MOBISTYLE

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

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Executive summary

This report is an outcome of the work done in task T2.6: *Composition of specific sets of data acquisition for the five study and demonstration cases* that will be used for the purposes of MOBISTYLE project, funded under European Union Horizon 2020 Innovation Action programme (H2020).

To provide interesting information for different building user types, certain parameters have to be monitored in chosen demonstration buildings. The objective of the MOBISTYLE task T2.6 is to assess current sensoring systems installed in the demonstration rooms (buildings) and to decide which additional measuring devices need to be installed to realize all the case specific MOBISTYLE objectives. Therefore, this deliverable introduces existing as new measuring devices in the five cases, in terms of: sensor description, product characteristics, product connection requirements and costs of each device. The technical description of the functional system as also financial analysis of additional sensoring systems are reported in D4.1. Furthermore, for a more comprehensive understanding of MOBISTYLE demonstration and monitoring actions at each of the five MOBISTYLE pilot case studies it is referred to D6.1.

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1 Introduction

The purpose of MOBISTYLE is to raise consumer awareness and motivate behavioural change towards more energy conscious building use, improved indoor environment and healthy lifestyle. The goal is to utilize the data gathered by existing sensoring devices installed in the buildings and translate this data into attractive and easy comprehensible information for the identified building users.

As showed the outcomes of the work done at an earlier stage of the MOBISTYLE (see outcomes of MOBISTYLE deliverable D2.2 *Inventory of user needs and expectations* [1] and D2.3 *Recommendations for improvement and further development of solutions* [2]), combined information on energy use with other relevant information such as the actual indoor environmental quality or their well-being is more interesting for building users than just solely energy consumption data.

To allow this, appropriate measuring devices need to be installed in relevant building locations and connected to the common database. The additional devices were chosen based on the latest state-of-the-art devices available on the European market. The inventory of measuring equipment presented in the deliverable D2.1 *Inventory of supplied data* [3] was used as a basis. However, as the market development of sensoring solutions is going fast, some better alternatives from other suppliers were found during the project duration. Additional relevant devices in the rooms at the demonstration buildings were installed and connections established where data is transferred to the MOBISTYLE database. For deeper understanding of architecture of the MOBISTYLE monitoring system and connection of all sensors to the MOBISTYLE database and afterward to the platform it is recommended to the D4.1 *Applicable hardware and software solutions for sensing technologies* and D4.2 *Applicable platform and database for software and information interoperability* [4]. As part of the current D2.5, the preparation work at the demonstration sites included an investigation on which of the devices from the inventory D2.1 can be applied to which situations and how different devices can be connected into one system (continued in D4.1).

For the five demonstration cases detailed monitoring action plans were defined that will help realizing MOBISTYLE main objectives as also case specific objectives. The five real life environments where MOBISTYLE demonstration takes place are:

- A residential building complex in Aalborg, Denmark;
- Smart homes in Wroclaw, Poland;
- A hotel in Turin, Italy;
- Faculty buildings of University of Ljubljana, Slovenia;
- An office environment in Maastricht, the Netherlands.

More detailed description and information on the MOBISTYLE demonstration cases is available in the deliverable *D6.1 Detailed final monitoring, awareness and information campaigns for the five cases* [5]. This deliverable also includes presentation of the parameters that need to be measured to answer the defined case specific MOBISTYLE objectives. Based on decision on which parameters to monitor as part of MOBISTYLE project, the decision for additional instrumentation was done as presented in D2.5.

1.1 Aim of the report

This document presents the MOBISTYLE deliverable D2.5 reporting the inventory of the sensors and measuring devices that will be used for the purposes of the MOBISTYLE project for each of the 5 demonstration cases. It includes description of existing devices already installed in the MOBISTYLE demonstration buildings as also new devices that were installed additionally as part of the MOBISTYLE project. It provides overview of different products characteristics such as data measured, measuring frequency, operating range, minimum accuracy, technical connection requirements etc., device costs and information about its location in the building/room. Detailed technical description of the infrastructure and integration approach on how to connect all the different devices into one functional MOBISTYLE system is available in D4.1.

2 Data acquisition sets for the MOBISTYLE demonstration cases

Specific sensors and measuring devices were chosen that are feasible and interesting for each of the five MOBISTYLE demonstration cases applications. All the demonstration cases are measuring data that should be translated into information interesting for end-users. Consequently, end-users should be stimulated to change their behaviour leading to reduced building energy use of at least 16 % (main MOBISTYLE objective). Furthermore, each of the five demonstration cases has specific objectives and action plan on how to achieve the main MOBISTYLE goal. The decision criteria for which parameters to measure and which sensors to install was based on the outputs of the tasks 2.1, 2.2 and 2.3 that shaped the structure of specific data acquisition sets for the five demonstration cases. The complete MOBISTYLE data acquisition system programme for each demonstration case was done by:

- Assessment of the already present data acquisition systems in the buildings, provisions and extension possibilities;
- Possible modifications to these systems to meet the requirements from tasks 2.1 – 2.3 (referring to D2.1 [3], D2.2 [1] and D2.3 [2]);
- Addition of data acquisition systems in relation to the requirements from tasks 2.1 – 2.3 and the specific challenges mentioned in D6.1 [5].

Existing and new sensors were identified and categorized according to the measuring phenomena and their main characteristics were described. The decision for most applicable new devices was done based on usefulness, cost effectiveness, applicability and product's geographical availability. Product data sheets served as a basis for the identification of the sensor characteristics. Not for all the devices all information was available. The aim was to gather in the inventory description of sensor characteristics (measuring frequency, operating range, minimum accuracy, position in the room), sensoring requirements (data acquisition, communication protocols, sensors connectivity, required power, sensors output signal, additional notes) and costs. All gathered information is available for each demo case in the annex documentation (See Annex 1-5 Excel files). The word document summarizes main characteristics of the selected sensor types that were chosen as most suitable solutions for MOBISTYLE purposes.

Practical considerations including description of sensoring work, compatibility with other components forming a monitoring system and MOBISTYLE database – platform connection feasibility studies are further discussed in other deliverables, please see: D2.1 [3], D4.2 [4] and D5.1 [6].

Economic considerations presented in this report are representing only the initial purchase of the devices. The total cost-effectiveness of the MOBISTYLE system as a whole will be subject of analysis in *D5.5 MOBISTYLE Exploitation plan* to be elaborated by the end of the project. In general, the life time costs are related to:

- Initial purchase costs and shipping costs;
- Installation and operation costs (including additional instrumentation to enable connection to the MOBISTYLE database and platform);
- Calibration and maintenance costs;
- Repairs, disposal costs [D2.1].

