MOBISTYLE

MOtivating end-users Behavioral change by combined ICT based modular Information on energy use, indoor environment, health and lifeSTYLE

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Publishable executive summary

This report - Deliverable 6.1 - presents the research activities within WP6 (Work Package 6) during the first two years of the MOBISTYLE project and describes the ***Elaboration of a detailed action plan and monitoring campaign for each case***. The Stage I of the MAP (first year of the project), presented general information and establishes the overall strategies, approaches, and plans for the measurement campaign. It included the necessary information for initiating the reference monitoring period. The Stage II of the MAP (second year of the project), presented in this report, consist of more detailed information regarding the specific solutions, the evaluation methods and plans for carrying out the monitoring and evaluation plans.

The structure of the report follows the steps taken in the development process of the action plan and the various steps taken to prepare for the execution of successful and tailor-made monitoring campaigns in all demonstration cases.

In line with this, the report first provides information on the goals of the project and the relevant work packages, establishes the importance of a detailed action plan, and describes the approach taken in order to achieve these goals (including detailed time chart).

Furthermore, the developed action plan template is presented. Its contents briefly described, followed by a short introduction of the different demonstration cases, the development process, including the various challenges met, and the next steps within the project.

Finally, both the action plan template, and the individual demonstration case action plans have been presented. Summary for all demonstration case is made to get an overview of the monitoring actions plan in the MOBISTYLE project.

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1 Introduction

The six tasks within Work Package 6 (WP6) will cover planning, execution, and evaluation stages with D6.1 focusing on the first – planning – phase. The overall objective of WP6 is to demonstrate that it is possible to achieve a significant reduction of energy use in different real environments by a sustainable behavioural change. The developed services, ICT-based solutions, and tools will be tailor made, deployed, and monitored for the selected demonstration cases, in five different climatic regions, covering different building types, different types of energy end-users, and different scales (district, building).
The monitoring in MOBISTYLE covers the following real-life environments:

1. A complex of residential buildings (Denmark);
2. A campus of university buildings, more specifically, four faculty buildings – Faculty for Economics, Faculty for Arts, Faculty of Computer Science and Informatics, and Faculty for Chemistry (Slovenia);
3. A hotel (Italy);
4. An open plan office building (Netherlands);
5. A housing district connected to a common electricity grid (Poland).

More specifically, WP6 is focused on the practical applications of the tools, apps and services, demonstrating their usefulness, validity and practicability in real environments. The methodologies, tools, and the business and exploitation models will be demonstrated for the addressed study and demonstration cases in real life operating conditions, in five different geo-clusters with following main objectives:

1. To illustrate and demonstrate the approach and methodologies and there from developed and derived ICT-tools and services by:
    a. Measurement and monitoring of energy use in practice for the cases and specific items;
    b. Validation of tools, services and measurements;
    c. Improvement and optimization of tools and services.
2. Demonstration and validation of the usefulness and acceptance.
3. To demonstrate the additional value of offering combined modular services.
4. To gather monitoring data about energy use of buildings (split up in several partial energy uses) and the influencing parameters about user/occupant behaviour.

For each demonstration case, an action plan with a detailed monitoring campaign (including measurements, awareness, information, and feedback campaigns) has been elaborated, describing the type of activities to be carried out, the schedule of implementation and the associated costs. An agreement among the partners involved on the details of information exchange and common evaluation is carried out during task development. For each case, a specific preliminary initial monitoring campaign has been drafted at the beginning of the MOBISTYLE project.

As the results and analyses of the demonstration cases will be used as feedback for WP 3, 4 and 5 to adjust and fine-tune the methodologies, tools, services and supporting business

models, it is essential to systematically develop unique action plans for each individual case study to successfully plan and carry out the measurement campaigns.

In the MOBISTYLE scope and approach, several specific themes are addressed and will be included in WP6, such as understanding (and measuring) of occupant behaviour and providing tailor-made information to create awareness and behavioural change in users.

It is necessary to establish a baseline and register the current situation in all case studies, regarding all relevant and chosen parameters. In order to successfully execute the MOBISTYLE objectives, a carefully revised and systematically planed monitoring and analysis campaign needs to be put forth and will be illustrated in this report.

Once the process of the development of practical tools is completed, the developed solutions will be applied to the demonstration cases for demonstration and validation purposes. The use of specific developed personal apps and tools by the end-users will be monitored and registered in chosen demonstration cases. Moreover, for each case, a basic monitoring and information campaign will be devised continuing after the project duration. Specific campaigns and validations can be added throughout the project duration. Finally, the results of the validation will be used for further recommendations, especially how to take into account 'soft measures' in energy performance regulations. The development of a detailed action plan for the individual demonstration case monitoring campaigns is, therefore, essential for a successful achievement of the overall goals of MOBISTYLE and WP6 especially.

The following sections of the report will consist of:

- A short description and overview of the content of the action plan template;
- A short description of the goal with and content of each chapter;
- A description of the development process thus far
- A summary describing all demonstration cases, their specific objectives, behavioural and monitoring plans, ICT-solution implementation, and
- The next steps in development for Stage II of the monitoring action plan.

Finally, all five Monitoring Action Plans (MAP), as filled out by the individual demonstration case holders have been attached to this report.

2 Monitoring Action Plan template

MAP template content overview

The MAP template contains various chapters requesting information regarding the individual cases. A short description is provided in red to guide the case holder towards the relevant information that should be provided.

As the five demonstration case studies vary greatly, the template is intentionally kept generally broad, to accustom and accommodate the various cases, whilst preserving the overall structure of the MAP objectives. The subjects of interest range from the technical

aspects of the building, including the focus areas, to the chosen KPIs (Key Performance Indicators), instrumentation, data handling, and time and resource planning.

1 Short description

In this chapter, information about the building or buildings in question is required. Characteristics regarding room type, layout, and technical aspects are all relevant. Drawings and floor plans can be provided to illustrate target areas, indicate specific rooms of interest and illustrate location of sensors. The intention of the chapter is to provide an insight and an overview of the demonstration cases.

2 Demonstration vision and objective

In this chapter, the goal and intent of the individual demonstration case is described. Taking the overall objectives of the MOBISTYLE project and WP6 in particular as the starting point specific objectives are defined for each individual case to exploit the unique features of each of the different cases.

3 Specific purpose of the Action Plan

In this chapter, the questions that the outcome of the monitoring activities should answer are listed. The case holder is required to define relevant areas of interest and consider both quantitative and qualitative questions in various subsections – health and wellbeing, energy, and indoor environment. It is recommended to be very specific and concise, as it will make it easier to determine the required monitoring methods.

The intention of this chapter is to define the unique objectives and characteristics of the individual case studies and to describe the approach chosen in order to highlight the characteristics and performance of the tailor-made solutions applied to each of the demonstration cases.

4 Required parameters and information

In this chapter, the list of the parameters and data needed to be monitored to be able to answer both the defined quantitative and qualitative questions is provided.

The list for answering quantitative questions include the parameter type, the required resolution, accuracy, time steps etc. This list is based on recommendations from the work in WP3 and is created in cooperation and with input from WP3.

The list for answering qualitative questions include the actors to be involved, the number of required participants, etc. and is based on recommendations from the work in WP2 and is developed in cooperation and with input from WP2, namely based on focus group outcomes in deliverables D2.2 *Inventory of user needs and expectations* [1] and D2.3 *Recommendations for improvement and further development of solutions*. [2]

The parameters and their accompanying data that need to be monitored is listed in a table for an easier overview. The template lists many possible parameters, of which each

demonstration case can select the relevant ones for fulfilling the specific objectives of the case.

Chapters 3 and 4 are crucial in a successful planning and execution of the measurement campaign as they define the areas of interest and the associated parameters to be monitored in order to gain the information desired.

5 Behavioural Action Plan

This chapter includes the definition of the methods to provide feedback to users about their energy use and indoor environment and guiding them to change their practices.

Due to the nature of the MOBISTYLE project, different methods are applied to each case study for user feedback. For more detailed explanations of the methods established in the MOBISTYLE project, kindly refer to WP2 and WP3, namely the deliverables D3.1 *Detailed monitoring and information campaign parameters* [3] and D3.2 *Developed indicators based on environmental conditions* [4].

6 Project Evaluation Methods

This chapter includes the definition of the methods (quantitative and/or qualitative) that will be used to analyse and interpret the data obtained to get the necessary knowledge to answers the questions defined in the previous chapters as well as the key performance indicators used to characterize the building and system performance in relation to energy, indoor environment and health.

The methods and KPI's is selected in cooperation and with input from WP2 and WP3 and has, therefore, been an ongoing process. The template lists many possible parameters, of which each demonstration case can select the relevant ones for fulfilling the specific objectives of the case. D3.3 *Evaluation method to test the effectiveness of the combined feedback campaigns* [5].

This is another important component of the success of the project as the chosen and developed KPIs should bridge the gap between the building professionals and the end-users.

7 Monitoring plan

In this chapter, the quantitative and qualitative monitoring plans, including under which conditions it will be performed, the monitoring time and period, the location of the measurement points, measurement frequency, the type and number of actors involved should be established. Subsections include the preparation process, measurement procedure, data acquisition, sharing, and exchange, and the reporting format.

In this way, the case holder is providing practical and functional information in order to execute the measurement campaign. The information provided in this chapter defines the factual and feasible parameters of the individual case opportunities and characteristics.

8 Evaluation Plan

This chapter describes the plan for evaluation of the case study and the demonstrated technologies. It includes a plan for evaluating the impact or outcome of the demonstration.

This includes evaluation of the changes in energy use and in indoor environmental quality in the apartments as well as evaluation of the changes in user practices experienced as a result of user feedback, see chapter 6. It also includes a plan for evaluation of the feedback process (identifying user perception of feedback and guidance as well as possible optimization and improvements of the implemented solutions).

9 Instrumentation

In this chapter, the case holders are required to provide information regarding the appropriate instruments and sensors chosen, the data collection and communication methods, data storage devices etc. It is suggested that this should be done in cooperation and with input from WP2 and WP4. For example, deliverables D2.5 *Composition of specific sets of data acquisition for the five study and demonstration cases* [6] and D4.1 *Applicable hardware and software solutions for sensing technologies* [7] describe the existing and new sensor network, as well as the local data storage infrastructure at each demonstration case.

Moreover, the methods, software, and platform for collection of quantitative data should also be considered. This chapter is important in order to gain a practical overview of the individual case needs, instrumentation related expenses, and overall, the situation in each demonstration case, in order to implement the MOBISTYLE solutions successfully and cohesively.

10 Resources and time schedule

This chapter expands on the previous ones requiring practical information regarding the required resources and associated costs to carry out the action plan. A time schedule for implementation is also requested. Furthermore, the organizational structure and organizations that are involved in the demo-case execution are described. Lastly, the chapter also summarize the potential risks and respective risk mitigations plans at the demo site.

The goal is both to maintain an overview over all demonstration cases to ensure that the MOBISTYLE objectives are being honoured, whilst tailoring the monitoring campaign to suit each unique demo case.

11 Ethics in MOBISTYLE

This chapter provides information regarding user protection and data security policies to be respected in each demonstration case, therefore, regardless of the specific objectives of the case study, monitoring will be based on a written consent and gathered before any activities will be monitored according to Ethics requirements set in D8.1 POPD – Requirement no.1 report on Ethics in MOBISTYLE. User awareness and understanding of the nature of the

research and monitoring is essential in order for users to voluntarily decide whether or not to participate and is, thus, important to be included in the MAP.

12 References

This chapter lists any possible references and external sources used if relevant in the individual case study.

3 Development process

The elaboration of the Action Plan and subsequently, the D6.1 has been ongoing with its fair share of challenges.

Challenges related to large differences between demonstration cases

One of the immediate challenges revealed itself early in the development process as each case is uniquely different and requires an individual approach. To illustrate this, the overall MOBISTYLE objective, and the five demonstration cases are listed once more in Table 1, describing their unique focus areas and user interaction with technical systems.

Table 1: Demonstration building description, user interaction with technical systems

Case	Type	Target Area	Area/Occupancy	Technical Systems/ User interaction
Case 1 Kildeparken	Residential	18 apartments	Area: 67-130 m2, 1- 5 persons/apartment	Heating (setpoint), DHW use, window opening
Case 2 University of Ljubljana	Office	8 offices	Area: 15 - 60 m2	Solar shading, window opening, lighting, HVAC setpoints
Case 3 Hotel Residence L'Orologio	Hotel	4 hotel apartment, reception area	Area: 36-39 m2, 2-3 rooms/apartment	HVAC (setpoint), window opening, appliances
Case 4 Qeske	Office	Open plan offices	Area: 200 m2, 8 persons/office	-
Case 5 Smart City Wroclaw	Residential	1000 units	Area and persons/residence: Varying	Window opening, lighting, appliances

Another reason for the differences between the specific case objectives are due to the case and user interests and impact areas, where it is attempted to link various parameters that are motivating and relevant for the individual users, as opposed to energy parameters only. Moreover, this tailored information is expected to motivate and increase the user awareness, which helps users behave in a more energy conscious manner long-term. As a consequence, energy efficient behaviour is promoted, but the tailored approach avoids replicating generic feedback programs, which aren't successful long-term.

Challenges related to parallel development in other work packages

Another challenge proved to be the parallel development of definitions, methods, and solutions in other work packages. In many of the tasks relevant definitions, methods and solutions were being developed in parallel to the development of the action plan for the demonstrations and, thus, required both continuous communication between work packages, an iterative development approach and a clever distribution of tasks to avoid repeated work.

The work on the development of the action plan for the demonstration cases started at a workshop in Amsterdam in January 2017, where the specific objectives of each case demonstration were discussed based on identified typical user profiles and user behaviour characteristics.

This was followed up by focus group interview with selected users and continued with regular internal and external web meetings with the project participants. At the consortium meeting in Ljubljana, Slovenia in April 2017 the work on the action plan template was further advanced. As mentioned, the continuous interaction and interdisciplinary communication has been crucial for the development of the actions plans for the demonstration cases.

Another solution to these challenges was the decision to develop the action plan in multiple stages, thus, addressing the case complexity and allowing for a continuous detailing and updating as ongoing tasks in other work packages is carried out and completed. The goal is to embrace, accommodate, and facilitate an iterative process of planning and execution of the monitoring campaigns to exploit the continuous development in other work packages.

The Stage I of the MAP, presented general information and establishes the overall strategies, approaches, and plans for the measurement campaign. It included the necessary information for initiating the reference monitoring period. The Stage II of the MAP, presented in this report, consist of more detailed information regarding the specific solutions, the evaluation methods and plans for carrying out the monitoring and evaluation plans.

4 Summary of MAP for all demonstration cases

In this chapter it is summarized how each case holder is implementing MAP in their building. It is shortly described for which behavioural actions and what feedback is given to the occupants. The differences between the demonstration cases in building typology, occupancy patterns and end-user behavior, require to adjust the monitoring activities according to case specific objectives. Furthermore, the added value, relevance, innovation and impact potential of the demonstration cases is outlined. Finally, the overview regarding the timeline and deployment of ICT based solutions is presented in the last section.

Behavioural action plan

The case specific feedback on energy use, IEQ, health parameters and user behaviour are summarized in the following table.

Table 2: Behavioural action plan and feedback strategies

Case	Feedback on energy use	Feedback on IEQ	Feedback to improve Health	Feedback on user practices
Case 1 Kildeparken	Heating, DHW, (Cost)	Temperature, CO_2, RH	Indoor Air Quality	Window opening, heating setpoint, DHW
Case 2 University of Ljubljana	-	Temperature, CO_2, RH	Messages for motivation	Heating and cooling setpoint, window opening, solar shading position, use of appliances, light switching
Case 3 Hotel Residence L'Orologio	Electricity for HVAC and appliances, cost	Temperature, CO_2, RH	Indoor Air Quality	Heating and cooling setpoint, window opening, use of appliances
Case 4 Qeske	-	-	Health parameters	-
Case 5 Smart City Wroclaw	Electricity for appliances and smart plugs, cost	Temperature, RH	Indoor Air Quality	Heating setpoint, window opening, use of appliances

Case 4 Qeske building in Netherlands is the case study which differs the most from the other demonstration cases. In the first phase of the Dutch demonstration case it is tested how people perceive imposed indoor conditions physiologically (change of metabolic rate, heart rate etc.). It is assumed that lower temperatures indoors are healthier (physiological measurements) for occupants and at the same time lead to energy savings. Nevertheless, if people are educated via ICT solutions, this could change their acceptance psychologically. This could not prove if the imposed different indoor condition scenarios are actually healthier. Therefore, no feedback is provided to subjects at the first monitoring and validation period.

Nevertheless, later on (if proven physiologically) different end-users solutions can be given to users to furthermore educate them about the importance of dynamic conditions that at the same time lead to significant energy savings as also to better personal health.

Monitoring campaign – case related objectives

The overall MOBISTYLE objective is to motivate behavioural change by raising consumer awareness and by providing attractive personalized combined pro-active knowledge services on energy use, indoor environment, health and lifestyle, by ICT-based solutions. Measurable benefits raises behavioural change by the awareness of feedback loops. This awareness will support and motivate end-users to well informed proactive behaviour towards energy use and health, thus empowering consumers and providing confidence of making the right choices. The combination of awareness on energy, health and lifestyle will offer consumers more and lasting incentives than only information on energy use.

Monitoring campaign Case 1 Kildeparken, DK

The *specific case objective* is to combine information regarding IEQ (Indoor Environmental Quality) and energy in order to establish how tailoring information according to different user types helps increase awareness and leads to energy efficient behaviour change.

Monitoring campaign Case 2 University of Ljubljana, SLO

The *specific case objective* is to provide users with information regarding IEQ in order to influence their short term behaviour and change in long term habits leading towards improved IEQ and energy reduction.

Monitoring campaign Case 3 Hotels Residence L'Orologio, IT

The *specific case objective* is to monitor IEQ and electricity consumption in order to provide the hotel guests with feedback on energy use and guidance on how to save energy, use smart control of heating and lighting. This could be combined with suggestions regarding healthy daily activities and encouraging energy efficient usage of whitegoods as additional information to increase user awareness, though these are not directly measured.

Monitoring campaign Case 4 Qeske, NL

The *specific case objective* is to establish a correlation between different indoor environment situations (dynamic temperature profile in comparison to traditional constant temperature setting) affect occupant's health (physiological) response and also how occupants perceive such conditions (psychological). Moreover, to support the main MOBISTYLE objective, an investigation of whether lowered indoor temperatures in the winter season could lead to not only energy savings, but also improved wellbeing, will be conducted.

Monitoring campaign Case 5 Smart City Wroclaw, PL

The *specific case objective* is to monitor the electricity consumption of users and motivate their behaviour change towards more energy efficient building usage by giving users attractive

information about their daily activity (healthy tips), IEQ and energy (recommendations for actions and measured data).

Moreover, the goal is to obtain real household profiles mapping internal needs of customers to understand and communicate potential benefits for both parties – the service providers and building owners.

The goal is also to observe daily activities of the residents combining information regarding lifestyle and energy consumption as this is the difference of MOBISTYLE in comparison to the existing projects only concentrating on providing info solely about energy.

Demonstration case specific objectives are summarized in the Table 3**.**

Table 3: Demo-case specific objectives related to energy, IEQ, health and user behaviour

Case	Reduce energy use	Improve IEQ	Improve Health	User practices
Case 1 Kildeparken	Heating, DHW	Reduce overheating, improve IEQ	By improving IAQ (better sleeping quality at night)	Optimize heating setpoint adjustments, window opening strategy, DHW use
Case 2 University of Ljubljana	Indirectly, energy use reduction estimated	Reduce overheating, avoid glare, improve IEQ, lighting quality, view to outside	By providing motivation	Improve user interaction with building systems
Case 3 Orologio Living Apartments	Electricity for HVAC and appliances	Reduce overheating, improve IEQ	By improve the sense of wellbeing in relation to indoor environment	Optimize fan- coil setpoints and window opening strategy, use appliances and electric devices
Case 4 Qeske	Indirectly, energy use reduction estimated as a results of reduced heating setpoints		By exposing occupants to different temperature conditions	Investigate response and perceived acceptability of varying temperatures
Case 5 Smart City Wroclaw	Electricity for appliances and plug loads	Reduce overheating, reduce humidity levels	By improving IAQ (better sleeping quality at night)	Optimize HVAC setpoint adjustments, window opening strategy

Added value, innovation, relevance and impact potential of each demonstration case

Justification of added value

Even though there are two demonstration cases with residential households, two cases with office environment and one case with hotel environment, each of the demo-case has its own added value to the MOBISTYLE project.

Looking closer at the residential pilot sites, the Danish case in Kildeparken residential housing area, mainly focuses on improving the heating use and IEQ quality. Meanwhile, in the Polish demonstration case the focus is set more on the electricity use and smart plugs. Furthermore, the use of appliances like Whirlpool smart washing machines is tested only in the Polish demonstration buildings. Also from upscaling perspective Smart City Wroclaw will have the highest impact potential as it is planned to extend the testbed up to 1000 households.

Furthermore, it can be said that Italian demonstration case presents a similar environment to residential buildings but with less or no ownership feeling from the user side, therefore it is a great challenge to make hotel guests more aware of their actions. Also, from all the pilot sites Orologio Living Apartments will be the demo-case with the most warm summer period with actively used mechanical cooling system.

Similarly, users working in office environment are less concerned about their energy use. Therefore, including office buildings adds value to the project. In Slovenian case, University of Ljubljana, buildings have a single-cell room layout, whereas the Qeske building in Netherlands has more like an open plan layout. Furthermore, Qeske office building is the most unique demonstration case as it will test user perception to the varying indoor temperature profiles, whereas in University of Ljubljana the air temperature is controlled and kept at more constant level according to the traditional constant temperature setting. Additionally, only employees in Qeske building will wear health and activity monitoring equipment like Fitbit wristbands.

Innovation

In the market the existing ICT-based solutions that are used to represent indoor climate and energy use mostly offer visualization of the data without a relevant feedback. MOBISTYLE ICT-solutions (Game and Dashboard) will provide not only feedback on the current conditions, but also information on how to improve the situation. This will be done via notifications in the Dashboard App and various missions in the Game App.

Relevance

While in building industry the implementation of smart building energy meters is already in a process, the same can’t be said about indoor climate metering devices. A partly conclusion is that it could be a barrier to scale-up mainly due to extra cost of installing IEQ monitoring devices. How to solve this? This is a topic to be addressed in future.

Impact potential

Apart from the reduction of energy and improving IEQ and Health, the MOBISTYLE project can increase interest among participating building owners via improved management of the technical systems. Additional information about the user interaction with technical systems and overview of the existing conditions. Thus the building owners can get more knowledge about how the systems are performing.

Deployment of ICT solutions

In MOBISTYLE there are two Information and Communications Technology (ICT) solutions implemented in order to achieve the MOBISTYLE goal to reduce energy consumption by 16% and improve Indoor Environmental Quality (IEQ) and health aspects in the demonstration buildings. These ICT-solutions are GAME and DASHBOARD, developed by Highskillz (HS) and Holonix (HLX) respectively. The overview for each demonstration case is presented in the following table.

Table 4: ICT-solution distribution across demonstration cases

Case	ICT - solution	Comments
Case 1 Kildeparken	GAME	Gamification of the IEQ parameters, heating energy use and water consumption
Case 2 University of Ljubljana	DASHBOARD	Visualization of IEQ parameters
Case 3 Hotel Residence L'Orologio	DASHBOARD	Visualization of IEQ parameters, Electricity for HVAC and appliances, cost
Case 4 Qeske	-	Experimental case study
Case 5 Smart City Wroclaw	GAME	Gamification of the IEQ parameters, electricity use and smart plugs, Whirlpool smart washing machines

DASHBOARD is implemented in the Case 2 University of Ljubljana and Case 3 Hotel Residence L'Orologio where it will visualize current IEQ parameters in the room and motivate user to improve these conditions if necessary. It will be available in a desktop version and in a mobile app version for both - building managers and occupants.

MOBISTYLE GAME solution is only implemented in the residential demonstration cases in Poland and Denmark, Case 1 Kildeparken and Case 5 Smart City Wroclaw, respectively. The reasoning behind different ICT solutions for different case buildings is based on the different use of each building. As the end-users in residential buildings are staying in their home for a long-term, therefore the GAME solution at first is implemented only in these case studies.

MOBISTYLE GAME will include mission achieving interaction to alternate user behaviors towards energy efficient behavior. GAME app is relying to provide feedback to the user and their practices on the basis of sensor data available in the households.

Implementation of ICT solutions

Due to the fact that ICT solutions are developed by two companies separately, there are slightly different timelines for demonstration cases where GAME or DASHBOARD is deployed.

Both residential cases (Case1 and Case 5) have the following proposed timeline for implementing GAME solution, monitoring and evaluation

Table 5: Timeline for GAME App implementation, monitoring and evaluation periods

June 2017 – May 2018	June 2018 – August 2018	September 2018 – February 2019	March 2019 - January 2020
M13 – M20	M21 – M23	M24 – M29	M30 - M40
	M21 GAME Mock-up (18+20)	M24 GAME Prototype I (18-20) M27 GAME Prototype II (18+100)	M30 Final GAME(18+1000)
Reference monitoring	Initial monitoring	Feedback monitoring	Impact monitoring
Checking existing conditions	Check if equipment works, initial user feedback and observations	Performance evaluation, identification of possible improvement to strategies developed based on data extracted and user feedback received	Assessing the project results
Benchmark evaluation	Initial evaluation	Feedback evaluation	Final impact evaluation
Define reference performance in relation to energy use and indoor environmental quality in M20	Analyze data in M23	Analyze data in M26 and M29	Final data extraction and analysis in M40

GAME implementation process will include the following steps. Firstly, presentation of the mock-up version (web version) of the GAME in summer 2018 to the housing associations and case holder representatives. Secondly, Prototype I and Prototype II version as a mobile application will be made. This development process will include the usability testing of the Prototype versions. Usability testing workshops will be made in collaboration with Ljubljana University (IRI-UL) which are responsible for Task 2.5 Usability testing. And lastly, the final mobile application in month 30 will be available to the building tenants.

Parallel with the implementation of the GAME solution, the data for IEQ and energy use will be monitored and evaluated. This includes Reference, Initial, Feedback and Impact monitoring periods, which correspond to the previously described GAME app development process. This data analysis will be the basis to evaluate the MOBISTYLE impact on the user behavior.

For the demonstration Case 2 University of Ljubljana with DASHBOARD as selected ICT – solution the proposed timeline is the following table:

Table 6: Timeline for Dashboard App implementation, monitoring and evaluation periods in University of Ljubljana

June 2017 – May 2018	June 2018 – August 2018	September 2018 – February 2019	March 2019 - January 2020
M13 – M20	M21 – M23	M24 – M29	M30 - M40
	M21 DASHBOARD Prototype I (Desktop version)	M24 DASHBOARD Prototype II (Mobile App)	Final (Mobile App)
Reference monitoring	Initial monitoring	Feedback monitoring	Impact monitoring
Checking existing conditions	Check if equipment works, initial user feedback and observations	Performance evaluation, identification of possible improvement to strategies developed based on data extracted and user feedback received	Assessing the project results
	Benchmark evaluation	Intermediate evaluation	Final impact evaluation
	Define reference performance in relation to energy use and indoor environmental quality in M24-M25	Evaluation at the end of the first step of monitoring the feedback Analyze data in M31 – M32	Final data extraction and analysis in M40

For the Case 3 Hotel Residence L'Orologio the DASHBOARD implementation timeline is:

Table 7: Timeline for DASHBOARD App implementation, monitoring and evaluation periods in Hotel Residence L'Orologio

April 2017 – October 2018	November 2018 – May 2019	June 2019 - January 2020
M19 – M25	M26 – M32	M33 - M40
Prototype desktop dashboard M21 Prototype App dashboard M24		Final App
Reference monitoring	Initial monitoring	Impact monitoring
Checking existing conditions	Check if equipment works, initial user feedback and observations	Performance evaluation and continuous data collection, possible improvement to strategies developed based on data extracted and user feedback received
Benchmark evaluation	Intermediate evaluation	Final impact evaluation
Define reference performance in relation to energy use and indoor environmental quality in M20	Preliminary evaluation of perception of feedback, impact on performance and changes in user practices. Analyze data in M31-M32	Assessing the project results. Final data extraction and analysis in M40

Parallel with the implementation of the DASHBOARD solution, the data for IEQ and energy use will be monitored and evaluated. This includes Reference, Initial and Impact monitoring periods. This data analysis will be the basis to evaluate the MOBISTYLE impact on the changes in user practices during the different phases of the MOBISTYLE project.

5. References

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6. Appendices

The appendices present the developed Action Plan Template and the Monitoring Action Plan (MAP) for each individual demonstration case.

Appendix 1 MAP template

Demonstration Case "XXX"

1 Short description

(Describe the building and characteristics of target areas for the demonstration. Characteristics include room type, layout, usage, occupancy, constructions and technical systems, location of sensors, ,…)

1.1 Construction

1.2 Technical systems

1.3 Target areas (type, usage, occupancy, sensors)

1.4 Technical coordinator

2 Demonstration vision and objective

(Describe the vision and the specific objectives of the action plan. Starting point will be the vision and objectives of WP6 adapted to the specific case)

The vision of the Action plan is to demonstrate a sustainable behavioural change towards a significant reduction of energy use in a real environment by deploying and validating the developed solutions and services. These will be tailor-made and monitored for the selective demonstration case for a specific building type, in a specific climatic region, and with different end-users.

The objective is to validate the approach, tools, and services applied in terms of reduction in energy use and increase in indoor environment quality through user feedback and data analysis.

3 Specific purpose of the Action plan

(Define the questions that the outcome of the monitoring activities in the action plan should answer. Both quantitative and qualitative questions should be considered. It is recommended to be very specific and concise, as it will make it easier to determine the required monitoring methods)

3.1 Conditions overview

3.2 Health and wellbeing

3.3 Energy consumption

In this project, the type of energy or resources that will be treated, are the following:

- Thermal energy **(TE)** connected to heating and/or cooling systems
- Primary energies used inside the buildings **(PE) (Remark:** not relevant for the users (don't use for feedback, but for calculations and analysis)
- Cold water **(CW)**
- Domestic hot water **(HW)**
- Electric energy **(EE)**

Energy type or resource	Question	Parameter	Observation method	KPI (Key Performance Indicators)
(TE), (EE)	What is the [type of energy/resource] consumption of the devices inside the rooms? (at least those with high usage and/or high power cons.)	[type of energy/ resource] consumption	Directly measured	
(TE), (EE)	What is the [type of energy/resource] consumption of the room?	[type of energy/ resource] consumption	Directly measured	
ALL	What is the [type of energy/resource] consumption of the whole apartment/zone?	[type of energy/ resource] consumption	Directly measured	
ALL	How is [type of energy/resource] consumption in comparison to another rooms/apartments/zone?	[type of energy/ resource] consumption	Indirectly measured	
ALL	What is the [type of energy/resource] consumption during the reference measurement period? Is it well above average?	[type of energy/ resource] consumption	Indirectly measured	
(TE), (PE), (HW), (EE)	How much carbon dioxide (CO2) is produced per unit of [type of energy/resource] consumed?	CO2 emission/ [type of energy/ resource] consumption	Indirectly measured	

3.4 Thermal comfort & Indoor environment quality

Question	Parameter	Observation method	KPI
Is the comfortable operative temperature in a room/residential unit within a reasonable range?	Operative temperature/Outdoor temperature	Directly measured User perception	
Is the ventilation sufficient in a room/residential unit?	CO_2 level	Directly measured User perception	
Is the humidity in a room/residential unit within a reasonable range?	Relative Humidity	Directly measured User perception	

3.5 Outdoor conditions

Question	Parameter	Observation method
What is the current situation of the weather?	Outside Temperature, Relative Humidity, Solar radiation, Wind (speed and direction)	Directly measured
What was the weather situation in the previous days/last night?	Outside Temperature, Relative Humidity, Solar radiation, Wind (speed and direction)	Directly measured
How will the weather be?	Outside Temperature, Relative Humidity, Solar radiation, Wind (speed and direction)	Indirectly measured (forecast algorithm or data from the network)

3.6 Occupant's behaviour ("What we want to know")

To understand the mechanisms of occupants' behaviours there is the need to monitor the behaviour itself but also to determine the cause and effect relationships that behaviours have with energy consumption, indoor and outdoor environment, and the occupants' health status. This point is one of the main challenges of this project. In other words, it is possible, by cross-referencing the data, to understand every condition or variation correlated to some specific behaviour. This "knowledge" is very important for the project goals, because it permits to generate tailor-suited feedback for the users.

The types of behaviour important for the analysis can be listed here below:

- Occupancy
- Thermostat adjustment or any user interaction with the heating/cooling system
- Windows opening
- Whitegoods and general electrical devices
- Curtains or any type of solar shading
- Door opening
- Lighting switching and adjustment
- Ventilation adjustment (when HVAC system are not fully automatic)

What is important to know about every type of behaviour can be summarized in the table below, applying the several questions contained inside the table at each type of behaviour. The consequences will be treated in a detailed way in the next section analysing every behaviour individually (3.2.1).

What we want to know about behaviours (Generic behaviour)				
	Question	**Parameter**	**Data sources**	**Observation method**
CHARACTERISTIC AND CAUSES	What are the characteristics of the behaviour?	When did the behaviour occur? How long?	• Device/object state	Directly measured
		How did the users set up the device? (if regulations are permitted)	• Device/object state	Directly measured
		Who did it? Who affects?	• Occupancy • User tracking	Indirectly measured
	What drivers and motivators influence user behaviour?	Are there recurring moments during the day?	• Device/object state	Indirectly measured (statistical analysis)
		Was there any IEQ/outside parameters that were critical before the "behaviour"?	• IEQ sensors • Outside condition	Directly measured
		How people that can be affected felt before the behaviour?	• Blood pressure	Directly measured
			• Heart rate	Directly measured
			• General sense of wellbeing	User perception
			• Sense of control over one's surroundings	User perception
CONSEQUENCES	What effects do user behaviour have on energy consumption, indoor environment and health?	Does behaviour lead to increased energy consumption?	• Indoor-outdoor temperature difference • Heating/cooling devices energy consumptions • Electric energy consumption • Solar radiation	Indirectly measured: -simple analysis to evaluate if the impact on energy consumption can be good or bad; -more complex analysis to do a quantitative evaluation.
		Did behaviour lead some IEQ parameters outside the reasonable range?	• IEQ sensors	Directly measured
		Did behaviour lead to an improvement of the users' health conditions?	• Blood pressure	Directly measured
			• Heart rate	Directly measured
			• General sense of wellbeing	User perception
	Final evaluations	How "bad" is the behaviour for energy consumption?	• Frequency • Duration • Intensity	Indirectly measured
		How "bad" is the behaviour for users' health?	• Frequency • Duration • Intensity	Indirectly measured

4. Required parameters and information

(Make a list of the parameters/data that needs to be monitored for quantitative answers to defined questions. The list should include parameter type, required resolution and accuracy, time steps, … This should be done in cooperation and with input from WP3) The parameters and their accompanying data that need to be monitored could be listed in a table (incl. outdoor measurements).

(Make a plan for obtaining required data/information for qualitative answers to defined questions. This should include requirements to actors involved, number of participants, …. This should be done in cooperation and with input from WP2)

The parameters and their accompanying data that need to be monitored are listed in the table below.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Units/Other/Notes
Primary energy consumption (EP)	Energy use					kWh/year kWh/m^{2}year kWh/m^{3}year
Emission of $CO_{2,equivalent}$	Energy use					$kgCO_{2,equivalent}$/year $kgCO_{2,equivalent}$/m^{2}year $kgCO_{2,equivalent}$/m^{3}year
Electricity consumption	Energy use					kWh_{el}/year kWh_{el}/m^2 year kWh_{el}/m^3 year
Costs for electricity consumption	Energy use					€/year
Electricity use ratio (EEUR)	Energy use					$kW_{el,used}/kW_{el,installed}$ (%)
Normalized electricity use to occupant number	Energy use					kWh_{el}/occ
Natural gas consumption	Energy use					kWh_{ng}/year kWh_{ng}/m^2 year kWh_{ng}/m^3 year kWh_{ng}/m^2(HDD) year
Costs for natural gas consumption	Energy use					€/year
Normalized natural gas use to occupant number	Energy use					kWh_{ng}/occ
District heating consumption	Energy use					kWh_{dh}/year kWh_{dh}/m^2 year kWh_{dh}/m^3 year kWh_{dh}/m^2(HDD) year
Costs for district heating consumption	Energy use					€/year
Normalized district heating use to occupant number	Energy use					kWh_{dh}/occ

District cooling consumption	Energy use					kWh_{dc}/year kWh_{dc}/m^2 year kWh_{dc}/m^3 year kWh_{dc}/m^2(CDD) year
Costs for district cooling consumption	Energy use					€/year
Normalized district cooling use to occupant number	Energy use					kWh_{dc}/occ
Domestic water use	Energy use					m^3/year or l/year
Specific domestic water use	Energy use					m^3/m^2 year m^3/m^3 year m^3/occ
Costs for domestic water use	Energy use					€/year
Operative temperature	IEQ	0.1°C	±5 %	15 min		°C
PMV	IEQ					-3; +3
PPD	IEQ					%
Thermal comfort category	IEQ					I-IV (Mechanically cooled)
Thermal comfort category (adaptive approach)	IEQ					I - III (Adaptive)
Draught rate	IEQ					%
POR	IEQ					
PD	IEQ					%
Indoor air quality category (human perception)	IEQ					I-IV
Level of CO_2	IEQ		±5 %	15 min		ppm
Ventilation air flow	IEQ		±5 %	15 min?		l/s
Level of relative humidity	IEQ		±5 %	15 min		%
Indoor air quality category (humidity)	IEQ					I-IV
POR	IEQ					%
Maintained luminance (general and task lighting)	Visual comfort					lx
UGR (Unified Glare Rating)	Visual comfort					
Ra (Colour rendering index)	Visual comfort					

Daylight distribution – optional	Visual comfort					
Blood pressure	Health & wellbeing					mmHg
Heart rate	Health & wellbeing					beats/min
Core temperature	Health & wellbeing					°C
Skin temperature	Health & wellbeing					°C
Thermostat adjustments	User behavior					
Window opening	User behavior			A new action		
Door opening	User behavior					
Mechanical ventilation (manual setting)	User behavior					
Solar shading	User behavior					
White goods	User behavior					
Light switching	User behavior					
Occupancy	User behavior					
Solar radiation						

Parameter	User requirements	Actor requirements	Number of participants	Data extracted	Other/Notes
Technology acceptance	App downloads, technology use, daily habits	Interviews, observation and monitoring			
Personal health and sense of wellbeing	Personal monitoring and logging, Data recording	Questionnaires, data collection, data analyses		Change in sleep quality, energy levels, personal perception of a high quality of life	
Perception of environment (IEQ)					
Sense of control over one's surroundings					
Impact					Change in behavior

5 Behavioral action plan

(Define methods to provide feedback to users about their energy use and indoor environment and guiding them to change their practices)

5.1 Feedback for end users about energy use and indoor environment

5.2 Feedback for end users guiding them to changing their practices

5.3 Information for calculation/selection of feedback to users

6 Project evaluation methods

(Define the methods (quantitative and/or qualitative) that will be used to analyze/interpret the data obtained to get the necessary information that answers the questions defined. This should be in cooperation and with input from WP2 and WP3, refer to D3.1 specifically.)

6.1 Evaluation of energy use and indoor environment

6.2 Evaluation of the change in user practices as a result of user feedback

6.3 Evaluation of the use of the MOBISTYLE solution and user perception of feedback and guidance

6.4 Information for calculation of Key Performance Indicators (KPI)

7 Monitoring plan

(Define the quantitative monitoring plan including under which condition it will be performed, monitoring time and period, location of measurement points, measurement frequency, ….)
(Define the qualitative monitoring plan including the type and number of actors to be involved, the frequency of 0, 2, 6 and 12 months, ….)

7.1 The measurement campaign preparation process

7.2 Description of the measurement procedure

7.3 Data acquisition

7.4 Data sharing and exchange

7.5 Reporting format

The final monitoring report will be the revised Action Plan and shall contain the following information:

- A description of the equipment used and their location within the monitoring site.
- An identification of the specific equipment configuration under the measurement process as described in the XXX.
- A description of the measurement site and the ambient conditions.
- Identification of the sensors and data acquisition system, including documentation of calibrations for the sensor's transmission lines, and data acquisition system.
- A description of the method of data acquisition, storing, and analysis as described in Section 5 KPI analysis and interpretation methods of this Action Plan.
- A description of the measurement procedure as described in XXX.
- Presentation of measured data as described in XXX.

8 Evaluation plan

(Describe the plan for evaluation of the case study and the demonstrated technologies. It should include a plan for evaluating the changes in energy use and in indoor environmental quality in the apartments, the changes in user practices experienced and the user perception of feedback and guidance from the developed solutions).

9 Instrumentation

(Choose appropriate instruments and sensors, data collection and communication methods, data storage devices, …. This should be in cooperation and with input from WP2 and WP4)
(Choose methods/software/platform for collection of qualitative data.)

For a complete list, when known, develop a bullet point or a table – based on either each room (apartment by apartment), parameter by parameter, or concept by concept.

10 Resources and Time Schedule

(Describe the required resources and associated cost to carry out the action plan. Prepare a time schedule for implementation.)
The table below summarizes the required resources to carry out the action plan in terms of costs, time, and hours of labour.

10.1 Overview

Execution of the monitoring campaign				
Task	**Time period**	**Hours of labour needed**	**Associated costs**	**Notes**
Equipment purchase, calibration, and installation	M12			
Quantitative data collection	M13 – M42			
Qualitative data collection	M1 – M42			
Equipment maintenance and repair	M13 – M42			
Equipment removal and dismounting	M43			
Data extraction and handling	M13 – M42 Check ins M14 M18 M24 M36			
	Total:			

10.2 Detailed time plan

Gantt chart per month or period of time or all MOBISTYLE project.
Information regarding the specifics on cost, procedure and time estimations.

10.3 Organizational structure

Description of how the monitoring process at the demonstration case is managed, including the list of persons involved in the MOBISTYLE process with the contact information.

10.4 Review of the possible risks

Mention the possible risks that can occur during the implementation process of ICT solutions.

11 Ethics in MOBISTYLE

Monitoring will be based on Informed Consent, that is, written consent will be gathered before any activities will be monitored according to Ethics requirements set in D81.1 POPD – Requirement no.1 report on Ethics in MOBISTYLE. The users participating in the study will have freedom to choose which health related parameters they want to monitor and therefore share, when and how long. Guidance will be provided in order to clarify what and why the data is collected.

Informed consent is one of the primary ethical requirements underpinning research with human subjects and is an ongoing process (especially with data acquisition subject to continuous change). The forms presented in table below just show examples. However, once it will be defined precisely what kind of activities will be done having involvement/concerning users, this informed consent document will be updated and revised. This document will include as much detailed description of activities as possible so the subjects will understand and know what they are signing.

The purpose of informed consent is to ensure prospective subjects will understand the nature of the research and monitoring and can voluntarily decide whether or not to participate. MOBISTYLE's interpretation of the EC H2020 guide 'How to complete your ethics Self-Assessment' is that when the study involves research involving participants.

1. An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures, and identification of any procedures which are experimental;
2. A description of any reasonable risks or discomforts;
3. A description of any benefits to the subject or to others;
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
6. For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;
7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject;
8. A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Following forms are examples of Informed Consent Statement Example for Surveys which can be used in:

Monitoring in a health care institution azM Herstelzorg at St. Pieterstraat

Informed Consent for participating in scientific research:

"MOBISTYLE"

I have been informed about the research. I have read the written information. I have received the opportunity to ask questions. I have received the opportunity to consider my participation to the research. I have the right to withdraw my consent at any time, without giving a specific reason.

I consent with participating in the research and give permission to use the data as described in the information letter.

I wish to/not to (please circle choice) be informed on the research outcome.

I give permission to save the data up to 5 years after the research has finished.

I wish to/not to (please circle choice) be contacted for further research.

Name _____
Date of birth _____

Date Signature

Signee, responsible researcher, declares that the abovementioned person has been informed about the research both orally and by written text.

Name _____
Function _____
Date Signature

Model 2:

"You have been invited to participate in this survey based on _____**.** I would greatly appreciate your participation in a short **(**_____**)** minute survey about _____**.**

General Information
The information on this page is intended to help you understand exactly what I am asking of you so that you can decide whether or not you would like to participate in this study. Please read this consent form carefully before you decide to proceed with the survey. If you decide to not participate, it will not be held against you in any way. You may exit out of the survey at any time.

Privacy and confidentiality
Your participation in this survey is completely voluntary, and your responses will not be shared with your employers. Your answers will be kept confidential and your identity protected. All data will be transmitted by a secure, encrypted internet connection and stored in a password protected file. The ****insert university/institution here**** Office of Research Assurances has determined that this study satisfies the criteria for ****insert applicable national or EU legislation****

Potential harms / benefits
There are no known harms associated with your participation in this research ***(if there are potential harms, state them here). *State how they will or will not benefit from participation****

If you agree to the terms listed above, please proceed to the survey ***(*if they click onto the next page, that serves as their informed consent*).*** Thank you in advance for your time and cooperation. Please be honest with your answers. Your responses are extremely valuable to our research! If you have any questions, please do not hesitate to ask.

Thank you,
Contact information here

12 References

Add references if it is relevant to the MAP of the demonstration case.

Appendix 2 Kildeparken, DK MAP

Demonstration Case “Kildeparken”

1 Short description

Kildeparken, a complex of residential buildings, serves as the Danish demonstration case. For more information regarding the buildings, refer to its Case Description. In the following document, the specifics regarding the measurement campaign at Kildeparken will be described.

1.1 Construction

The existing construction prior to the renovations was based on a column/beam structure with concrete slabs. The concrete sandwich elements in the façade have been replaced with new facades consisting of an insulating wooden cassette with different types of rain screen (brick wall, wood, or zinc with ventilated cavity between the cassette and the rain screen).
A new roof construction with new insulation is constructed. Internally, the new floors, kitchen and bath as well as new heating, water, sanitary and electric systems are installed.

1.2 Technical systems

Heating is delivered by a district heating company. Each apartment block has one direct connection to the district heating grid and heating is distributed to each apartment within the block. A weather compensated supply water temperature is used. Floor heating is used in hallways and bathrooms. Other rooms are equipped with radiators. Both are controlled by the user. DHW is produced through a heat exchanger in each block and distributed to each apartment.
Mechanical exhaust in kitchens and bathrooms. Constant airflow rate, adjusted in the kitchen exhaust hood. Fresh air supply through window vents. Manual window opening for cooling and extra ventilation.

1.3 Target areas (Type, usage, occupancy)

The demonstration will be carried out in approximately 19 apartments. These are selected among the already renovated apartments at Kildeparken area, which have undergone NZEB standard renovations. 2-4 rooms (living room and bedrooms specifically) per apartment will be observed. Thus, the Action plan target areas include habitable spaces with a standard domestic usage and occupancy of 168 hours/week. However, user profiles and their daily routines vary.

There are 24 different residential unit types at Blåkildevej varying from 67 – 130 m^2 and the demonstration will include 14 of these. Some apartments of different types and sizes is selected for presentation in this action plan and plan drawings is used to indicate the types and locations of various equipment installed and linked to several parameters of interest, as described in the Action Plan.

In all apartments, measurements regarding energy consumption and indoor environmental quality (IAQ) will be monitored, specifically, operative temperature, CO_2, relative humidity, and consumption regarding cold and domestic hot water and heating energy, as well as additional parameters like window opening and presence.

Below, examples of some of the apartment types – a floor plan indicating the room types, expected apartment sizes and their layout and position of sensors. The star indicates sensors for operative temperature, CO_2, relative humidity and window opening is installed in the space.

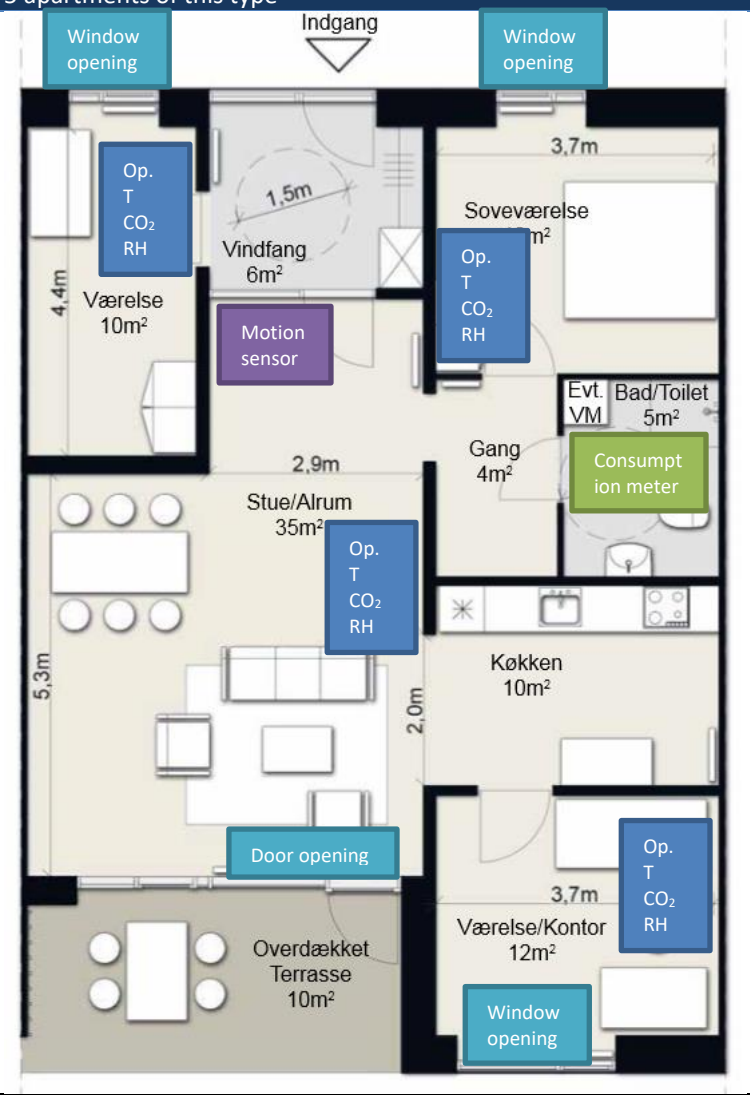
Figure 1 Kildeparken housing area, Aalborg, Denmark

Apartment	Type C1 /Type C3, 111 m2, 4 rooms, with a balcony 1 apartment of this type

Indgang – Entrance
Værelse – Bedroom
Vindfang – Wind catcher
Soveværelse – Master bedroom
Køkken – Kitchen
Alrum – Dining room
Gang – Corridor
Bad/Toilet – Bathroom/WC
Stue – Living room
Værelse/kontor – Bedroom/office
Altan - balcony

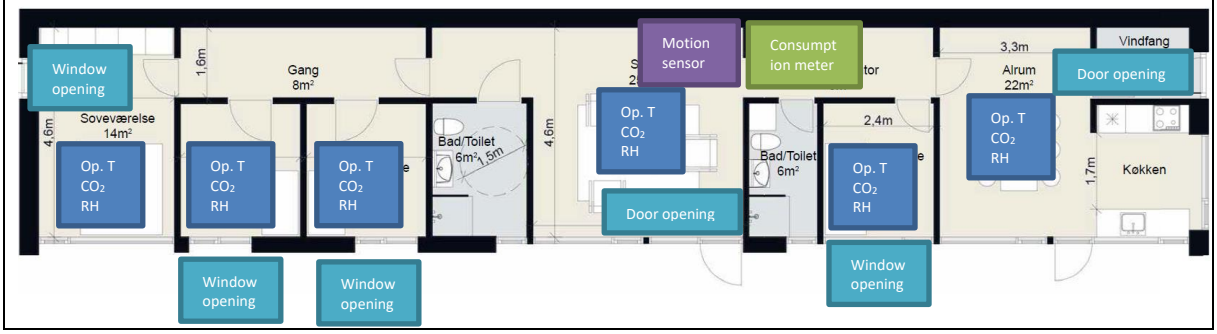
Apartment	Type C11, 91 m2, 4 rooms, with a balcony 2 apartments of this type

Altan - balcony
Soveværelse – Master bedroom
Stue/Alrum – Living/Dining room
Værelse – Bedroom
Køkken – Kitchen
Bad/Toilet – Bathroom/WC
Gang – Corridor
Forrum – Entrance room
Vindfang – Wind catcher
Indgang – Entrance

Apartment	Type D2 Stor, 111 m2, 4 rooms, with a terrace 5 apartments of this type
Altan - balcony Soveværelse – Master bedroom Stue/Alrum – Living/Dining room Værelse – Bedroom Køkken – Kitchen Bad/Toilet – Bathroom/WC Gang – Corridor Forrum – Entrance room Vindfang – Wind catcher Indgang – Entrance Overdækket Terrasse – Covered terrase	

Apartment	Type G4, 130 m2, 5 rooms, level free access 1 apartment of this type

Soveværelse – Master bedroom
Gang – Corridor
Værelse – Bedroom
Bad/Toilet – Bathroom/WC
Stue – Living room
Galleri/Kontor – Gallery/Office
Alrum – Dining room
Vindfang – Wind catcher
Køkken – Kitchen



Apartment	Type G5, 130 m2, 5 rooms, level free access 1 apartment of this type

Soveværelse – Master bedroomi/Kontor – Gallery/Office
Værelse – Bedroom
Bad/Toilet – Bathroom/WC
Gang – Corridor
Værelse – Bedroom
Bad/Toilet – Bathroom/WC
Vindfang – Wind catcher
Stue/Alrum – Living/Dining room
Køkken – Kitchen

2 Demonstration vision and objective

The vision of the Action plan is to demonstrate a sustainable behavioral change towards a significant reduction of energy use in a real environment by deploying and validating the developed solutions and services. These will be tailor-made and monitored for the selective demonstration case for a specific building type, in a specific climatic region, and with different end-users.
The objective is to validate the approach, tools, and services applied in terms of reduction in energy use and increase in indoor environment quality through user feedback and data analysis.

3 Specific purpose of the Action plan

The purpose of the Action plan is to illustrate and demonstrate the approach and methodologies used. From there, the developed and derived ICT tools and services can be assed. According to the Case Description, the demonstration will furthermore aim to provide answers to the following questions:

- What drivers and motivators influence user behaviour?
- What effects do user behaviour have on energy consumption and indoor environment?
- Which methods and approaches create awareness and a substantial behavioural change in users?
- What is the frequency and intensity of use of the personal apps and tools, monitored, and registered at the start, after 2 months, 6 months, and 12 months of implementation?
- Which specific campaigns and validations were necessary during the project?
- What basic monitoring and information campaign should be continued after the project duration? Which parameters should be monitored, how should the information be presented, and what are the aims of a continuous campaign?
- How would a list of further recommendations, based on the results obtained, look after the project is completed? How could “soft measures” be considered in future energy performance regulations?

Below, more specific questions, categorized in various focus areas, are listed.

3.1 Conditions overview

To increase the users’ knowledge and awareness about what is happening inside the apartment/building, it is important to collect data on the environment (indoor and outdoor) and on the health of the occupants that does not necessarily refer to a specific type of behaviour. This way people can use the app/web site to have access to useful information about the weather, IEQ, energy consumption or health.

3.2 Health and wellbeing

Health or its improvement will not be monitored in the Danish demonstration case. Feedback will be used as a motivation to stimulate user's actions, prompting exercise, encouraging lower indoor temperatures and similar.

3.3 Energy consumption

In this project, the type of energy or resources that will be treated, are the following:

- Thermal energy **(TE)** connected to the heating system
- Cold water **(CW)**
- Domestic hot water **(HW)**
- Electric energy **(EE)**

Energy type or resource	Question	Parameter	Observation method	KPI
(TE)	What is the heating consumption of the radiators and floor heating inside the apartment unit?	Heating consumption	Directly measured	kWh/m^2/year
(TE)	What is the domestic hot water consumption of the apartment unit?	DHW consumption	Directly measured	kWh/m^2/year
(EE)	What is the electricity consumption of the apartment unit?	Electricity	Directly measured	kWh/m^2/year
ALL	What is the energy consumption during the monitoring period compared to the reference measurement period?	Heating, DHW, Electricity	Indirectly measured	
ALL	How is the energy consumption in comparison to another apartments during the monitoring period?	Heating, DHW, Electricity	Indirectly measured	

3.4 Thermal comfort & Indoor environment quality

Question	Parameter	Observation method	KPI
Is the comfortable operative temperature in a room/residential unit within a reasonable range in relation to energy efficiency?	Operative temperature/Outdoor temperature	Directly measured User perception	
Is the comfortable operative temperature in a room/residential unit within a reasonable range in relation to the user health and wellbeing?	Operative temperature/Outdoor temperature	Directly measured User perception	
Is the ventilation sufficient in a room/residential unit in relation to comfort?	CO_2 level	Directly measured User perception	
Is the humidity in a room/residential unit within a reasonable range?	Relative Humidity	Directly measured User perception	
What is the IEQ during the monitoring period compared to the reference measurement period?	Operative temperature, CO_2, Relative Humidity	Indirectly measured User perception	

3.5 Outdoor conditions

Question	Parameter	Observation method
What is the current situation of the weather?	Outside Temperature, Relative Humidity, Solar radiation, Wind (speed and direction)	Directly measured/Weather station
How will the weather be?	Outside Temperature, Relative Humidity, Solar radiation, Wind (speed and direction)	Indirectly measured/Data from the network

3.6 Occupant's behaviour ("What we want to know")

To understand the mechanisms of occupants' behaviours there is the need to monitor the behaviour itself but also to determine the cause and effect relationships that behaviours have with energy consumption, indoor and outdoor environment, and the occupants' health status. This point is one of the main challenges of this project. In other words, it is possible, by cross-referencing the data, to understand every condition or variation correlated to some specific behaviour. This "knowledge" is very important for the project goals, because it permits to generate tailor-suited feedback for the users.
The types of behaviour important for the analysis can be listed here below:

- Occupancy
- Thermostat adjustment
- Windows opening
- Ventilation adjustment

What is important to know about every type of behaviour can be summarized in the table below, applying the several questions contained inside the table at each type of behaviour. The consequences will be treated in a detailed way in the next section analysing every behaviour individually (3.2.1).

