SOCIAL GREEN - REGIONAL POLICIES TOWARDS GREENING THE SOCIAL HOUSING SECTOR

IMPLEMENTATION REPORT FOR

SOCIAL GREEN PILOT ACTION IN ALBA IULIA

“Improving energy efficiency in social apartments using smart monitoring solutions”

Includes:

- Initial report (technical and social data analysis, system configuration, initial feedback)
- Mid-term report (system installation, monitoring, feedback, preliminary results)
- Final report (monitoring, system extension, feedback, results, conclusions)

February - 2021

Author: Alba Iulia Municipality (Romania)

Partner: Tartu Regional Energy Agency (Estonia)

European Union
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INITIAL STUDY FOR PILOT ACTION IN ALBA IULIA

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SUMMARY

During SOCIAL GREEN - INTERREG project meetings, discussions and analyses, partners teams from Alba Iulia Municipality (Romania) and Tartu Regional Energy Agency (Estonia) discovered the potential to replicate in Alba Iulia some of the good practices related to smart buildings and Building Performance Monitoring and Assessment (BPMA) framework developed in Estonia and obtained the approval to test them in a pilot action during project phase 2.

In the first task of the pilot project, using the BPMA framework, the present document is studying energy efficiency issues in a social building from Alba Iulia, based on existing data and initial surveys and analysing both of the local situation of energy consumption and the behavioural pattern of the citizens living in social houses in terms of energy consumption and openness to the introduction of smart metering devices and sensors for measuring various KPIs at the level of the apartments from social houses. Document includes criteria for choosing apartments from the social houses, an energy consumption analysis/ year, identification of main consumers and a profile of the tenants, in order to define a "before implementation" model. During this process of initial data gathering and analysis, some technical or personal constrains were identified and considered in further stage of this document, when partner's technical teams were developing the smart solution for monitoring main technical or consumption data collection, influencing systems, sensors or software to be installed and used, considering also tenants needs and social housing apartments profile. Based on feedback and expertise from Tartu Regional Energy Agency and December 1-st University from Alba Iulia, several technical solution were analysed.

On the same time, questionnaires related to tenants consumption behaviour and their attitude regarding energy efficiency and smart solutions were used for determining their initial profile at the start of the pilot.

The present study is important for all other stages of the pilot project, preparing the acquisition and installation of the smart home systems, the monitoring stage and the reporting one, as major milestones in order to achieve objectives of the project.

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Cap. I. Introduction

Gathering several partners across Europe (Tartu Regional Energy Agency (EE), Extremadura Energy Agency (ES), Regional Energy Agency North (HR), CCDR-N - Regional Coordination and Development Commission of Norte (PT), CEiiA - Centre for Excellence and Innovation in the Automotive Industry (PT), Alba Iulia Municipality (RO), South Muntenia Regional Development Agency (RO), Nordregio – Nordic Centre for Spatial Development (SE)), the Social Green project is funded by INTERREG Europe (through the European Regional Development Fund, between April 2016 and March 2021) and is promoting the greening of the social housing sector, based on mutual learning, improved regional policies and best practices for green buildings, in order to improve social buildings energy efficiency and comfort.

Project is proposing improved, greener methodologies, processes, good practices and policies dedicated to social housing sector, targeting both new constructions or retrofitting of existing buildings.

Following the main project objective, the following sub-objectives were defined:

1. To understand the role of the green building intervention in the social housing sector and the link with fuel poverty;
2. To identify green measures for the social housing sector, specifically including energy efficiency and renewable energy development;
3. To identify, share and transfer experiences and good practices and to develop joint policy tools and instruments related to innovative solutions for greening social housing sector, namely in the areas of fuel poverty and energy efficiency;
4. To develop strategic guidelines and policy recommendations as an integrated toolkit for regional and local authorities,
5. To improve regional/local policies by introducing best practices into EU mainstream programmes in order to contribute towards fostering the competitiveness, sustainability and social cohesion of cities, regions and the EU as a whole.

During the project, an Integrated self- assessment Report collected data and information about social housing sector, policies and activities related to green buildings and energy efficiency in each partner municipality and region and involved local stakeholders in developing a knowledge base useful for preparing local action plans, including activities and monitoring of green social housing evolutions.

The study used several benchmark indicators and in case of the region of Alba Iulia Municipality revealed that:

- Social housing represents just 1.5% of local housing stock;
- Regional burdensome cost of housing is quite high (45%) compared to EU average (35%);
- There is a low satisfaction regarding quality of social housing (below 10% compared with EU average of 35%);
- Overcrowding is high (over 50% compared to 18% EU average, but quite common in East Europe);
- Quite low lack of adequate heating (12.5% compared to 10% EU average);
- Local social housing stock is new and includes some green energy measures.

During the Social Green project, broader and inclusive definitions were proposed for Social housing, housing ownership, target groups together with new policies, including European funds dedicated for new or retrofitting of social housing stocks, regardless of the ownership structure.
More than that, during the Social Green meeting in Estonia (Tartu – Tallinn, Jan. 2018), Alba Iulia Municipality team identified a series of good practice examples for energy efficiency and buildings retrofitting, based on a Building Performance Monitoring and Assessment (BPMA) framework (as defined by the Estonian good practice) which is setting a robust methodology enabling the assessment of building energy performances, on the basis of adequate KPIs reflecting both energy-related and human-related parameters. Following the discussions and analyses started with Tartu Regional Energy Agency, the Alba Iulia Municipality team identified the possibility to replicate some of those solutions (beginning with smart metering ones) at the level of social housing in Alba Iulia and obtained the approval of the Joint Secretariat and of the Monitoring

Committee of the Social Green project to test these new approaches in a pilot implementation, jointly designed and implemented in phase 2 of the project.

Smart metering solutions for buildings have the potential of being replicated to a high degree in Alba Iulia, in the other Romanian and EU regions and moreover, it would be highly relevant for the financial instrument addressed by AIM – Regional Operational Program (like the policy instrument ROP Axis 3 and Axis 9). The Building Performance Monitoring and Assessment (BPMA) framework can be used in a similar model by Alba Iulia Municipality (AIM), given the fact that several conditions are highly similar to those from Estonia (similar weather conditions, access to high speed internet, relatively similar types of buildings due to Communist heritage, social policies, etc.).

Cap.2. Pilot project objectives and milestones

2.1. General aspects of the pilot

The pilot in Alba Iulia implements a series of good practices in the area of Building Performance Monitoring and Assessment (BPMA) framework (as defined by the Estonian good practice) who addresses several major aspects used for building energy performances assessments, based on:

- Gathering information on the indoor/ outdoor conditions of buildings;
- Installing several sensors and smart monitoring devices;
- Collecting data for a relevant period;
- Analysing data and comparing scenario “before implementation” and “after implementation” ;
- Propose measures for optimising energy consumption;
- Measure changes in behaviour of tenants living in the social housing dwellings.

Pilot is implemented in Alba Iulia, in 8 apartments from social housing dwellings, hosting vulnerable groups. According to model developed in Tartu, for energy performance assessment a full year of data are needed before and after pilot implementation, as demonstrated by applying the BPMA framework in other demo sites in Estonia and Spain.

Following this model of approach, the Pilot Action in Alba Iulia will analyse and monitor both technical and behaviour data, based on existing data, new data gathered by smart home systems or questionnaires and surveys. On the technical part, monitoring is including energy consumption (like electricity or heat) and indoor conditions (like temperature, humidity, CO_2 concentrations), while on other part, improvements to energy related behaviour are going to be studied. Conclusions of the pilot will be sent as a final Report to the Managing Authority of the ROP (with support from the Regional Development Agency-ADR Centru), able to take into consideration the inclusion of this type of energy monitoring method and actions as eligible activities and expenses within the next calls under Axis 3 and under Axis 9 of the Regional Operational Program.

2.2. Main objectives of the Pilot Action in Alba Iulia

The PA in Alba Iulia has several main objectives:

- Analysing the energy-efficiency situation at the level of AIM’s social housing, with possibility to use developed methodology in other cases;

- Complete useful energy audit data with consumer’s attitude and consumption behaviour through surveys and questionnaires;

- Demonstrate that smart metering and monitoring systems at level of the social housing and other buildings is bringing an added value in terms of energy efficiency and consumer pattern;

- Identify (based on BPMN framework) relevant KPI’s (for energy and human-related parameters) and best approaches in order to provide real-time building energy performances and monitoring and including the tenants perspective;

- Based on solution tested, contribute to better governance by proposing new eligible activities under the ROP funded calls submitted to the thematic call;

- Improvements to policy instruments, considering both technical and user satisfaction as evaluation criteria for projects submitted under the priority of investment Axis 3 - “Supporting the transition to a low carbon economy” and priority of investments Axis 9 - “Local development placed under the community’s responsibility”;

- The Municipality and other national and international administrations can use pilot conclusions in future decisions about social housing, other municipal buildings and relevant energy-efficiency measures implemented at local level.

