opendomo Platform is perfectly adaptable to integrate this new meters.

Regarding with the energy produced by the PV system, Opendomo will integrate this data in a specific application for this system.

New Condensing Boilers. The energy consumption of the gas Boiler have to be registered by the Gas Meter. Currently it is not possible to measure directly with monitoring equipment, therefore the energy consumption of this system have to be analysed through the data collected from bills.

6. LANDSKRONAHEM.

6.1 ANALISYS OF INFORMATION AVAILABLE AND COLLECTED FOR PLANING THE STRATEGY FOR ENERGY MONITORING.

Table 50: Information available and collected for planning the strategy for energy monitoring

LANDSKRONAHEM PILOT INITIAL INFORMATION REQUESTED.	Initial Availability	AGENT INVOLVED	SCOPE	TIPOLOGY	FREQUENCY	2012	2013	2014	2015
ENERGY CONSUMPTIONS.									
DISTRICT HEATING. (HEATING&DHW) B11,13,15,17,19	NO	LANDSKRONA ENERGY	Sum 5 Buildings	MEASURED	HOURLY		available	available	available
DISTRICT HEATING. (HEATING&DHW) B11,13,15,17,19	NO	LANDSKRONAHEM (BMS)	Sum 5 Buildings	NORMALIZED	MONTHLY	available	available	available	available
ELECTRIC CONSUMPTION (COMMUNAL INSTALLATIONS)	NO	LANDSKRONA ENERGY	Each Building.	MEASURED	MONTHLY		available	available	available
ELECTRIC CONSUMPTION (COMMUNAL INSTALLATIONS)	NO	LANDSKRONA ENERGY	Each Building.	MEASURED	HOURLY				available
ELECTRIC CONSUMPTION TENANTS AGGREGATE.	NO	LANDSKRONA ENERGY	Each Building.	MEASURED	HOURLY				available
M3 DHW	NO	LANDSKRONA ENERGY	Sum 5 Buildings	MEASURED		available	available	available	available
INDOOR TEMPERATURE	NO	LANDSKRONAHEM (ECOGUARD)	Each Flat,	MEASURED	HOURLY				available from dic2015
	NO		5 Buildings.						
VENTILATION	NO				NONE AVAILABLE DATA				
EXAUSTED AIR HEAT PUMP.	NO	LANDSKRONAHEM	Building 1	ESTIMATION: Through DH Production and Electric Consumption.					
BUILDING DESCRIPTION. (drawings technical description)									
Arquitectonical	YES	LANDSKRONAHEM	Basic description provided						
Electric installation	NO	LANDSKRONAHEM	Basic description provided						
HAVC installation.	NO	LANDSKRONAHEM	Basic description provided						
SOCIOLOGICAL CHARACTERISITC									
Number of tenants per dwelling	NO	LANDSKRONAHEM	Not Provided yet						
Family status.	NO	LANDSKRONAHEM	It is been imposible to perform tenants interviews before renovations.						

6.2 BUILDING AND INSTALLATIONS DESCRIPTION.

Koppargården buildings were built between 1965-1974. The buildings included in the Dreeam project have a total floor area (BOA + LOA) of 11 621 m^2. The included area contains of 110 dwellings, a few smaller commercial premises, a training facility and a group home. The buildings share a central heating system connected to the district heating system through one service line, placed in the mechanical room in one of the buildings.

Fig. 63: Buildings location

The Buildings included in Dreeam Project are Building 13 (B13) ,B15 ,B17, B19. These buildings are integrated in a bigger group that includes B11 that shared the same distribution line of district heating. Considering that all the energy data available for district heating correspond to the five buildings (B11, B13, B15, B17, B19), B11 is also included in the energy analysis of the buildings.

The five buildings have the following characterization:

Table 51: Apartments types

BUILDING	FLOORS	ORIENTATION	APARTMENTS	APARTMENT TYPES		STAIRWELLS	ELEVATOR	DISTRICT HEATING SUBSTATION
				T1 (1 Bedroom)	T2 (2 Bedroom)			
11	7	NW-SE	56	28	28	2	2	1
13	3	NW-SE	18		18	3		
15	7	NW-SE	56	28	28	2	2	
17	3	NE-SW	18		18	3		
19	3	NW-SE	18		18	3		
			166	**56**	**110**			

FLOOR DISTRIBUTION (2-7) BUILDING 11, 15

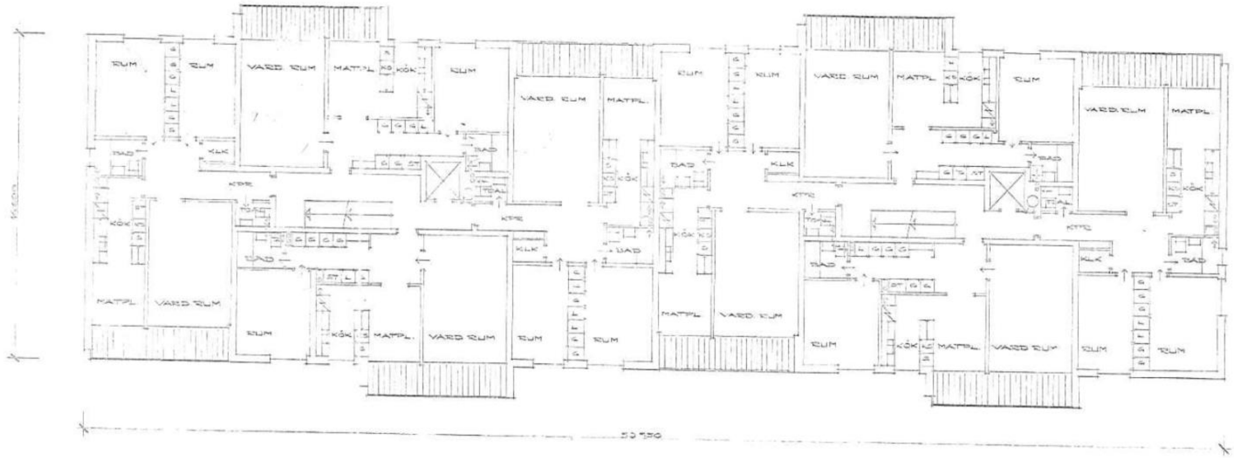


Fig. 64: Floor distribution (2-7), buildings 11, 15

FLOOR DISTRIBUTION (2-3) BUILDING 13, 17,19

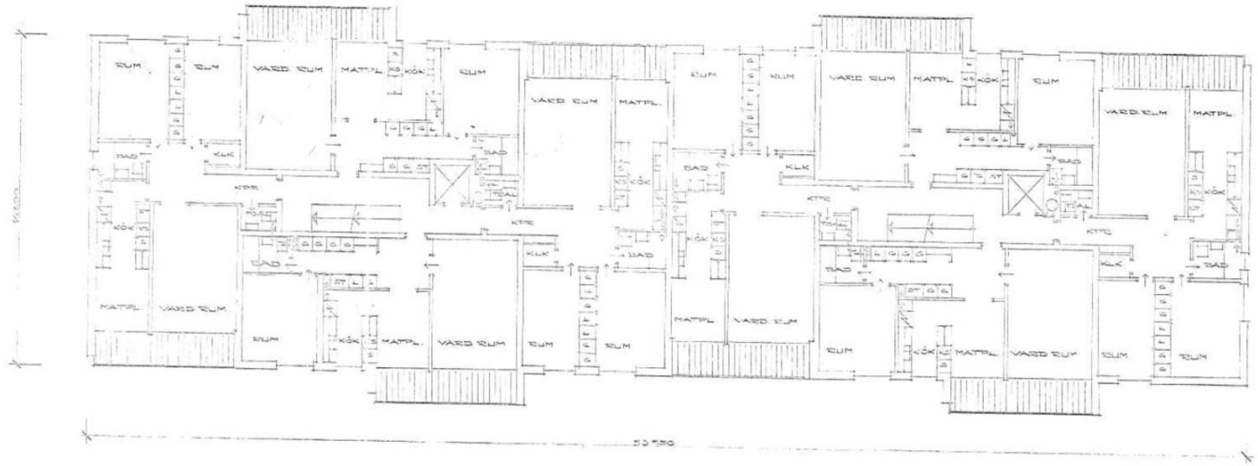


Fig. 65: Floor distribution (2-3), buildings 13, 17, 19

Fig. 66: Building 13, (3 Floors)/ Building 15 (7 Floors)

HEATING SYSTEM.