What we want to know about behaviours (Generic behaviour)				
			Data sources	Observation method
CHARACTERISTIC AND CAUSES	What are the characteristics of the behaviour?	When did the behaviour occur? How long?	• Device/object state	Directly measured
	When are users present in the apartment?	What is the typical user profile?	• Occupancy • User perception	Directly measured
	What is the heating set point in the apartment unit?	Does the set point change in time? Are set points the same in all the rooms observed?	• Operative temperature • Heating consumption • User perception	Indirectly measured
	What is the window opening behavior of the users in the apartment?	When and for how long is the window open? Why do users open the window? Are there recurring moments during the day?	• Window sensor • Occupant log • User perception	Directly measured
	How do users operate the ventilation?	When and for how long is the ventilation system activated? Why do users activate the ventilation system? Are there recurring moments during the day?	• Occupant log • Changes in CO_2 and Relative Humidity levels • User perception	Indirectly measured

CONSEQUENCES	What effects does thermostat adjustment by the user have on energy consumption, indoor environment and health?	Does the thermostat adjustment lead to increased energy consumption?	• Occupancy • Indoor-outdoor temperature difference • Heating consumption • User perception	Indirectly measured
		Does the thermostat adjustment lead to acceptable thermal comfort?		
		Does the thermostat adjustment lead to a healthy indoor environment?		
	What effects does window opening behavior have on energy consumption, indoor environment and health?	Does the window opening behavior lead to increased energy consumption?	• Occupancy • Indoor-outdoor temperature difference • Window sensor • Heating consumption • CO_2 • Relative Humidity • User perception	Indirectly measured
		Does the window opening behavior lead to acceptable IAQ and thermal comfort?		
		Does the window opening behavior lead to a healthy indoor environment?		
	What effects does ventilation operation behavior have on energy consumption, indoor environment and health?	Does the ventilation operation behavior lead to increased energy consumption?	• Occupancy • Indoor-outdoor temperature difference • Heating consumption • CO_2 • Relative Humidity • User perception	Indirectly measured
		Does the ventilation operation behavior lead to acceptable IAQ?		
		Does the ventilation operation behavior lead to a healthy indoor environment?		
	Final evaluations	What changes in behavior have occurred during the monitoring period?	• All data sources	Indirectly measured
		What is the impact of the behaviour change on the energy consumption?		
		What is the impact of the behavior change on the comfort and health of the users?	• All data sources	Indirectly measured

4 Required parameters and information

The parameters and their accompanying data that need to be monitored are listed in the table below.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/Notes
Heating	Energy	1 kWh	±5 %	15min	ultego® III smart ultrasound meter	Apartment level Wired M-Bus
Electricity	Energy	0.1 W	±10 %	15min	Kamstrup 382 Generation M	Apartment level Wired M-Bus
Hot water	Energy	1 l/hour	±2 %	15min	modilys® m 16401	Apartment level Wired M-Bus
Operative temperature	IEQ	-	±0.3 °C	15min	LAN-WMBUS-G2-TH Ambient Sensor for temperature/humidity	Room level AMR-Wireless M-Bus
Relative humidity	IEQ	-	±3% RH	15min		
CO_2	IEQ		±(50 ppm+3%) ±0.3 °C ±3% RH	15min	LAN-WMBUS-E-CO2 Ambient Sensor for CO2/temperature/humidity	Room level AMR-Wireless M-Bus
Occupancy	User behavior	-	Activity/5 min	-	LAN-WMBUS-OD Motion detector Design 33X	Only living room AMR-Wireless M-Bus
Window opening	User behavior	0/1	-	Total count	LAN-WMBUS-M (Door and Windows AMR-)	Room level AMR-Wireless M-Bus
Thermostat adjustments	User behavior	-	-	-	-	Indirectly / temperature in the night
Ventilation adjustments	User behavior	-	-	-	-	Window opening
Temperature	Outdoor climate	-	+/- 0.2 °C	15min	CMa20w - Outdoor temperature/humidity sensor	One building North facade Wireless M-BUS
Relative humidity		-	±2% RH	15min		

Parameter	User requirements	Actor requirements	Number of participants	Data extracted	Other/Notes
Technology acceptance	App downloads, technology use, daily habits	Interviews, observation and monitoring	All	App downloads, recorded app and technology use	
Personal health and wellbeing	Personal monitoring and logging, Data recording	Data collection, data analyses	All	Change in sleep quality, energy levels, personal perception of a high quality of life	Will be based on user feedback
Perception of environment (IEQ) and sense of control over one's surroundings	Questionnaires, occupant log	Data collection, data analyses	Focus group	Thermal comfort, IAQ, heating set point, window opening, ventilation control	
Impact	-	Data analyses	All	Change in behavior Change in energy use Change in indoor environment Change in user perception	

5 Behavioural Action Plan

Due to the nature of the MOBISTYLE project, different methods are applied to each case study for user feedback. For more detailed explanations of the interpretation methods established in the MOBISTYLE project, kindly refer to WP3 and Task 3.4 specifically.

To benefit from the opportunity of collecting a large amount of data, the data interpretation and, subsequently, the feedback provided to the users as part of the monitoring campaign in the Kildeparken case study will be based on a combination of standards, measurements, and relative comparisons between an established baseline and the individual units in question. This chapter include selected methods for the following purposes:

- Feedback for end users about their energy use and indoor environment
- Feedback for end users about (un)expected conditions/events
- Feedback for end users guiding them to changing their practices

5.1 Feedback for end users about energy use and indoor environment

Energy Use

The feedback related to energy use for heating and domestic hot water are divided into two parts – energy use during the actual day and energy use during the running year.

A generic profile for heating and domestic hot water is developed for the apartments. For each apartment the profile is adjusted for their actual use (based on their monthly prepayment for energy).

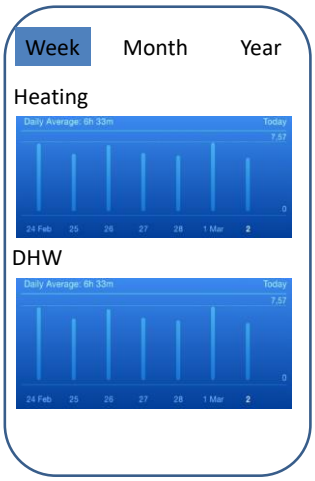
Energy use today is the running sum of the energy use for heating and domestic hot water of the day in relation to the expected energy use of the day (according to the adjusted generic profile), i.e. it starts with 0 (green each day) and moves as the day passes reaching yellow or red, if the energy use of the day is high enough, see table below.

Energy use this year is the running sum of the energy use for heating and domestic hot water of the year in relation to the expected energy use of the year (according to the adjusted generic profile), i.e. it will stay in green, if the weighted sum of the previous days were green.

The colour codes presented to users are based on the following relations between actual an expected energy use:

Label	From expected use	DHW	Heating
Red	Yearly:	> 105%	> 105%
	Monthly:	> 105%	> 105%
	Daily:	> 115%	> 115%
Yellow	Yearly:	95%-105%	95%-105%
	Monthly:	95%-105%	95%-105%
	Daily:	85%-115%	85%-115%
Green	Yearly:	< 95%	< 95%
	Monthly:	< 95%	< 95%
	Daily:	< 85%	< 85%

Historic records of energy use for heating and domestic hot water, respectively, should be provided for the end users, fx. for every day during the last week, the last 4 weeks and/or for every month during the last year.



Indoor Environmental Quality

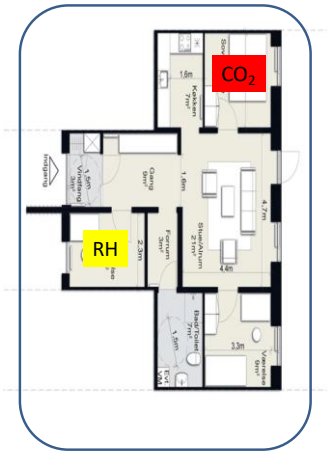
The status of the indoor environmental quality should be given for the apartment as a whole for the three measured parameters: temperature, relative humidity and CO2 concentration, see below.

The colour code is determined by the room with the worst condition. The colour code for each parameter is given below. It is based on a running mean value for the last hour.

Label	Condition	Temperature (winter) °C	Temperature (summer) °C	CO2 (ppm)	RH (Winter) %	RH (Summer) %
Red	One room in the range	> 24	> 26	> 1500	> 70	> 90
Yellow	One room in the range	22-24	24-26	1000 – 1500	50-70	70-90
Green	All rooms in the range	< 22	<24	< 1000	< 50	< 70

Information on actual values should be given to users for each parameter and for each room:

Room type	Temperature	Relative Humidity	CO2
Living room			
Master Bedroom			
Kids room			
Office			



5.2 Feedback for end users about (un)expected conditions/events



User behavior	Conditions (when to show message)
Water use	No use (no colour) Use (blue) Use no body at home (flashing red)
Presence	None (no colour) Presence (blue) Presence (nobody should be home flashing red) (Marked on the GAME App)
Windows opening	All closed (no colour) One open (blue) One open, no presence (flashing red) (Marked on the GAME App)

5.3 Feedback for end users guiding them to changing their practices

Frequency or the type of the messages at this point is divided into two categories:

1. Conditional feedback messages
2. Historic messages, monthly reports

Conditional Messages

Feedback messages that are guiding users to change practices to save energy or to improve indoor environmental quality should be given to users when the situations occur. Messages can be further developed based on analysis of the data collected in the reference period.

The following table indicate a preliminary list of feedback messages:

Message	Conditions (when to show message)
Remember to open window in "xxx" bedroom to improve sleeping quality (to be provided in the morning)	**IF** CO2 level reached red label (for one or more measurements) the previous night (23 – 07) **and** the window was closed
Larger window opening in "xxx" bedroom is recommended to ensure sleeping quality (to be provided in the morning)	**IF** CO2 level reached red label (for one or more measurements) the previous night (23 – 07) **and** the window was open
Open window in "xxx room" to reduce "YY"	**IF** CO2, RH or temperature level (running mean value for the last hour) reaches red label during daytime **and** the window is closed (If outside temperature conditions are known, then for temperature only if $t_{room} > t_{outside}$).
Open windows on both sides of your apartment to increase ventilation	**IF** CO2, RH or temperature level (running mean value for the last hour) reaches red label during daytime **and** the window is open (If outside temperature conditions are known then for temperature only if $t_{room} > t_{outside}$).
Open window in "xxx" sleeping room to reduce temperature (to be provided in the evening)	**IF** temperature in sleeping room is in red label at 6PM **and** the window is closed
Consider to close the window in "xxx room".	**IF** heating is on, CO2/RH label is green **and** window is open in "xxx room"

Your heating energy use will be high – consider to reduce heating set-point (to be provided during daytime)	**IF** heating energy use the day before reached red label **and** the minimum temperature during previous night (23-07) was in red label **and** heating was on (23-07)
Your ….. (to be continued)	

Historic Messages

Feedback messages giving an overall assessment of energy use and indoor environment in the apartment compared to other users in the building, where for example the energy use of the selected apartment is compared with similar apartment in the same building, or the average consumption in the building.

It could be given as a monthly report that include the review of energy use combined with energy saving tips. Based on the specific user and his actual behaviour, each energy label (green, yellow, red) will have different tips how to adjust the behaviour to a more sustainable manner.

Monthly energy use in the apartment for heating and domestic hot water is compared to other apartments of the same size and/or of the same number of household members. (Reference numbers can be calculated for all apartments in Kildeparken). The indoor environment is compared to other apartments in the building

Energy saving tips	Condition
You are among the top 25% spenders of heating in Kildeparken. Reducing your heating set-point will for every degree save you 5% in the heating bill. (to be provided monthly)	**IF** heating energy use the last month is in top 25% among the monitored apartments **and** the minimum temperature during night (23-07) is in red label when heating is on
You are among the top 25% spenders of domestic hot water. Reducing the length of you showers from XX minutes to 5 minutes will save you yy% in heating bill (to be provided monthly)	**IF** domestic hot water usage is in top 25% **and** length of 50% of showers are more than 5 minutes in average
Your heating energy use will be high – Consider to open the window less in “xxx room”. (to be provided monthly)	**IF** heating energy use is in red label **and** heating is on **and** average (for the last month) CO2 label is green **and** windows are open more than 30 min each day in “xxx room”
…. To be continued	

IEQ improving tips	Condition
You can improve your indoor air quality by open your window for short periods during the day in “xx” room. (to be provided weekly)	**IF** CO2 or RH level (average value for the last week) reaches yellow or red label **and** the window is open less than 30 min each day in “xxx room”
You can reduce the temperature in your apartment by keeping windows open during night (to be provided weekly)	**IF** temperature level (average value for the last week) reaches red label during daytime **and** the window is closed during night (23-07)
…. to be continued	

5.4 Information for calculation/selection of feedback to users

Description is included in the previous two sections

6 Project Evaluation Methods

Due to the nature of the MOBISTYLE project, different methods are applied to each case study for evaluation of the performance of the MOBISTYLE approach and solutions. For more detailed explanations of the interpretation methods established in the MOBISTYLE project, kindly refer to WP3 and Task 3.4 specifically.

To benefit from the opportunity of collecting a large amount of data, the data interpretation and, subsequently, the evaluation of the performance, as part of the monitoring campaign in the Kildeparken case study will be based on a combination of standards, measurements, and relative comparisons between an established baseline and the individual units in question. The following include selected methods for the following purposes:

- Evaluation of energy use and indoor environment in apartments
- Evaluation of the change in user practices as a result of user feedback
- Evaluation of the use of the MOBISTYLE solutions and user perception of feedback and guidance.

6.1 Evaluation of energy use and indoor environment

Energy

Energy use is found for both the reference and the monitoring period. Energy use for heating and domestic hot water is given for each month during the year. Energy use for heating is given in relation to the size of the apartment (kWh/m2) while energy use for domestic hot water is given both in relation to the size of the apartment (kWh/m2) and in relation to the number of users (kWh/occ.) Energy use for heating and domestic hot water, respectively, for each year is found as the sum of the monthly values.

Energy use for heating and domestic hot water will be compared between the reference and the monitoring period. As especially heating energy use will be dependent on the season, periods with similar outdoor environment will be compared with each other.

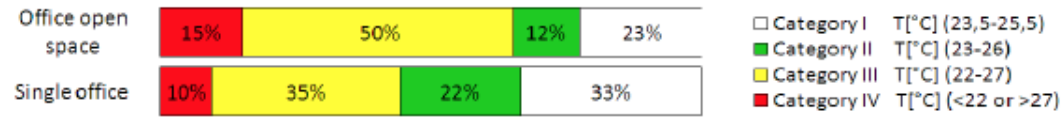
The variation of energy use for heating and domestic hot water between the apartments will be analysed, and it will be investigated if correlations can be proved between energy use for heating and parameters like indoor temperature level, window opening behaviour and/or number of occupants and their presence.

Indoor Environment

Indoor environmental quality is evaluated for both the reference and the monitoring period. **Temperature** levels are evaluated for each room and as an area averaged value for each apartment for the reference and the monitoring period, respectively. The table shows for which time periods thermal conditions should be evaluated for the different rooms:

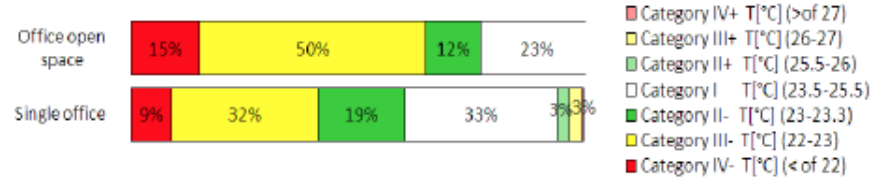
	24 hours	Day 7-23	Night (23-7)
Apartment	X		
Living room	X	X	
Sleeping rooms	X		X

Temperature levels are evaluated according to comfort categories given in standards, see figure below:

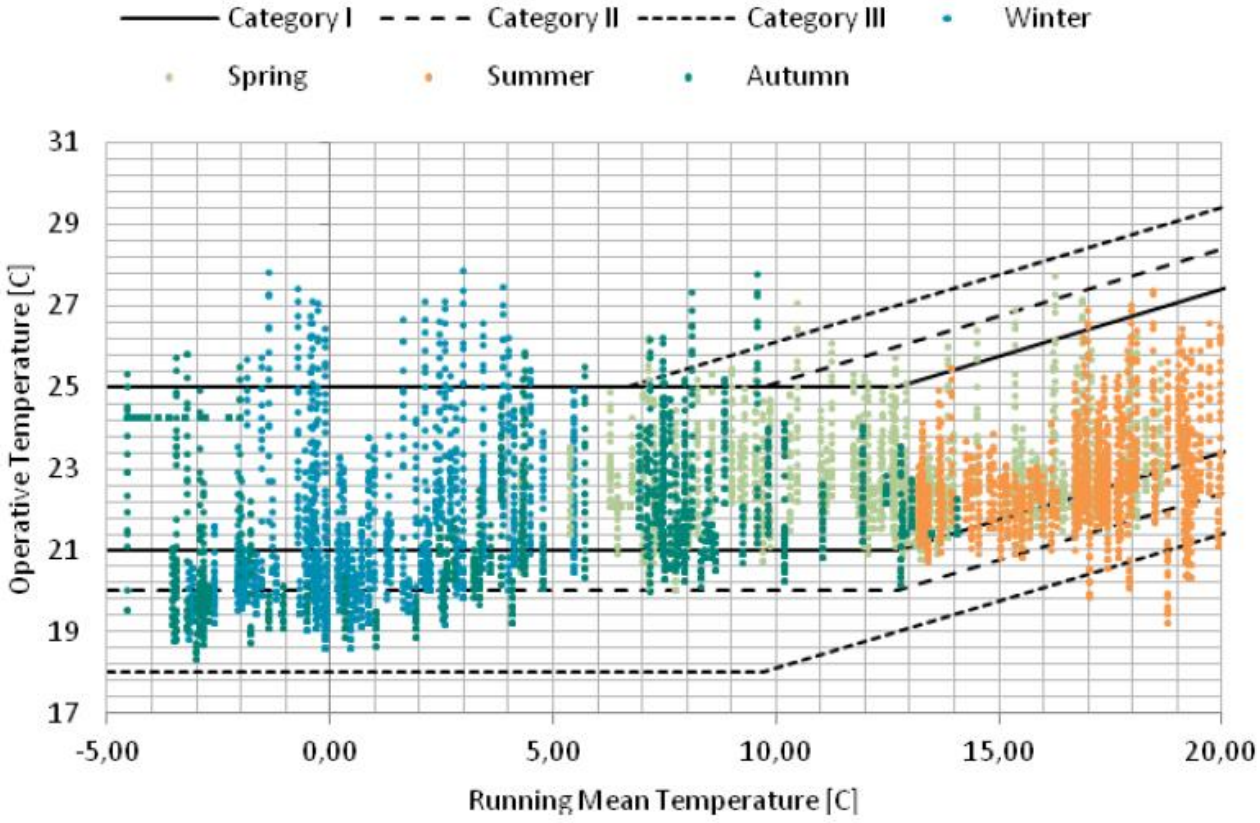


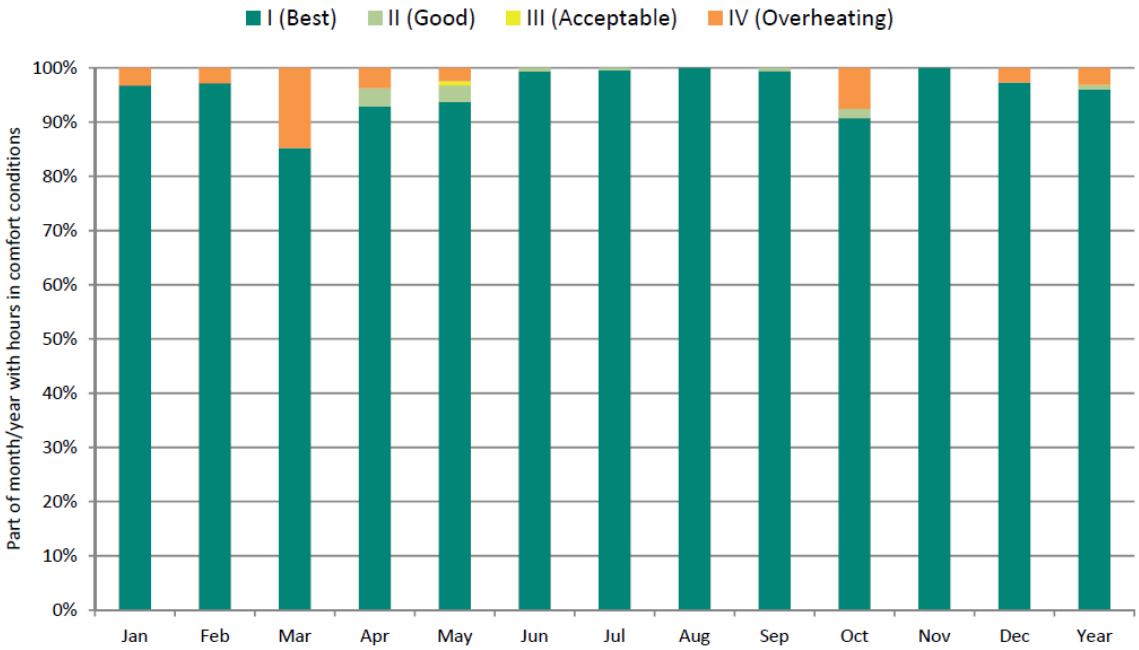
Note: The figure must be changed to show + or – for category I

Alternative with above and below temperature range



To capture differences between seasons, temperature levels should also be evaluated as illustrated in the figures below.

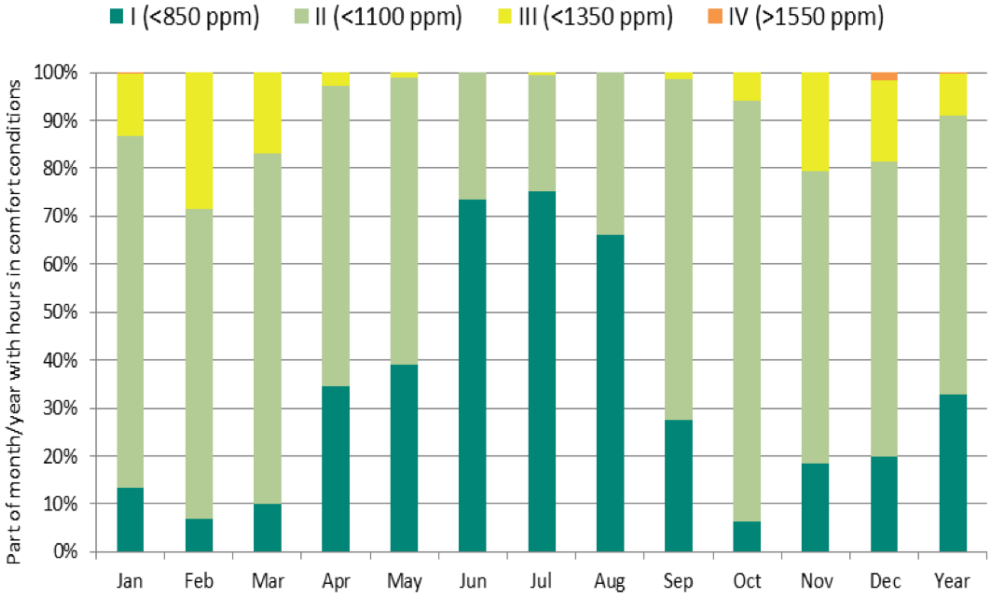




CO2 levels are evaluated for each room and as an area averaged value for each apartment for the reference and the monitoring period, respectively. The table shows for which time periods thermal conditions should be evaluated for the different rooms:

	24 hours	Day 7-23	Night (23-7)
Apartment	X		
Living room	X	X	
Sleeping rooms	X		X

CO2 levels are evaluated according to comfort categories given in standards, see figure below:



Relative humidity to be presented in the same way as CO2.

6.2 Evaluation of the change in user practices as a result of user feedback

Change in indoor air quality

Changes in indoor air quality between the reference and the monitoring periods can be illustrated by comparing carpet plots, where it can be illustrated when, how much and for how long changes occur. Special attention will be focused on illustrating changes in indoor air quality in periods after giving feedback on benefits of window opening or closing.

Change in indoor temperatures outside heating season

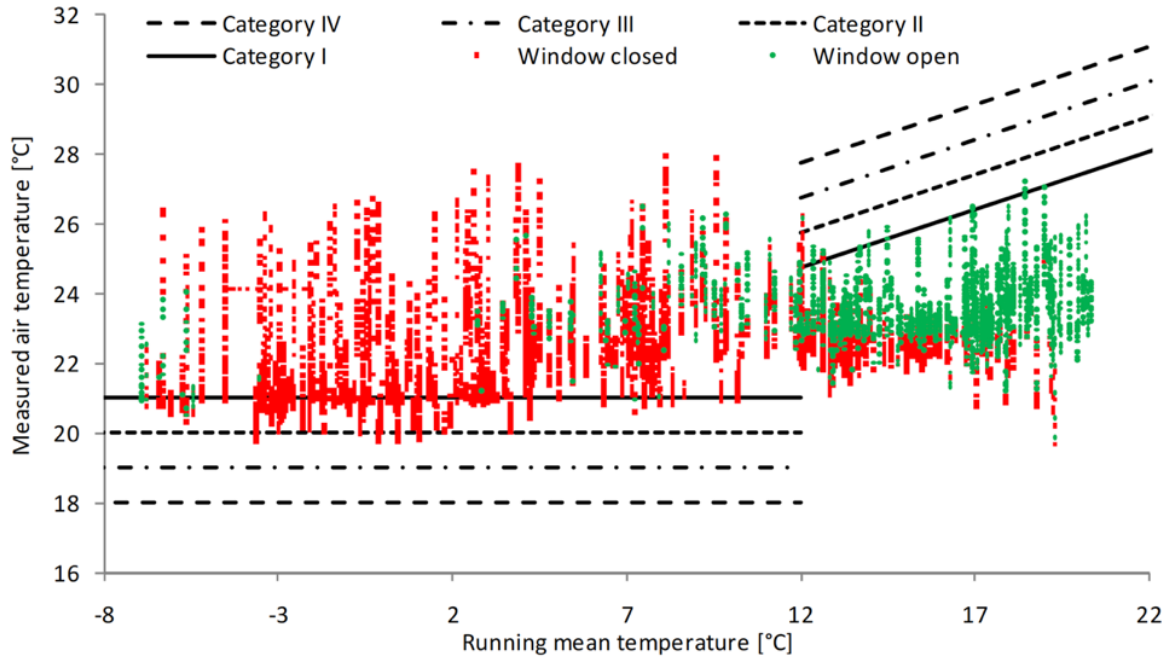
Changes in indoor temperatures outside heating season (periods after two days with heating off) between the reference and the monitoring periods can be illustrated by comparing carpet plots, where it can be illustrated when, how much and for how long changes occur. Special attention will be focused on illustrating changes in indoor temperature levels in periods after giving feedback on benefits of window opening. Especially, night temperatures will be important to analyse and compare.

Change in set point temperature in the heating season

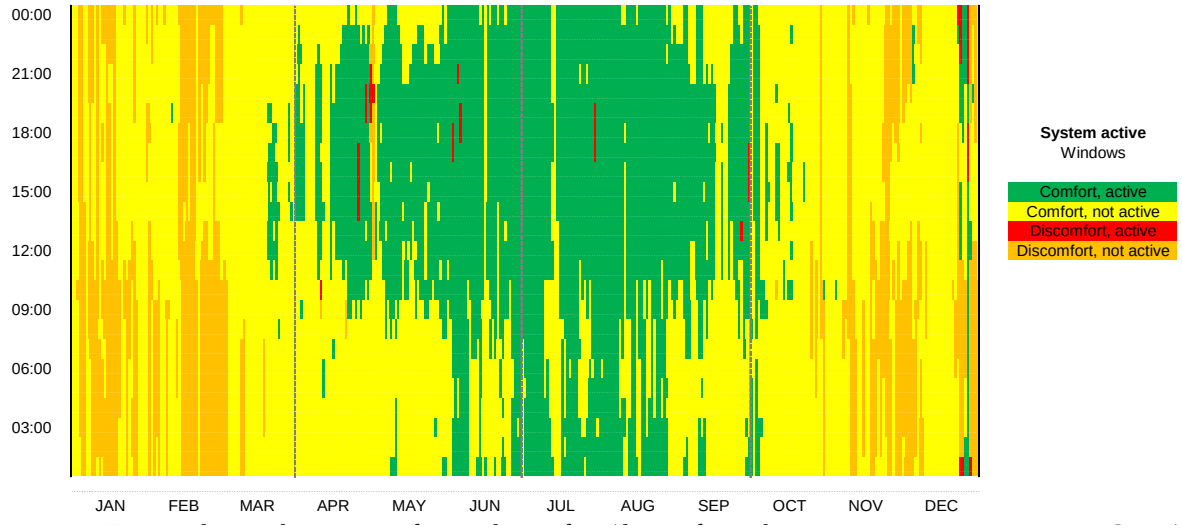
Changes in set-point temperature between the reference and the monitoring periods will be estimated by analysis of the data (Differences in minimum temperature levels during nights with heating on). Special attention will be focused on illustrating changes in set-point temperature in periods after giving feedback on benefits of changing it.

Change in window opening practices

The use of windows will be evaluated on room level based on the type of figure shown below for the same periods as shown in the table above. Window opening behaviour will be illustrated as a function of temperature level, CO2 level and humidity level in the actual room, respectively.



Special attention will be focused on comparing changes in user practices between the reference and the monitoring periods, i.e. when and for how long are windows open and are there recurring moments during the day. This can be illustrated by a carpet plot as shown below complemented by statistical analysis.



Special attention will also be focused on illustrating if changes occur in user practices in periods after giving feedback on benefits of changing window opening behaviour.

Change in domestic hot water usage

Domestic hot water usage will be compared between the reference and the monitoring period. Special attention will be focused on illustrating changes in user practices in periods after giving feedback on benefits of changing domestic hot water use

6.3 Evaluation of the use of the MOBISTYLE solutions and user perception of feedback and guidance.

Evaluation of the use of the MOBISTYLE solution will be carried out as a combination of focus group interviews and interviews of individual users. Focus group interviews will be carried out in the initial development phase to get user feedback on the first prototype.

Interviews with open questions will be conducted with users in each apartment to evaluate their perception of the MOBISTYLE solution, how they use it, when and for how long. The interview will also identify user perception of the feedback information and feedback received as well as if it based on their own opinion has led to any changes in their practices. This interview will be carried out two times. The first one half way through the demonstration and the results will be used to adapt and revise the Mobistyle solution, while the second one will be used for the evaluation of the outcome of the project.

6.4 Information for calculation of Key Performance Indicators (KPI)

Description is included in the previous sections.

7 Monitoring plan

Both the quantitative and the qualitative monitoring will take place for a period of 30 months, from October 2017 until March 2020 (both included). This covers both an observation measurement period to establish a reliable baseline and a monitoring period in which behavioral change is observed. As the entire MOBISTYLE project is scheduled to last 42 months, starting from October 2016 (M1), the observation measurement period will take place for 8 months from month 12 (M12), October 2017 until month 19 (M19), May 2018. The monitoring period will take place for 22 months, M20 – M42, June 2017 to March 2020, respectively.
The monitoring will be continuous and consistent, measuring and logging the parameters defined for the specific case. These parameters will subsequently be analyzed and interpreted to achieve the project goals. A detailed time schedule and a brief overview of the monitoring plan is presented in Section 7.2.

Measuring campaign condition parameters will be established by performing outdoor data logging. Weather stations will record outdoor conditions, such as temperature, atmospheric pressure, relative humidity, wind speed etc. Information regarding the weather station in being acquired.

As part of ISTA, one of the world's leading companies offering energy services to optimize energy efficiency in buildings, *"Varmekontrol"* is an actor closely involved in the Kildeparken demonstration case. Their contribution includes data logging, storing, and sharing. Moreover, the actors involved in the project include the residents of Kildeparken, the focus group members, and volunteers outside of the focus group.

In the illustrations in *Chapter 1 Short description*, the location of measurement points can be seen. The following subsections comprise an action based list of tasks in a chronological order containing relevant information about each step in order to execute the measurement campaign.

7.1 The measurement campaign preparation process

It is crucial that the specific test conditions related to the measurement campaign are well documented and reported during the monitoring process. An essential part of the preparation process shall include decisions regarding logging, documenting, and archiving. The equipment used shall be assessed, described, and reported to uniquely identify the specific sensor, software, and component configuration provided by the manufacturer or estimated through calculations.

7.2 Description of the measurement procedure

The measurements performed in Kildeparken follow a standard method often used during monitoring of IEQ, energy, and user comfort monitoring, and will be briefly described in the following section. Data is obtained to characterize user behavior and the performance of selected apartments in terms of energy consumption and indoor environment.

According to the method, various sensors and measurement devices are placed or installed in order to provide values, which can be analyzed, see chapter 1. A process of correction or normalization as well as uncertainty estimation is also established. Various obstacles, for

example, a temporary loss of network connection, may occasionally interrupt the data collection process resulting in a reduction of measurement availability and a methodology to handle this will be developed.

Any equipment specifications, which may have an effect on the measurements, should be clearly stated during the monitoring process, so that such influences could be accounted for. As mentioned previously, the measurement period consists of both a reference and monitoring period. Both quantitative and qualitative data will be collected. Qualitative data collection will include questionnaires for all participants, interviews for some; likely the focus group members. The monitoring will be continuous and data collection and review will take place at certain intervals during the project timespan in order to be able to react on observations made and carry out possible improvements to the methodologies and feedback developed.

Briefly speaking, the monitoring will be divided into four phases as can be seen in the table below:

1. Reference monitoring: Checking the existing conditions.
2. Initial monitoring: Assuring that what is installed performs as expected and if the users understand the situation,
3. Feedback monitoring: Performance evaluation regarding initial feedback provision
4. Impact evaluation monitoring: Performance impact evaluation of optimized feedback provision.

	June 2017 – May 2018	June 2018 – August 2018	August 2018 – April 2019	April 2019 - January 2020
MOBISTYLE project timeline	M13 – M20	M21 – M23	M23 – M31	M31 - M40
Monitoring timeline		M0 – M2	M2 – M10	M10 - M20
Phase name	Reference monitoring	Initial monitoring	Feedback monitoring	Impact monitoring
Phase description	Checking existing conditions and establishing a base line	Check if equipment works, initial user feedback and observations	Performance evaluation, identification of possible improvement to strategies developed based on data extracted and user feedback received	Assessing the project results
Notes	No solutions implemented, only monitoring	Analyze data in M2	Analyze data in M6 and M12	Final data extraction and analysis

7.3 Data acquisition

Data will be collected continuously in 15 minutes intervals. The data base shall fulfil the requirements set by “Varmekontrol” and MOBISTYLE ICT partners.

7.4 Data sharing and exchange

Data will be collected in the MOBISTYLE database and feedback will provided to users based on analysis of the collected data.

Case study holders will be given access to the data for analysis and performance evalution at regular intervals, see section 8.

7.5 Reporting format

The final monitoring report will be the revised Action Plan and is expected to contain the following information:

- A description of the equipment used and their location within the monitoring site.
- An identification of the specific equipment configuration under the measurement process.
- A description of the measurement site and the ambient conditions.
- Identification of the sensors and data acquisition system, including documentation of calibrations for the sensor’s transmission lines, and data acquisition system.
- A description of the method of data acquisition, storing, and analysis as described in Section 5 KPI analysis and interpretation methods of this Action Plan.
- A description of the measurement procedure.
- Presentation of measured data.

8 Evaluation Plan

The following describes the evaluation of the case study and the demonstrated technologies. The purpose of the evaluation is to:

- Evaluate the impact or outcome of the demonstration. This includes evaluation of the changes in energy use and in indoor environmental quality in the apartments as well as evaluation of the changes in user practices experienced as a result of user feedback, see chapter 6
- Evaluate the feedback process (identifying user perception of feedback and guidance as well as possible optimization and improvements of the implemented solutions).

The goal is then to figure out both the project's effectiveness (estimating the extent to which the project's outcomes meet its objectives) and the project's relevance (identifying if the project's goals are responding to the identified users' needs)

The evaluation will be divided into four different phases, where each of them have their own objectives:

1. Benchmark evaluation: Evaluate the existing conditions.
2. Initial evaluation: Preliminary evaluation of perception of feedback, impact on performance and changes in user practices
3. Feedback evaluation: Evaluation of perception of feedback, impact on performance and changes in user practices.
4. Final Impact Evaluation: Final evaluation of project achievements

	June 2018	August 2018	April 2019	January 2020
MOBISTYLE project timeline	M21	M23	M31	M40
Monitoring timeline	M0	M2	M10	M20
Phase name	Benchmark evaluation	Initial evaluation	Feedback evaluation	Final Impact evaluation
Phase description	Define reference performance in relation to energy use and indoor environmental quality			Assessing the project results
Notes	No solutions implemented, only monitoring	Analyze data in M2	Analyze data in M5 and M10	Final data extraction and analysis

8.1 Benchmark Evaluation

The purpose of the benchmark evaluation is to determine the reference situation before application of the MOBISTYLE solution and will be based on monitored values. Energy use for heating and domestic hot water is evaluated for each month during the reference monitoring period. Indoor environmental quality is evaluated for the reference period. Temperature, CO2 and RH levels are evaluated for each room and as an area averaged value for each apartment. Reference user practices in relation to set-point temperature and window opening will also be determined.

8.2 Initial Evaluation

The purpose of the initial evaluation is to ensure that the MOBISTYLE solution is installed properly, that the users understand the ideas behind it and how it works, and that data and feedback are correct. All participants will be invited to a workshop, where the solution will be demonstrated and assistance can be given in installing and managing it. At the end of the initial monitoring period a visit will be planned to each apartment to check if everything is working.

8.3 Feedback Evaluation

The purpose of the feedback evaluation is to get a preliminary idea of the impact and perception of the MOBISTYLE Solution and to receive opinions from the user regarding improvement possibilities. The feedback evaluation will be carried out two times during the feedback monitoring period (Medio and ultimo). Based on monitored data it will include evaluation of:

- Energy use for heating and domestic hot water for each month in the feedback period and initial comparison with the reference period (if possible)
- Temperature, CO2 and RH levels for each room and as an area averaged value for each apartment and initial comparison with the reference period
- User practices in relation to set-point temperature and window opening and initial comparison with the reference period

An interview with open questions will be conducted with users in each apartment to evaluate their perception of the MOBISTYLE solution, how they use it, when and for how long. The interview will also identify user perception of the feedback information and feedback received as well as if it based on their own opinion has led to any changes in their practices.

8.4 Final Impact Evaluation

The purpose of the final impact evaluation is to document the impact and perception of the MOBISTYLE Solution. It will use the same methodology as carried out two times in the feedback evaluation period. This will allow a continuous improvement of the methodology as well as improve quality of feedback from users on their perception as they will get used to the methodology and the questions asked.

The final impact evaluation will be carried out in the end of the impact monitoring period. Based on monitored data it will include documentation of:

- Reduction in energy use by comparing energy use for heating and domestic hot water for each month in the reference and impact monitoring periods.
- Improvement in indoor environmental quality by comparing temperature, CO2 and RH levels for each room and as an area averaged value for each apartment in the reference and impact monitoring periods

- Changes in user practices by comparing set-point temperatures and window opening practices in the reference and impact monitoring periods

An interview with open questions will be conducted with users in each apartment to evaluate their perception of the MOBISTYLE solution, how they have used it, when and for how long. The interview will also identify user perception of the feedback information and feedback received as well as if it based on their own opinion has led to any changes in their practices.

9 Instrumentation

Existing monitoring devices - costs

All apartments in residential housing area in Kildeparken have smart heat and water meters installed and they are managed by the utility company Varmekontrol. These heat, electricity and waters monitoring units are connected in a Wired M-Bus network in each apartment block.

Additionally, 3 apartments involved in MOBISTYLE will need an extra smart heat and water meters to be installed because they are managed by another company than Varmekontrol.

Additional monitoring devices

For the MOBISTYLE project purposes IEQ, window/door opening and presence detection measuring devices are installed in 19 apartments. Furthermore, 9 additional data collectors are installed to gather the data from these new measuring devices. Additionally, one Wireless outdoor M-Bus temperature and humidity sensor is installed to register outdoor climate conditions.

The summary of the new hardware and related installation costs are presented in the table below. Corresponding prices are given in Danish krone (DKK) using sign 'kr.' Prices are excluding VAT, as well as costs associated with development of the new system are not yet included.

Device	Nb of devices	Price per device, kr.	Costs of devices, kr.	Additional costs* (installation), kr.	Total costs, kr.
Temperature / RH	81	580,00	46 980,00	10 530,00	57 510,00
CO2	81	670,00	54 270,00	10 530,00	64 800,00
Window/Door	81	730,00	59 130,00	10 530,00	69 660,00
Presence	19	1 475,00	28 025,00	2 470,00	30 495,00
Data collector	9	1 870,00	16 830,00	1 170,00	18 000,00
Heat meter	3	1 300,00	3 900,00	390,00	4 290,00
Water meter	3	1 100,00	3 300,00	390,00	3 690,00
Outdoor temperature / humidity sensor	1	1 025,00	1 025,00	130,00	1 155,00
		SUM:	**213 460,00**	**36 140,00**	**249 600,00**

*installation costs are 130 kr. pr. one measuring device.

10 Resources and Time Schedule

The table below summarizes the required resources to carry out the action plan in terms of costs, time, and hours of labor.

10.1 Overview

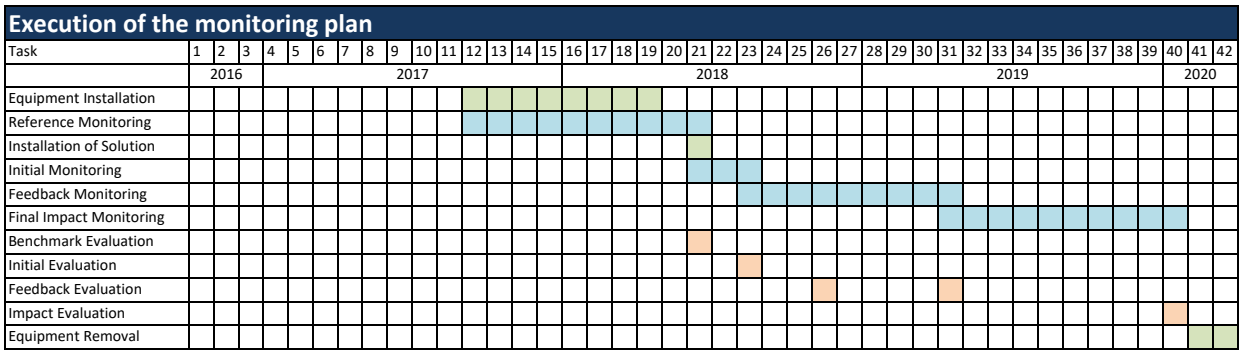
Execution of the monitoring campaign

Task	Time period	Hours of labor needed	Associated costs	Notes
Equipment purchase, calibration, and installation	M12	1 MM	€40.000	
Quantitative data collection	M13 – M40	1 MM		
Qualitative data collection	M23 – M40	2 MM		
Equipment maintenance and repair	M13 – M40	½ MM		
Equipment removal and dismounting	M42	½ MM		
Data extraction and handling	M13 – M40 Check ins M21, 23, 31 and 40	1/2 MM		
Performance Evaluation	M21, 23, 31 and 40	1 1/2 MM		
	Total:	7 MM	€ 40.000	

10.2 Detailed time plan

Project timeline

The Gantt chart per month presents an overview of the demonstration activities and their duration.



Deployment of ICT solutions

In MOBISTYLE there are two Information and Communications Technology (ICT) solutions implemented in order to achieve the MOBISTYLE goal: reduce energy consumption by 16% and improve Indoor Environmental Quality (IEQ) and health aspects in the demonstration buildings. These ICT-solutions are GAME and DASHBOARD, developed by Highskillz (HS) and Holonix (HLX) respectively.

In residential demo-cases like Kildeparken only the GAME App will be implemented. The timeline for this process is presented in the following table.

June 2018 – August 2018	September 2018 – February 2019	March 2019 - January 2020
M21 – M23	M24 – M29	M30 - M40
M21 GAME Mock-up (Housing association, Himmerland Boligforening and AAU)	M24 GAME Prototype I (18 apartments) M27 GAME Prototype II (18 apartments)	M30 Final GAME(18 apartments)

Initially the GAME App is presented to the AAU and the housing association Himmerland Boligforening as a web-version. This version presents a draft version of the graphical user interface (GUI) layout and structure of the application. It includes some examples from the MOBISTYLE missions with respect to IEQ improvements that will be given the users can complete.

Further, it is planned to develop the GAME application as a first prototype version for the Android mobile phones (M24). Soon after the GAME Prototype I version will be available to the building residents, it is planned to organize a meeting with them in order to evaluate user interaction with application. This will be done by organizing meeting with focus group residents. Here the residents will complete the System Usability Scale (SUS) and an evaluation of the first mobile version. Afterwards the GAME App (Prototype II in M27) will be further improved with respect to the user comments. If required, another meeting with users will take place before the Final GAME version in M30 will be available.

The schedule during the GAME implementation will be updated according to the work progress of ICT partners HS.

10.3 Organizational structure

In the Danish demonstration case, there are three organizations involved to provide a successful implementation of MOBISTYLE solutions. These organizations are Aalborg University (AAU), social housing association Himmerland Boligforening and consumption metering company Varmekontrol. Within the scope of MOBISTYLE project, AAU is managing the coordination and communication between these organizations.

Company Varmekontrol is a part of ista Danmark A/S, which is part of ista International GmbH. Varmekontrol is providing an energy management service for the housing association. They provide billing and metering services for heat and water consumption. They are also responsible for the installment of the IEQ sensors, sensor day-to-day operation and data transfer to the MOBISTYLE database managed by ICT-partners, DEMO consultants (DMO).

People from housing association Himmerland Boligforening are the first ones to be in direct contact with the end-users of the Kildeparken building project. AAU always arranges focus group meetings with agreement of Himmerland Boligforening.

People involved in the MOBISTYLE project are mentioned in the following table.

Organization	Contact information
Aalborg University	Per Heiselberg, WP6 leader and Coordinator, E-mail: ph@civil.aau.dk Sandijs Vasilevskis, Research Assistant, E-mail: sv@civil.aau.dk
Himmerland Boligforening	Project Manager and Development Manager are involved into the project, public company contact information, E-mail: info@abhim.dk
Varmekontrol	Development & System Analyst is involved in the project, public company contact information, E-mail: v@rmekontrol.dk

10.4 Review of the possible risks

Description of the risk	Proposed risk-mitigation measures	Status of risk
Poor or no collaboration from the owners/key persons or organizations in the 5 study and demonstration cases	Direct involvement of owners/managers and other key organizations via regular meetings and emailing.	No risks occurred. Social housing association is involved in the dialogue with AAU.
Insufficient amount of apartments participate in the implementation of ICT-solution. This is crucial in Danish case because there are only 19 apartments in total.	Communication with key owners and key, demonstrating the benefits of MOBISTYLE (energy saving potential, IEQ improvements).	No risks occurred. Social housing association and AAU approves further development of the GAME solution based on the mock-up ideas.
Insufficient amount of apartments want to participate in the MOBISTYLE implementation after presenting the mock-up version of ICT solution	Present the mock-up version of the ICT solution, when it is well prepared and detailed, also graphically. This could mean postponing the presentation date. Invite ICT developers to the mock-up presentation to explain the ideas behind the ICT solution.	No risks occurred. To be updated after the first meeting with end-user.
Limited amount of end-users have Android mobile phones. (GAME solution is being developed for Android operating systems). This will cause a decrease in number of participating apartments	Make a survey and quantify the number of mobile phone operating systems. Alternatively, in Danish demonstration case new Android phones could be provided to the users; however, there would still be the risk that end-users would not want to have the Android phone if they are used to the iOS operating system.	Not enough information about the Android vs iOS proportion.
End-user not participating in MOBISTYLE implementation due to English language used in the GAME application.	Inform the end-users that the GAME first will be made in English and later it will be translated in Danish language.	No risks occurred. To be updated after the first meeting with end-user.

11 Ethics in MOBISTYLE

Monitoring will be based on Informed Consent, that is, written consent will be gathered before any activities will be monitored according to Ethics requirements set in D8.1 POPD – Requirement report on Ethics in MOBISTYLE. Guidance will be provided in order to clarify what and why the data is collected.

Informed consent is one of the primary ethical requirements underpinning research with human subjects and is an ongoing process (especially with data acquisition subject to continuous change). The forms presented in table below shows information letter and informed consent form used in the demonstration. The purpose of informed consent is to ensure prospective subjects will understand the nature of the research and monitoring and can voluntarily decide whether or not to participate.

MOBISTYLE's interpretation of the EC H2020 guide 'How to complete your ethics Self-Assessment' is that when the study involves research involving participants,

1. An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures, and identification of any procedures which are experimental;
2. A description of any reasonable risks or discomforts;
3. A description of any benefits to the subject or to others;
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
6. For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;
7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject;
8. A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Informed Consent in Danish language is presented in the following pages.

MOBISTYLE AALBORG UNIVERSITY DENMARK HIMMERLAND BOLIGFORENING

INFORMATIONSBREV

MOBISTYLE: EU forskningsprojekt om energiforbrug og indeklima

Tak for din deltagelse i EU-projektet MOBISTYLE, der omhandler måling og registrering af indeklima og energibesparelser i din bolig, og for din hjælp til at udvikle og afprøve nye IT-løsninger, der gerne skulle hjælpe dig med at blive bedre til at styre dit indeklima og spare på energien i din bolig.

Som deltager i projektet vil der ske følgende:

- Din bolig udstyres den 22. eller 23. marts 2018 med sensorer til måling af indeklima og vinduesåbning i opholds- og soverum samt tilstedeværelse i opholdsrummet. Sensorerne vil måle dit indeklima i de efterfølgende 24 måneder.
- Monteringen foretages af Varmekontrollen i samarbejde med Himmerland Boligforening og tager ca. ½ time. Daniel Sørensen fra Varmekontrollen vil kontakte dig for at aftale det nøjagtige tidspunkt.
- Du vil i forbindelse med monteringen af sensorer i din lejlighed blive bedt om at underskrive en samtykkeerklæring, der giver tilladelse til opsamling af data om dit indeklima og energiforbrug og brug af disse data i forskningsøjemed. Kopi af erklæringen er vedlagt denne mail. Venligst læs den igennem inden Varmekontrollens besøg.
- Du vil i løbet af sommeren 2018 få tilsendt besked om adgang til data om dit energiforbrug og indeklima. Adgangen sker med en ny APP, som du kan downloade til din smartphone. Der vil blive arrangeret et eller flere tidspunkter, hvor du i fælleshuset vil kunne få hjælp til dette og/eller få svar på spørgsmål.
- Du vil via App'en modtage vejledning i, hvordan du evt. kan forbedre dit indeklima og/eller reducere dit forbrug af energi.
- I løbet af det første år og ved projektets afslutning vil du blive interviewet (ca. 3 gange) om dit syn på og brug af app'en, som løbende vil blive forbedret og tilpasset dine ønsker/behov. Interviewene vil vare ca. 1 time.
- Du vil også blive inviteret til 1-2 workshops, hvor du vil få mulighed for at komme med dine forslag til forbedringer og videreudvikling af IT-løsningen.

Opsamlede data vil blive brugt i forskningsøjemed for at kunne udvikle relevant vejledning til dig om forbedring af dit eget indeklima og om opnåelse af energibesparelser. Opsamlede data vil også blive brugt til at blive klogere på indeklima og energiforbrug i lejligheder, på hvilken betydning vores egne vaner har for indeklimaet og energiforbruget, og på om disse vaner kan ændres, når man bliver bevidst om deres betydning.

Kontakt: Rasmus Hjorth, Himmerland Boligforening**,** Tlf. 9631 5238 **,** E-mail: rh@abhim.dk
Per Heiselberg, Aalborg Universitet, Tlf. 2023 4660, E-mail: ph@civil.aau.dk

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MOBISTYLE AALBORG UNIVERSITY DENMARK HIMMERLAND BOLIGFORENING

Informeret samtykke i forbindelse med deltagelse i forskningsprojektet *"MOBISTYLE"*

I MOBISTYLE projektet indsamles data om energiforbrug og indeklimaforhold i din lejlighed, som jeg via en APP kan få adgang til og som skal bruges i forskningsøjemed.

Jeg er blevet informeret om ovennævnte forskningsprojekt ved deltagelse i informationsmøde den 15. november 2017 i Fælleshuset, Blåkildevej, og/eller ved læsning af det skriftlige materiale.

Jeg har haft mulighed for at stille spørgsmål, har tilmeldt mig projektet og har givet tilladelse til, at indeklimasensorer monteres i min lejlighed.

Jeg har til enhver tid mulighed for at fortryde min deltagelse og kan forlange at indeklimasensorer i lejligheden fjernes igen, uden at jeg skal give nogen forklaring.

Jeg giver samtykke til deltagelse i forskningsprojektet og tilladelse til at opsamlede data vedrørende energiforbrug og indeklima i min lejlighed bruges i forskningsøjemed.

Jeg ønsker / ønsker ikke (venligst marker valg) at blive informeret om projektets resultater.

Jeg giver tilladelse til, at data kan opbevares op til 10 år efter, at projektet er afsluttet.

Navn _____

Fødselsdato _____

Dato Underskrift

Undertegnede ansvarlige forsker erklærer, at ovennævnte person er blevet informeret om forskningsprojektet både mundtligt og skriftligt.

Navn: _____

Funktion: _____

Dato Underskrift:

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Appendix 3 University of Ljubljana, SL MAP

Demonstration Case “University of Ljubljana buildings”

1 Short description

Demonstration case of University of Ljubljana (UL) consists of 4 faculty buildings located in Ljubljana, which are in details described in the preliminary demo description:

- Faculty of Computer and Information Science (FRI)
- Faculty of Chemistry and Chemical Technology (FKKT)
- Faculty of Economics (EF)
- Faculty of Arts (FF)

Since all four buildings have a similar room typology and users, we focus on the FRI FKKT facility **for in-depth measurements and complex analysis**. Other buildings will be used for verification and generalisation of findings and further implementation of the solution. A specific theme to be addressed in UL demonstration case will be the indoor environment quality (IEQ) in relation to short-term behaviours and long-term habits of different user types.

1.1 Construction

All buildings are made of reinforced concrete and are insulated. FRI and FKKT are built recently (2013), the common buildings (X) has double glass façade. The buildings have flat roofs. EF is partly positioned underground. The retrofit covered optimization of HVAC and lighting systems, BMS upgrade and windows heat bridges minimization. The FF Aškerčeva 2 is a monolith 6-storey building. Retrofit covered thermal insulation of façade, replacement of some windows, lighting optimization, HP instalment and BMS upgrade.

1.2 Technical systems

FRI+FKKT: Natural gas is used for heating in two condensing boilers providing heat for whole FRI FKKR complex. The facility has one boiler and a chiller room. Each building (FRI, FKKT, X-curved building) has its own heating and cooling substation. Each heating substation has the following users/lines:

- Pre-heating air for air handing units (AHU),
- additional air heating prior entering the rooms,
- radiators and convectors,
- domestic hot water.

There are 17 major ventilation systems (AHU) at the premises, but not all the room have mechanical ventilation. Some room have variated air flow regulation, some lecture rooms based on CO_2. Heat is distributed in the building by warm air (via AHU), radiators and convectors, depending on the room typology. Cold is distributed by AHU and celling

convectors. HW is prepared for each building separately on its substation heat exchanger. Building has its own high-voltage connection point.

EF: Heating is delivered by a district heating company. Heat is distributed by warm air, radiators and convectors, depending on the room type. There are 12 larger ventilation systems (AHU) on site. Reversible HP and additional chillers are used for cold generation. PV power plant (105 kWp) is installed on the roof. HW is prepared in the substations by heat exchangers. Building has its own high-voltage connection point.

FF: Heating is delivered by a district heating company. Heating is enabled mainly by radiators in combination with warm air (several AHUs). A small heat pump is installed in the energy station. There is no central HW preparation. Chillers are installed on the roof. Building has its own high-voltage connection point.

1.3 Target areas (type, usage, occupancy, sensors)

Typology of rooms is based on preliminary selection,[1] technical possibilities and usability in the frame of UL demo specific MOBISTYLE goals (IEQ in relation to behaviour). The rooms vary in area, but have the same building systems and possibilities for interaction.

The demonstration will be done in rooms of fully automated building of FRI FKKT, approximately 8 of them will be monitored in detail (installation of additional IEQ sensors). Available data from SCADA will be used and new equipment will be installed as well. Focus will be on the rooms where user interaction with building systems is possible – **offices**. This will be rooms used by teaching staff, researchers, administrative and technical staff (1 each, total 4x + 4 for verification).

Information available is referring to SCADA[2] system. The first step will be to save signals to process database (GE Historian is available on site). The data will be saved on SCADA system for up to 200 days and needs to be transferred to other database in order to create a long-term storage and safety reasons. The relevant tags are transferred from SCADA system to VPC[3] within the highly secured firewall. In order to transfer file from inside the SCADA network, the one way data transfer is established from VPC to exchange server accessible from outside via SFTP[4]. The file type and tags were defined together with ICT partners.