2.1 Data acquisition system for the Danish demonstration case

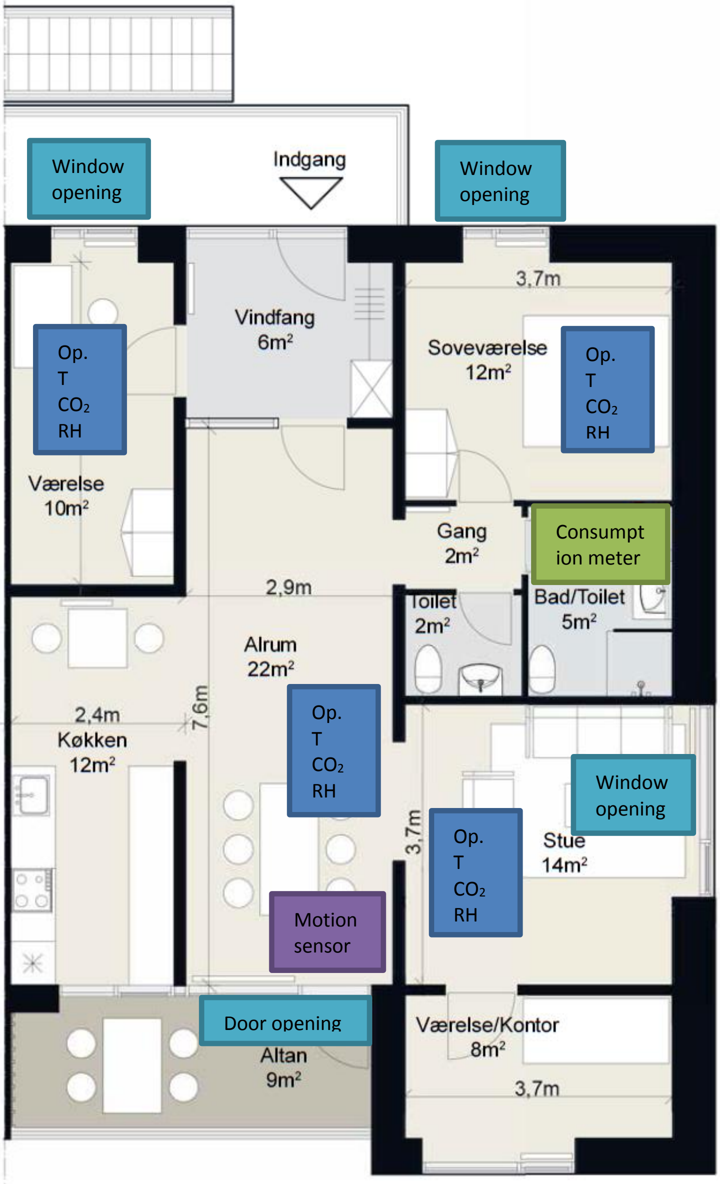
As described in D6.1 [5], the Danish demonstration case is represented by a residential housing area located in Kildeparken, Denmark. The main MOBISTYLE aim for this demonstration case is to demonstrate a sustainable behavioural change leading towards a significant reduction of energy use by offering ICT based solution giving information and knowledge regarding occupant's IEQ and energy use. Additional requirement is that the developed MOBISTYLE solutions should work with the already established and offered services for the residents at Kildeparken.

MOBISTYLE test installation was done in October 2017 for one apartment – to test how often it is possible to retrieve the data, how works connection etc. Until the summer 2018 were installed all necessary devices in 2-3 rooms (bedroom, living room, child's room) for the 19 apartments where in these rooms it will be monitored CO_2, temperature, humidity and window opening. Occupancy is monitored only in one room (living room-kitchen-hallway). The external company is monitoring heating and cold and hot water usage. Smart meters are installed, however, electricity supplier is individual's owner decision therefore depends with whom they have a contract.

The following figures present the floor plans of the chosen apartments (different types) where MOBISTYLE demonstration will take place. Each apartment has marked locations of sensors location measuring IEQ and occupancy.

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



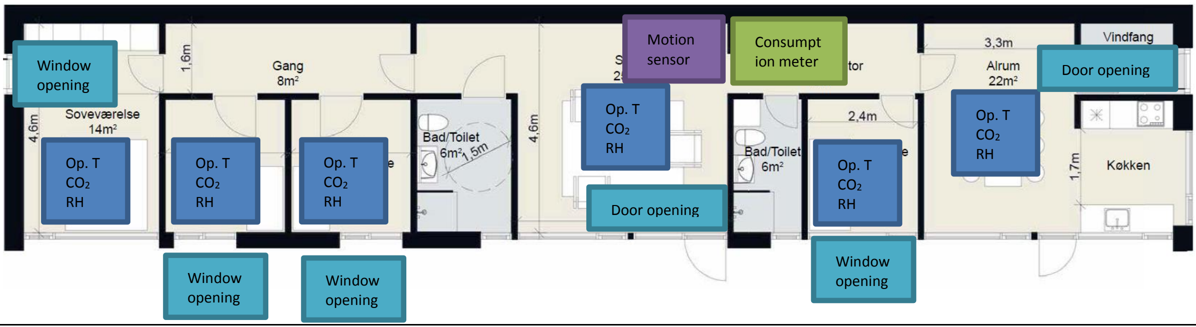
Apartment	Type C11, 91 m2, 4 rooms, with a balcony 2 apartments of this type

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	

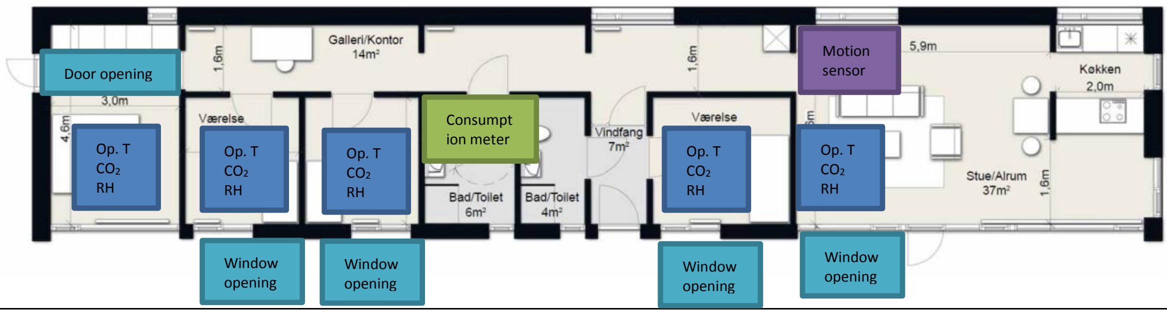
Apartment	Type G4, 130 m2, 5 rooms, level free access 1 apartment of this type

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



2.1.1 Existing monitoring devices in the MOBISTYLE demonstration rooms

The energy use for space heating and Domestic Hot Water (DHW) consumption was already measured in each apartment before MOBISTYLE project. Metered data from these sensors are used for reference monitoring. The existing sensor network supports connection and use of M-Bus standard protocol. Existing monitoring devices are connected via Wired M-Bus network. Additional monitoring devices are connected via Wireless M-Bus network.

Existing monitoring devices

In Table 1 are presented existing devices (and its characteristics – resolution, accuracy, time step for data retrieval, connection possibilities) installed in the apartments that allow measurements of space heating, DHW, electricity and cold-water consumption.

Table 1: Existing consumption related measuring devices installed in the Kildeparken apartments. The available information includes devices resolution, accuracy, time step for data retrieval and connection routes used.

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
Cold water	Water	1 l/hour	±2.5 %	15min	modilys® m 16501	Apartment level Wired M-Bus

2.1.1 Additional monitoring devices

To meet the MOBISTYLE requirements, following additional monitoring devices were installed as presented in Table 2, 3 and 4. Mostly wireless M-BUS devices from LANSEN systems are installed to extend the existing sensor network. Besides the IEQ monitoring devices, an outdoor ambient temperature and humidity sensor and additional data collectors (CMi-Box - Wireless M-Bus Receiver) were installed to collect the new data flow.

IEQ monitoring devices

To monitor the IEQ indoors, temperature, relative humidity and CO2 are measured with the following devices presented in Table 2.

Table 2: New IEQ measuring devices installed in the Kildeparken apartments. The information includes devices resolution, accuracy, time step for data retrieval and connection routes used.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/notes
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		
CO2	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

User behaviour measuring devices

To assess behaviour of users in the building and find correlation between the occupancy and IEQ parameters, the following devices are used as presented in Table 3.