2.3. Main tasks, activities and their implementation

Task	Months	Activity	Brief description
T1	M1 - M2	**Set up of the experimental action**	Study (present document) on energy efficiency issues at the social housing level in Alba Iulia, including initial surveys and analysis of the local situation in terms of energy efficiency and the behavioural pattern of the tenants in terms of energy consumption and openness to the introduction of smart metering devices and sensors for measuring various KPIs at the level of the social houses. The study will also relate to potentially other similar actions, performs initial energy consumption/ year and tenants profile for the initial (before implementation) stage. Partners teams (Alba Iulia Municipality, Tartu Regional Energy Agency, University 1 December Alba Iulia) will analyze best solutions for pilot implementation.
T2	M2 - M3	**Organizing public tenders**	Acquisition of smart-metering devices, sensors and other smart appliances and tools for measuring energy efficiency at the level of 8 public housing flats.
T3	M3 - M4	**Installing the smart-metering monitoring system**	Installing sensors, smart-metering devices, smart appliances, tools etc. at the level of 8 targeted social housing apartments with the consent of the tenants which volunteer for the proposed pilot, systems being monitored and managed by the municipality, using the adequate software and communication tools. The system will be installed by technical experts from the municipality and from private companies which deal with smart-metering systems.
T4	M4 - M16	**Organizing surveys**	After the installing of all the technical components at the level of the social housing apartments, the management team will organize a first survey in order to analyse the initial feedback from the tenants of the apartments and their interest in the appliances and smart-metering devices installed in their homes ("attractiveness" of smart solutions,

			attitude and perceptions on technology, satisfaction, technical difficulty).
T5	M4 - M16	**Monitoring the energy parameters of the social housing flats**	Monitoring energy parameters and organizing monthly meetings with the tenants in order to present the monthly statistics, data acquired and discussing options for behavioural change in order to obtain optimal results in terms of energy consumption and increased comfort. The monitoring period will be of at least 12 months ("after implementation" period) and involves the Estonian partner in order to insure the success of the pilot.
T6	M10	**Half period reporting**	Analyzing of results of the pilot in a workshop, including partners and tenants; based on feedback, system can be improved for eliminating dysfunctionalities and achieve a successful implementation.
T6	M10 - M16	**Continuing the monitoring and survey**	Perfecting the system and resolving any dysfunctionalities; the tenants can evaluate their own consumption of energy, observe the data acquired by the smart metering devices and sensors installed at the level of their apartment, and report any malfunctions. The technical experts will be responsible for monitoring the parameters of the apartments and the results will be analyzed in order to propose energy efficiency solutions for the tenants, and for identifying any possible behaviours that could be changed.
T6	M17	**Organizing final workshop**	The Final Report of the pilot project will be presented to all the relevant stakeholders at the local level, will be sent to all the project partners for greater dissemination and for supporting the transfer of good practices in the field of energy efficiency at the level of social housing, made public for free and will be used in order to foster a behaviour-change for other citizens of Alba Iulia.
T7		**Sending the final Report of the PA**	Final Report will include recommendations for changing the policy instrument ROP Axis 3 and Axis 9 to the Regional Development Agency - ADR Centru in order for future calls to include eligible activities drawn from the PA results. The ADR Centru will also be responsible for forwarding the Report of the PA and the recommendations for policy change to the Managing Authority of the ROP.

Table.1. Social Green pilot in Alba Iulia – main activities

Cap.3. Development of the present study

This report regarding energy efficiency in social apartments in Alba Iulia is of major importance for the pilot action, because is gathering necessary information and data in order to obtain a "before implementation" situation, easing a decision for a technical solution and preparing the next task, the acquisition of smart monitoring systems and practically all other tasks and activities which will follow.

3.1. Documents and other sources of information

a) Previous Social Green project documents:

- Integrated self assessment, - Alba Iulia Municipality

- Pilot action proposal – Alba Iulia Municipality
- Social Houses in Tallinn - Tallinn City Property Department Construction and Maintenance Division; Oliver Eglit, Hardi Alliksaar, Evgeny Maksimov
- Accelerating Energy renovation solution for Zero Energy buildings and Neighborhoods, D6.1 Definition of the RenoZEB Building Performance Monitoring and Assessment methodology (BPMA) by Sergeï AGAPOFF – CSTB, Mathieu RIVALLAIN – CSTB, Antoine BREITWILLER – CSTB, Michele Vavallo – SOLINTE

b) Local experience from other projects

Alba Iulia Municipality developed beginning with 2017, the most ambitious Smart City pilot project in Romania, based on collaboration with private companies and other institutions, which implemented 56 smart solutions (from a total of 106 analized and prepared). All those solutions are presented on a dedicated website (www.albaiuliasmartcity.ro) and some of them are related to building energy efficiency and monitoring, like:

- Thermodynamic system for hot water (with Delphi Electric);
- Remote meters reading (with Vegacomp);
- Water meters reading via LoRA (with Orange);
- Smart school lighting (with Telekom);
- Smart building (with Technical University from Cluj Napoca).

Many of such solutions can be integrated and developed by Municipality in projects co-financed with European funds (like ROP or Operational Programme for Administrative Capacity).

c) Other sources

This includes other information, methodologies and documents serving to project scope, or statistical data. Sources, including internet, are mentioned when used.

3.2. The Building Performance Monitoring and Assessment (BPMA) framework *

* Following information is based on Estonian best practice presented in "Accelerating Energy renovation solution for Zero Energy buildings and Neighbourhoods - Building Performance Monitoring and Assessment methodology" (BPMA) by Sergeï AGAPOFF – CSTB, Mathieu RIVALLAIN – CSTB, Antoine BREITWILLER – CSTB, Michele Vavallo – SOLINTE; www.renozeb.eu ; CSTB – H2020 project.

The Building Performance Monitoring and Assessment (BPMA) framework was developed for measuring the performance of building energy retrofits, using KPI's for measuring parameters related to energy and human behaviour. Because usually building use and climate conditions vary and energy bills are not providing a reliable comparison, methodology is used for assessing energy performance before and after renovation, regardless of variations in climate, occupation and usage, or gaps between predicted and real performances.

BPMA framework is proposing an integration between information about building, behaviour of occupants and near real time energy monitoring in order to obtain an objective and accurate assessment of energy savings achieved.

The BPMA methodology was applied on two real building demo sites in Vorü/Estonia and Durango/Spain.

Usually, building retrofits are implemented for:

- minimizing energy consumption;

- minimizing environmental impact;

- improving indoor environmental quality (IEQ; ex. air quality, thermal, visual, acoustic, comfort, etc.);

- improving and updating building quality (materials, components, equipment, performances).

Many of retrofits projects are considering first two objectives, IEQ and building quality being difficult to assess, because conditions between the two stages has important variations. That's why, several aspects must be considered, like building intrinsic performance, the use and occupation conditions and the climate conditions. For evaluating the energy savings, the baseline and the reporting period should contain at least a system full cycle, considering that data, weather or occupation must be monitored for at least 1 year, on the basis adequate KPIs reflecting both energy-related and human-related parameters.

Input data for BPMA

Input data for BPMA are provided by the building audit, modelling and monitoring, including:

a) Building information before and after retrofit (address, geometry, orientation, windows surface and orientation, number of apartments, number of occupants/ apartment, occupation scenarios, existing equipment);
b) Building modelling (usually using special software for Building Information Modelling – BIM) is used for energy simulations, combining energy consumption and indoor conditions;
c) Indoor conditions (indoor temperature, humidity, CO2 concentrations, illuminance) and usage (windows opening, heating set points, lighting scenario, shading position).

The process accuracy is influenced by number of monitored parameters, monitoring devices, measurement frequency or sensors resolution. Because such a process is complicated and expensive, requiring a monitoring system for all those parameters and for the entire building is difficult, in practice just some of the parameters are at building scale (like measurement of radiant external walls temperature, as an indicator for both insulation and comfort).

As a compromise between accuracy of data collected by sensors and the constraint of minimizing energy consumed from batteries, usual data transmission frequency is set to 5-10 min for the majority of sensors and at 6 hours for parameters with slow variation (like wall temperature).

d) Outdoor conditions (air temperature °C, atmospheric pressure Pa, relative humidity %, solar radiation W/m2, wind speed/ direction, CO2 concentration, facade illuminance – lux);
e) Energy measurements (natural gas m3, electricity consumption kWh, heat kWh).

For energy measurements, recommended reading frequency is 5 - 10 min.

f) Virtual sensors – are calculated for physical quantities that are not measured directly by sensors but can be deduced from the measurement of one or multiple sensors, like:
   - Average indoor air temperature of a building or housing;
   - Boolean of window opening (from variation of CO2 concentration and/or Indoor Air Temperature);
   - Boolean of presence in each housing (deduced from electrical consumption/ temperature and/or CO2 concentration and window opening and meta data from the occupant survey); used for metabolic gains generated by occupants;
   - Heating set point temperature (if not directly monitored), which is different from the measured indoor air temperature.

List of usual Key performance indicators (KPIs) monitored in BPMA

According to national and EU regulations, for each KPI the BPMA sets goals, like for:

- Energy savings (kWhFE/m2; kWhPE/m2; In occupation / no-occupation periods; In actual conditions / in standard conditions, etc.);
- CO2 savings;
- Difference to the predictions (kWhFE/m2.y; kWhPE/m2.y; Conventional conditions: climate, occupancy, etc.);
- Difference in energy demand (power);
- Occupants' thermal comfort;
- Indoor air quality (CO2 based);
- Actual components and equipment properties / performances;
- Building (U-Value; Thermal bridges; Air tightness; Ventilation rate; Heating system efficiency; DHW efficiency, etc.).

BPMA main actions/ outputs

- Thermal insulation of the building (windows, walls and roof surfaces);
- Change of equipment (the heating/dwelling hot water systems);
- Setting of efficient controls tools.

Because in retrofit actions is difficult to identify individual contribution of these actions, usually the energy savings are calculated using a whole building model, which is compared to the whole building energy consumption after renovation.

BPMA main steps

Here are the main steps of BPMA for creating the "reference" (baseline, actual, before renovation model) and the building energy model "after" renovation:

- Building audit;
- Monitoring data acquisition;
- Data pre-processing and tagging;
- Calculation of virtual sensors;
- Energy end-use identification and analysis;
- Building energy modelling;
- Re-simulation;
- Post-processing.

The BPMA framework was tested in two demo buildings, in Vorü/Estonia (collective/ district heating system) and Durango/Spain (individual heating). For the demo in Vorü, the monitoring data related to energy consumptions (especially heating) is available at building scale (different from the apartment level) and the assessment of energy savings is performed at building scale also. Data related to indoor conditions, thermal comfort and air quality (CO2) were collected at room/ apartment levels and were adapted in order to represent building scale, after a BEM calibration.

Conclusions useful for pilot in Alba Iulia

1) BPMA is a complex framework used mainly for assessing buildings energy consumption before and after retrofits, combining technical and consumer's behaviour aspects, acquiring, monitoring data and using advanced building and energy (BIM/ BEM) models in order to obtain best solutions. This is not the case of the social building from Alba Iulia, which is quite new (2013) and will not be a subject for retrofitting. The demo building tested in Vorü/Estonia is considering a central heating solution, same solution existing in the pilot building in Alba Iulia (at the building level).
2) In terms of main actions used by BPMA, the pilot won't use advanced modelling for thermal insulation of the building or for changing main equipment. Instead, the pilot will focus on implementation of monitoring and control tools, using sensors and "smart home" systems.
3) BPMA will be used as reference for main sensors and parameters used for monitoring energy performance; in this respect, the framework is proposing a large number of indoor, outdoor, occupancy and virtual sensors, from which pilot will consider the main ones, relevant for the energy consumption, consumption patterns and interior climate at the apartment level, in order to identify the positive impact of smart measuring solutions on energy efficiency/ consumption.
4) At consumer's level (as human parameters) the BPMA is considering the influence of occupation, comfort or metabolic energy gains, while the pilot is proposing a larger investigation on attitude of tenants of social houses regarding energy and smart monitoring solutions.

