TEMPLATE

Investment report

Version 1

I4 - Investment in an energy monitoring system including an advanced regulation system for pilot actions in 7 public buildings in Maribor (PA3)

Project index number and acronym	CE51 Together
Responsible partner (PP name and number)	University of Maribor, PP3
Linked to pilot action (number and title)	D.T3.3.4 – Report on PA3 realised by UM in 7 educational and dormitory buildings located in Maribor/Krško- SI
Project website	http://www.interreg-central.eu/Content.Node/TOGETHER.html
Delivery date	18.01.2018

Description of the investment (including technical characteristics) explaining its embedding into the linked pilot action

University of Maribor (UM) has implemented Smart Metering Systems (SMS) into 4 pilot buildings. The implemented SMS allows user to control and monitor energy performance of the building. It allows to archive and analyse data and alarm in case of failure or irrational use of energy. Four of pilot buildings are fully equipped with systems for measuring/monitoring all indicators determining their energy consumption. Each of the building has their own system and it is not combined with others, this assures that system works independent, without potential external interferences. The SMS consists of: regulation equipment, smart meters, electric cabinets and fine material.

The investment allows to measure and display in real time and stores all required parameter on local server, which is used for analyzation of captured information. In buildings, following parameters are acquired:

- fuel consumption,
- heat consumption,
- consumption of energy for domestic hot water preparation,
- consumption of water and
- indoor comfort (temperature, humidity and illumination).

For measuring fuel consumption there are used fuel meters, which counts natural gas according to the consumption. These meters were upgraded with Modbus module, which assures communication with Programmable logic controller (PLC). Heat consumption is measured with heat meters, in most cases are used meters of the manufacturer Enercon CF-ECHO II. They have already built-in proper communication ports. Water is monitored via existing water meters, which have been upgraded with incremental encoder, for data transfer. All acquired data is transferred via Modbus protocol to common PLC, which is responsible for data processing. For indoor comfort measurement is used solution of company Wireless Sensor Tags. Wireless Sensor Tags and Kumo Sensors monitor and record motion events, temperature, humidity and illuminance located in reference premises. Data is transferred via wireless signal to data concentrator, which is connected to internet. This allows to connect the system in SMS.

Investment location		
NUTS 3	**Address (Street, house number, postal code, city, country)**	**GPS coordinates**
SI032 Drava Statistical Region (Podravska statistična regija)	Student Dormitory Number 1, Tyrševa ulica 23, SI-2000 Maribor Slovenia	Y: 549909, X: 157948
SI032 Drava Statistical Region (Podravska statistična regija)	Student Dormitory Number 2, Pri parku 7, SI-2000 Maribor Slovenia	Y: 549980, X: 157948
SI032 Drava Statistical Region (Podravska statistična regija)	Student Dormitory Number 3, Tyrševa ulica 30, SI-2000 Maribor Slovenia	Y: 549948, X: 157953
SI036 Lower Sava Statistical Region (Spodnjeposavska statistična regija)	Faculty of Energy Technology, Hočevarjev trg 1, SI-8270 Krško, Slovenia	Y = 537877, X = 91638

Duration and process of investment implementation

Start date	End date
14.09.2017	30.09.2017

Major milestones of investment implementation

In the 1st period UM has prepared technical/project documentation about SMS on the basis of already built-in and equipment that is necessary to implement according to the SMS description. Right in the start of the 2nd period, our legal office prepared agreements for SMS installation in pilot buildings that were signed by all involved parties. In meanwhile, our legal office prepared a procurement documentation according to the national regulations and pre-prepared technical/project documentation. Public procurement was open for 2 weeks, between 14. 7. 2017 and 25. 7. 2017. Petrol d.d. company was only bidder, therefore UM signed contract with them.
Whole investment implementation process was on the company Petrol, because of the signed turn-key contract. In the first phase, that were held in the first week after contract was signed, hardware installation works were completed. The second phase was to establish a communication between the installed parts of SMS for each pilot building, and to connect it with suppliers' server for establishment of the cloud service for the remote access. The third and the most important phase was development of software for requested needs. All works were completed in time, except after a while some minor mistakes were shown, and further corrections were needed.

Investment costs (Total costs and ERDF in EUR) including a break-down of main cost items

The contract of the company being responsible for the smart meter installation included two main tasks:

1) Mechanical, electrical and communication equipment – 27.677,08 € with VAT (ERDF: 23.525,52 €)
2) Services and education (delivery of the material, elaboration of the program, establishment of the system, implementation of energy monitoring, commissioning, education of the client) - 22.209,66 € with VAT (ERDF: 18.878,21 €)

Total contracted amount: 49.886,74 € with VAT (ERDF: 42.403,73 €)

Ownership and durability of the investment (e.g. maintenance, financing)

For purposes of ownership, durability and maintenance of the investment, UM prepared agreements for SMS in pilots that were signed by all involved parties. The involved parties are Faculty of Energy Technology UM as project partner, Student Dormitories UM as the owner of 3 out of 4 pilot buildings and Petrol d.d. company as universities' energy manager. In 2009, UM and Petrol d.d. have signed contract for energy management for all buildings under the university, thus Petrol was necessary to include in the agreement. UM and Petrol agreed that the owner of the investment is Faculty of Energy Technology UM, and the Petrol is in charge of maintenance of the implemented thematic equipment. The duration of the agreement is at least 5 years after the last ERDF payment on the UM's bank account. After that, the ownership of SMS implemented in 3 student dormitories will be transferred on Student Dormitories UM. In meanwhile, all maintenance works has to be done according to the contract signed in 2009.

Transnational effect and added value of the investment to the partnership

The installation and application of the SMS primarily contribute to the pilot implementation and serve the local energy efficiency goals of the involved buildings. However, the partnership has different dissemination tools through which the results and the lesson leant about SMS are and will be disseminated also on transnational level. Such tools are for instance the newsletters, the library on the project website, Integrated Tools, several international conferences, where participants get familiar with the usage of such systems. In addition, the partnership plans to publish an article in a specialized magazine explaining the different technical approaches of the partners related to smart metering and the lessons learnt from the application of the different metering systems. Yet, the pilot reports will summarize the main experiences gained from the implementation of the investment which will be also disseminated as project results on transnational level motivating municipalities of other countries to invest in the installation of such system in their public buildings.
Regarding the added value of the investment to the partnership, UM plan to organize on spot visits during the 4th partner meeting in Maribor.