Table 3: New devices installed in the Kildeparken apartments allowing assessment of building's occupancy and certain users behaviour. The information includes devices resolution, accuracy, time step for data retrieval and connection routes used.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/notes
Occupancy	User behavior	Activity/5 min	Activity/5 min	-	LAN-WMBUS-OD Motion detector Design 33X	Only living room AMR-Wireless M-Bus
Window/Door opening	User behavior	0/1	-	Total count	LAN-WMBUS-M (Door and Windows AMR-)	Room level AMR-Wireless M-Bus

Outdoor sensing devices

To assess outdoor conditions, both data from the closest weather station and separate instruments placed in the social housing area will be used as presented in the Table 4.

Table 4: New devices installed in the Kildeparken apartments allowing assessment of outdoor conditions (temperature and relative humidity). The information includes devices resolution, accuracy, time step for data retrieval and connection routes used.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/notes
Temperature	Outdoor climate	-	+/- 0.2 °C	15min	CMa20w - Outdoor temperature/ humidity sensor	One building North facade Wireless M-Bus
Relative humidity		-	±2% RH	15min		

2.1.2 Economic considerations – cost of devices

Table below shows price for the additional sensoring devices installed for the Danish case as also the total costs (including installation costs).

Sensor	Price (€)	Quantity	Cost of devices (€)	Installation costs (€)	Total costs (€)
LAN-WMBUS-G2-TH Ambient Sensor for temperature/humidity	77.75	81	6,297.59	1,411.53	7,709.12
LAN-WMBUS-E-CO2 Ambient Sensor for CO2/temperature/humidity	89.81	81	7,274.80	1,411.53	8,686.33
LAN-WMBUS-M (Door and Windows AMR-)	97.86	81	7,926.27	1,411.53	9,337.80
LAN-WMBUS-OD Motion detector Design 33X	197.72	19	3,756.70	331.10	4,087.80
CMi-Box - Wireless M-Bus Receiver	250.67	9	2,256.03	156.84	2,412.87
MULTICAL® 602 & ULTRAFLOW®	174.26	3	522.79	52.28	575.07
modilys® m	147.45	3	442.36	52.28	494.64
CMa20w - Outdoor temperature/humidity sensor	137.40	1	137.40	17.43	154.83
				Summary	33,458.45

Additional information about the sensors for the Danish case is presented in Annex 1.

2.2 Data acquisition system for the Polish demonstration case

The Polish demonstration case is covering the monitoring of the residential buildings located in Wroclaw whose building owners are clients of Polish energy provider TAURON – MOBISTYLE consortium partners (connected to the Smart city Wroclaw). As described in the previous deliverable D6.1 [5], the main objective for this MOBISTYLE demonstration is to monitor electricity consumption and investigate how to motivate and change behaviour of users towards more energy efficient building use in their homes.

In this deliverable no floor plans are presented as there is no 'standard' apartment. At the last demonstration cycle, demonstration will be held for 1000 TAURON clients who expressed their interest to join MOBISTYLE demonstration. Candidates live in different parts of the city where the apartments differentiate significantly in the characteristics of their construction, size and location on the map of the city.

The participants that took part in the focus groups (WP2) contained subjects from different groups' where selection was based on 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 allow to read the electricity consumption in the system every 15 seconds. Data collected from previous pilot projects and based on data held by the company TAURON Sprzedaż 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.

2.2.1 Existing monitoring devices in the MOBISTYLE demonstration rooms

Energy consumption sensing devices

Each house and apartment qualified for the MOBISTYLE demonstration is already equipped with a smart AMI-plus meter used to measure electricity consumption (in kWh). The meter allows readings of electricity consumption in real time; allows to read the electricity consumption in the system every 15 seconds. Data showing energy consumption collected from AMI require approximately 30 MB/year for one energy meter.

Table 5: Existing electricity measuring devices installed for the TAURON clients in Wroclaw. The available information includes device's resolution, accuracy and time step for data retrieval.

Parameter	Type	Resolution	Accuracy	Time steps	Instrument used	Other/notes
Total electric consumption	Energy	1 kWh	Class B according to MID	15min and round the clock	AMI meter	

Existing system description

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 to read the actual value of the electricity consumption in a 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.

2.2.2 Additional monitoring devices

For MOBISTYLE purposes, the following parameters will be measured: total electric energy consumption, energy consumption of certain appliances connected to smart plugs, operative temperature, relative humidity, windows opening and doors opening. Every smart metering set has its unique device ID, which will be used to access device's details and the data transmitted by it.

Additional energy consumption measurement of the wash cycles

Additionally, it has been agreed that for a small number of TAURON customers (individual households) a new functionality will be offered where the house occupants can follow the efficiency of their washing machine usage. This white good appliance monitoring will allow provision of feedback to a small number of consumers about how their behaviour and usage of washing machines affects their building energy usage. Based on the analysed activity (load of individual cycles, efficiency of each cycle, temperature, duration, cost of each cycle etc.) users will be educated on how to optimize their washing machine usage and become more energy efficient. MOBISTYLE partner Whirlpool provide their washing machines installed in 10 demonstration buildings. Within this information, consumer will get an insight in whether the energy inside a building is wasted and therefore turns the appliances off when not needed. Furthermore, the advanced technology also allows communication and exchange of information (data) between different devices and in future even further optimization will bring direct communication and control between different devices.

For the purposes of demonstration, the data about different was cycles is in JSON format, providing the communication from the product to the cloud. In that file you have all the info that the washer exchanges with the cloud, so much more info that needed for the project. Only the information related to determine the wash cycle is selected for the MOBISTYLE purposes. The information provided by Whirlpool machines gives estimation of power consumption based on a reference table that reports for each combination of cycles. It provides users knowledge on what kind of power consumption (as measured in Whirlpool labs) he can expect if maximum loaded washing machine per certain cycle. This value is then the maximum consumption consumers may expect for that cycle, since consumption is proportional to load. In this way user can compare options and finds out the cheapest one.

IEQ sensing devices

In all the apartments will be placed sensors used to improve the quality of life of users by monitoring certain IEQ sensors. Door/window opening, humidity and temperature sensors are installed for the purposed of MOBISTYLE. Their construction allows for easy and non-invasive installation on the wall, ceiling or any other surface. Thanks to the system of fasten able stands, the assembly of the equipment is very simple and fast to implement. Door/window sensors will be placed in the most occupied space: common living room. Temperature and humidity sensor should be in areas, where people are most likely to stay. Indoor conditions are measured with temperature and humidity sensors.

Table 6: New IEQ measuring devices installed for the TAURON clients in Wroclaw to satisfy MOBISTYLE objectives. The available information includes device's accuracy and communication connection possibilities.

Parameter	Type	Accuracy	Instrument used	Other/notes
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

2.2.3 Economic considerations – cost of devices

The equipment used during the pilot project will come from one of the Smart Home units manufacturers. The examples of sensors and its prices are presented in Table 7.

Table 7: Costs of measuring devices for the Polish demonstration case.

Sensor	Price (€)	Quantity	Total cost (€)
Window sensor WISZB-120	36,65	4	146,6
Humidity Sensor - HMSZB-110	40,87	1	40,87
Smart plug (type E)	50,74	4	202,96
Gateway	206,51	1	206,51
		Summary	596,94

Additional information about the sensors for the Polish case is presented in Annex 2.

2.3 Data acquisition system for the Italian demonstration case

As described in D6.1 [5], the Italian demonstration case presents a hotel building located in Turin where hotel guests are mostly long-term stayers. The MOBISTYLE demonstration will cover four apartments inside this hotel and the reception area. The specific objective for the Italian demonstration case is to monitor IEQ and electricity consumption in order to provide the hotel guests with feedback on energy use with guidance on how to save energy while creating a healthy and adequate indoor environment. Based on their surface area, the selected apartments are defined either 'Comfort' or 'Superior' (see Figure 1).