3.3. Monitoring tenant's behaviour and attitude

In order to demonstrate the impact of monitoring and smart solutions on energy consumption, the pilot must also address consumer's behaviour, who based on provided information are willing to change their attitude regarding energy efficiency/ utilities consumption and volunteer for using new technologies. As opposite to the data provided by sensors, which can be considered "hard" or "quantitative" data, behaviour changes are much more subtle, take time and involve a series of stages through which individuals' progress. More than that, "qualitative" data, usually obtained through "soft" methods, like questionnaires and surveys are used for progress monitoring.

Based on a theoretical framework of how people change their behavior, **MaxSumo**
(http://www.epomm.eu/index.php?id=2602)

is a systematic standardized evaluation methodology developed beginning with 2009 especially for mobility projects, which ensures step by step guidance in planning, monitoring and evaluating projects. In time, MaxSumo demonstrated its value and applicability in a multitude of domains, because is using targets, indicators and results specified at four different levels, which follow on from one other in a logical way and at each level you need to decide what you want to measure, what indicators to use and how to measure these:

Level 1: Intervention framework conditions (specific to location and target group); considers local external factors and person-related factors;

Level 2: Assessment of services provided (different activities and outputs), based on project awareness, usage of provided services and satisfaction with options offered;

Level 3: Assessment of options offered (related to the behaviour the project is trying to change), reflected in acceptance, take-up and satisfaction with the option offered during the project;

Level 4: Overall effects (main outcomes of the project with regard to new attitudes and behaviours adopted).

An important distinction must be made between monitoring (measures what has happened based on the systematic collection, storage, and compilation of data) and evaluation (why changes have occurred, based on analysis of impact) of projects.

The MaxSumo process involves 7 steps:

Step 1: Define the scope of projects and set overall goals

Targets must be defined using the SMART model (Specific; Measurable; Ambitious & Accepted; Realistic; Time-limited);

Step 2: Define the target groups

The target group is critical considering allocating resources to groups that are likely to produce the greatest effects; target group depends on project objectives and is selected based on multiple criteria (area; purpose; usage mode; socio-demographic; etc.)

Step 3: Define the services that will be provided by the project and the option(s) offered

This includes a specific range of measures taken in order to change behaviour, like: information measures, promotional measures, organizational and coordination measures, education and training measures, site-based measures and infrastructure, telecommunication and flexible time organisation, supporting and integrating measures.

Step 4: Review all assessment levels, chose what levels to monitor and define targets and indicators for the chosen assessment levels

Step 5: Define suitable methods for collecting data for the chosen assessment levels

Based on defined targets and indicators to monitor, in the next step is necessary to decide on the most suitable method of collecting data (count, measure, documentation, investigations on site, surveys, etc.), considering quantitative and qualitative information and usage of different tools.

Step 6: Monitor the chosen assessment levels

Project data collection is critical for monitoring and evaluation of the project - what indicators are measured, necessary methods and when to measure each indicator. The usual service acceptance criteria must be monitored during the entire project, including behaviour before, during and after the project, together with costs associated with each measure and service, in order to have a cost efficiency of each measure and a project overall cost-effectiveness at a later stage.

Step 7: Evaluate the project and explain observed changes

Practically, for steps 4 to 7, it is recommended to have a monitoring and evaluation process, in order to know how to proceed with the project and how to perform the activities and to improve project impact.

The MaxSumo steps were considered for development of the template necessary for preparing implementation plans and first documents for the target group constituted by tenants of social apartments.

MaxSomo is based on understanding the underlying processes necessary for behavioural change In order to successfully change people’s behaviour, considering two key aspects:

- In any given population (target group) some people are more susceptible to changing their behaviour than others, being related to subjective factors such as their attitudes and perceptions towards their current/ existent choices;

- Behavioural change is not a fast, one-step process; is more a series of steps which individual progress through in achieving a new behaviour.

Usually, there are 4 stages of progress: pre-contemplative (content with actual attitude/ behaviour), contemplative (not so content, but not decided), action (decide to try new options) and maintenance (when new habits are formed).

As a conclusion, is important to investigate and evaluate users existing stage, using recommended data and questions in order to demonstrate progress.

3.4. Steps in preparing the present report

1) Investigate alternative buildings together with the city hall administrative department;

2) First site visit, general location, building;

3) Technical visit – building and existing equipment; comparison with Tartu; data from the technical book of the building;

4) Based on occupancy and technical aspects/ data availability, decide on location, building and target group;

5) Investigate availability of historical data regarding utilities consumption/ cost; energy/ utilities cost and their impact;

6) Prepare initial documents for tenants and administrator;

7) First meeting with the target group;

8) Gather data;

9) Check technical alternatives with Tartu Regional Energy Agency and 1 December University; identify constrains vs. BPMA recommendations;

10) Meetings with the target group – clarifications;

11) Work with partners in designing possible technical solution;

12) Third meeting with extended target group;

13) Data analysis

14) Prepare report; decision on technical solution and preparing next stage, system acquisition.

Cap.4. Location and building

Social buildings are located in a semi-central area of Alba Iulia, near the stadium.

4.1. Buildings position and apartments

Fig.1. Social buildings in Alba Iulia

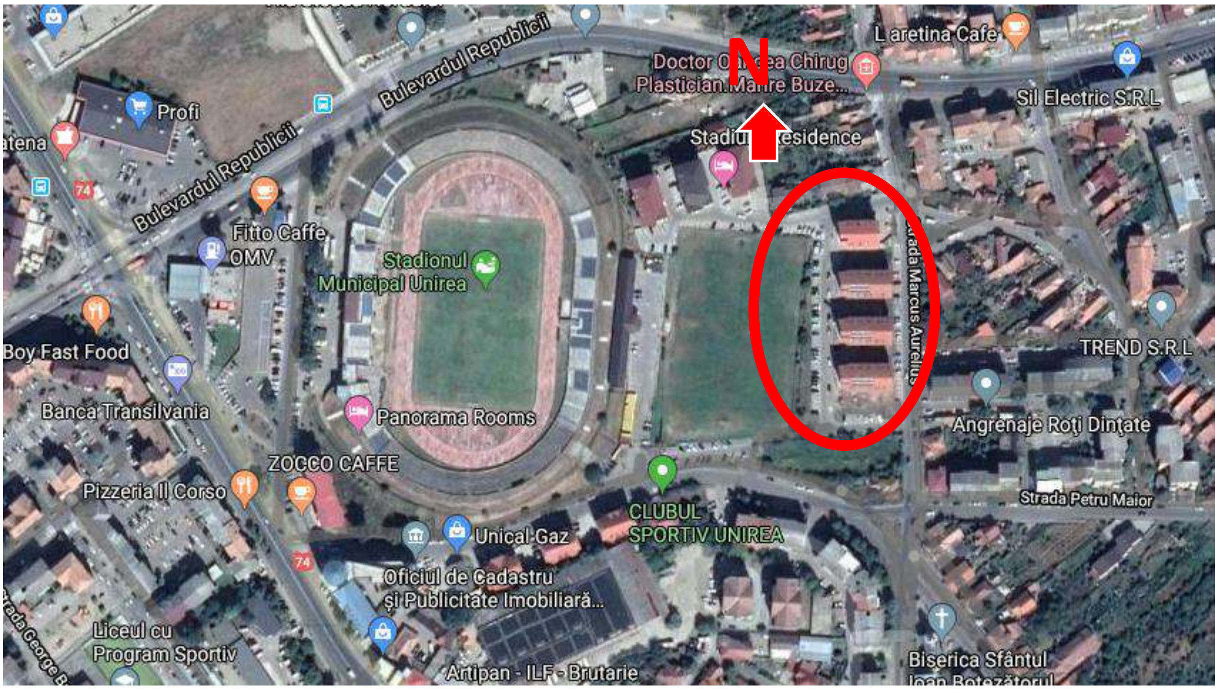


Fig.2. Position and orientation of social blocks

Blocks of social apartments are similar, in the same area and having the same position. According to BPMA recommendations, blocks are sharing same external climate conditions, but there are certain differences between apartments with windows to North (in the shadowing area) and those with windows to South. It is expected that energy consumption for heating or lighting to be higher in the first case, so we decided to use those apartments on Northern façade as first candidates for pilot.

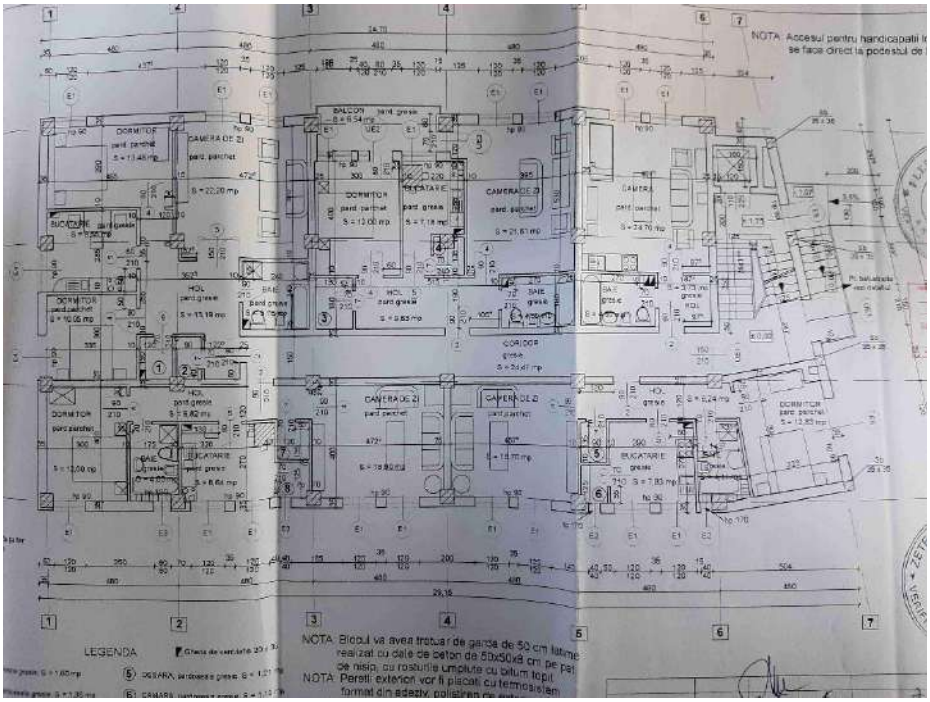


Fig.3. Technical plan of a floor

Each block has 5 floors (ground floor, 3 floors, and attic) hosting a total of 25 apartments. On each floor, there are 3 x 2 room (2 with Northern orientation), 1 x 3 room and 1 x 1 room apartments, with kitchen and bathroom. Blocks are quite new (2013), have thermal insulation, double pane windows, insulated doors.