Expected impact and benefits of the investment for the concerened territory and target groups and leverage of additional funds (if applicable)

The impact of the investment on the target group is thanks to the fact that the building users and managers receive a direct and “real time” feedback about their energy consumption through the dashboards (energy info points) on which the data measured by the SMS are presented. However, UM did not invested just in monitors but also the system (Wireless Sensor Tags) for measurement of indoor climate were implemented. An application for mobile devices can be used to follow the indoor changes, which gives the users the direct feedback what is going on in their premises. This way significant change – towards energy efficiency - in the behavior of the building users are foreseen in the pilot buildings. However, the way of achieving this change will be different depending on the type of the target groups. It cannot be expected that different targets groups will have the same comprehension, thus different approaches have to be pointed out. The software consists of two parts, for experienced users in energy efficiency, energy manager is the best example, because of its complicated structure and more advanced user interface. While energy monitoring is a solution for users with average knowledge about energy efficiency, with main aim to visualize required data in a user-friendly way. However, the daily users can be attracted with LCD monitors, which displays information about annual, monthly, daily and current consumption of all energy consumption and energy savings and this way allows a direct connection with the users of the building.

If applicable, compliance with relevant regulatory requirements (e.g. environmental, building regulations, authorisations)

Environmental, construction permits were not necessary, therefore this section is not relevant.

Contribution to sustainable development - potential effects of the investment on the environment and climate. In case of negative effects, mitigation measures conducted

The investment has a significantly positive effect on the environment and climate through the behavioral change expected to occur at the building users facing them with their own energy consumption data. In addition, this gives an opportunity to buildings owners to monitor daily consumption, which can lead to implementation of more advanced energy efficient measures. Practice shows that the introduction and proactive use of SMS can result in up to 15% of savings. Even more, if we combine such system with proper involvement of building users (Behavioral Demand Side Management), additional 5% can be achieved. This can result in reduction of energy demand, consequently reduction of emissions and CO_2 impact. In other words, it can be said that implementation of SMS can be the main figure in setting up a sustainable development of public buildings in case of project Together.
No negative effects are foreseen due to the investment.

Consideration of other horizontal principles such as equal opportunities and non-descrimination (e.g. barrier-free accessibility)

SMS is implemented in all 4 pilot buildings in a way that gives equal opportunities to all involved men, women, also the communication and information are disseminated in equal way, and they are all involved to the related pilot actions without any discriminations.

References to relevant deliverables (e.g. pilot action report, studies) and web-links If applicable, additional documentation, pictures or images to be provided as annex

References to relevant deliverables :

- D.T3.1.1 – Preparatory analysis of the technical and management requirements for installing smart meters
- D.T3.2.3 – PA3 design for 7 buidings - educ.&dormitories buildings in Maribor/Krško SI. Report +EN summary
- D.T3.3.4 – Report on PA3 realised by UM in 7 educational and dormitory buildings located in Maribor/Krško- SI

The investment is described in the following documents:

- Description of smart meters/investment
- Photo documentation

SMART METERING SYSTEM IMPLEMENTED IN 4 PILOT BUILDINGS

PP3 – UNIVERSITY OF MARIBOR

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1. DESCRIPTION OF IMPLEMENTED SMART METERING SYSTEM/INVESTMENT

1.1. THE HARDWARE DESCRIPTION

The implemented smart metering system (SMS) allow user to control and monitor energy performance of the building. It allows to archive and analyse data and alarm in case of failure or irrational use of energy. Four of pilot buildings are fully equipped with systems for measuring/monitoring all indicators determining their energy consumption. Each of the building has their own system and it is not combined with others, this assures that system works independent, without potential external interferences. The SMS consists of: regulation equipment, smart meters, electric cabinets and fine material.
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For measuring fuel consumption there are used fuel meters, which counts natural gas according to the consumption. These meters were upgraded with Modbus module, which assures communication with Programmable logic controller (PLC). Heat consumption is measured with heat meters, in most cases are used meters of the manufacturer Enercon CF-ECHO II. They have already built-in proper communication ports. Water is monitored via existing water meters, which have been upgraded with incremental encoder, for data transfer. All acquired data is transferred via Modbus protocol to common PLC, which is responsible for data processing. For indoor comfort measurement is used solution of company Wireless Sensor Tags. Wireless Sensor Tags and Kumo Sensors monitor and record motion events, temperature, humidity and illuminance located in reference premises. Data is transfered via wireless signal to data concentrator, which is connected to internet. This allows to connect the system in SMS.

1.2. THE SOFTWARE DESCRIPTION

The SMS is accessible via web interface and implemented as a service in the cloud. It enables remote monitoring, parameterization and system management. The advanced regulation system with remote access acquires the data and increases in parallel the energy efficiency. This advanced technology is linked to the high level of interaction between “human” and “technological” components registered in the pilot buildings and a central monitoring system is necessary in this situation. Software is devided into two parts:

- Energy monitoring
- SCADA

Energy monitoring is web based platform that allows monitoring based on:

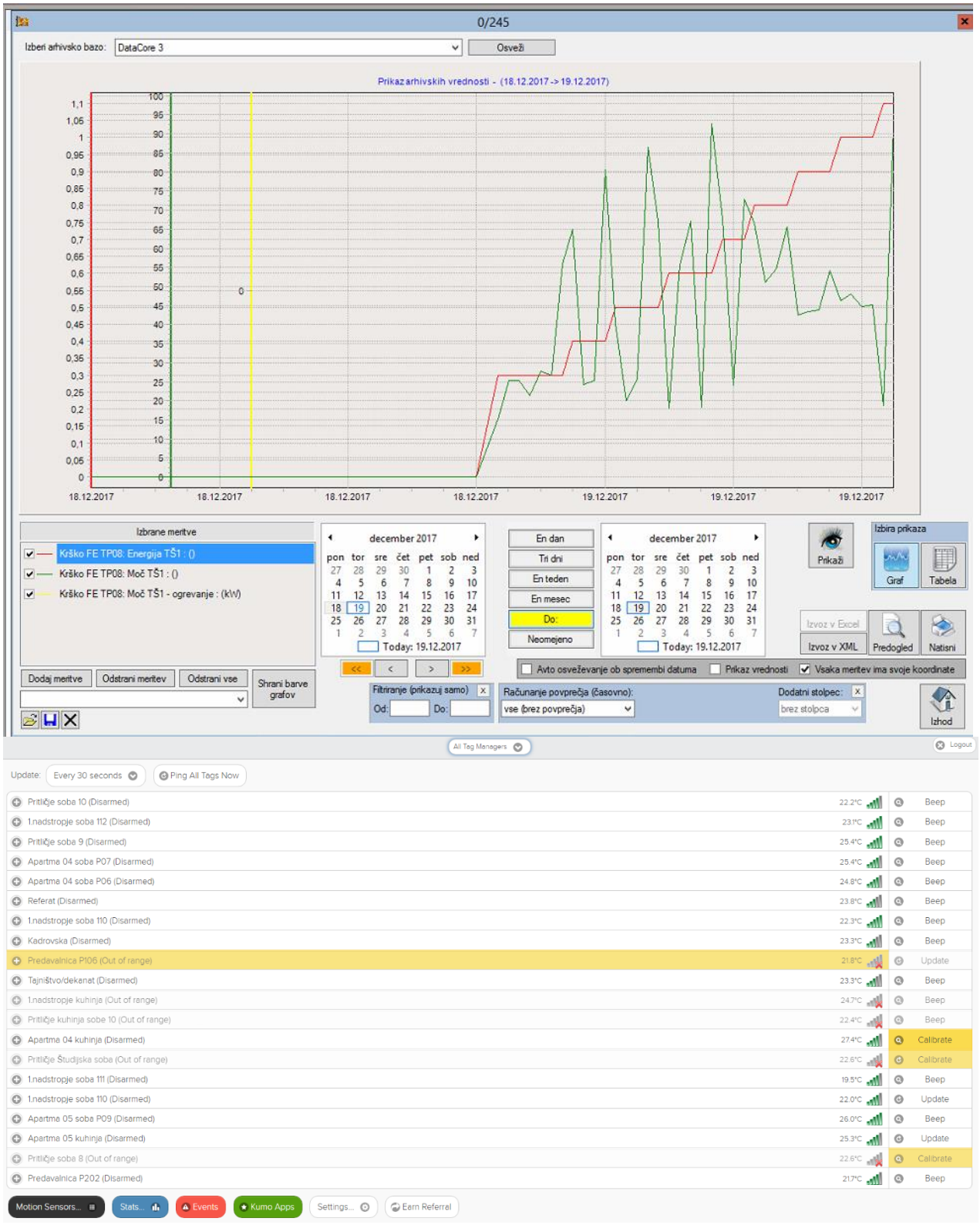
1. transfer of data from the central database of the SCADA system to the Energy Monitoring System (aquired data from PLC based on Real time sampling),
2. Manually inserted data from bills on monthly basis.

The main part of SMS software is SCADA (Supervisory control and data acquisition). Its key advantages are:

- Data archiving: the system periodically archives the chosen operating parameters of the system. The saved can be displayed allowing to review any period of operation of any systems. Also the archives could provide an excellent basis for a system analysis to identify possible areas, where savings can be achieved.
- On-line implementation: the system allows on-line implementation for all controlled consumption points and production sources from one control centre.
- Automatic remote monitoring: for remote reading of parameters monthly visits at consumption points are no longer necessary, since the system can provide measured data for any selected date and time.
- Alarming: The potential errors and problems in the system are highlighted, which is allowing an immediate response from the competent person.

Therefore, SCADA presents the software/program for controlling and monitoring data/consumption for users with experiences in energy efficiency, energy manager is the best example, because of its complicated structure and more advanced user interface. While energy monitoring is a solution for users with average knowledge about energy efficiency, with main aim to visualize required data in a user-friendly way. Thus, the usage of this software is not complicated and access can be assigned to many persons with limited access.
System allows management and control of the operation of the system devices according to the occupancy of the facility, use schedule. The program allow an hourly selection of full-function for each day of the week separately, as well as a schedule for operation in a reduced mode.

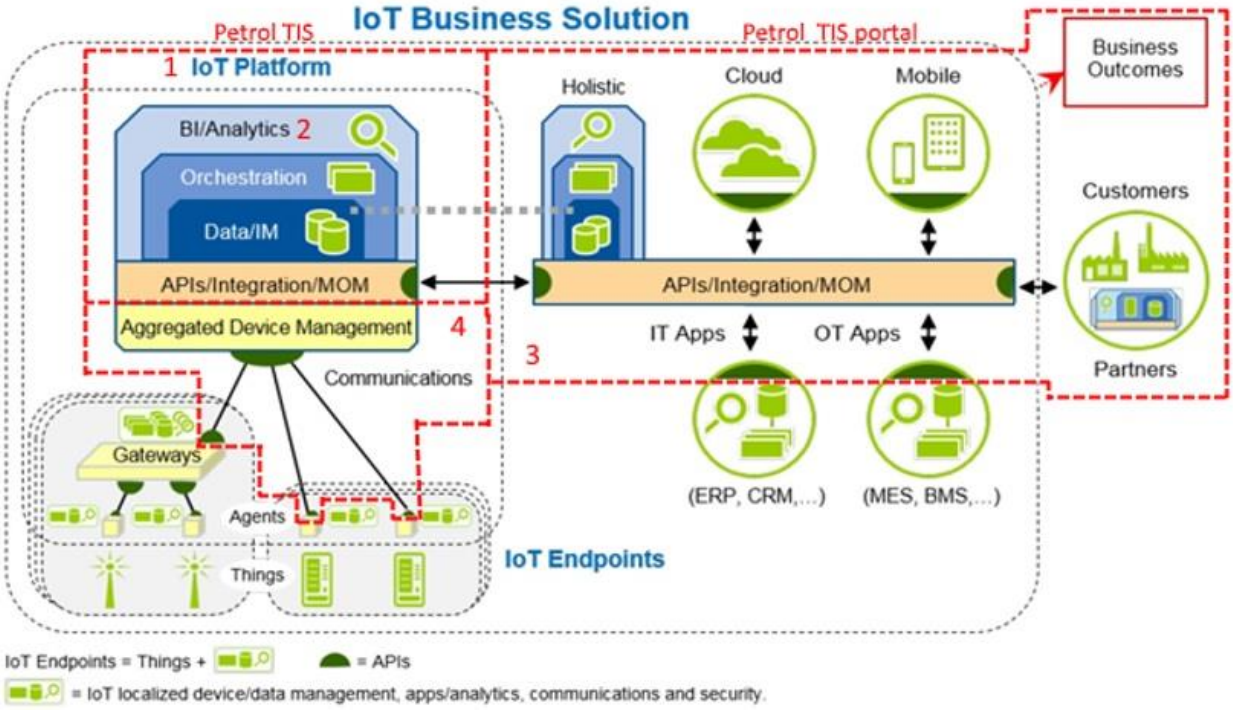
The program for energy monitoring enables the setting of M & T diagrams, CuSum diagrams, alarming, and specific energy use from any interval; on hourly, daily, weekly, monthly and yearly interval. Data can be aggregated / processed using KPIs (Key Performance Indicator) and visualized according to user requirements.