The buildings have a distribution of district heating from the same line. See the following distribution scheme:

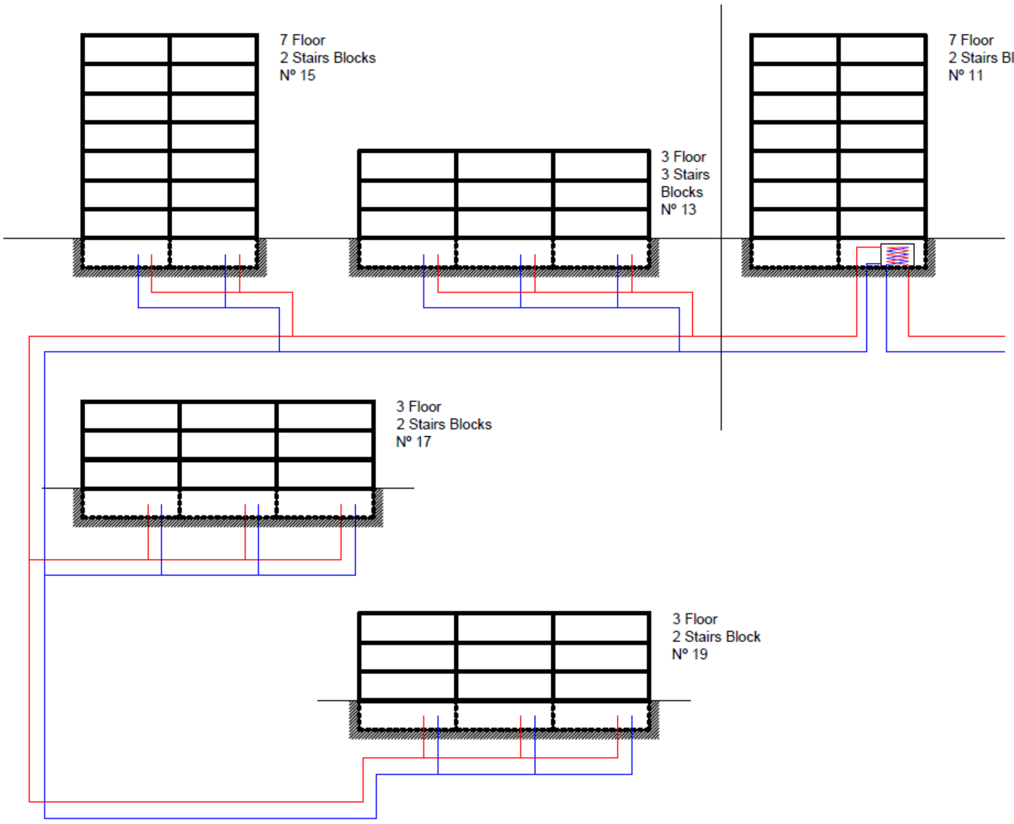


Fig. 67: Heating distribution heating

There is a Substation for district heating in building 11. This Substation is equipped with the pumping system and Heat exchangers. From this point, the Heated water is produced to cover the demand for Heating System and Domestic Hot water of the Buildings 11,13,15,17,19.

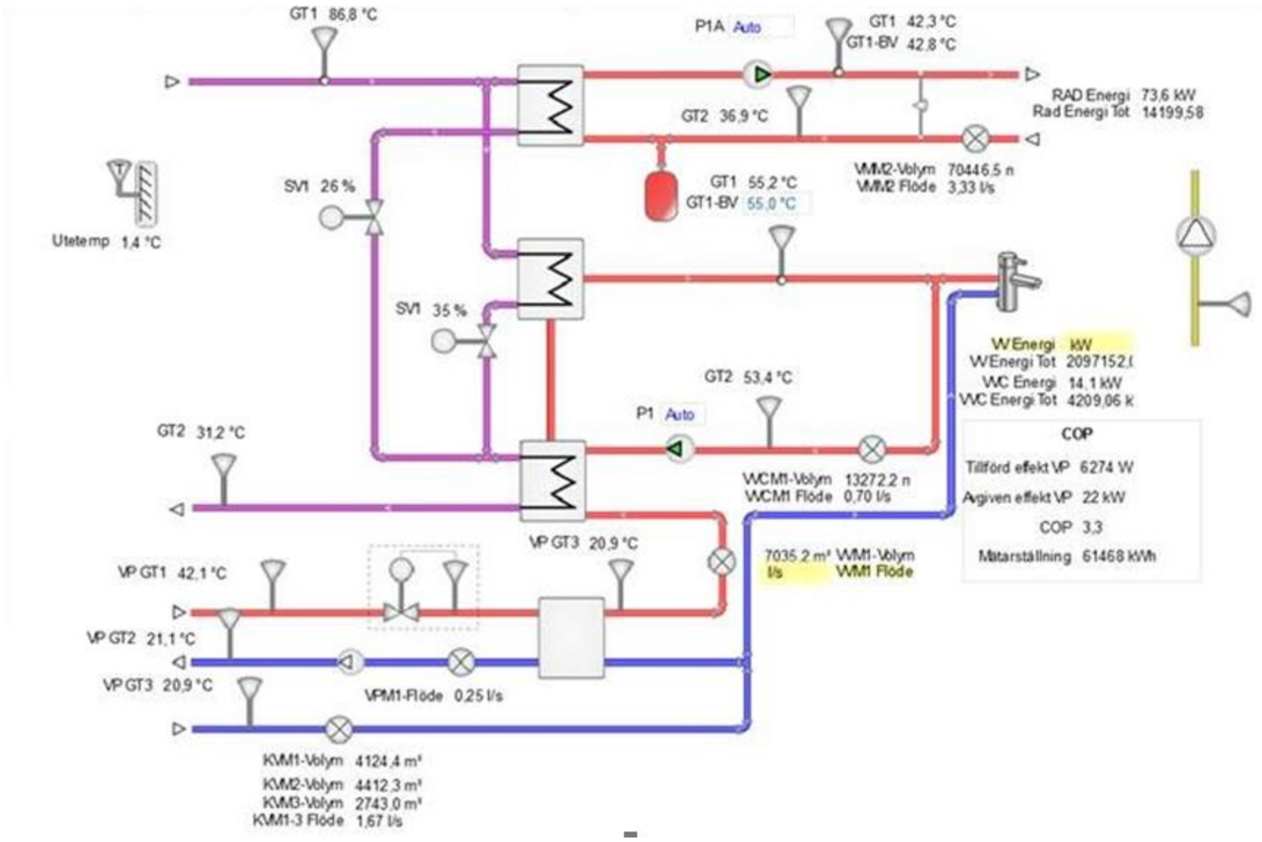


Fig. 68: *District heating Substation Scheme Building 11.*

There are three units of Heat Exchangers for Heating and Domestic Hot Water.

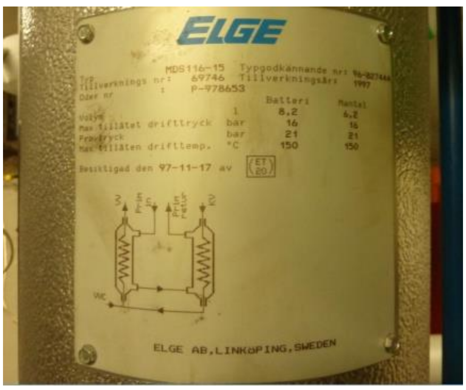


Fig. 69: Heat exchangers

One Unit Pump heating System: Grundfos Magna 3. with Automatic analysis of the heating system conditions. Automatic search of the optimum setting point and adjust to changes in demand.

)

Fig. 70: Pump heating system (Grundfos Magna 3)

DOMESTIC HOT WATER.

The pumping system for domestic hot water is equipped with one outlet pump in Substation, building 11 for the whole circuit (Wilo perfecta QS CZ 25-9) and one recirculating Pump in each building (Perfecta Logic Pro)

Fig. 71: *DHW Pumps*

APARTMENT HEATING SYSTEM.

In the apartments the heat distribution is produced by radiators. There are one radiator for each room, they are equipped with normal valves and the tenants can select the level of usage for each radiator.

Fig. 72: Radiators

APARTMENT VENTILATION

Apartments have two systems of ventilation:

- Livingroom and Bedrooms have natural ventilation below the window and behind the radiators that ideally heat the fresh air introduced in the room.

Fig. 73: Air Intake/ air outlet in the room.

- Bathroom Ventilation. In the Bathroom there is forced ventilation by a little fan.

Fig. 74: Bathroom ventilation

LIGHTING SYSTEM APARTMENT AND COMMUNAL AREAS.

According with the information provided by Landskronahem, tenants do not usually use Low consumption bulbs. In the communal areas the majority of the bulbs are incandescence typology.

Fig. 75: Apartment and communal areas Bulbs

APARTMENT ELECTRIC SCHEME.

The electric installation of the apartment is design to supply the electric consumption for Appliances Lighting and other few electric consumption. There is not electric contribution for Heating or DHW systems.

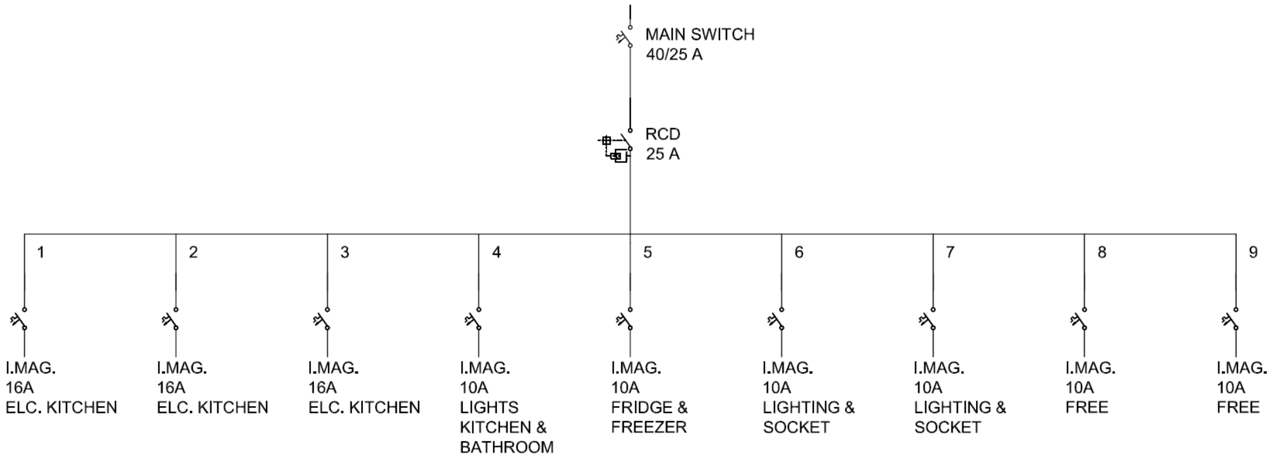


Fig. 76: Electric scheme

Fig. 77: Apartment electric board

dreeam

LAUNDRY SERVICE.