For the chosen MOBISTYLE apartments more detailed analyses will be done by gathering data via smart plugs to measure electricity of certain devices and sensors for IEQ assessment. Regarding occupant behaviour, window opening, door opening, thermostat adjustments and fan-coil adjustment will be monitored. Table below presents plan drawings of both types of apartments, with indicated location of the measuring devices. The measured variables in the apartment are:

IEQ:

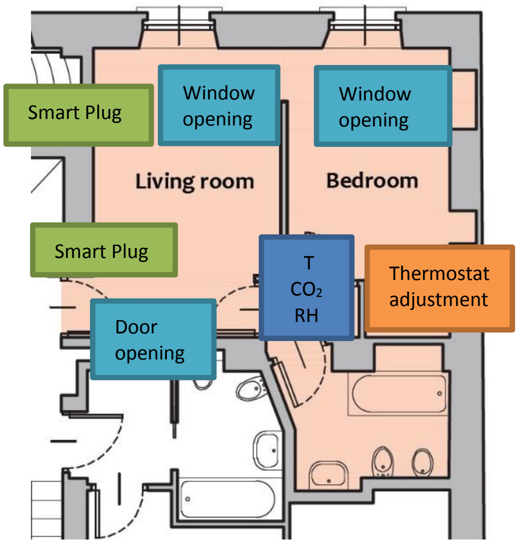
- Air temperature (°C)
- Relative Humidity (%)
- CO_2 concentration (ppm)

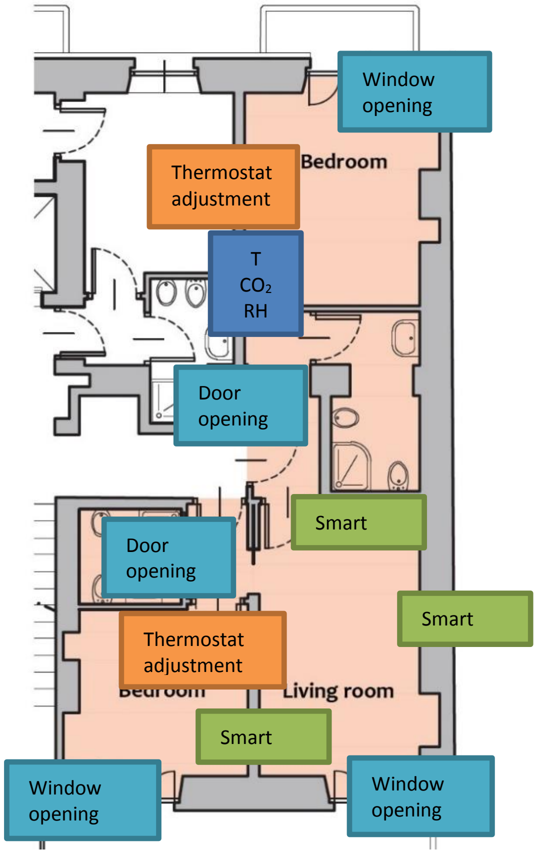
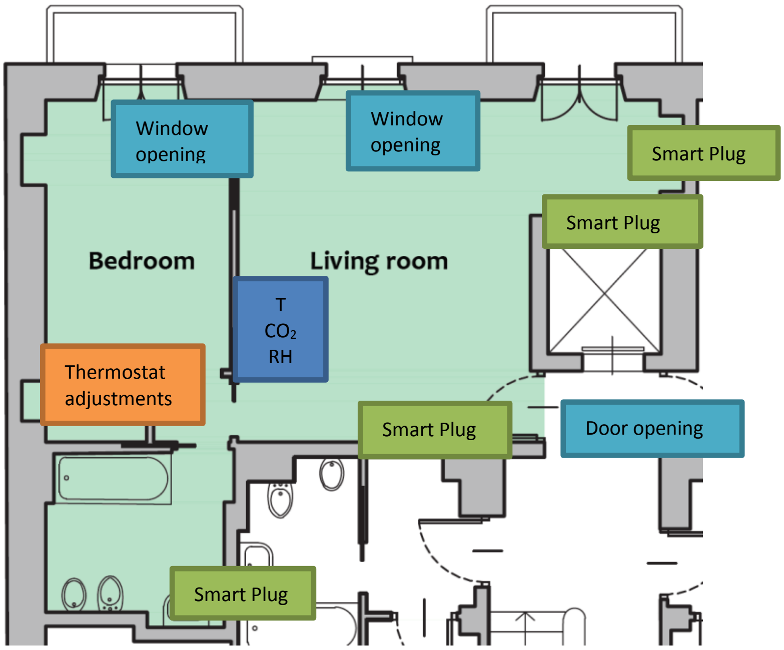
Energy:

- Overall energy consumptions of the single apartment (kWh)
- Energy consumptions of single electrical devices (e.g. TV, dishwasher, washing machine) (kWh)
- Instant power of single electrical devices (e.g. TV, dishwasher, washing machine) (kW)

Behaviour:

- Window openings (1/0)
- Door openings (1/0)
- Thermostat adjustments (°C)

Room 01 Floor area: 37,5 m^2 Typology: Comfort Number of occupants: 1-2 Description: 2 rooms without balcony Other characteristics: • one bathroom • two windows with northwest exposure	

Room 103 Floor area: 36,8 m^2 Typology: Comfort Number of occupants: 1-4 Description: 3 rooms with 2 balconies Other characteristics: • 2 entrance doors • 2 bathrooms • 3 windows with both northwest and southwest exposure	
Room 302 or 402 Floor area: 39 m^2 Typology: Comfort Number of occupants: 1-4 Description: 2 rooms with 2 balconies Other characteristics: • one bathroom • 3 windows with northwest exposure	

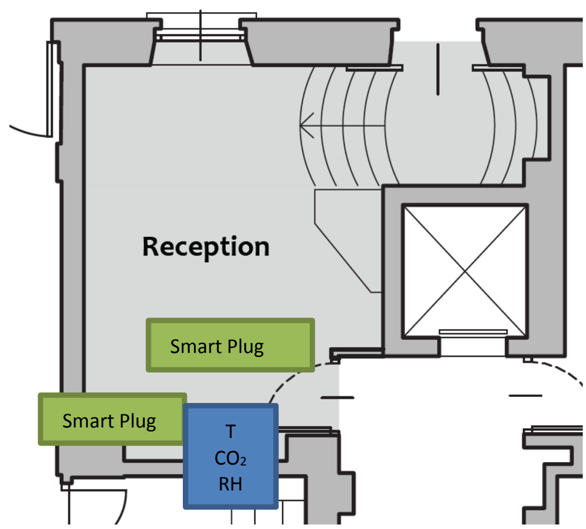
Reception Main characteristics: • one entrance door • one window with northwest exposure	

Figure 1: The floor area of different apartments (rooms) and reception area floor plan used for Italian MOBISTYLE demonstration.

To successfully carry out the monitoring campaign in the case study, it is necessary to exploit existing monitoring devices and add additional sensors where needed. Existing and additional monitoring devices will be described in the following paragraphs. For setting up an effective monitoring campaign, the following risks and mitigation strategies were considered as presented in Table 8.

Table 8: Identification of risks and proposed mitigation measures that were considered for the Italian demonstration case.