[1] Building Assessment Sessions Outcomes after the 1st Specific Workshop in Amsterdam, 14-15 February 2017

[2] All UL demo buildings have SCADA (Supervisory Control And Data Acquisition) systems as BMS (Building Management System).

[3] Virtual PC

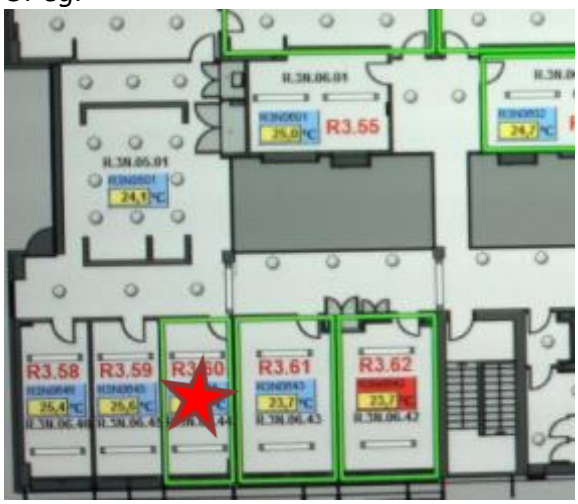
[4] Secure File Transfer Protocol

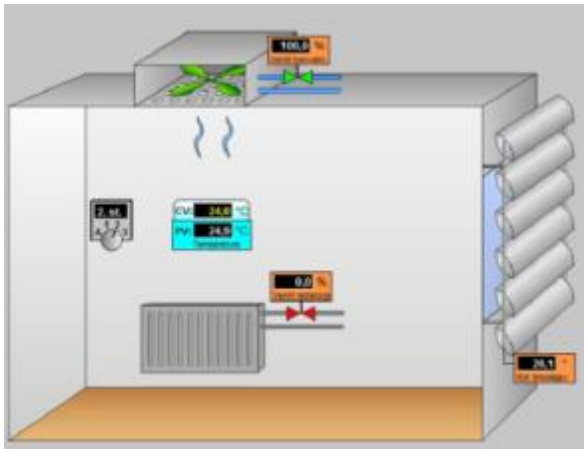
Offices (researchers 60 m^2, a cabinet for teaching staff 15 m^2)

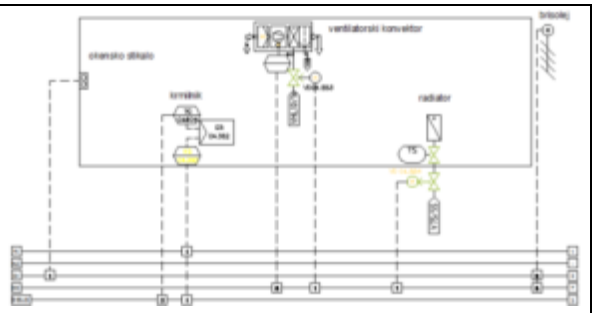
Signals available from SCADA:

- Valve position convector cooling [%]
- Valve position radiator heating [%]
- Daily regime [Off/ comfort/ standby/ saving]
- Hysteresis heating for 3 different regimes [°C]
- Convector ventilator speed [0-3]
- External shading position [°]
- Occupancy from access [0/1]
- Daily regime setting from schedule
- Set point temperature [°C]
- Active set point temperature [°C]
- Actual set point temperature [°C]
- Set point temperature - offset [°C]
- Set shading angle automatic [°]
- Convector ventilator switch status [A/0/1/2/3]
- Room air temperature [°C]
- Temperature regime [Heat/Cool/Off]
- Window switch [0/1]
- No cooling media available [0/1]
- Lights use for each circuit [0/1]

Or eg.





1.4 Technical coordinators

Institute for Innovation and Development of University of Ljubljana: Jure Vetršek, email: jure.vetrsek@iri.uni-lj.si.

University of Ljubljana Faculty of Computer and Information Science and Faculty of Chemistry and Chemical Technology: Simon Pikovnik, email: simon.pikovnik@fkkt.uni-lj.si

2 Demonstration vision and objective

The action plan is designed for demonstrating a sustainable behaviour change towards improvement of indoor environment quality and reduction of energy consumption in a real environment by deploying and validating the developed tailor-made solutions and services.

The objective is to validate the approach, tools, and services applied in terms of increase in indoor environment quality and reduction in energy use through user feedback and data analysis.

The focus of UL demo case will be on improved indoor environment quality (IEQ) as result of modified behaviour. Energy saving will be achieved in parallel to improved IEQ.

The vision of the University of Ljubljana in the frame of MOBISTYLE project is to implement full monitoring and continuous awareness campaigns. With the implementation of ICT support for energy monitoring and ICT tools for systematic influence on user behaviour (awareness building and push approach), savings up to 16% are anticipated and user satisfaction is increased. As the strongest argument for behaviour change, health related data will be used. There are requirements for clear and simple communication of e.g. temperature fluctuation health benefits that can be used as arguments for users (influence on eg. cardiovascular diseases, diabetes and obesity).

Functionalities could be the following:

- *For occupants/users: Interactive and attractive information exchange and attractive visualisation of savings, state of IEQ and personal health; relation between energy saving and IEQ.*
- *For facility managers, building owners: Information of energy performance and diagnostics.*

3 Specific purpose of the Action plan

Effect of modified behaviour on IEQ will be examined in Slovenian demo case while increased energy efficiency is achieved. To designate the baselines and goals of the reduction of energy consumption, it is first required to know the base-line; the adequate data on the building level will be acquired from the energy information system (EIS). It incorporates software, hardware and data for efficient handling of energy in processes, systems, facilities and organisations.

The purpose of the Action plan is to illustrate and demonstrate the approach and methodologies used. From there, the developed and derived ICT tools and services can be assed. According to the Case Description, the demonstration will furthermore aim to provide answers to the following questions:

- *What drivers and motivators influence user behaviour?*
- *What effects does user behaviour have on energy consumption and indoor environment?*
- *Which methods and approaches create awareness and a substantial behavioural change in users?*
- *What is the frequency and intensity of use of the personal apps and tools, monitored, and registered at the start, after 2 months, 6 months, and 12 months of implementation?*
- *Which specific campaigns and validations were necessary during the project?*
- *What basic monitoring and information campaign should be continued after the project duration?*
- *Which parameters should be monitored, how should the information be presented, and what are the aims of a continuous campaign?*
- *How could "soft measures" be considered in future energy performance regulations?*

To answer all these questions it is important to have an overview about what are the conditions inside/outside the room without forgetting how those conditions change as a result of occupant's behaviour and how due to outdoor conditions and buildings systems operations. For this reason, it is useful to identify what are the measurable data that does not necessarily refer to a specific type of behaviour or user and which one are strictly related to the occupant behaviour.

3.1 Conditions overview

Currently IEQ conditions are dictated by the building systems control strategies and user behaviour. These will need to be understood in detail, to be able to differentiate from the impact due to behaviour change. To increase the users' knowledge and awareness that will led to actions inside the building or specific room they spend time in, it is important to collect data on the environmental conditions and on possibly the health of the occupants. By using an app or website, people can get access to this information (weather, IEQ, Energy consumption…).

3.2 Health and wellbeing

Health or its improvement is used as a motivation to stimulate users actions in Slovenian demo case, but will not be monitored directly or permanently. Health facts based feedback will be used as a motivation to stimulate user's actions, prompting natural ventilation, encouraging lower indoor temperatures (also as part of temperature training), use of stair instead of elevators and similar.

3.3 Energy consumption

As for the UL demonstration case, the main objective is to observe relation between the changing indoor environment conditions as a result of users interactions based on the increased awareness. Therefore, energy consumption monitoring is not the main objective, but will be done nevertheless. The consumption will be observed on the building level.
In this project, the type of energy or resources that will be treated, are the following:

- Thermal energy **(TE)** connected to heating and/or cooling systems
- Primary energies used inside the buildings **(PE)**
- Cold water **(CW)**
- Domestic hot water **(HW)**
- Electric energy **(EE)**

Information regarding energy use will be obtained from SCADA control system by the use of Energy information system (EIS) to be installed (FRI FKKT).

Energy type or resource	Question	Parameter	Observation method	KPI[5]
(TE)	What is the heat consumption of the building?	Heating consumption	Directly measured	kWh/m^2/ year
(CW)	What is the cold consumption of the building?	Cooling consumption	Directly measured	kWh/m^2/ year
(HW)	What is the hot water consumption of the building?	Heating consumption	Calculated from water use and temperature	kWh/m^2/ year
(EE)	What is the electricity consumption of the devices inside the room?	Electricity	Directly measured	kWh/m^2/ year
(EE)	What is the electricity consumption of the building?	Electricity	Directly measured	kWh/m^2/ year
ALL	What is the energy consumption during the monitoring period compared to the reference measurement period?	Heating, Cooling, HW, Electricity	Indirectly measured	

[5] In the table, KPIs are presented per year. In the solutions, frequencies will vary depending on application.

3.4 Thermal comfort & Indoor environment quality

UL demo case will focus on IEQ. Measurements available will be used, and new ones will be applied to the demo.

Question	Parameter	Observation method	KPI
Is the comfortable operative temperature in a room within a reasonable range in relation to energy efficiency?	Operative temperature/ Outdoor temperature	Directly measured	Temperature
Is the comfortable operative temperature in a room within a reasonable range in relation to the user health and wellbeing?	Operative temperature/Outdoor temperature	Directly measured User perception	Temperature
Is the ventilation sufficient in a room in relation to comfort?	CO_2 level	Directly measured User perception	Level of CO_2
Is the humidity in a room within a reasonable range?	Relative Humidity	Directly measured User perception	Level of relative humidity
What is the IEQ during the monitoring period compared to the reference measurement period?	Operative temperature, CO_2, Relative Humidity	Indirectly measured User perception	IEQ category Percentage Outside the Range index

3.5 Outdoor conditions

There is a weather station on the premises of FRI that is connected to SCADA. It is possibility to get the retroactive data for national meteorological and air pollution measuring station from Ljubljana.

Question	Parameter	Observation method
What is the current situation of the weather?	Outside Temperature, Relative Humidity, Solar radiation, Wind (speed and direction)	Directly measured/ Weather station
What is the level of outdoor air pollution?	Particulate matter (PM_{10}), SO_2, O_3, NO_x	Indirectly measured (data from the network[6])

3.6 Occupant's behaviour ("What we want to know")

To understand the mechanisms of occupants' behaviours there is on one side a need for monitoring behaviour and for determining connections of these behaviours with energy consumption, indoor and outdoor environment, and occupants' health and wellbeing. In other words, we should try to understand every condition or variation correlated to a specific behaviour. This tacit knowledge is important for the project goals, since it permits to generate and tailor feedback for the users and to help supporting creation of their long-term habits.

Types of behaviour relevant for the analysis are among other:

- Vacancy and access
- Thermostat adjustment or any user interaction with the heating/cooling system
- Opening of windows
- Solar shading adjustments

[6] https://www.ljubljana.si/sl/moja-ljubljana/varstvo-okolja/stanje-okolja/kakovost-zraka/

- Lighting switching and adjustment

What is important to know about every type of behaviour can be summarized in the table below, applying several questions contained inside the table at each type of behaviour.

What we want to know about behaviours (Generic behaviour)				
			Data sources	**Observation method**
CHARACTERISTIC AND CAUSES	What are the characteristics of the behaviour?	When did the behaviour occur? How long?	• Device/object state	Directly measured
		How did the users set up the device? (if regulations are permitted)	• Device/object state	Directly measured
		Who did it? Who affects?	• Occupancy • User tracking	Indirectly measured
	What drivers and motivators influence user behaviour?	Are there recurring moments during the day?	• Device/object state	Indirectly measured (statistical analysis)
		Was there any IEQ/ outside parameters that were critical before the "behaviour"?	• IEQ sensors • Outside condition	Directly measured
		How people that can be affected felt before the behaviour?	• Blood pressure	Directly measured
			• Heart rate	Directly measured
			• General sense of wellbeing	User perception
			• Sense of control over one's surroundings	User perception
CONSEQUENCES	What effects do user behaviour have on energy consumption, indoor environment and health?	Does behaviour lead to increased energy consumption?	• Indoor-outdoor temperature difference • Heating/cooling devices energy consumptions • Electric energy consumption • Solar radiation	Indirectly measured: -simple analysis to evaluate if the impact on energy consumption can be good or bad; -more complex analysis to do a quantitative evaluation.
		Did behaviour lead some IEQ parameters outside the reasonable range?	• IEQ sensors	Directly measured
	Final evaluations	How "bad" is the behaviour for energy consumption?	• Frequency • Duration • Intensity	Indirectly measured
		How "bad" is the behaviour for users' health?	• Frequency • Duration • Intensity	Indirectly measured

4 Required parameters and information

Several rooms at UL FRI will be measured in details and for longer time. Existing sensory equipment allows us to collect and extract large amounts of data. A part of this data will be used for comparing the same types of rooms. The technical limitation is available tags (measurements, set points…) and time they are preserved on the SCADA process database (GE Historian). Existing measurements will be complemented with additional measurements in room in order to quantify IEQ.

The parameters and their accompanying data that need to be monitored are listed in the table below.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/Notes
Thermal energy	Energy use kWh	100 kWh	±5 %	imp	Kamstrup MULTICAL 602, ultraflow 54	On building level, from EIS (heat and cold separately)
Cold water consumption	Water	0,1 m^3	±5 %	month	Water meter	On building level, from EIS
Domestic hot water consumption	Water	0,1 m^3	±5 %	month	Pulse water meter	On building level, from EIS
Electricity consumption	Energy use	1 W	±5 %	15 min	OWL, EIS	On building level, from EIS room level INAP ACS
Operative temperature	IEQ	0,1°C	±5 %	15 min	INAP ACS	SCADA + INAP ACS
Setpoint temperature	User behavior	1°C	/	A new action	Thermostat to PLC[7]	SCADA
Relative humidity	IEQ	1 %	±5 %	15 min	INAP ACS	
CO_2 + VOC	IEQ	10 ppm	±5 %	15 min	INAP ACS	
Cooling celling convector ventilator switch status	User behavior	/	/	A new action	Convector via PLC	SCADA
Window opening	User behavior	/	/	A new action	Magnetic contact	SCADA
Room access	User behavior	/	/	A new action	Electronic lock	SCADA
Light switching	User behaviour	/	/	A new action	Switch via PLC	SCADA
Solar shading	User behaviour	°	/	A new action	Switch via PLC	SCADA
Outdoor illumination	Outdoor	1 klux		15 min	Weather station	SCADA

[7] Programmable Logic Controller (industrial digital computer)

Parameter	User requirements	Actor requirements	Number of participants	Data extracted	Other/Notes
Technology acceptance	App downloads, technology use, daily habits	Interviews, observation and monitoring	All		If applicable
Personal health and sense of wellbeing	Personal monitoring and logging, Data recording	Questionnaires, data collection, data analyses	All	Perception of a high quality of life	Based on user feedback
Perception of environment (IEQ)	Questionnaires, occupant log, nr. of feedback	Data collection, data analyses	All	Thermal comfort, IAQ, heating set point, window opening	
Impact		Data analyses	All	Change in indoor environment Change in behaviour Change in energy use Change in user perception	

5 Behavioural Action Plan

Case study activities at University of Ljubljana buildings will be mainly so called information campaigns with feedback for raising awareness about responsible and sustainable energy use and its consequences, healthy lifestyle and importance of indoor environment quality (IEQ). The last is focus of Slovenian demo case. Continuous interaction with the building users at UL demo buildings will be carried out through a combination of communication channels in order to raise awareness of users in the building (building manager, teaching, research and administrative staff, students and visitors) that will trigger measurable actions. It is more likely that their awareness will be increased and actions taken even further when there is continuous and regular flow of information from/to them via different channels.

It is necessary to point out that students, as the largest group, have minimal impact on IEQ and energy use in the UL demo case due to small possibilities for buildings systems interaction. On the other hand, the personnel occupying offices, which are the in the focus of UL demo, have better options for managing IEQ and energy use.

Use of key data from various systems will be utilized in innovative ways for selected activities that will increase involvement of people who generally do not keep in mind energy use, well-being and costs in public facilities represented by UL demo case. Due to the nature of buildings (educational purposes) this can have significant long term effects, since student will eventually become employees and residents and are already tenants in student lodgings. Furthermore, they will encourage other people to act according to the MOBISTYLE objectives; therefore, more people will become aware (snow-ball effect) and the awareness raising will be more efficient.

Continuous interaction with end-users through a mixture of communication channels is essential. The cooperation between WP6 and WP7 is aiming to support MOBISTYLE approach and establishing of new energy-related practices (raising awareness leading to action) through different tailored communication and promotion materials. The MOBISTYLE awareness campaigns will promote, for example, temperature trainings not only as part of demonstrators but as a part of overall and healthy lifestyle.

As an example, users will be educated that lowering down temperatures on a thermostat will not just enable energy savings but will also contribute to their well-being and better metabolism. Moreover, it can be encouraged that users take stairs instead of an elevator as this does not only save energy, but is in addition healthier for them. Similarly, opening windows in favourable conditions can increase productivity and lead to healthier and more productive indoor environments while decreasing energy use.

Who are you trying to influence (targeted audience)?

In the focus are students, teachers, administrative staff, building managers, and visitors of buildings. However, the main user groups consist of people who are capable of systems interactions (staff). Students and visitors will be targeted to achieve wider impact.

What do you want to make happen?

- Increased user awareness and understanding how IEQ, energy use and health are inter-related.
- Stimulate users to influence an accept parameters of IEQ in the directions of more health and better productivity and efficiency.
- Encourage them to maintain personal health by giving them simple tips (employees – relation to productivity; building managers – energy performance and costs; students – health and productivity).
- Increase knowledge of wider energy use implications by regularly communicating energy production consequences and its effects (global climate change, local pollution and resources depletion).

What do they already know about MOBISTYLE and the issue (importance of energy saving)?

Building manager of FRI FKKT is aware of the MOBISTYLE project and is actively participating in project activities. EF and FF building managers are aware of the project and have been engaged in some activities. On the declarative level, employees and students are educated about the importance of energy saving and reduction of CO_2 emissions; however, it does not necessary lead to actions in the proposed direction.

Who or what is in the way?

- Awareness is not necessary triggering actions; environmental responsibility is not the best motivation for behavioural change in energy use except partly for students. It should be coupled with IEQ and health related implications.
- Comfort is the key element employees are interested in.
- In general, employees in public buildings are not motivated to take actions.
- The target group of employees, capable of managing systems, is very diverse.
- A direct user activity tracking is not possible and available.
- Possible technical difficulties might occur due to high complexity of systems when trying to provide building specific feedback.

Who from authorities is on our side? How active are they willing to be?

Building managers understand the relevance of energy saving and see the MOBISTYLE project as an opportunity to raise awareness of employees who in general do not care about the public building operational costs.

What is the selling point?

The main selling point is increased understanding of the users that their health, productivity and well-being are to large extent dependent and affected by IEQ. Based on this, health

advices are given to them that consequently lead also to energy savings and decrease of environmental footprint.
Due to the nature of the MOBISTYLE project, methods and approaches applied in each case study vary. This is valid above all for types and modes of user feedback. For University of Ljubljana, the demo will be developed on the case of FRI and will later be verified on other UL buildings which are also foreseen as demo sites (FKKT, FF, EF).
This chapter includes selected methods for the following purposes:

- feedback for end users about their indoor environment;
- feedback for end users guiding them to changing their practices.

It is assumed that improved behaviour encouraged at educational buildings of Slovenian demo case can lead to energy savings and improved IEQ also in other contexts (e.g. at home for current building users and in future when students become workers and leaders). Targeted buildings users can encourage other people to act according to the MOBISTYLE objectives (snow-ball effect).
Arising from D2.2 and D2.3, a single and universal ("one-size-fits-all") awareness campaign is not optimal and in most cases not even possible. Therefore, the general approach should be tailored according to specific needs and characteristics of the UL user groups. The tailored MOBISTYLE message will introduce the MOBISTYLE approach, main objectives to the building users where it will be explained why, what, and how the MOBISTYLE demonstration can be carried out in "their" buildings. Furthermore, it will be clearly explained how data protection and user privacy according to GDPR is ensured.
Among other, the MOBISTYLE awareness campaigns will promote temperature trainings not only as part of demonstrators but as a part of overall healthy lifestyle and healthy ageing strategy. As example, users are educated that lowering down temperatures on their thermostats (in heating season) will not just bring energy savings but can also contribute to their well-being and metabolic health. Moreover, it can be encouraged that users take stairs instead of elevator as this does not only saves building's electricity consumption but also is healthier for them. Specific actions for individual target groups (administration, teachers and researchers, technical staff and students) are yet to be defined. For this purpose the questionnaire was distributed and will serve as one informational layer to prepare appropriate actions.
Arising from D 2.3, one important habit is turning off lights. Participants of the focus group mention non-economic motivation factors. One of them even said: "I do it *(save electricity)* on principle, not because of money, since I know that one lightbulb doesn't mean anything." All participants of the focus group perceived electricity at home and work as energy and didn't mention heating. Motivating factors for changing energy related habits are quite diverse. However, the two main motivators are savings and environmental responsibility. Shared values and activities are very important for changing health and energy related habits. The discussion shows that different community agreements and pacts (e.g. to prevent swearing

and support running or energy savings) could be important to change the way individuals behave.

Participants of this focus group find different technologies that try to influence their habits "silly" (the word was used by a participant of a focus group). They understand different apps and wearables as a sort of a "game", which does not make much sense in their lives. In addition, some of them say they don't need a device which tells them about their own bodily parameters, since they can listen to their own body. Some of participants actually bought smart watches and wristbands and stopped using them. Specific recommendations from D2.3. can be summarized as:

- *In public buildings, the existing or new displays can be used as user interfaces.*
- *Smartphone app can be used to inform people about indoor (classroom) and outdoor temperature and air quality. The information can be supplemented by direct recommendations for actions (e.g. turning on lights, opening windows, doing some exercise)*
- *We can support group activities, e.g. engaging students to collaboration or competition between groups and departments. A simple example is using stairs instead of elevator*.
- *Voting about IEQ parameters and their adjustment accordingly by "health and energy democracy approach". For example, if a majority votes to decrease the temperature in the certain room, the building manager receives a notification to do so.*

Possible obstacles and selling points of the MOBISTYLE project and strategies in the specific context of Slovenian case are yet to be determined.

Non-technical measures for influencing behaviour

These arise from D2.3 and are summarized below:

Studies show that when an individual's decision for changing a certain habit is presented to other people and to public, this provides a strong "peer pressure" and stimulates a person to actually achieve a certain commitment.

For this reason, we will create some sort of public dedication.

5.1 Feedback for end users about energy use and indoor environment

To benefit from the opportunity to collect a large amount of data, the data interpretation and, subsequently, the feedback provided to the users as part of the monitoring campaign, UL case study will be based on a combination of standards, measurements, and relative comparisons between an established baseline and the individual units in question.

Energy Use

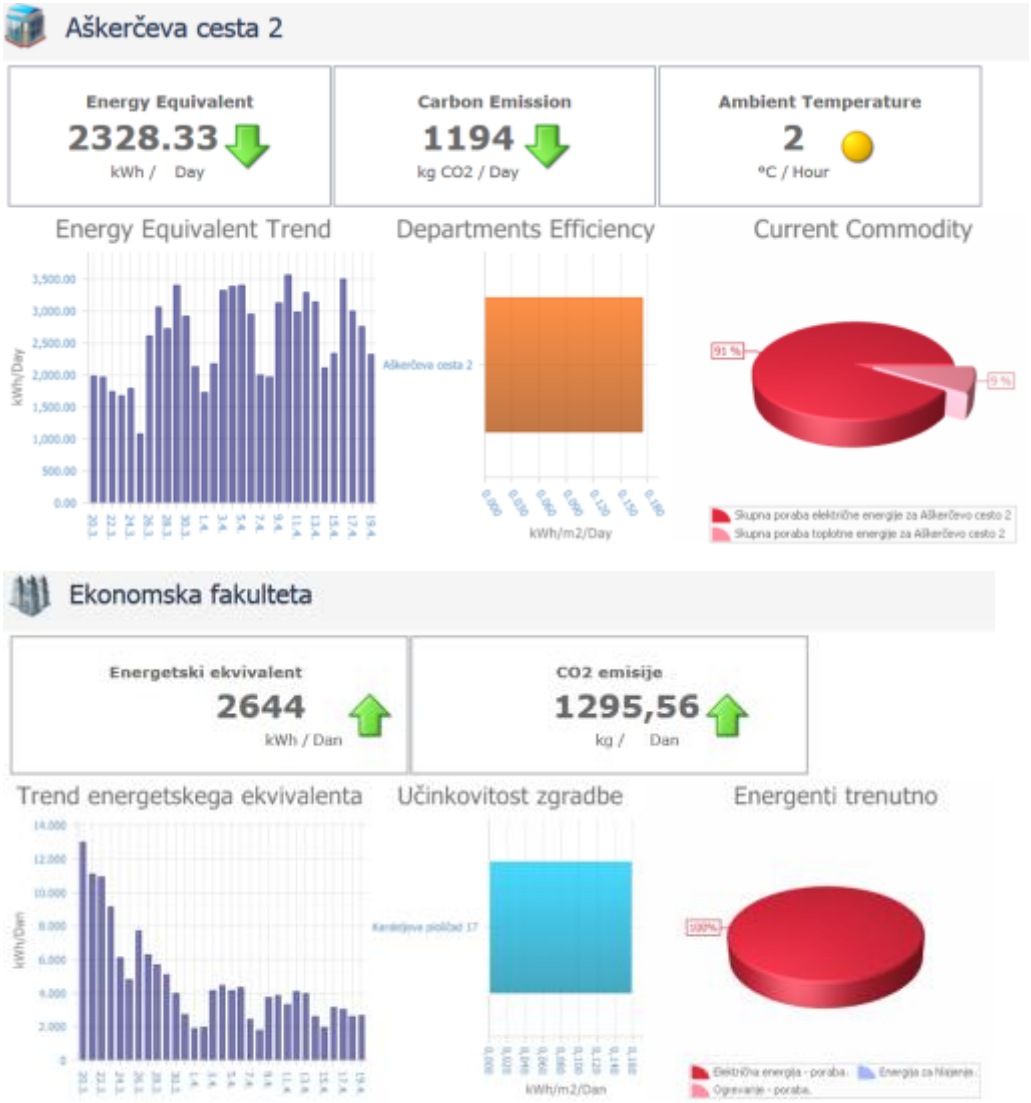
The feedback on energy use for Slovenian demo is related to the whole building level based on data from EIS[8]. There are various possibilities to present the data within the set up system that is collecting data (measurement and energy bills). The energy consumption data will be

[8] Energy information system

displayed to the end user in a graphical form. Available also tables and graphs for in depth analysis. The energy saving target is 16%.

The user (e.g. technical staff) can configure the data and its format he or she wants to see (gauge, graphs…) on the info pane. The boundaries are configurable.

The dashboard shows the daily data for the previous days (up to one month). With the green arrow it is shown whether the use is higher or lower compared to previous day.



The energy use and costs are presented. The historical use is available since the start of the monitoring.

The energy information systems for SI demo buildings are available at the following addresses:

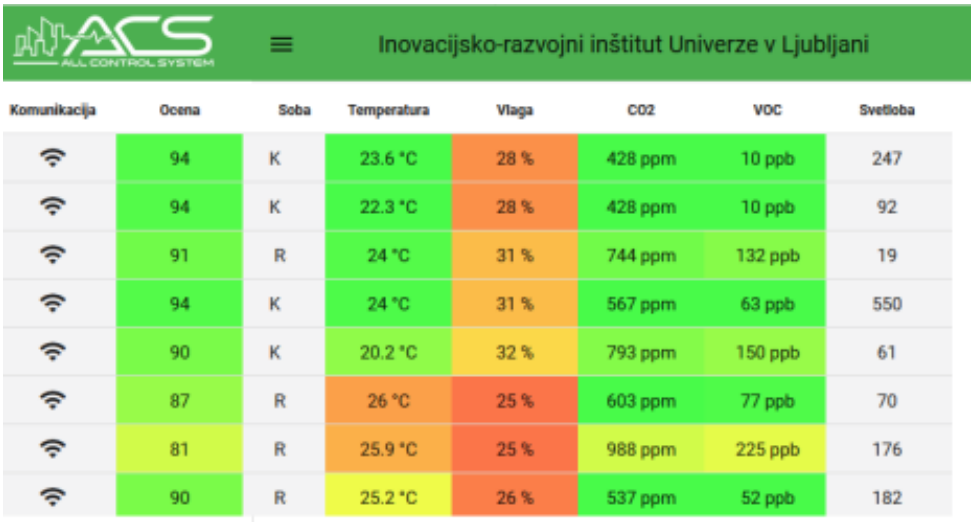
- http://energija.ef.uni-lj.si for EF
- http://energija.ff.uni-lj.si/MepisEnergy/ for FF
- http://energija.fri.uni-lj.si/ for FRI
- http://energija.fkkt.uni-lj.si/ for FKKT

Indoor Environmental Quality

The status of the indoor environmental quality should be given for the room for the three measured parameters: temperature, relative humidity and CO_2 concentration. As in the previous case, the IEQ feedback is communicated to the user mainly through a graphic form that involves the use of three levels of colour.

The colours change according to the set limits for each parameter.

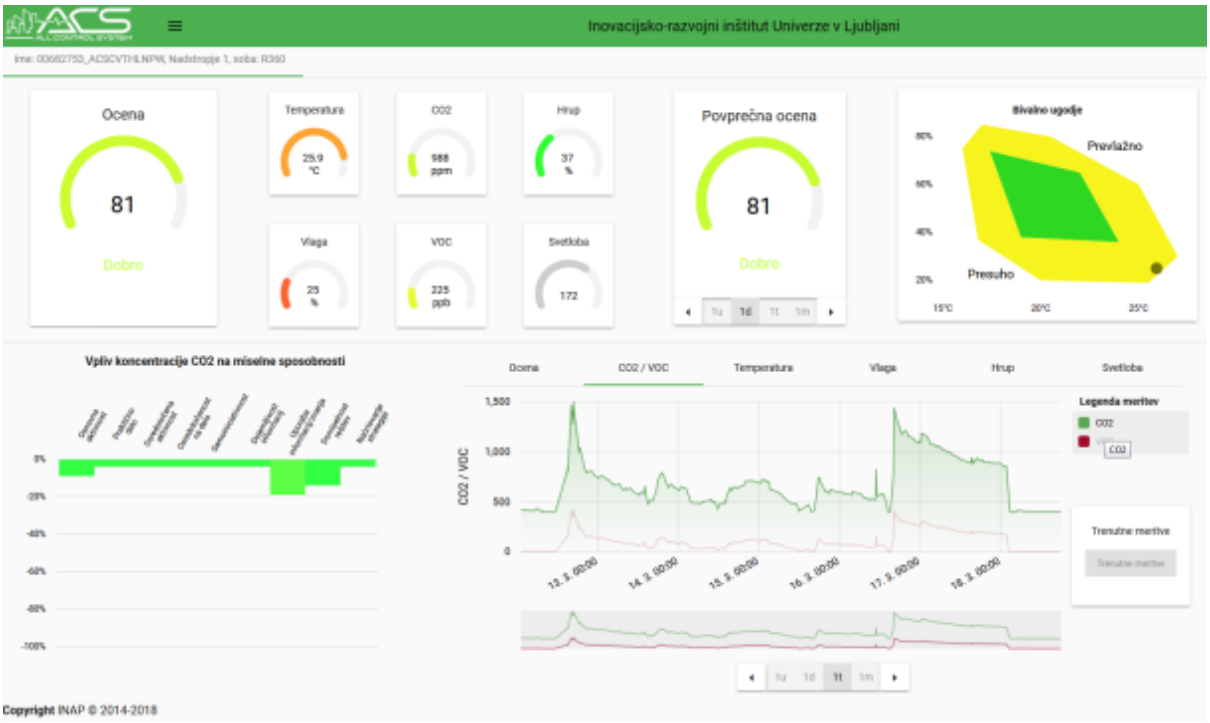
Data presentation on the technical staff level for the IEQ is available below.



Inovacijsko-razvojni inštitut Univerze v Ljubljani

Komunikacija	Ocena	Soba	Temperatura	Vlaga	CO2	VOC	Svetloba
	94	K	23.6 °C	28 %	428 ppm	10 ppb	247
	94	K	22.3 °C	28 %	428 ppm	10 ppb	92
	91	R	24 °C	31 %	744 ppm	132 ppb	19
	94	K	24 °C	31 %	567 ppm	63 ppb	550
	90	K	20.2 °C	32 %	793 ppm	150 ppb	61
	87	R	26 °C	25 %	603 ppm	77 ppb	70
	81	R	25.9 °C	25 %	988 ppm	225 ppb	176
	90	R	25.2 °C	26 %	537 ppm	52 ppb	182

View of the dashboard for the single room available below.



5.2 Feedback for end users guiding them to changed practices

Several channels will be used to target users; from digital to analogue ones (local feedback via diode colour, push massages, dashboards, notes on paper…).

In addition to digital data presentations described in previous chapter, local analogue ***non-invasive feedback*** will be provided in the spirit of "*Calm technology principles*[9]" as part of the campaign. The installed IEQ sensor has a RGB diode capable of linearly changing colour from green to red based on measured values. In the baseline monitoring period, the RGB diode is disabled thus no feedback is provided.

This measure is in line with the "calm technology" principles, specifically the one that states *we should strive to communicate information to the user without interrupting or distracting them from their primary goal*.

[9] https://calmtech.com/

To guide the users to change practices to achieve energy savings or to improve indoor environmental quality it is necessary to provide targeted feedback based on user actions and analysis of data collected during monitoring. The following types of behaviour change objective with associated needed possible actions have been identified:

- *O1 Energy Saving - Heating, Cooling; Adjusting setpoint temperature*
- *O2 Energy Saving - Natural Ventilation; Opening/closing window*
- *O3 Health - Heating, Cooling; Adjusting setpoint temperature - temperature training*
- *O4 Health - Natural ventilation; Opening/closing window*
- *O5 Health - Natural light; Adjusting shading position*
- *O6 Health - Energy Saving (electricity); Using stairs, not elevators*
- *O7 Energy Saving – Equipment; Usage of office equipment*
- *O8 Energy Saving - Artificial Lighting; Switching off/lights*
- *O9 Energy Saving - Water Saving; Use less water*
- *O10 Energy Saving -Stand-by Power ; Switching stand/by power*
- *O11 Energy Saving – Adaptive behaviors; Dinking hot/cold water, adding/removing layers of clothes, take a walk into a colder/warmer*

Objective O1-O6 will be measured directly on the room level, the rest will result only on energy use patterns on the whole building level.

Conditional messages

For each of the behaviour change objectives (O1-O11), several conditional messages were developed.

For the office demo case, the focus will be on improved indoor environment quality (IEQ) and reduced energy consumption, as result of modified behaviour of the target occupants (Professors, Admin Staff, Researchers, Students). Accordingly, we identified 11 key objectives for the elicitation study[10] to support the user engagement and awareness methodology and its further implementation into the MOBISTYLE gamification app.

O1 Energy Saving – Heating, Cooling

Action: Adjusting setpoint temperature

Measure[11]: Yes

Sensor: SCADA Set point temperature (heating/cooling) [°C]

Engagement objective: Would the office worker agree (him/herself or the co-workers) to lowering/increasing the heating/cooling set point temperature for the purpose of saving energy?

Energy saving facts:

- *Lowering the heating/cooling temperature by 1°C can reduce the overall energy by 7%.*

Energy saving facts:

- *Yesterday, the average temperature in occupied time was X*
- *Yesterday, you consumed X € for heating/cooling*
- *Yesterday, due to drifting temperature, you saved X €.*

O2 Energy Saving – Natural Ventilation

Action: Opening/closing window

Measure: Yes

Sensor: SCADA Room temperature [°C], Window Position sensor [0/1], CO_2 Sensor

Engagement objective: Would the office worker agree (him/herself or the co-workers) to open the windows to provide fresh air to the working space based on inputs provided by the app on the current room temperature and window position for the purpose of saving energy?

Energy saving facts:

- *When outdoor conditions are suitable, opening the window will freshen your room and provide energy savings.*
- *Fresh air is beneficial for health. However, leaving the window open too long does not benefit much your wallet! Instead you will lose money for heating.*

[10] Developed in the MOBSTYLE document: *Implementation of the elicitation study questionnaire for the Ljubljana Office Demo case*

[11] Referring to measuring the specific action that happens due to notification.

Energy saving suggestions:

- *It seems you have left the window open for X hours, and outdoor conditions are not favourable.*
- *Open the window, it is warmer/cooler outside*
- *Open the window now and for just one minute. You will provide fresh air, without losing money for heating/cooling.*

O3 Health – Heating, Cooling

Action: Adjusting setpoint temperature
Measure: Yes (temperature training)
Sensor: SCADA Set point temperature [°C]
Engagement objective: Would the office worker (him/herself or the co-workers) agree to lowering/increasing the heating/cooling set point temperature for the purpose of increasing his/her health and/or the general wellbeing of the co-workers?
Health facts:

- *Variation in the thermal environment can challenge the human body to increase resilience.*
- *Lower temperatures increase metabolic rate and thus promote a healthy metabolic profile.*
- *Lower temperatures are beneficial for heat loss during activities.*
- *Reducing the environmental temperature might increase alertness and productivity.*
- *If the temperature is higher/lower than 22°C, it reduces productivity and speed of completing intellectual work.*
- *Higher temperature is associated with higher abdominal circumference.*
- *There is significant association between higher indoor temperature and higher abdominal circumference among elderly independent of physical activity, total energy intake, and socioeconomic status.*

Health suggestions:

- *Do the temperature training to increase resilience!*
- *Increase the temperature! Overcooling brings lower performance in the office!*
- *Lower temperatures help to have healthy metabolism!*
- *Reduce the temperature and boost your brains!*
- *Want to lose some weight due to increased metabolism rate? Reduce the heating setpoint in your office!*
- *High temperature might kill your productivity. Switch off heating for a while!*
- *If you feel cool, put on some clothes!*

O4 Health – Natural Ventilation (IAQ)

Action: Opening/closing window

Measure: Yes
Sensor: Window Position sensor [0/1], CO_2 concentration [indoor]
Engagement objective: Would the office worker agree (him/herself or the co-workers) to open the windows to provide fresh air to the working space based on inputs provided by the app on the current room temperature, CO_2 concentration and window position increasing his/her health and/or the general wellbeing of the co-workers?
Health facts:

- *Fresh air will boost vigilance.*
- *Performance might increase after ventilating the room.*
- *Fresh air increases well-being.*
- *Frequent ventilation helps reducing formation of mould.*
- *Opening a window will decrease CO_2 level in the room. You will be able to concentrate better and stay alert.*
- *Letting fresh air in can decrease humidity and reduce asthma and allergy symptoms.*

Health suggestions:

- *Do you have trouble to concentrate? Open the window!*
- *Feeling tired? Fresh air might boost your vigilance!*
- *Ventilate the room! CO_2 has been above X ppm for X minutes, you might get a headache and your productivity might decline*
- *The outdoor conditions are excellent for letting some fresh air in!*
- *Ventilate the room! There is a risk of mould growth that can be hazardous to your health.*

O5 Health – Natural Lighting

Action: maximizing natural lights/view from outside
Measure: External shading positions, the use artificial lights, outside illuminance level, solar radiation (weather station)
Health facts:

- *Blue light should be increased in the morning hours for increased alertness and less sleepiness*
- *Blue light should be decreased in the evening for a better sleep.*

Health suggestions:

- *Level of light in your work environment is not sufficient. Increase the amount of daylight or switch on lights.*
- *Turn off the lights and save your eyesight. After all, it is sunny outside!*

O6 Health – Energy Saving (Electricity)

Action: Use stairs, not elevators
Measure: No

Health facts:

- *Stair climbing burns more calories than a walk on a flat surface and increases chance to achieve weight loss.*
- *Climbing stairs is a great way to improve energy, increase the function of immune system and lower risk for diabetes, high blood pressure, osteoporosis and heart disease.*
- *Harvard Medical School reports that stair climbing is an effective way to lose weight and keep it off, since people who walk upstairs, even at a slower pace, burn calories three times faster than when walking at a faster speed on a normal surface.*
- *A workout on the stairs provides maximum challenge for people who already maintain good fitness, including football players and other athletes, since the activity is estimated to be twice as vigorous as lifting weights or walking on a steep incline.*
- *Fitness experts usually recommend between 30 and 60 minutes of aerobic activity like stair climbing on three to five days every week in order to gain the most health benefits.*
- *Climbing just eight flights of stairs a day lowers average early mortality risk by 33%*
- *Seven minutes stair climbing a day can halve the risk of heart attack over 10 years.*
- *Just two minutes extra stair climbing a day is enough to stop average middle age weight gain.*
- *Stair climbing burns more calories per minute than jogging.*
- *Stair climbing reduces cardio risk by more than 30%.*
- *Stair climbing helps control weight and builds muscle tone*
- *Stair climbing saves up to 15 minutes a day and cuts CO2 emission*
- *People who use stairs have 15% more chances to live to the old age.*
- *1 minute of walking the stairs uses 9,3 kcal (10,8 Wh or heat 1 l of H_2O for 9,3 °C)*
- *For substantial health benefits, adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity – like using the stairs.*

Health suggestions:

- *Taking care of your healthy means also using the stairs.*
- *Why waiting for the elevator? Use the stairs, save time, get fit and live longer.*
- *Avoid inactivity, use the stairs.*

O7 Energy Saving – Equipment

Action: Usage of office equipment

Measure: No

Energy saving facts:

- *People use significant part of electricity for small equipment.*
- *Being connected 24/7 means information and communication technology (ICT) devices draw energy all the time, even when in standby mode*

- *1W power is approximately 1€/year*

Energy saving suggestions:

- *If you aren't frequently using a device, unplug it.*
- *Turn off your computer and monitor.*
- *Use a switchable power strip*
- *Schedule automatic power off.*

O8 Energy Saving – Artificial Lighting

Action: Switching off/lights

Measure: No

Energy saving facts:

- *Worldwide, grid-based electric lighting consumes 19 % of total global electricity production*

Energy saving suggestions:

- *Its sunny outside, do you really need the light on?*
- *Turn off the light and equipment, if there is no one in the room.*
- *Turn off the lights and save your eyesight. After all, it is sunny outside!*
- *If you will be out of a room for 15 minutes or less, leave it on.*
- *If you will be out of a room for more than 15 minutes, turn it off*

O9 Energy Saving – Water Saving

Action: Use less water

Measure: No

Energy saving facts:

- *Electricity is needed for transport, preparation, heating and treatment of water.*
- *Water is needed for electricity production.*
- *Heat use for water heating is important part heat use in buildings.*

Energy saving suggestions:

- *Do you really need hot water for washing your hands?*
- *Take care of water use.*

O10 Energy Saving – Stand-by Power

Action: Switch off stand-by power (smart strings, power outlets)

Measure: No

Energy saving facts:

- *Stand by use is responsible for X% of energy use.*
- *1W power is approximately 1€/year*

Energy saving suggestions:

- *Try to reduce electricity wastes and vampire loads. Do you really need all the devices plugged in?*
- *Are the any lights blinking/on? This is stand by use that should be avoided.*
- *Unplug chargers from the socket.*
- *Use a switchable power strip*

O11 Energy Saving – Adaptive behaviors

Action: dinking hot/cold water, adding/removing layers of clothes, take a walk into a colder/warmer space.

Measure: No

Energy saving facts:

- *Performing activities (e.g. a short walk, use of stairs) increases your metabolism and keeps you warm.*
- *Need to exercise our thermoregulatory system as part of a healthy lifestyle (use it or lose it). By regular exposure outside the thermoneutral zone:*
    - *Increase brown adipose tissue and energy expenditure capacity*
    - *May increase insulin sensitivity*
- *Increase resilience to more extreme weather condition (important for healthy aging)*

Energy saving suggestions:

- *If you feel cool, put on some clothes!*
- *If you feel hot, you should cool yourself and/or move to another room.*
- *If you do X sit-ups, you will feel warmer and more focused.*
- *Stand up and stretch a bit.*
- *Exercise your thermoregulatory system for increased energy expenditure capacity, and resilience to extreme weather conditions!*

6 Project Evaluation Methods

An effective methodology needs to plan not only collection of data, but also data analysis. Once considered the purpose of the monitoring in the previous sections, the next step is to define an analysis methodology. What is most important is that data are analysed in a way that provides answers to key monitoring and evaluation questions that are then used to increase performance, and not just to satisfy externally imposed reporting requirements. Data analysis is then useful to elaborate raw data into significant indicators that allow highlighting any signs of progress and changing that result from an activity.

The following aspects of data analysis will be undertaken:

- **Comparing disaggregated data**. For indicators with disaggregated data, plan how it will be compared, displayed, and analysed.
- **Comparing current performance against multiple criteria.** For each indicator, plan how actual performance data will be compared with
    - past performance,
    - planned or targeted performance or
    - other relevant benchmarks.
- **Analysing relationships among performance indicators.** Plan how internal analyses of the performance data will examine interrelationships.

6.1 Evaluation of energy use and indoor environment

Analysing the microclimatic quality of the indoor environment and the buildings energy consumption is presented in the following paragraphs.

Energy

Energy use is measured for all periods on at least monthly frequency. Energy use for heating, cooling and electricity on the building level is given for each month during the year. Heat use for the DHW is calculated from quantity of cold water heated. Energy use is given as absolute values for the building. Energy use for each year is sum of the monthly values.

Energy use for heating, cooling and domestic hot water will be compared between the reference and the monitoring period. Because heating energy use dependents on the season, periods with similar outdoor environment will be compared with each other. The variation of the offices heat and cold use due to implemented MOBISTYLE solution will be assessed based on the actual and set point temperatures and valve positions of radiator heating and convector cooling in correlation to the needs.

Indoor Environment

Indoor environmental quality is evaluated for both the reference and the monitoring period. From the collected data is possible to obtain statistical values to give judgement on environmental quality:

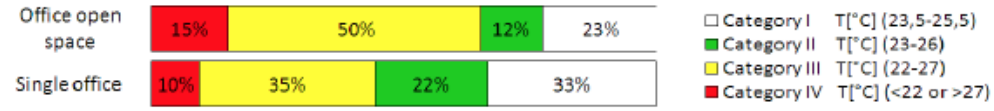
- Mean hourly values (RH_{1h}, T_{1h})
- Mean daily values (RH_{1d}, T_{1d})
- Standard deviation (St. Dev.)

- Minimum and Maximum values during the investigation period (Min, Max)
- Frequency distribution and cumulated frequency.

The variation of IEQ parameters between the offices will be analysed. Users interaction with the buildings systems and their impact on IEQ will be examined. CO_2 levels and Relative humidity can be evaluated with the number/percentage of occupied hours (POR) in which the respective IEQ parameters falls outside the range of predefined comfort classes (Class I,II,III) – this allows also for defining the number of hours outside these ranges (discomfort).

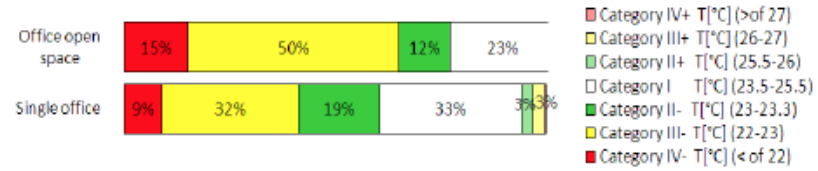
Temperature

Temperature levels are evaluated for each ofice for the reference and the monitoring period according to comfort categories given in standards, see figure below:



Note: The figure must be changed to show + or – for category I

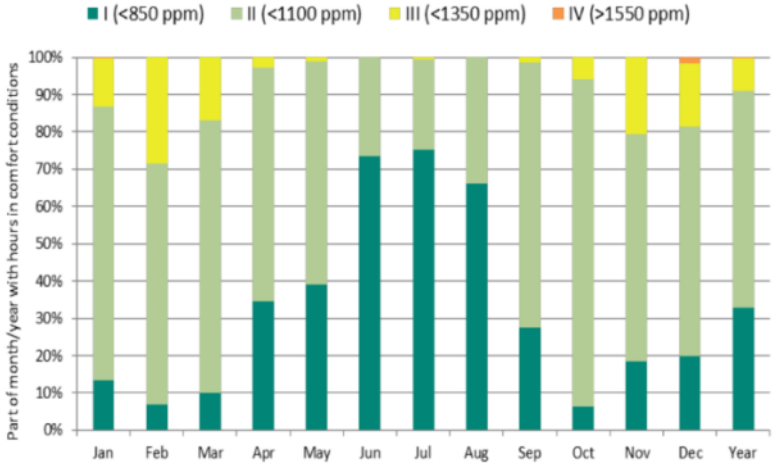
Alternative with above and below temperature range



In order to capture differences between seasons, temperature levels should be evaluated using operative and running mean temperatures.

CO_2

CO_2 levels are evaluated for each room for the reference and the monitoring period according to comfort categories given in relevant standards, as presented in the figure below.



Relative humidity to be presented in the same way as CO_2.

6.2 Evaluation of the change in user practices as a result of user feedback

The measurement equipment installed will collect data regarding system operations, user interaction with the systems, and link the existing conditions to user behaviours. IEQ is the priority in Slovenian demo case, followed by energy consumption. User behaviour is assessed based on actions taken at various situations and combined with qualitative ethnographic data. Behavioural change can be evaluated through the answers of MOBISTYLE participants on tailored questionnaire delivered before the feedback provision and after (when possible) the feedback provision. The aim of the questionnaire is to understand changes in terms of perception by the participants related to comfort, energy health, interactions with buildings and the MOBISTYLE project. In addition ethnographical inquiry methods will be used for this purpose, such as interviews and focus groups before and after the feedback. They will be combined with data mining of workspace related sensor data (e.g. window opening, occupancy, lights use) as a new approach to anthropology successfully merging quantitative and qualitative methods.

Change in indoor air quality

Changes in indoor air quality between the reference and the monitoring periods can be illustrated by comparing carpet plots, where it can be shown when, how much and for how long changes occur. Special attention will be focused on illustrating changes in indoor air quality in periods after giving feedback on benefits of window opening or closing.

Change in set point temperature in the heating/cooling season

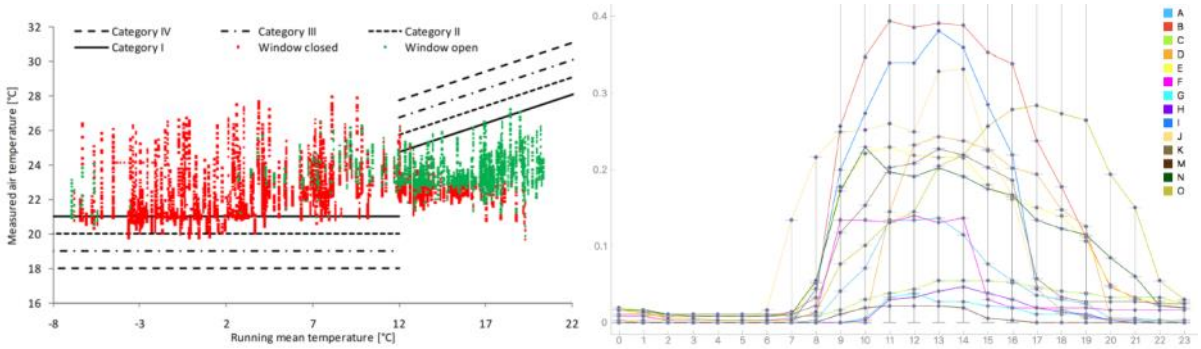
Changes in set-point temperature between the reference and the monitoring periods will be shown based on information from user interactions with thermostats obtained from SCADA. Special attention will be focused on illustrating changes in set-point temperature in periods after giving feedback on benefits of changing it.

Change in indoor air temperatures

Changes in indoor air temperatures between the reference and the monitoring periods can be illustrated by comparing plots, where it can be illustrated when, how much and for how long changes occur. Special attention will be focused on illustrating changes in indoor temperature levels in periods after giving feedback on benefits of window opening.

Change in window opening practices

Window opening behaviour will be illustrated as a function of temperature level, CO_2 level and humidity level in the actual room, respectively. Special attention will be focused on comparing changes in user practices between the reference and the monitoring periods, i.e. when and for how long are windows open and are there recurring moments during the day. This can be illustrated by a carpet plot as an example below left and window opening frequency by the hour of the day as shown below right. Special attention will also be focused on illustrating if changes occur in user practices in periods after giving feedback on benefits of changing window opening behaviour.



Change in artificial light and external shading use

Change in electric lights use and external shading interactions as a function of outside illuminance level between the reference and the monitoring periods can be illustrated by comparing carpet plots. Special attention will be focused on illustrating changes in artificial light use in periods after giving feedback on benefits of natural lighting use.

6.3 Evaluation of the use of the MOBISTYLE solution and user perception of feedback and guidance

It is foreseen to evaluate the effectiveness of feedback categories related to different segments:

- IEQ and natural ventilation
- Heating
- Cooling
- Lighting
- Health and wellbeing

To test the effectiveness of the different feedback categories in terms of IEQ, it is required to compare the relative variation of the percentage of hours outside the comfort rage (POR) for individual feedback category before and after the feedback provision.
The user perceptions will be evaluated by the use of ethnographic inquiry methods (tailored questionnaires and focus groups).

6.4 Information for calculation of Key Performance Indicators (KPI)

In the following tables, selected indicators for each area (energy, IEQ, health) are reported giving a brief explanation and their units. The time frequency is stated per year, but this will in reality depend on the application and needs (per month, day, hour).

KPI (Energy)		
Category	**Description**	**Unit**
Total building energy performance indicators	**Emission of $CO_{2,equivalent}$.** Measures the amount of $CO_{2equivalent}$ caused by the energy consumption in certain period. A measure of how much carbon dioxide and how much the users might contribute to climate change is created. It is necessary to use CO_2 conversion factors in order to translate the different energy related to carriers into emissions.	$kgCO_{2,equivalent}$/year $kgCO_{2,equivalent}/m^2$ year $kgCO_{2,equivalent}/m^3$ year $kgCO_{2,equivalent}$/occ year
Electricity building performance indicators	**Electricity consumption.** Measures the amount of electricity in a certain period. Can also be referred to specific electric equipment or to the lighting system. Can be related to the conditioned net building area, the conditioned net building volume or occupants number.	kWh_{el}/year, kWh_{el}/m^2 year kWh_{el}/m^3 year kWh_{el}/ occ year
	Costs for electricity consumption. Represents the amount of money in period related to electric energy consumptions (can be divided for different end uses or equipment). The users can easily understand and relate to costs.	€/year
	Normalized electricity use to occupant number. Relates the building or building part electricity consumption during the occupancy hours to the number of occupants.	kWh_{el}/occ

KPI (IEQ)		
Category	**Description**	**Unit**
Thermal Comfort	**Operative Temperature.** Represents the temperature measured in the room. It can be given as the present value or as an average value for a given time period (daily, weekly).	°C
	PMV. The PMV is an index that predicts the mean value of the votes on the thermal environment of a large group of persons on a 7 point thermal sensations scale (hot, warm, slightly warm, neutral, slightly cool, cool, cold)	-3; +3
	PPD. The PPD index predicts the percentage of thermally dissatisfied persons. It predicts the percentage of persons voting +3, +2, -2 or -3 on the PMV index.	%
	Thermal comfort category. Based on the percentage of thermally dissatisfied persons (PPD index) thermal comfort sensations are divided into different categories: - Cat. I PPD<6%; - Cat. II PPD<10%; - Cat III PPD<15%;	I-IV (Mechanically cooled)

	- Cat. IV PPD > 15%. It can be given as the present value or as an average value for a given time period (daily, weekly)	
	Thermal comfort category (adaptive approach). Thermal comfort categories taking into account that thermal sensation of persons changes with the outdoor environment in free running buildings where users have possibilities to adapt to the indoor environment. It can be given as the present value or as an average value for a given time period (daily, weekly)	I - III (Adaptive)
	POR. The Percentage Outside the Range index , POR, calculates the percentage of occupied hours, when the operative temperature is outside a specified range.	%
Indoor Air Quality	**PPD.** The PPD is an index that predicts the number of people expected to be dissatisfied with the indoor air quality (mainly persons as pollution source) when entering a room. It can be given as the present value or as an average value for a given time period (daily, weekly).	%
	Indoor air quality category (human perception). Based on the percentage of expected dissatisfied persons with the indoor air quality: - Cat. I PPD<15%; - Cat. II PPD<20%; - Cat III PPD<30%; - Cat. iV PPD > 30%. It can be given as the present value or as an average value for a given time period (daily, weekly). Categories are also defined based on the relation between indoor CO_2 concentration above the outdoor concentration and the percentage of persons dissatisfied with the indoor air quality: - Cat. I CO_2<550ppm; - Cat. II CO_2<800ppm; - Cat III CO_2<1350ppm; - Cat. IV CO_2 > 1350ppm. It can be given as the present value or as an average value for a given time period (daily, weekly)	I-IV
	Level of CO_2. Represents the measured level of CO_2 in the indoor environment. It can be given as the present value or as an average value for a given time period (daily, weekly).	ppm
	Level of relative humidity. Represents the measured level of relative humidity in the indoor environment. It can be given as the present value or as an average value for a given time period (daily, weekly).	%
	Indoor air quality category (humidity). Defined based on the level of relative humidity: - Cat. I RH<50%; - Cat. II RH<60%; - Cat III RH<70%;	I-IV

	- Cat. IV RH> 70%. It can be given as the present value or as an average value for a given time period (daily, weekly).	
	POR. The Percentage Outside the Range index , POR, calculates the percentage of occupied hours, when the indoor air quality (perceived, CO2 or RH) is outside a specified range.	%

KPI (Health)		
Category	**Description**	**Unit**
	Heart rate. Heart rate is the amount of contractions of the heart muscle in a certain period of time and can be influenced easily by changes in environment or activity. This also makes it difficult to define a certain threshold for heart rate. According to the American Heart Association a normal heart rate during rest is between 60 and 100 beats per minute for an average person. Monitoring of heart rate is easy with current monitor devices.	beats/min

7 Monitoring plan

Both the quantitative and the qualitative monitoring will take place for a period of 30 months, from October 2017 until March 2020 (both included). Quantitative monitoring based on measurements will be focused on FRI, qualitative will include also FKKT, FF and EF. FRI is a specific test bed where we will be able to use various layers of information in order to understand user behaviour (data from technical systems will be combined with anthropological approaches), other buildings (FKKT, EF and FF) will be used for verification and generalization.