4.2. Comparison with Estonian projects/ buildings

In terms of climate, Alba Iulia is considered nationally in Zone III, as presented in Appendix I, and has a quite similar climate compared with Tallinn, as presented on world climate map in Appendix II.

We compared main building characteristics of a renovated block from Tallinn with a social building from Alba Iulia.

Tuulemaa 6 Tallinn (1972, 3400m2, 70 apartments)	Alba Iulia (2013, 25 apartments)
Construction aspects	
Thermal insulation on the walls, roof and foundation	Thermal insulation on the walls, roof and foundation
Triple pane windows positioned into the same plane as the additional external thermal insulation to minimize the cold from the thermal bridges	Double pane windows positioned after the plane of the additional external thermal insulation
Heat recovering ventilation system	NA (Not available); solution is rarely used locally
New/ centralized Heating system	Yes, at building level

New finishing (kitchens, toilets, bathrooms, laundry rooms, hallways)	Not needed (new)
Full renovation including electricity, heating system, water, sewage etc	Not needed (new)
Furnishing	NA
Renewables/ energy recovery	
Solar panels	Yes, 24 panels for hot water
Drain water heat recovery system	NA
Photovoltaic solar system (35kW)	NA (used in other buildings)
Local ventilation in apartments	NA
Facilities	
Children/ Elder day center	Separate dedicated buildings in other locations
Public sauna	NA (available just in SPA's)
Laundry room	NA; Most of families have a washing machine
Energy class and building modelling	
From E class (181-220kWh/m2) to class B (101-120kWh/m2) or A (<100kWh/m2)	Class B (141kWh/m2)
Using BIM (Building Information Modelling) system for rehabilitation	Not applied yet for municipal buildings in Alba Iulia

Table 2. Comparison between 2 blocks in Tallinn and Alba Iulia

Comparison revealed that main constructive solutions are similar and both buildings are using renewable energy for a part of their energy consumption. In Tallinn, there are systems for energy recovery from the ventilation system and from waste water, which are not common solutions in Alba Iulia.

These solutions, combined with the existing photovoltaic solution is ensuring lower consumptions and a better energy class (120kWh/m2) compared with the building from Alba Iulia (141kWh/m2).

4.3. Thermal insulation and Building energy class

We have tested the thermal insulation of one block using 2 professional equipment:

- IR Thermal camera;
- Multifunctional IR Thermometer

Existing weather conditions:

- Temperature: -7 ^{o}C
- Distance: 11.5 m
- Humidity: 39.4%

Test revealed a good exterior insulation, expected if we consider existing 10 cm of insulation, walls being at a quite constant temperature and structural resistance elements and usually associated thermal bridges not being present. On other hand, windows are at a significant higher temperature (2.7 ^{o}C) and thermal loses are visible in windows openings areas.

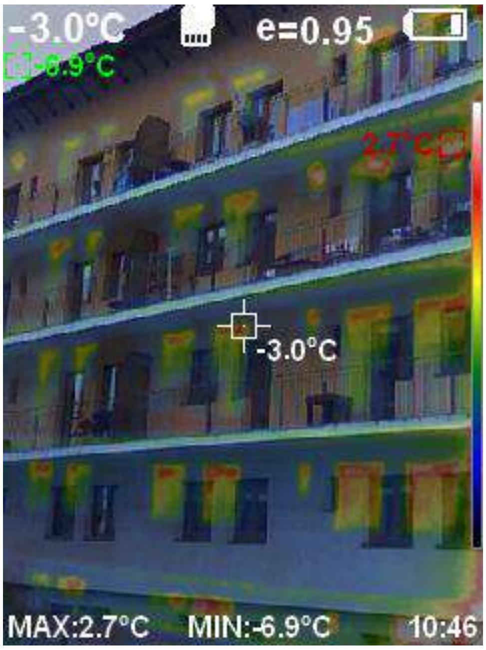


Fig.4. Thermal IR image *Fig.5. Multifunctional IR thermometer image*

As a conclusion, building has a good thermal insulation, but compared with the block from Estonia, even better results can be obtained if we consider:

- 3 pane windows instead of 2 pane ones;
- Installing windows at walls level, for minimizing thermal bridges;
- Improved insulation around windows.

Existing social buildings in Alba Iulia are considered in B class, consumption being of 141kWh/m2. As construction solutions are quite similar to those from Tallinn, we will analyse main components in Appendix III, according to existing standards.

If lighting (11,28 kWh/m2) and ventilation (4,76kWh/m2) are in class A, heating is in B class (73 instead of 70 kWh/m2) and hot water is in C class (52 compared to 35 kWh/m2 for class B).

As a conclusion, overall B class is mainly influenced by a higher than normal consumption of hot water, possible if we consider a higher occupation of apartments.

4.4. Building equipment

The basement of the building hosts 2 x 150kW heating/boiler systems using natural gas, hot water storage/ mixer with hot water from 24 solar panels, expansion vessels, pumps and classic automation based on temperatures and pressure.


Fig. 6. Heating/ boiler systems for heating and hot water; *Fig.7. Hot water storage*

Electricity is provided by tri-phase line, fuses and general meter, from which through individual single phase digital electricity meters, electricity is routed to each apartment.

Fig. 8. General electric panel with fuses, protections, tri-phase general meter and individual meters (digital)

On the entry hall, near each apartment entrance, there are individual meters for natural gas, cold and hot water and heat. Excepting the heat meter which is digital, the rest of meters are mechanical.

Fig.9. Cold and hot water meters *Fig.10. Heat meter with distribution pipes*

Fig.11. Individual gas meter

Inside apartments, there are water taps in kitchen and bathroom, radiators for heating, gas pipe with protection in kitchen and electricity distribution panel with fuses.

Fig.12. Electricity distribution panel with fuses *Fig.13. Radiator with mechanical thermostat*

In conclusion, there are appropriate meters for all utilities, but excepting those for electricity and heating which are digital, the rest are classical mechanic meters. For generating invoices, meters are manually read and indexes may be transmitted online and checked manually by the distribution companies every 3 months. There is no meters remote reading and transmission available at this moment.

4.5. Selection of apartments for pilot (technical aspects)

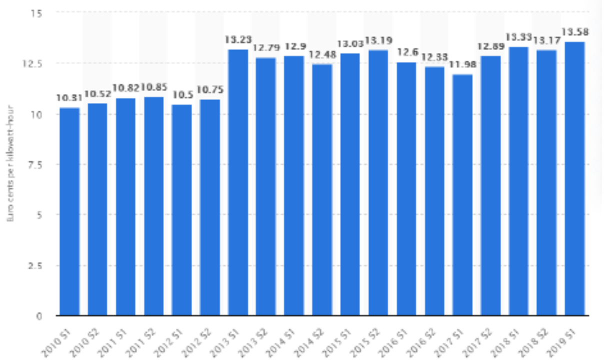
As pilot is going to be implemented in 8 apartments, decision is between 2 room apartments, from a total of 15, because differences in surface between those apartments and those with 1 or 3 rooms are significant. If we are excluding balconies, 2 room apartments' useful surfaces are in the same range (30-35 m2). There are influences from exterior for ground floor and attic apartments, but we will prefer apartments with same exposure, placed on two vertical columns and facing north. That means that main candidates are 2 apartments for each floor. This configuration has another technical advantage, being on same utilities distribution columns.

The rest of 5 with 2 room apartments facing south will be considered as back-up, in case that some tenants are not willing to participate in pilot.

Cap.5. Energy and utilities cost and impact

5.1. Energy cost evolution

In order to estimate the impact of energy cost in families' budget, we will use statistical data centralized by www.statista.com for gas and electricity and will compare prices with those from Estonia.



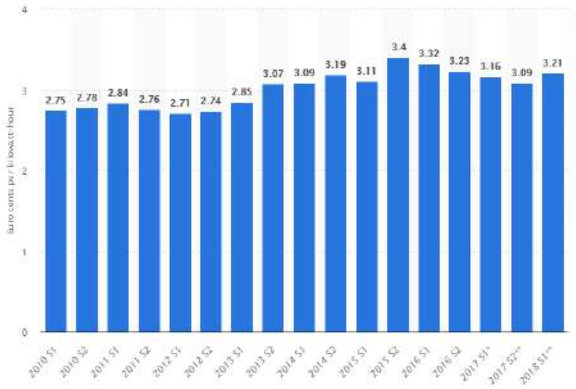
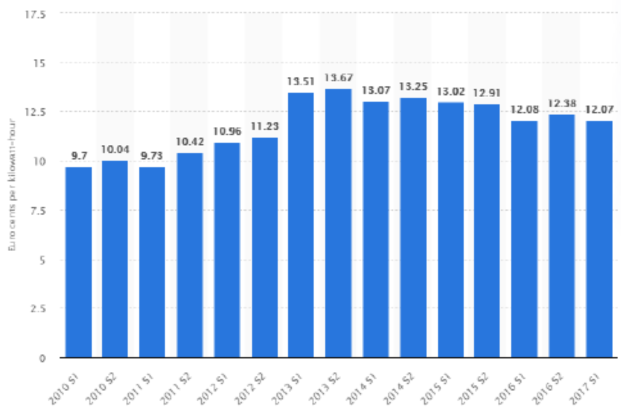


Fig.12. Electricity prices for Romanian households (2010-2019), eurocents/kWh

Fig.13. Natural gas prices for Romanian households (2010 – 2018), eurocents/kWh

In last 8-9 years in Romania, electricity prise rose with 31.2% and natural gas price rose with 16.7%, reaching 13.58 and respectively 3.21 eurocents/kWh. This evolutions are especially visible after 2013, when Romania aligned prices with those from EU and the local market gradually was liberalised to competition.