Description of the risk	Proposed risk-mitigation measures	Status of risk
Choice of new sensors that fit in the existing sensor system and communication protocol	Careful selection of additional sensors that are aligned with the KNX communication protocol	No risks occurred, all sensors are aligned with the current system structure
Continuous monitoring of all variables	Regular data check and close collaboration with hotel technician and staff	Risk is under control.
Hotel guests or staff might (re)move smart plugs	Regular check on location and operation of smart plugs	Risk is under control. One smart plug had to be removed due to technical problems.
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.

2.3.1 Existing monitoring devices

All apartments have already installed *thermostats* to measure air temperature in the rooms. The energy consumption is monitored on the building level where no energy meters for thermal or electric consumption monitoring are installed on the room level.

Air temperature sensor

The indoor air temperature (°C) is measured by the system type TUX / U1.1 allowing measurements in the range of -5 to 50 °C with a thermostat suitable for insertion into boxes from three-module recessed. The thermostat permits to adjust, in each apartment, the indoor temperature +/- 3°C with respect of reference temperature (21 °C in winter and 23°C in summer). The installed fan coils permits, enabling

a feature currently unused, to monitor which fan speed the user has set. As investigated, this existing system installed for the Italian demonstration case allows the real time data access. An API interface is available when needed to enable the connection to the MOBISTYLE system. The system TUX / U1.1 is designed to achieve room temperature control using an EIB / Konnex bus-based communication system. The system can realize thermoregulation by controlling the convectors up to three levels of speed. Two speeds are controlled directly via the relays on the device. The third speed requires an external actuator connected via bus to TUX / U1. The external supply requires 10-32 VDC, 12-24 VAC 3W peak (supply in case of absence of the bus)
More information (in Italian) is described on the product's datasheet:
https://library.e.abb.com/public/c9693e80c4a5486aac79c3184ea07f59/TUXU_11.pdf.

Occupancy and door opening

Occupancy is now assessed based on data gathered by the entrance door opening system (key card) of each apartment. It was considered to install an occupancy sensor (360° sensor) mounted on the ceiling to have a better understanding of how each occupant uses the hotel room. However, this will not be done as it does not bring an additional value for the MOBISTYLE project at this stage.

Window opening

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.

Existing system description

The case study is equipped with 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.
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 existing communication protocol of the hotel will be exploited to define the final sensoring structure and to acquire data useful for the scope of MOBISTYLE project. The communication protocol is based on the KNX standard (see EN 50090, ISO/IEC 14543 – https://www.knx.org), which is an open standard for building automation in commercial and residential buildings. The case study makes use of the ABB i-bus KNX in Hotel Guest Rooms. Further information on the protocol can be found here:
(https://www.ivoryegg.co.uk/site_files/b5f761d5/7e3b/49a7/998b/8214e814008f_2CDC500118N0201_Presentation_Hotel_Guest_Rooms.pdf?1498544956).

Data can be visualized and downloaded with the SQL server management studio (https://www.microsoft.com/en-gb/sql-server) that permits to view data from both existing and added sensors. It is also used by the hotel technicians for configuring, managing, and administering all components. The Figure 2 below shows the interface of the SQL server for accessing the hotel data. Raw monitored data from can be retrieved from here and further elaborated by MOBISTYLE partners (WP4/WP5).

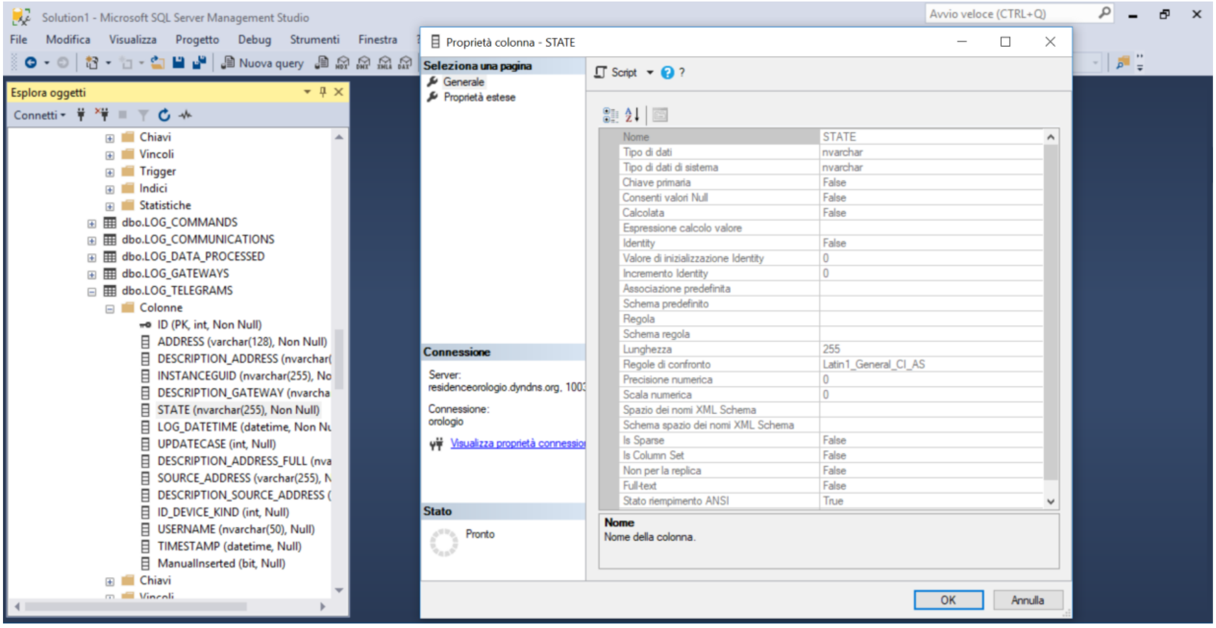


Figure 2: Interface of the SQL server for accessing the hotel data.

2.3.2 Additional monitoring devices

In all apartments, measurements regarding energy consumption and IEQ will be taken, specifically, operative temperature, CO_2, relative humidity, and electricity consumption. Electricity consumption inside demonstrated apartments is measured by the smart meters in the distribution board. Electricity consumption of particular devices is monitored by using smart sockets at the certain sockets. There is still ongoing investigation on whether there is budget and an interest to purchase wearables to stimulate a healthier lifestyle. If decided, devices for monitoring user's activity level and person's position (sedentary/standing) will be purchased.

Energy consumption sensing devices

Inside the MOBISTYLE demonstration apartments electricity consumption will be monitored for five devices per apartment. 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. An alternative solution to monitor electrical appliances it might be the use of devices, always connected to the KNX bus, that measure instantaneous electric power directly on the wire that power the socket. This solution is to be completely wired.