This covers both an observation measurement period to establish a reliable baseline and a monitoring period in which behavioural change is observed. As the entire MOBISTYLE project is scheduled to last 42 months, starting from October 2016 (M1), the observation measurement period will take place for 8 months from month 12 (M12), October 2017 until month 19 (M19), May 2018. The monitoring period will take place for 22 months, M20 – M42, June 2017 to March 2020, respectively. The monitoring will be continuous and consistent, measuring and logging the parameters defined for the specific case. These parameters will subsequently be analysed and interpreted to achieve the project goals. The data collection will take place frequently, at set intervals of 0, 2, 6, and 12 months respectively. At each time step, data will be collected for analyses.

Measuring campaign condition parameters will be established by performing outdoor data logging from the weather station on FRI and FKKT building. Weather station will record outdoor conditions, such as temperature, solar radiator, relative humidity, wind speed and direction. It is possible to obtain historical meteorological data for national meteorological service measuring station in Ljubljana. Company METRONIK (leading system integrator for industrial and building automation) will be included in Slovenian demo case, because they build entire SCADA system, including installing hardware for FRI FKKT, and partly for FF and EF. Theirs solutions are used also on EF and FF. This eases the wider replicability in the UL buildings. IEQ sensors will be supplied, integrated and fata flow ensured by a different company.

Moreover, the actors involved in the project include the users of UL 4 faculties, the focus group members, and volunteers outside of the focus group. The focus group members will contribute with their interviews and feedback both prior to and during the measurement campaign as part of thick data collection.

In the images in Chapter 1 Short description, the location of measurement points can be seen.

The following subsections comprise an action based list of tasks in a chronological order containing relevant information about each step in order to execute the measurement campaign.

The measurement campaign preparation process

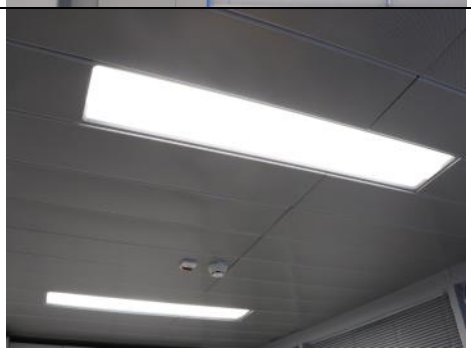
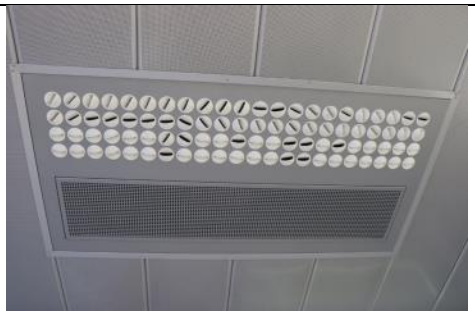
It is crucial that the specific test conditions related to the measurement campaign are well documented and reported during the monitoring process. An essential part of the preparation process will include decisions regarding logging, documenting, and archiving.

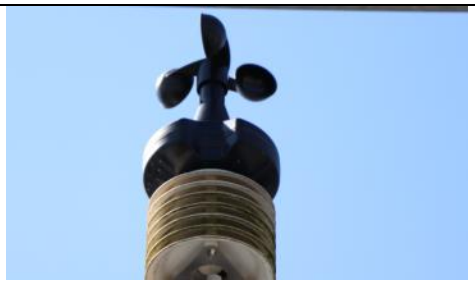
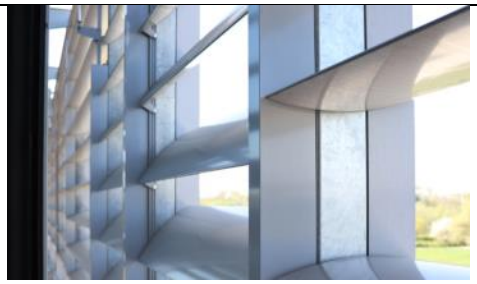
The installation process will include defining, harnessing, processing, sending, saving and interacting with MOBISTYLE platform for:

- data from existing SCADA for user interaction with building systems
- newly installed IEQ sensors

Connected equipment

Equipment (sensors and actuators) that are monitored are presented in the table below.

Connected equipment		
Window opening by window switch		
Lights use for each circuit		
Cooling media use by valve position of celling cooling convector		
Room occupancy from access by electronic lock		

Weather parameters from onsite weather station	
External shading position	
Heating media use by radiator valve position	
Set point temperature from room thermostat	
Temperature, humidity, CO_2 from IEQ sensor	

Description of the measurement procedure

The measurements performed follow a standard method often used during monitoring of IEQ, energy, and user comfort monitoring, and will be described in the following section.

Approach of the EN 15251 Indoor environmental input parameters for design and assessment of energy performance of buildings, addressing indoor air quality, thermal environment, lighting and acoustics are used.

Data is obtained to characterize user behaviour and the performance of selected rooms in terms of energy consumption and indoor environment quality.

Various sensors and measurement devices are placed, installed and data from existing sensors is used in order to provide values, which can be analysed. A process of correction or normalization as well as uncertainty estimation is also established. Various obstacles, for example, a temporary loss of connection, may occasionally interrupt the data collection process resulting in a reduction of measurement availability. Reaction in these instances is jet to be determined; weather a process of automatic interpolation between the measurements available will be applied or empty fields will be showed to avoid false conclusions.

Any equipment specifications, which may have an effect on the measurements, should be clearly stated during the monitoring process, so that such influences could be accounted for.

The measurement period consists of both a reference and monitoring period. Both quantitative and qualitative data will be collected. Depending on the case, strategies in qualitative data collection will include questionnaires for all participants, interviews for some; likely the focus group members. The monitoring will be continuous and data collection and review will take place at certain intervals during the project timespan in order to be able to react on observations made and carry out possible improvements to the methodologies and feedback developed.

6 interviews and 2 focus groups combined with participant observation will be conducted for baseline and for developed solutions impact evaluation. Areas of research will be:

- Time management,
- Interaction with technologies and systems in the buildings,
- Use of public and private (offices) spaces
- Influence of energy use and IEQ on health and wellbeing.

Monitoring activities will be divided in four phases:

1. *Checking the existing conditions – reference measurements.*
2. *Assuring that what is installed performs as expected and if the users understand the situation.*
3. *Performance evaluation and data collection.*
4. *Final impact assessment – proving what worked.*

Data acquisition

For obtaining, analysing and presenting energy related data, Energy information system (EIS) will be implemented in the demo buildings. This includes SW licences to be installed on virtual PC on university server, installation and configuration, synchronization with existing process data base (GE Historian), applicative software and customization of interface done by the solution integrator. All energy related measurements will be saved here.

In order to obtain information from existing SCADA system (e.g. opened windows, access, thermostat interactions…) the tags of the parameters of interest will need to be identified.

The system integrator will have to reconfigure the SCADA and its process data base so these tags/measurements are saved.
IEQ data is obtained by specialized combined wireless transfer.

Data sharing and exchange

Due to safety concerns it is not possible, that external parties access SCADA database. There are space related limitations of parameters saved in this database (200 days). Data is therefore transferred to another database. There it will be stored for longer periods of time, and available to MOBISTYLE applications. Data is transferred to SFTP server accessed by the MOBISTYLE partners. In short, VPC containing SCADA creates .csv file and periodically copies them to other local server based VPC. There is a service with one way traffic transferring created files every 15 minutes to a SFTP server accessible from the outside (to MOBISTYLE platform administrator).
IEQ and optional electricity use room sensors (INAP ACS) are separated from the SCADA, also communications wise. It connects to a hidden wireless local network and via a specialized locally installed equipment and university highly secured firewall to a company's cloud. Ta MOBISTYLE partner access the data stored in the cloud by standard means.

Reporting format

The final monitoring report will be the revised Action Plan and shall contain the following information:

- A description of the equipment used and their location within the monitoring site.
- An identification of the specific equipment configuration under the measurement
- A description of the measurement site and the ambient conditions.
- Identification of the sensors and data acquisition system, including documentation of calibrations for the sensor's transmission lines, and data acquisition system.
- A description of the method of data acquisition, storing, and analysis as described in Section 5 KPI analysis and interpretation methods of this Action Plan.
- A description of the measurement procedure.
- Presentation of measured data.

8 Evaluation Plan

The following describes the evaluation process of the case study and the demonstrated technologies. The purpose of the evaluation is mainly to:

- Evaluate the impact or outcomes of the demonstration. This includes evaluation of the changes of indoor environmental quality in the offices, impact on buildings energy and evaluation of the changes in user practices as a result of feedback.
- Evaluate the feedback process (identifying user perception of feedback and guidance as well as possible optimization and improvements of the implemented solutions).

The goal is to figure out the project's effectiveness (estimating the extent to which the project's outcomes meet its objectives) and the project's relevance (identifying if the project's goals are responding to the identified users' needs).
The evaluation will be divided into three different phases, where each of them has their own objectives:

1. Benchmark definition: Evaluate the existing conditions.
2. Intermediate evaluation: Preliminary evaluation of perception of feedback, impact on performance and changes in user practices.
3. Final Impact Evaluation: Final evaluation of perception of feedback, impact on performance and changes in user practices. Accurate verification of the project achievements.

	September 2018	April 2019	January 2020
MOBISTYLE project timeline	M24-M25	M31-M32	M40-M42
Evaluation timeline	E1	E2	E3
Phase name	Benchmark evaluation	Intermediate evaluation	Final Impact evaluation
Phase description	Define reference performance in relation to energy use and indoor environmental quality	Preliminary evaluation of perception of feedback, impact on performance and changes in user practices.	Assessing the project results
Notes	No solutions implemented, only monitoring	Evaluation at the end of the first step of monitoring with feedback.	Final data extraction and analysis

Benchmark definition (E1)

The purpose of the benchmark evaluation is to determine the reference situation before application of the MOBISTYLE solution and will be based on monitored values. References will be defined for each chosen indicator in the defined fields (energy, comfort, and potentially health). In case of energy indicators, reference will be analysed through normalized and specific KPIs (per person, HDD, building area, etc…) using monthly data on the building level. Indoor environmental quality is evaluated for the reference period. Temperature, CO_2 and RH levels are evaluated for each room. Interactions of the users with systems will be reported and analysed in order to have a baseline behavioural profile.

The following items will be included in the analysis:

- preferences in terms of IEQ parameters (T_{in}, CO_2, …)
- comfort preferences, satisfaction and health-related aspects (ethnographic inquiry tools)
- Occupational patterns and specific interactions with systems (number of window openings, thermostat and shading adjustments, light use).

Intermediate evaluation (E2)

The purpose of the intermediate evaluation is to get a preliminary idea of the impact and perception of the MOBISTYLE solutions and feedback and to receive opinions from the user regarding improvement possibilities. Based on monitored data it will include evaluation of:

- Temperature, CO_2 and RH levels for each monitored apartments and initial comparison with the reference period. Main descriptive statistical parameters will be obtained: mean hourly values, standard deviation, minimum and maximum values during the investigation period, frequency distribution and cumulated frequency.
- Occupational patterns and specific interactions with systems (number of window openings, thermostat adjustments, usage of electrical appliances) will be analysed and compared with the reference period
- Energy use each month in the feedback period and initial comparison with the reference period (if possible)

A focus groups will be conducted with users of offices to assess their perception of the building, how they use the systems and MOBISTYLE solutions, when, for how long and to what extent their preferences for comfort and satisfaction and health aspects have changed. The focus group will also identify user perception of the feedback information and feedback received as well as if it based on their own opinion has led to any changes in their practices.
In order to improve and optimize the feedback process, the following factors will be analysed:

- Different feedback category will be analysed and compared in terms of achieved results. For example, it is possible to compare feedback related to heating, lighting, electrical appliances with the final energy used for heating, artificial lighting, appliances to calculate where the major savings are obtained.
- The effectiveness of the communication adopted and its characteristics as:
  - type (numerical, graphical),
  - communication strategy (prompts, pop up message, educative advices, serious game, newsletters, not technology based activities),
  - length (concise/long),
  - wording and design (efficacy of the chosen terms in the message),
  - credibility (coherency of provided feedback) and
  - level of detail of communication.

- The efficacy of communication channel should be also evaluated in terms of: usability, user-friendliness, easiness of use, barriers, reliability, user satisfaction/experience and interaction rate.

Final evaluation (E3)

The purpose of the final impact evaluation is to document the impact and perception of the MOBISTYLE Solution. It will use the same methodology as carried out in the previous evaluation period and the monitoring phase M2 (provision of optimized feedback), monitoring phase M1 (feedback provision) and M0 (initial monitoring) will be compared. This will allow a continuous improvement of the methodology as well as improve quality of feedback from users on their perception as they will get used to the methodology and the questions asked.
Moreover, final evaluation will assess if MOBISTYLE goals described in the proposal are achieved. The assessment of these goals should then regard:

- Improvement in indoor environmental quality by comparing temperature, CO_2 and RH levels for each office to the reference period.
- User practices in relation to set-point temperature, window opening, lights use and comparison with the reference period.

Final evaluation of measured data will be combined with ethnographic research means. Above mentioned quantitative methods can easily answer the ‘what’, ‘where’ and ‘when’ type of questions, but struggle with the ‘why’. For this reason we will employ anthropological fieldwork and ethnography as the main method of anthropology. We will conduct interviews with room occupants to explain what the uncovered patterns mean and why people behave the way they do.

9 Instrumentation

The equipment and concepts are described above. The significant part of SI demo is obtaining the data from existing systems (SCADA) in a safe way (not to put SCADA at risk with possible access from the outside). Some steps are able to be done only by the SCADA provider. Several interfaces between different systems had to be developed for the first time therefore we include those as well in the instrumentation list.

Sensor/segment	Price in EUR
Energy information system MePIS Energy Buildings installation and configuration	5600
EIS an GE Historian process DB reconfiguration for data accusation	420
Applicative program environment for data accusation from controllers and IEQ measuring equipment	6650
Development of application for .csv files generation from the process DB	815,4
Energiemonitor Smart Meter 3 Phase Pack + integration	300
Development and configuration of SW tolls for IEQ and energy data accusation	2900
INAP ACS sensor – CO_2, VOC, Temp, Humidity (8x)	120
Cloud for on line viewing and achieved measurements for 2 years	1500

All prices indicated are excluding taxes (22%) and for 1 piece of equipment.

10 Resources and Time Schedule

The table below summarizes the required resources to carry out the action plan in terms of costs, time, and hours of labour.

10.1 Overview

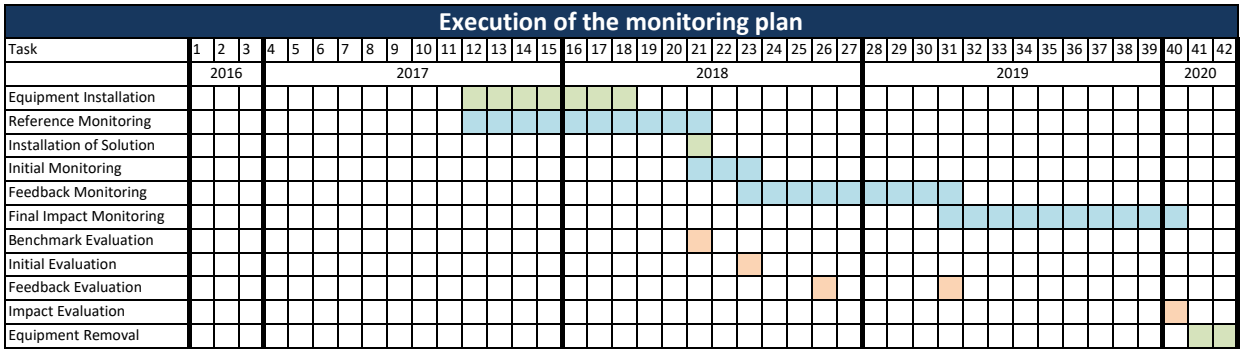
Most of the sensors, except the INAP IEQ sensor were already in place as part of SCADA based building automation system. What was missing and needed to be added was how to get data out of existing systems and databases. Due to sensitive system in terms of security, this was not a trivial task.

Execution of the monitoring campaign				
Task	**Time period**	**Hours of labour needed**	**Associated costs**	**Notes**
Equipment purchase, calibration, and installation	M13-M18	60 H	-	*For costs see section 9 Instrumentation
Quantitative data collection	M19 – M42	20 H		
Qualitative data collection	M1 – M42	60 H		
Equipment maintenance and repair	M19 – M42	-		
Equipment removal and dismounting	M43	10 H		
Data extraction and handling	M19 – M42	60 H		
	Total:	210 H		

10.2 Detailed time plan

Project timeline

The Gantt chart per month presents an overview of the demonstration activities and their duration. To be modified according to solution availability.



Deployment of ICT solutions

In MOBISTYLE there are two Information and Communications Technology (ICT) solutions implemented in order to achieve the MOBISTYLE goal: reduce energy consumption by 16% and improve IEQ conditions and health aspects in the demonstration buildings. These ICT-solutions are GAME and DASHBOARD, developed by Highskillz (HS) and Holonix (HLX) respectively.

In public demo-cases like UL buildings only the DASHBOARD App will be implemented. The timeline for this process is presented in the following table.

June 2018 – August 2018	September 2018 – February 2019	March 2019 - January 2020
M21 – M23	M24 – M29	M30 - M40
M21 DASHBOARD Prototype I (Desktop version)	M24 DASHBOARD Prototype II (Mobile App version)	M30 Final DASHBOARD (Mobile App version)

Initially, the Desktop version of the DASHBOARD (Prototype I, M21) is created and presented to the key persons from IRI-UL and building managers of the demo-case building.

Further, it is planned to develop the DASHBOARD application for the Android mobile phones (Prototype II, M24). Soon after the Prototype II version will be available to the UL employees, it is planned to organize a meeting with them in order to evaluate end-user interaction with the application. This will be done by organizing meeting with focus group participants to evaluate the usability of a system. Here the end-users will complete the System Usability Scale (SUS) and make an evaluation of the first mobile version. Afterwards the DASHBOARD App (Final, M30) will be further improved with respect to the user comments.

The schedule during the DASHBOARD implementation will be updated according to the work progress of ICT partner HLX.

10.3 Organizational structure

In the Slovenian demonstration case, there are 4 organizations involved to provide a successful implementation of MOBISTYLE solutions. These organizations are:

- Institute for innovation and development of university of Ljubljana (IRI UL),
- faculties of university of Ljubljana selected for demonstrations,
- company providing SCADA at the faculties – Metronik and
- company providing IEQ sensors – Inap.

Within the scope of MOBISTYLE project, IRI UL is managing the coordination and communication between these organizations.

Company Metronik build and to some extend manages the SCADA system and they are absolutely necessary to be involved in order to get the data from existing building automations systems. They implemented the hardware and software solutions and supplied the software solution for energy management and data transferability from SCADA to MOBISTYLE database managed by ICT-partners, DEMO consultants (DMO).

Company Inap is responsible for the instalment of the IEQ sensors and data transfer to the MOBISTYLE database. People involved in the MOBISTYLE project are mentioned in the following table.

Organization	Contact information
IRI UL	Jure Vetršek, SI demo case leader, E-mail: jure.vetrsek@iri.uni-lj.si
Faculty (FRI & FKKT)	Simon Pikovnik, building manager, E-mail: simon.pikovnik@fkkt.uni-lj.si
Metronik	Aleš Skušek, sales manager, E-mail: ales.skusek@metronik.si
Inap	Gregor Podlogar, director, E-mail: gregor.podlogar@inap.si

Beside mentioned personnel, several other people are helping implementing the solutions e.g. IT department at faculties (connectivity, security of the grid…), maintenance staff etc.

10.4 Review of the possible risks

Description of the risk	Proposed risk-mitigation measures	Status of risk
Poor or no collaboration from the owners/key persons or organizations in the 5 study and demonstration cases	Direct involvement of owners/managers and other key organizations via regular meetings and emailing.	No risks occurred.
Not being able to get the data from SCADA to the external system due to security concerns and technical difficulties (several independent systems, firewall….)	Involving IT department at the faculty and getting stat of the art security advises. BMS provider.	No risks occurred.
Low data availability due to safety concerns and technical problems	Involving BMS contractor.	Partly, we are solving case by case.
GDPR implemented will not allow to work with individuals	Informing participants from the beginning, getting approval from the top management and consent from each individual	No risks occurred yet. GDPR not transferred to Slovenian law jet, meaning whole directive is valid.
End-user not participating in MOBISTYLE implementation due to low interest of room occupants.	Continuous communication with the end users, regular physical meetings.	No risks occurred. To be updated.

11. Ethics in MOBISTYLE

Monitoring in WP6 will be based on Informed Consent. Informed consent is one of the primary ethical requirements underpinning research with human subjects and is an ongoing process (especially with data acquisition subject to continuously changing). The purpose of informed consent is to ensure prospective subjects will understand the nature of the research and monitoring and can voluntarily decide whether or not to participate. MOBISTYLE's interpretation of the EC H2020 guide 'How to complete your ethics Self-Assessment' is that when the study involves research involving participants,

1. An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures, and identification of any procedures which are experimental;
2. A description of any reasonably risks or discomforts;
3. A description of any benefits to the subject or to others;
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
6. For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;
7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject;
8. A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Informed Consent in English language is presented in the following pages.

Model 1 (used in UL Case, local language):

Informed Consent for participating in scientific research:

"MOBISTYLE"

I have been informed about the research. I have read the written information. I have received the opportunity to ask questions. I have received the opportunity to consider my participation to the research. I have the right to withdraw my consent at any time, without giving a specific reason.

I consent with participating in the research and give permission to use the data as described in the information letter.

I wish to/not to (please circle choice) be informed on the research outcome.

I give permission to save the data up to 5 years after the research has finished.

I wish to/not to (please circle choice) be contacted for further research.

Name _____
Date of birth _____

Date Signature

Signee, responsible researcher, declares that the abovementioned person has been informed about the research both orally and by written text.

Name _____

Function _____

Date Signature

On the next page the Informed Consent that was given to the participants is presented in Slovenian language.

Soglasje za sodelovanje v raziskavi

K ljudem usmerjeni pristopi pri razvoju orodij za zmanjšanje porabe energije

Spoštovani,

Povabljeni ste bili k sodelovanju v raziskavi projekta PEOPLE (K ljudem usmerjeni razvojni pristopi v praktičnih in učnih okoljih), ki se osredotoča na uporabo energije v delovnih okoljih in na navade, povezane z zdravjem ljudi. Zelo bi bili veseli vašega sodelovanja pri projektu.

Splošne informacije
Informacije na tej strani so namenjene podrobnemu razumevanju raziskave in kaj se v njej pričakuje od vas. Na podlagi tega se lahko odločite, ali želite sodelovati v raziskavi. Prosim, pozorno preberite soglasje, preden se odločite nadaljevati. Če v raziskavi ne želite sodelovati, to nikakor ne bo uporabljeno proti vam. Sodelovanje lahko v katerem koli trenutku prekinete.

Namen raziskave je zbrati informacije o vedenju in navadah uporabnikov v delovnih okoljih. Če se odločite sodelovati, bomo spremljali in analizirali uporabo vaše pisarne. Povabljeni boste tudi na intervju, ki nam bo pomagal razumeti motivacijo in vzroke posameznih dejavnosti. Raziskava je tudi del širše doktorske disertacije, ki združuje podatkovno analitiko senzornih podatkov z etnografskimi (kvalitativnimi) pristopi.

Podatki
V raziskavi bomo zbirali naslednje podatke: temperatura sobe, aktivna želena temperatura, odprtost ventila za hlajenje, odprtost ventila za gretje, dejanska hitrost ventilatorja, položaj stikala ventilatorja, dnevni režim, temperaturni režim in meritve zunanje vremenske postaje. Del podatov za leti 2016 in 2017 bomo pridobili iz arhiva sistema SCADA. Nadalje želimo pridobiti tudi meritve porabe energije, kvaliteto zraka v prostoru (stopnja CO2, prah, kemikalije) ter zgodovino vstopanja v prostor. Če ne želite zbiranja zgolj določenega dela podatkov, to sporočite raziskovalcu in vaši podatki za izbrano meritev bodo izvzeti iz raziskave.

Zaupnost podatkov
Vaše sodelovanje v raziskavi je povsem prostovoljno. Vaši podatki bodo anonimizirani in ne bodo posredovani nikomur brez vašega soglasja, razen če se izrecno želite odpovedati anonimnosti. Vaši odgovori bodo uporabljeni zgolj za namene raziskave. Podatki se bodo prenašali preko varne, enkriptirane povezave in bodo shranjeni v zaščiteni podatkovni bazi. Inovacijsko-razvojni inštitut Univerze v Ljubljani, ki je nosilec projekta PEOPLE, zagotavlja, da raziskava izpolnjuje državne in evropske standarde s področja zaščite osebnih podatkov.

Možna škoda / prednosti
Raziskava ne predvideva nobene možne škode za sodelujoče.

Če se strinjate z zgornjimi pogoji, potrdite svoje sodelovanje s podpisom. Najlepša hvala že vnaprej za vaš čas in sodelovanje. Prosim, bodite odkriti pri svojih odgovorih, saj so ti izredno dragocen vir informacij za raziskavo. Če imate dodatna vprašanja, sem vam na voljo.

Hvala,

Ajda Pretnar
doktorska študentka in raziskovalka
ajda.pretnar@fri.uni-lj.si

Ime in priimek:

_____

S podpisom potrjujem sodelovanje v raziskavi.

Kraj in datum: *Podpis:*

_____ _____

Komentar:

Appendix 4 Orologio Living Apartments, IT MAP

Demonstration Case “Orologio Living Apartments”

1 Short description

“Orologio Living Apartments”, an urban residence hotel located in a central area of Turin, is the Italian demonstration case. For more information regarding the building, please refer to its “Case Description”. In the following document, the proposed measurement campaign at Orologio Living Apartments will be described.

1.1 Construction

Orologio Living Apartments presents a very traditional structure since the building was built at the beginning of 20th century with load bearing masonry walls. During the first refurbishment of the building, 10 years ago, no further insulation was added because their thermal transmittance respected the national minimum requirements. Nonetheless, the walls transmittance ($U_{wall,hotel}$ = 1,12 W/m^{2}K) is far below the limit U-value required today in Piedmont ($U_{wall,standard}$ = 0,33 W/m^{2}K). On the contrary, all the windows were substituted with the most up-to-date solution in 2005: windows with double-pane and wooden frame ($U_{window,hotel}$ = 2,5 W/m^{2}K). Again, the thermal performance of windows are below the current standards expectations ($U_{window,standard}$ = 2,00 W/m^{2}K).

1.2 Technical systems

The building is heated by 2 condensing boilers powered by natural gas (rated output 84 kW), also used for Domestic Hot Water (DHW) production. The DHW loop also includes an accumulation tank of 300 litres, where water is maintained at the temperature of 46°C. A chiller (cooling capacity 97 kW) is installed for the cooling system. Two-pipes fan coil units, placed in the false ceiling, are the terminals of the heating and cooling system (except radiators inside bathrooms). At present, the building does not have mechanical ventilation system (except for exhaust air systems in bathrooms and kitchens) and it does not a use any on-site renewable energy source.

1.3 Target areas (type, usage, occupancy, sensors)

The demonstration will be carried out in 4 apartments and in the reception. All the guestrooms are comparable to small apartments in terms of internal layout and equipment as the hotel business mainly relies on guests’ long-term stays.

The selected apartments are two-room or three-room flats but with similar size:

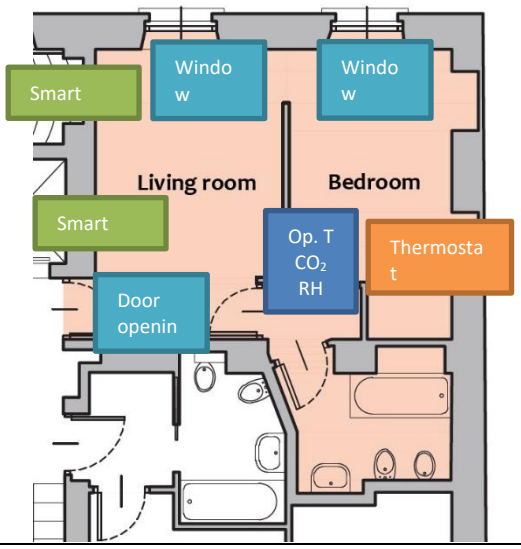
- “Room 01” 37,5 m^2
- “Room 103” 36,8 m^2

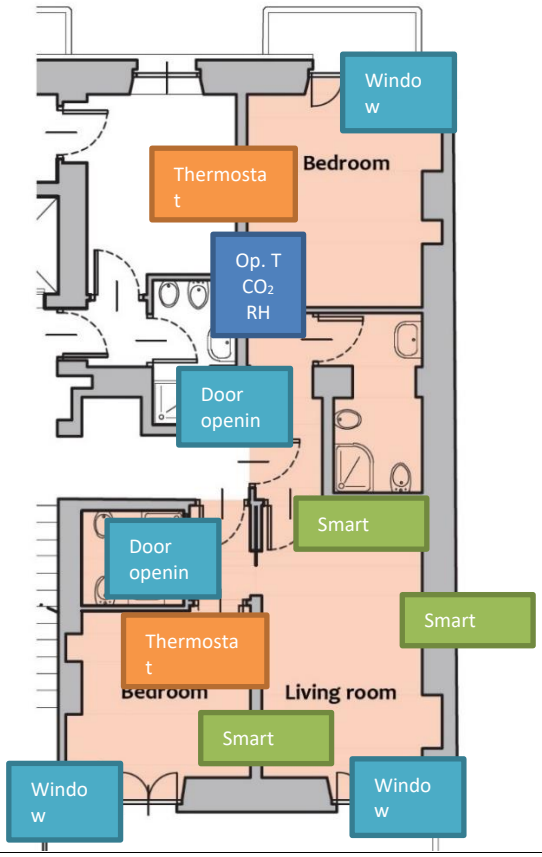
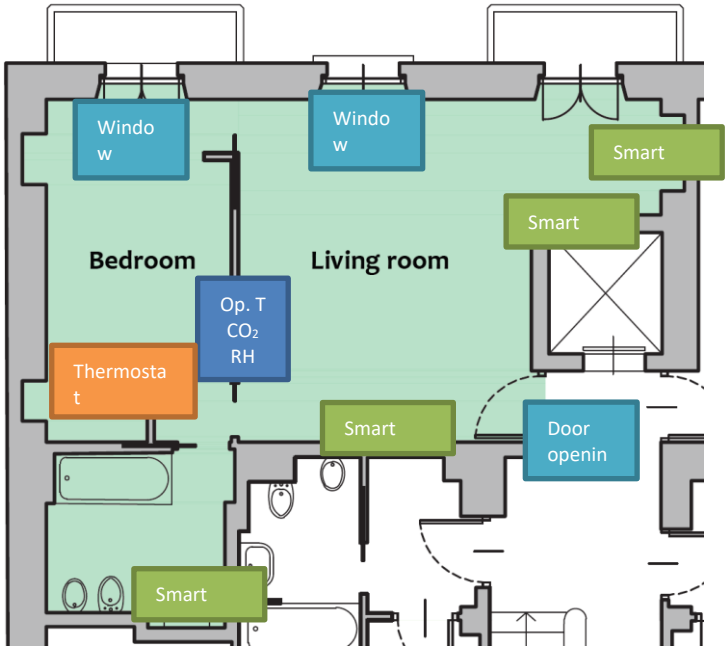
- "Room 302" 38,5 m^2
- "Room 402" 39 m^2

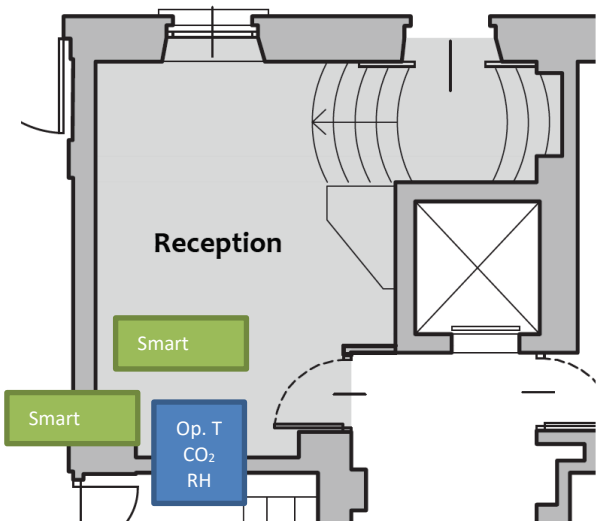
The apartment plan drawings will be used to indicate the types and locations of various equipment installed and linked to several parameters of interest, as described in the Action Plan.

In all apartments, measurements regarding energy consumption and indoor environmental quality (IAQ) will be taken, specifically, indoor air temperature, indoor CO_2 concentration, indoor relative humidity, and electricity consumption. Regarding occupant behaviour, window opening, door opening, thermostat adjustments, fan-coil adjustment and whitegoods usage will be monitored.

Below, apartments from the previous apartment list are illustrated with a floor plan indicating the room types, apartment sizes and their layout.

Room 01 37,5 m^2 two rooms without balcony Main characteristics: • one bathrooms • two windows with northwest exposure	

Room 103 36,8 m^2 three rooms plus two balconies Main characteristics: • two entrance door • two bathrooms • two bedrooms • three windows with both northwest and southwest exposure	
Room 302 or 402 39 m^2 two rooms plus two balconies Main characteristics: • one entrance door • one bathrooms • three windows with northwest exposure	

Reception Main characteristics: • one entrance door • one with northwest exposure	

1.4 Technical coordinator

Politecnico di Torino: Valentina Fabi, email: valentina.fabi@polito.it
Orologio Living Apartments: Stefania Talaia, email: stefania.talaia@edilcem.biz

2 Demonstration vision and objective

The vision of the Action plan is to demonstrate a sustainable behavioural change towards a significant reduction of energy use in a real environment by deploying and validating the developed solutions and services. Furthermore, a very important aspect for the ownership Manager is to join the opportunity to enter in the “green economy” with the hospitality sector. The objective of this action plans is to validate the approach, tools, and services applied in terms of reduction in energy use and increase in indoor environment quality e services for hotel guests and management.

3 Specific purpose of the Action plan

The purpose of the Action plan is to illustrate and demonstrate the approach and methodologies used. From there, the developed and derived ICT tools and services can be assed. According to the Case Description, the demonstration will furthermore aim to provide answers to the following questions:

- What drivers and motivators influence user behaviour?
- What effects do user behaviour have on energy consumption and indoor environment?
- Which methods and approaches create awareness and a substantial behavioural change in users?
- What is the frequency and intensity of use of the personal apps and tools, monitored, and registered at the start, after 2 months, 6 months, and 12 months of implementation?
- What basic monitoring and information campaign should be continued after the project duration? Which parameters should be monitored, how should the information be presented, and what are the aims of a continuous campaign?
- Which specific campaigns and validations were necessary during the project?
- How would a list of further recommendations, based on the results obtained, look after the project is completed? How could “soft measures” be considered in future energy performance regulations?

3.1 Conditions overview

To answer all these questions is important to have an overview about what the conditions inside/outside the apartment without are forgetting how those conditions change as a result of occupant's behaviour. For this reason, it is useful to identify what are the measurable data that does not necessarily refer to a specific type of behaviour or user and which one are strictly related to the occupant behaviour.

Generic and synthetic data about energy, IEQ and health are important to increase the users’ knowledge and awareness, and this paragraph will provide some questions aimed to identify key parameters to be monitored.

3.2 Energy consumption

In this case study the type of energy or resources that will be treated, are the following:

- Electric energy **(EE)**

Energy type or resource	Question	Parameter	Observation method	Parameter Code
(EE)	What is the *power* of each appliance inside the rooms? (at least those with high usage and/or high-power cons.)	Kilowatt [kW]	Directly measured	E1

(EE)	What is the *power* of the room?	Kilowatt [kW]	Directly measured	E1
(EE)	What is the *power* of the whole apartment/zone?	Kilowatt [kW]	Directly measured	E1
(EE)	What is the *electric energy consumption* during the reference measurement period? Is it above average?	Kilowatt hour [kWh] consumption	Directly measured	E2
(EE)	How is *electric energy consumption* in comparison to other rooms/apartments/zone?	Kilowatt hour [kWh] consumption	Indirectly measured	E2
(EE)	How much money will the user pay for electric energy bills?	€	Indirectly measured	E3

3.3 Thermal comfort & Indoor environment quality

Question	Parameter	Observation method	Parameter Code
Is the indoor temperature in a room/residential unit within a reasonable range?	• Indoor temperature • Outdoor temperature	• Directly measured • User perception	IEQ1
Is the ventilation sufficient in a room/residential unit?	• CO_2 level	• Directly measured • User perception	IEQ2
Is the humidity in a room/residential unit within a reasonable range?	• Relative Humidity	• Directly measured • User perception	IEQ3

3.4 Health and wellbeing

Question	Parameter	Observation method	Parameter Code
What is the level of well-being related to the indoor environment?	• General sense of wellbeing	• User perception	• H4

3.5 Outdoor conditions

There is not present a microclimatic center station for gaining the outdoor conditions. Eventually, they could be indirectly measured (data from free weather API).

3.6 Occupant's behaviour ("What we want to know")

To understand the mechanisms of occupants' behaviours it is necessary to monitor the behaviour itself but also to determine the cause and effect relationships that behaviours have with energy consumption, indoor and outdoor environment, and the occupants' health status. This point is one of the main challenges of this project. In other words, it is possible, by cross-referencing the data, to understand every condition or variation correlated to some specific behaviour. This "knowledge" is very important for the project goals, because it allows to generate tailored feedback for the users.

The types of behaviour analysed in this case study can be listed here below:

- Occupancy
- Thermostat adjustment or fan coil regulation
- Windows opening
- Whitegoods or other electrical devices
- Door opening

What is important to know about every type of behaviour can be summarized in the table below, applying the several questions contained inside the table at each type of behaviour.

<table>
<tr><td rowspan="9">CHARACTERISTIC AND CAUSES</td><td colspan="2">Research questions</td><td rowspan="2">Data sources</td><td rowspan="2">Observation method</td></tr>
<tr><td>Level 1</td><td>Level 2</td></tr>
<tr><td rowspan="3">What are the characteristics of the behaviour?</td><td>When did the behaviour occur? How long?</td><td>• Device/sensor state</td><td>Directly measured</td></tr>
<tr><td>How did the users set up the device? (if regulations are permitted)</td><td>• Device/sensor state</td><td>Directly measured</td></tr>
<tr><td>Who did it? Who affects?</td><td>• Occupancy sensor</td><td>Indirectly measured</td></tr>
<tr><td rowspan="4">What drivers and motivators influence user behaviour?</td><td>Are there recurring moments during the day?</td><td>• Device/sensor state</td><td>Indirectly measured (statistical analysis)</td></tr>
<tr><td>Was there any IEQ/outside parameters that were critical before the "behaviour"?</td><td>• IEQ sensors
• Outside condition</td><td>Directly measured</td></tr>
<tr><td rowspan="2"></td><td>• General sense of wellbeing</td><td>User perception</td></tr>
<tr><td>• Sense of control over one's surroundings</td><td>User perception</td></tr>
<tr><td rowspan="3">CONSEQUENCES</td><td colspan="2">Research questions</td><td rowspan="2">Data sources</td><td rowspan="2">Observation method</td></tr>
<tr><td>Level 1</td><td>Level 2</td></tr>
</table>

	What effects do user behaviour have on energy consumption, indoor environment and health?	Does behaviour lead to increased energy consumption?	• Indoor-outdoor temperature difference • Electric energy consumption	Indirectly measured: -Simple analysis (qualitative evaluation) -Complex analysis (quantitative evaluation)
		Did behaviour lead some IEQ parameters outside the reasonable range?	• IEQ sensors	Directly measured
			• General sense of wellbeing	User perception
	What are the long-term effects?	How sustainable is the behaviour for energy consumption?	• Frequency • Duration • Intensity	Indirectly measured
		How “bad” is the behaviour for users’ health?	• Frequency • Duration • Intensity	Indirectly measured

4 Required parameters and information

The parameters and their accompanying data that need to be monitored are listed in the table below.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/Notes
Electricity consumption	Energy use		±5 %	10 min	• Power meter • Smart plug	
	Power		±5 %	Variation of 50W	• Power meter • Smart plug	
Indoor temperature	IEQ	0.1°C	±5 %	15 min	Band gap temperature sensor	
Indoor relative humidity	IEQ	0.1%	±5 %	15 min	Capacitive humidity sensor	
CO_2	IEQ	1 ppm	±5 %	5 min	Non-dispersive infrared (NDIR)	
Window opening	User behaviour	/	/	Variation of state	Magnetic switch	
Door opening	User behaviour	/	/	Variation of state	Magnetic switch	
Occupancy	User behaviour	/	/	/	Key card reader	
Thermostat adjustments	User behaviour	/	/	/	Thermostat	Actual set-point and regulation percentage (±3°C is registered)

Parameter	User requirements	Actor requirements	Number of participants	Data extracted	Other/Notes
Technology acceptance	App downloads, technology use, daily habits	Interviews, observation and monitoring	5	User preferences by typology of feedback	
Personal health and sense of wellbeing	Personal monitoring and logging, Data recording	Questionnaires, data collection, data analyses		Change in sleep quality, energy levels, personal perception of a high quality of life	
Perception of environment (IEQ)	Personal monitoring and logging, Data recording	Questionnaires, data collection, data analyses			
Sense of control over one's surroundings	Personal monitoring and logging, Data recording	Questionnaires, data collection, data analyses			
Impact				Effectiveness of feedback in changing behaviour	

5 Behavioural action plan

As MOBISTYLE demonstration in Orologio Living Apartments case study cannot be seen as a stand-alone measure, these activities will be supported with continued awareness, information, and feedback campaign activities for raising awareness about conscious energy usage, healthy lifestyle and importance of good indoor environment. Continuous interaction with *all* the building users at Orologio Living Apartments will be done through a mixture of communication channels to raise awareness of all end-users in the building (building manager, hotel guests, receptionists, cleaning staff). It is believed that their awareness will be increased even further when there is continuous provision of information and through different channels.

It should be noted that the occupants' improved behaviour encouraged within the Orologio Living Apartments (Turin, Italy) can lead to energy savings also in other situations they encounter in their everyday life. Furthermore, they can encourage other people to act according to the MOBISTYLE objectives and therefore more people are becoming aware (snow-ball effect).

Within the MOBISTYLE project, *tailored information* will be provided to the users at Orologio Living Apartments. As the outcomes of D2.2 and D2.3 showed a single one fit all awareness campaign is not optimal/possible, this will be tailored according to specific needs and characteristics of the hotel environment and occupants who interact with it (manager, guests, receptionists, cleaning staff).

The tailored message should introduce the project approach, main objectives to the building users where it will be explained why, what, and how is carried on the MOBISTYLE demonstration in the building they are living. Furthermore, it should be clearly explained how data protection & user privacy is ensured.

Continuous interaction with end-users through a mixture of communication channels is essential. The work between WP6 and WP7 is aiming to support MOBISTYLE approach and new energy practices (rising awareness) through providing different tailored communication & promotion material.

The MOBISTYLE awareness campaigns could promote temperature trainings not only as part of demonstrators but as a part of overall and healthy lifestyle and healthy ageing strategy. As example, users should be educated that lowering down thermostat will not just bring energy savings but can also contribute to their better well-being and metabolic health.

Moreover, it can be encouraged that users take stairs instead of an elevator as this does not only saves building's electricity consumption but also is healthier for them.

Furthermore, the smart and conscious use of appliances (e.g. stand-by mode) and lighting might help to reduce energy consumptions and can be an interesting trigger for savings costs (manager), as well, next to reducing the environmental impact of the activity.

The following table summarizes the target audience of Orologio Living Apartments (hotel guests, manager, receptionists and cleaning staff), what the MOBISTYLE project could make happen in the context of this specific case study, and with which means/communication tools.

Targeted audience	What?	How?
HOTEL GUESTS (long term)	- Encourage an energy-friendly and healthy regulation of the thermostat set-point (+/- 3°C) - Encourage the use of stairs rather than the elevator - Encourage an energy-friendly use of the electric appliances (e.g. standby) and lighting devices - Inform Hotel guests about the indoor environmental conditions and how they can be improved (e.g. is the indoor air quality adequate? Too cold/hot?) - Combine MOBISTYLE information with other interesting hints for the guests (weather forecast, events in the city)	- Information in the room (e.g. on TV, displays, sticky-catchy messages with hints and explanations) - Newsletters, brochure, flyers - Mobile application
MANAGER	- Encourage the manager to adopt energy-friendly settings of the installed systems - Provide a comprehensive overview to the manager of energy consumptions and related costs – what can be changed through behavioural change? Any low-capital strategies that help achieving energy savings?	- Reports on project overview (IT) - Newsletters - Mobile application
RECEPTIONISTS	- Encourage an energy-friendly and healthy regulation of the thermostat set-point (+/- 3°C) - Encourage an energy-friendly use of the electric appliances (e.g. PC) and lighting devices - Healthy tricks and exercise for office employees - Inform receptionists about the indoor environmental conditions and how they can be improved	- Serious Gaming (e.g. screen saver or 'sustainable' game on the desktop, widget PC) - Ambient display in the reception - Newsletters - Smart watch
CLEANING STAFF	- Encourage an energy-friendly use of the electric appliances and lighting devices - Healthy, time-saving and energy-saving cleaning tricks for hotel housekeepers - Inform the cleaning staff about the indoor environmental conditions and how they can be improved	- Smart watch - Ambient display - Newsletters

The MOBISTYLE project has been currently introduced to the hotel manager, two receptionists and the cleaning staff. The hotel manager has a very aware attitude as regards the energy-related management of the building and seems highly motivated to implement the MOBISTYLE strategies in the Italian case study to further improve the energy performance of the building and to raise awareness among the hotel guests and staff - while possibly optimizing their health and comfort conditions, as well. The hotel staff (receptionists and cleaning staff) generally seems to present a slightly lower level of knowledge regarding energy-related topics and achieving energy savings for them seems to play a slightly less important role. However, they appear very willing to apprehend and to be actively involved in the project. Hotel guests have not been investigated so far, as highlighted in D 2.3 "Recommendations for improvement and further development of solutions", communication strategies could also contain simple messages in the room: "*Influencing habits of the hotel guests was another big topic of the discussion. Simple non-technological means (for example flyers) had proven to be efficient tools; however, the participants believe that they should be strategically placed, e.g. close or even on the AC remote control. An interactive IT solution which would communicate with the guest would be another important possibility to influence the people. As it was explained in the debate, all guests are not the same – their cultural background often dictates and defines their habits. Foreigners (non-Italians), for example, don't want their rooms to be constantly cleaned. In addition, many of them set the AC to lower temperatures, while the Italians just set it to "dry". Manager of the hotel gave an example of guests who complained about room temperatures and try to set it below 20 degrees, but could not do it, since the temperatures are pre-set. In addition to room temperatures, WiFi is another technology which the guests complain about the most. Participants of the debate do not use many technologies and devices for changing and supporting their habits. One of them uses a smartphone app (Runtastic) and another app for skiing. They also mentioned the reason for avoiding the technologies: an additional and unnecessary cognitive overload.*"

Possible obstacles and selling points of the MOBISTYLE project and strategies in the specific context of this case study can be summarized as follows:

Targeted audience	Selling points	Obstacles
HOTEL GUESTS (long term)	Knowledge transfer, enhanced service	Different users throughout the project
MANAGER	Comprehensive overview of energy uses in the building, potential energy/cost savings through behavioural change, introduction of strategies that might be adopted on a long term	Needs to respect the privacy of the guests and meet their expectations in terms of a comfortable stay
RECEPTIONISTS	Knowledge transfer, sense of belonging	Risk of cognitive overload due to the usage of too many technologies/ electronic devices
CLEANING STAFF	Knowledge transfer	Physically very busy during working hours, a lot of movement in different spaces with potentially different thermal conditions

To be as credible as possible to the targeted audience and to be sure that people trust MOBISTYLE application, it is suggested to provide referenced suggestions and feedback. The MOBISTYLE project, its aims and international background should be clearly introduced and well-explained also to the hotel guests to encourage their active participation. Furthermore, the well-established and recognized role of POLITO institution at local level could help making people trust the project application.

5.1 Feedback for end users about energy use and indoor environment

To benefit from the opportunity of collecting a large amount of data, the data interpretation and, subsequently, the feedback provided to the users as part of the monitoring campaign in the *Orologio living apartments* case study will be based on a combination of standards, measurements, and relative comparisons between an established baseline and the individual units in question.

Energy Use

The feedback regarding energy use is based on the overall electricity use in the apartment and on the electrical appliances use (depending on the appliances in the apartment). Depending on the manager's choice, feedback can be based on data from the day before, the week before, the month before or the current year. The generic profile for electricity consumption and appliances usage will be developed using the energy consumption data collected during the initial monitoring (M0). The energy consumption data will be displayed to the end user in a graphical form using three colour levels (green, orange and red). The relationship between colour levels and user consumption is based on the generic profile defined during benchmarking and energy saving targets for the case study (energy saving of 16%). For example, the feedback on daily energy use is related to the energy consumption of the day before and it is updated every day after the midnight.

The colour codes presented to users are based on the following relations:

	From expected use	Total electricity consumption/Appliances consumption
RED	Daily/Weekly/Monthly	**≥100% of reference consumption**
ORANGE	Daily/Weekly/Monthly	**84%-100% of reference consumption**
GREEN	Daily/Weekly/Monthly	**≤84% of reference consumption**

Historic records of energy use for energy consumption of the apartment or for each electrical appliance should be provided for the end users, for every day during the last week. Users must also have the possibility to read real-time consumption.

Indoor Environmental Quality

The status of the indoor environmental quality should be given for the apartment as a whole for the three measured parameters: temperature, relative humidity and CO2 concentration. As in the previous case, the IEQ feedback is communicated to the user mainly through a graphic form that involves the use of three levels of colour.

The hourly mean value of each parameter is updated every hour and compared with the ranges defined in the following table.

Label	Set-point temp. (winter day) oC	Set-point temp. (winter night) oC	Set-point temp. (summer day) oC	Set-point temp. (summer night) oC	CO2 (ppm)	RH (%)
RED	> 23	> 18	<23	<24	> 1000	>70 or <30
ORANGE	22-23	16-18	23-25	24-26	800 – 1000	50-70
GREEN	< 22	< 16	>25	OFF	< 800	30-50

Historic records of temperature, CO2 level and relative humidity of the apartment should be provided for the end users, for every day during the last week, the last 5 weeks and/or for every month during the last year. Users must also have the possibility to read real-time values of the monitored parameters.

5.2 Feedback for end users guiding them to changing their practices

To guide the users to change practices to achieve energy savings or to improve indoor environmental quality it is necessary to provide targeted feedback based on user actions and analysis of data collected during monitoring. The following types of behaviour have been identified:

- H1 - Energy Saving - Heating
- H2 - Energy Saving - Washing Machine
- H3 - Energy Saving - Dish Washer
- H4 - Energy Saving - TV
- H5 - Energy Saving - Microwave

- H6 - Health - IAQ
- H7 - Energy saving – PC
- H8 - Energy saving – Printer

The following table shows, in a concise way, the correspondence of each type of behaviour with measures and with the action that the users should take.

	Behavioural Change Objective	Target	Action	Context	Measure	Sensor	Variable [app control measure]	Unit
H1	Energy Saving - Heating Cooling	Hotel Guest	Adjusting setpoint temperature	Hotel Apartments	[°C]	BMS	Set point temperature	[°C]
H2	Energy Saving - Washing Machine		Switching stand by power - Reduction of washing cycles	Hotel Bathroom	[kWh]	Smart Plug	Electricity Consumption	[kWh]
H3	Energy Saving - Dish Washer		Switching stand by power - Reduction of washing cycles	Hotel Kitchen	[kWh]	Smart Plug	Electricity Consumption	[kWh]
H4	Energy Saving - TV		Reduction of viewing activity	Hotel Living	[kWh]	Smart Plug	Electricity Consumption	[kWh]
H5	Energy Saving - Microwave		Switching stand by power	Hotel Kitchen	[kWh]	Smart Plug	Electricity Consumption	[kWh]
H6	Health - IAQ		Opening/closing window	Hotel Bedroom	[kWh]	Window Position	CO2 concentration	[ppm]
H7	Energy saving PC	Staff	Switching stand by power	Reception	[kWh]	Smart Plug	Electricity Consumption	[kWh]
H8	Energy saving Printer		Switching stand by power	Reception	[kWh]	Smart Plug	Electricity Consumption	[kWh]

In detail, for each type of behaviour previously identified and to motivate the user to act in a specific way, targeted conditional messages have been identified to be provided to the users in the event of certain situations occurring (conditions). In addition, it is possible to provide users with information pills, here called "Eco pills", to increase their knowledge and raise their awareness. The following table shows examples of messages and eco-pills.

H1	Energy Saving – Heating/Cooling
Message	DURING DAY – Please lower/raise the set-point temperature to “xxx”. DURING NIGHT - Please lower/raise the set-point temperature to “xxx”. (TEMPERATURE TRAINING – lower the temperature to “xxx” for “xxx” minutes)
Criteria for decision tree	DURING DAY - If set-point temperature is higher/lower (winter/summer) than 22°C/26°C, DURING NIGHT - If set-point temperature is higher/lower (winter/summer) than 16°C/27°C, TEMPERATURE TRAINING – lower the temperature to “xxx” for “xxx” minutes
Eco pills	If you are not satisfied with the proposed set-point temperature, please check the state of windows. If you keep the windows open for a long time during winter/summer, the temperature in your room might drop/raise significantly. Consequently, the room must be heated/cooled again! Especially during periods of overheating, effective natural ventilation can meet the thermal comfort requirements of confined spaces, controlling certain parameters such as relative humidity, temperature and air speed. Every time you prefer natural ventilation to refinement, you save energy and gain health! Keep curtains and sun screens open in windows that look out to the sun when it's cold, and remember to keep doors closed to prevent heat from spreading to environments that don't need to be heated
H2-1	**Energy Saving – Washing machine - Switching stand by power**
Message	Please turn the washing machine completely off when you don’t use it.
Criteria for decision tree	If stand-by consumption of washing machine is detected
Eco pills	90% of the energy consumed by a washing machine is used to heat up the washing water. Modern detergents and washing machines also wash very well with 30° of temperature. With a 30-degree wash instead of 90 you save 70% of electricity and up 20% compared to a 40-degree wash.
H2-2	**Energy Saving – Washing machine - Reduction of washing cycles**
Message	Please reduce the number of your washing cycles.
Criteria for decision tree	If more than “xxx” washing cycles per week are detected (national average value)
Eco pills	It is advisable to fill the washing machine to the nominal load, because if the washing machine is not loaded enough, there is a risk of damaging the fabrics and increasing the consumption of water and energy by up to 20%.
H3-1	**Energy Saving - Dish Washer - Switching stand by power**
Message	Please turn the dish washer completely off when you don’t use it.
Criteria for decision tree	If stand-by consumption of dish washer is detected
Eco pills	One often wonders if it is more ecological to wash dishes by hand or with the dishwasher. If hand wash takes place under a constant flow of hot water there are no doubts: with the dishwasher. A class A +++ household appliance consumes 7-10 liters of hot water and 0.7-0.9 kWh of current for washing.

H3-2	Energy Saving - Dish Washer - Reduction of washing cycles
Message	Please reduce the number of your washing cycles.
Criteria for decision tree	If more than “xxx” washing cycles per week are detected (national average value)
Eco pills	Is it necessary to rinse the dishes before inserting them in the dish washer? False!!! Detergents need dirt to clean and if the dishes are already cleansed, the soap enzymes act less than their potential. Not to mention that the operation involves unnecessary waste of water. To remove food residues, it is better to use a damp sponge or paper towels used during the meal (which would however be thrown away).
H4	**Energy Saving - TV**
Message	Please reduce your viewing activity.
Criteria for decision tree	If more than “xxx” hours of viewing activity per week are detected
Eco pills	It is important to know that electricity consumption it is directly proportional to the dimensions of the screen and that, for the same class, are televisions bigger to consume more. A class-inch 32-inch (diagonal 82-cm) TV will absorb less energy of one of 55 inches (diagonal of 140 cm) belonging to the class A ++. Also, the consumption of LED TVs exceeds 100 kWh per year if the brightness of the images is adjusted.
H5	**Energy Saving - Microwave**
Message	Please turn the microwave completely off when you don’t use it.
Criteria for decision tree	If stand-by consumption of dish washer is detected
Eco pills	The microwave oven only converts part of the electrical energy into microwave energy. A typical microwave oven absorbs 1,100 W of power to produce 700 W of power in the microwave, with an efficiency of 64%. Therefore, when on the microwave oven control panel, you see written, for example, 700 W, that is not the power absorbed but only that of the microwaves, which as mentioned is more than 30% lower than that absorbed.
H6	**Health - IAQ**
Message	Please open the windows for improving the indoor air quality!
Criteria for decision tree	If the indoor CO2 concentration is higher than “xxx”
Eco pills	To allow the exchange of air it is better to open the windows for a short time, rather than keep them a slightly open for a long time. In the cooler hours of the day, in summer, natural ventilation must be used to cool down the space: in this way you can achieve ideal air quality and avoid harmful emissions into the CO2 environment. Keeping the window open for about 10 minutes will result in a correct air exchange. Therefore, it is not advisable to ventilate the rooms too long, and anyway it is advisable to do it during the hottest hours in winter and the coldest hours in summer. The amount of heat offered by the system in winter not only serves to bring the living areas to optimum temperature but must also compensate for the regular air exchange every time the windows are opened.