Each building provide a room with facilities for Laundry services. The electric consumption of the Laundry is provided by the electric communal services. The equipment for the Laundry is showed in the following scheme.

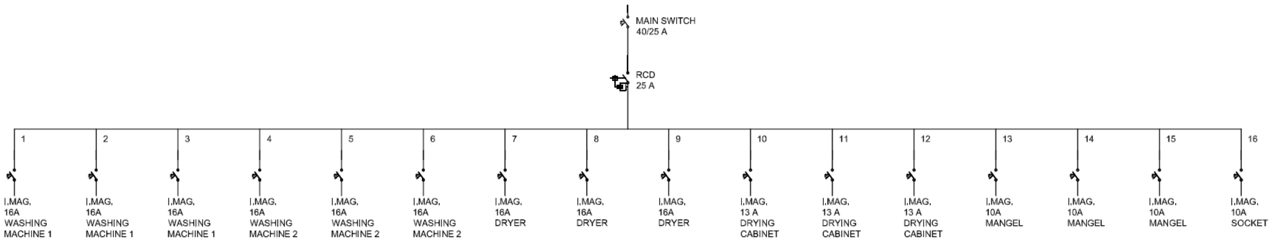


Fig. 78: Laundry electric scheme

Fig. 79: Laundry equipments

6.3 MEASUREMENT AND VERIFICATION PLAN.

6.3.1 MEASUREMENT BOUNDARY.

In Landskronahem Pilot buildings the purpose of the report is calculate the energy performance of the Buildings selected for Dreeam Project: B13, B15, B17, B19. In order to develop a complete analysis of the buildings two different scopes are considered.

- SCOPE DISTRIC HEATING BUILDINGS. This group of buildings is formed by: B11,B12,B13,B15,B17,B19. The information available of historic energy consumption data of district heating is from this group of buildings. The district heating meter for the five buildings is installed in B11, and the data available has been provided by Landskrona Energy (district heating supplier). For this group, a base line for district heating consumption is going to be calculated. This base-line will allow to compare the energy performance before and after renovations. In addition, considering the characteristics of each building it is possible to estimate accurately the energy consumption of each building.

- SCOPE DREEAM BUILDINGS. This group of buildings is formed by: B13, B15, B17, B19. For this group of buildings there is not specific energy data available. The monitoring plan will focus on collect data for this group of buildings and the energy consumption breakdown for each system.

For this two options the measurement boundary considered in IPMVP is Option C: Whole Facility. Continuous measurements of the entire facility's energy use will be taken by the data provided by Landskrona Energy and the monitoring equipment.

6.3.2 BASELINE PERIOD, ENERGY AND CONDITIONS.

The data available to evaluate the energy performance are from years 2013, 2014, 2015. The year 2015 is initially selected as Baseline year because hourly consumption for district heating and electric consumption in communal areas have been provided by Landskrona energy.

The following base line will be provided for the different systems.

- District heating baseline, which makes possible to calculate ECMs savings produced by the different retrofit solutions that reduces heating energy consumption. For instance, improvement in insulations, radiators, ventilation…
- Electric consumption in communal areas, which allows to calculate ECMs savings produced by the generation of PV system, improvements in Lighting system…
- Aggregated electric consumption of tenants. Will allow to calculate ECMs savings focus on reduced tenant's electric consumption.

INDEPENDENT VARIABLES and STATIC FACTORS

- Ambient temperature is selected as the main independent variable to define a mathematical relation to represents the energy performance. In the energy performance report will be described the different mathematical models that represent the consumption after perform the analysis with the data available for Heating Degree Days.

The static Factors considered for this pilot are

- Pattern of use from tenants. Set points. Running time.
- amount of space being heated or air conditioned
- indoor environmental standard: light levels, ventilation rate.
- Occupancy data and social Characterization are considered static factors, although Landskronahem has described one possible scenario where tenants after renovations could be different from initial tenants. In this case the Non-routinaryadjustment for these variables have to be calculated.

6.3.3 MONITORING ACTIVITIES AND REPORTING PERIOD.

The reporting period have to include at least one normal operating cycle of the equipment or facility, in order to fully characterize the savings effectiveness in all normal operating modes.

According with the following planning the reporting period is considered one year after renovations works that implies that renovation works should be finished September 2018.

Table 52: Reporting planning period

LANDSKRONAHEM MONITORING PLANING and Reporting Period.																					
		2015				2016				2017				2018				2019			
		1 Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
0	**INITIAL INFORMATION**																				
1	COLLECTING INFORMATION																				
2	FIELD VISITS																				
I	**MONITORING DEFINITION**																				
2	TENANTS INTERVIEWS (not possible)																				
3	MONITORING EQUIPMENT DEFINITION																				
4	MONITORING EQUIPMENT INSTALLATION																				
II	**BASELINE PERIOD**																				
1	Period with energy information provided by Landskrona Energy																				
2	Period with detailed information from monitoring equipment																				
III	**ESTIMATED PERIOD FOR RENOVATIONS WORKS**																				
IV	**REPORTING PERIOD**																				

6.4 OPTIONS FOR ENERGY CONSUMPTION MONITORING

6.4.1 Option for Extended Monitoring in District Heating and DHW

Background

The data collection with supplier has been successful for the District heating and the DHW,

The data collected so far for DH and DHW are related to the global consumption of 5 buildings, including the 4 pilot buildings that will be renovated.

The DH and DHW consumption of the 4 pilot buildings before/after renovations will be estimated as first analysis.

This estimation will be calculated by using:

- The global DH and DHW consumption of the 5 buildings
- The occupancy rate of each building
- Then an estimation of consumption of the 4 pilot buildings will be calculated based on the number of tenants living in each building.

The objective of installing new monitoring equipment is to collect additional specific data for the 4 pilot buildings included in the project. This new data will enable to develop accurate calculations of energy savings after renovations in the 4 buildings.

3 OPTIONS EXIST TO INSTALL ADDITIONAL MONITORING EQUIPMENT FOR DH AND DHW.

SinCeO2 proposes ideally to adopt the scenario no.1 but the budget of monitoring equipment will be probably too high.

Savills proposes the scenario no.3 in case the budget for monitoring equipment is not sufficient for option no.1

Table 53: Additional options of monitoring equipment installation

Option	Installation	Description	Comments
1	Thermal energy meters: ○ Heating ○ DHW	In each building: 1 meter for heating. 1 meter for DHW.	To develop this solution detailed plans of installation are needed. (Pipes Schemes). The budget for this option is high and exceed the amount for equipment in the project.
2	Electronic Heat cost allocators	1 device in each radiator.	Not mandatory according to Swedish law. Not included in OD meters.
3	Thermal energy meters: ○ Heating ○ DHW	Only in the building no.11 (not part of the DREEAM renovations) In the building: 1 meter for heating. 1 meter for DHW.	WE WILL BE ABLE TO CALCULATE THE DH AND DHW CONSUMPTION OF THE 4 PILOT BUILDINGS (NO.13, 15, 17, 19) AS FOLLOWED: ○ **GLOBAL DH AND DHW CONSUMPTION** OF THE 5 BUILDINGS (DATA FROM SUPPLIERS)**MINUS** REAL DH AND DHW CONSUMPTION OF THE **5TH BUILDINGS** (NON PART OF THE PILOT) = DH AND DHW CONSUMPTION OF THE **4 PILOT BUILDINGS.** ○ Depending on pipes scheme it would be also possible installing the meters in the pipe that supplies the 4 buildings. THIESE OPTIONS WOULD BE EFFICIENT FOR A LIMITED BUDGET