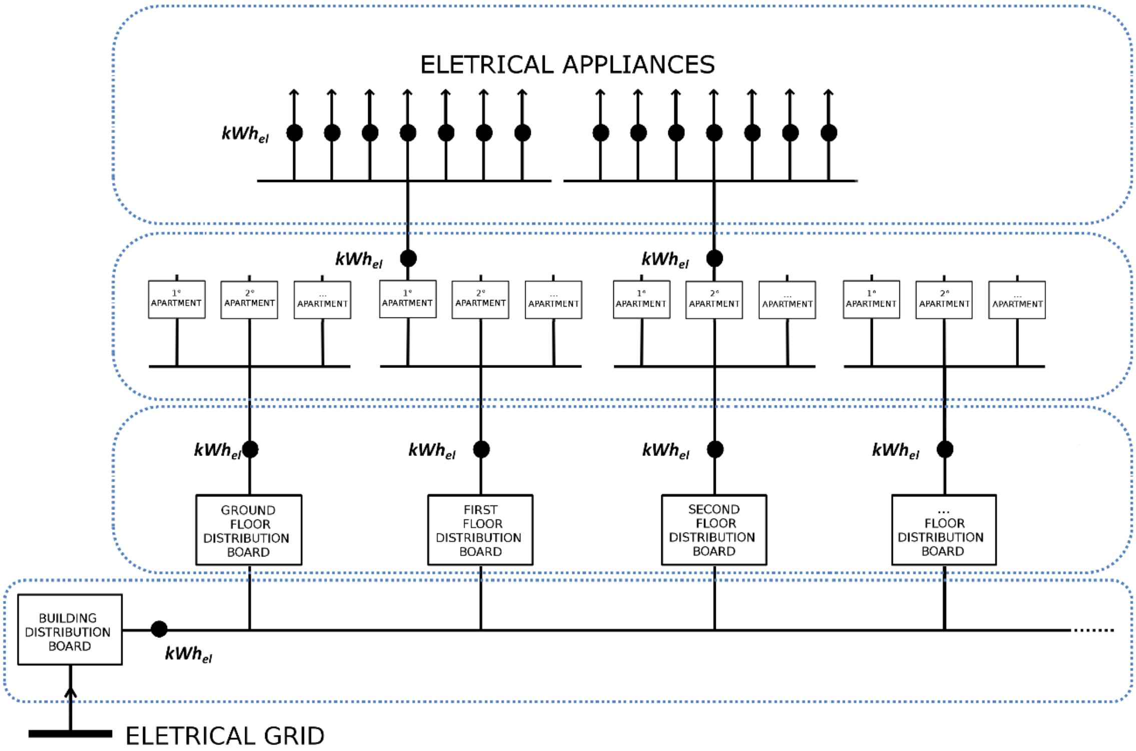


Figure 3: The hotel's simplified wiring diagram.

The Zennio **ZN1IO-KES+ ZN1AC-CST60** KES sensor type allows measurement of instant power (kW) and energy (kWh) inside the floor distribution board and aims to contribute to reducing energy consumption. It allows the measurement of instantaneous electric power and the energy consumed by up to three different monophase circuits or a single triphase circuit. The operating range is between 0.3 A to 60 A with 5 % max minimum accuracy. It allows real time data access via an API and data collection on a local server. It is supported by KNX bus connectivity. Additional technical information about this sensor type is available: http://zennio.com/products/knx-energy-saver/kes.

In some power sockets in the apartment **RF-AZK1ST.01** sensor type will be installed allowing measurements of instant power (kW) to assess consumption of individual devices. This sensor type has measuring frequency 2000 samples/500ms, the operating range is between 10 mA to 20 A with 2 % max minimum accuracy. It gives status response (active/passive) for each channel, allows real time data access via an API and data collection on a local server. It is supported by KNX RF based communication system, also using radio frequency. Additional technical information about this sensor type is available: http://www.mdt.de/EN_RF_Socket.html.

IEQ sensing devices

Schneider Electric KNX CO_2 (ppm), humidity (%) and temperature sensor (°C) AP **MTN6005-0001** will be installed to assess IEQ more accurate. Beside assessment of the thermal comfort (temperature, RH) this also allows assessing the indoor air quality (CO_2). The operating range is as follows:

- Temperature: -5 to +45 °C;
- RH: 20 to 100 % RH;
- CO_2 between 300 to 9999 ppm.

There are three independent thresholds of the readings for CO_2 and relative humidity as well as a threshold for the temperature reading. Exceeding or under-running the thresholds triggers a certain response. To enable connection with the MOBISTYLE database, interface (API) is available. When there is no connection with the database, it is possible local storage in sensor or gateway. The communication protocol is KNX via KNX bus. The current max consumption is 10mA (30V DC) and system is having a digital output. The product datasheet, user and installation guide is available on the manufacturer's website: https://www.schneider-electric.com/en/product/MTN6005-0001/knx-co2%2C-humidity-and-temperature-sensor-ap.

Health sensing devices

For the Italian case, it has not yet been decided which MOBISTYLE scenarios to incorporate that actions would lead to both, lower energy consumption and healthier lifestyle (e.g.: use stairs instead of elevator). The main issue is that that is impossible to find direct relation between a change in IEQ settings and health parameters. There are many different parameters and factors affecting individual's health state and his/her physiological parameters. Still, it is agreed to promote actions and activities that are healthier in comparison to other types of activities (e.g. standing instead of sitting all day). To allow monitoring effect of such activities, it is desired to measure user's activity level, heart rate and person's position (sedentary/standing).

Outdoor sensing devices

Outdoor conditions assessment (outdoor temperature, relative humidity and wind speed/direction) will be done by using the measurements provided by the nearest weather station or, in case of unavailability, data will be acquired through an online source.

2.3.3 Economic considerations – cost of devices

The number and type of devices was chosen based on the available equipment budget allocated as part of the MOBISTYLE budget. Table below presents the costs of measuring devices; however, it does not yet include the installation costs or possible network architecture (this reported in D4.1). The sensors were installed in February 2018.

Additional sensor	Cost per unit	NB of devices	Note
MTN6005-0001	265.96 €	5	1329.8 €
ZN1IO-KES+ ZN1AC-CST60	256.2 €	5	1281 €
RF-AZK1ST.01	181.78 €	15	3788.1 €
Total			8398.9 €

Additional information about the sensors for the Italian case is presented in Annex 3.

2.4 Data acquisition system for the Slovenian demonstration case

As described in D6.1 [5], the main MOBISTYLE demonstration in Slovenia is related to the monitoring of the faculty buildings at the University of Ljubljana (UL) where the specific objective for this demonstration case is improved indoor environment quality (IEQ) as result of modified behaviour. Energy saving will be achieved in parallel to improved IEQ. The demonstration will take place at the specific rooms of Faculty of Computer and Information Science (FRI) and Faculty of Chemistry and Chemical Technology (FKKT). The objective is to validate the MOBISTYLE behavioural change methodology, tools, and services applied in terms of increase in indoor environment quality and reduction in energy use through user feedback and data analysis.

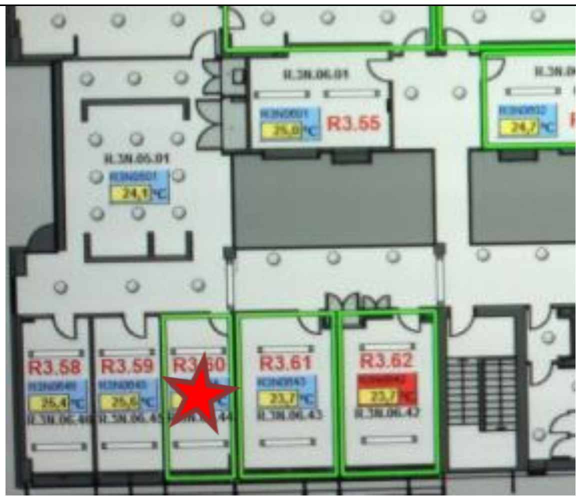
The demonstration will be done in rooms of fully automated building of FRI FKKT. Available data from SCADA will be used and new equipment will be installed. Focus will be on the rooms where user interaction with building systems is possible – offices. This will be rooms used by teaching staff, researchers, administrative and technical staff.

Eight chosen MOBISTYLE rooms will be monitored in detail (installation of additional IEQ sensors). The room distribution is done in a way to cower main building users groups. Typology of rooms is based on preliminary selection, 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. Regarding occupant behaviour and interacting with building systems, external shading position, occupancy from access, set point temperature, convector ventilator switch status, window switch and lights use for each circuit will be monitored based on signals from SCADA. In addition, IEQ sensory will be installed in these rooms (CO_2, RH, T).
There are 2 office types monitored (researchers 60 m^2 e.g. R2.38 and a cabinet for teaching staff 15 m^2 e.g. R3.60) as presented in the table below. Locations of sensors are clear from the images presented in Figure 4. Additional IEQ sensors were installed next to existing thermostats, as presented below in the Figure 4 for few examples.