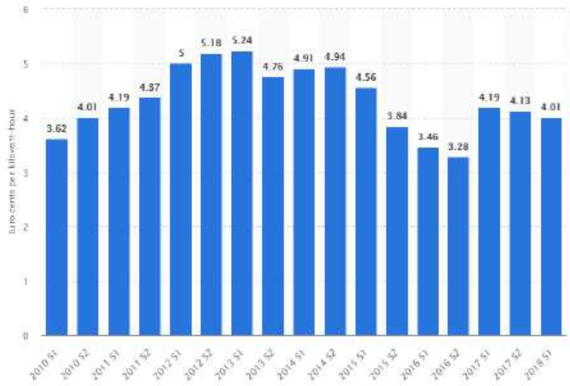


Fig.14. Electricity price for households in Estonia (2010-2017), eurocents/ kWh

Fig.15. Natural gas price for households in Estonia (2010 – 2018), eurocents/kWh

In Estonia, fluctuation was about 24% and prices stabilised at 12.07 for electricity and 4.01 for gas, (eurocents/kWh).

Considering recent (2019) raising prices evolutions in Romania, we can conclude that prices are in the same range for natural gas and more expensive in Romania for electricity (12%).

5.2. Estimation of energy cost in families budget

We will use prices for main utilities presented before, and consider data about average salaries in Tartu-Estonia and Alba Iulia – Romania. Considering usual consumptions for a family of 3 persons, we can estimate the following monthly costs:

Utility	**Per unit price, euro**		**Monthly cost, euro**	
	Alba	Tartu	Alba	Tartu
Water 10 m3	1.589	1.52	15.89	15.2
Electricity 200 kWh	0.1358	0.1207	27.16	24.14
Natural gas > 200m3 (2142kWh)	0.0321	0.041	68.7582	87.822
			111.8082	127.162
Average / minimum salary			688/ 403	1033
Percentage of salary			27.74%	12.31%

Table 3. Estimation and comparison of utilities costs

Is easy to see that there are big differences between the 2 cities, because:

- Average salaries are higher in Tartu;
- Natural gas has a big contribution > minimizing gas consumption (for heating) will have a great impact.

As a result, estimation assumes that utilities have an average of 12% in family's living costs in Tartu and 17% in Alba Iulia, reaching 27% in case of minimum salaries.

We have tried to obtain a better image on those aspects regarding living costs between the 2 cities, and we have found a comparison based on data presented by people from those 2 cities on www.numbeo.com (Appendix IV). Comparison revealed that even there are big differences on average salaries (more than double in Tartu), consumer's prices are much lower in Alba Iulia (-20 to -65%), the final difference being around 30-35%. That difference can be even more minimized considering that a great majority (96.8% in Romania) are owning their apartments in Alba Iulia and are not paying rent.

As our pilot is targeting families from social apartments, we will check further on those aspects, regarding utilities impact on personal/ families budgets. That's why, we will try to investigate:

- Their knowledge and information regarding utilities pricing and invoices components;
- Their perception regarding the most expensive utilities;
- Their willingness to change their consumption behaviour and influence energy costs.

Cap.6. Documents prepared with Administration and tenants

These documents were prepared for presenting the project to possible volunteers, representative for the pilot target group, and for gathering acceptance and primary data.

6.1. Occupancy

Information were gathered from the Administrative department, for the 15 apartments with 2 rooms of a building (which are technically recommended).
Number of family's members sharing a 2 room apartment varies between 2 and 5 people, with an average of 3.6 person/ apartment, revealing a high rate of occupation.
According to Eurostat, we must consider definitions for 2 important parameters:
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Overcrowding_rate

"A person is considered as living in an **overcrowded** household if the household does not have at its disposal a minimum number of rooms equal to:

- one room for the household;
- one room per couple in the household;
- one room for each single person aged 18 or more;
- one room per pair of single people of the same gender between 12 and 17 years of age;
- one room for each single person between 12 and 17 years of age and not included in the previous category;
- one room per pair of children under 12 years of age.

The **housing cost overburden rate** is the percentage of the population living in households where the total housing costs ('net' of housing allowances) represent more than 40 % of disposable income ('net' of housing allowances)."

According to definition, social apartments have a high occupation rate (average is 1.8 persons/ room), but with few exceptions are not considered overcrowded, because majority have one room for a couple, and one room for 1-2 minor children. As a "special social case", two families have just one parent.

If we consider also that each apartment has its own kitchen, entry hall, bathroom, storage, we can conclude that living conditions are very good.

6.2. Project and pilot presentation

We used just a very brief written presentation of the pilot (Appendix V), accent being on minimising costs with utilities.
Instead, during the meetings, all different aspects were discussed, in order to raise acceptance for participation, like:
- Why we decided to have a pilot project in Alba Iulia;
- What are the main project objectives;
- What are the estimated gains in terms of information, access at new technologies without cost and estimated utilities costs;
- What are the main activities of the pilot;
- What we need and what is expected from their implication;
- How we ensure confidentiality;

- Impact on other projects for people in similar social conditions, on environment, living costs and living quality.

6.3. Initial test - attitude towards utilities, costs and willingness of participation in pilot

In this first stage, is important to check tenant's level of knowledge regarding their energy/ utilities consumption and associated costs, and their attitude in relation to an energy efficiency project. In developing a simple questionnaire (presented in Appendix VI), we used existing information and recommendations from the MaxSumo framework.

We have defined the following areas:

a) Access to utilities, their importance, their quality and existing comfort;
b) Consumptions, associated costs and their impact on family budget;
c) Existing knowledge and behaviour regarding utilities;
d) Their willingness to participate and expectations from the pilot.

Bellow, we have the results of the questionnaire.

Area	No.	Question	Results	Conclusions
a	1	Assign a number from 1 to 10 which describes the importance of ensuring the necessary utilities:	- 41,67 % answered with 10 - 16, 67% answered with 9 -33,33 % answered with 8 -8,33 % answered with 7 average 8,91	The tenants consider important to provide the necessary utilities
a	2	Assign a number from 1 to 10 for the existing comfort degree:	- 41,66% answered with 10 -41,66% answered with 9 - 16,68% answered with 8 average 9,25	The tenants are very satisfied with the comfort they have in their home
a	3	Utilities are provided permanently, without interruptions, at normal parameters.	- 58,33% answered with TRUE - 33,33% answered with PARTIALLY TRUE - 8,34% answered with FALSE average 7,58	Most of the tenants consider that the utilities are provided permanently, without interruptions, at normal parameters
b	4	You are an independent user with very high utilities consumptions.	- 50% answered with TRUE - 41,66% answered with PARTIALLY TRUE - 8,34% answered with FALSE average 7,16	The tenants tend to have high utilities consumptions
b	5	Utility costs have a large share in the family budget.	- 75% answered with TRUE - 25% answered with PARTIALLY TRUE average 8,75	Most of the tenants consider that the utility costs have a large share in the family budget
b	6	Check the most expensive utility for your budget:	- 66,67% answered with HOT WATER	Hot water and Heat are the two most expensive

			33,33% answered with HEAT	utilities for tenants` budget
c	7	Do you consider that you are careful with the use of utilities and waste management?	- 25% answered with TRUE - 75% answered with PARTIALLY TRUE average 6,25	The tenants consider that they tend to be sometimes irresponsible with the use of utilities and waste management
c	8	Do you know relevant information about efficiency use of energy within your family and methods to reduce your costs?	- 25% answered with TRUE - 58,33% answered with PARTIALLY TRUE - 16,67% answered with FALSE average 5,58	The tenants` knowledge in efficiency use of energy tend to be moderate
d	9	Assign a number from 1 (not interested) to 10 (highly interested) for your interest to find out methods of reducing consumption and changing consumer behavior through the Social Green project.	- 75% answered with 10 -16,66% answered with 9 - 8,34% answered with 5 average 9,41	The tenants are highly interested in learning methods of reducing consumption and changing consumer behavior through the Social Green project
d	10	Assign a number from 1 (unlikely) to 10 (surely) for your interest to test and apply reducing consumption methods for lower bills.	- 75% answered with 10 -16,66% answered with 9 - 8,34% answered with 6 average 9,50	The tenants are highly interested in testing and applying reducing consumption methods for lower bills.
d	11	Assign a number from 1 (unlikely) to 10 (surely) for the probability to lower your consumption having access to specific information and also access to current consumption data (not only the ones provided by the official bills).	- 66,66% answered with 10 - 8,33% answered with 9 - 8,33% answered with 8 - 8,33% answered with 7 -8,33% answered with 6 average 9,16	Most of the tenants consider that if you are having access to specific information and also access to current consumption data, you can reduce your consumption
d	12	Assign a number from 1 (not interested) to 10 (highly interested) for your interest and commitment degree within the Social Green project.	- 75% answered with 10 -16,66% answered with 9 - 8,34% answered with 5 average 9,41	The tenants are highly interested in being involved in the Social Green project

Table 4. Centralized results of first questionnaire

Results offer interesting insights regrading tenant's perceptions regarding utilities and costs:

- Social apartments have a good level of comfort
- Utilities costs are important for family's budget
- Most expensive are heat and hot water (to be analysed)
- Utilities usage can be improved, based on relevant information and methods
- Tenants are highly interested in methods for diminishing utilities consumption and costs, together monitoring methods tested during Social Green pilot.

6.4. Aspects related to GDPR

Project needs many information and data, some of them requiring special attention, because are related to personal data. Such data includes personal aspects (name, contact details, family members, occupancy, daily schedule, etc.), confidential aspects (invoices, costs, revenues) and even access in homes for system installation. We developed a short model based on EU General Data Protection Regulation (2016/ 679 - GDPR), including main aspects and data involved, we checked it with our Data Protection Officer (DPO), together with our responsibilities, and asked tenants for acceptance, using the template presented in Appendix VII.

6.5. Main energy consumers in apartments

Once gathering main existing energy consumption data and costs, in order to identify more areas for energy efficiency and consumption behaviour we required a list of the main consumers residing inside an apartment, based on a comprehensive list presented in Appendix IX.

This proved to be a complicated task for most of the tenants, several clarifications being required. Main problems were caused by the difficulty of accessing labels of many different appliances and devices, or deciding on number of hours of daily operation. Excepting an accurate (25%) estimation from one apartment, most of the estimations on consumption are higher with 60 – 100% compared with real consumption data from invoices. This exercise, improved awareness regarding energy consumption of different home appliances and revealed also common consumers or possible actions for improving energy efficiency. Main conclusions:

- We have no estimation regarding energy from gas consumers, but all apartments have just a cooking machine with oven, using natural gas;
- All apartments have a laptop and internet router; this is important for smart systems communication;
- All apartments have basic appliances and estimated correctly their importance on electricity consumption: refrigerator, washing machine, iron, vacuum cleaner, tv, hair dryer, mixer; some of those appliances have over 5 years, so investigating further their type and consumption can be useful for consumption analysis;
- Several apartments have microwave oven, electric hood, coffee maker, second tv, etc.;
- We didn't identified air conditioning/ ventilation equipment, possibly because these appliances need intervention on construction;
- Excepting one apartment who has just LED bulbs and partially other two apartments, incandescent bulbs still form the majority for lighting; this situation can be explained by the high cost of LED bulbs and classic bulbs replacement can be the first action to be considered for improving energy efficiency.