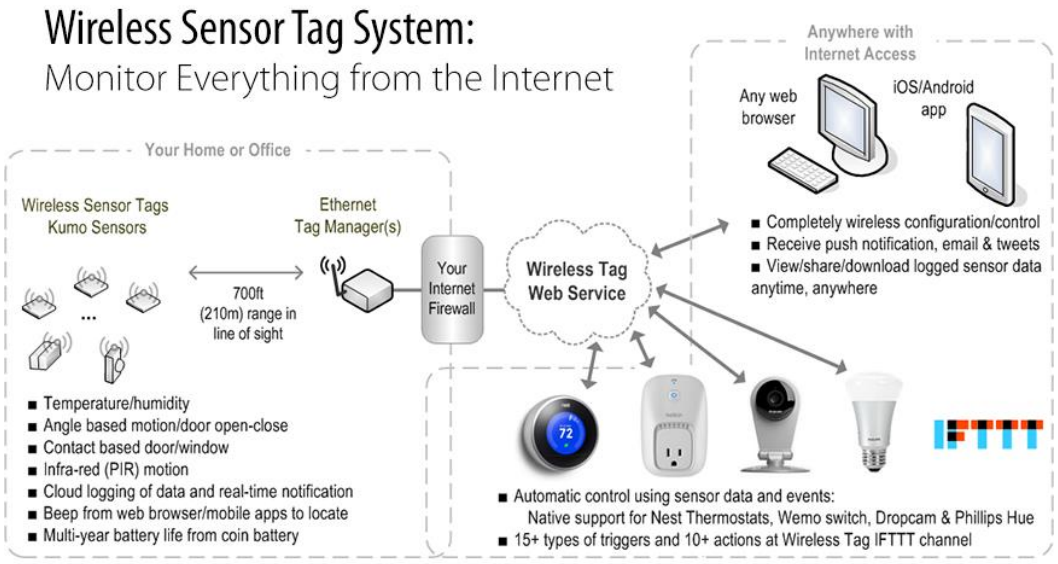
Picture 1: Print screens taken of the software

1.3. TYPOLOGY OF THE SMART METERING SYSTEM

SCADA diagram is presented on picture below. The data from PLCs are visualised as IoT endpoints and present the first step of data processing. Then the data is transmitted through filter in IoT platform, which allows storage and controlling the IoT endpoints. This is the brain of the system. Energy monitoring presents the portal on the right side, which is specially developed for user friendly operation and visualization of analysed data.



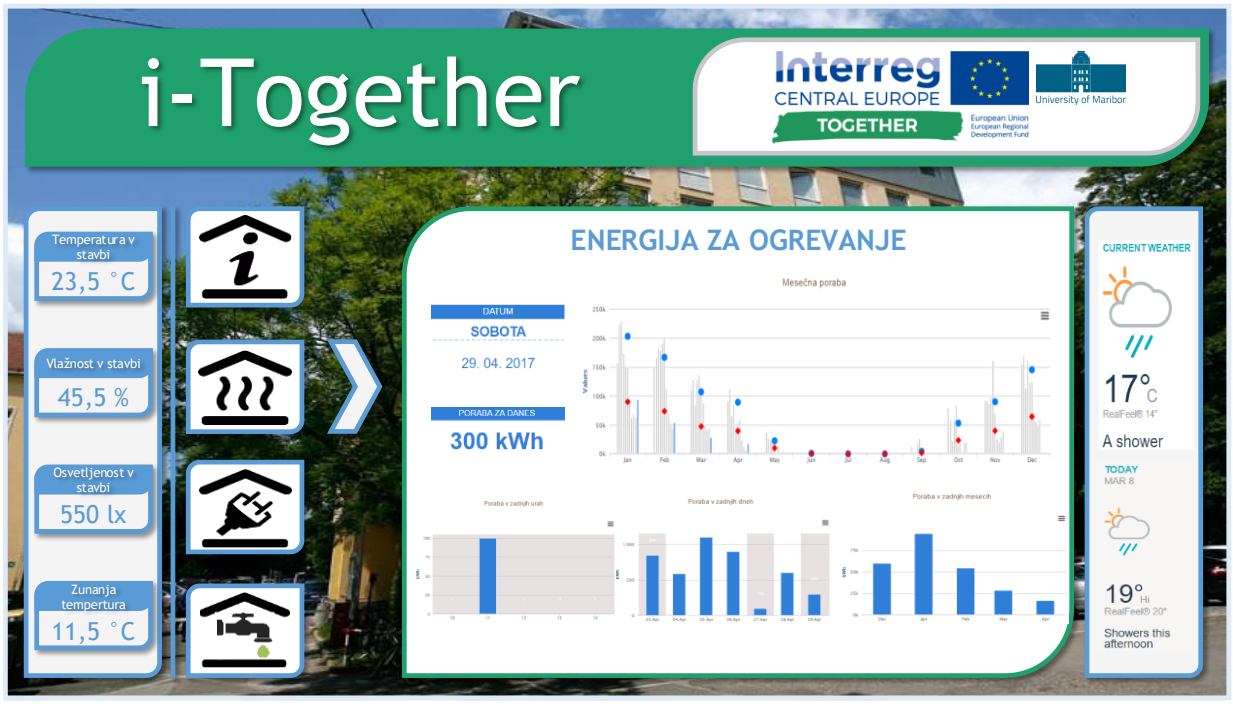
Picture 2: Typology of SMS



Picture 3: The topology of the system for indoor comfort measurement

1.4. THE ENERGY INFO POINT

The energy info point is a part of each implemented SMS in pilot building. It is a simple monitor (LCD), which displays information about annual, monthly, daily and current consumption of all energy consumption and energy savings and this way allows a direct connection with the users of the building. In all cases, LCDs are placed in a building where most of the people can see it, thus this way the maximum impact can be achieved.