Offices (researchers 60 m^2, a cabinet for teaching staff 15 m^2) Signals available from SCADA for each room: - 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]

Introduction picture of the SCADA control system.



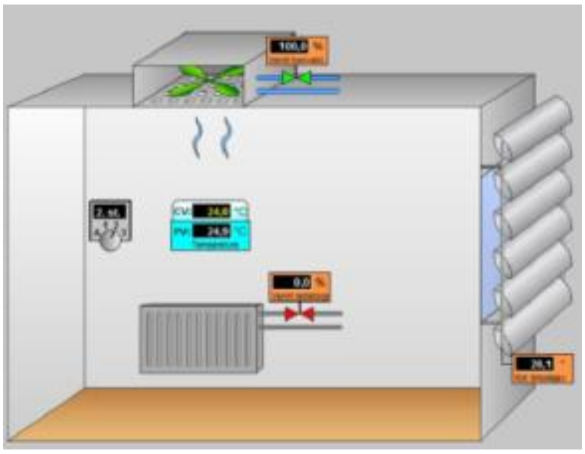


Figure 4: Exampled of SCADA signal available for MOBISTYLE project and the sensors location marked at the floor plans of relevant university spaces used in Slovenian MOBISTYLE demonstration.

2.4.1 Existing monitoring devices

As observable from Figure 5, the thermostats (Honeywell CentraLine) were already present in all the rooms. Other data regarding building systems is obtained from sensors and from the state of actuators via pre-existing SCADA and its subsystems e.g.:

- Window opening: widow magnet sends the signal to local Programmable logic controller (PLC) responsible for specific room. Control system architecture is distributed, meaning each PLC can operate autonomous. PLC communicates with main frame where GE based SCADA is installed.
- Access: there are electronic locks and NFC readers on each door. After the door is unlocked, the status is send from locks management system to SCADA (to change regimes).

Building level energy measurement devices (meters for electricity, heat, cooling and water) were in place, but data transfer, storage and processing was not available.

Figure 5: Existing thermostats (Honeywell CentraLine) already present in all the rooms for UL.

Energy related data acquisition

The energy consumption is measured on the building level where the consumption for the particular MOBISTYLE demonstration rooms will be calculated indirectly from measured parameters (e.g. saving due to changed behaviour). For shorter periods of time, electricity monitoring on a room level (sockets) will be done. Electricity for lighting will be calculated from use time.

IEQ related data acquisition

A lot of parameters are already monitored on the room level: operative temperature, setpoint temperature, cooling celling convector ventilator switch status, window opening, room access, thermostat adjustments. Existing measurements will be complemented with additional measurements in room to quantify IEQ.

Outdoor sensing devices

Solar radiation, outdoor temperature, humidity, wind speed and illumination are recorded on site by weather station.

Existing system description

Both buildings have existing standard Supervisory control and data acquisition (SCADA) system for building management. SW provider of SCADA solution is General Electrics with product iFix. PLC are of several producers, depending on the utility (Siemens Simatic, Robotina etc.). Room automation is based on Honeywell Lynx PLCs (for local heating/cooling and shading) and lighting on Robotina Cybro PLCs.

Figure 6: Image of room automation PLC.

For communications between sensors an PLC several communication means are used. PLC communicate with control system via Bacnet or CanBus communication network. As part of the systems (not necessary for the rooms monitored in detail in the frame of MOBISTYLE) temperature, air quality and pressure sensors from Honeywell and S+S are installed.

For obtaining, analysing and presenting energy related data, Energy information system (EIS) will be implemented in the demo buildings collecting data from installed meters and monthly data from bills. All energy related measurements will be saved here and available for verifications. In order to obtain information from existing SCADA system (e.g. opened windows, access, thermostat interactions etc.) the tags of the parameters of interest were identified. The system integrator will have to reconfigure the SCADA and its process database so these tags/measurements are saved. Due to safety concerns connected with external parties accessing SCADA database and time limitations of parameters saved in this database (200 days), this data will have to be transferred to another database. There it will be stored for longer period, and available to MOBISTYLE applications. This will be mostly the date defining users interaction with the building.

Information regarding energy use will be obtained from SCADA control system using EIS installed in FRI and FKKT. Several rooms at FRI will be measured in detail and for longer time. The data from SCADA will be sent to the MOBISTYLE database. The technical limitation is available tags (measurements, set points etc.) and time they are preserved on the SCADA process database (GE Historian).

IEQ and electricity sensors to be installed (INAP ACS) in the selected rooms will be separated from the SCADA, also communications wise. They will utilize wireless communication in the building. In the worst case a separated Wi-Fi router will have to be installed in order to harness these data. The security issues will have to be solved, due to the need to transfer data to the cloud of system provider or above mentioned another database.

2.4.2 Additional monitoring devices

The greatest challenge was how to obtain all the relevant data for individual rooms from highly secured central control system (that is not open to the outside, and behind firewalls). The data flow is streamed to the DEMO servers and must be secured. There are top IT experts (and keen students) on site highly motivated to brake in the systems just to show they can. Also, to exclude possible security breached that could result is equipment failures, safety was the number one concern when planning and executing data flow from the SCADA system. Consulted were top IT experts from Faculty of Computer and Information Science, company responsible for firewalls and SCADA provider (company Metronik). The final solution takes data from the SCADA process database and transferred it to a database on a separated computer (all is virtualized on local servers) still behind firewalls. Here files (.csv) of pre-agree format are generated periodically. Special service was built to transfer files by one-way communication via exemption on firewall to a SFTP server. Here data is extracted by DEMO periodically.

Energy consumption sensing devices

For campaign monitoring of room sockets electricity consumptions current clamps (OWL Energiemonitor) will be used that wirelessly communicate to a local RPI based hub and have connectivity to a cloud.

IEQ sensing devices

The following parameters will be monitored: CO_2, T, RH are obtained by INAP ACS sensor. Sensors wirelessly communicate to a local invisible wi-fi network. Additional exemption in the firewall were necessary to allow locally installed hub to be able to send the data to a company's cloud (acs.inap.si). from there DEMO gets the data via and API.
The operating range is as follows:

- CO_2: (eCO2) 400ppm - 5000ppm,
- VOC: Total Volatile Organic Compound (TVOC) 0ppb - 1200ppb
- Temperature: ±0.3°C,
- Relative humidity: ±2%RH.

Health sensing devices

For the Slovenian case, it has not yet been decided which MOBISTYLE scenarios to incorporate that actions would lead to both, lower energy consumption and healthier lifestyle (e.g.: use stairs instead of elevator). The main issue is that that is impossible to find direct relation between a change in IEQ settings and health parameters. There are many different parameters and factors affecting individual's health state and his/her physiological parameters. Still, it is agreed to promote actions and activities that are healthier in comparison to other types of activities (e.g. standing instead of sitting all day). To allow monitoring effect of such activities, it is desired to measure user's activity level, heart rate and person's position (sedentary/standing).

Outdoor sensing devices

Outdoor conditions assessment (outdoor temperature, relative humidity and wind speed/direction) will be done by using the measurements from onsite SCADA integrated weather station.

2.4.3 Economic considerations – cost of devices

The main portion of cost is associated with obtaining data from SCADA, data preparation and measurements integration.

Table 9: Costs (including device costs) connected with the Slovenian demonstration case.