H7-1	Energy saving – PC
Message	Please turn the computers at the reception completely off when you don't use them.
Criteria for decision tree	If stand-by consumption of office computers is detected
Eco pills	A typical office computer turned on for 9 hours a day arrives at consume up to 175 kWh in a year. By setting the energy saving option the consumption drops by 37%, with a saving of carbon dioxide (CO2) emitted in the atmosphere of about 49 kg! We are careful about stand-by! If we assume that your PC is on average 8 hours a day, the remaining 16 hours remains in stand-by mode. A stand-by PC consumes up to 20 watts of power per hour depending on the model. In 24 hours this "off" television consumed about 300 Wh. In one year, this energy waste will be about 120 kW equivalent to the average annual consumption of a dishwasher (about 180 washing cycles).
H7-2	**Energy saving – Printer**
Message	Please turn the printer completely off when you don't use it.
Criteria for decision tree	If stand-by consumption of printer is detected
Eco pills	An office printer can consume 63 kWh per year of electricity, which correspond to the emissions of 48 kg of CO2 emitted environment. Unplugging the printer outside office hours, consumption can go down to 48 kWh, with a CO2 savings of around 12 kg. Only 8% of the total energy consumption is due to the printing phase, while the remaining 49% is "spent" in the stand-by phase and 43% in the stand-by phase (with the plug inserted, of course!)

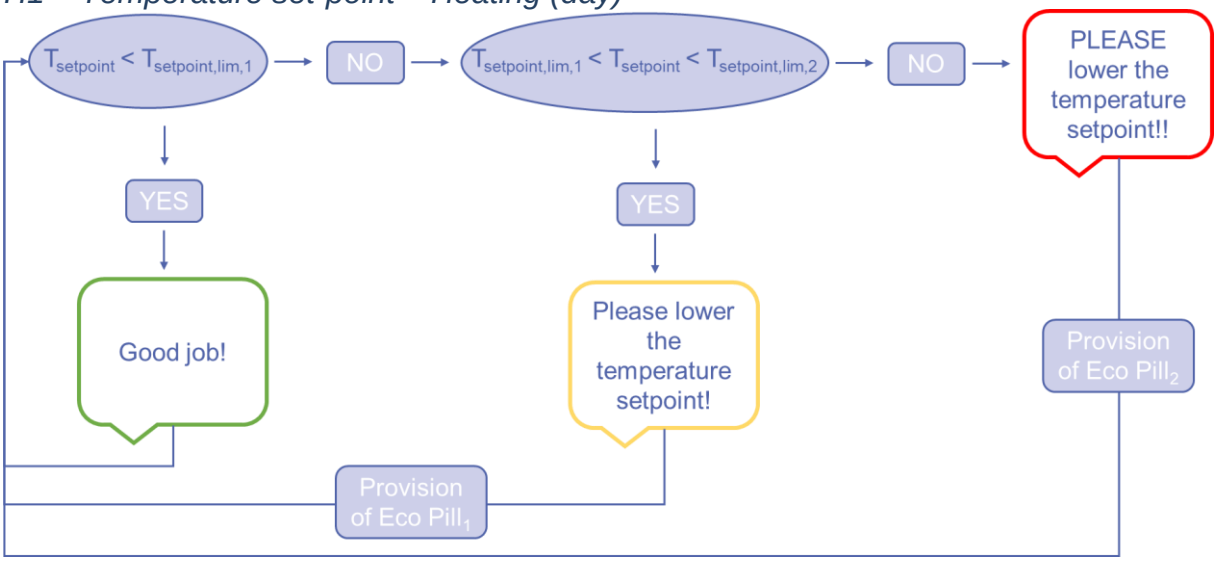
5.3 Information for calculation/selection of feedback to users

To offer a good quality of communication with users, we have chosen to diversify conditional messages into three communication levels (red, yellow, green), which correspond to the three levels of conditions that may occur. In the following table you can find the criteria with which the three levels mentioned above were defined.

	GREEN	ORANGE	RED
Set-point temperature (winter day) °C	< 22	22-23	> 23
Set-point temperature (winter night) °C	< 16	16-18	> 18
Set-point temperature (summer day) °C	>25	23-25	<23
Set-point temperature (summer night) °C	OFF	24-26	<24
Number of weekly washing cycles for single/couple (washing machine)	<2	2-3	>3
Number of weekly washing cycles for single/couple (dish washer) per week	<3	3-4	>4
Number of daily hours of viewing activity (TV)	<2	2-4	>4
CO2 (ppm)	< 800	800 – 1000	> 1000

The decision trees below describe how we intend to provide users with conditional messages. The following reasoning able to compare different parameters is not feasible in the dashboard, but could be feasible in a game with ad hoc decision tree, or other kind of applications.

H1 – Temperature set-point – Heating (day)



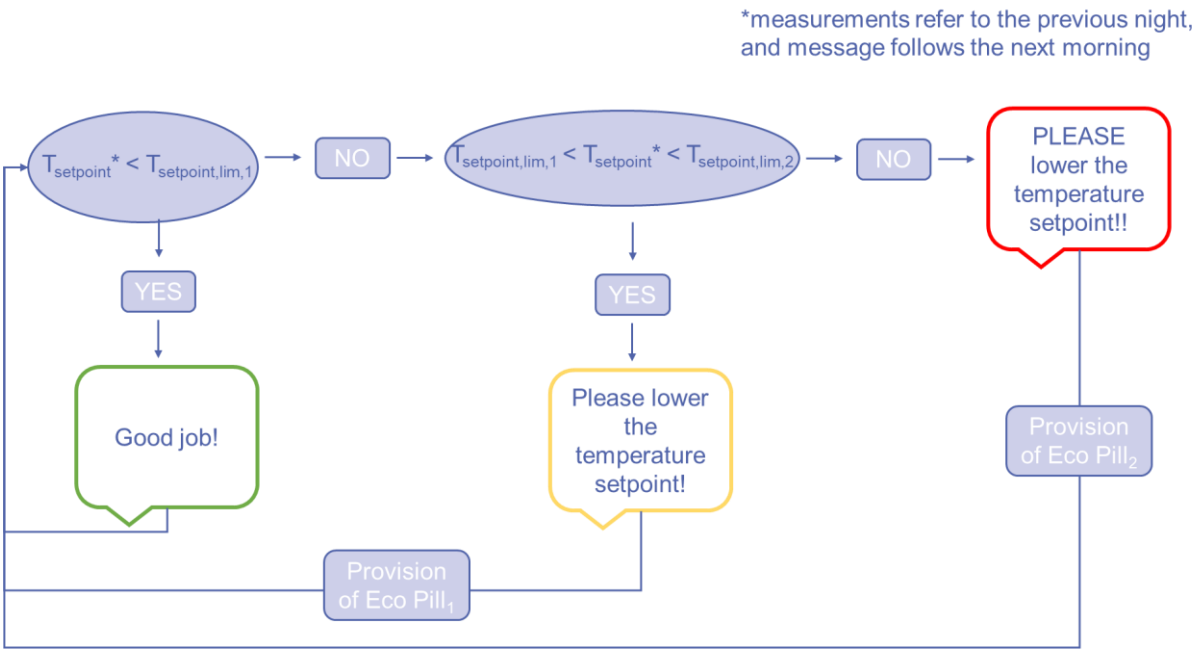
Measured parameter: Thermostat set point value

Restrictions: only during day hours on heating season

Every certain period, which is still to be determined, the system compares the value of set point set by the user with the limit values and sends the corresponding message. If the temperature exceeds the limit value of the green level, both the warning message and the

eco-pills are sent. If the limit value for the yellow level is also exceeded, the communication may be more persuasive (red level message).

H1 – Temperature set-point – Heating (night)

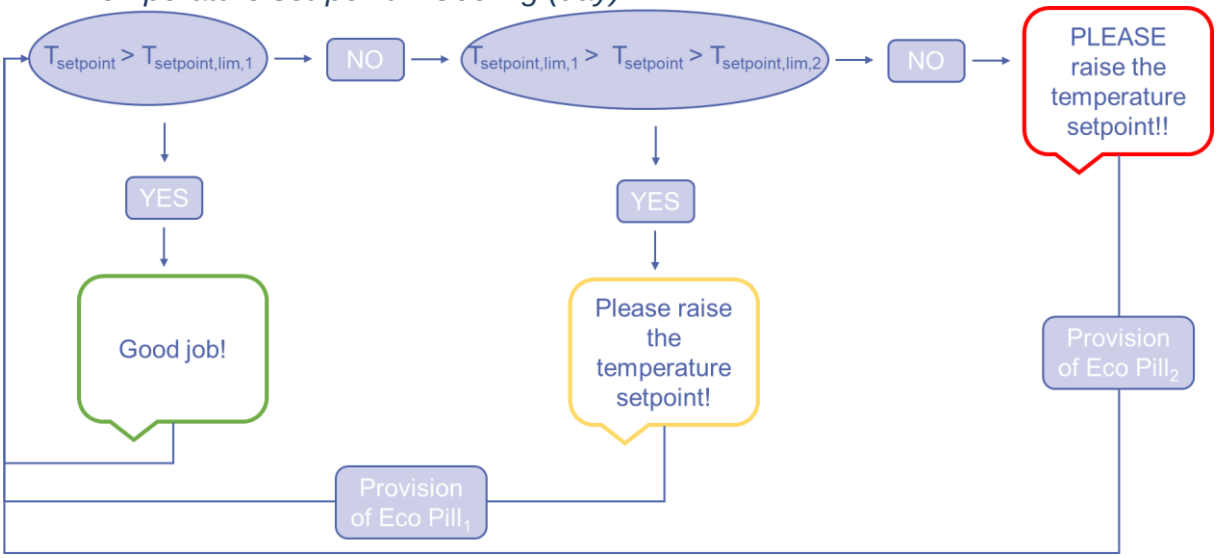


Measured parameter: Thermostat set point value

Restrictions: only during night hours on heating season

In the morning (i.e. at 8:00 am), the system compares the value of set point set by the user for the last night, with the limit values and sends the corresponding message. If the temperature exceeds the limit value of the green level, both the warning message and the eco-pills are sent. If the limit value for the yellow level is also exceeded, the communication may be more persuasive (red level message). This case differs from the previous one also due to the different limit values for the night case.

H1 – Temperature set-point – Cooling (day)

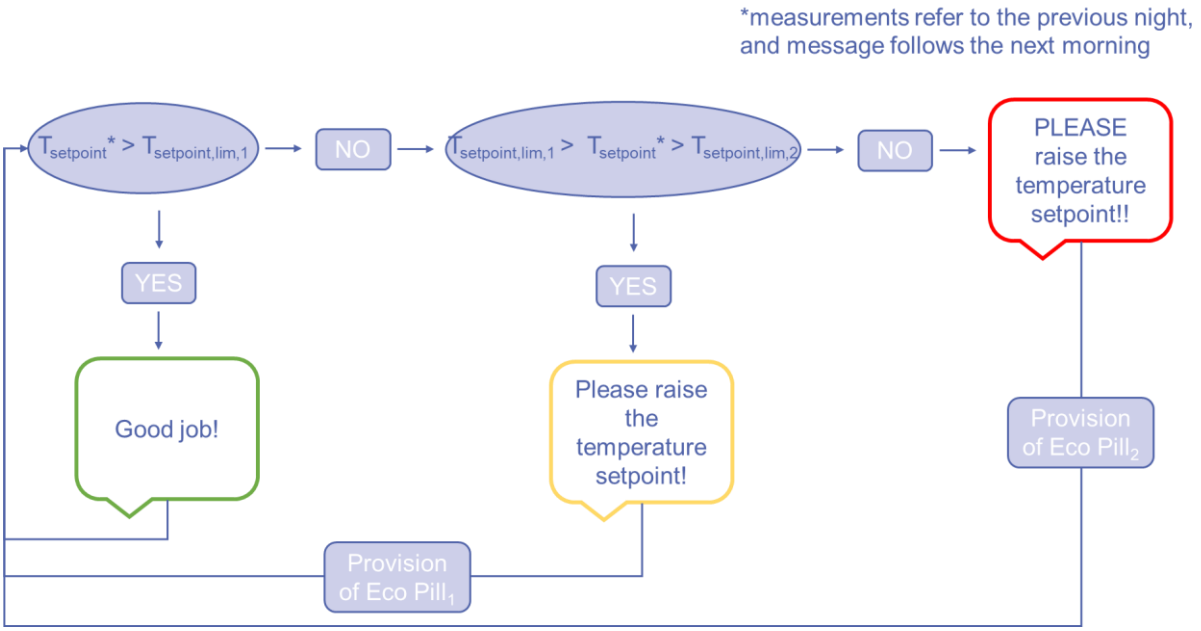


Measured parameter: Thermostat set point value

Restrictions: only during day hours on cooling season

Every certain period, which is still to be determined, the system compares the value of set point set by the user with the limit values and sends the corresponding message. If the setpoint temperature is lower than limit value of the green level, both the warning message and the eco-pills are sent. If the limit value for the yellow level is also exceeded, the communication may be more persuasive (red level message).

H1 – Temperature set-point – Cooling (night)

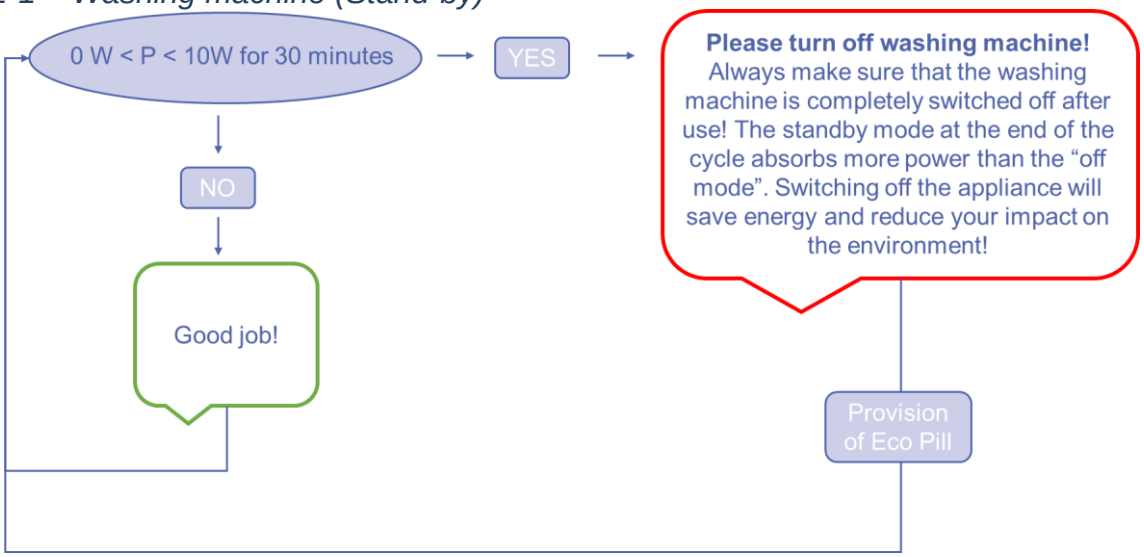


Measured parameter: Thermostat set point value

Restrictions: only during night hours on cooling season

In the morning (i.e.at 8:00 am), the system compares the value of set point set by the user for the last night, with the limit values and sends the corresponding message. If the setpoint temperature is lower than limit value of the green level, both the warning message and the eco-pills are sent. If the limit value for the yellow level is also exceeded, the communication may be more persuasive (red level message). This case differs from the previous one also due to the different limit values for the night case.

H2-1 – Washing machine (Stand-by)

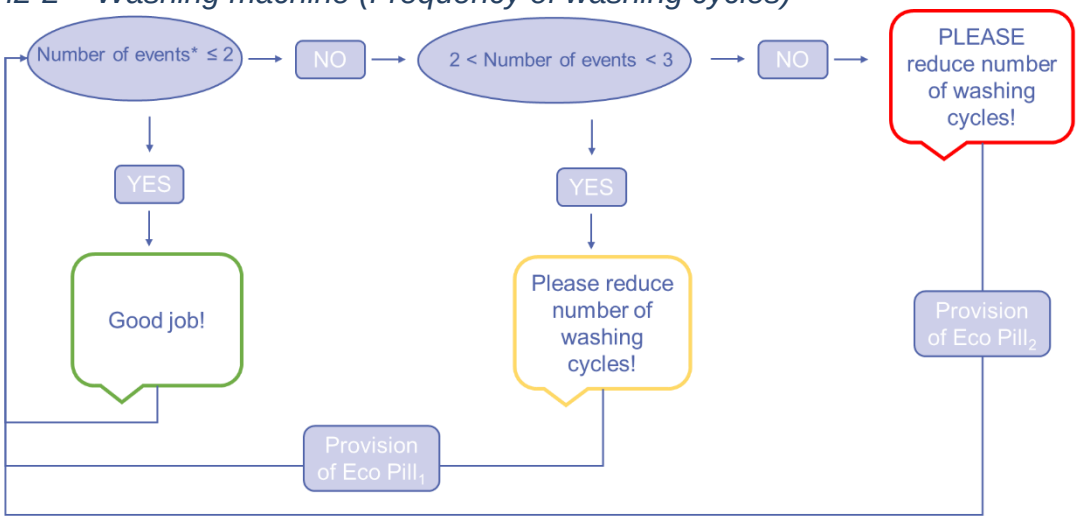


Measured parameter: Power absorbed by the washing machine

Restrictions: no restrictions

The system checks continuously whether the power absorbed by the washing machine is greater than 0 W and less than 10 W, that said in other words when the washing machine is switched on but in standby mode. This may happen if the user does not switch off the washing machine at the end of the washing cycle. When this situation continues for at least 30 minutes the system sends an alert informing the user of the consequence of his actions.

H2-2 – Washing machine (Frequency of washing cycles)



*the event starts if P is higher than 100W and stops if P is lower or equal to the stand by power (0.9 W)

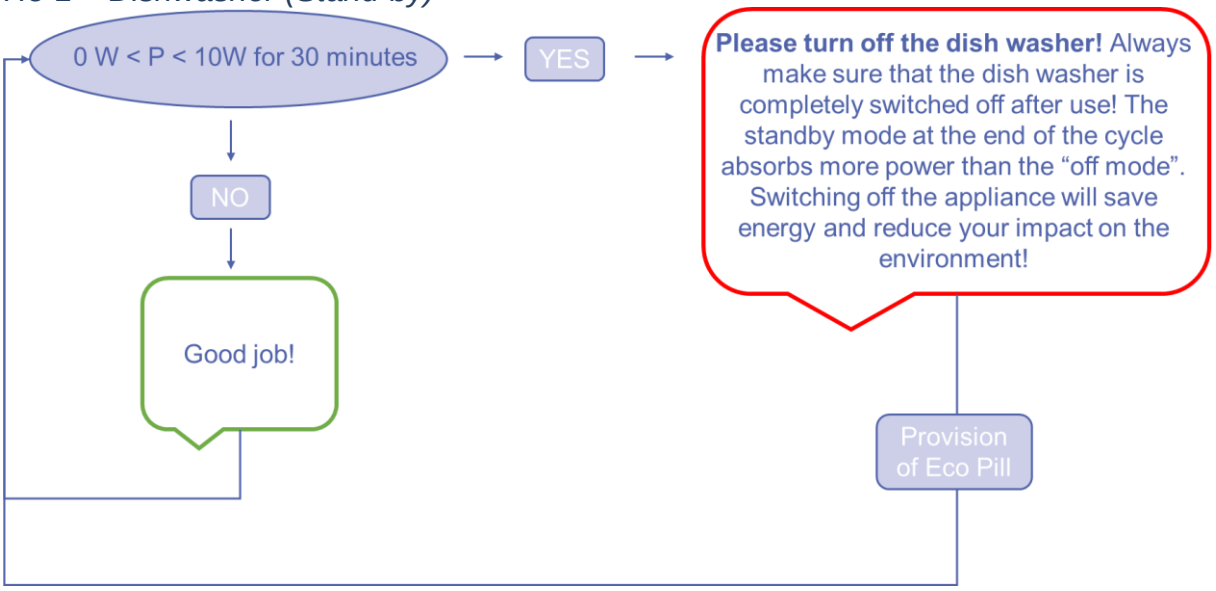
Measured parameter: Power absorbed by the washing machine

Restrictions: no restrictions

The system continuously monitors the power absorbed by the washing machine and when it reaches 100W it is assumed that a washing cycle is in progress. The washing cycle can be considered completed when the power absorbed is less than the power absorbed in standby mode (0.9-5W depending on the model) for at least 15 consecutive minutes. Every week (e.g. on Mondays) the system checks the number of washing cycles carried out during the past

week and compares them with the defined limit values. If more than 2 washes have been done (yellow level) or more than 3 (red level), warnings and eco pills are sent to inform users of the consequences of their actions.

H3-1 – Dishwasher (Stand-by)

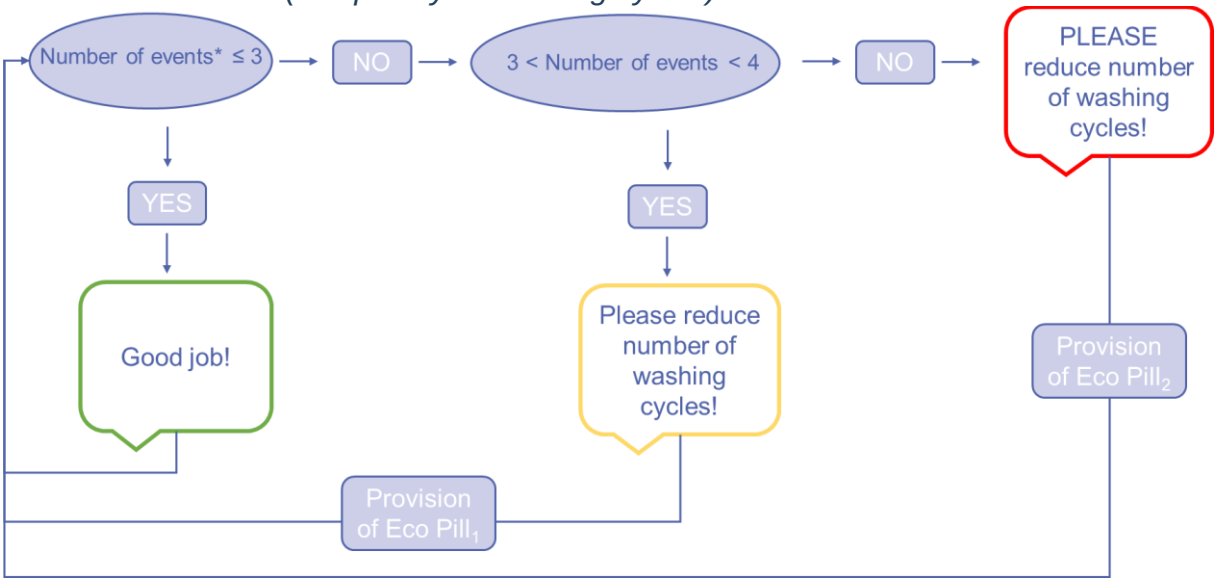


Measured parameter: Power absorbed by the dishwasher

Restrictions: no restrictions

The system checks continuously whether the power absorbed by the dishwasher is greater than 0 W and less than 10 W, therefore said in other words when the dishwasher is switched on but in standby mode. This may happen if the user does not switch off the dishwasher at the end of the washing cycle. When this situation continues for at least 30 minutes the system sends an alert informing the user of the consequence of his actions.

H3-2 – Dishwasher (Frequency of washing cycles)

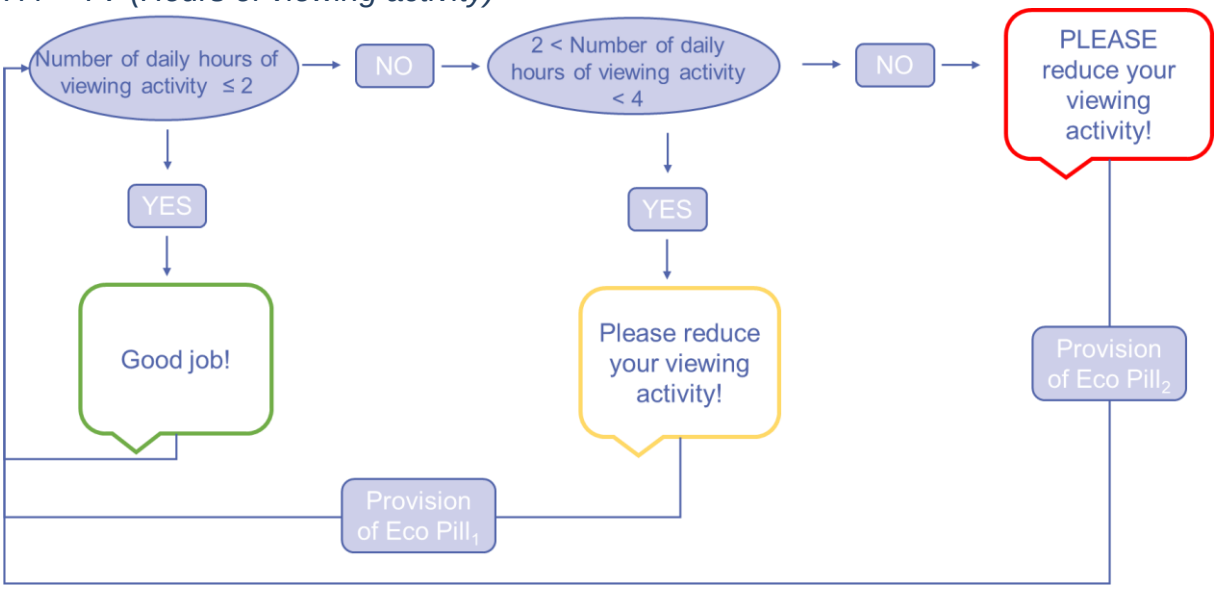


Measured parameter: Power absorbed by the dishwasher

Restrictions: no restrictions

The system continuously monitors the power absorbed by the dishwasher and when it reaches 100W it is assumed that a washing cycle is in progress. The washing cycle can be considered completed when the power absorbed is less than the power absorbed in standby mode (0.9-5W depending on the model) for at least 15 consecutive minutes. Every week (e.g. on Mondays) the system checks the number of washing cycles carried out during the past week and compares them with the defined limit values. If more than 2 washes have been done (yellow level) or more than 3 (red level), warnings and eco pills are sent to inform users of the consequences of their actions.

H4 – TV (Hours of viewing activity)

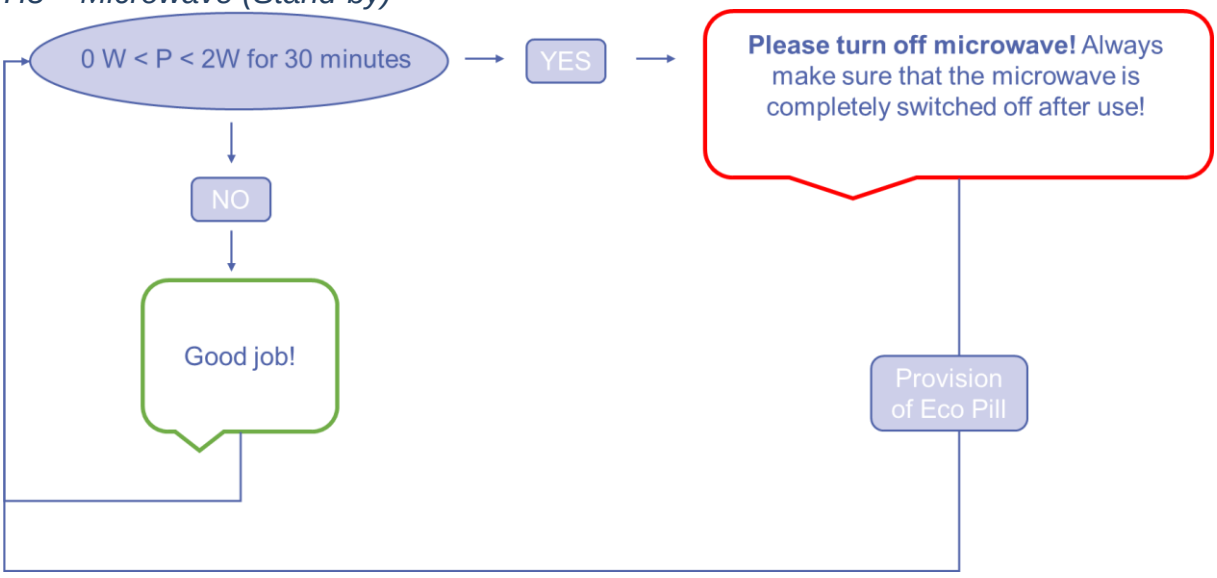


Measured parameter: Power absorbed by the TV

Restrictions: no restrictions

The system continuously monitors the power absorbed by the TV and records how long the TV has a higher power consumption than in standby mode (0.9-10 W). If the TV is turned on for less than 2 hours a day, a congratulatory message is sent. In the case of a user over 2 hours (yellow level) or over 4 hours (red level), the respective messages and Eco pills are sent.

H5 – Microwave (Stand-by)

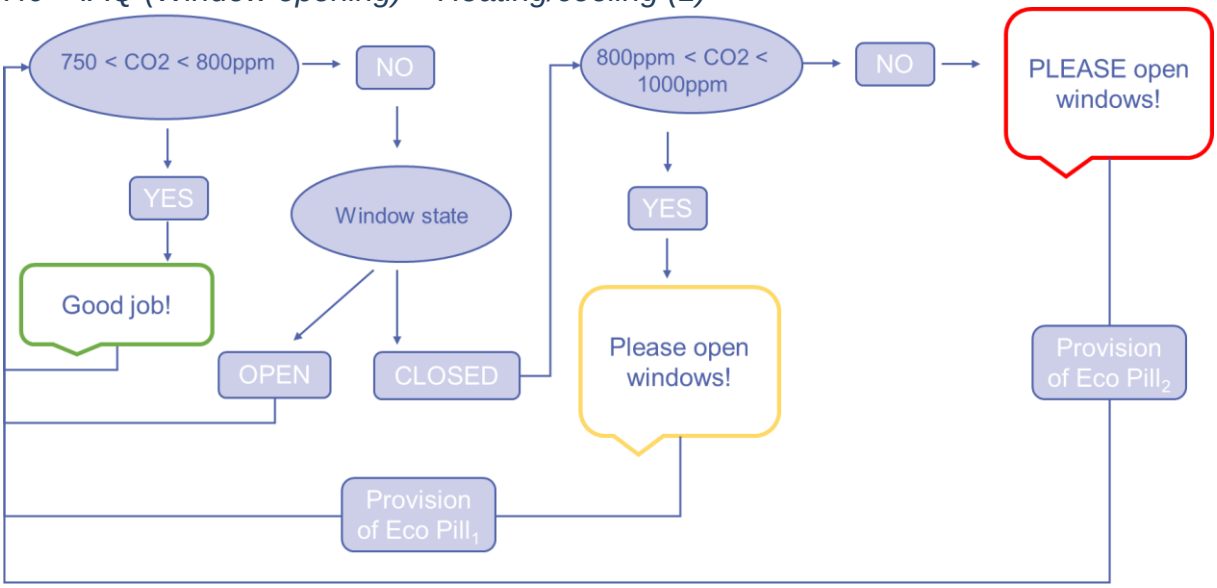


Measured parameter: Power absorbed by the microwave

Restrictions: no restrictions

The system checks continuously whether the power absorbed by the microwave is greater than 0 W and less than 2 W, therefore said in other words when the microwave is switched on but in standby mode. This may happen if the user does not switch off the microwave after using it. When this situation continues for at least 30 minutes the system sends an alert informing the user of the consequence of his actions.

H6 – IAQ (Window opening) – Heating/cooling (1)



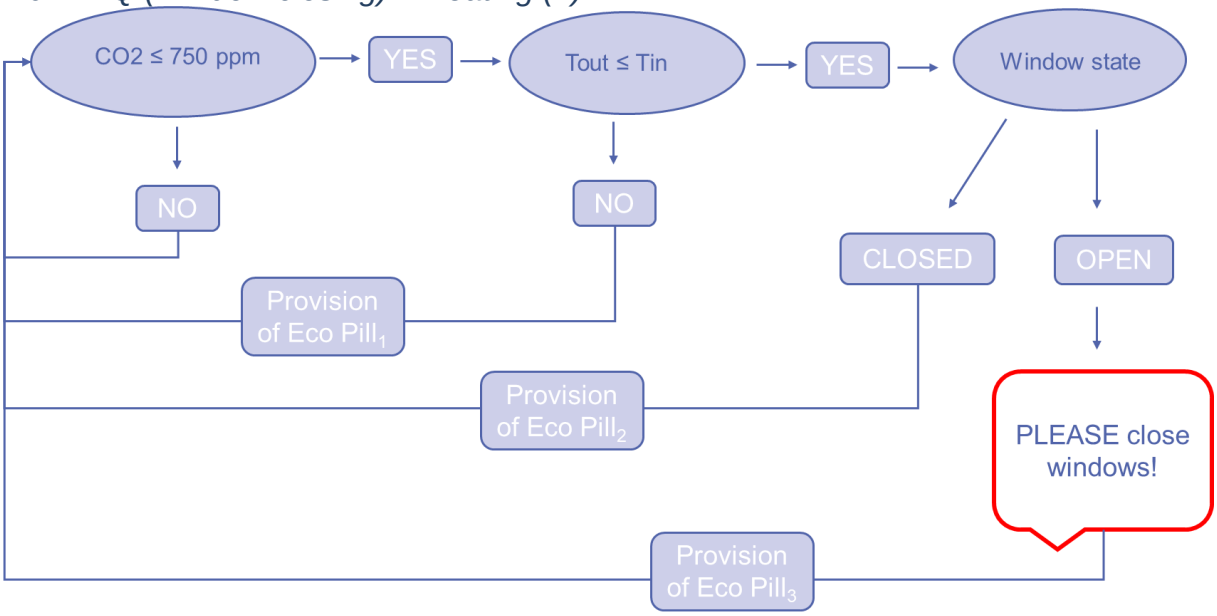
Measured parameter: CO2 level, Window state

Restrictions: Indoor CO2 level higher than 750 ppm

Every certain period, which is still to be determined, the system compares the measured indoor CO2 level with the pre-set limit values. In case of CO2 lever higher than 750 and lower than 800 ppm the system sends to the user a message of congratulation. In case of CO2 level

higher than 800 ppm the system checks if the windows are open: in the affirmative case the system sends to the user a message of congratulation; instead if the windows are closed but the CO2 level is still under 1000 ppm the system sends an alert and an eco-pill (yellow case) inviting the user to open the windows and increase the indoor environmental quality. In the worst case if the windows are closed and the CO2 level exceed 1000 ppm (red level message) the communication may be more persuasive than the previous case.

H6 – IAQ (Window closing) – Heating (2)

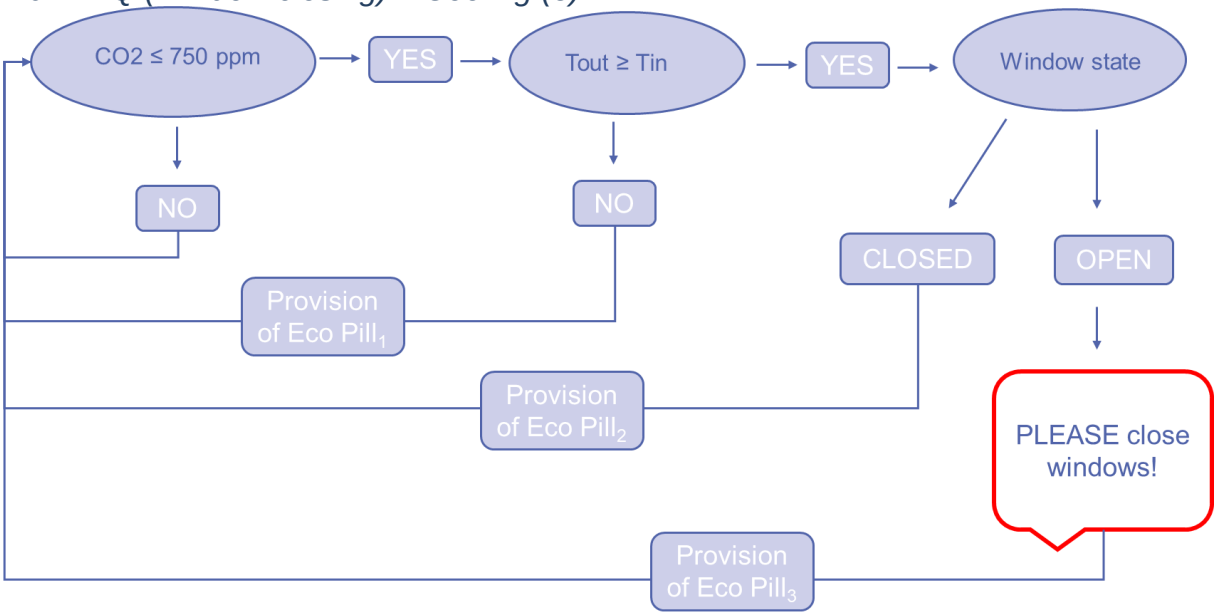


Measured parameter: CO2 level, Window state, Indoor air temperature, Outdoor air temperature

Restrictions: During heating season and when indoor CO2 level is lower than 750 ppm

Every certain period, which is still to be determined, the system compares the measured indoor CO2 level with the pre-set limit. In case of CO2 level lower than 750 ppm the system checks if outside is cooler than inside. In the affirmative case the system checks also if the windows are open or not: in the first case the system send an alert inviting the user to close the windows in order to minimize the energy waste and also an eco-pill to increase the awareness of the user.

H6 – IAQ (Window closing) – Cooling (3)

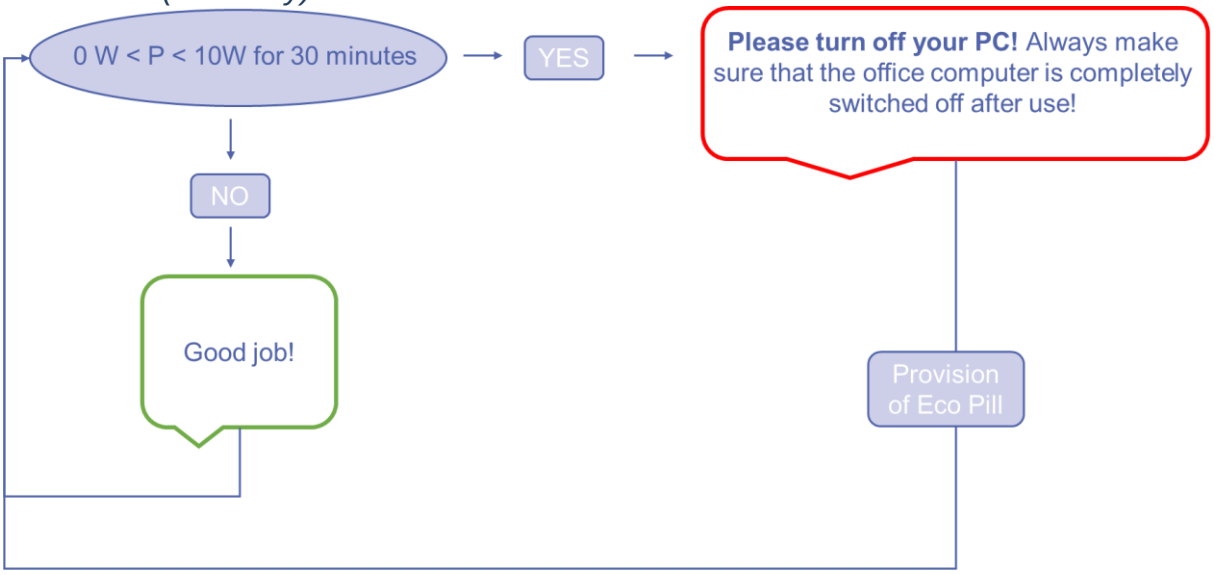


Measured parameter: CO2 level, Window state, Indoor air temperature, Outdoor air temperature

Restrictions: During cooling season and when indoor CO2 level is lower than 750 ppm

Every certain period, which is still to be determined, the system compares the measured indoor CO2 level with the pre-set limit. In case of CO2 level lower than 750 ppm the system checks if outside is warmer than inside. In the affirmative case the system checks also if the windows are open or not: in the first case the system send an alert inviting the user to close the windows in order to minimize the energy waste and also an eco-pill to increase the awareness of the user.

H7-1 – PC (Stand-by)



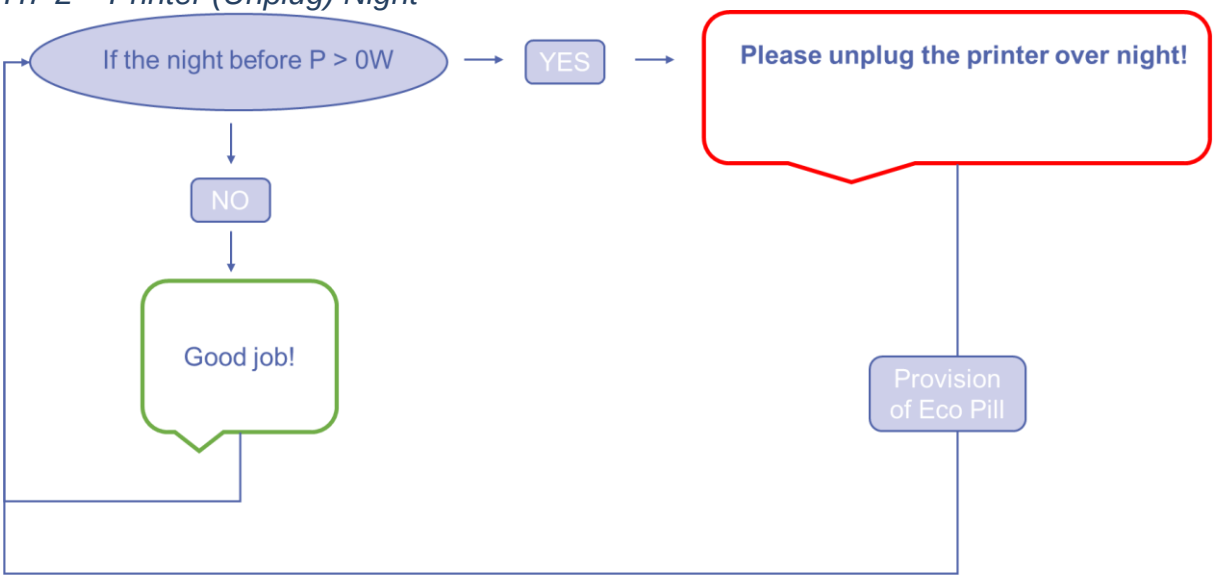
Measured parameter: Power absorbed by the PC

Restrictions: no restrictions

The system checks continuously whether the power absorbed by the PC is greater than 0 W and less than 10 W, therefore said in other words when the PC is switched on but in standby

mode. This may happen if the user does not switch off the microwave after using it. When this situation continues for at least 30 minutes the system sends an alert informing the user of the consequence of his actions.

H7-2 – Printer (Unplug) Night



Measured parameter: Power absorbed by the Printer

Restrictions: Night hours

The system, during the night, checks continuously whether the power absorbed by the Printer is greater than 0 W. This may happen if the user does not switch off the printer after using it at the end of the working hours. In the morning (i.e.at 8:00 am), if the system has measured consumption during the night just passed that is greater than 0, it sends a reminder to encourage night-time deactivation of the printer and to inform of the energy impact of not taking action.

6 Project evaluation methods

An effective methodology needs to plan not only collection of data, but also data analysis. Once considered the purpose of the monitoring in the previous sections, the next step is to define an analysis methodology to meet the needs of monitoring, evaluation and learning. What is most important is that data are analysed in a way that provides answers to key monitoring and evaluation questions that are then used to increase performance, and not just to satisfy externally imposed reporting requirements. Data analysis is then useful to elaborate raw data into significant indicators that allow to highlight any signs of progress and change that result from an activity.

The following aspects of data analysis will be undertaken:

- **Disaggregated data comparison.** For indicators with disaggregated data (for example energy data), it is fundamental to plan how it will be compared, displayed, and analysed.
- **Comparison of current (building, energy, IEQ, health) performance against multiple benchmarks.** For each indicator, plan how actual performance data will be compared with past performance, monitored or reported (vertical benchmarking), or planned or targeted performance or other relevant benchmarks (for example horizontal benchmarking with similar users).
- **Identify hidden relationships among performance indicators.** It means to determine possible internal analysis of the performance indicators to determine interrelationships between variables.

6.1 Evaluation of energy use and indoor environment

Analysing the microclimatic quality and the energy consumption of the case studies, it significant to evaluate the frequency distribution and cumulated frequency evaluation. Cumulated frequency of a parameter, referred to a specific survey period, associates each single value to the time percentage in which the parameter resulted below the considered value.

Energy

From the elaboration of the measures obtained through the monitoring activity, it is possible to obtain, in addition to the temporal profiles of the average power over time relative to the single appliances, also quantities aimed at a descriptive statistical characterization of the total energy consumption of each case study.

The following values can be evaluated calculated:

- the maximum, minimum, average and standard deviation values of the powers of each monitored appliance (if present) for significant periods;
- the quartiles of the total power and / or energy distributions and for the various monitored devices;

- the frequency and cumulative frequency of power requested over the period examined.

The impact on energy consumption of the MOBISTYLE solution can be assessed as difference in terms of energy use before (in the monitoring period without feedback) and after the feedback provision (first monitoring step with feedback).

After the analysis of the energy used/saved with the MOBISTYLE application, it is possible to calculate the environmental impact (CO_2 emission).

The same process may be replicable to compare the second period of feedback provision (monitoring with optimized feedback) with previous stages.
The variation of energy use between the apartments will be analysed, and it will be investigated if correlations can be proved between energy use and parameters like indoor temperature level, window opening behaviour and/or number of occupants and their presence.

IEQ

From the collected data is possible to obtain, as well as time profiles of thermo- hygrometric parameters, statistical values fundamental to give judgement on environmental quality:

- Mean hourly values (RH_{1h}, T_{1h})
- Mean daily values (RH_{1d}, T_{1d})
- Standard deviation (St. Dev.)
- Minimum and Maximum values during the investigation period (Min, Max)
- Frequency distribution and cumulated frequency.

To evaluate the conditions of comfort (or discomfort), it is required to proceed referring to classes indicated in EN15251 with the calculation of number/percentage of occupied hours (POR, as defined in D3.1) in which the indoor air temperature falls outside the range of predefined comfort classes (Class I,II,III) – this allows also for defining the number of hours outside these ranges (discomfort)
The variation of energy use for heating between the apartments will be analysed, and it will be investigated if correlations can be proved between energy use for heating and parameters like indoor temperature level, window opening behaviour and/or number of occupants and their presence.
CO_2 levels and Relative humidity can be evaluated with the number/percentage of occupied hours (POR, as defined in D3.1) in which the respective IEQ parameters falls outside the range of predefined comfort classes (Class I,II,III) – this allows also for defining the number of hours outside these ranges (discomfort).

6.2 Evaluation of the change in user practices as a result of user feedback

Behavioural change can be evaluated through the answers of MOBISTYLE participants on tailored questionnaire delivered before the feedback provision and after (when possible) the feedback provision. The aim of the questionnaire is to understand changes in terms of perception by the participants related to comfort, energy health, and the MOBISTYLE project. The questionnaire consisted in 5 sections (A-E) with a set of specific questions related to old/new perception of comfort; old/new perception of energy and related costs; old/new perception of health; perception of feedback provision and MOBISTYLE project and intention to change the own behaviour in a long-lasting manner.

Change in indoor temperatures

Changes in indoor temperatures between the reference and the monitoring periods can be illustrated by comparing carpet plots, where it can be illustrated when, how much and for how long changes occur. Special attention will be focused on illustrating changes in indoor temperature levels in periods after giving feedback on benefits of window opening. Especially, night temperatures will be important to analyse and compare.

Change in set point temperature in the heating/cooling season

Changes in set-point temperature between the reference and the monitoring periods will be estimated by the data received by the thermostats in the apartments. Special attention will be focused on illustrating changes in set-point temperature in periods after giving feedback on benefits of changing it.

Change in window opening practices

Window opening behaviour will be illustrated as a function of temperature level, CO2 level and humidity level in the actual room, respectively. Special attention will be focused on comparing changes in user practices between the reference and the monitoring periods, i.e. when and for how long are windows open and are there recurring moments during the day. This can be illustrated by a carpet plot complemented by statistical analysis. Special attention will also be focused on illustrating if changes occur in user practices in periods after giving feedback on benefits of changing window opening behaviour.

6.3 Evaluation of the use of the MOBISTYLE solution and user perception of feedback and guidance

For each case study, it is necessary to evaluate the effectiveness of feedback categories related to different final energy uses:

1. Heating
2. Cooling
3. Equipment
4. Lighting
5. Domestic hot water
6. IEQ and natural ventilation
7. Health

To test the effectiveness of the different feedback categories in terms of energy savings, it is required to compare the relative variation of energy uses of each feedback category before and after the feedback provision.
To test the effectiveness of the different feedback categories in terms of indoor environmental quality, it is required to compare the relative variation of the percentage of hours outside the comfort rage (POR) for each feedback category before and after the feedback provision.
It is then possible to evaluate the effectiveness of different *time frequencies* at which feedback is provided for the same feedback category (e.g. is it better to provide feedback for a specific domestic appliance daily or weekly?). This allows to find the frequency (e.g. once per week, once per day, continuously) with which major energy savings are achieved. This evaluation is aimed at optimizing the process and can be developed during test periods (e.g. t1, t2) that are characterised by different frequencies (f1,f2). Feedback frequencies can then eventually be optimised.
The *evaluation of the communication* content would require testing different communication contents during different test periods, similarly to the indications in the previous paragraph. The timing and set up of the MOBISTYLE implementation in IT tools probably will not allow to test a large variety of interfaces and communication contents.

Finally, to test the user satisfaction, a survey regarding the use of the MOBISTYLE app could carried on together with the participants. The purpose of the survey is to get direct feedback from the participants concerning the experience of using MOBISTYLE app and the experience of participating in the project as a whole as well as gathering general information and information regarding motivation aspects while using the app.
The user satisfaction survey was intended to gather the perceptions and opinions that the participants had regarding the use of the MOBISTYLE app during their staying in the hotel. This enquiry will be based on a five point scale (Strongly disagree, Disagree, I don’t know, Agree, Strongly agree) which allows the participants to express how much they agree or disagree with each statement.

All in all, with the information such as a general evaluation of the product, experience, preferences, impressions, attitudes, expectations, wishes, etc should be gathered.
In particular three main themes should be covered in the structure of the survey:
- General information
- Use of MOBISTYLE app
- Motivation to use the app and motivation in general.

First, general information of the participant could be asked. It included aspects such as the frequency of MOBISTYLE app openings, the use of mobile phone in the hotel rooms as well as the way the participants follow their progress and the problems that they have while doing it. Second, questions about the use of MOBISTYLE app during the project will be asked. They aim to:
- discover what the participant's feelings and thoughts about using the app
- what features they like most or they do not like
- whether there are features that they would remove from the app or there are new ones that they would add.

Design implications for user acceptance and satisfaction should include:
- Perceived value for the user investigating:
  - if the provided service content is comprehensive, topical and familiar
  - if the app provide personal and tailored content
  - if the app provide utility, communication or fun for the users
- Perceived ease of use investigating:
  - clear overview of the app and the project
  - fluent navigation on a small screen
  - smooth user interaction with the app
  - personally relevant services and information without expending effort on personalisation set-up
  - easy access to relevant information
- Trust
  - the user should be able to rely on the app and in the project in intended contexts of use
  - the user needs to feel and really be in control

Finally, questions related to motivation in general and while using the app were intended to discern what aspects motivate the users so that they want to continue using the app in the future.
An example of user satisfaction enquiries is given below.
1. To which extent the contents of the app are important to you?
2. To which extent it was difficult to you to understand the structure of the app?

3. Do you think that the appearance of the app was pleasant?
4. Do you think that the home screen of the app was easy to understand?
5. Do you find difficulties on moving from one section to another?
6. Was the use of the app fluent for you?
7. Are you satisfied with the ease of use of the app?
8. Was it easy to perform the given tasks?
9. To which extent the app included terms and words that were unfamiliar to you?
10. Are you going to use the app later?

6.4 Information for calculation of Key Performance Indicators (KPI)

In the following tables, selected indicators for each area (energy, IEQ, health) are reported giving a brief explanation, the parameter code and their units. The parameter code it is used to connect the following KPIs to the parameters reported previously in the section 3.

KPI (Energy)			
Category	**Description**	**Unit**	**Parameter Code**
Electricity building performance indicators	**Electricity consumption.** Measures the amount of electricity in a certain period (monthly, yearly). Can also be referred to specific electric domestic appliances. We expect the user to know about the existence of this indicator, still for some users it might be hard to quantify kWh.	kWh_{el}/year kWh_{el}/m^2 year kWh_{el}/m^3 year	E2
	Costs for electricity consumption. Represents the amount of money the users have to pay for their bills related to electric energy consumptions (can be divided for different end uses or different domestic appliances). The users can easily understand and relate to costs.	€/year	E3
	Normalized electricity use to occupant number. Relates the building electricity consumption during the occupancy hours to the number of occupants. This indicator might be used for "energy-racing" to compare different functional areas of the same building.	kWh_{el}/occ	E2

KPI (IEQ)			
Category	**Description**	**Unit**	**Parameter Code**
Thermal Comfort	**Indoor air Temperature.** Represents the temperature measured in the room. It can be given as the present value or as an average value for a given time period (daily, weekly).	°C	IEQ1
	POR. The Percentage Outside the Range index , POR, calculates the percentage of occupied hours, when the operative temperature is outside a specified range.	%	
	Level of CO2.	ppm	IEQ2

	Represents the measured level of CO2 in the indoor environment. It can be given as the present value or as an average value for a given time period (daily, weekly).		
	Level of relative humidity. Represents the measured level of relative humidity in the indoor environment. It can be given as the present value or as an average value for a given time period (daily, weekly).	%	IEQ3
	POR. The Percentage Outside the Range index, POR, calculates the percentage of occupied hours, when the indoor air quality (perceived, CO2 or RH) is outside a specified range.	%	IEQ2,IEQ3

KPI (Health)			
Category	**Description**	**Unit**	**Parameter Code**
	Heart rate. Heart rate is the amount of contractions of the heart muscle in a certain period of time and can be influenced easily by changes in environment or activity. According to the American Heart Association a normal heart rate during rest is between 60 and 100 beats per minute for an average person. Monitoring of heart rate is easy with current monitor devices.	beats/min	H2

Here below, the KPIs for user visualization and KPIs used for the evaluation of the impact of the MOBISTYLE application will be reported.

MEASUREMENTS	UNIT	KPI for user	UNIT (KPI user)	TIMESTAMP
electricity/apartment	[KWh]	electricity consumption (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
		costs for electricity consumption	[€/day]	one day (on the basis of previous day)
		Emission of $CO_{2,equivalent}$ (translated into "number of trees that it takes to absorb the total apartment emissions")	[number of trees/year] (based on [$kgCO_{2,equivalent/year}$])	one day (on the basis of previous day)
electricity/washing machine	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
electricity/dish washer	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
electricity/TV	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
electricity/microwave	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
electricity/oven	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
electricity/PC	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
electricity/printer	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	one day (on the basis of previous day)
air temperature	[°C]	air temperature*	[°C]	15 min
relative humidity	[%]	*level of CO_2*	[ppm]	15 min
CO_2 concentration	[ppm]	*level of relative humidity*	[%]	15 min

MEASUREMENTS	UNIT	KPI for expert	UNIT (KPI expert)	TIMESTAMP
electricity/apartment	[KWh]	*electricity consumption*	[kWh/month]	one month
electricity/washing machine	[KWh]	*electricity consumption*	[kWh/month]	one month
electricity/dish washer	[KWh]	*Emission of $CO_{2,equivalent}$*	[kgCO2,equivalent/ year]	
electricity/TV	[KWh]	*electricity consumption* (for graphical visualization)	[kWh/day]	
electricity/microwave	[KWh]	*electricity consumption*	[kWh/month]	one month
electricity/oven	[KWh]	*electricity consumption*	[kWh/month]	one month
electricity/PC	[KWh]	*electricity consumption*	[kWh/month]	one month
electricity/printer	[KWh]	*electricity consumption*	[kWh/month]	one month

As explained in the beginning of this section, monitored data should be elaborated to arrive to a synthetic indicator. This section provides the main formulas for transforming the raw data into KPIs. In the following table, each KPI is associated with the main elaboration from raw data available with the monitoring.