6.6. Conclusions regarding tenants initial attitude and behaviour

Based on technical recommendation, the initial focus group included tenants from 10 apartments, having same orientation and disposed on two building verticals. Even during first meetings the tenants responded positively for volunteering the project, energy consumption and bills being one of their concerns in the family budget, only 4 provided information regarding their energy consumption and costs, representing an initial acceptance of 40%. After 3 weeks, 2 families refused participation, claiming lack of time, possible discomfort for them and their children, concerns regarding their data and too complicated process for finding historical consumption data. In the next stage, we involved another 5 apartments with 2 rooms, in order to achieve the required participation of 8 apartments. After clarifications and support, we obtained data and acceptance from 6 apartments of the initial group (60%) and 2 apartments from the second group (40%).

Cap.7. Energy and utilities consumption and cost in social apartments

7.1. Energy consumption and costs for electricity and natural gas

Each apartment has individual meters for electricity and natural gas. Meter readings are made manually by tenants (data being sent online) or by authorized persons of distributors in order to generate invoices. As pilot needs historical data for the “before” pilot implementation, the only available possibility was to request data regarding consumption and costs from tenants, based on old invoices. These request had some difficulties, because some tenants don’t have already paid old invoices, and other don’t use online billing archives (available at distributors, but just for 6 months). We used a simple table for consumption and value, as presented in Appendix VII. We obtained the following results:

Electricity

a) Electricity consumption is lower during summer months;
b) Average electricity consumption is of 132 kWh and average cost is of 19.37 € (91 Lei);
c) For one year, average consumption is of 1612kWh, generating a cost of 235.9 € (1109 Lei);
d) There are significant differences between apartments (1238 vs. 2063 kWh/year, 178 vs298 €, 839 vs 1408 Lei).

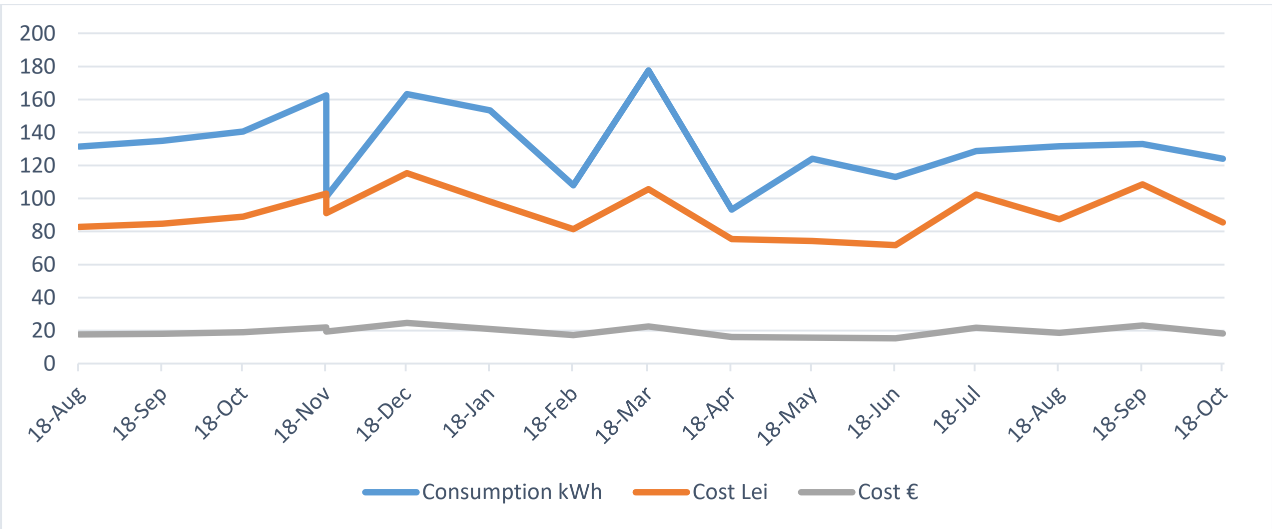


Fig. 16. Evolution of average electricity consumption (kWh) and cost (€) – Aug.2018 – Oct.2019

Natural gas

a) Meters show consumption in m3 and values are converted at 10.711kWh/m3;
b) Invoices are for 3 months, we don’t have a monthly evolution;

c) Consumption is significantly higher during winter;
d) Average consumption for an apartment is of 1041 kWh/year, at a cost of 35.97 € (169 Lei);
e) There are significant differences between apartments (880 vs 1160 kWh/year, 30.4 vs 40.1 €/year (143 vs 188 Lei/year).

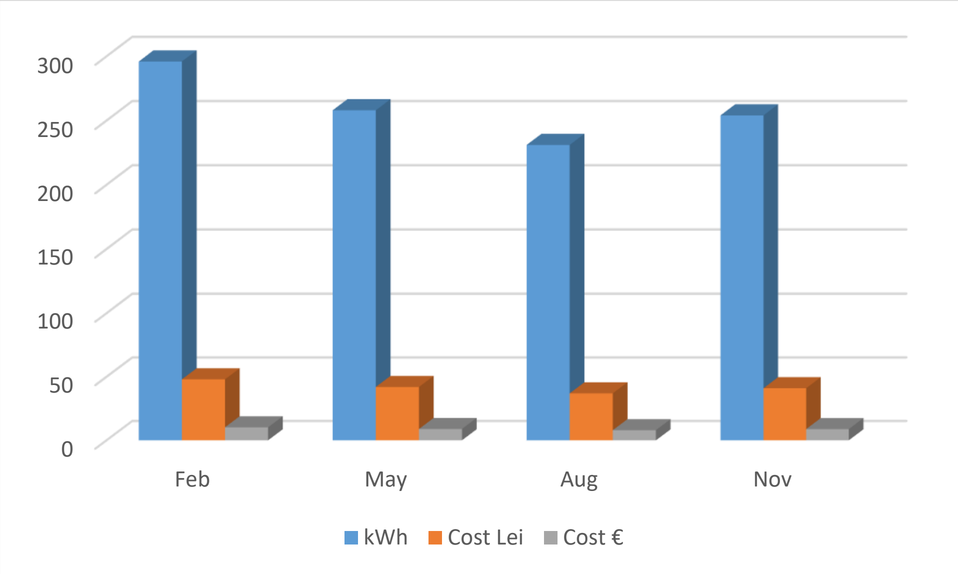


Fig.17. Evolution of average consumption and cost of natural gas

Conclusions

1) Nobody is checking regularly its meters, consumption and costs (recurring and time consuming activity);
2) As invoices are based on estimations and readings just at 3 months, tenants don't have necessary information for pro-active controlling consumption and costs before the invoice is issued;
3) More than that, as majority of invoices for electricity are estimations based on historical data, real data being based on real readings and adjusted at 3 months, information is not completely accurate;
4) Presented data are preliminary, and if necessary, can be adjusted with data from other apartments;
5) Invoices are very complicated and difficult to understand, especially for electricity; example: electricity monthly invoice includes: production cost + energy transport + energy distribution + cogeneration tax + green certificates + excise + VAT;
6) It is difficult to demonstrate efficiency of energy measures just using the invoices, as those are not accurate on short term;
7) Significant differences of energy consumption between similar apartments and occupation, reveals different consumption habits;
8) Evaluations on energy efficiency measures must consider average and individual consumptions on mid and longer terms, 12 months in the pilot case.

7.2. Other utilities consumption and cost – cold/ hot water, heating

For other utilities, including cold water, hot water, waste water, heating, general and individual meters are read monthly by block administration and calculated for each apartment considering also general invoices received from distribution companies (Electrica for electricity, EoN for gas, Apa CTTA for water).

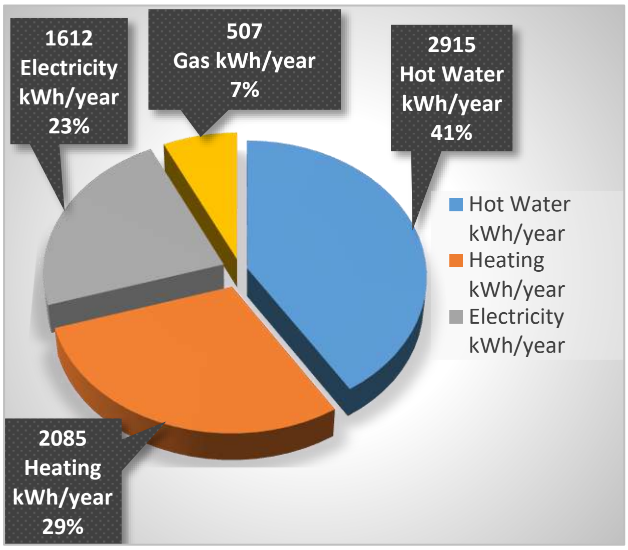
That's why, more detailed historical data are available from the administration archive (we used data from January 2018 to October 2019, for 10 apartments). Calculation of those utilities requires:

a) **For cold water:** whole block consumption, invoiced by Apa CTTA, divided individually according to individual consumption read on cold water meters;
b) **For hot water:** primary data are building water consumption from Apa CTTA invoice, building gas consumption for preparing hot water based on invoice from EoN and individual consumption of hot water read on individual meters;
c) **For heating**: primary date is gas consumption from the EoN invoice and readings of Gcal from individual heat meters; conversion rate applied is the classical one, 1Gcal = 1162.222 kWh;
d) **For waste water:** equals the sum of individual cold and hot water, plus a fraction of water from rain.
After centralizing all results and calculation of average data, we obtained the following results:

1) **Cold water:** Average consumption of cold water is 4.67 m3/month/ apartment (from 1.95 to 5.8 m3); average individual consumption is 1.34 m3/person/month and expectations were that apartments with higher occupancy have higher consumption, but is not a general rule (consumption varies from 0.97 to 1.92m3/person/month); average associated cost for cold water is 85€/year.
2) **Water needed for hot water:** Average consumption of hot water is 4.21 m3/month/ apartment (with a variation from 2.54 to 5.18) with an associated cost of 77 €/year.
3) **Waste water:** was calculated as percentage of cold, hot and rain water; average cost is 87 €/year.
4) **Solar panels:** building has 24 solar panels for minimising cost for production of hot water; we considered a cost comparison between summer and winter months at same unit of hot water consumption; result shows an average reduction of 19% for hot water bills during 5 months (May – September), equivalent of 20€/year/apartment. This result (smaller than expected) can be partially explained by higher hot water consumption during morning and evening, when solar panels are not so efficient, but requires also a technical investigation of the system.
5) **Energy for hot water:** most of hot water is produced by the building boiler, using natural gas. This process requires an average energy of 2915 kWh/apartment/year, with an associated cost of 227 €/year/ apartment (with a large variation, from 138 to 270 €/year/ apartment).
6) **Energy for heating:** heating is produced by the building boiler, using natural gas and measured by individual heat meters. On average, energy consumed for heating is of 2085 kWh/year/apartment, at a cost of 139 €/year/ apartment (with a variation between 97 to 292 €/year/ apartment). This seems reasonable, but considering that heating is functioning just 7 months we obtain a higher impact of cost during winter months, when invoices add in many cases over 40 €/month/ apartment.