Picture 4: Graphical visualisation of energy info point.

2. FACULTY OF ENERGY TECHNOLOGY

2.1. HEAT METERING

Picture 5: Integrated incremental encoder for measuring energy consumption / natural gas consumption.

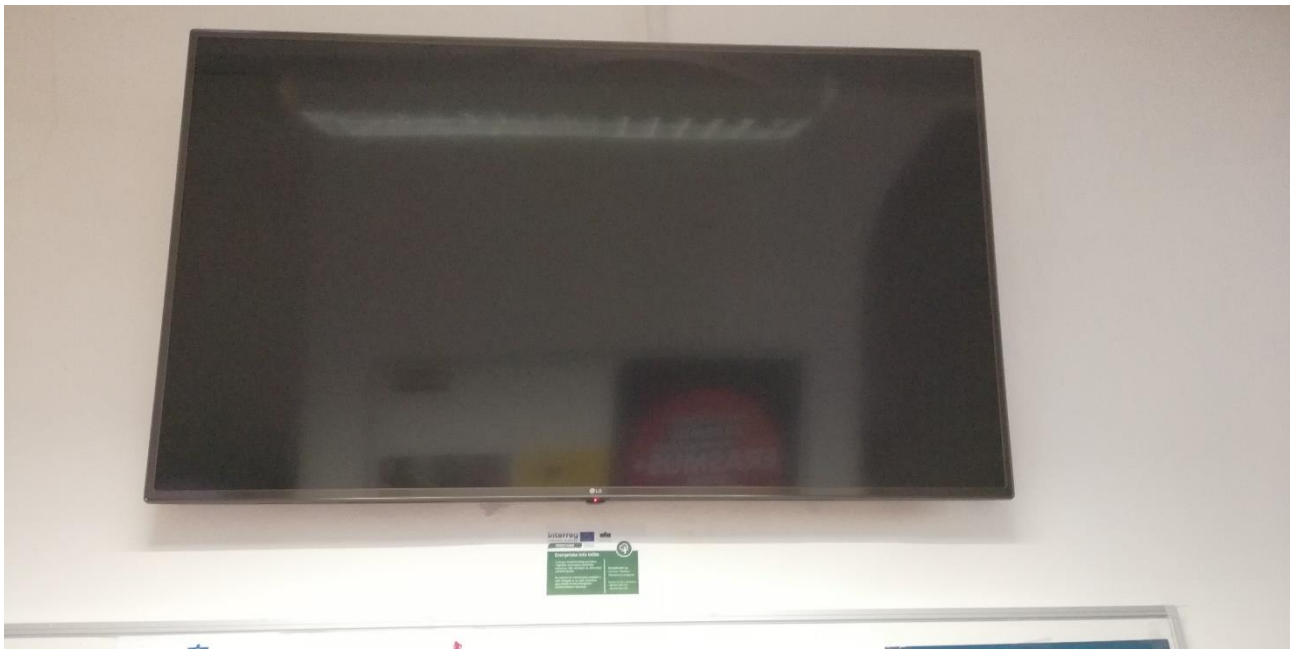
Picture 6: Built-in heat meter for measuring the consumption of heat produced.

Picture 7: An updated cabinet for controlling the operation of the entire boiler room (on the left) and an updated Viessman gas boiler with an expansion module (on the right).

2.2. ELECTRICITY METERING

Picture 8: An updated electric cabinet on the ground floor with a smart power analyzer.

2.3. ENERGY INFO POINT



Picture 9: Energy info point - LCD monitor for informing users about energy efficiency.

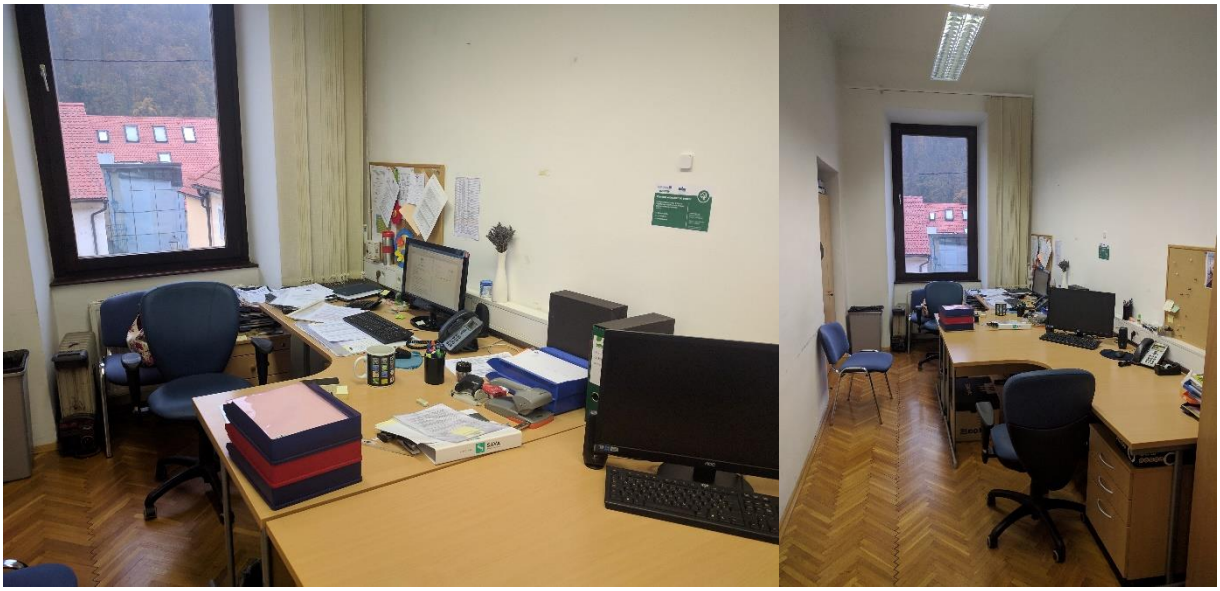
2.4. INDOOR CLIMATE METERING

Implemented sensor systems in the reference premises:

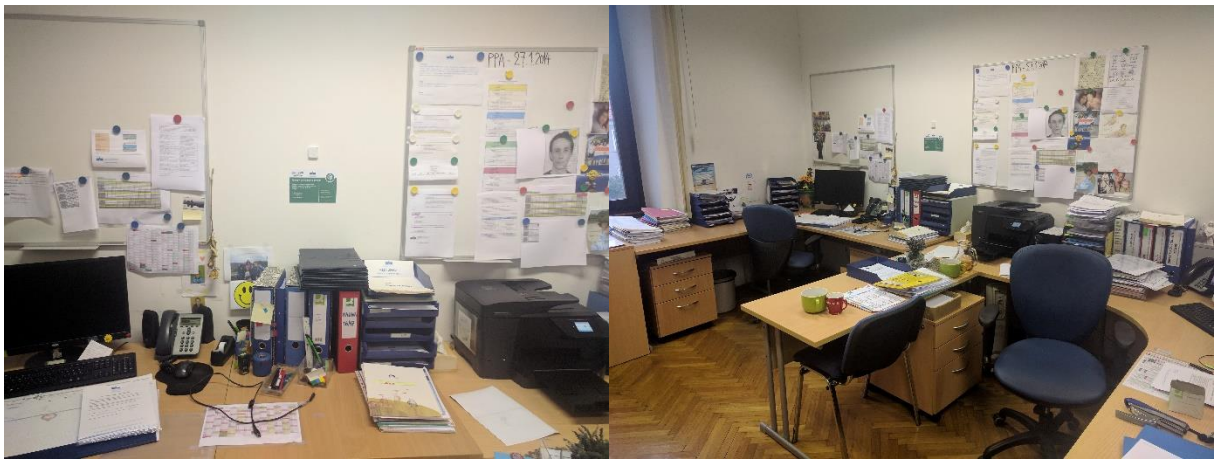
Picture 10: Lecture room P106.

Picture 11: Lecture room P202.

Picture 12: Secretariat room.



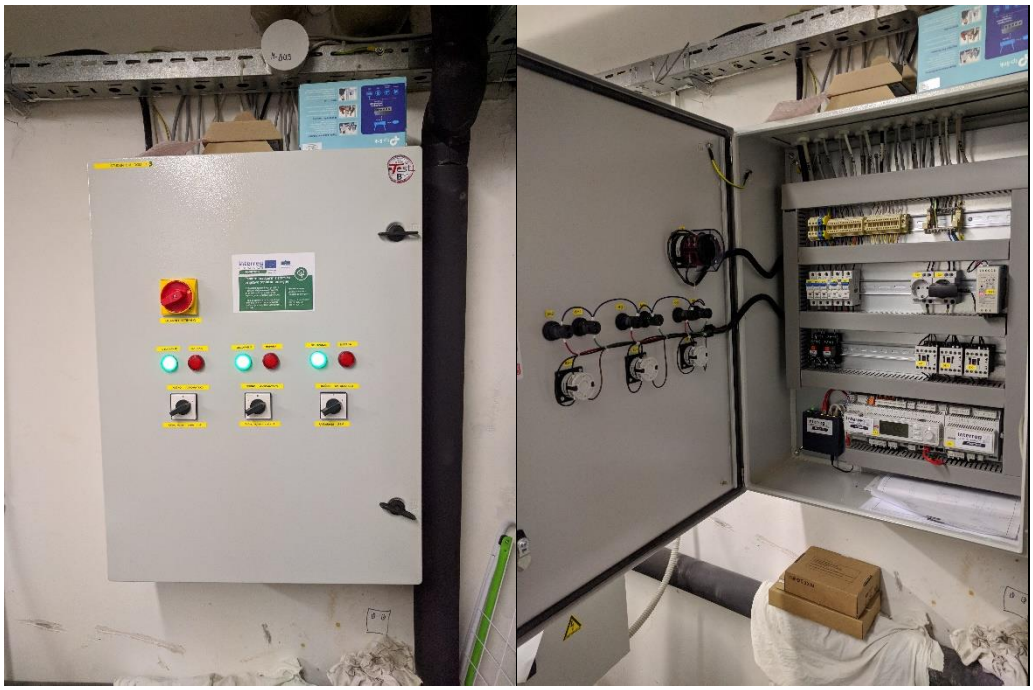
Picture 13: Human resources department.



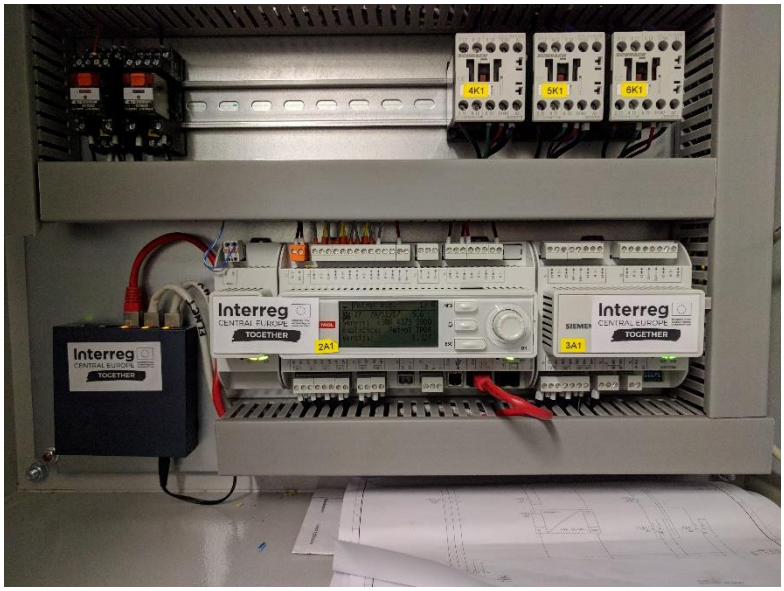
Slika 14: Reception room.

3. STUDENT DORMITORY 1

3.1. HEAT METERING



Picture 15: Built-in main cabinet to control the operation of the entire boiler room.