KPI	UNIT	FIXED VALUES	FORMULA	
electricity consumption	[kWh/month]	formula refers always to 00:00 h	$E_{el} = E_{el\,(current\ day)} - E_{el\,(previous\ day)}$	Eel = electricity consumption (daily)
electricity costs	[kWh/month]	Electricity costs: 0,19 €/kWhel (effective value)	$Cost_{E_{el}} = E_{el} * PR_{kWh,el}$	PRkwh,el = electricity tariff
Emission of $CO_{2,equivalent}$	[kgCO2,equivalent/year]	K1 = 0,337 $kgCO_2$/KWh	$CO_{2,eq} = \mathrm{E_{del}} * \mathrm{K1} * 365$	Edel = electricity consumption (daily) K1 = CO2,eq for electricity
Emission of CO2,equivalent (translated into "number of trees that it takes to absorb the total apartment emissions"))	[number of trees/year] (based on [kgCO2,equivalent/year])	K2 = 22 $kgCo_2$/year*tree	$\mathrm{n} = CO_{2,eq}/\mathrm{K2}$	n=number of trees thatit takes to absorb apartment CO2 emissions; K2=conversion factor from CO2,eq to number of trees/year
***electricity consumption* (for graphical visualization)**	[kWh/day]	formula refers always to 00:00 h	$E_{el} = E_{el\,(current\ day)} - E_{el\,(previous\ day)}$	Eel = electricity consumption (daily)

7 Monitoring plan

Both the quantitative and the qualitative monitoring will take place for a period of 24 months, from March 2018 until March 2020 (both included). This covers both an observation measurement period to establish a reliable baseline and a monitoring period in which behavioural change is observed. As the entire MOBISTYLE project is scheduled to last 42 months, starting from October 2016 (M1), the observation measurement period will take place for 8 months from month 18 (M18), April 2018 until month 25 (M25), October 2018. The monitoring period will take place for 15 months, M26 – M40, November 2018 to February 2020, respectively.

The monitoring will be continuous and consistent, measuring and logging the parameters defined for the specific case. These parameters will subsequently be analysed and interpreted to achieve the project goals. The data collection will take place frequently, at set intervals of 0, 2, 6, and 12 months respectively. At each time step, data will be collected for analyses. A detailed time schedule is presented in Section 8 *Resources and time schedule*.

Measuring campaign condition parameters will be established by performing outdoor data logging. Outdoor conditions, such as temperature, brightness, relative humidity, wind speed/direction, will be measured by a weather station or, in case of unavailability of this option, data will be acquired through an online source.

The hotel has a fully operative BEMS (Building energy management systems) and SMS (Security management systems) based on KNX standard as communication protocol. Currently, the system monitors indoor air temperature (and thermostat adjustment), window opening and door openings in each room of the hotel. Surveillance and security system are implemented with also remote control.

The network architecture is based on KNX standard with IP/USB interface. The transmission BUS is connected to a server responsible for logging, storing, and sharing the collected data. The server permits to share data, through a software platform, to every type of computer device, tablet or smartphone.

The company that installed the current monitoring system, "*Big Studio S.r.l.*", will play an active role in the project during the installation process, component configuration and system upgrade.

In order to reach the MOBISTYLE project goals in this case study and due to the difficulties to mount sensors on the thermal system of an old building, the monitoring campaign will focus, regarding energy, on electricity consumption and on electrical appliances.

The actors involved in the project include possibly selected guests of chosen apartments and the focus group (6 participants). The focus group members will contribute with their interviews and feedback both prior to and during the measurement campaign as part of thick data collection, while the other hotel guests participating in the project will contribute with the data measured during the observation and monitoring period.

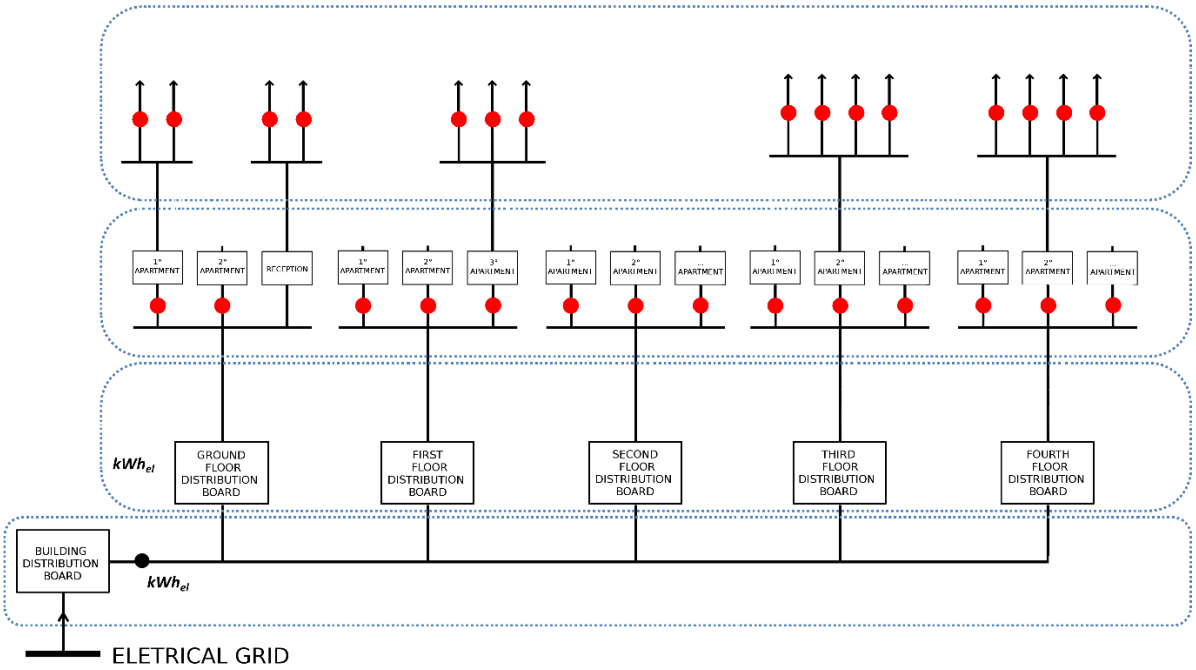
The following subsections comprise an action-based list of tasks in a chronological order containing relevant information about each step-in order to execute the measurement campaign.

7.1 The measurement campaign preparation process

The current system monitors indoor air temperature (and thermostat adjustment), window opening and door openings in each room of the hotel. The following parameters will be monitored with new sensors:

- Indoor Temperature
- Relative humidity
- CO2 indoor level
- Apartment electricity consumption
- Electrical appliances

Indoor temperature, relative humidity and CO2 level will be measured using a wall sensor, directly connected to the hotel's KNX system, containing three sensors that permit to collect the three IEQ parameters just listed. The position inside the rooms will be on a wall and the height from the floor will be 1,1 meters in the living rooms and 0,6 meters in the bedrooms.
Electricity consumption will be monitored in the apartment distribution board and inside the apartment using approximately 3/4 smart electricity sockets. The smart meter in the distribution board will measure the total consumption of the apartments and it will send data to the server through a KNX communication module that is connected to the KNX bus. The smart sockets will permit to monitor how the users use electrical appliances (like dishwasher, washing machine, TV etc…) and to assess how much each of them impact on the total electricity consumption through the measurement of instantaneous electric power. The smart sockets will communicate by KNX radio frequency to a *KNX RF+ line coupler* connected to the KNX bus.



Hotel simplified wiring diagram.

The red dots in the figure are all the points of measure of electricity: in the main distribution board, at the floor level and inside the apartments with the smart sockets.

Smart Whitegoods, (probably microwaves from July 2018) will monitor how the occupant use them and will guide the users to a more sustainable usage. This appliance will require wi-fi connection to connect to Whirlpool servers, to log data and send to the users' smartphone app. The microwave will be available only in the 2018 so it will be possible to compare the use of a smart microwave to old one and assess the impact that the new technology has.

Occupancy now is available through the data that comes from the entrance door opening system (key card) of each apartment.

Window opening is already monitored in each window of the hotel for energy and security control. The measure comes from a magnet switch the returns only the signal of aperture of the window when the two magnets are not aligned.

Door opening is now monitored to manage all the guest access in the hotel room.

Thermostat permits to adjust, in each apartment, the indoor temperature +/- 3°C with respect of reference temperature (21°C on winter and 23°C on summer). The installed fan coils allow, enabling a feature currently unused, to monitor which fan speed the user has set. This update of the system requires more investigation on the technical feasibility.

In the following table a summary of all the monitored parameters and devices in all the hotel rooms is reported.

	Electricity consumption	Smart plugs							IEQ sensor	Thermostat adjustment	Fan coil speed	Windows opening	Door opening	Occupancy
		TV	Microwave	Oven	Washing machine	Dishwasher	PC	Printer						
Reception							✓	✓	✓					
Room 01	✓	✓		✓					✓	✓	✓	✓	✓	✓
Room 02	✓													
Room 03	✓													
Room 101	✓													
Room 102	✓													
Room 103	✓	✓	✓		✓				✓	✓	✓	✓	✓	✓
Room 201	✓													
Room 202	✓													
Room 203	✓													
Room 301	✓													
Room 302	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓	✓
Room 303	✓													
Room 401	✓													
Room 402	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓	✓
Room 403	✓													

In the following table the list of installed sensors is reported. All the other technical characteristics of the sensors can be find at the end of this document as attachments.

Parameter	Device name	Wired/Wireless	Resolution	Accuracy	Sampling rate	Other/Notes
Electricity consumption	MDT KNX RF+ Socket	Wireless	10mA	2%	15 sec	Smart plugs
	Zennio KES KNX Energy Saver	Wired	10W	5%	15 sec	For the overall consumption of the apartments
Air temperature	MTN6005-0001	Wired	1°C	±1 °C	10 min	

Relative humidity (indoor)	MTN6005-0001	Wired		±5 %RH	10 min	
CO_2	MTN6005-0001	Wired	1 ppm	±120ppm	10 min	
Window opening	/	Wired	/	/	Variation of state	
Door opening	/	Wired	/	/	Variation of state	
Thermostat adjustments	ABB TUX/U 1.1	Wired	/	/	Variation of state	

7.2 Description of the measurement procedure

According to the method, various sensors and measurement devices are placed or installed to provide values, which can be analysed. A process of correction or normalization as well as uncertainty estimation is also established. Various obstacles, for example, a temporary loss of network connection, may occasionally interrupt the data collection process resulting in a reduction of measurement availability. In these instances, a process of automatic interpolation (when applicable) between the measurements available will be applied.

Any equipment specifications, which may influence the measurements, should be clearly stated during the monitoring process, so that such influences could be accounted for.

As mentioned previously, the measurement period consists of both a reference and evaluation monitoring period. Both quantitative and qualitative data will be collected. Depending on the case, strategies in qualitative data collection will include questionnaires for all participants and interviews for the focus group members. The monitoring will be continuous and data collection and review will take place at certain intervals during the project timespan to be able to react on observations made and carry out possible improvements to the methodologies and feedback developed.

The monitoring period will be divided into three general phases as follows:

1. Checking the existing conditions – reference measurements.
2. Assuring that what is installed performs as expected and initial feedback provision
3. Performance evaluation and optimized feedback provision

The three periods are illustrated in the table below.

Both the quantitative and the qualitative monitoring will take place for a period of 23 months, from April 2018 until March 2020 (both included). This covers both an observation measurement period to establish a reliable baseline and a monitoring period in which behavioural change is observed. As the entire MOBISTYLE project is scheduled to last 42 months, starting from October 2016 (M1), the observation measurement period will take place for 7 months from month 19 (M19), April 2018 until month 25 (M25), October 2018. The monitoring period will take place for 15 months, M26 – M40, November 2018 to February 2020, respectively.

	April 2017 – October 2018	November 2018 – May 2019	June 2019 – February 2020
MOBISTYLE project	M19 - M25	M26 - M32	M33-M40
Monitoring timeline	M0	M1	M2
Phase name	Reference monitoring	Initial monitoring phase	Intermediate impact evaluation
Phase description	Establishing a base line for case studies	Check if equipment works, initial user feedback and observations	Performance evaluation and continuous data collection, possible improvement to strategies developed based on data extracted and user feedback received
Notes	No solutions implemented, only monitoring	Collect data	Collect data

7.3 Data acquisition

Data shall be collected as continuously as possible, at various rates for different parameters as specified in the measurement procedure description. The data acquisition systems used for the various channels must be synchronized regularly and continuously. To ensure that only data obtained during normal operation of the equipment are used for the analyses, a process of data filtering shall be established. Any other rejection criteria shall be clearly reported.

There is already a Building Management System that collects the data and stores them into a database.

The format of acquired data with the monitoring campaign is text or numbers. Data are collected every minute and sent to the database in a historical manner (not real-time).

The Building Management System has a server SQL for exchange of data (Microsoft SQL).

The amount of data could not yet be hypothesised.

7.4 Data sharing and exchange

All the data collected by the sensors are logged and stored inside the server. The server permits to share data, through a software platform, to every type of computer device, tablet or smartphone.

There are several unknown factors regarding data handling, which makes it difficult to establish associated expenses. The data sharing model is not clear or priced yet, other than establishing that the pricing will depend on the amount of data exchanged. As mentioned, this is a service, which will be logged, time-stamped, and invoiced per MB of data.

It is known that an online webpage will be needed, as opposed to a data base, which exists currently. A storage cloud will be needed.

It will be necessary to define a procedure to avoid data lost. A daily control on the server can be performed, comparing the amount of received data against the expected.

7.5 Reporting format

The final monitoring report will be the revised Action Plan and shall contain the following information:

- A description of the equipment used and their location within the monitoring site.

- An identification of the specific equipment configuration under the measurement.
- A description of the measurement site and the ambient conditions.
- Identification of the sensors and data acquisition system, including documentation of calibrations for the sensor's transmission lines, and data acquisition system.
- A description of the method of data acquisition, storing, and analysis.
- A description of the measurement procedure.
- Presentation of measured data.

8 Evaluation plan

The purpose of the evaluation, regarding this case study, is mainly:

- Evaluate the impact or outcomes of the demonstration. This includes evaluation of the changes in energy use and in indoor environmental quality in the apartments as well as evaluation of the changes in user practices experienced as a result of user feedback.
- Evaluate the awareness campaign process to identify possible optimizations and improvements of the implemented process.

The goal is then to figure out both the project's effectiveness (estimating the extent to which the project's outcomes meet its objectives) and the project's relevance (identifying if the project's goals are responding to the identified users' needs.

The evaluation phase is important to assess the amount of energy saved by a MOBISTYLE project. "Energy savings" refers to the reduction in energy use in the case study resulting from the MOBISTYLE application. The primary focus is then on energy savings by users participating in the project. It can be described as the observed change in energy use by participants, less any change that is not caused by the project.

The evaluation will be divided into three different phases, where each of them have their own objectives:

5. Benchmark definition: Evaluate the existing conditions.
6. Intermediate evaluation: Preliminary evaluation of perception of feedback, impact on performance and changes in user practices.
7. Final Impact Evaluation: Final evaluation of perception of feedback, impact on performance and changes in user practices. Accurate verification of the project achievements.

	September 2018	April 2019	January 2020
MOBISTYLE project timeline	M24-M25	M31-M32	M40-M42
Evaluation timeline	E1	E2	E3
Phase name	Benchmark evaluation	Intermediate evaluation	Final Impact evaluation
Phase description	Define reference performance in relation to energy use and indoor environmental quality	Preliminary evaluation of perception of feedback, impact on performance and changes in user practices.	Assessing the project results
Notes	No solutions implemented, only monitoring	Evaluation at the end of the first step of monitoring with feedback.	Final data extraction and analysis

8.1 Benchmark definition (E1)

The purpose of the benchmark evaluation is to determine the reference situation before application of the MOBISTYLE solution and will be based on monitored values. References will be defined for each chosen indicator in the defined area (energy, comfort, health). In case of energy indicators, reference will be analysed through normalized and specific KPIs (per person, HDD, floor area, etc…). Moreover, descriptive statistics (min, max, average, SD, …) will be reported for depict. Indoor environmental quality is evaluated for the reference period. Temperature, CO2 and RH levels are evaluated for each apartments. Interactions of the users with systems will be reported and analysed in order to have a baseline behavioural profile.
The following items will be included in the analysis:
- load profile (energy use for electricity, appliances)
- preferences in terms of IEQ parameters (Tin, CO2, …)
- comfort preferences and satisfaction and health-related aspects (questionnaire)
- Occupational patterns and specific interactions with systems (number of window openings, thermostat adjustments, stand by usage).

8.2 Intermediate evaluation (E2)

The purpose of the intermediate evaluation is to get a preliminary idea of the impact and perception of the MOBISTYLE solutions and feedback and to receive opinions from the user regarding improvement possibilities. Based on monitored data it will include evaluation of:

- Energy use for total electricity use and electrical appliances for each month or week in the feedback period and initial comparison with the reference period (if possible).
- Once the amount of energy used is calculated, it is possible to analyse also the resulting impact on the environment. It is measured applying the conversion factors for electricity.
- Temperature, CO2 and RH levels for each monitored apartments and initial comparison with the reference period. Main descriptive statistical parameters will be obtained: mean hourly values, standard deviation, minimum and maximum values during the investigation period, frequency distribution and cumulated frequency.
- Occupational patterns and specific interactions with systems (number of window openings, thermostat adjustments, usage of electrical appliances) will be analysed and compared with the reference period.

An interview with open questions will be conducted with users of each apartment to assess their perception of MOBISTYLE solutions, how they use them, when, for how long and to what extent their preferences for comfort and satisfaction and health aspects have changed. The interview will also identify user perception of the feedback information and feedback received as well as if it based on their own opinion has led to any changes in their practices.
In order to improve and optimize the feedback process, the following factors will be analysed:

- Different feedback category will be analysed and compared in terms of achieved results. For example, it is possible to compare feedback related to heating, lighting,

electrical appliances with the final energy used for heating, artificial lighting, appliances to calculate where the major savings are obtained.

- Efficacy of feedback frequency (hourly, daily, or continuous) leading to increased user awareness and the best results in terms of behavioural change should be assessed.
- The effectiveness of the communication adopted and its characteristics as: type (numerical, graphical), communication strategy (prompts, pop up message, educative advices, serious game, newsletters), length (concise/long), wording and design (efficacy of the chosen terms in the message), credibility (coherency of provided feedback) and level of detail of communication.
- The efficacy of paper-based (poster, brochure) or ICT-based (mobile phone, website, email, ambient displays) communication media should be also evaluated in terms of: usability, user-friendliness, easiness of use, barriers, reliability, user satisfaction/experience and interaction rate.

8.3 Final evaluation (E3)

The purpose of the final impact evaluation is to document the impact and perception of the MOBISTYLE Solution. It will use the same methodology as carried out in the previous evaluation period and the monitoring phase M2 (provision of optimized feedback), monitoring phase M1 (feedback provision) and M0 (initial monitoring) will be compared.This will allow a continuous improvement of the methodology as well as improve quality of feedback from users on their perception as they will get used to the methodology and the questions asked.
Moreover, final evaluation will assess if MOBISTYLE goals described in the proposal are achieved. The assessment of these goals should then regard:

- achieved energy savings
- number of people:
    - changing their behaviour
    - understanding information IEQ, energy and health
    - actively using the tool and services
    - finding information services usable and attractive
    - finding wearables technologies meaningful and useful
    - embedding services in daily routines

9 Instrumentation

Quantity	Sensor	Cost per unit	Note
15	Smart socket	150€	Wireless (AC powered)
3	RF coupling module	290€	Wired (KNX powered)
5	Smart meter	200€	Wired
5	KNX CO2, Temp., RH sensor	220€	Wired (KNX powered)

All prices indicated are including taxes. The cost for installation, registration, and coding/calibration of all sensors is, up to now (March 2017) is 2000€. Smart appliances prices and installation prices of them are currently unknown.

10 Resources and Time Schedule

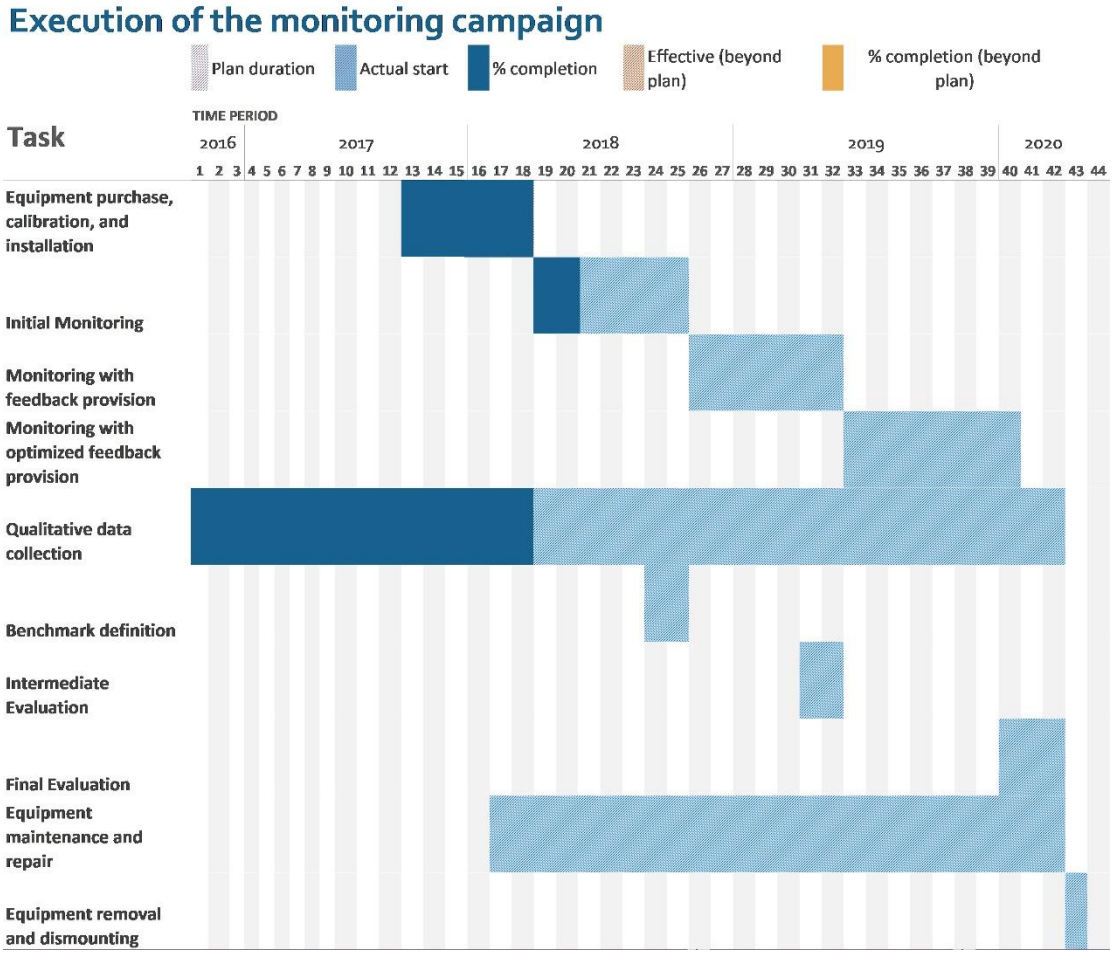
The table below summarizes the required resources to carry out the action plan in terms of costs, time, and hours of labour.

10.1 Overview

Execution of the monitoring campaign				
Task	**Time period**	**Hours of labour needed**	**Associated costs**	**Notes**
Equipment purchase, calibration, and installation	M13-M18	320	9600	
Quantitative data collection	M19 – M42	300	7000	
Qualitative data collection	M1 – M42	220	5500	
Equipment maintenance and repair	M19 – M42	150	3000	
Equipment removal and dismounting	M43	150	2000	
Data extraction and handling	M19 – M42	200	5000	
	Total:	1340	32100	

10.2 Detailed time plan

Project timeline



Deployment of ICT solutions

In MOBISTYLE there are two Information and Communications Technology (ICT) solutions implemented in order to achieve the MOBISTYLE goal: reduce energy consumption by 16% and improve IEQ conditions and health aspects in the demonstration buildings. These ICT-solutions are GAME and DASHBOARD, developed by Highskillz (HS) and Holonix (HLX) respectively.

In non-residential demo-cases like Orologio Living Apartments only the DASHBOARD App will be implemented. The timeline for this process is presented in the following table.

June 2018 – August 2018	September 2018 – February 2019	March 2019 - January 2020
M21 – M23	M24 – M29	M30 - M40
M21 DASHBOARD Prototype I (Desktop version)	M24 DASHBOARD Prototype II (Mobile App version)	M30 Final DASHBOARD (Mobile App version)

Initially, the Desktop version of the DASHBOARD (Prototype I, M21) is created and presented to the POLITO researcher team and building managers of the demo-case building.

Further, it is planned to develop the DASHBOARD application for the Android mobile phones (Prototype II, M24). Soon after the Prototype II version will be available to the hotel residents, it is planned to organize a meeting with them in order to evaluate end-user interaction with the application. This will be done by organizing meeting with focus group participants to evaluate the usability of a system. Here the end-users will complete the System Usability Scale (SUS) and make an evaluation of the first mobile version. Afterwards the DASHBOARD App (Final, M30) will be further improved with respect to the user comments.

The schedule during the DASHBOARD implementation will be updated according to the work progress of ICT partner HLX.

10.3 Organizational structure

In the Italian demonstration case, there are two organizations involved to provide a successful implementation of MOBISTYLE solutions. These organizations are Politecnico di Torino (POLITO) and the demo case itself – Orologio Living Apartments. Within the scope of MOBISTYLE project, POLITO supports the coordination and communication between the demo case and the data acquisition from the hotel to the MOBISTYLE platforms. Furthermore, the hotel manager facilitates the communication between MOBISTYLE operators and the different end-users, such as hotel guests and staff.

People involved in the MOBISTYLE project are mentioned in the following table.

Organization	Contact information
Politecnico di Torino	Stefano P. Corgnati, WP3 leader, E-mail: stefano.corgnati@polito.it Valentina Fabi, E-mail: valentina.fabi@polito.it Cristina Becchio, E-mail: cristina.becchio@polito.it Verena M. Barthelmes, E-mail: verena.barthelmes@polito.it Giulia Vergerio, E-mail: giulia.vergerio@polito.it
Orologio Living Apartments	Stefania Telaia, Hotel manager, E-mail: stefania.talaia@orologio-residence.com

10.4 Review of the possible risks

Description of the risk	Proposed risk-mitigation measures	Status of risk
Poor or no collaboration from the hotel manager and hotel guest/staff	Direct involvement of manager and end-users via regular meetings and emailing	No risks occurred with the hotel manager and the staff. Collaboration with new hotel guests is always a new risk.
Insufficient interest of hotel guests in the proposed ICT solutions, not enough active access to the dashboard	Participatory planning of the ICT solution, user-friendly interface, pop up alerts that motivates passive users	No risks occurred. To be updated when ICT solution is in place.
Hotel guests and occupancy in some of the hotel rooms might change frequently throughout the project	Monitoring, feedback and evaluation periods will be adjusted to the duration of stay of the hotel guests	No risks occurred. To be updated after occupancy has changed in the hotel.
Limited interest of hotel guests to save energy/money since they pay to stay in the hotel and expect good services	Especially in this demo case, the main focus of engagement should regard not only energy, but advices on indoor air quality, the impact on the environment and health	No risks occurred.
Limited amount of end-users have computers or Android mobile phones.	Make a survey and quantify the number of computers/mobile phone. Eventually include systems in the hotel (e.g. TV).	To be updated.

11 Ethics in MOBISTYLE

Monitoring in WP6 will be based on Informed Consent. Informed consent is one of the primary ethical requirements underpinning research with human subjects and is an ongoing process (especially with data acquisition subject to continuously changing). The purpose of informed consent is to ensure prospective subjects will understand the nature of the research and monitoring and can voluntarily decide whether or not to participate. MOBISTYLE's interpretation of the EC H2020 guide 'How to complete your ethics Self-Assessment' is that when the study involves research involving participants,

1. An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures, and identification of any procedures which are experimental;
2. A description of any reasonably risks or discomforts;
3. A description of any benefits to the subject or to others;
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
6. For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;
7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject;
8. A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Informed Consent in Italian language is presented in the following pages.

Consenso informato per la partecipazione alla ricerca scientifica:
"MOBISTYLE"
Io sottoscritto sono stato informato sulla ricerca in questione, ho letto informazioni scritte su di essa e ho avuto la possibilità di fare domande a riguardo. Ho avuto l'opportunità di prendere in considerazione la mia partecipazione alla ricerca. Ho il diritto di revocare il mio consenso in qualsiasi momento, senza specificarne la ragione.

Acconsento a partecipare alla ricerca e autorizzo l'utilizzo dei dati come descritto nella lettera informativa.

Desidero/non voglio (cerchiare la scelta) essere informato sui risultati della ricerca.

Autorizzo a salvare i dati fino a 5 anni dopo la fine della ricerca.

Voglio/non voglio (cerchiare la scelta) essere contattato per ulteriori ricerche.

Nome _____
Data di nascita _____

Date Firma

Il firmatario, ricercatore responsabile, dichiara che la persona sopracitata è stata informata della ricerca sia oralmente che per iscritto.
Nome _____

Posizione _____

Data Firma

Sei stato invitato a partecipare a questo sondaggio basato su _____**.** E' gradita la vostra partecipazione in breve sondaggio di **(**_____**)** minuti in riguardo a _____**.**

Informazioni generali

Le informazioni contenute in questa pagina hanno lo scopo di aiutarvi a capire esattamente ciò che vi viene chiesto, in modo che possiate decidere se volete o meno partecipare a questo studio. Si prega di leggere attentamente il presente modulo di consenso prima di decidere di procedere con il sondaggio. Se decidete di non partecipare, non vi sarà alcuna conseguenza negativa nei vostri confronti. È possibile uscire dal sondaggio in qualsiasi momento.

Privacy e riservatezza

La vostra partecipazione a questo sondaggio è completamente volontaria e le vostre risposte non saranno condivise. Le tue risposte saranno tenute riservate e la tua identità protetta. Tutti i dati saranno trasmessi tramite una connessione internet sicura e crittografata e memorizzati in un file protetto da password. L'ufficio AFLEG - Servizio Affari Legali del Politecnico di Torino ha stabilito che questo studio soddisfa i criteri per *inserire la legislazione nazionale o comunitaria applicabile*.

Potenziali danni / benefici

Non ci sono danni noti associati alla vostra partecipazione a questa ricerca .

Indicare in che modo beneficeranno o non della partecipazione*

Se accetti i termini sopra elencati, procedi al sondaggio (se clicca sulla pagina successiva, vale come consenso informato*). Vi ringrazio in anticipo per il vostro tempo e la vostra collaborazione. Si prega di essere onesti con le vostre risposte. Le vostre risposte sono estremamente preziose per la nostra ricerca! Se avete domande, non esitate a fare.

Cordialmente,

Informazioni contatto

Attachments

A Sensors technical characteristics

KNX RF+ Socket

Technical Data	RF-AKK1ST.01	RF-AZK1ST.01
Current measurement range	--	10mA - 20A
Measuring inaccuracy	--	2%
Sampling rate	--	2000 samples/500ms
Transmitter frequency	868,3MHz (For operating inside the EU)	868,3MHz (For operating inside the EU)
Range	150m	150m
Output level	10dBm	10dBm
Sensitivity	>-105dBm	>-105dBm
Compatibility	KNX RF S-Mode (with ETS5 support)	KNX RF S-Mode (with ETS5 support)
Output switching ratings		
Ohmic load	16A	16A
Capacitive load	21uF	21uF
Voltage	230VAC	230VAC
Maximum inrush current	80A/150µs 40A/600µs	80A/150µs 40A/600µs
Maximum load		
Incandescent lamps	2300W	2300W
Halogen lamps 230V	2000W	2000W
Halogen lamps, electronic transformer	800W	800W
Fluorescent lamps, not compensated	800W	800W
Fluorescent lamps, parallel comp.	180W	180W
Max. number of electronic transformers	3	3
Output life expectancy (mechanical)	1.000.000	1.000.000
Permitted wire gauge		
KNX busconnection terminal	0,8mm Ø, solid core	0,8mm Ø, solid core
Power supply	230VAC/50Hz	230VAC/50Hz
Power consumption mains 230VAC typ.	< 0,3	< 0,3W
Operation temperature range	0 to + 45°C	0 to + 45°C
Enclosure	IP 20	IP 20

MDT KNX RF+ Line Coupler

Technical Data	RF-LK001.02
Transmitter frequency	868,3MHz (For operating inside the EU)
Range	150m
Output level	10dBm
Sensitivity	>-105dBm
Compatibility	KNX RF S-Mode (with ETS5 support)
Specification KNX interface	TP-256
Available application software	ETS5
Permitted wire gauge	
KNX busconnection terminal	0,8mm Ø, solid core
Power supply	KNX bus
Power consumption KNX bus typ.	<0,3W
Operation temperature range	0 to + 45°C
Enclosure	IP 20
Dimensions (W x H x D)	41mm x 41mm x 22mm

Smart meter EK-ME1-80M

Technical data

Power supply

- Power supplied from the voltage circuit
- Nominal measurement voltage ±20%
- Max consumption: 7,5 VA - 0,5 W
- Nominal frequency: 50/60 Hz

Voltage

- 230...240 V 50/60 Hz (nominal values)

Current

- Starting current I_{st}: 20 mA
- Minimum current I_{min}: 250 mA
- Transitional current I_{tr}: 500 mA
- Reference current I_{ref} (I_b): 5 A
- Maximum current I_{max}: 80 A

Accuracy

- Active energy class B according to EN 50470-3
- Reactive energy class 2 according to IEC/EN 62053

S0 outputs

- 2 passive optoisolated
- Maximum values: 250 V_{AC-DC} - 100 mA
- Pulse length: 50 ±2 ms

Tariff input

- Active optoisolated
- Voltage range for tariff 2: 80 ... 276 V_{CA-CC}

Metrological LED

- Meter constant: 1000 imp/kWh

Environmental conditions

- Operating temperature: -25°C ... +55°C
- Storage temperature: -25°C ... +75°C
- Humidity: 80% max without condensation
- Protection degree: IP51 frontal part - IP20 terminals

Appendix 5 Qeske, NL MAP

Demonstration Case “Qeske”

1 Short description

An office building ‘Qeske’ located in the region Limburg, the Netherlands. This office building Qeske is located on Wiebachstraat 77A, 6466 NG Kerkrade (see Figure 1).

Qeske is an initiative in which education, colleges, universities and companies form a platform. The building users consist of students (age of 20+), young entrepreneurs, experienced professionals, and professors (age up to 65). Students become active partners during the ideas development and their implementation. Accompanied by experienced professionals (seniors), these upcoming employees form the new economy by working together on innovative concepts. Qeske aims to boost the self-awareness of young people and makes them aware of the fact that they themselves can also be innovators in the entrepreneurial or scientific field.

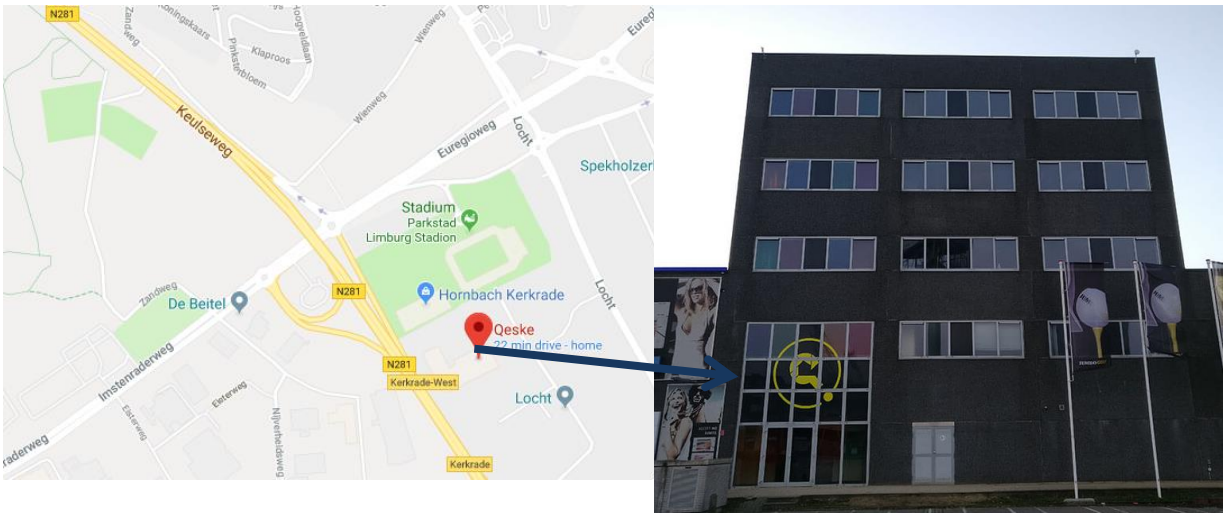


Figure 1: Location of the Dutch demonstration building – an office building Qeske in Kerkrade, Limburg, the Netherlands.

1.1 Construction

The building presents a multi-storey building where the vertical load bearing structure consists of concrete columns with brick walls and horizontally concrete beam-slab construction.

1.2 Technical systems

Central ventilation is provided by a balanced mechanical ventilation system with heat recovery and is equipped with an air-to-air heat exchanger. In addition, local heating and cooling is provided by decentralized heat pumps. Lighting consists of normal lighting systems and in addition sets of adjustable integrated LED light fittings will be installed.

1.3 Target areas (type, usage, occupancy, sensors)

Figure 2: Floor plan of the office space with marked office work places.

The demonstration will be carried out in an open-plan office space, having floor plan shown on Figure 2. There is an open-plan office of 200 m^2. The height of the area is 3,4 m. The demonstrated office space has external walls (with windows). The orientation of the windows is North to South. The demonstration will take place between June 2018-June 2019 where it is expected that most of the employees will be taking holidays during the summer 2018 (less occupancy during July and August 2018). The employees who are willing to take part in the demonstration will be introduced to the project, educated about the demonstration objectives and will be told how and why will be gathered relevant data via the sensors installed in the buildings.

1.4 Technical coordinator

The facility coordinator Paul Crutzen is a contact person for all the related issues.

2 Demonstration vision and objective

Findings from recent research (TRECO, EOS-LT INTEWON) show that people adapt to differences in mean seasonal indoor temperatures (enlargement of thermal neutral zone) and that people benefit from daily changes in indoor temperatures (*enhancing physical activity*). Allowing lower temperatures in winter and higher in summer can even further have effect both on our *metabolic health* as well as *energy savings*.
Furthermore, using building's natural response (morning colder, middle of the day warmer indoor environment) and building's orientation natural indoor climate zoning can be utilized for any building type or geographical location in Europe.
Many aspects of human health, physiology and behaviour are dominated by the exposure to surrounding conditions. Therefore, for the Dutch demonstration case it is explored how different generated indoor environment situations (requiring a certain energy use) affect occupants health related parameters and well-being, but also comfort, acceptation and habituation to the new conditions.

New online questionnaire distribution and focus groups

As there was a change in the demonstration building typology for the Dutch demonstration case with different building occupant group, a new focus group will be organized for this demonstration case. The same focus group methodology will be followed as presented for the other focus groups at the rest of the demonstration cases (reported in D2.2 and D2.3). The first focus groups at Qeske building will take place in week 41 of 2018, where in 1.5h relevant MOBISTYLE related topics will be discussed. When identifying the subjects to take part in these focus groups, it is desired to include representatives of different 'sub-groups' (different departments, age groups, education profiles, etc.). In total seven people are identified (five people and two additional people if any replacements are needed later on during the project): 1 building manager, 6 employees,

The key issues that are of interest to be discussed:

- What are the motivating factors for them to change their daily routine to a more energy efficient and healthier lifestyle?
- Would they be more motivated if working toward energy efficiency goal individually or collectively?
- Which information medium would the most interesting for them (tablet, phone, hard copy newsletter etc.).
- Are they satisfied with the current building, workplaces?

•

3 Specific purpose of the Action plan

The vision of the Action plan for the demonstration case is to improving health and well-being and reducing energy use. The objective of this action plan is to realize an optimal dynamic indoor climate in offices through a dynamic indoor temperature over the day that ensures a healthy and productive office environment and thus also achieves energy savings compared to a traditional air-conditioned office by simulations.

Researchers at the Department of Nutrition and Movement Sciences at Maastricht University (MU), conducted several studies [1-3] where they showed that fluctuating temperatures may actually be better for our health than the recommended uniform design temperatures imposed by European standard EN 15251 [4] based on Fanger's Predicted Mean Vote (PMV) comfort model. Therefore in this demonstration rather than applying constant set points from the standard a new thinking is encouraged enhancing temperature trainings as part of the healthy lifestyle. The researchers at MU showed that temperature deviation during a day time of 8 °C (17 °C - 25 °C) is perceived acceptable for both young adults as elderlies (main result: acceptable comfortable) [1].

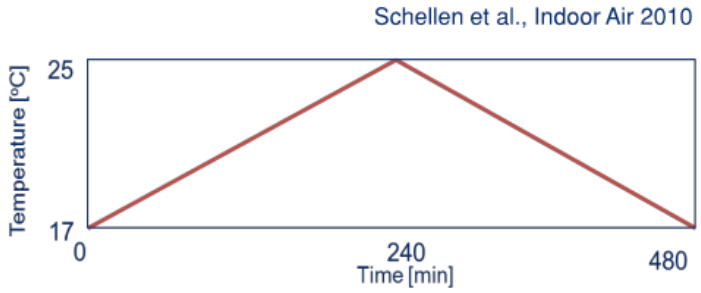


Figure 3: Temperature deviation showing a transient condition from 17 to 25 °C in 4h and then decrease from 25 to 17 °C in the following 4h that was tested in climate chamber at MU by Schellen et al. [1].

The results showed that most of the subjects (elderly, young adults) perceived such conditions as acceptable comfortable. Furthermore, as several studies from MU showed [1-6], such dynamic indoor conditions might also be better for our health than uniform constant indoor temperatures.

The chamber studies at MU showed that such dynamic temperature profile (temperature training) and exposure to mild cold can increase our metabolism and brown fat (healthy fat) activity [5], increase resilience to cardiovascular diseases (ongoing research at MU), and also it has been shown that regular exposure to mild cold increases insulin sensitivity [6].

For the office spaces personalized heating, ventilation and air conditioning (HVAC) control system (split-unit) will be tested with the drifting temperature settings and their effects on occupants' health and energy savings.

3.1 Conditions overview

The current office temperatures at Qeske building are maintained at constant 22 °C.

3.2 Health and wellbeing

For the office spaces in Qeske building that are going to be part of the demonstration, temperature training will be imposed where it will be investigated in real-life environment

what effect dynamic varying temperatures on building's energy performance, acceptance by the occupant and occupant's health related parameters (heart rate, skin temperatures, physical activity) and well-being (their comfort, sensation, mood, sleepiness, alertness and acceptance evaluated through a questionnaire) have.

3.3 Energy consumption

As for the demonstration case, the main objective is to observe relationships between the changing indoor environment conditions (mainly temperature) and resulting health parameters. Therefore, energy consumption monitoring is not the main objective. However, as already discussed, using building's natural response (morning colder, middle of the day warmer indoor environment), seasonal differences (winter colder, summer warmer temperatures) and building's orientation natural indoor climate zoning can be utilized for any building type or geographical location in Europe.

Using dynamic building simulation tool, the yearly simulations for the Qeske building located in Kerkrade (with appropriate weather data file) will be performed to analyse energy savings to be obtained in a year if the proposed dynamic temperature range in summer and winter is allowed for all the office spaces in the examined Qeske building.

This hypothesis will be tested for the Qeske building to evaluate whether such yearly energy saving can be obtained for the building located in Limburg, the Netherlands.

Energy type or resource	Question	Parameter	Observation method	KPI
Q_h (heating consumption)	What is the building's heating consumption during the reference heating period (1st October – 30th April 2018) when defining: - traditional settings (22 °C); - proposed dynamic winter temperature schedule?	Heating consumption (natural gas and electricity)	Simulated	kWh_{th}/m^2
Q_c (cooling consumption) / E (electricity)	What is the building's mechanical cooling (electricity for fan operation) consumption during the reference cooling period (1st June – 30th September 2018) when defining: - traditional settings (22 °C); - proposed dynamic summer temperature schedule?	Cooling consumption (electricity for fan operation)	Simulated	kWh/m^2
CO_2	What is the building's yearly carbon footprint when applying: - traditional temperature settings; - dynamic temperature schedule?	CO_2 emission (calculated for a type of energy medium – natural gas/electricity)	Simulated	Annual Kg/m^2

3.4 Thermal comfort & Indoor environment quality

Question	Parameter	Observation method	KPI
Is the comfortable operative temperature in an office space within a reasonable range?	Operative temperature/Outdoor temperature	Directly measured User perception	
Is the ventilation sufficient in an office space?	CO_2 level	Directly measured User perception	
Is the humidity in an office space within a reasonable range?	Relative Humidity	Directly measured User perception	

3.5 Outdoor conditions

Data from the nearest weather station will be used. As discussed by different researchers, the BMS sensors can overestimate outdoor temperatures due to the direct sun exposure. Therefore, when using outdoor data from BMS system it is needed to know where sensors are positioned. As data from meteorological information source normally include data from extensive weather station this seems even more reliable source as the outdoor data coming from the BMS (not knowing what is the effect of solar radiance etc.).

The measured data from the online site *weatherunderground.com* can be used when doing evaluation/comparison with indoor climate to outdoor conditions (also information about RH).

3.6 Occupant's behaviour ("What we want to know")

For this demonstration case, the main goal is to observe the relation between human physiological response to different indoor environment situations and people's perception and acceptance of it. It is believed that with education of users and easy comprehensible information provision on why we are doing what we are doing this will further increase understanding and users acceptance. The objective is to observe people's psychological response over time to the temperature deviations. With sufficient time period there is body acclimatization (physiological response) which is followed by the user's acceptance (psychological response).

It will be further researched how gradually cooler environment in winter besides leading to higher acceptance and increased metabolism (related to health) also leads to energy saving.

It will be observed how people perceive the dynamic temperatures and how do they react to it (via comfort, sensation, alertness, and physical activity assessment).

4 Required parameters and information

The parameters and their accompanying data that need to be monitored are listed in the table below.

Parameter	Type	Instrument used	Resolution	Accuracy	Time steps	Other/Notes	Costs (per device, €)
Occupants physical monitoring (including heart rate)	Heart rate, physical activity	FitBit					200 €
Skin temperature	Underarm and hand	iButton	0.1°C	±5 %	15 min		
Mirco climate	Brioche	iButton	0.1°C	±5 %	15 min		
Exhaust temperature fancoil units		Environmental sensors (3x)	0.1°C	±5 %	15 min		
Operative temperature	Measuring tree (1) and environmental sensors (4x)	(MRT by black globe thermometer, T_{air} by thermocouple)	0.1°C	±5 %	15 min		
Relative humidity	Measuring tree (1) and environmental sensors (4x)			±5 %	15 min		
Air velocity	Measuring tree (1)	anemometer	0,01 m/s	±5 %	15 min		
CO_2	Measuring tree (1)			±5 %	15 min		

Parameter	User requirements	Actor requirements	Number of participants	Data extracted	Other/Notes
Technology acceptance	App downloads, technology use, daily habits	Interviews	Building occupants, 5-7 persons		
Thermal sensation	Evaluation of thermal sensation questionnaire		Building occupants (employees)		
Thermal comfort	Evaluation of thermal comfort questionnaire		Building occupants (employees)		
Well-being (Sleepiness, alertness)	Sleepiness test (Karolinsky Sleepiness Scale – KSS); Alertness test (Psychomotor Vigilance Task – PVT)	Sleeping test elaboration: data collection, analysis done by MS team	Building occupants (employees)		
Perception of environment (IEQ)	Results coming from - Perceived air quality questionnaire	Questionnaires, data collection& analyses	Building occupants (employees)		
Impact			Building occupants (employees)		

5 Project evaluation methods

5.1 Information for calculation of Key Performance Indicators (KPI)

The findings from the focus group organized for this demonstration case will described in D2.3. Based on the organized focus groups, the anthropology experts will analyse the results and develop a list of recommendations on how to develop solutions that encourage people to act in a way that leads to energy savings, improved indoor environment and personal health. For the office environment some tailored suggestions on what kind of solutions to offer to building occupants will be given.

Based on the extended analysis and list of recommendations given in D2.3, the interpretation methodology will be elaborated to transform data in comprehensible and attractive way for the users of the Qeske building. Again, it should be pointed out that the employees will not have influence on choosing the temperature settings as the idea is to test the temperature profile approach presented in Chapter 3. The recommendation coming from D2.3 will be used to develop awareness campaigns and choose the right ways to communicate information to the users (see Chapter 10).

6 Monitoring and evaluation plan

As introduced earlier, in the demonstration office space, temperature deviations will be imposed. Throughout the day the rooms will warm up from 18 °C to 23 °C during the morning in the winter and down again from 23 °C to 18 °C, see Figure 4. During the summer the profile will be increased with 2°C, from 20 °C to 25 °C during the morning and down again from 25 °C to 20 °C. Before starting the experiments with the dynamic temperature profiles, measurements will be conducted with a baseline temperature of 21°C in the winter and 23°C in the summer.

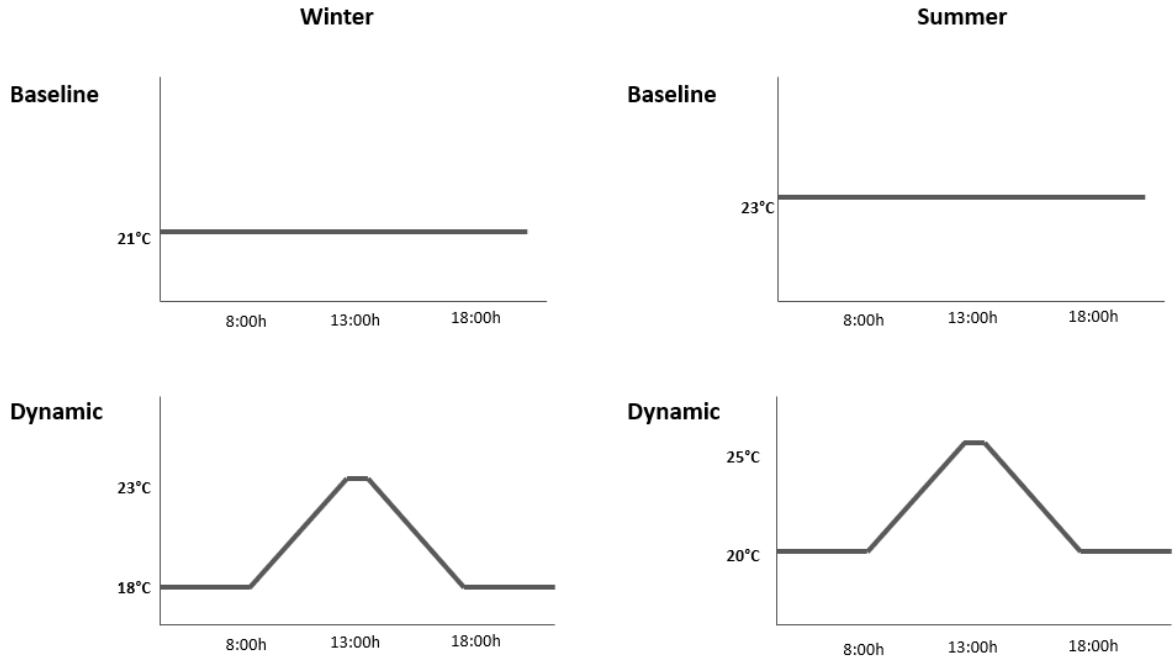


Figure 4: Different dynamic temperature profiles

Throughout the day, participants will wear a set of wearable devices monitoring activity, heart rate (sample time: 1 min) and skin temperature (sample time: 5 min). On several moments throughout the day participants will be asked to fill in questionnaires about thermal comfort and sensation, sleepiness and hunger (once every 2 hours). Additionally, participants will also perform a performance task to measure their alertness (productivity).

6.1 The measurement campaign preparation process

The 8 fixed employees (volunteering to participate in the MOBISTYLE demonstration) will be exposed to different indoor environment situations over the MOBISTYLE duration period (June 2018 - June 2019). For these employees it will be evaluated how their surrounding indoor climate affects their health and well-being.

For the MOBISTYLE purposes one open plan office will be investigated; traditional settings and dynamic temperature settings (20-25°C or 18-23°C) will be implemented. During the dynamic process activation, the subjects may experience the dynamic temperature change.

Factors that influence the indoor thermal behavior of space:

1. Occupation: The climate system must be able to adapt according to the changing occupation.
2. Equipment: In the calculations the internal gains from limited equipment are included, such as laptop / artificial lighting and printing/scanning equipment.
3. Climatological: Especially the exterior is subject to climatic conditions, such as outside temperature, wind and solar load.
4. Construction Physics: The enclosure of the space consists of different materials. These materials have a different thermodynamic behavior.
5. Temperatures: There are different temperatures that can be measured: operative temperature, air temperature, mean radiant temperature, surface temperature etc. For the dynamic setting, it is considered that the space is fully conditioned with the air to be blown in, however, the surfaces temperatures follow passively. Therefore, an air temperature measurement is not sufficient and operative temperature should be calculated from measured mean radiant temperature and air temperatures.
6. Relative humidity: Changing the room temperature will result in changed relative humidity (not yet known details).

Feasibility Principle

A daily amplitude of 6K is large for the HVAC systems (usually 3K). It is possible to achieve a temperature change within 6 hours but it depends on the desired gradient, usually 1K / h. The operations of normal building HVAC system is more unstable with a more parabolic emissions (temperature rise and fall). Therefore, a linear profile as used in the climate chambers (Schellen et al. 2010) will be difficult to realise. When selecting the mode of control and the mode of heating and cooling, this will have to be taken into account. After a pilot the actual range in temperarure will be set.

Three Daikin fan coil units (FCU) are present in the office, see Figure 5. These units are all separately controlled by a RF remote controller. For this project a controller is designed that can control all three units together and will be able to use more setpoints over time to reach the desired dynamic profile.

Figure 5: Daikin units installed to realize the proposed dynamic temperature profiles.

6.2 Description of the measurements

- Heart rate:

Heart rate will be measured continuously throughout the day using a Fitbit with a build-in heart rate sensor. Sample rate of the monitor will be set to 1 min intervals (or data will be converted to beats per minute).

- Skin temperature:

Skin temperature will be measured with the use of iButtons (iButton® Maxim integrated, USA) and will be logged with a sample time of 5 min. All iButtons will be fixed to the body on predefined locations with semi-adhesive tape that is permeable to air (Fixomull, BSN medical GmbH, Hamburg, Germany).

- Alertness task: Psychomotor Vigilance Task (PVT)

This task is developed to measure how quickly a participant can respond to a certain stimulus (e.g. a light flashing on/off) using a laptop or tablet. Participants will be asked to respond as quickly as possible by pressing a button after the stimulus is given. The measured outcome will be the reaction time. This measurement will be carried out once every 2 h.

- Questionnaires: Thermal comfort and sensation, sleepiness and hunger and saturation scales

All questionnaires will be presented on either a laptop or tablet allowing the answers to be send to the MU servers directly (decoded according to all data privacy requirements). Questionnaires will be filled in on several moments throughout the day (2 h intervals apart). The thermal comfort and sensation scales will ask the participant questions about their level of comfort with the current ambient temperature and how they perceive the current temperature. The Karolinsky Sleepiness Scale (KSS): this scale measures the subjective level of sleepiness at a particular time during the day. The hunger and saturation scales measure the level of hunger and saturation as experienced by the participant.

6.3 Data acquisition

To be done in the next 2 months –the sensors will not be connected to DMO database.

6.4 Data sharing and exchange

The sensors will not be connected to DMO database.

6.5 Reporting format

Not applicable for this demo-case.

7 Instrumentation

As described in Chapter 4, the parameters to be measured at the Qeske building for the purposes of the MOBISTYLE project have been defined in this MAP. The elaboration of this task is currently under development where demonstration case representatives work in close collaboration with work package (WP) 2, 4 and 5 (experts in the field of sensoring). The D2.5 will help bringing the monitoring action plan elaborated in this document to concrete data acquisition (sensoring) inventory (gathering more precise and technical information).

8 Resources and Time Schedule

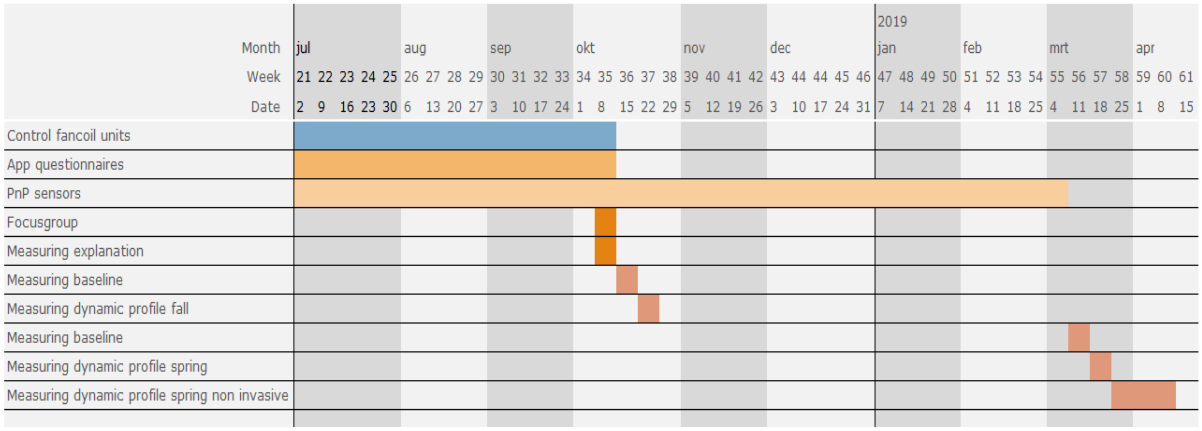
The table below summarizes the required resources to carry out the action plan in terms of costs, time, and hours of labour.