7.3. Results for energy and utilities consumption and costs

For simplicity, data calculated in previous chapters were centralized in figures bellow.



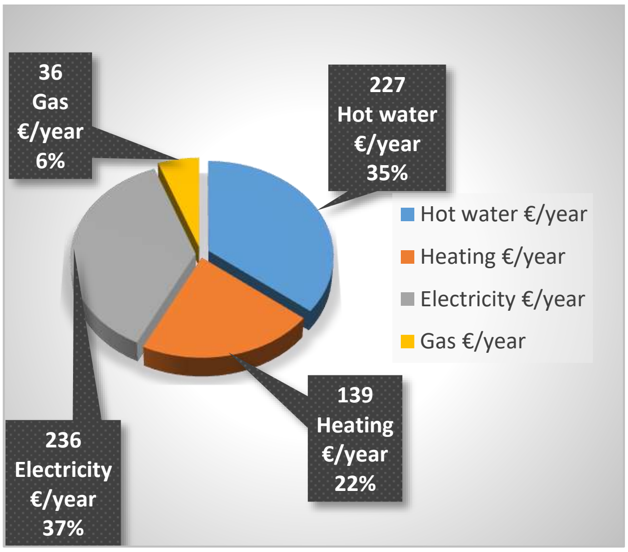


Fig.18. Average energy consumption/ apartment/year *Fig.19. Average energy cost/ apartment/ year*

In order, average energy consumption of an apartment for one year is formed by hot water, heating, electricity and natural gas, totalising 7119 kWh. This represent an average of 192 kWh/m2, bigger than previous measurement of 145 kWh/m2 at building level, but including energy consumed by appliances that usually are not included in an energy audit.

In terms of cost, order is changed, because 1 kWh of natural gas is cheaper than one from electricity, so electricity, hot water, heating and gas are contributing to a total average cost of 638 €/year/ apartment for energy. If we add water costs (cold water, hot water, waste water) of 249 €/year/ apartment, average cost of energy and utilities is of 887 €/year/ apartment, which represents 17% of the average salary and 26% of the minimum one.

These results, provide an important input for adopting various energy efficiency measures. Also, we must consider that 2 apartments have usually lower consumptions than the rest, suggesting a different consumption behaviour or applying various methods for limiting consumption and costs.

Cap.8. Requirements for the monitoring system

8.1. Parameters recommended by BPM

As building information before and after a retrofit, or building modelling is not in our pilot project scope, we will focus on parameters related to energy and interior climate:

a) Indoor conditions - indoor temperature, humidity, CO2 concentrations, heating set points; optional on illuminance;
b) Energy measurements (natural gas m3, electricity consumption kWh, heat kWh);
c) Optional outdoor conditions (air temperature °C, atmospheric pressure Pa, relative humidity %, solar radiation W/m2, wind speed/ direction) if needed, will use existing weather data.
d) Other parameters, protection sensors (like smoke, gas, flood) or virtual sensors only if needed.

It is recommended that the reading frequency of parameters to be set around 10 min.

8.2. Restrictions and challenges from existing metering solutions

a) Electricity consumption monitoring

Existing individual electricity meter is property of the distributor (Electrica) is digital, is sealed and cannot be accessed. The only possibility is one of a smart meter, installed in each apartment inside/ near the fuse panel, without modification on electrical diagram.

b) Natural gas monitoring

The existing gas meter is property of the distributor (EoN), is mechanical, is sealed and cannot be accessed or modified in order to generate impulses for monitoring. The only solution is a complicated one, installing a digital gas meter, based on an approved project (required considering explosion risk).

c) Cold and hot water monitoring (building property)

Existing meters are mechanical and the producer considered that is very complicated to adapt them for generating electrical signals, proposing replacement with more modern ones, with digital output.

d) Heat meters (building property)

Existing individual heat meter is digital, but is not produced anymore and requires a special optical or M-bus adapter, option being replacement with a newer (and expensive) model.

8.3. Restrictions imposed by tenants

As apartments are in use, interventions on existing installations and discomfort must be reduced to a minimum. Is preferable that the system to be installed in few hours, without wires and minimise sensors related to occupancy (like presence sensors, video, open windows). Interventions on important utilities (like electricity, water, heating) must be reduced to a minimum, considering that is winter season and all families have children.

8.4. Project restrictions

Project requirements must be considered in terms of minimal measured parameters, short implementation time (system must be functional in February 2020), budget (maximum 9.000 € for equipment), data acquisition and reporting.

8.5. Possible technical solutions

Alba Iulia Municipality team, with project partners Tartu Regional Energy Agency, 1st December 1918-University of Alba Iulia and other consultants (like Technical University Cluj and companies specialised in smart metering solutions) analysed possible solutions and system configuration.

a) Professional / industrial solutions

This solution has the advantage of using professional, accurate and long life industrial solutions, many of them being adopted for large buildings automation and management. These solutions are standard for different meters like those for electricity, cold/hot water, gas, flow, pressure, temperature, etc., being able to measure all needed parameters. In most cases, communication is based on cables (wired M-Bus) or radio (wireless M-bus), require power supply, data acquisition and processing systems and industrial computers/ controllers. This solution requires a dedicated project, approvals, important intervention/ replacement of existing equipment, long access time in location and a budget more than double of the existing one.

b) Smart home solutions

These solutions appeared recently and are not yet common, being used on small scale in individual homes or buildings. Their development is accelerated by smart appliances (like Google Home or Nest, Amazon Alexa) able to work based on vocal recognition and programmed execution and automation. While this solutions are still in an accelerated development, usage of this solutions in Romania is still minimal, for majority being considered not important, affordable or respecting privacy. These solutions have several advantages, like: multiple standards, usual wireless communication, easy configuration (plug and play principles), acceptable range of sensors, programmed scenarios, friendly reporting and control on mobile, reasonable cost. As disadvantages, range is limited (30 m without concrete walls), power is insured by batteries and sensitive meters (like those for gas or water) are not common, available or enough tested.

8.6. Adopted monitoring solution

Considering all aspects presented above, the team had to reach a compromise between controlled parameters, system configuration, implementation and costs. The final solution implies a smart home system (replicated in all 8 apartments), with accent on two main components (electricity and heating) including:

- Smart home controller, with mobile control and report;
- General electricity consumption and 2 smart wall plugs for main electrical consumers;
- Heat control in 3 rooms;
- Climate monitoring – temperature, humidity and CO_2;
- Smoke protection (apartments already have gas sensor and valve);
- LED bulbs for replacing classical incandescent ones.

Based on this configuration, we have prepared technical system requirements as presented in detail in Appendix X and needed for the acquisition process. Other important requirements refers to system installation, initial configuration ("turn key solution"), users training, maintenance and troubleshooting.

As water (cold and hot) and heat monitoring are difficult to implement, we will use a periodic manual reading, in order to have more accurate readings and compare evolution. For illuminance, we will manually verify existing levels and levels after using LED bulbs.

Cap.9. Conclusions

The present study proved to be more complex than estimated, because it involves two dimensions:

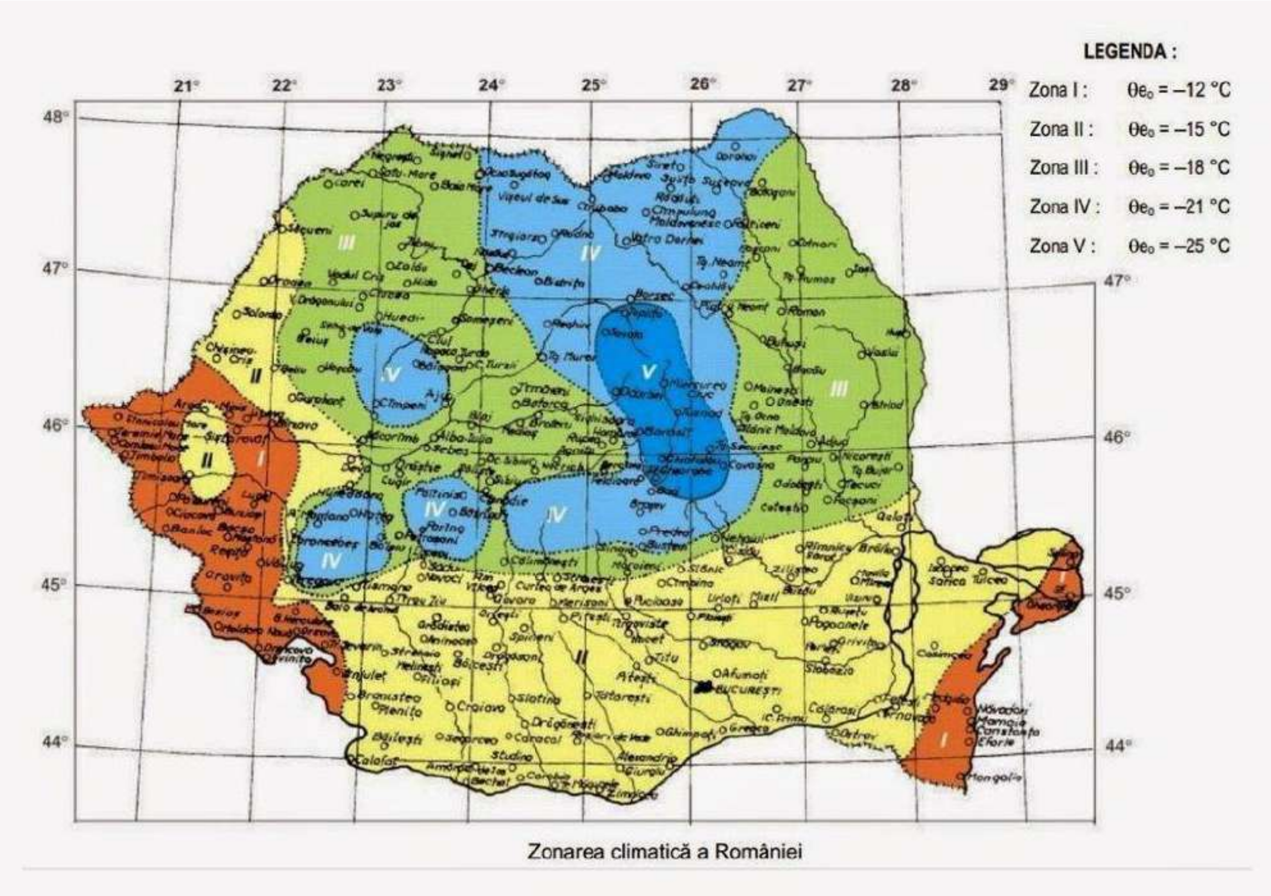
- Technical one – finding an acceptable solution in an functional building with existing constrains on metering and monitoring energy and water in an effective way;
- Sociological – convincing tenants of social apartments to volunteer in this pilot, providing their feedback, personal or consumption information, providing access in their homes, willing to improve their consumption habits and improve energy efficiency based on information and usage of new solutions.