6.4.2 Options for extended monitoring in electric consumptions.

Electric Consumption scheme

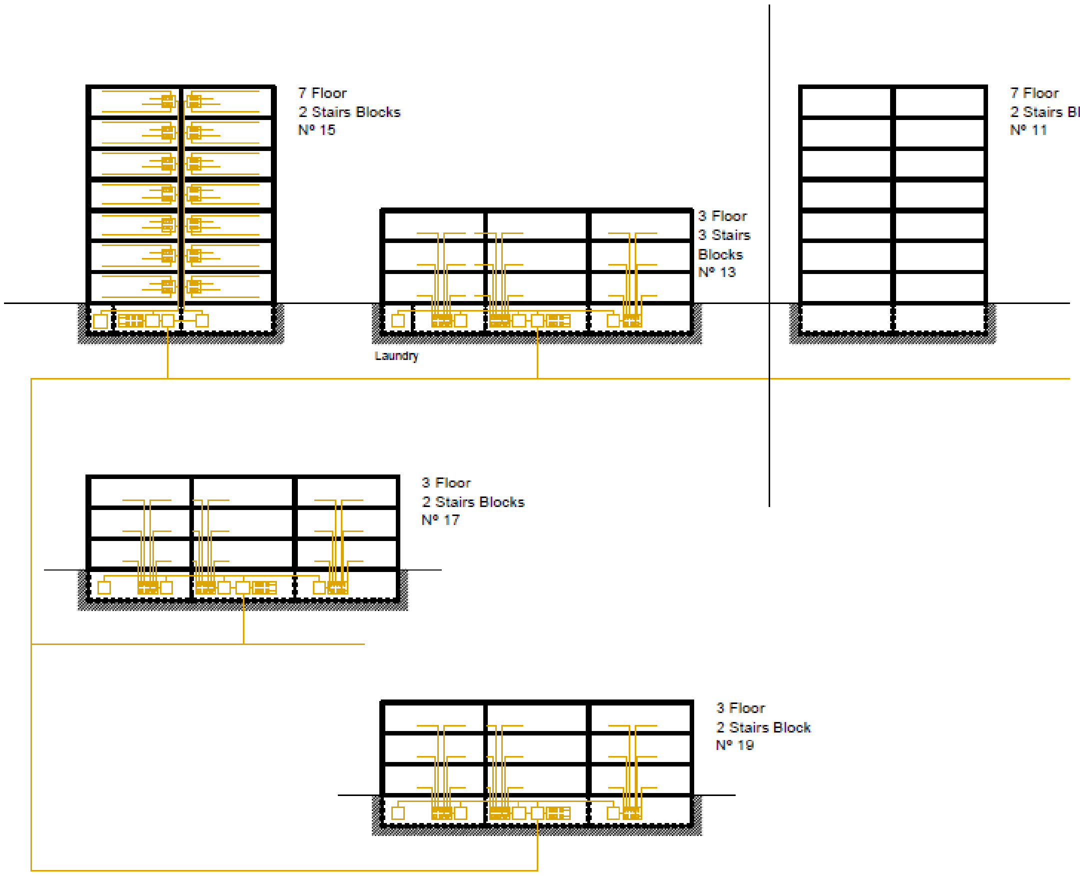


Fig. 80: Electric Consumption scheme

Background:

According to the availability of the Electric Consumption Data from the Electric supplier in each building, the recommendation is extend the electric sub-metering to collect the consumption of significant installations:

- Laundry.
- Exhaust air recovered heat pump.
- Ventilation.
- And other systems or installations finally installed in the renovations.

OPTIONS EXIST TO INSTALL ADDITIONAL MONITORING EQUIPMENT FOR ELECTRICITY

Table 54: Options exist to install additional monitoring equipment for electricity

Option	Installation	Description	Comments
1	**LAUNDRY**	MEASURE: KWH EQUIPMENT: - ELECTRIC THREEPHASE METER (ODENERGY). 1 THREEPHASE METER FOR THE WHOLE CONSUMPTION OF THE LAUNDRY IN EACH BUILDING.	THIS INSTALLATION CAN BE DEVELOPED WITH OPENDOMO HARDWARE INDEPENDENTLY. THE SOLUTION COULD BE COST-OPTIMIZED IF THE NEW METERS ARE INTEGRATED IN THE CURRENT ECOGUARD SYSTEM, AND THEN OPENDOMO COLLECTS THE DATA THROUGH SOFTWARE INTEGRATION (TO DO SO IT IS NECESSARY TO HAVE THE INFORMATION ABOUT THE INFRASTRUCTURE OF ECOGUARD SYSTEM)
2	**EXHAUST AIR HEAT PUMP.**	MEASURE: KWH EQUIPMENT: ELECTRIC THREEPHASE METER (ODENERGY) ELECTRICAL CONNECTION IN INSTALLATION ELECTRICAL BOARD IN EACH BUILDING.	-SAME SOLUTION AS THE LAUNDRY METERS.
3	**VENTILATION.**	MEASURE: KWH EQUIPMENT: ELECTRIC THREEPHASE METER (ODENERGY) ELECTRICAL CONNECTION IN VENTILATION ELECTRICAL BOARD IN EACH BUILDING.	-IT IS RECOMMENDED TO MEASURE THIS CONSUMPTION BECAUSE THERE IS NO REAL DATA ABOUT THE VENTILATION ELECTRIC CONSUMPTION. -SAME SOLUTION AS THE LAUNDRY METERS.

1. District heating&DHW pipes

2. Electric Room (3units/building)

3. Laundry electric board.

6.4.3 DISTRICT HEATING/BMS SCHEME and OD INTEGRATION

How we integrate the data in the opendomoplatfom to establish the energy performance of buildings

Background

The scheme below explains all the options for data communication flow to be developed with the different systems available.(1,2,3…10)

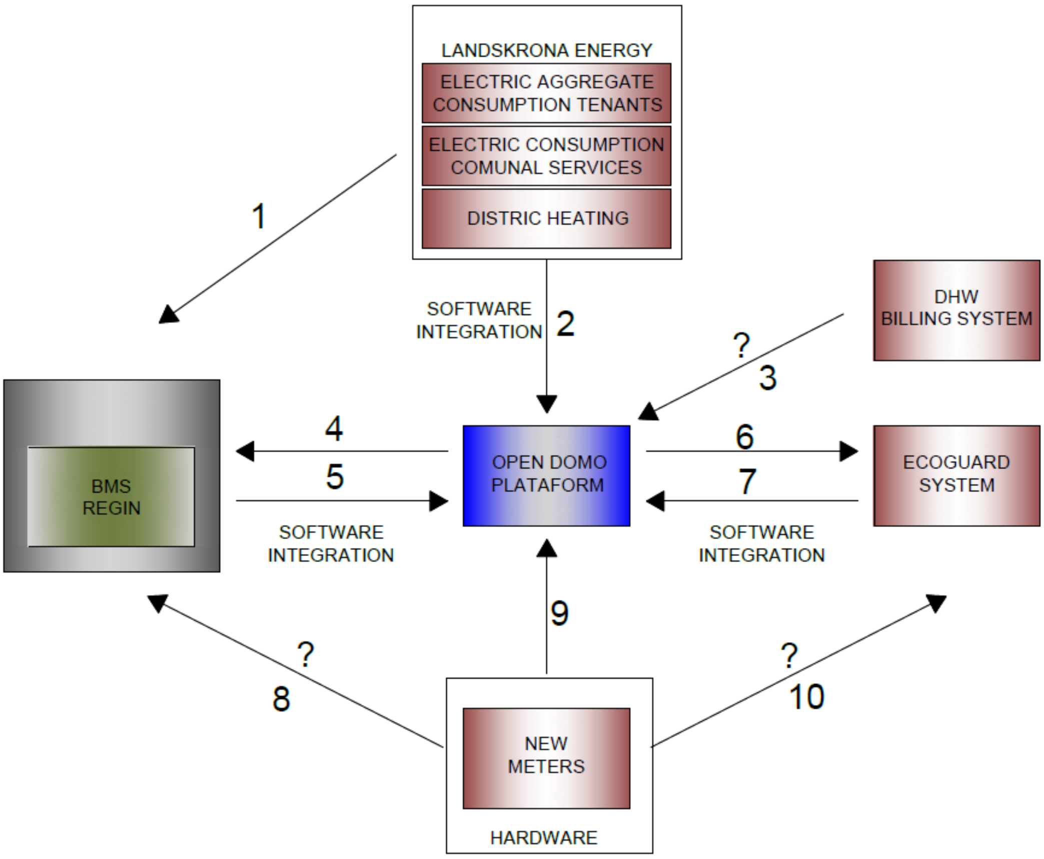


Fig. 81: Background scheme

Based on DREEAM objectives, SinCeO2 proposes for each process number different options below:

Process n°1: Currently this process 1 is done manually. It could be replaced by an API (Application Program Interface) developed to send data automatically, directly or through OpenDomo (2+4)

Process n°2: API (Application Program Interface) can be developed to send data automatically to Open Domo

Process n°3: Open Domo and SinCeo2 don't have enough information today about the DHW billing system to make a proposal (to be discussed)

Process n°5: It is recommended to integrate the data of the sensors collected by BMS. To perform detailed energy analysis.

Process n°7: It is recommended to integrate the data of Temperature sensors to perform detailed energy analysis.

Process n°9: The data collected with the new metter will be implemented in the Open Domo platform. Another option is possible: If Ecoguard infrastructure is available, the process n°9 this could be replaced by the process n°10 (data transmission new meters to Ecoguard) + process N° 7 (data transmission Ecoguard to Open Domo platform)

Process n°8&10: Landskronahem should decide about it, this could be replace by: 9+4 and 9+6

6.4.4 MEASUREMENTS CAMPAIGN

In case, there is not possibility to install additional monitoring equipment according to this proposal, or even in addition of this proposal, SinCeO2, would develop a Measurements campaign during 4-5 days.

In order to collect the energy consumption of the following Systems and installations:

- Ventilation.
- Exhausted air heat pump.
- Laundry
- Lighting system, (communal areas)
- Pumping system, (District Heating, recirculation pump for DHW)
- Thermal energy consumption, District heating and DHW in each Building. For this measures it is needed to be done during heating period.