8.1 Overview

Execution of the monitoring campaign				
Task	**Time period**	**Hours of labor needed**	**Associated costs**	**Notes**
Equipment purchase, calibration, and installation	M12 – M21	50	5000 €	
Quantitative data collection	M13 – M42	300		
Qualitative data collection	M13 – M42	238		
Equipment maintenance and repair	M13 – M42	50		
Equipment removal and dismounting	M43	20		
Data extraction and handling	M13 – M42 Check ins M14 M18 M24 M36	350		
	Total:	1008		

8.2 Detailed time plan

Table below shows a time schedule when each monitoring phase related to the Qeske building should be realized in order to be on time with overall MOBISTYLE time planning.



At the time of writing the report, this here is a preliminary time plan for the Qeske demo-case and a more elaborated and detailed execution of the experiments are being developed during the execution stage of the MOBISTYLE project. The updated description of the Qeske demo-case is planned to be attached for the amendment procedure of the MOBISTYLE project.

9. Ethics in MOBISTYLE

Monitoring will be based on Informed Consent, written consent will be gathered before any activities will be monitored. The Qeske building occupants participating in the study will have freedom to choose which health related parameters they want to monitor and therefore share, when and how long. Guidance will be provided in order to clarify what and why the data is collected.

Informed consent is one of the primary ethical requirements underpinning research with human subjects and is an ongoing process (especially with data acquisition subject to continuously changing). The forms presented in table below just show examples of how it might be used for the Dutch demo case. However, once it will be defined precisely what kind of activities will be done, when and for how long, this informed consent document will be updated and revised. This document will include as much as possible detailed description of activities so the subjects will understand and know what they are signing.

The purpose of informed consent is to ensure prospective subjects will understand the nature of the research and monitoring and can voluntarily decide whether or not to participate. MOBISTYLE's interpretation of the EC H2020 guide 'How to complete your ethics Self-Assessment' is that when the study involves research involving participants,

1. An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures, and identification of any procedures which are experimental;
2. A description of any reasonably risks or discomforts;
3. A description of any benefits to the subject or to others;
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
6. For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;
7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject;
8. A statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled, and the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Following forms are examples of Informed Consent Statement Example for Surveys which can be used in:

Monitoring in the Qeske office building in Kerkrade

Informed Consent for participating in scientific research:

"MOBISTYLE"

I have been informed about the research. I have read the written information. I have received the opportunity to ask questions. I have received the opportunity to consider my participation to the research. I have the right to withdraw my consent at any time, without giving a specific reason.

I consent with participating in the research and give permission to use the data as described in the information letter.

I wish to/not to (please circle choice) be informed on the research outcome.

I wish to/not to (please circle choice) be contacted for further research.

Name _____
Date of birth _____

Date Signature

Signee, responsible researcher, declares that the abovementioned person has been informed about the research both orally and by written text.

Name _____
Function _____
Date Signature

Model 2:

"You have been invited to participate in this survey based on **_____.** I would greatly appreciate your participation in a short **(_____)** minute survey about **_____.**

General Information
The information on this page is intended to help you understand exactly what I am asking of you so that you can decide whether or not you would like to participate in this study. Please read this consent form carefully

before you decide to proceed with the survey. If you decide to not participate, it will not be held against you in any way. You may exit out of the survey at any time.

Privacy and confidentiality
Your participation in this survey is completely voluntary, and your responses will not be shared with your employers. Your answers will be kept confidential and your identity protected. All data will be transmitted by a secure, encrypted internet connection and stored in a password protected file. The ***insert university/institution here*** Office of Research Assurances has determined that this study satisfies the criteria for ***insert applicable national or EU legislation***

Potential harms / benefits
There are no known harms associated with your participation in this research ***(if there are potential harms, state them here). *State how they will or will not benefit from participation****

If you agree to the terms listed above, please proceed to the survey ***(*if they click onto the next page, that serves as their informed consent*).*** Thank you in advance for your time and cooperation. Please be honest with your answers. Your responses are extremely valuable to our research! If you have any questions, please do not hesitate to ask.

Thank you,
Contact information here

Informed Consent together with Information letter and manual in Dutch language is presented in the following pages.

TOESTEMMINGSVERKLARING

voor deelname aan het wetenschappelijk onderzoek:

DYNKA metingen

Ik ben over het onderzoek geïnformeerd. Ik heb de schriftelijke informatie gelezen. Ik ben in de gelegenheid gesteld om vragen over het onderzoek te stellen. Ik heb over mijn deelname aan het onderzoek kunnen nadenken. Ik heb het recht mijn toestemming op ieder moment weer in te trekken zonder dat ik daarvoor een reden behoef op te geven.

Ik stem toe met deelname aan het onderzoek, en geef hierbij tevens toestemming voor het gebruik van mijn onderzoeksgegevens, zoals omschreven in de informatiebrief.

Over de resultaten van het onderzoek (zoals die op mij van toepassing zijn) wens ik wel / niet **(A.U.B. Uw keuze aangeven)** geïnformeerd te worden.

Naam deelnemer :
Geboortedatum :

Handtekening : Datum:

Ondergetekende, verantwoordelijke onderzoeker, verklaart dat de hierboven genoemde persoon zowel schriftelijk als mondeling over het bovenvermelde onderzoek is geïnformeerd.

Naam :
Functie :

Handtekening : Datum:

Informatiebrief veldstudie Qeske

Introductie

Beste meneer/mevrouw,
We hebben u benaderd om deel te nemen aan een onderzoek voor wetenschappelijke doeleinden. Om deel te nemen hebben we uw schriftelijke goedkeuring nodig. U hebt deze brief ontvangen omdat u op onze studie-uitnodiging heeft gereageerd en u in aanmerking komt voor deelname. Voordat u beslist of u wilt deelnemen, ontvangt u informatie over wat de studie inhoudt. Lees deze informatie zorgvuldig door en vraag de proefleider (12. Contactinformatie) om een onderwerp verder uit te leggen dat u niet helemaal duidelijk is.

1. Algemene informatie

Dit onderzoek wordt uitgevoerd door het DYNKA consortium met proefleiders van de Technische Universiteit in Eindhoven, Universiteit Maastricht en Huygen Ingenieurs en Adviseurs.
Voor dit onderzoek zullen 8 deelnemers worden gevraagd om deel te nemen.

2. Doel van de studie

Het doel van deze studie is om de invloed van licht en temperatuur op prestaties, comfort, alertheid en slaap van een persoon te meten. Deze informatie wordt gebruikt om te bestuderen hoe omgevingsfactoren in een kantooromgeving de mens beïnvloeden. Dit helpt ons bij het ontwerpen van een optimale kantooromgeving.
Deze studie maakt deel uit van een PhD-traject en de data kan geanonimiseerd worden gepubliceerd in wetenschappelijke tijdschriften en / of het laatste proefschrift.

3. Achtergrond van de studie

We brengen ongeveer 90% van onze tijd door in binnen omgevingen. Om optimale werkomstandigheden te garanderen, is het relevant om deze microklimaten te bestuderen en na te gaan hoe deze ons beïnvloeden.

4. Wat deelname met zich meebrengt

De veldstudie duurt 2 werkweken, van 15 oktober t/m 26 oktober. Deze zal plaatsvinden op de tweede verdieping van Qeske. Tijdens deze weken meten we:

Met de fitbit:

- Uw hartslag
- Het activiteiten niveau gedurende de dag
- Energieverbruik
- Kwaliteit van slaap, incl. de verschillende slaapstadia

Met de iButtons:

- Huidtemperatuur op 2 plaatsen en hiermee hoe het lichaam op de blootgestelde temperatuur reageert.
- Omgevingstemperatuur waar u aan blootgesteld wordt gedurende de dag.

Met de Lightlogger:

- Het licht waar u gedurende de dag aan blootgesteld wordt.

Met de vragenlijsten:

- Zelf beoordeelde comfort en sensatie van temperatuur en licht
- Zelf beoordeelde slaapkwaliteit
- Alertheid
- Gedragen kleding

Alle sensoren mogen te allen tijde gedragen worden, maar hoeft niet. De fitbit en lightlogger zijn niet waterproof en moeten daarom afgedaan worden tijdens het douchen. De fitbit is wel spatwaterdicht, dus regen of handen wassen is geen probleem. De iButtons zijn waterdicht. Alle sensoren moeten afgedaan worden als er kans is op beschadiging, bij bijvoorbeeld intensief sporten.

De fitbit wordt gedurende de hele dag tijdens de meetweken gedragen (incl. de avond en nacht) van zondag avond vooraf gaande van de werkweek tot zaterdag ochtend, zodat de nacht voor en na de meetweek ook geregistreerd wordt. For de lightlogger geldt hetzelfde, deze mag gedurende de nacht met de sensor naar boven op het nachtkastje gelegd worden. De iButtons hoeven alleen gedragen te worden tijdens werktijden. Voor meer informatie zie de handleiding van de veldstudie.

Alle sensoren mogen afgedaan worden als het dragen van sensoren niet gewenst is voor een korte periode (afspraak bij een klant of feestje). Graag bij houden wanneer dit het geval is. De lightlogger moet dan met de sensor naar beneden op tafel gelegd worden.

Verder worden in de ruimte nog een aantal omgevingsparameters gemeten:

- Luchttemperatuur
- Inblaastemperatuur
- Stralingstemperatuur
- Luchtsnelheid
- Luchtvochtigheid
- CO_2
- Lux verticaal en horizontaal

Tot slot wordt de praktische luminantie verdeling nog gemeten met de Bee-Eye. De luminantie is de eenheid die gebruikt woord om de hoeveelheid licht te meten dat wordt gereflecteerd door de verschillende materialen in een ruimte. Metingen worden periodiek (elke minuut) uitgevoerd, deze bestaan uit het maken van een High Dynamic Range (HDR) afbeelding. Gebaseerd op deze HDR afbeeldingen kan vervolgens de luminantie verdeling berekent worden. De doelstellingen van deze metingen zijn het in kaart brengen van de luminantie verdeling op het werkoppervlak, gemeten vanaf

het plafond, en het bepalen van een relevant meetinterval voor dit type luminantie metingen. De HDR afbeeldingen, met enkel de rauwe pixel waarden (901x676) en een tijdsbepaling, worden opgeslagen op een beveiligde server in het bouwfysica laboratorium van de Technische Universiteit Eindhoven. Deze HDR afbeeldingen worden na 1 maand, nadat de relevante luminantie data is berekent, verwijderd.

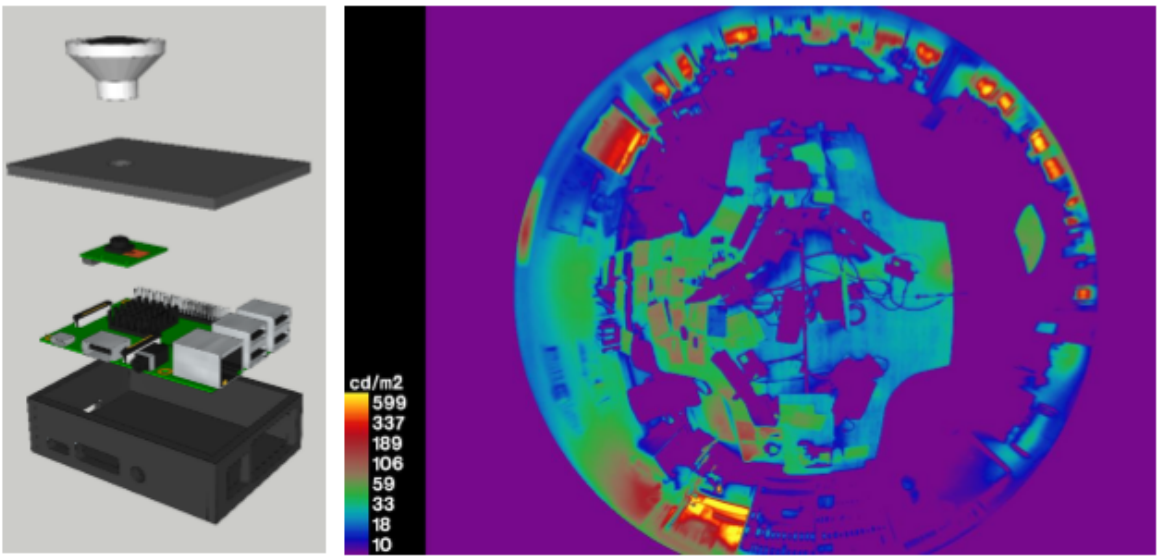


Figure 1. Links: de Bee-Eye. Rechts: Een vergelijkbare luminantie verdeling

5. Risico's en bijwerkingen

Dit onderzoek brengt geen negatieve bijwerkingen of risico's met zich mee.

6. Mogelijke voor- en nadelen voor deelname

Het is belangrijk dat u alle mogelijke voor- en nadelen van deelname aan dit onderzoek in overweging neemt. Uw deelname aan deze studie biedt u geen andere voor of nadelen.

Deelname aan dit onderzoek omvat ook het volgende:
- Instructie van maximaal 1 uur.
- Het onderzoek zelf verbruikt 8 x 2 minuten van uw tijd per dag.
- En eenmalig 20 minuten voor de lange vragenlijst
- U moet zich houden aan de eerder beschreven richtlijnen.

7. Intrekking van deelname

U kunt zelf beslissen of u deel wilt nemen aan deze studie. Deelname is volledig vrijwillig.
Als u besluit om deel te nemen, kunt u - op elk moment - van gedachten veranderen en uw deelname beëindigen. Het is ook mogelijk om dit tijdens een sessie of tussendoor te doen. U hoeft niet aan te geven waarom u zich terugtrekt, maar u moet dit onmiddellijk melden aan de proefleider (12. Contactinformatie). De gegevens die tot nu toe zijn verzameld, worden gebruikt voor het onderzoek.

8. Einde van deelname

Uw deelname aan deze studie eindigt als:
- Je de twee meetweken hebt voltooid

- Je besluit je terug te trekken uit deelname
- Je wordt zwanger
- De proefleider besluit dat het beter voor u is om uw deelname te beëindigen

Je wordt na je deelname geïnformeerd over de details van de studie.
De volledige studie eindigt als alle deelnemers de twee meetweken hebben voltooid. Na het analyseren van de gegevens, kunt u door de proefleider worden geïnformeerd over de resultaten. Als u hierin geïnteresseerd bent, neem dan contact op met de proefleider (12. Contactinformatie).

9. Gebruik en opslag van uw persoonlijke gegevens

Voor deze studie worden uw persoonlijke gegevens gebruikt en opgeslagen. Gegevens die dit met zich meebrengt zijn uw naam, leeftijd, geslacht en gegevens over uw gezondheid. We vragen uw toestemming om deze gegevens te gebruiken. Om uw privacy te beschermen, worden uw gegevens gecodeerd. Uw naam en andere gegevens die kunnen worden gebruikt om u direct te identificeren, worden bij deze codering weggelaten. Alleen met de sleutel tot de code kunnen de gegevens naar u worden getraceerd. Deze sleutel wordt lokaal opgeslagen op een computer die alleen toegankelijk is met een wachtwoord. In elke publicatie over deze studie zijn gegevens niet naar u te herleiden. Sommige mensen kunnen toegang krijgen tot alle gegevens. Dit is nodig om te controleren of de studie op betrouwbare wijze en volgens de regels van de EU Algemene Verordening Gegevensbescherming is voltooid. Deze personen zullen uw gegevens vertrouwelijk houden. We vragen uw toestemming voor hun toegang tot de gegevens.
Alle gegevens moeten gedurende een periode van 5 jaar worden bewaard bij het DYNKA consortium. De gegevens worden opgeslagen om eventuele aanvullende analyses die verband houden met dit doctoraatstraject later in het project mogelijk te maken. U kunt uw goedkeuring intrekken voor verder gebruik van uw persoonlijke gegevens. De gegevens die zijn verzameld tot het moment waarop u uw goedkeuring intrekt, kunnen in het onderzoek worden gebruikt.
Eventuele verdere vragen met betrekking tot de verwerking van de gegevens en de naleving van de privacyrichtlijnen kunnen aan de proefleider worden voorgelegd (12. Contactinformatie).

10. vragen

Als u meer informatie wilt over dit onderzoek of klachten heeft, kunt u dit aan de proefleider vragen (12. Contactinformatie).

11. Geïnformeerde toestemming

U wordt gevraagd om te beslissen over uw deelname aan deze studie. Als u ermee instemt deel te nemen, zullen wij u vragen om een informed consent-formulier te ondertekenen. Door ondertekening van dit toestemmingsformulier geeft u aan dat u de informatie in deze brief hebt begrepen en ermee instemt deel te nemen aan dit onderzoek. Dank je.

12. Contactgegevens

Loes Visser
06 – 26 62 81 36
l.visser@huygen.net
Huygen Ingenieurs & Adviseurs
Parkweg 22b
Maastricht

Handleiding Veldstudie Qeske

Fitbit

De Fitbit is een horloge dat uw activititeit, hartslag, energieverbruik en slaap meet. Hierom is het belangrijk om de Fitbit gedurende de hele studie te dragen, dus niet alleen overdag maar ook gedurende de nacht. Draag de Fitbit niet als deze beschadigd kan raken, bijvoorbeeld bij intensief sporten. Het apparaat is niet waterproof, dus u kunt het NIET dragen tijdens het douchen, maar wel in de regen. Het verzamelen van de data gebeurd automatisch en u hoeft hier verder niets voor te doen.

Lightlogger

De lightlogger meet het licht in uw omgeving. Ook hierbij is het belangrijk om de lightlogger gedurende de hele studie te dragen. Wanneer u naar bed gaat, kunt u de lightlogger op het nachtkastje plaatsen met de sensor naar boven. Draag de lightlogger op uw kleding, vlakbij uw kin met de sensor in de kijkrichting. Probeer er op te letten dat de lightlogger niet bedekt wordt door kleding (bijvoorbeeld een jas). Wanneer u naar buiten gaat, en een jas draagt, dan kunt u de lightlogger tijdelijk aan uw jas bevestigen zodat deze niet bedekt is. Wanneer u dan naar binnen gaat, vergeet dan niet om de lightlogger weer op uw shirt te bevestigen. Probeer de lightlogger gedurende de studie steeds op dezelfde positie te dragen. Mocht u om een reden de lightlogger tijdelijk niet kunnen dragen, leg deze dan op een tafel met de sensor naar beneden, zo weten wij dat de logger op die momenten niet gedragen werd.

IButtons

De ibuttons meten de temperatuur van uw huid. Gedurende de studie draagt u 3 ibuttons; op uw hand, onderarm, en kleding. Deze worden bevestigd met een stukje tape. Verwijder de ibuttons als ze beschadigd kunnen raken, bijvoorbeeld bij intensief sporten. Verder kunt u gewoon douchen met de ibuttons. Het is niet nodig deze in het weekend te dragen, vergeet niet ze maandagochtend opnieuw te bevestigen. Mocht de tape niet meer zo fris zijn, dan kunt u de tape vervangen bij de proefleider.

id	ibutton hand	ibutton onderarm	ibutton kleding	lightlogger
1	3a	3c	3d	LL39
2	3e	4w	4j	LL53
3	3h	3j	3k	LL30
4	3l	3m	3n	LL55
5	4wx	3q	3s	LL27
6	3t	3u	3v	LL32
7	4a	4c	4d	LL51
8	4e	4f	4g	LL26

Dagelijkse vragenlijsten

Naast het dragen van de ibuttons, Fitbit en lightlogger, zal u gedurende de studie ook vragenlijsten invullen op uw telefoon. Dit gaat door middel van de app MetricWire, deze kunt u gratis downloaden. Tijdens werkdagen krijgt u 8 keer per dag, op random momenten, een notificatie op uw telefoon om de vragenlijst in te vullen. Het invullen van deze vragenlijsten duurt maximaal 2 minuten. De vragen gaan over verschillende onderwerpen: wat u van het licht vindt, hoe u zich op dit moment voelt, wat u vindt van de huidige temperatuur en een deel context. Aan het einde van de werkdag verschijnt er nog 1 korte vragenlijst met wat vragen over de dag zelf, zoals welke kleding u droeg en of het een typische werkdag was.

Verder wordt er tijdens deze studie ook een slaapdagboek bijgehouden. Deze verschijnt aan het begin van de dag in de applicatie. Deze vragen gaan onder andere hoe u heeft geslapen en op welke tijden.

Om ervoor te zorgen dat we goede data verzamelen, vragen wij van u het volgende:

- Houdt uw smartphone 24/7 aan, vergeet deze dus niet op te laden. Houdt gedurende de studie uw telefoon ook constant bij u, tenzij het ongepast is (bijvoorbeeld tijdens een vergadering of sporten)
- De applicatie stuurt u een notificatie, de applicatie hoeft hiervoor niet open te staan
- Zorg ervoor dat de applicatie toestemming heeft om notificaties te geven. Verder willen wij van u vragen om het geluid van uw telefoon aan te laten, tenzij het niet gepast is, zodat u de notificaties hoort
- Het is niet nodig om internet constant aan te hebben. De applicatie kan data lokaal opslaan. Probeer af en toe verbinding te maken zodat deze data doorgestuurd kan worden.

Eenmalige vragenlijst

Wij vragen u om eenmalig een langere vragenlijst online in te vullen. U krijgt de link hiervoor via de mail opgestuurd. Het invullen van deze vragenlijsten duurt ongeveer 20 minuten.

Vragen?

Als u vragen heeft kunt u contact opnemen met Loes Visser op het volgende emailadres: l.visser@huygen.net.

10 References

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Appendix 6 Smart City Wroclaw, PL MAP

Demonstration Case “Wroclaw”

1 Short description

Wroclaw one of the biggest city in Poland, serves as the Polish demonstration case. In the following document, the specifics regarding the measurement campaign at Wroclaw will be described.

1.1 Construction

The city of Wroclaw is divided on districts with big variety in level of urbanization and residence. The houses qualified for the study have a variety of constructions and are divided primarily on:

- Detached houses
- Multi-family dwellings
- Blocks of flats

Single-family (detached) houses and multi-family houses are usually made of materials such as bricks and wood. Construction is usually made on foundation made of concrete. Compared to the other two options, the residential area of detached house is much larger than the area of multi-family dwellings or in area in flat in block of flats.

Multi-family dwellings are buildings inhabited by more than one family. The size of multi-family dwelling and number of tenants depends on the design of the building.

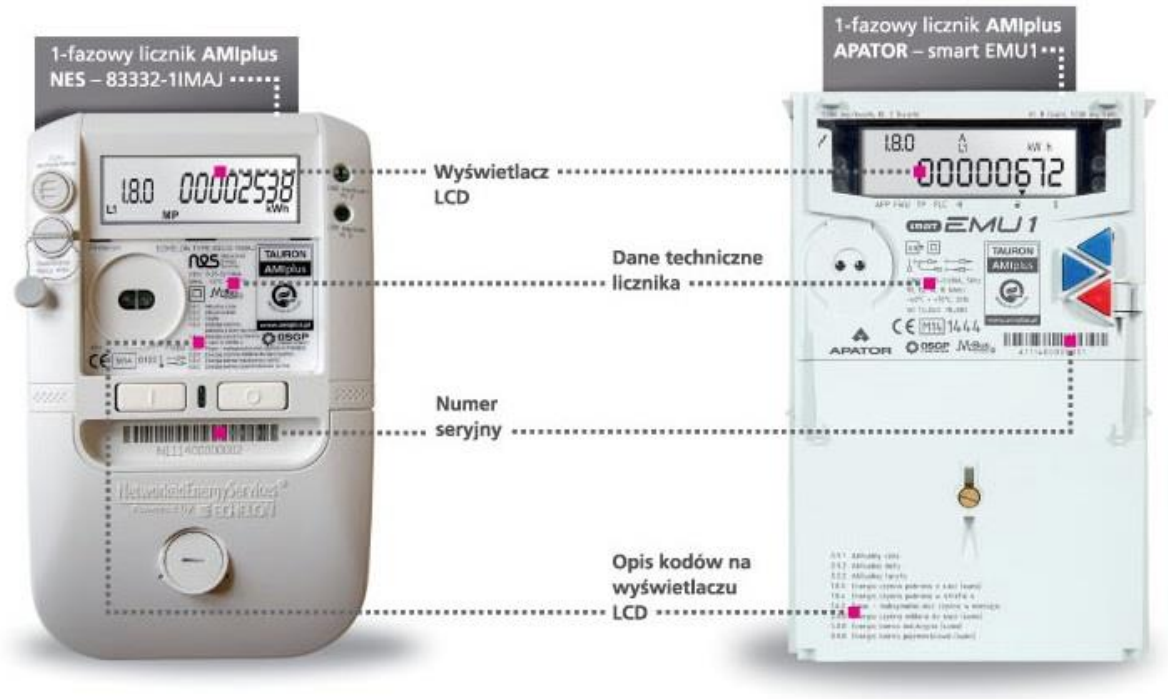
Block of flats are a form of building based on the assumptions of modernism: facades made of raw concrete, without plasters or with prefabricated linings. Structures based on prefabricated elements in the form of concrete elements with reinforcement and fixings from steel rods, anchor welded plates and fitting and suspensions made of stainless steel, Living space compared to the other two options is smaller than the area of multi-family and single-family dwellings.

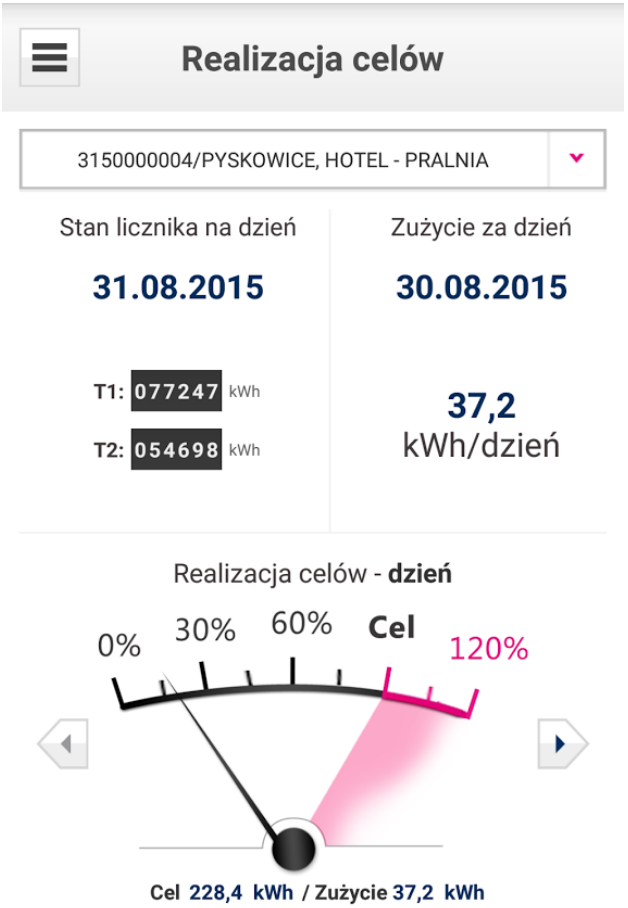
1.2 Technical systems

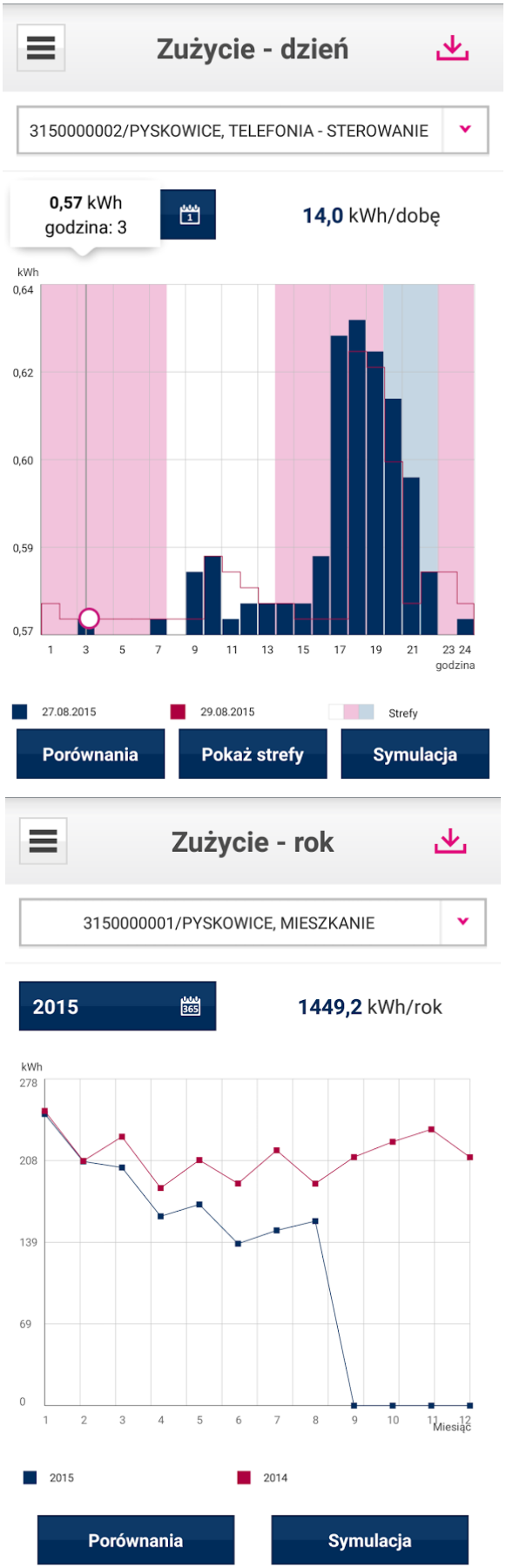
According to local standards, home electrical systems are part of TN-S or TN-C-S system. Each house and apartment qualified for the pilot program is equipped with a smart AMI-plus meter used to measure electricity consumption. The meter allows you to read the actual value of the electricity consumption in real time. End users have access to the data through an application offered by the TAURON Group or internet. The energy consumption meter was made available free of charge by the TAURON Group within AMIPlus Smart City Wroclaw program.

Out of the 330,000 participants in the project, a group of 1,000 candidates were selected for the demonstration. Most household do not consume electricity to produce heat. Basing on the billings we selected the group with the highest Energy consumption. They most likely use electric heating to produce heat in the apartment. In the most homes, electricity is mainly consumed by lightning and cooling systems (conditioners and refrigerators).

Example of AMI meters and user application named: TAURON e-licznik






Zużycie - dzień
3150000002/PYSKOWICE, TELEFONIA - STEROWANIE
0,57 kWh
godzina: 3
14,0 kWh/dobę
kWh
0,64
0,62
0,60
0,59
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1 3 5 7 9 11 13 15 17 19 21 23 24
godzina
27.08.2015
29.08.2015
Strefy
Porównania
Pokaż strefy
Symulacja
Zużycie - rok
3150000001/PYSKOWICE, MIESZKANIE
2015
1449,2 kWh/rok
kWh
278
208
139
69
0
1 2 3 4 5 6 7 8 9 10 11 12
Miesiąc
2015
2014
Porównania
Symulacja

1.3 Target areas (type, usage, occupancy, sensors)

Demonstration will be held for 1 000 selected candidates in the city of Wroclaw. Candidates can live in different parts of the city. In case of flats in spans a large span in the characteristics of their construction, size and location on the map of the city. The Focus group contains few social groups' selected based on data about their place of residence, sociological factors and the amount of electricity consumed from data from AMIPlus Smart City Wroclaw.
It is assumed to monitor the electricity consumption throughout the apartment, based on the technology of meters AMI, which allows to read the electricity consumption in the system every 15 seconds. Data collected from previous pilot projects and based on data held by the companies: Tauron Sprzedaż and Tauron Dystrybucja will serve to establish customer profiles. In all the apartments will be placed sensors for control of electricity and used to improve the quality of life of users by monitoring and remote control of systems.

2 Demonstration vision and objective

Demonstration vision is to motivate end-users to change behavior by combining ICT tools and information services on energy use, internal environment, health and lifestyle. This goal is to be achieved through an appropriate approach, tools and services and the data analysis and results achieved.

3 Specific purpose of the Action plan

The main aim of the project is to illustrate and demonstrate how to approach and apply the methodology to end users' energy consumption. According to the description of the project, the demonstration will be aimed at answering the following questions:

- What drivers and motivators influence user behavior?
- What effects do user behavior have on energy consumption and indoor environment?
- Which methods and approaches create awareness and a substantial behavioral change in users?
- What is the frequency and intensity of use of the personal apps and tools, monitored, and registered at the start, after 2 months, 6 months, and 12 months of implementation?
- Which specific campaigns and validations were necessary during the project?
- What basic monitoring and information campaign should be continued after the project duration? Which parameters should be monitored, how should the information be presented, and what are the aims of a continuous campaign?
- How would a list of further recommendations, based on the results obtained, look after the project is completed? How could "soft measures" be considered in future energy performance regulations?

Detailed objectives:

- presenting energy consumption and energy efficiency in a way that is understandable, easy and attractive to consumers;

- the transformation of "**Big Data**" into "**Smart Data**", converting data into meaningful information which will be understandable;
- development of **easy-to-use ICT tools** to monitor energy consumption and other factors ("daily activity" for end users as well as data intended for professionals such as building managers);
- Correlation of **health and lifestyle information with respect to power consumption** by connecting Internet of Things devices wearable devices and energy consumption monitoring (energy meter) - impact on customer behavior through factors not directly related to energy costs;
- motivating and supporting change in consumer behavior after providing complementary information on energy consumption, health and lifestyle;
- supporting new business models;
- Developed and implemented solutions and services in different types of buildings and types of users, demonstrating optimization of final energy consumption;
- Demonstration of the results of the five demonstration projects (DK, SI, IT, NL, PL).

The TAURON Group can use knowledge about energy consumers in Europe as well as the tools that will emerge during the project - below some examples of potential use of knowledge and project products:

- TAURON Polska Energia (Polish Energy) and Sprzedaż (Sales) - access to the results of work on the behavior, causes and motives of energy consumers in Poland and Europe;

- TAURON Dystrybucja (Distribution), Sprzedaż (Sales), Polska Energia (Polish Energy), Ciepło (Heating) - leverage the knowledge of customer needs, market and demand in the product and service development process, or extend existing ones to those that customers need or expect. Better knowledge of easily inaccessible information directly increases the likelihood of market success (Design Thinking approach), and perhaps in parallel the reduction of development and / or R & D costs

- TAURON Sprzedaż (Sales) and Dystrybucja (Distribution) - adaptation of documents sent to clients as part of normal operating activities to increase their readability, attractiveness and possibly reduce their costs;

- TAURON Sprzedaż (Sales), Obsługa Klienta (Customer Service), Ciepło (Heating), Polska Energia (Polish Energy) - increasing synergies and business collaboration between areas that have direct contact with the client (using good practice, mentoring and mutual coaching);

- TAURON Sprzedaż (Sales), Polska Energia (Polish Energy) – increasing energy awareness among customers can contribute to successful implementation of energy management methods in line with Demand Side Management;

- TAURON Dystrybucja (Distribution), Sprzedaż (Sales), Polska Energia (Polish Energy), Ciepło (Heating) – use the potential of the project on a European scale to strengthen and / or consolidate the image of the innovation of individual TAURON Group companies by actively engaging customers in the demonstration project.

During the project there may also be developed new, previously untapped knowledge, functionality or products that may influence the extension of the planned applications of the TAURON project results.
Solutions developed within the project may be sold or otherwise used (such as usage licenses) in the future, which may increase the company's revenue, but the final policy will be developed within the project.
Below are more detailed questions, divided into categories in various sectors.

3.1 Conditions overview

In order to increase user knowledge and awareness of what is happening inside the apartment/building, it is important to collect data on the environment (indoor) and on the health of the occupants. By using an app or website, people can get access to useful information on weather, IEQ, Energy consumption and health.

3.2 Health and wellbeing

Over the past five years, the subjective ocean of statistical health of Poles has increased by 5%. The greatest improvement occurred among the middle-aged (40-60) years. According to analyzes conducted by the Polish National Institute of Hygiene, after a sharp improvement in the health indicators of Poles (e.g. mean life expectancy, mortality in the area of civilization diseases, infant mortality), there was a time of stagnation. The distance between Poland and the countries of the old Union is enormous, and it can take up to a few decades to overcome it. The hierarchy of the most serious health problems of adult Poles has been standing for years. Almost half of deaths result from cardiovascular diseases, including stroke. These diseases are one of the most important causes of absenteeism, hospitalization and disability. They also significantly influence the quality of life of Poles, especially those of middle and senior age.
A serious problem in adult Poles is the difficulty with the motion system, including the spine. The most common ailment mentioned by people over the age of 15 are back pain, neck and osteoarthritis. These problems do not pose a direct threat to life, but neglected can lead to the loss of the ability to live independently. Likewise, the problem of asthma and asthmatic states is disregarded, and half of asthmatics do not cure.

Based on the EZOP research conducted on a group of 10 000 people enrolled in Poles aged 18 to 65, 70% of the respondents declared that they were very good or excellent mental health. At the same time, a large proportion of respondents admitted that at least once in their lives they experienced one of the symptoms of mental health disorders: depression of mood and activity, phobia, anxiety, irritability and aggression. After analyzing the interviews, the authors assessed that 2.5 million Poles suffer from various types of neurotic disorders. Alcohol, tobacco and drug disorders affect 3.3 million people in working age. Mood disorders affect millions of people. Every 30th Pole has a problem with the inability to master his own aggression and impulsive behavior. Since 2014, Poland has faced a negative natural increase, the number of deaths is higher than the number of births.

3.3 Energy consumption

In this project, the type of Energy or resource that will be treated, is the following:

- Electric energy(EE)

Energy type or resource	Question	Parameter	Observation method	KPI
EE	What is the amount of electricity consumed in the apartments?	Electricity	Directly measured	kWh/m^2/year
EE	What is the consumption of electricity during the project compared to the consumption before the project?	Electricity	Indirectly measured	
EE	What is the consumption of electricity compared to other flats during the project?	Electricity	Indirectly measured	

3.4 Thermal comfort & Indoor environmental quality

Question	Parameter	Observation method	KPI
It the comfortable operative temperature in a room/residential area within a reasonable range in relation to energy efficiency?	Operative temperature/Outdoor temperature	Directly measured User perception	
Is the comfortable operative temperature in a room/residential area within a reasonable range in relation to the user health and wellbeing?	Operative temperature/Outdoor temperature	Directly measured User perception	
Is the humidity in a room/residential area within a reasonable range?	Relative humidity in apartment	Directly measured User perception	
What is the IEQ during the monitoring period compared to the reference measurement period?	Operative temperature, relative humidity in apartment	Indirectly measured User perception	

3.5 Occupant's behavior ("What we want to know")

By monitoring the end-user habits and determining the impact of behavior on energy consumption, the TAURON Group intends to understand the mechanics of driving habits. This is one of the main goals and challenges of the whole project. There is a possibility of linking to different types of habits based on the data obtained from different sources and the understanding of the conditions conducive to human behavior. This knowledge is important for the achievement of individual project goals, due to the alignment of feedback messages addressed to end users.

The factors that are important for the analysis of behavioral models are as follows:

- Temperature in the apartment
- Windows opening
- Number of tenants
- Air conditioning and ventilation systems
- Humidity in the apartment

Each of these factors and their habits can be summed up using the table below, answering each question. The second table shows the effects of changes caused by user behavior.

What do we know about our habits?				
			Data sources	Measurement method
CHARACTERISTICS AND CAUSES	What are the characteristics of human habits?	When did the behavior occur? How long did we behave this way?	• Device states	Direct measurement
	When people live in their apartments?	What is a typical user profile?	• Living • Feelings of the user	Direct measurement
	How people try to save electricity?	Are there favorable conditions for savings?	• Measurement of electricity consumption • Frequency of use Smart Wi-Fi plugins	Indirect measurement
		Are tenants take any steps on its own to reduce electricity consumption in the apartment?		
	What are the habits of home temperature?	Is the temperature changing over time?	• Temperature and humidity sensor	Direct measurement
	What are the habits of opening windows?	When and how long people open windows?	• Door and window opening sensor • User Feelings	Indirect measurement
		Why people open windows?		
		Is there a repeating scheme during the day?		
	How do people use ventilation systems?	When and how long are the ventilation systems switched on?	• User Feelings • Temperature and humidity sensor	Indirect measurement
		Why people use ventilation systems?		

		Is there a repeating scheme during the day?		
	How people manage lighting systems at home?	Are there conditions conducive to the management of lighting systems?	• User Feelings	Indirect measurement
		Are there specific habits involved in home lighting management?		

Effects	What is the impact of user action seeking to reduce electricity consumption?	Does the use of Smart plugs affect the reduction of electricity consumption?	• Electric energy usage • User Feelings	Indirect measurement
		Does the use of Smart plugs to reduce electricity consumption has a negative impact on the lifestyle?		
		Does the use of Smart plugs affect the health of end users?		
	What is the impact of window openings on energy consumption, indoor environment and health?	Does opening windows increase energy consumption?	• indoor temperature • Humidity • Window opening sensors • User Feelings	Indirect measurement
		Do window opening habits affect the comfort of the environment and environmental conditions?		
		Do window opening habits affect the quality of life?		
	What are the effects on the health and energy consumption of home temperature regulation habits?	Do habits related to changes in home temperature affect the consumption of electricity?	• Temperature inside the house • User Feelings	Indirect measurement
		Do habits related to temperature changes affect the health of users?		
	What is the impact of ventilation on energy consumption, internal environment and health?	Does the use of ventilation systems lead to increased electricity consumption?	• indoor temperature • Humidity • User Feelings	Indirect measurement
		Do habits related to the use of ventilation systems have a positive impact on the internal environment?		

		Do habits related to the use of ventilation systems have a positive impact on the health of the environment?		
	What is the impact of home lighting management on electricity consumption, living comfort and health of users?	Does lighting management have an impact on improving energy efficiency?	• Electric energy usage • User Feelings	Indirect measurement
		Does lighting management have a negative or positive impact on the lifestyle of end users?		
		Does lighting management have a negative or positive effect on the health of end users?		
	Final rating	What changes in behavior occurred during the monitoring period?	• All sources	Indirect measurement
		What was the impact of changes in energy consumption behavior?		
		What was the impact of behavioral changes on the comfort and end-user life?		

4 Required parameters and information

The parameters with detailed data on results, measurement accuracy, measurement frequencies and devices are listed in the table below:

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/notes
Total electric energy consumption	Energy	1 kWh	Class B according to MID	15min and round the clock	AMI meter	
Electricity	Energy				Smart plug Wi-Fi	On/off timer
Temperature and humidity	IEQ		+/- 1,5°C		Temperature and humidity sensor	
Opening windows	User behavior				Opening window sensor	ZigBee HA 1.2. network construction
Opening doors	User behavior				Opening door sensor	ZigBee HA 1.2. network construction

Parameter	User requirements	Actor requirements	Number of participants	Data extracted	Other/notes
Technology acceptance	App download, technology use, daily habits	Interviews, observation and monitoring	All	Recorded information about app downloads and use	
Personal health and wellbeing	Personal monitoring and logging. Data recording	Data collection, data analyses	All	Changes in sleep quality, energy levels, personal perception of a high quality of life	
Perception of environment (IEQ) and sense of control over one's surroundings	Questionnaires, occupant log	Data collection, data analyses	Focus group	Thermal comfort, window opening, ventilation control	
Impact		Data analyses	All	Change in behavior Change in energy use Change in indoor environment Change in user perception	

5 Behavioral action plan

5.1 Feedback for end users about energy use and indoor environment

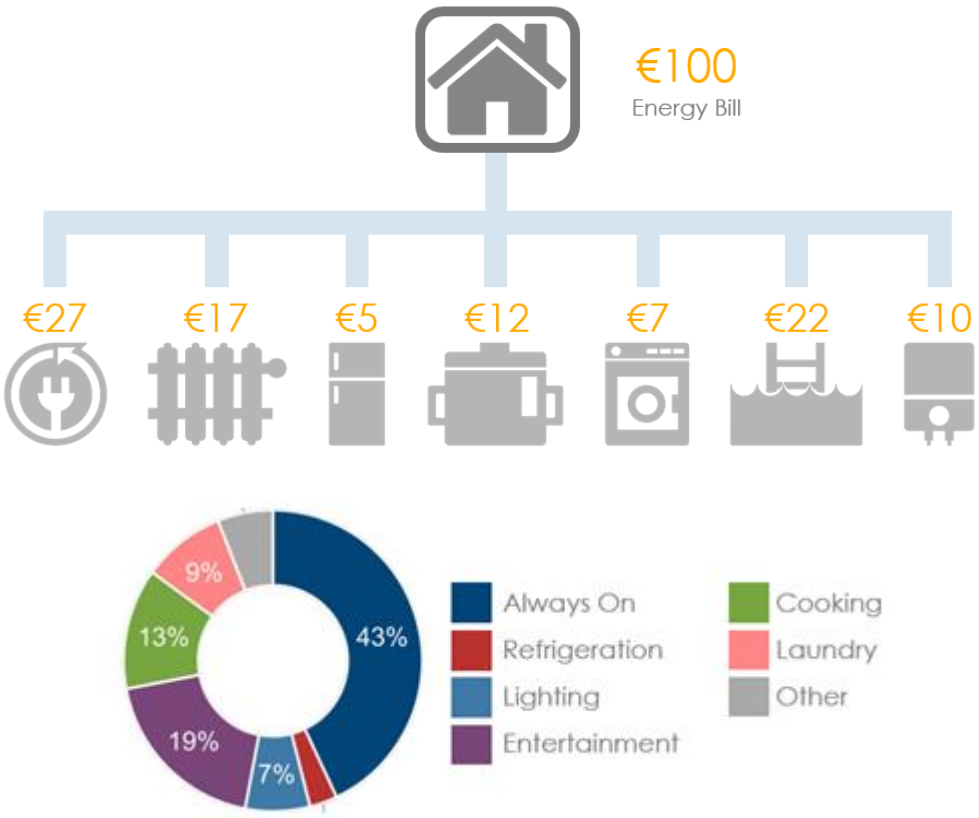
Energy use

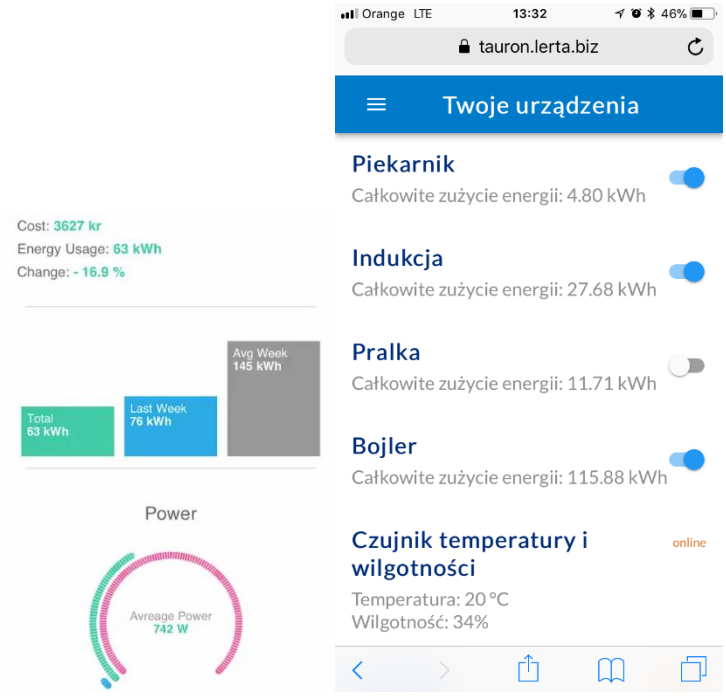
The user receives feedback in accordance with the type of sensors installed in the place of residence. Available sensors are: Smart plug, temperature and humidity sensor, door / window opening sensor.

Electricity consumption

Information on electricity consumption is based on reports on a daily, weekly, monthly and annual basis. The user also has the option of selecting the date range from which he would like to do the analysis. Users can check the cost of electricity consumption in daily, weekly, monthly and yearly intervals for each group of energy consumers connected to the central unit. At the same time, they can visualize their consumption during the same period of the previous month or year.

Users can check their household electricity consumption for every complete day, compare when this value was the highest and see if they consume as much electricity as people using the same tariff, e.g. with users of apartments of similar size and the number of residents in household.





Today's energy consumption is the amount of energy consumed by all devices in the household, including the heating of domestic hot water in comparison to the energy consumption forecast for a given day. If the consumption is low, the color on the scale is blue, if it approaches the assumed consumption, it changes color to orange, whilst after exceeding the forecast - to red.

The monthly and annual consumption report is respectively the value of the sum of a daily and monthly energy consumption in comparison to the forecast for a given day and month. In case of reaching the forecast, the user will receive information via a message. After exceeding the forecast, appropriate information will also be sent. Results presentation, could be done e.g. on a bar graph.

Indoor environmentental conditions

Indoor conditions are measured with temperature and humidity sensors.

The user receives feedback on the temperature and humidity in the room in real time. Parameters are presented separately for each room in which the sensor is installed.

The users can independently define a specific temperature range at which they feel comfortable. At that point the application will display information about the conditions inside the room and signal the necessity of undertaking a specific activity, e.g. opening a window.

If the conditions defined by the users are met, they will receive information with a specific message:

Colour	Temperature oC	Humidity %
green	<21	<70
orange	21-25	70-90
red	>25	>90

Door / window opening sensors.

Opening the window / door indicated in the application.

- Window / door open
- Window / door closed

5.2 Feedback for end users guiding them to change their practices

The frequency depends on the conditions inside the room.

Messages about conditions inside the room

These types of messages are designed to change habits / behaviors in order to save electricity and improve the quality of conditions inside the room.

Messages need to be transmitted if situations in accordance with the set parameters occur.

Messages (PUSH) that can be send to the users:

Message	Condition
The weekend's here, want to save money? How about turning on the washing machine at night?	The weekly use of electricity is close to the assumed forecast
You consumed more electricity than your neighbor. You will spend x more per year.	Analysis of other participants with similar criteria shows that you can use less energy
Congratulations! You have reduced your weekly electricity consumption. Your wallet thanks you!	The electricity consumption in the previous week is higher than in the current week.
You have exceeded the daily energy consumption by "x" kWh. Try switching off your unnecessary light or appliance.	Exceeding the daily forecast
Your neighbour turns the washing machine on at night so that he reduces his electricity bill by "x". Maybe you should do so as well?	Comparison of the results of other participants with similar segmentation criteria indicates that energy consumption is too high.
The temperature in the bedroom is "x" too high. Turn the heating down - you will definitely sleep better. Otherwise try opening the window.	The temperature in the bedroom is higher than: "x"
Open the window in the living room to increase the humidity. This will improve your well-being.	Humidity has fallen below the level "x"
Close the balcony window at night. You do not want someone to break into your apartment.	The balcony window is open (for users living on the ground floor)

The temperature in the living room is "x" too high. For your comfort turn the heating down, or at least open the window.	The room temperature has exceeded the "x" level.
You are one of the "x" users who reduced their electricity consumption last week	If energy consumption is on the "x" list of the best results
Congratulations! You're the best. You have achieved the lowest energy consumption among all users in your segment	If energy consumption is in the first place of the list "x" of the best results
In the past week you used "x" less than a week ago. You saved "x" money.	If electricity consumption is lower than in the previous week
The average temperature in the past week was at the "x" level. Maybe you should turn down the heating/open the windows more often to feel better.	If the average temperature in the previous week was above "x" ^{o}C
Your monthly electricity bill will be around "x". Maybe next month switch on the washing machine and dishwasher in the evening, to save money.	

5.3 Information for calculation/ selection of feedback to users

Information for calculating / selecting feedback for users:

1. Square meters
2. Home type
3. Number of households
4. Daily tariff 6.00 - 22.00, night tariff 22.00-6.00
5. Cost of kWh
6. Forecast of electricity consumption on a daily / weekly / monthly / annual basis.

Index:

Average electricity consumption in daily, weekly, monthly and annual terms

Average temperature in rooms in daily, weekly, monthly and annual terms.

DESKTOP STRUCTURE

CONSUMPTION OF ELECTRIC ENERGY / COST

- daily

- weekly

- monthly

- annual

NOTIFICATION

DEVICES

- temperature sensor (installation location)

- humidity sensor (installation location)

- plug in (place of installation)

SETTINGS

- Parameters for the needs of reports

- Type of tariff, cost per kWh
- Apartment space
- Number of people in the household
- Maximum electricity consumption in a month

- configuration of the central unit

- counter configuration

LOG OUT

HELP

6 Project evaluation methods

An effective methodology must plan not only data collection, but also data analysis. After considering the purpose of monitoring in the previous sections, the next step is to define the analysis methodology to meet the needs of monitoring, evaluation and learning. Most importantly, the data is analyzed in a way that provides answers to key monitoring and evaluation questions that are then used to optimize and increase efficiency. Data analysis is then needed to develop raw data for important indicators that allow to highlight any signs of progress and changes resulting from the action.

The following data analyzes will be undertaken:

• Comparison of current efficiency with other attributes – how users are behaving towards app and game signals. Analysis should take into account users reactions on the recommendations given by app and game as well as possibility to compare with the other users (group) to observe its influence on users behavior.

For each indicator, it should be planned how the actual performance data will be compared to past performance, monitored or reported. Scheduled or targeted performance or other appropriate patterns (e.g., benchmarking with other users).

• Analysis of the relationship between performance indicators - internal analysis of performance indicators to determine the possible relations between variables.

Installed measuring equipment will gather data on user interaction with systems and user behavior.

The impact on energy consumption of the MOBISTYLE solution can be assessed as the difference in energy consumption before (during the monitoring period without feedback) and after providing feedback (first phase monitoring with feedback).

After analyzing the energy consumed / saved using the MOBISTYLE application, it is possible to calculate the environmental impact (CO2 emissions).

The same process can be reproducible to compare the second feedback period (monitoring with optimized feedback) with previous steps.

The variability of energy consumption between different dwellings will be analyzed and it will be examined if correlations between energy consumption and parameters such as room temperature, window opening behavior and / or the number of inhabitants and their presence can be proven.

6.1 Evaluation of energy use and indoor environment

Analyzing the quality of the microclimate and energy consumption, it is important to estimate the dependence of energy consumption in relation to the conditions prevailing in the room. The obtained parameters will allow to determine the specificity of users' behavior and the amount of energy consumed in conditions consistent with lifestyle.

Energy

From the analysis of data obtained in the measurements, it is possible to get an information on average power, determine the time of the highest energy consumption, energy consumption by specific devices. It is also possible to obtain data on average energy

consumption on a daily, weekly or monthly basis in relation to the conditions in the room or the number of inhabitants if user provide this information in game/app.
The following values can be calculated:
- maximum, minimum, average and standard values of energy consumption for each monitored device (if any) for significant periods;
- average room temperature in relation to specific time periods, only in cases where the source of heat is electric heating. If the source of heat is unknown we can just estimate the possible impact.

6.2 Evaluation of the change in user practices as a result of user feedback

Changing behavior can be assessed by supplementing the participants' response form specially created for this purpose. The purpose of the form is to understand changes in the perceived by participants related to comfort, health and the use of electricity.

Change indoor temperatures

Temperature changes in rooms between the reference period and monitoring periods. Particular attention will be focused on illustrating changes in temperature levels in rooms during periods after information about the benefits of opening the window. Temperature and temperature analysis at night will be particularly important.

Change in set point temperature in the heating/cooling season

Changes in the set temperature between the reference period and the monitoring periods will be estimated on the basis of data received by the thermostats in the apartments. Particular attention will be focused on illustrating the temperature changes of the set point in periods after giving feedback on the benefits of changing it.

Change in window opening practices

The way of opening the window will be illustrated depending on the temperature level in the current room. Particular attention will be paid to the comparison of changes in user practices between the reference period and the monitoring periods, i.e. When and how long the windows are open and whether there are recurring moments during the day.

Humidity

Maintaining proper humidity levels depends on the way of opening windows as well as the right temperature. Humidity levels will be controlled by humidity sensor. It is recommended to ensure humidity level between 40 and 60 percent, so the particular attention will be paid to control humidity changes and review it with temperature and window opening practices to give a certain feedback to the user about healthy and comfort indoor environment,
The application measure humidity and its changes in relation to different time periods. The parameters are compared with the room temperature and the seasons. From the obtained parameters, feedback about the influence of the humidity level on the well-being is transmitted.

6.3 Evaluation of the use of the MOBISTYLE solution and user perception of feedback and guidance

To test the effectiveness of different categories of feedback in terms of energy savings, compare the variation in energy consumption in each category of opinion before and after providing feedback.

In addition, you can evaluate the behavior of users after sending a message and how to respond to it. Such an assessment will allow to indicate the impact of data provided to users on their behavior. The information can be evaluated in relation to specific time intervals and periods.

Evaluating the content of messages would require testing of different communication contents during different test periods.

6.4 Information for calculation of Key performance Indicators (KPI)

Due to the nature of the MOBISTYLE project, different methods have been used, depending on the entity involved in the project. For the TAURON Group and the city of Wroclaw, characterized by the diversity of development, living conditions and the status and age of end users, an extensive evaluation criteria system is described in the following chapter.

One of the main studied parameters was the consumption of electricity by end users. Within the framework of the project, the TAURON Group is expected to acquire a very large amount of data on energy consumption and the habits and behavior of end users. Collection and return communication with end users will be based on TAURON Group standards and available resources.

Depending on the parameter, the scales describing the conditions in the apartment were determined.