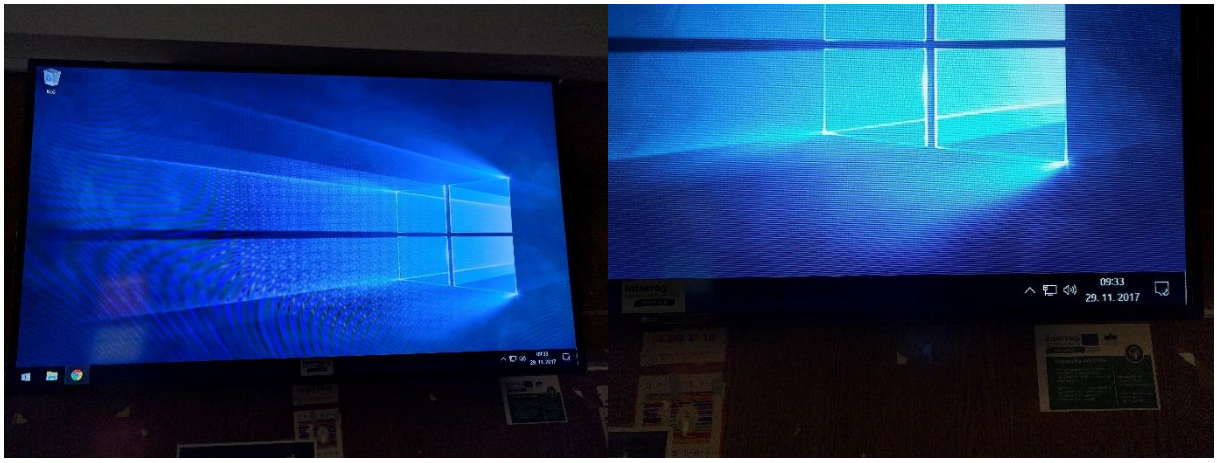


Picture 16: Built-in smart controller for controlling the entire boiler room for the heat preparation for heating and sanitary water.

3.2. ELECTRICITY METERING

Picture 17: An updated electric cabinet on the ground floor with a smart power analyser.

3.3. ENERGY INFO POINT



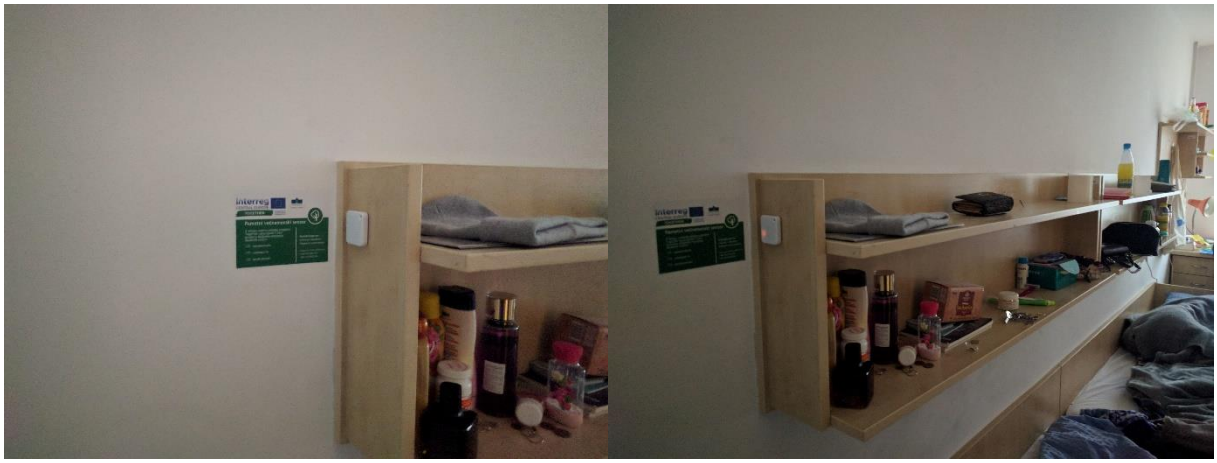
Picture 18: Energy info point - LCD monitor for informing users about energy efficiency.

3.4. INDOOR CLIMATE METERING

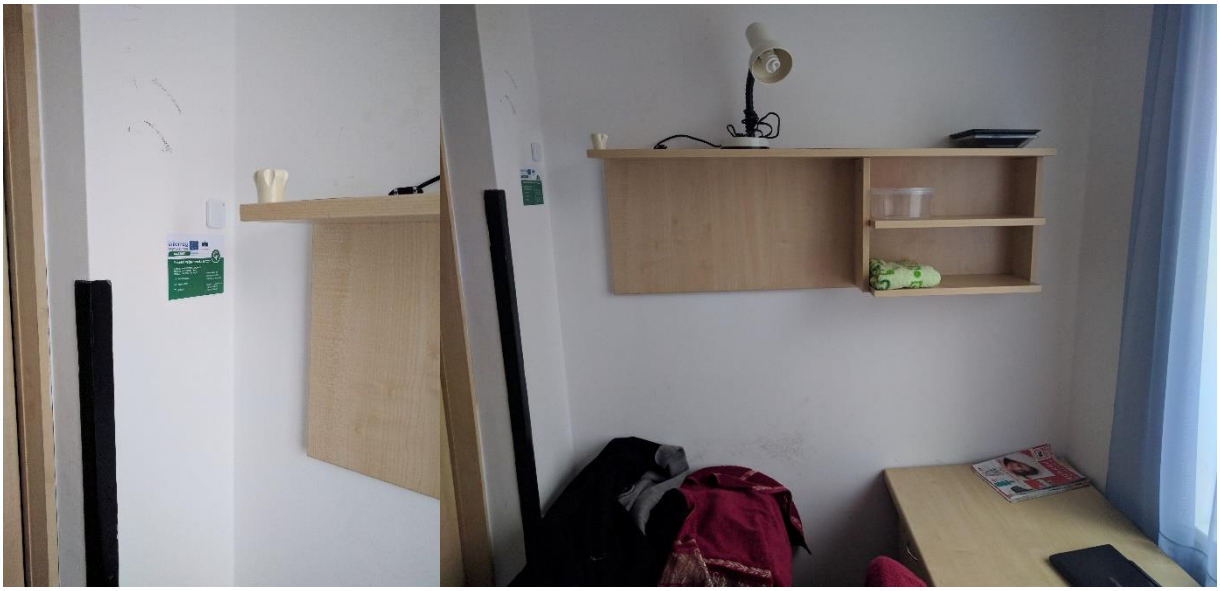
Implemented sensor systems in the reference premises:

Picture 19: Common kitchen in the first floor.