6.5 Detailed Monitoring plan.

NECESSARY INFORMATION TO DEFINE EQUIPMENTS OF MONITORING

To define the monitoring equipment correctly the following information is needed:

Thermal Energy Meter

District Heating and DHW Pipe Scheme, including the following information:

- Pipes Diameter
- Pipe material
- Description of the possible area to install the energy meter. Power supply and internet access are needed for the meter: position 1 or 2, taking into consideration the advantages/disadvantages indicated below.
- The purpose of the installation of the monitoring equipment is to get as exact as possible understanding of the consumption in the DREEAM buildings. Two positions are possible:

Position 1: direct measurement of the consumption for building Nº 11 (5th). The consumption of Dreeam Buildings (13,15,17,19)is calculated by deducting the consumption of building Nº 11 from the total consumption of the five buildings (11,13,15,17,19) provided by Landskrona Energy.

- The advantage for this position is that it is more useful for Landskronahem, because exact data for one building will be collected.
- The disadvantage of this solution is that we will always depend on Landskrona Energy to get the data for all the buildings.

Position 2: Direct measurement of Dreeambuildings (13,15,17,19). This position could be located in Building 11, (after building 11 pipe connection) or in building 13, (before building 13 pipe connection).

- The advantage of this position is that we will have the data of Dreeam buildings directly without any collaboration from Landskrona energy.

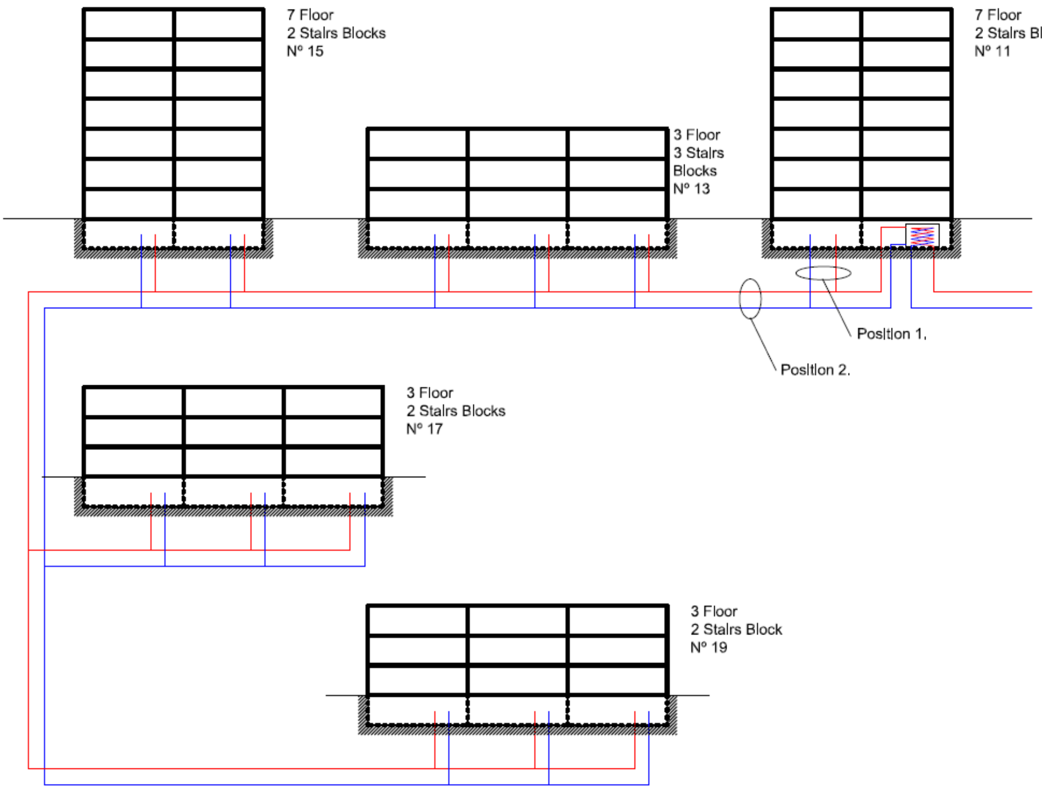


Fig. 82: District Heating and DHW Pipe Scheme

ELECTRIC METERS

Electric meters (3 Units OD energy) will be installed in each building (13,15,17,19) in an electric room/board that supplies laundry, ventilation and exhausted air heat pump. The electric room needs to have an internet access. If this is not possible, a solution with a router GPRS can be provided).

For each building (13,15,17,19) we need the following information:

- A drawing or scheme the electric room for each building, in which the electric supply for theservices mentioned above is located.
- Electric circuits that supplies laundry, ventilation, and exhaust air heat pump (electric switch, wire sections). Photos of the electric board and wires are enough.
- Is there internet access in the electric rooms, or can it be provided?

EXAMPLE OF UK “Plug and Play” MONITORING KIT

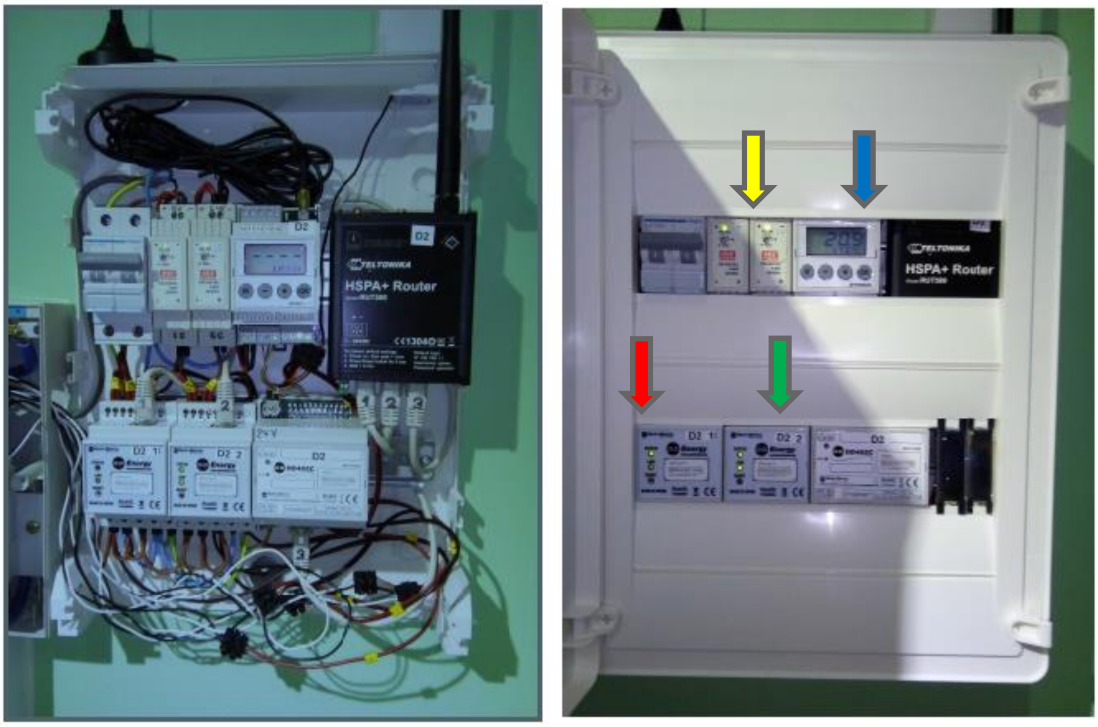


Fig. 83: EXAMPLE OF UK “Plug and Play” MONITORING KIT

This is the monitoring kit that we have installed in UK homes, the devices installed are:

2 electric meters ODenergy (red)

1 gateway Od485 (green)

1 RF base for temperature sensors (not in lands pilot) (yellow)

1 Router GPRs (blue)

A similar monitoring kit could be developed for Landskronahem in addition of the thermal meters. The ideal solution would be that all the electric circuits to measure are in the same electric room.

6.6 ENERGY CONSERVATION MEASURMETS (ECM´s) MONITORING

This section includes the procedure for measuring the different renovations concepts that have been analysed by Exeleria, Chalmers and Landskronahem.

Table 55: Systems considered in Renovations Concepts

Passive Systems considered in Renovations Concepts related with Global energy Consumption and Comfort	Active Systems considered in Renovations Concepts related with electric supply
ENVELOP RENOVATIONS:	Centralized Ventilation system with heat recovery and demand control
Ventilated Facade	Extract ventilation system with Demand control and air quality sensors
Windows: New glass and frames	PV System Roof and Facade
Floor: Celler roof insulation	

Envelop renovation.

Savings due to the influence from envelop renovation through the implementation of new insolation will be calculated by the analysis of the data consumption registered in the district heating meters. In addition, some thermic meters are planned to be installed in order to obtain a breakdown for each building. Indoor conditions analysis will be performed by the comparison of the indoor temperature in apartments before and after renovations.

New Active Systems supplied by electric energy.

Savings due to the new ventilation system will be monitoriced through the installation of new electric meters. The consumption from current ventilation system is possible to be obtained through the analysis of the data from the electric communal services because it has a fixed operating program that allows to identify the energy consumption pattern. The new ventilation system will have a variable regulation according with the air conditions. This regulation mode implies that the energy consumption of this system have to be monitoriced with electric meters. The Opendomo Platform is ready to integrate this new meters and also additional parameters from the BMS.

Regarding with the energy produced by the PV system, Opendomo will integrate this data in a specific application for this system.