Equipment purchased	Costs €
Energy information system for obtaining and processing energy data	5.600,00
Apl. software for data transfer and analysis from existing systems (SCADA) and sensors	6.650,00
Computer and software for project and data analysis	2.201,04
Development of application for .csv files generation from the process DB	815,40
Additional Computer equipment	498,00
Energiemonitor Smart Meter 3 Phase Pack + integration	300,00
INAP ACS sensor – CO_2, VOC, Temp, Humidity (8x)	960,00
Development and configuration of SW tolls for IEQ and energy data acquisition	2900,00
Total:	19.924,44

Additional information about the sensors for the Slovenian case is presented in Annex 4.

2.5 Data acquisition system for the Dutch demonstration case

As described in D6.1 [5], the Dutch demonstration case is an initiative in which education, collages, 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). The MOBISTYLE demonstration will cover one floor of this office building. The MOBISTYLE objective of the Dutch demonstration case is to improve health and well-being and reducing energy use by realizing an optimal dynamic indoor climate in offices through a dynamic indoor temperature over the day that ensures healthy and productive office environment and thus also achieves energy savings compared to a traditional air-conditioned office by simulations.

For the office spaces in the Dutch demonstration case 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. 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.

2.5.1 Existing monitoring devices

Figure 7: Floor plan of the office space with marked work places.

The demonstration will be carried out in an open-plan office space, having floor plan shown on Figure 7. 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. Before the MOBISTYLE monitoring no sensors where installed in the office and no data was collected.

2.5.2 Additional monitoring devices

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 how

different indoor environment situations effect people's health will further increase understanding and users acceptance of the imposed indoor environment conditions. The objective is to observe people's psychological response over time to the temperature deviations. With sufficient time period there is estimated 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 beside 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).

The MOBISTYLE game and dashboard won't be used for this demonstration case at first demonstration phase because of the different objectives of the demonstration project. First, the aim is to prove that dynamic conditions induced in surrounding environment result in people's body responses (physiological response) that can be evaluated as 'healthy'. If this will be proved, further demonstration phase can be used to also increase their psychological acceptance by giving them information provision. Hence, for the first phase, the sensors won't be connected to the MOBISTYLE database due to health-related data collection (data protection and user privacy issues related to GDPR). Instead, the sensors will collect their data locally on the devices where after the data will be retrieved and saved on a local hard drive. No data will be shared over internet (e-mail or cloud services) with other parties. Relevant data for analysis will be received on a USB stick encrypted with a password.

Wearables – per test subject

The following table provides characteristics of wearables that will be used for the Dutch demonstration.

Table 10: Characteristics of the wearables that subjects will wear at the Qeske building as part of the MOBISTYLE demonstration.

Sensor type			Sensor characteristics			Sensor connectivity					
Sensor	***Parameter***	***Unit***	***Resolution***	***Accuracy***	***Time Steps***	***Data collection method***	***Data access method***	***Data storage device***	***Data storage MOBISTYLE***	***Sensor Connectivity***	***Battery***
Fitbit Charge 2	Heart rate	bpm			1min	Connection to Fitbit server through app	Real-time access through API	+/- 5 days of data - FIFO	Connection to HIA database	Fitbit app	2 days life span, charging during the night
	Physical activity				1min						
iButton	Skin temperature	°C	0.1°C	±5 %	5min	Local storage	Export to csv files	+/- 5 weeks of data	Saved locally on HIA computer for data analysis on that pc	-	2 years life span
	Micro climate										

IEQ

The Table 11 presents which IEQ sensors will be measured where correlation will be investigated between the physiological parameters of the subjects measured by the wearables (Table 10) and the indoor environment conditions.

Table 11: The IEQ parameters that will be measured for Qeske building to assess the correlation between physiological conditions of building occupants and indoor environment conditions at Qeske.

Sensor type			Sensor characteristics			Sensor connectivity				
Sensor	***Parameter***	***Unit***	***Resolution***	***Accuracy***	***Time Steps***	***Data collection method***	***Data access method***	***Data storage device***	***Data storage MOBISTYLE***	***Battery***
Atal	Exhaust temperature fancoil units	°C	0.1°C	±5 %	15min	Local storage	Export to csv files	+/- 5 weeks of data	Saved locally on HIA computer for data analysis on that pc	2 years life span
	Operative temperature									
	Relative humidity	%								
GRV HCHO SENS	Air velocity	m/s	0,01 m/s	±5 %	15min					
	CO2	ppm		±5 %	15min					

2.5.1 Economic considerations – cost of devices

The number and type of devices was chosen based on the available equipment budget allocated as part of the MOBISTYLE budget. Table 12 presents the costs of measuring devices, however, it does not yet include the installation costs or possible network architecture.

Table 102: Costs of additional sensing devices to be used in the MOBISTYLE demonstration.

Additional sensor	*Cost per unit*	*NB of devices*	*Note*
Fitbit Charge 2	€139	8	€1112
Total			€1112

Additional information about the sensors for the Dutch case is presented in Annex 5.

3 Conclusion

This deliverable presents an inventory of the existing and additional devices that are installed in the five pilot cases for the purposes of MOBISTYLE demonstration.

Economic considerations presented at this report are representing only the initial purchase of the devices as for most of the demonstration sites. The complete installation of the additional sensor and establishment of the whole MOBISTYLE system will be included in the last cost-effectiveness analysis presented in D5.5. The investigation done so far showed that installation work in Denmark will be in average 3-4 times more expensive than compared to the installation work (the same amount of work) for the same type and amount of sensors installed in Poland.

Also, as discovered during this task elaboration, the main issue does not lie within the sensors layers but, in the connections, and interoperability between different sensors (computation and application layer). This is further explained in deliverables D4.1 and D4.2. When expanding an existing system installed in a building, as in case of MOBISTYLE, the interoperability between different systems is of high importance. Currently, there are available several standard protocols, hence, the main problem is when combing different sensors from different manufacturers into a single framework (as described in D2.1 [3] and D4.2 [4]).

The demonstration of MOBISTYLE concept is applied for 5 demonstration locations presenting a range of different locations in Europe, different building types and diverse sizes and use patterns. As discovered during the MOBISTYLE demonstration site preparation work, price of sensors was not the main issue. The main bottleneck is related to connections between the different devises, network architecture, protocols and softwares. The end goal is to interconnect different types of measuring devices into one sensoring network by allowing real time data gathering at the MOBISTYLE database and processing it via MOBISTYLE Open Users Platform. The disclosure of information to end-users will be via the MOBISTYLE game and the dashboard.

References

[1] Podjed, D.; Vetršek, J. MOBISTYLE D2.2 – Inventory of user needs and expectations. March 2017. MOBISTYLE Project H2020 Programme. Grant Agreement no: 723032.

[2] Podjed, D.; Vetršek, J. MOBISTYLE D2.3 – Recommendations for improvement and further development of solutions. June 2017. MOBISTYLE Project H2020 Programme. Grant Agreement no: 723032.

[3] Tisov, A. MOBISTYLE D2.1 – Inventory supplied data. March 2017. MOBISTYLE Project H2020 Programme. Grant Agreement no: 723032.

[4] Olivadese, R. MOBISTYLE D4.2 – Applicable platform and database for software and information interoperability. September 2017. MOBISTYLE Project H2020 Programme. Grant Agreement no: 723032.

[5] Heiselberg, P., Skovgaard Møller, R. MOBISTYLE D6.1 – Detailed final monitoring, awareness and information campaigns for the five cases. October 2017. MOBISTYLE Project H2020 Programme. Grant Agreement no: 723032.

[6] Arabsolgar, D. MOBISTYLE D5.1 – MOBISTYLE Things Connector. September 2017. MOBISTYLE Project H2020 Programme. Grant Agreement no: 723032.