Picture 20: Student room P110.



Picture 21: Student room P111.



Picture 22: Student room P112.

4. STUDENT DORMITORY 2

4.1. HEAT METERING

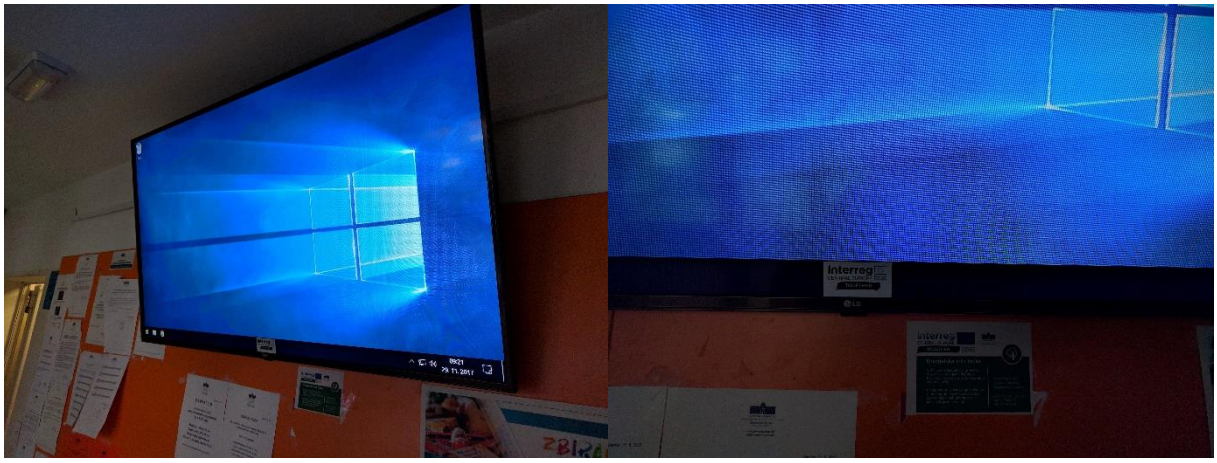
Picture 23: Built-in main cabinet to control the operation of the entire boiler room.

Picture 24: Built-in smart controller for controlling the entire boiler room for the heat preparation for heating and sanitary water.

4.2. ELECTRICITY METERING

Picture 25: An updated electric cabinet on the ground floor with a smart power analyser.

4.3. ENERGY INFO POINT



Picture 26: Energy info point - LCD monitor for informing users about energy efficiency.

4.4. INDOOR CLIMATE METERING

Implemented sensor systems in the reference premises:

Picture 27: Student room P06.

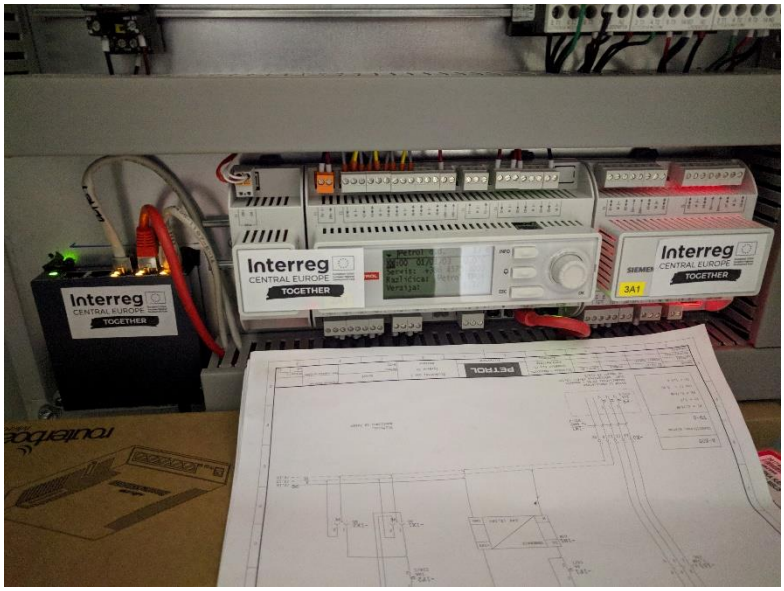
Picture 28: Student room P07.

Picture 29: Student room P09.

5. STUDENT DORMITORY 3

5.1. HEAT METERING

Picture 30: Built-in main cabinet to control the operation of the entire boiler room.



Picture 31: Built-in smart controller for controlling the entire boiler room for the heat preparation for heating and sanitary water.

5.2. ELECTRICITY METERING

Picture 32: Integrated electric cabinet on the ground floor with a smart power analyser.

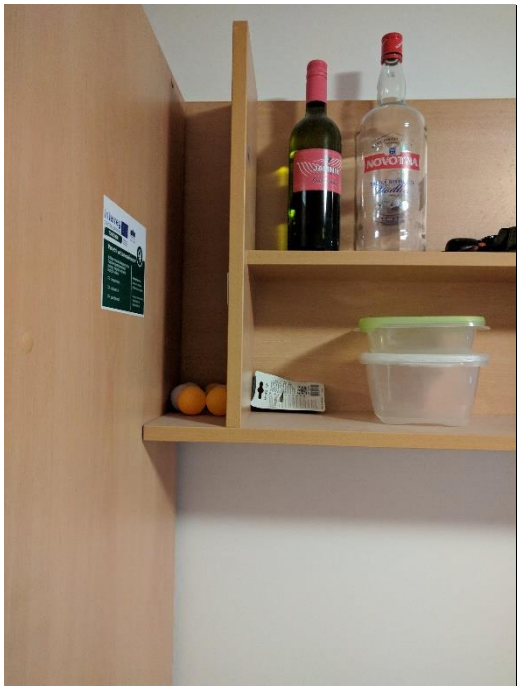
5.3. ENERGY INFO POINT

Picture 33: Energy info point - LCD monitor for informing users about energy efficiency.

5.4. INDOOR CLIMATE METERING

Implemented sensor systems in the reference premises:

Picture 34: Student room P08.



Picture 35: Student room P09.

Picture 36: Student apartment P10.

Picture 37: Student room P10.

Picture 38: Study room in ground floor.