7. ANNEXES

7.1 ANNEX 1. PADIHAM INSTALLATION REPORT

PADIHAM MONITORING INSTALLATION REPORT

CONTENT:

This document summarize the information collected and the test performed in each dwelling during the installation of monitoring equipment from 21/09 to 23/09. (2016)

For each Dwelling the report is composed of three main parts:

- DESCRIPTION OF THE DWELLING: Typology of the Dwelling, Heating Use, Appliances, according with the info provided by tenants and verified during the visit.

- TEST RESULTS: the measured Electric house circuit has been checked and identified in the platform. The registered values in the table are instantaneous value registered during the test of each circuit. OFF Peak Circuit will be verified in the following days, (it is only on during night).

- INSTALLATION PHOTOS.

The installation of monitoring equipment and initial test on site has been completed successfully and our following step is configure the platform for developing data analysis. SinCeO2 will inform Dreeam Partners when this configuration is ready.

DWELLING: D1

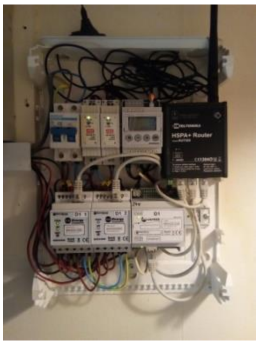
DATE: 21-09-2016

Description:
26 Whitegate gardens Padiham BB12 8TL.
Electric and Gas House.
Ground floor flat. 1 Bed. 1 Tenant.

Normal Heating Use:
Period: October – March
All heaters on, at night low set point of temperature.
Radiators: Hall, Living Room, Bedroom and Kitchen.

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Kettle.
Lighting Bulbs: Low consumption Bulbs

		CODE	Csensor	CIRCUIT	Power (kW)	Temp./Hum.	Test
ODENERGY 1		D1.1.L1	120 A	Main Switch	5,4		Shower
		D1.1.L2	120 A	Shower	5,3		Low Power
		D1.1.L3	120 A	House Sockets	0,08		
ODENERGY2		D1.2.L1	80 A	Cooker	1,9		
		D1.2.L2	80 A	Boiler	0		
		D1.2.L3	80 A	Kitchen Sockets	1,3		Microwave
OD485C	SONDA1	D1.TEMP.LIV				18	
		D1.HUM.LIV				70	
	SONDA2	D1.TEMP.BED				18	
		D1.HUM.BED				79	


DWELLING: D2

DATE: 21-09-2016

Description:
38 Whitegate Close Padiham BB12 8TL.
Electric House.
Mid terrace. 2 Bed. 2 Tenants.

Normal Heating use:
Period; October – March
Electric Storage heater normally On during winter: Living room + Hall
Auxiliary electric panel (700 W): 1 Livinroom,1 bedroom,1bedroom,1 Storeroom. (normally on during winter)
Electric storage heaters: Hall, Living Room, Bedroom and Kitchen.

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Kettle, 2 TV, !stereo.

		CODE	Csensor	CIRCUIT	Power (kW)	Temp./Hum.	Test
ODENERGY 1		D2.1.L1	120 A	Off Peak (e.s.heaters)	0		
		D2.1.L2	120 A	Main Switch	0,322		House Sockets.
		D2.1.L3	120 A	Shower	2,1		low
ODENERGY2		D2.2.L1	80 A	Downfloor Sockets	0,33		
		D2.2.L2	80 A	Immersion (DHW)	3,2		
		D2.2.L3	80 A	Bathroom Heater	2,1		
OD485C	SONDA1	D2.TEMP.LIV				20,9	
		D2.HUM.LIV				65	
	SONDA2	D2.TEMP.BED				21,5	
		D2.HUM.BED				63	


DWELLING: D3

DATE: 21-09-2016

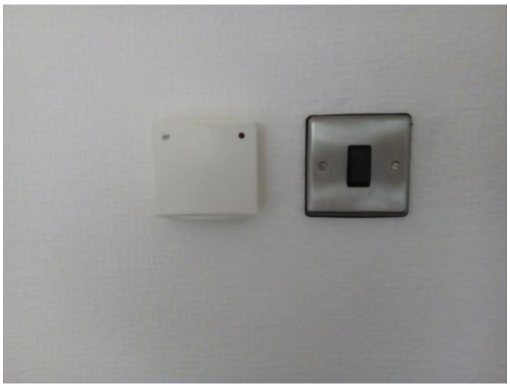
Description:
8 Whitegate Close Padiham BB12 8TJ.
Electric House.
Mid Terrace, 2 Bedrooms, 2 Tenants.

Normal Heating use:
Period; October/November – March
Electric Storage heater normally On during winter: Livingroom+hall
Auxiliary electric panel : 1 Living room, (only in very cold weather)

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Kettle,
Lighting Bulbs: Low consumption, LED

		CODE	Csensor	CIRCUIT	Power (kW)	Temp./Hum.	Test
ODENERGY 1		D3.1.L1	120 A	Off Peak (e.s.heaters)	0		
		D3.1.L2	120 A	Main Switch	6,8		Shower+BH
		D3.1.L3	120 A	Shower	4,5		medium
ODENERGY2		D3.2.L1	80 A	Sockets Downstair	0,11		
		D3.2.L2	80 A	Immersion (DHW)	-		
		D3.2.L3	80 A	Bathroom Heater	2,3		
OD485C	SONDA1	D3.TEMP.LIV				20,7	
		D3.HUM.LIV				67	
	SONDA2	D3.TEMP.BED				21,5	
		D3.HUM.BED				64	




DWELLING: D4	DATE: 21-09-2016

Description:
1 Victoria Court Padiham BB12 8TH.
Electric House.
Ground Floor Flat, 1 Bedrooms, 1 Tenant.

Normal Heating use:
Period; October –April.
Electric Storage heater normally On during winter: Living room, hall, kitchen
Auxiliary electric heater in Living room 2000 W

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Kettle, toaster

Lighting Bulbs: Incandescence

		CODE	Csensor	CIRCUIT	Power (kW)	Temp./Hum.	Test
ODENERGY 1		D4.1.L1	120 A	Main Switch			
		D4.1.L2	120 A	Shower	9		High
		D4.1.L3	120 A	Off Peak (e.s.heaters)			
ODENERGY2		D4.2.L1	80 A	Immersion (DHW)	3,17		
		D4.2.L2	80 A	Sockets	2,121		aux.heater
		D4.2.L3	80 A	Bathroom Heater	2,14		
OD485C	SONDA1	D4.TEMP.LIV				25	
		D4.HUM.LIV				48	
	SONDA2	D4.TEMP.BED				23,3	
		D4.HUM.BED				53	
	SONDA3	D4.TEMP.EXT				18,4	
		D4.HUM.EXT				67,7	

DWELLING: D5

DATE: 22-09-2016

Description:
11 Whitegate Gardens, Padiham BB12 8TL.
Electric and Gas House.
End Terrace, 3 Bedrooms, 1 Tenant.

Normal Heating use:
Period; Sept – April
Radiators normally on: all of them
DHW by Gas except shower

All heaters on at night low set point of temperature.
Radiators: Hall, Living Room, Bedroom and Kitchen.

Appliances (Electric Consumption):
Fridge, freezer, Washing machine, Kettle, toaster

		CODE	Csensor	CIRCUIT	Voltage (V)	Power (kW)	Current (A)	Power Factor	TEST
ODENERGY 1		D5.1.L1	120 A	Main Switch	247	10,7	43	0,99	Microwave+Shower
		D5.1.L2	120 A	Shower	244	5,4	21	0,99	medium
		D5.1.L3	120 A	House Sockets	246	0,22	0,95	0,98	TV
ODENERGY2		D5.2.L1	80 A	Cooker					No use
		D5.2.L2	80 A	Boiler					
		D5.2.L3	80 A	Kitchen Sockets	245	1,3	5,45	0,98	Kettle
OD485C	SONDA1	D5.TEMP.LIV							17,6
		D5.HUM.LIV							64%
	SONDA2	D5.TEMP.BED							18,1
		D5.HUM.BED							70%

DWELLING: D6

DATE: 22-09-2016

Description:
29 Whitegate Close, Padiham BB12 8TJ.
Electric House.
First Floor Flat, 1 Bedrooms, 1 Tenant.

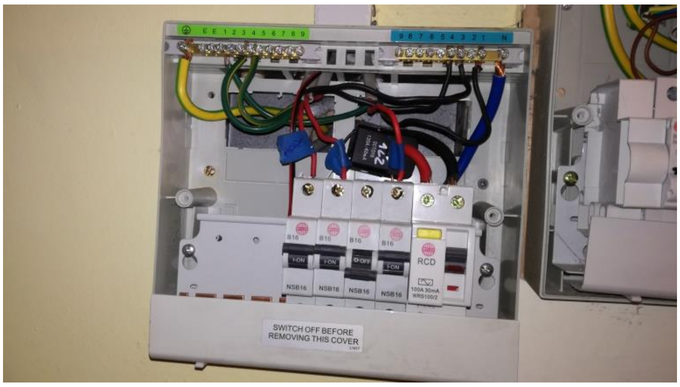
Normal Heating use:
Period; October- April
Electric Storage heater normally On during winter: Living room, bedroom
Auxiliary electric heater (2500 W) in 1 Living room

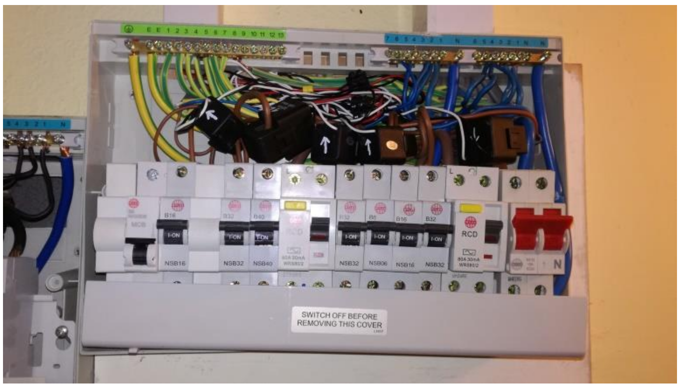
Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Kettle, toaster, cooker robot

Lighting Bubs: Saving bulb, led.