KPI Typology		DATA ANALYSIS		
		Formula	Where…	Units
Electricity building performance indicators	Electricity consumption	$E_{el} = \sum_{i=1}^{n} E_{el,i}$	$E_{el,i}$ = electricity consumption by different end use "i"	kWh_{el}/year
		$E_{el,S} = \frac{E_{el}}{S}$	S = conditioned net area of the building	kWh_{el}/m^2 year
		$E_{el,V} = \frac{E_{el}}{V}$	V = conditioned net volume of the building	kWh_{el}/m^3 year
	Costs for electricity consumption	$Cost_{E_{el}} = E_{el} * PR_{kWh,el}$	$PR_{kwh,el}$ = electricity tariff	€/year
	Normalized electricity use to occupant number	$E_{el,occ} = \frac{E_{el}}{N_{occ}}$	N_{occ} = number of occupants	kWh_{el}/occ

List of measurements for KPI's

Electricity [kWh]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
***electricity consumption* (for graphical visualization)**	[kWh/day]	one day (on the basis of previous day)	*electricity consumption*	[kWh/month]	one month		$E_{el} = \sum_{i=1}^{n} E_{el,i}$	$E_{el,i}$ = *electricity consumption by different end use "i"*
costs for electricity consumption	[€/day]	one day (on the basis of previous day)	*electricity consumption*	[kWh/month]	one month	Electricity costs:	$Cost_{E_{el}} = E_{el} * PR_{kWh,el}$	$PR_{kwh,el}$ = *electricity tariff, different price in different tariffs*

Electricity/smart plug [kWh]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
***electricity consumption* (for graphical visualization)**	[kWh/day]	one day (on the basis of previous day)	*electricity consumption*	[kWh/month]	one month	formula refers always to 00:00 h	$E_{el} = E_{el\,(current\ day)} - E_{el\,(previous\ day)}$	E_{el} = *electricity consumption (daily)*

Air temperature [°C]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
Air temperature	[°C]	15 min	average temperature, max temp diff	[°C/month]				

Relative humidity [°C]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
Air temperature	[°C]	15 min	average temperature, max temp diff	[°C/month]				

Window opening [0/1]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
			correlation between temp/humidity and windows opening					

Energy consumption/washing machine WHP [kWh]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
***electricity consumption* (for graphical visualization)**	[kWh/day] [kWh/washing cycle]	one day (on the basis of previous day) one washing cycle (compare with similar washing cycle]	*electricity consumption*	[kWh/month]	one month	formula refers always to 00:00 h	E_{el} = $E_{el\ (current\ day)}$ - $E_{el\ (previous\ da}$ E_{elc} = $E_{elc\ (current\ washing}$ - $E_{elc\ (previous\ washin}$	E_{el} = *electricity consumption (daily)* E_{elc} = *electricity consumption (per washing cycle)*

Water consumption/washing machine WHP [kWh]

KPI for user	UNIT (KPI user)	TIMESTAMP	KPI for expert	UNIT (KPI expert)	TIMESTAMP	FIXED VALUES	FORMULA	
***water consumption* (for graphical visualization)**	[m^3/day] [m^3/washing cycle]	one day (on the basis of previous day) one washing cycle (compare with similar washing cycle]	*water consumption*	[m^3/month]	one month	formula refers always to 00:00 h	$E_w = E_{w\ (current\ day)}$ - $E_{w\ (previous\ day)}$ E_{wc} = $E_{wc\ (current\ washing\ cycle)}$ - $E_{wc\ (previous\ washing\ cycle)}$	E_w = *water consumption (daily)* E_{wc} = *water consumption (per washing cycle)*

7 Monitoring plan

The project is scheduled to begin in December 2017 (M14) by recruitment of a pilot group of approximately 20 participants. The following months, when the game is approved and ready to implement the recruitment of main group of participants (approximately 1.000 households) will start Q1 2019. . The duration of the project and the collection of measurement data is scheduled to take place by October 2019 (M36). For beginning, before the start of the research project, should take place the selection of candidates included the group of 330 000 inhabitants of Wroclaw city. A detailed time schedule is presented in Section 8 with the milestones.

During the project end user flats and houses and user behavior will be monitored. Data collection will take place frequently, at set intervals of 0,2,6,12 months respectively.

Determine the exact location of sensor in apartments is impossible due to the varied construction of flats and houses in which measurements will be made. Pictures and diagrams are examples that cover the largest number of candidates selected to participate in the measurement campaign. In most cases, end users have influence on placing device, which may result in change of sensor location. The section below contains information about the development of individual project tasks, chronologically organized.

7.1 The measurement campaign preparation process

In order to carry out thorough research before the start of the project, decisions about how data are collected, documented and archived will be determined. This is one of the most important factors involved in carrying out proper documentation during the measurements.

As part of the measurements, equipment used by the TAURON Group within Smart Home and AMIPlus meters will be used. Sensors and software are manufactured by Ferguson, working with the TAURON Group. The number and type of units installed in the dwelling will depend on the type of home, single-family homes, multi-family dwellings and blocks of flats. Three different offers have been prepared based on project and client needs.

The Smart Wi-Fi plug is based on Wi-Fi wireless technology that can be remotely controlled by the application. The integrated cloud server allows user to control his device outside the local area network. For installation, connect the Smart Wi-Fi Plug to the outlet to start up the device. After installing application on your phone, add the device to the application. On the side of the plug, press the network button until its starts to blink, which means that it is ready for network setup. Once you have selected a plugin from the list, it will go into setup mode. Then you can change its name and confirm its status. The plug can be installed in each power socket, assuming it will not be loaded with more than 3000W power. Device should be placed in most energy consuming devices, whose management may have an impact on reducing energy consumption at home.

Sensors: door/window opening, smart plugs, temperature and humidity sensorcan be installed in the home without specialist help. Their construction allows for easy and non-

invasive installation on the wall, ceiling or any surface. Thanks to the system of fasten able stands, the assembly of the equipment is very simple and fast to implement.
Door/window open sensors should be placed in most used places. Smart plugs should be installed with appliances which can be use in a more effective way i.e. to reduce its energy consumption (switch off when not used/stand-by). Temperature and humidity sensor should be located in areas, where people are most likely to stay. Due to this conditions and the varied housing developments in the city, most likely in every apartment, the distribution of sensors will be different.

7.2 Description of the measurement procedure

The method of carrying out measurements in the city of Wroclaw is based on the standard procedures of the TAURON Group and will be described in the following section.
Counters perform measurements in accordance with the MID Directive and the Principal Office of Measures (Główny Urząd Miar). OSGP technology in PCL communication provides interoperability.
Based on the data received, user behavior and performance of selected dwellings in terms of energy consumption and indoor environment are characterized.
Depending on the type of apartment according to the methods used, devices used to collect measurement data have been arranged. Due to the diversity in the construction of detached houses, multi-family houses and blocks of flats, the place of installation of devices and their type may differ significantly from the pictorial images.
Due to various obstacles, such as momentary loss of connection, data collection may sometimes be interrupted, resulting in inaccessibility of measurements. In cases of this type of failure, the process of automatic interpolation between the available measurements will be applied.
During the monitoring process, any impact of the equipment on the measurement data resulting from the equipment specifications should be clearly defined to take account of such effects during data collection.
The measurement period includes a reference and monitoring period during quantitative and qualitative data will be collected. Data monitoring will continue on a continuous basis, data collection and viewing will take place continuously, and data collection and processing will take place at intervals that allow for reaction and possible improvements in the measurement methodology, and to provide feedback to end users.
The monitoring phase is divided into four main phases

1) Checking the existing conditions - Creating a reference to the measurements
2) Ensure that what was installed worked as it should and that users understood the purposefulness of the action
3) Evaluation of activities and data collection
4) Final Impact Assessment - proving what has been achieved

7.3 Data acquisition

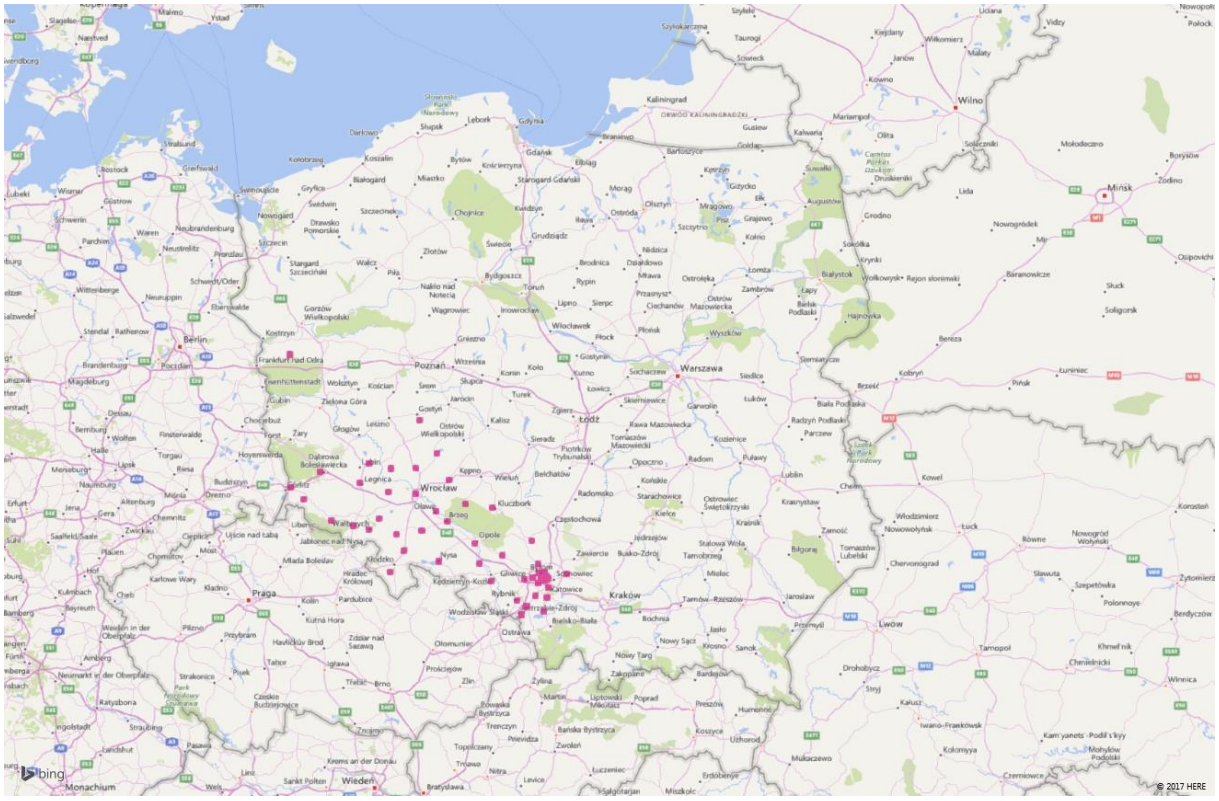
Data will be collected in the shortest possible time, according to the technical parameters of each device. Data collection systems must be regularly synchronized. To determine that only data obtained during normal operation of the equipment will be used for analysis, the data filtering process will be established. Any other criteria suggesting rejection will be reported. Data showing energy consumption collected from AMI will weight approximately 30 MB/year for one energy meter. Concerning that we will examine 1.000 subjects, the amount of 30 Gb data will be shared yearly.

TYPE	DAY	MONTH	YEAR
24h AMR	1,44 kB	0,04 MB	0,51 MB
24h SM	1,1 kB	0,03 MB	0,39 MB
PROFILE AMR	45 kB	1,31 MB	16,04 MB
PROFILE SM	34,5 kB	1,01 MB	12,29 MB

Data acquisition from AMI assumes two sources:

1) Profiles – 6 values in every 15 minutes, means 576 records daily, 17.280monthly,
2) Registers – 6 values daily, 180 monthly.

The obtained data can be compared with the data collected by the TAURON Group within the scope of supply and sale of electricity in the examined areas of the city of Wroclaw. Based on available equipment which is Smart Hub FS1SH Ferguson all data will be collected. Remote home control center could be install in an easy, nicely way on a wall or other surface. Technical standards include Wi-Fi which allow to connect with telephone, tablet or computer and ZigBee as a home sensor for protocol of security.


Berlin
Poznań
Wrocław
Warszawa
Łódź
Praga
Kraków
Lwów
Wilno
Minsk
Wiedeń
Monachium
bing
© 2017 HERE

The pilot demonstration group was separated from the Tauron customers from the Lower Silesian, Silesian and Opole voivodships, having AMIPlus meters. The size of the group is 348012 customers with a total of 357,273 power points. The largest group are the customers living in the area of Lower Silesia, with an estimated annual volume of close to 713 GWh, of which 91% is consumed in Wroclaw.

Distribution of consumption in different periods shows that the largest group of customers are consuming approx. 1-2 MWh per year. Customers with a higher average annual volume are probably households of electrical heating. This group of customers is particularly interesting from the point of view of the project and will be a research target group.

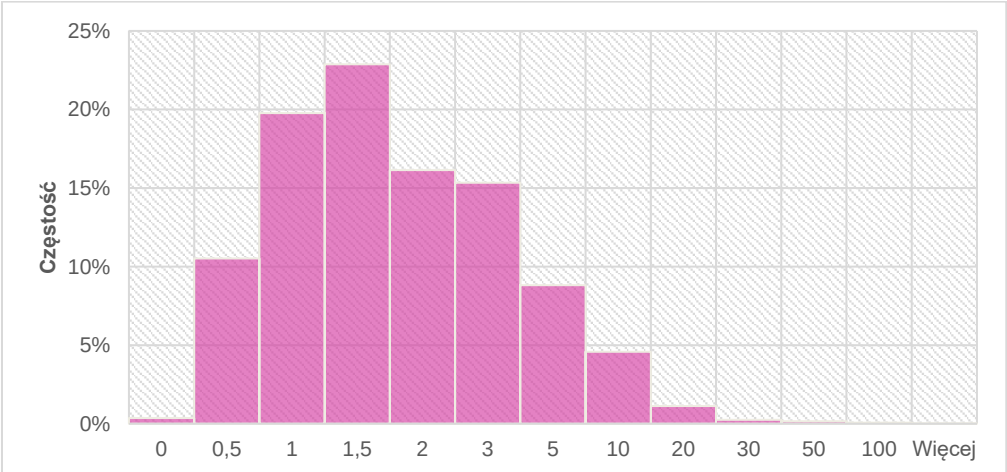


Chart: Frequency of usage an MWh

A group of 31, 1447 customers (319,242 electricity consumption points, of which 96% in the G tariff group and the remaining in the C1 tariff group) have AMIPlus counters in the Wrocław

area. Based on the average annual electricity consumption for pilotage, approximately 1000 customers in the group consuming more than 5 MWh per year (17,229 customers) will be qualified.

Average annual volume [MWh]	Number of customers	%
0-1	93.783	30%
1-2	126.353	41%
2-3	48.210	15%
3-4	17.368	6%
4-5	8.504	3%
5-10	12.898	4%
>10	4.331	1%
Summary	311.447	

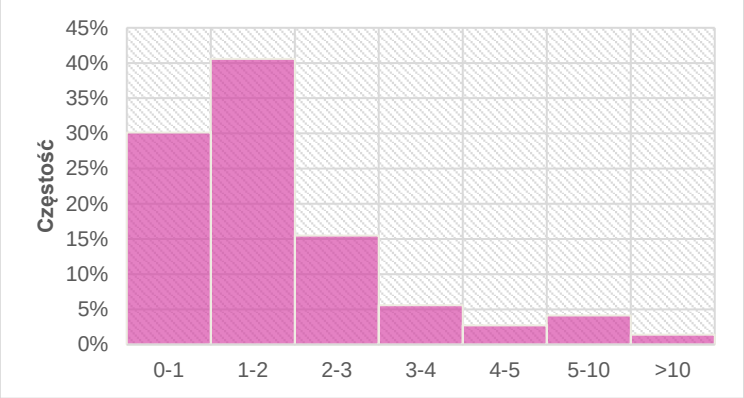


Chart: Frequency of Average annual volume of MWh

7.4 Data sharing and exchange

All the data collected by the AMI are logged and stored inside the server. The server permits to share data, through a software platform, to every type of computer device, tablet or smartphone. Data may be shared in formats like xls, xml, dblink or database views.

7.5 Reporting format

The final monitoring report will contain the following information:

- A description of the equipment used and their location within the monitoring site
- An identification of the specific equipment configuration under the measurement process
- A description of the measurement site and the ambient conditions
- Identification of the sensor and data acquisition system, including documentation of calibrations for the sensor's transmission lines, and data acquisition system.
- A description of the method of data acquisition, storing and analysis
- A description of the measurement procedure
- Presentation of measured data

8 Evaluation plan

8.1 Description of evaluation plan and content

The purpose of the assessment related to this case study is mainly:

- Evaluate the impact or results of the demonstration. This includes assessing changes in energy consumption and internal quality of the environment in homes, as well as assessing changes in user practices experienced as a result of user feedback.
- Evaluate the awareness campaign process to identify possible optimizations and improvements to the implemented process.

The aim is therefore to determine both the project's effectiveness (estimating the extent to which the project results meet its objectives) and the project's validity (determining whether the project's objectives correspond to the identified needs of users.

The evaluation phase is important for assessing the amount of energy saved in the MOBISTYLE project. "Energy saving" refers to the reduction of energy consumption in the case study resulting from the MOBISTYLE application. The main focus is then on energy savings for users participating in the project. This can be defined as the observed change in energy consumption by participants, changes in the lifestyle of participants.

The assessment will be divided into three different phases, each of which has its own objectives:

1. Definition of the reference level: evaluation of existing conditions.
2. Intermediate evaluation: preliminary assessment of feedback perception, impact on performance and changes in user practices.
3. Final impact assessment: final evaluation of feedback perception, impact on results and changes in user practices. Precise verification of the project's achievements.

9 Instrumentation

The equipment used during the pilot project comes from one of the Smart Home units manufacturers. The examples of sensors and its prices are as follow:

Type of tool	Price [PLN]
Smart Wi-Fi plug	115
Wi-Fi camera (Smart Eye 100 IP)	209
Wi-Fi camera (Smart Eye 200 IP)	415
Wi-Fi Camera (Smart Eye 330 IP)	445
Control panel for sensors	444
Gas sensor	135
Choke sensor (CO)	199
Smoke sensor	119
Temperature and humidity sensor	109
A motion sensor	119
Sensor to open doors and windows	79
Water / flood sensor	90

Detached house	Price [PLN]	Quantity	The total cost of equipment
Smart WiFi Plug	115,00	8	920,00
WiFi camera (SmartEye 100 IP)	209,00	1	209,00
Control for sensors	444,00	1	444,00
Smoke sensor	119,00	2	238,00
Temperature and humidity sensor	109,00	2	218,00
A motion sensor	119,00	2	238,00
Sensor to open doors and windows	79,00	2	158,00
Water/flood sensor	90,00	1	90,00
Gas sensor	135,00	1	135,00
Choke sensor (CO)	199,00	1	199,00
		Summary	2 849,00

Multi-family dwellings	Price [PLN]	Quantity	The total cost of equipment
Smart Wi-Fi plug	115,00	6	690,00
Wi-Fi camera (Smart Eye 100 IP)	209,00	0	-
Control for sensors	444,00	1	444,00
Gas sensor	135,00	0	-
Choke sensor (CO)	199,00	1	199,00
Smoke sensor	119,00	0	-
Temperature and humidity sensor	109,00	1	109,00
Water/flood sensor	90,00	1	90,00
Sensor to open doors and windows	79,00	1	79,00
		Summary	1 611,00

Flat in block of flats	Price [PLN]	Quantity	The total cost of equipment
Smart Wi-Fi plug	115	4	460
Wi-Fi camera (Smart Eye 100 IP)	209	0	-
Control for sensors	444	1	444
Gas sensor	135	0	-
Choke sensor(CO)	199	1	199
Smoke sensor	119	0	-
Temperature/humidity sensor	109	1	109
Water/flood sensor	90	1	90
Sensor to open doors and windows	79	1	79
		Summary	1381

Independently on the type of apartment (detached house / multi-family / apartment block), one set of sensors has been developed, to unify game parameters.

10 Resources and Time schedule

The table below summarizes the project plans presented in milestones with a time frame and costs. The project was accepted to be run as R&D project in Tauron Sprzedaż with extra budget. Costs listed below exceeding the MOBISTYLE budget will be held from our own budgets and will not take part in the grant.

10.1 Detailed time plan

The table below summarizes the required resources to carry out the action plan in terms of costs, time, and hours of labor.

Stage / mile steps	From	To	Costs [in PLN]
Characteristics of customers to study.	2017-08-20	2017-09-14	5 040,00
Selection of candidates for internal pilot in TAURON Group	2017-09-15	2018-01-15	0,00
Signing pilotage terms and conditions with internal pilot users.	2018-01-16	2018-07-01	0,00
Direct communication using corporate mails and communicators.	2018-01-16	2019-12-31	0,00
Assembly hardware and software integration.	2017-12-01	2019-03-31	2 000,00
Selection of candidates based on the characteristics created. Determine how to communicate with selected customer groups	2018-09-15	2018-11-03	27 720,00
Signing contracts with clients.	2018-11-03	2019-04-01	19 840,00
Development of dedicated communication methods with clients.	2018-12-01	2019-12-31	21 328,00
Assembly hardware and software integration.	2017-12-01	2019-03-31	3 698,00
Monitoring customers behavior, implementing patches to the system.	2018-01-01	2019-10-01	52 838,00
Completion of piloting, summary of data in the form of final applications	2019-10-02	2020-03-1	35 856,00
Purchase of equipment			1 595 859,6
Indirect costs			295 820,40
Marketing – internet campaign, press, mailing and calling			250 000,00
Summary			2 310 000,00

The obtained data allow to characterize the behavior of the user and the performance of selected dwellings in terms of energy consumption and indoor environment.

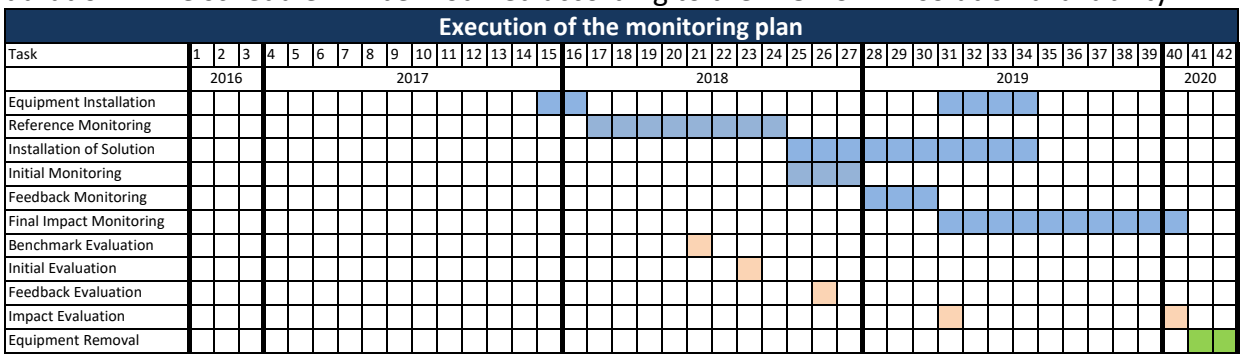
10.2 Overview

Execution of the monitoring campaign

Task	Notes	Expenses	Time Period
Phase 1 – pilot preparation	1. Client data base acquisition, analysis and segmentation. 2. Planning and organization of pilot participants recruitment. 3. Preparation of pilot documentation: participants agreement, rules, corporate agreements and smart home devices purchase. 4. SH devices testing: connectivity, data inquiry, communication. 5. Pilot participants recruitment and devices delivery.	65 k PLN	M 12 - 14
Phase 2 – pilot	1. Signing contracts with participants and installation of devices. 2. Delivery and installation of WHP appliances. 3. Inquiring data from devices and smart meters by DEMO. 4. Maintenance, operations related to clarify data base and increase understanding. 5. Initial feedback monitoring.		M 14 - 25
Phase 3 – aplication/game	1. Implementation of prototypes to pilot group for testing. 2. Gathering information from participants. 3. Feedback monitoring 4. Recommendation for game improvement. 5. Preparation for 1.000 participants recruitment: • devices purchasing, • communication, • marketing, • offer and contracts, • delivery. 6. Approval for the market ready game and it's implementation.		M 25-30
Phase 4 – final stage	1. MOBISTYLE campaign – recruitment of 1.000 participants. 2. Delivery and installation of devices. 3. Inquiring data and researching the effects of the game. 4. Final impact monitoring.	1,6 mln PLN – devices 0,2 mln PLN - sales	M 31 - 40
Phase 5 – final report	Finalization of the project with the report stating the findings about approached efficiency and customer behaviour effects.		M 41-42

Project timeline

The Gantt chart per month presents an overview of the demonstration activities and their duration. Time schedule will be modified according to the MOBISTYLE solution availability.



Deployment of ICT solutions

In MOBISTYLE there are two Information and Communications Technology (ICT) solutions implemented in order to achieve the MOBISTYLE goal: reduce energy consumption by 16% and improve IEQ conditions and health aspects in the demonstration buildings. These ICT-solutions are GAME and DASHBOARD, developed by Highskillz (HS) and Holonix (HLX) respectively.

In residential demo-cases like Polish case only the GAME App will be implemented. The timeline for this process is presented in the following table.

June 2018 – August 2018	September 2018 – February 2019	March 2019 - January 2020
M21 – M23	M24 – M29	M30 - M40
M21 GAME Mock-up (20 apartments)	M24 GAME Prototype I (20 apartments) M27 GAME Prototype II (100 apartments)	M30 Final GAME(1000 apartments)

Initially the GAME App is presented to the TAURON Sprzedaż sp. z o.o. as a web-version. This version presents a draft version of the graphical user interface (GUI) layout and structure of the application. It includes some examples from the MOBISTYLE missions with respect to IEQ improvements that later will be given the users to complete.

Further, the GAME application is developed for the Android mobile phones (Prototype I, M24). Soon after the GAME Prototype I version will be available to the building residents, it is planned to organize a meeting with focus group (20 apartments) in order to evaluate user interaction with application. This will be done by organizing meeting with focus group residents. Here the residents will complete the System Usability Scale (SUS) and will do the usability evaluation of the first mobile version. Afterwards the GAME App (Prototype II in M27) will be further improved with respect to the user comments. Prototype II version will be delivered to more users, approximately 100 households. If required, another meeting with users will take place before the Final GAME version in M30 will be available for 1000 apartments.

The schedule during the GAME implementation will be updated according to the work progress of ICT partner HS.

10.3 Organizational structure

In the Polish case, the organizational structure is based on three companies: TAURON Polska Energia S.A. – consortium partner, TAURON Sprzedaż sp. z o.o. the subsidiary company from Group TAURON responsible for the MOBISTYLE demonstration and Husar Labs Sp. z o.o. Husar Labs is an IoT company chosen to supply Smart Home devices, application and software inquiring and exchanging data for a pilot group of testers.

Organization	Contact information
TAURON Polska Energia S.A.	1. Magdalena Dembińska - Documentation, R&D, e-mail: Magdalena.dembinska@tauron.pl 2. Krystian Wojtasik –Documentation, R&D, e-mail: Krystian.wojtasik@tauron.pl
TAURON Sprzedaż sp. z o.o.	1.Paweł Marciniak- Project Manager e-mail: Pawel.Marciniak@tauron.pl 2.Joanna Herczakowska – Documentation, Analysis expert, e-mail: Joanna.Herczakowska@tauron.pl 3.Miłosz Gruszczyński- gamification, E-commerce expert, e-mail: Milosz.Gruszczynski@tauron.pl 4. Kinga Warchoł – Marketing expert, e-mail: Kinga.Warchol@tauron.pl
Husar Labs sp. z o.o.	Krzysztof Drożyński – Software Engineer, data uploading, e-mail: Krzysztof.drozynski@lerta.energy.pl

10.4 Review of the possible risks

Description of the risk	Proposed risk-mitigation measures	Status of risk
Poor or no collaboration from the inhabitants of chosen apartments in the demonstration case.	Direct involvement of major inhabitants by implementation of gamification.	High risk – 3% of TAURON's clients who has installed smart meters use our metering application.
Insufficient amount of apartments want to participate in the MOBISTYLE implementation without rewards or bonuses.	Special offer for TAURON's products like energy or gas with addition of smart home devices included in project.	Medium risk – the demand for smart home solutions is still not very high, and people avoid being observed in their houses.
Limited amount of end-users have Android mobile phones. (GAME solution is being developed for Android operating systems). This will cause a decrease in number of participating apartments	The survey and quantification of the polish market shows 91,5% Poles use Android, but this share significantly drop when quantifying High Tech oriented customers.	Low risk – 85% of our pilot group use Android.
The barriers for communication of the smart home devices with smart meters	Planning of marketing campaign in the areas we have highest certain the barrier would not appear.	High risk – during the pilot we identified several barriers like: the distance from the meter in basement to apartment, concrete floors or walls blocking the signal, the distance between the meter at the fence and gateway in house.
Problems with the installation and configuration of devices	Preparation of proper instruction manual for participants, especially for the smart meter configuration.	Low risk – few people needed support during pilot but problems were solved.
A large amount of data recorded by smart devices - a problem with storage, transmission and use of data by the partner responsible for data analysis	Preparation of data base for significant amounts of data and data exchange testing plus data clarification.	Low risk – data stream were leaned during pilot and parties are aware of the planned amounts.
End-user not participating in MOBISTYLE implementation due to English language used in the GAME application.	Inform the end-users that the GAME first will be made in English and later it will be translated in Polish language.	No risks occurred. To be updated after the first meeting with end-user.

11 Ethics in MOBISTYLE

Monitoring in WP6 will be based on Informed Consent. Informed consent is one of the primary ethical requirements underpinning research with human subjects and is an ongoing process (especially with data acquisition subject to continuously changing). The purpose of informed consent is to ensure prospective subjects will understand the nature of the research and monitoring and can voluntarily decide whether or not to participate. MOBISTYLE's interpretation of the EC H2020 guide 'How to complete your ethics Self-Assessment' is that when the study involves research involving participants,

1. An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures, and identification of any procedures which are experimental;
2. A description of any reasonably risks or discomforts;
3. A description of any benefits to the subject or to others;
4. A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;
5. A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;
6. For research involving more than minimal risk, an explanation as to whether any compensation and an explanation as to whether any medical treatments are available if injury occurs and, if so, what they consist of, or where further information may be obtained;
7. An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject;
8. RESIGNATION FROM PARTICIPATION IN PILOT is described in a pilotage terms and conditions as follows:
    a. The participant has the right to resign from participation in the pilot during its duration.
    b. The participant in the case described in paragraph 1 is obliged to return the Smart Devices to the Organizer's request under the pain of payment of a contractual penalty in the amount of PLN 2,500.00 (equipment cost).
    c. The participant, in the case referred to in paragraph 1 is obliged to return the Smart Devices to the following address: TAURON Sprzedaż sp. z o.o., ul. Łagiewnicka 60, 30 - 417 Kraków.

Informed Consent in Polish language is presented in the following pages.

Regulamin Pilotażu
MOBISTYLE

§ 1 POSTANOWIENIA OGÓLNE

1. Organizatorem Pilotażu MOBISTYLE, zwanego dalej: „***Pilotażem***", jest **TAURON Sprzedaż sp. z o.o.** z siedzibą i adresem: ul. Łagiewnicka 60, 30 – 417 Kraków, zwana dalej: „***Organizatorem***", działająca na zlecenie **TAURON Polska Energia S.A.** z siedzibą i adresem: ul. Ściegiennego 3, 40 – 114 Katowice, zwana dalej: „***TPE***".
2. Pilotaż realizowany jest w ramach Konsorcjum MOBISTYLE na podstawie umowy konsorcjum opierającej się na ROZPORZĄDZENIU (UE) Nr 1290/2013 PARLAMENTU EUROPEJSKIEGO I RADY z dnia 11 grudnia 2013 r. ustanawiającym zasady uczestnictwa i upowszechniania dla programu „*Horyzont 2020 – programu ramowego w zakresie badań naukowych i innowacji (2014 – 2020)*" oraz na Ramowej Umowie Wzorcowej Komisji Europejskiej o Udzielenie Dotacji, zawieranej z wieloma beneficjentami, wraz z jej załącznikami i została zawarta dnia 01 grudnia 2014 r.
3. Partnerami Pilotażu – obok TPE – są:
   a) **Husar Labs sp. z o.o. z siedzibą w Poznaniu,**
   b) **Huygen Installatie Adviseurs BV z siedzibą w Holandii,**
   c) **DEMO Consultants BV z siedzibą w Holandii,**
   d) **Maastricht University z siedzibą w Holandii,**
   e) **Institute for Innovation and Development of University of Ljubljana z siedzibą w Słowenii,**
   f) **Aalborg University z siedzibą w Danii,**
   g) **Politechnico Torino z siedzibą we Włoszech,**
   h) **Holonix S.r.l. z siedzibą we Włoszech,**
   i) **Highskillz Limited z siedzibą w Wielkiej Brytanii,**
   j) **Whirlpool Europe srl z siedzibą we Włoszech,**

   zwani dalej: „***Partnerem***".
4. Regulamin określa zasady i warunki skorzystania z Pilotażu dla Uczestników, którzy spełniają wszystkie warunki uczestnictwa w Pilotażu określone w Regulaminie, zwanym dalej „***Regulaminem***", w tym w szczególności warunki opisane w § 2 Regulaminu.
5. Użyte w Regulaminie pojęcia oznaczają:
   5.1. **Laureat Konkursu „Mobistyle"** – pracownik spółek z Grupy TAURON, który wziął udział w organizowanym przez Organizatora Konkursie pod nazwą „Mobistyle" i jest laureatem tego Konkursu (zwycięzcą nagrody przewidzianej w tym Konkursie).
   5.2. **Członek Zespołu Projektowego** – pracownik spółek z Grupy TAURON, oddelegowany do prac nad projektem Mobistyle.
   5.3. **Uczestnik** – osoba fizyczna, która spełniła wszystkie warunki uczestnictwa w Pilotażu określone w Regulaminie, w tym w szczególności warunki opisane w § 2 Regulaminu.
   5.4. **PPE (Punkt Poboru Energii)** – punkt w sieci elektroenergetycznej, w którym produkty energetyczne (energia, usługi dystrybucji, moc, itp.) są mierzone przez urządzenia umożliwiające rejestrację danych pomiarowych. Jeśli pod jednym adresem znajduje się więcej niż jedno urządzenie pomiarowe to każde z nich jest osobnym PPE i posiada unikatowy numer identyfikacyjny.
   5.5. **Ankieta** – dedykowany formularz umieszczony na stronie www.tauronet.tauron.pl/mobistyle lub przesłany na podany przez Uczestnika adres e-mail, zawierający pytania dotyczące funkcjonowania MOBISTYLE. Organizator oraz Partner zastrzegają sobie prawo do telefonicznego kontaktu z Uczestnikiem celem przeprowadzenia dodatkowej weryfikacji funkcjonowania MOBISTYLE. Kontakt nastąpi na podany przez Uczestnika numer telefonu komórkowego. Przykładowa ankieta stanowi Załącznik nr 1 do niniejszego Regulaminu.
   5.6. **Aplikacja** – dedykowane oprogramowanie na komputer personalny, smartfon lub tablet, które stworzone zostanie w trakcie trwania Pilotażu, bazując na danych przekazywanych z Inteligentnych Urządzeń oraz posłuży w dalszej fazie Pilotażu do realizacji jego celu.
   5.7. **MOBISTYLE** – system zintegrowanych Inteligentnych Urządzeń automatyki, sterowania i kontroli, pozwalający na zarządzanie urządzeniami, oświetleniem oraz bezpieczeństwem w budynku. Podstawowym interfejsem do komunikacji pomiędzy Uczestnikiem a urządzeniami MOBISTYLE jest dedykowana aplikacja dostępna na smartfonach, tabletach oraz stronie www.
   5.8. **Inteligentne Urządzenia** – urządzenia posiadające autonomiczną komunikację bezprzewodową WiFi (2,4 GHz) oraz realizujące m.in. funkcje:
      - inteligentnych pomiarów pobranej energii elektrycznej lub
      - mierzenia i prezentowania użytkownikowi końcowemu parametrów środowiskowych w gospodarstwie domowym (temperatura, wilgotności itd.) lub

- wykrywania zdarzeń zaistniałych w gospodarstwie domowym (ruch, detekcja otwartych drzwi/okien, detekcja dymu, czadu, gazu, zalania oraz monitoring on – line).

Jako Inteligentne Urządzenia należy traktować również sprzęt RTV lub AGD, dostarczony Uczestnikom w ramach Pilotażu.

Każde Inteligentne Urządzenie posiada własną dokumentację (m.in. instrukcję instalacji i obsługi lub regulamin użytkowania), z którą Uczestnik musi się zapoznać i która musi być przez Uczestnika zaakceptowana. Przyjęcie Inteligentnych Urządzeń potwierdzone podpisaniem protokołu przekazania sprzętu MOBISTYLE oznacza automatyczną akceptację załączonej dokumentacji. Pełna dokumentacja Inteligentnych Urządzeń dostępna jest na stronie www.tauronet.tauron.pl/mobistyle.

5.9. **Rozporządzenie** - Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2016/679 z dnia 27 kwietnia 2016 r. w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych oraz uchylenia dyrektywy 95/46/WE (ogólne rozporządzenie o ochronie danych). Tekst Rozporządzenia można znaleźć w Punktach Obsługi Klienta oraz na stronie www.tauron.pl/rodo.

§ 2 UCZESTNICY PILOTAŻU

Uczestnikiem Pilotażu może stać się osoba fizyczna posiadająca pełną zdolność do czynności prawnych i będąca konsumentem, która spełni łącznie następujące warunki:

- Jest Laureatem Konkursu „Mobistyle" albo jest Członkiem Zespołu Projektowego i
- Posiada inteligentny licznik energii AMI należący do TAURON Dystrybucja Pomiary Sp. z o.o. i
- Posiada szerokopasmowe łącze internetowe oraz urządzenie sieciowe obsługujące bezprzewodową transmisję WiFi 2,4 GHz (router bezprzewodowy WiFi). Uczestnik zobowiązany jest posiadać lub nabyć we własnym zakresie router bezprzewodowy WiFi oraz odpowiednio go podłączyć oraz skonfigurować i
- Posiada telefon komórkowy typu smartfon, pracujący pod kontrolą systemu operacyjnego iOS (iOS 8 lub nowszy) lub Google Android (4.2 lub nowszy) i zobowiązuje się do korzystania z tego typu urządzenia w okresie obowiązywania pilotażu i

Przystąpienie do niniejszego Pilotażu wiąże się z koniecznością przekazania przez Uczestnika posiadanego przez niego adresu e – mail i numeru telefonu, co Uczestnik akceptuje. Adres e – mail i numer telefonu będą wykorzystywane przez Organizatora oraz Partnera w celu realizacji niniejszego Pilotażu, w szczególności w związku z doręczaniem ankiet dla Uczestnika.

§ 3 PILOTAŻ

1. Celem Pilotażu jest stworzenie aplikacji oraz platformy komunikacji z odbiorcami energii elektrycznej, oraz zbadanie jej wpływu na zwiększenie świadomości klientów w zakresie optymalnego zużycia energii, poprawy jakości środowiska domowego, zdrowia i stylu życia. Motywacją do zmiany przyzwyczajeń i zachowań w tym zakresie mają być spersonalizowane, modułowe usługi informacyjne dostarczane do końcowych użytkowników za pomocą atrakcyjnych rozwiązań ICT.
2. Pilotaż rozpocznie się nie wcześniej niż 01.01.2018 i potrwa do 30.06.2020.
3. Pilotaż składa się z dwóch etapów:
   - Tworzenie aplikacji – w trakcie etapu Uczestnik korzystał będzie z Inteligentnych Urządzeń, a dane z nich zbierane posłużą do stworzenia Aplikacji MOBISTYLE,
   - Program badawczy – Uczestnik korzystał będzie z Inteligentnych Urządzeń oraz Aplikacji, biorąc aktywny udział w programie badawczym.
4. W trakcie trwania Pilotażu Organizator, TPE lub Partner dostarczy Uczestnikom Inteligentne Urządzenia.
5. Uczestnik Pilotażu otrzyma maksymalnie 15 Inteligentnych Urządzeń. O rodzaju i ilości Inteligentnych Urządzeń dostarczanych Uczestnikom decyduje Organizator.
6. Przekazanie Inteligentnych Urządzeń odbędzie się po podpisaniu odpowiednich protokołów przekazania sprzętu MOBISTYLE.
7. Pierwsze Inteligentne Urządzenie zostanie przekazane Uczestnikowi najpóźniej 30 dni od daty poinformowania go o wynikach Konkursu „Mobistyle", którego Uczestnik jest Laureatem. Kolejne Inteligentne Urządzenia Organizator lub Partner będą dostarczać sukcesywnie.
8. Inteligentne Urządzenia wysyłane będą przesyłką kurierską na adres PPE Uczestnika, na który Uczestnik złożył zgłoszenie w Konkursie „Mobistyle".
9. W momencie nadania przesyłki kurierskiej, na adres e-mail, lub na numer telefonu, zostanie wysłany odpowiednio e-mail lub sms z informacją o wysyłce urządzenia.
10. Uczestnik samodzielnie uruchamia i konfiguruje Inteligentne Urządzenia otrzymane od Organizatora lub Partnera w terminie 14 dni od ich odbioru.

11. Wobec wydanych Uczestnikowi Inteligentnych Urządzeń stosuje się przepisy Kodeksu cywilnego jak dla stosunku użyczenia rzeczy, przy czym czas użyczenia jest równoznaczny z terminem obowiązywania Pilotażu.
12. Uczestnik zobowiązuje się korzystać z Inteligentnych Urządzeń na adresie PPE, na który Uczestnik złożył zgłoszenie.
13. Klient może przystąpić do Pilotażu tylko raz dla danego PPE.

§ 4 POWINNOŚCI UCZESTNIKA PILOTAŻU

1. Uczestnik jest zobowiązany do korzystania z otrzymanych Inteligentnych Urządzeń zgodnie z ich przeznaczeniem oraz zasadami użytkowania w okresie o którym mowa w § 3 pkt 2.
2. Uczestnik zobowiązuje się do wypełnienia Ankiet, które w okresie obowiązywania Pilotażu, umieszczane będą na stronie www.tauronet.tauron.pl/mobistyle lub wysyłane na podany przez Uczestnika adres e-mail. O konieczności wypełnienia ankiety Uczestnik zostanie powiadomiony drogą elektroniczną na adres e-mail podany podczas zgłoszenia w konkursie. Uczestnik jest zobowiązany do wypełnienia ankiety w ciągu 14 dni kalendarzowych od dnia otrzymania od Organizatora informacji e-mail o konieczności wypełnienia Ankiety.
3. Po zakończeniu Pilotażu, użyczone przez Organizatora Inteligentne Urządzenia mogą przejść na własność Uczestnika Pilotażu za kwotę 1 zł brutto.
4. Uczestnikowi, który naruszył którekolwiek z postanowień Regulaminu nie przysługuje prawo do wykupienia urządzeń za 1 zł brutto i jest on zobowiązany do zwrotu urządzeń na wezwanie Organizatora pod rygorem zapłaty kary umownej w wysokości 2 500 zł (koszt urządzeń).
5. Uczestnik, w przypadku o którym mowa w pkt 4 jest zobowiązany do zwrotu Inteligentnych Urządzeń na adres: TAURON Sprzedaż Sp. z o.o., ul Łagiewnicka 60, 30-417 Kraków.
6. Uczestnik jest zobowiązany do zgłoszenia stwierdzonych usterek lub błędów, które uniemożliwiają dalszą realizację Pilotażu na wskazany adres e-mail: mobistyle@tauron.pl lub drogą telefoniczną pod numerem telefonu +48 739 014 300. Zgłoszenia należy dokonać nie później niż następnego dnia roboczego po dniu wykrycia usterki lub błędu.

§ 5 INFORMACJA O PRZETWARZANIU DANYCH OSOBOWYCH

1. Administratorem danych osobowych Uczestników jest TAURON Sprzedaż sp. z o.o. z siedzibą w Krakowie (kod pocztowy 30 – 417), przy ul. Łagiewnickiej 60, Sąd Rejonowy w Krakowie, XI Wydział Gospodarczy KRS, Rejestr Przedsiębiorców KRS: 0000270491, NIP: 6762337735, Kapitał zakładowy: 479 029 800,00 PLN.
2. Z powołanym Inspektorem Danych Osobowych Uczestnicy mogą się kontaktować pisząc na adres email ts.iod@tauron.pl lub na adres korespondencyjny: IOD TAURON Sprzedaż sp. z o.o. ul. Lwowska 23, 40 – 389 Katowice.
3. Przetwarzanie danych osobowych Uczestników odbywa się na podstawie art. 6 ust. 1 lit. a) Rozporządzenia UE 2016/679 z dnia 27 kwietnia 2016 r. (dalej „Rozporządzenie"), tj. na podstawie zgody Uczestników.
4. Podanie przez Uczestników danych osobowych jest dobrowolne. Podanie danych: imię, nazwisko, dane adresowe, adres PPE, adres e – mail, numer telefonu stanowi jednak warunek udziału w Programie MOBISTYLE.
5. Dane osobowe Uczestników będą przetwarzane w celu udziału w Pilotażu MOBISTYLE – czyli stworzenia aplikacji oraz platformy komunikacji z odbiorcami energii elektrycznej, oraz zbadania jej wpływu na zwiększenie świadomości klientów w zakresie optymalnego zużycia energii, poprawy jakości środowiska domowego, zdrowia i stylu życia. Dane osobowe Uczestników będą przetwarzane przez okres niezbędny do realizacji celu, o którym mowa powyżej tj.: do 30.06 2020 r., a w każdym przypadku do czasu wycofania zgody.
6. Uczestnik ma prawo do wycofania zgody na przetwarzanie danych osobowych w dowolnym momencie (bez wpływu na legalność przetwarzania danych osobowych przed cofnięciem zgody), jednakże wiąże się to z rezygnacją z udziału w Pilotażu MOBISTYLE. Zgodę na przetwarzanie danych osobowych można wycofać w następujący sposób: mailowo na adres mobistyle@tauron.pl.
7. W związku z przetwarzaniem danych osobowych, przysługują Uczestnikom następujące prawa:
   - **Prawo dostępu do danych osobowych.** Prawo do uzyskania od Administratora potwierdzenia, że przetwarza on dane osobowe Uczestników. Uczestnik ma również prawo do uzyskania dostępu do tych danych osobowych, kopii danych, a także informacji, o których szczegółowo traktuje art. 15 ust. 1 Rozporządzenia.
   - **Prawo do sprostowania danych osobowych**. Uczestnik ma prawo zażądać, aby Administrator niezwłocznie sprostował dane osobowe, które są nieprawidłowe. Uczestnik ma również prawo zażądać, aby Administrator uzupełnił niekompletne dane osobowe.
   - **Prawo do usunięcia danych osobowych** (zwanego również „prawem do bycia zapomnianym"). Uczestnik ma prawo żądać, żeby Administrator niezwłocznie usunął jego dane osobowe. Pod warunkiem spełniania przynajmniej jednej z przesłanek:

- ✓ Dane osobowe Uczestnika nie są już niezbędne do realizacji celów dla których zostały zebrane lub są przetwarzane,
- ✓ Uczestnik sprzeciwił się przetwarzaniu danych osobowych, a Administrator nie ma uzasadnionych prawnie, nadrzędnych podstaw ich przetwarzania
- ✓ Administrator przetwarza dane osobowe Uczestnika niezgodnie z prawem,
- ✓ Administrator musi usunąć dane osobowe Uczestnika, aby wywiązać się z prawnie nałożonego na niego obowiązku,
- ✓ osoba, której dane dotyczą, cofnęła zgodę, na której opiera się przetwarzanie i nie ma innej podstawy prawnej przetwarzania.

Administrator może odmówić Uczestnikowi realizacji prawa do bycia zapomnianym, powołując się na art.17 ust.3 Rozporządzenia.

- **Prawo do ograniczenia przetwarzania danych osobowych**. Uczestnik ma prawo żądać, aby Administrator ograniczył przetwarzanie danych osobowych w następujących przypadkach:
  - ✓ jeśli kwestionowana zostanie prawidłowość danych osobowych, które są przetwarzane,
  - ✓ jeśli przetwarzanie danych osobowych jest niezgodnie z prawem, a Uczestnik sprzeciwia się aby zostały one usunięte, żądając w zamian ograniczenia ich wykorzystania,
  - ✓ jeśli Administrator nie potrzebuje już danych osobowych Uczestnika do celów przetwarzania, ale są one potrzebne do ustalenia, dochodzenia lub obrony roszczeń Uczestnika,
  - ✓ jeśli Uczestnik wniesie sprzeciw wobec przetwarzania danych osobowych.

  Jeśli Uczestnik skorzysta z prawa do ograniczenia przetwarzania danych osobowych, Administrator może je przetwarzać w wyjątkowych sytuacjach, wskazanych w art.18 ust.2 Rozporządzania.
- **Prawo do przeniesienia danych.** Uczestnik ma prawo, aby otrzymać dane osobowe lub upoważnić Administratora do przesłania danych osobowych innemu administratorowi – w ustrukturyzowanym powszechnie używanym formacie, jeżeli przesłanie jest technicznie możliwe. Mogą to być dane osobowe, które Administrator otrzymał bezpośrednio od Uczestnika, jak i dane wynikające z jego zachowania np. dane o zużyciu energii. Przeniesienie nastąpi wyłącznie co do tych danych osobowych spełniających łącznie następujące warunki:
  - ✓ przetwarzanie odbywa się w sposób zautomatyzowany, tj. nie są to dane osobowe w formie papierowej,
  - ✓ dane osobowe przetwarzane są na podstawie zgody lub w związku z umową.

8. Jeśli Uczestnik będzie chciał skorzystać z praw, o których mowa powyżej lub uzyskać więcej informacji – możliwy jest kontakt na wybrany z poniższych sposobów:
   - pisemnie na adres TAURON Obsługa Klienta sp. z o.o. ul. Lwowska 23, 40-389 Katowice;
   - mailowo na adres daneosobowe.wnioski@tauron.pl
   - telefonicznie pod numerem +48 32 606 0 606.

   Jeśli Uczestnik zdecyduje się skorzystać z powyższych praw, Administrator udzieli mu odpowiedzi co do rozpatrzenia żądania, bez zbędnej zwłoki, jednakże nie później niż w terminie miesiąca od dnia otrzymania żądania.
9. **Prawo do wniesienia skargi do organu nadzorczego.** Jeśli Uczestnik uważa , że przetwarzanie danych osobowych narusza przepisy prawa, przysługuje mu prawo do wniesienia skargi do organu nadzorczego – Prezesa Urzędu Ochrony Danych Osobowych.
10. Odbiorcami danych osobowych są:
    a) Inni administratorzy przetwarzający dane osobowe we własnym imieniu:
       - TAURON Polska Energia S.A.,
       - Partnerzy Pilotażu wymienieni w § 1 ust. 3 niniejszego Regulaminu,
       - Podmioty prowadzące działalność pocztową lub kurierską,

    b) Podmioty przetwarzające dane osobowe w naszym imieniu:
       - TAURON Obsługa Klienta sp. z o.o.,
       - Podmioty obsługujące systemy teleinformatyczne i świadczące usługi IT,
       - Podmioty wspomagające nas w obsłudze korespondencji czy w procesie obsługi Klienta;
       - Podmioty świadczące nam usługi doradcze, konsultacyjne, audytowe, pomoc prawną, podatkową, rachunkową;
       - Podmioty świadczące usługi archiwizacji dokumentów;

    w zakresie w jakim jest to niezbędne do realizacji celów przetwarzania danych osobowych.

§ 6 REKLAMACJE

1. Wszelkie reklamacje wynikające z udziału w Pilotażu, a także dotyczące wad fizycznych Inteligentnych Urządzeń należy składać drogą elektroniczną na adres e-mail mobistyle@tauron.pl
2. W przypadku wystąpienia wad fizycznych Inteligentnych Urządzeń, Organizator oraz Partner zobowiązują się do nieodpłatnej naprawy wadliwie działającego Inteligentnego Urządzenia lub jego podzespołu. Organizator oraz Partner mogą zdecydować, że zamiast naprawy wadliwie działającego Inteligentnego Urządzenia dokonają jego wymiany na Inteligentne Urządzenie wolne od wad.
3. W przypadku wystąpienia wad fizycznych Inteligentnych Urządzeń, Uczestnik jest zobowiązany do poinformowania Organizatora o zauważonych wadach. Jeżeli konieczne będzie odesłanie Inteligentnego Urządzenia to Uczestnik zobowiązuję się wysłać je pocztą kurierską wskazaną przez Organizatora lub Partnera na adres wskazany przez Organizatora drogą mailową i/lub telefoniczną w odpowiedzi na zgłoszenie Uczestnika.
4. Organizator oraz Partner zobowiązują się do naprawy bądź wymiany wadliwego Inteligentnego Urządzenia w ciągu 30 dni. Jeżeli z przyczyn niezależnych od Organizatora oraz Partnera termin ten nie będzie mógł być dotrzymany, Uczestnik zostanie o tym poinformowany drogą elektroniczną na adres e-mail.
5. Niniejsze postępowanie reklamacyjne nie wyklucza dochodzenia ewentualnych roszczeń przez Klienta na podstawie powszechnie obowiązujących przepisów prawa.

§ 7 OBOWIĄZYWANIE PILOTAŻU

1. Pilotaż trwa od 01.01.2018 i nie dłużej niż do 30.06.2020.
2. W przypadku okoliczności opisanych w § 9 pkt 1, Organizator zastrzega sobie możliwość zmiany terminu obowiązywania Pilotażu określonego w ust. 1.
3. O zmianie terminu obowiązywania Pilotażu Uczestnik zostanie powiadomiony drogą elektroniczną na adres e-mail. Wszelkie zmiany terminów zostaną także ogłoszone na stronie www.tauronet.tauron.pl/mobistyle.

§ 8 REZYGNACJA Z UDZIAŁU W PILOTAŻU

1. Uczestnik ma prawo do rezygnacji z udziału w pilotażu w trakcie jego trwania.
2. Uczestnik w przypadku opisanym w ust. 1 zobowiązany jest do zwrotu Inteligentnych Urządzeń na wezwanie Organizatora pod rygorem zapłaty kary umownej w wysokości 2.500,00 PLN (koszt urządzeń).
3. Uczestnik, w przypadku o którym mowa w ust. 1 jest zobowiązany do zwrotu Inteligentnych Urządzeń na adres: TAURON Sprzedaż sp. z o.o., ul Łagiewnicka 60, 30 – 417 Kraków.

§ 9 POSTANOWIENIA KOŃCOWE

1. Ze względu na badawczy charakter Pilotażu, Organizator informuje Uczestnika, że rozwiązanie MOBISTYLE może być obarczone wadami, które mogą utrudniać bądź uniemożliwiać korzystanie z MOBISTYLE i nie stanowić to będzie podstaw do składania reklamacji w rozumieniu obowiązujących przepisów prawa, co Uczestnik akceptuje.
2. W kwestiach nieuregulowanych w Regulaminie stosuje się odpowiednie zapisy Kodeksu cywilnego.
3. Zmiana Regulaminu (z wyjątkiem zamian opisanych w § 7 ust. 2) wymaga formy pisemnej pod rygorem nieważności.
4. Regulamin Pilotażu dostępny jest przez cały czas obowiązywania Pilotażu w siedzibie Spółki, Punktach Obsługi Klienta oraz na stronie www.tauronet.tauron.pl/mobistyle.

Oświadczam, że zgadzam się na przetwarzania moich danych osobowych w postaci: imię, nazwisko, dane adresowe, adres PPE, adres e – mail, numer telefonu celem w celu udziału w Pilotażu MOBISTYLE – czyli stworzenia aplikacji oraz platformy komunikacji z odbiorcami energii elektrycznej, oraz zbadania jej wpływu na zwiększenie świadomości klientów w zakresie optymalnego zużycia energii, poprawy jakości środowiska domowego, zdrowia i stylu życia..

Oświadczam, że zgadzam się na przekazywanie danych pomiarowych z mojego inteligentnego licznika energii elektrycznej AMI przez Spółkę TAURON Dystrybucja Pomiary Sp. z o.o., Spółce TAURON Sprzedaż sp. z o.o. oraz pozostałym Partnerom wymienionym w § 1 pkt 3 celem ich przetwarzania w trakcie realizacji Pilotażu MOBISTYLE.

Oświadczam, że zostałem poinformowany o obowiązku wypełniania Ankiet dotyczących funkcjonowania MOBISTYLE, które przynajmniej raz w miesiącu umieszczane będą przez Organizatora na stronie www.tauronet.tauron.pl/mobistyle.

Oświadczam, że zostałem poinformowany, iż po zakończeniu Pilotażu, użytkowane przeze mnie podczas Pilotażu Inteligentne Urządzenia, mogą przejść na moją własność za kwotę 1 zł brutto.

.....	.....
(miejscowość, data)	*(podpis Klienta)*

Załącznik nr 1 do Regulamin Pilotażu MOBISTYLE

Przykładowa Ankieta oceniająca funkcjonowanie
MOBISTYLE

Prosimy o wypełnienie poniższej ankiety, która służy badaniu poziomu zadowolenia Uczestników Pilotażu z rozwiązania MOBISTYLE. Zebrane opinie i otrzymane wyniki przyczynią się do wprowadzenia ewentualnych zmian w funkcjonalności testowanego rozwiązania.

I. INTELIGENTNA WTYCZKA

1. Jakie urządzenie podłączone zostało do Inteligentnej Wtyczki? *(możliwość wyboru kilku odpowiedzi)*

☐a) Lodówka
☐b) Telewizor
☐c) Lampa
☐d) Komputer
☐e) inne (jakie?) .....

2. Jak oceniasz działanie Inteligentnej Wtyczki?

☐a) Działa bezproblemowo
☐b) Działa zbyt głośno
☐c) Wystąpiły problemy podczas konfiguracji
☐d) inne uwagi (jakie?) .....

II. APLIKACJA

1. Na jakim urządzeniu korzystasz z aplikacji *(możliwość wyboru kilku odpowiedzi)*

☐a) Smartphone
☐b) Tablet
☐c) Komputer

2. Z jakiego systemu operacyjnego korzystasz?*(możliwość wyboru kilku odpowiedzi)*

☐a) Google Android
☐b) iOS

III. SUGESTIE dotyczące jakości zasobu, usług, sprzętu itp.

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