NOTE1: "IMMERSION" Domestic hot water tank does not work correctly.
NOTE 2. Kitchen sockets circuit is registering unreliability data, SinCeO2 will review this data in the following days and will inform PFP

		CODE	Csensor	CIRCUIT	Voltage (V)	Power (kW)	Current (A)	Power Factor	TEST
ODENERGY 1		D6.1.L1	120 A	Off Peak (e.s.heaters)					
		D6.1.L2	120 A	Main Switch	242	12,1	48,5	0,99	Shower + kettle
		D6.1.L3	120 A	Shower	243	9,18	36	0,99	High
ODENERGY2		D6.2.L1	80 A	House Sockets	246	2,3	9	0,99	Aux Heater
		D6.2.L2	80 A	Immersion (DHW)					
		D6.2.L3	80 A	Kitchen Sockets	246	1,39	5,15	0,99	Kettle + Microwave
OD485C	SONDA1	D6.TEMP.LIV							18,5
		D6.HUM.LIV							69,50%
	SONDA2	D6.TEMP.BED							18,3
		D6.HUM.BED							67,50%





DWELLING: D7

DATE: 22-09-2016

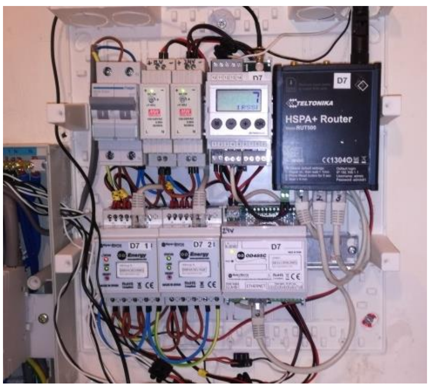
Description:
55 Whitegate Close, Padiham BB12 8TJ.
Electric House.
End Terrace,2 Bedrooms (converted in 3 bedrooms), 3 Tenants (1 Adult+2 children)

Normal Heating pattern of use:
Period; October – April
Electric Storage heater normally On during winter: Living room+ 2 bedroom, (main bedroom without heater)
Auxiliary heater by gas on ground floor.
Auxiliary electric heater (2000 w) in kitchen.

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Drier machine, Kettle, toaster

		CODE	Csensor	CIRCUIT	Voltage (V)	Power (kW)	Current (A)	Power Factor	TEST
ODENERGY 1		D7.1.L1	120 A	Off Peak (e.s.heaters)					
		D7.1.L2	120 A	Main Switch	246	2,6	10,31	0,99	Washing
		D7.1.L3	120 A	Shower	245	8,33	33,12	0,99	High
ODENERGY2		D7.2.L1	80 A	Kitchen Sockets	246	3,18	12,6	0,99	Washing+Kettle
		D7.2.L2	80 A	Immersion (DHW)	246	3,18	12,46	0,99	Boost
		D7.2.L3	80 A	Bathroom Heater	245	2,16	8,58	0,99	
OD485C	SONDA1	D7.TEMP.LIV							21
		D7.HUM.LIV							41,67%
	SONDA2	D7.TEMP.BED							22,6
		D7.HUM.BED							47%





DWELLING: D8

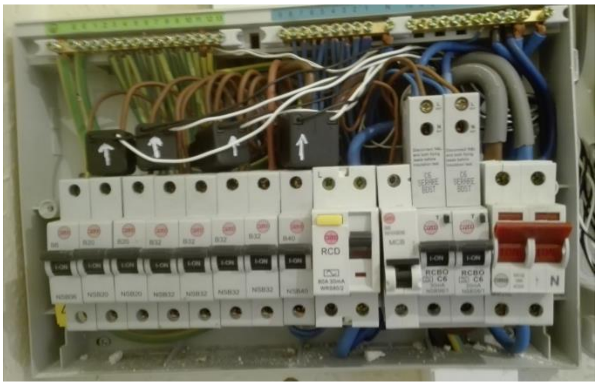
DATE: 22-09-2016

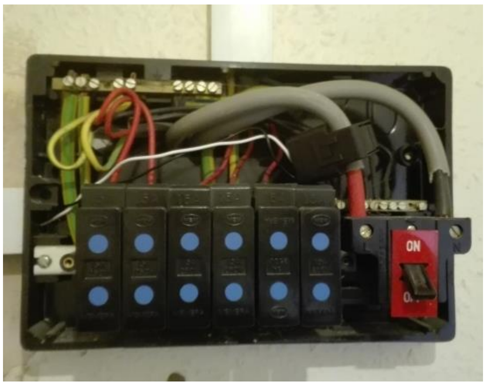
Description:
70 Whitegate Close, Padiham BB12 8TJ.
Electric House.
End Terrace,2 Bedrooms, 3 Tenants. (2 Adults+1children)

Normal Heating use:
Period; October-april
Electric Storage heater normally On during winter: Livingroom+ bedroom
Auxiliar electric panel (2000 W): 1 Livinroom.

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Drier Machine, Kettle

		CODE	Csensor	CIRCUIT	Voltage (V)	Power (kW)	Current (A)	Power Factor	TEST
ODENERGY 1		D8.1.L1	120 A	Off Peak (e.s.heaters)					
		D8.1.L2	120 A	Main Switch	245	12,13	48,3	0,99	Shower+Heater Bath
		D8.1.L3	120 A	Shower	245	9,7	38	0,99	High
ODENERGY2		D8.2.L1	80 A	Downfloor Sockets	246	2,32	9,2	0,99	Aux heater
		D8.2.L2	80 A	Immersion (DHW)	245	3,3	1,3	0,99	Boost
		D8.2.L3	80 A	Heater Bathroom	243	2,11	8,42	0,99	
OD485C	SONDA1	D8.TEMP.LIV							19,9
		D8.HUM.LIV							52%
	SONDA2	D8.TEMP.BED							19,4
		D8.HUM.BED							60%





DWELLING: D9	DATE: 23-09-2016

Description:
17 Whitegate Close, Padiham BB12 8TJ.
Electric House.
Mid Terrace,3 Bedrooms, 2 Tenants (1 adult+ 1child)

Normal Heating use:
Period; October – Abril
Electric Storage heater normally On during winter: 1 Livingroom+2 bedrooms) heater in main Bedroom normally off.
Auxiliar electric heater: 1 livingroom+1 bedroom.

All heaters on at night low set point of temperature.
Radiators: Hall, Living Room, Bedroom and Kitchen.

Appliances (Electric Consumption):
Fridge, Microwave, Cooker, Oven, Washing machine, Drier machine, aux cooker machine, Kettle, toaster

		CODE	Csensor	CIRCUIT	Voltage (V)	Power (kW)	Current (A)	Power Factor	Notes
ODENERGY 1		D9.1.L1	120 A	Off Peak (e.s.heaters)					
		D9.1.L2	120 A	Main Switch	245	12,2	48,3	0,99	Heater+Shower
		D9.1.L3	120 A	Shower	245	9,55	37,87	0,98	High
ODENERGY2		D9.2.L1	80 A	Downfloor Sockets	245	3	11,8	0,99	
		D9.2.L2	80 A	Immersion (DHW)	246	3,3	13,1	0,99	boost
		D9.2.L3	80 A	Heater Bathroom	244	2,1	8,4	0,99	Heater
OD485C	SONDA1	D9.TEMP.LIV							18,6
		D9.HUM.LIV							67%
	SONDA2	D9.TEMP.BED							18
		D9.HUM.BED							72%

dreeam

7.2 ANNEX 2 MONITORING EQUIPMENT TECHNICAL DATA.

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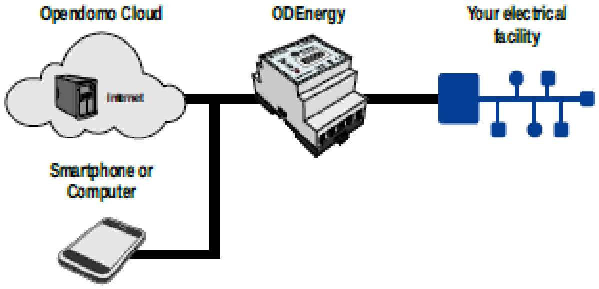
ODEnergy rev.19.1 2015

IP Smart Energy Meter
ODEnergy



Characteristics of the models

Model	System	Connectivity
ODEnergy ME	Single-phase	Ethernet
ODEnergy MEW	Single-phase	Ethernet + WIFI
ODEnergy TE	Single-phase/three-phase	Ethernet
ODEnergy TEW	Single-phase/three-phase	Ethernet + WIFI

Note: WIFI + Ethernet versions allow only one of the two connections at once.

Equipment characteristics

- **Values measured:** Active Power (KW), Reactive power (Kvar), Apparent power (KVA), cos phi, Volts, Amperes.
- **Supply voltage:** From 85 to 265V AC Grid frequency 47-80 Hz. A supply voltage of 230 V ± 15% and 50-60 Hz is recommended to maintain high accuracy.
- **Equipment consumption:** 5 VA
- **Relative error:** 1%
- **Maximum power measured:** 2,147 GW
- **Maximum energy measured:** 2147 Gwh
- **Ethernet Connectivity:** 10Base-T with Rj45 connector.
- **WIFI Connectivity:** Compatible with 802.11b / g / n networks, Output Power: 10dBm, receiver sensitivity: -91dBm, supports WEP, WPA-PSK, WPA-2-PSK.
- **Box sizes:** 86x53x58 mm. DIN rail format: 3 units to be installed on any standard electrical box.
- **Memory size:** 48 hours [1].

1. ODEnergy has an internal memory allowing you to store data (for sending frequency every 15 minutes) in case internet access is lost.

APPLICATIONS

- Monitoring of the main electrical consumption.
- Monitoring of multi-site electrical consumption.
- Load controller.
- Data logger.
- Site monitoring through internet.
- Alarm generator of over-consumption.

1

Características

- 8 puertos digitales de entrada
- 8 puertos digitales de salida de estado sólido (colector abierto)
- 8 puertos ADC
- Interfaz IP con conector RJ45 10/100M
- Puertos de expansión (1 interno + 1 externo)
- LED bicolor de estado
- Reloj en tiempo real (rev.1)
- Montaje en carril DIN o sobre superficie.

Parámetro	Mínimo	Típico	Máximo
Voltaje de alimentación	8VCC	12VCC	14VCC
Corriente de alimentación	150mA	180mA	1,5A(1)
Voltaje de los puertos digitales de salida	VCC – 0,7		12VCC
Corriente de los puertos digitales de salida			170mA
Potencia de los puertos digitales de salida			2W
Voltaje de los puertos digitales de entrada	0V		30V
Valor lógico "alto" de los puertos digitales de entrada	5V	12V	30V
Valor lógico "bajo" de los puertos digitales de entrada	0V	0V	1,5V
Voltaje de entrada de los puertos ADC	0V		+2,5V
Sección de los cables de alimentación	0,5mm² AWG20		2,5mm² AWG12
Sección de los cables de los puertos digitales	0,2mm² AWG30		1,5mm² AWG16
Temperatura operativa	0ºC		+50ºC
Dimensiones (ancho, largo, alto)		71x90x58mm	
Tamaño en carril DIN		4 unidades	

Notas:
1. Todas las salidas activadas con el máximo consumo.

TEFL WIRELESS ROOM SENSOR

TEFL is a wireless transmitter operating on the frequency range off 868.3MHz. It has been designed for reliable operation in wide range of environments. Totally 4 measurements and signals can be sent by one transmitter; temperature, set point, humidity and the state of a 5-position switch.

Communication between the transmitters and the FLTA base station is bidirectional, and the readings are updated at once when the measurement has changed enough, however at least once an hour.
Minimum changes causing immediate update message to FLTA:

-temperature:	+/- 0,2 °C
-set point:	+/- 0,2 °C
-humidity:	+/- 0,5 %RH

The base station is monitoring also the transmitters for any malfunctions and for the low battery level. TEFL transmitters have a battery operating life time up to 6 years.

Each FLTA base station may have up to 99 transmitters in its operation area and up to 63 FLTA base stations may operate in the same wireless area. In theory totally 6237 transmitters may be used in a single area.

Each wireless transmitter, repeater and base station needs to have a unique address. Each transmitter address consists of two parts; SID (sensor ID) and MID (master / base station ID). These addresses will be configured wireless by using FLSER service tool.

The transmission area can be extended by using FLREP or FLREP-U repeaters (up to 8 pcs) between transmitters and the FLTA base station.

As the communication is bi-directional all the time, is also the transmitter aware of the function of the network. By the lamp the transmitter is able to inform about the problems in the network and about the needed service. For example the transmitter is alarming when less than 5% of the battery capacity remains.

Function of the lamp during operation:

1 flash / 2 s	battery - and network alarm
1 flash / 4 s	battery alarm
1 flash / 8 s	network alarm

FLTA base station receives the same information and transmits it forward to the monitoring system.

Technical data:

Supply	3V6 AA Lithium Battery 2Ah
Transmission Frequency	868.30 MHz Class1
Transmission Range	Up to 500m line of sight 20 to 100m inside buildings
Transmission Power	+8dBm
Reception sensitivity	-109 dBm
Modulation type	FSK
Measurement accuracy	
temperature	+/- 0,5 °C, (25 °C)
humidity	+/- 3% RH, (25 °C)
Ambient temperature	0 … 50°C
Ambient humidity	0...100 % RH, non-condens.
Measurement range	
temperature	0… +50°C
humidity	0… 100%RH
-continuous use	5 … 95 %RH
Set point range	18 …24°C
Housing	ABS-plastics, IP20
Battery life	6 years
Battery life with FL-N	3 years
Battery life after low battery alarm	3 months

Ordering guide:

Model	Product nr.	Description
TEFL	1191010	Wireless room sensor
TEFL-P	1191011	+ Set point 18…24°C
TEFL-RH	1191020	+ humidity
TEFL-RH-P	1191021	+ humidity and Set point
FL-S5	1191050	5-positional switch A0123
FL-N	1191060	display unit
FL-DI	1191051	DI option
A04491	A04491	Battery

Products fulfil the requirements of directives 2004/108/EC, 2006/95/EC, 1999/5/EC and 2000/299/EC and are in accordance with the standards EN61000-6-3 (Emission), EN61000-6-2 (Immunity), EN60730, EN300220-2 and EN301489-3.

Produal Oy

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info@produal.fi

FLTA BASE STATION FOR WIRELESS SENSORS / IO-MODULES

FLTA is a base station for wireless transmitters, detectors and IO-modules using 868.30 MHz frequencies. Incoming information will be forwarded to the control or BMS by using Modbus communication or eight analogue outputs of the base station. Respectively the control information coming via Modbus will be forwarded to the IO-modules. The FLTA module has 8 x 0…10Vdc outputs that can be configured for example for temperature, humidity, set point or 5-position switch and also for those analogue / digital signals from LAFL detectors and RYFL IO-modules.

FLAN antenna for FLTA is always needed to ensure reliable transmission between base station and transmitters / IO-modules. The transmission area can be extended by using FLREP or FLREP-U repeaters (up to 8 pcs) between transmitters / detectors / IO-modules and the FLTA base station.

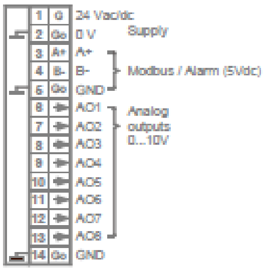
Each FLTA control module can have up to 99 transmitters or IO-modules in its operating area. Up to 63 FLTA base stations can operate in the same wireless area. In theory totally 6,237 transmitters and IO-modules can be connected in a single system.

During commissioning each base station must have its own address MID (Master ID) entered by using buttons and display of the base station (see installation and service guide / instructions).

Changed measurement readings are transmitted immediately. FLTA base station receipts each message and generates alarm if at least one message is missing more than one hour. When Modbus network is activated this information (= alarms) is available only via Modbus. When Modbus network is not activated alarm information is available as a 5Vdc voltage output from the terminal 4 (B-) against Go level. Also the display of the base station shows this alarm information.

After the break of supply the outputs of FLTA base station are returning to the status which was prevailing before the break.

Wiring:



Technical data:

Supply	24Vac/dc (22…28Vac/dc), 2 VA
Frequency	868.30 MHz, Class 1
Range	500m line in sight 20 … 100m in buildings
Transmission power	+8 dBm
Reception sensitivity	-109 dBm
Modulation	FSK
Outputs, 8 pcs 0-10V	
with TEFL-P-RH-S5	temperature 0...50°C humidity 0...100% RH set point 18...24C 5-pos. switch 1...5V (e.g.. position 3 = 3V)
with KLUFL	humidity 0...100% RH temperature -50...+150°C light level 0…1000 lx
with TEUFL	temperature -50...+150°C voltage 0…10V
with LAFL-LX	occupancy 0 / 10V light level 0…2000 lx
with RYFL	voltage 0…10V digital input 0 / 10V
Communication	Modbus RTU (RS485)
Ambient:	
temperature	-25°C… +65°C
humidity	0...100 % RH (non-condensing)
Housing, protection class	ABS-plastics, IP20
Dimensions w x h x d	53 x 90 x 58 mm

Ordering guide:

Model	Product nr	Description
FLTA	1191030	base station
FLAN	1191040	antenna for base station
FLANJJ-4.5	1191041	antenna extension cable 4,5m

Products fulfil the requirements of directives 2004/108/EC, 2006/95/EC, 1999/5/EC and 2000/299/EC and are in accordance with the standards EN61000-6-3 (Emission), EN61000-6-2 (Immunity), EN60730, EN300220-2 and EN301489-3.

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