On the technical side, this report fully prepares the next project phase, monitoring system acquisition and installation.

On the human scale, project revealed that tenants need more information regarding their energy consumption, their utilities bills, or habits that can be changed in order to improve their existing behaviour, together with constant support during the rest of the pilot.

As far as we know, it is between the first studies of its kind in Romania and its conclusions, together with the following project activities can be considered as first steps for a change in the way in which energy efficiency projects are developed and implemented in social apartments.

APPENDIX I - Climate zones for Romania



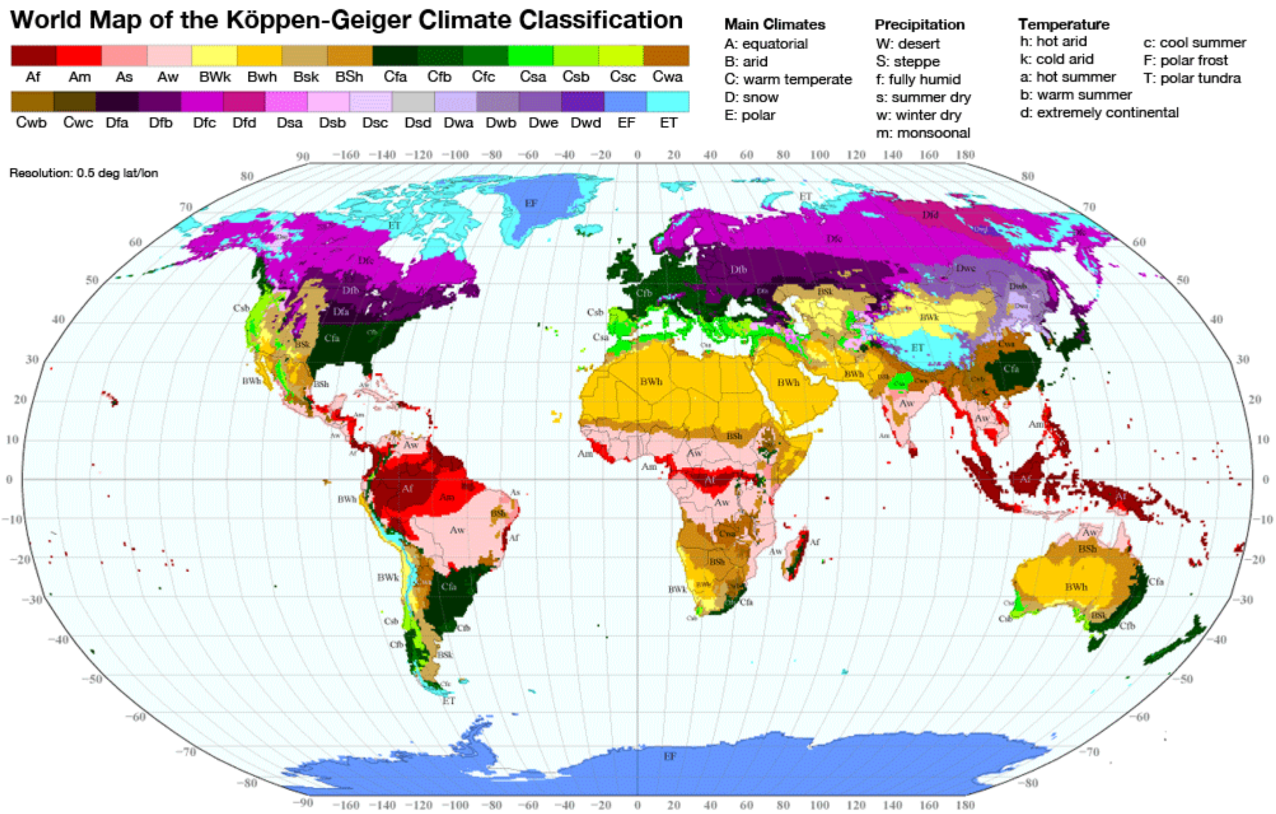
Ministry of Regional Development and Public Administration – Methodology for calculation of Energy Performance of Buildings, MC 001/4 – 2009
https://www.mdrap.ro/userfiles/reglementari/Domeniul_XXVII/27_11_MC_001_4_5_2009.pdf

Alba Iulia is in climate zone III.

APPENDIX II - World climate zones

https://www.weatherbase.com/gr/koppen.png

Alba Iulia and Tallinn are considered in the same climate area



APPENDIX III - Energetic class for a bloc of social apartments in Alba Iulia

Building energy performance classes according to energy consumption W/m2/year

Heating

A	B	C	D	E	F	G
	70	117	173	245	343	500
	73.19					

Hot water

A	B	C	D	E	F	G
	15	35	59	90	132	200
		52.19				

Lighting

A	B	C	D	E	F	G
	40	49	59	73	91	120
11.28						

Basic (Heating + Hot water + Lighting)

A	B	C	D	E	F	G
	125	201	291	408	566	820
	136.66					

Mechanical ventilation

A	B	C	D	E	F	G
	5	8	11	15	21	30
4.76						

Climatisation

A	B	C	D	E	F	G
	20	50	87	134	198	300

Conclusion: building has energy class B, with 141.42 kWh/m2/year, but is close to class A (130kWh/m2/year).

Energy class is influenced mainly by heating (class B) and especially by hot water consumption (class C), justified by a high level of occupancy.

Building complies with the energy requirements set by national laws and regulations at 153 kWh/m2 for buildings up to 4 floors.

Ministry of Regional Development and Public Administration – Methodology for calculation of Energy Performance of Buildings, MC 001/4 – 2009
https://www.mdrap.ro/userfiles/reglementari/Domeniul_XXVII/27_11_MC_001_4_5_2009.pdf

Appendix IV - Living costs in Tartu / Estonia and Alba Iulia / Romania

https://www.numbeo.com/cost-of-living/compare_cities.jsp?country1=Estonia&country2=Romania&city1=Tartu&city2=Alba+Iulia

You would need around 1,388.35€ (6,633.57lei) in Alba Iulia to maintain the same standard of life that you can have with 2,300.00€ in Tartu (assuming you rent in both cities).

Indices Difference
Consumer Prices in Alba Iulia are 35.50% **lower** than in Tartu
Consumer Prices Including Rent in Alba Iulia are 39.64% **lower** than in Tartu
Rent Prices in Alba Iulia are 56.80% **lower** than in Tartu
Restaurant Prices in Alba Iulia are 48.95% **lower** than in Tartu
Groceries Prices in Alba Iulia are 28.21% **lower** than in Tartu
Local Purchasing Power in Alba Iulia is 35.89% **lower** than in Tartu

	Tartu	Alba Iulia	Difference
Restaurants			
Meal, Inexpensive Restaurant	6.00 € (28.67 lei)	3.56 € (17.00 lei)	-40.70 %
Meal for 2 People, Mid-range Restaurant, Three-course	40.00 € (191.12 lei)	17.79 € (85.00 lei)	-55.53 %
McMeal at McDonalds (or Equivalent Combo Meal)	6.00 € (28.67 lei)	3.51 € (16.75 lei)	-41.57 %
Domestic Beer (0.5 liter draught)	3.50 € (16.72 lei)	1.15 € (5.50 lei)	-67.11 %
Imported Beer (0.33 liter bottle)	4.00 € (19.11 lei)	1.47 € (7.00 lei)	-63.37 %
Cappuccino (regular)	2.36 € (11.29 lei)	1.20 € (5.75 lei)	-49.06 %
Coke/Pepsi (0.33 liter bottle)	1.42 € (6.79 lei)	1.02 € (4.89 lei)	-28.00 %
Water (0.33 liter bottle)	0.71 € (3.40 lei)	0.88 € (4.20 lei)	+23.48 %
Markets	[Edit]	[Edit]	
Milk (regular), (1 liter)	0.80 € (3.82 lei)	0.84 € (4.00 lei)	+4.79 %
Loaf of Fresh White Bread (500g)	0.79 € (3.76 lei)	0.52 € (2.50 lei)	-33.58 %
Rice (white), (1kg)	1.38 € (6.57 lei)	0.92 € (4.40 lei)	-33.03 %
Eggs (regular) (12)	1.47 € (7.00 lei)	1.99 € (9.53 lei)	+36.15 %
Local Cheese (1kg)	7.10 € (33.92 lei)	4.29 € (20.50 lei)	-39.57 %
Chicken Breasts (Boneless, Skinless), (1kg)	5.33 € (25.48 lei)	3.66 € (17.50 lei)	-31.33 %
Beef Round (1kg) (or Equivalent Back Leg Red Meat)	8.40 € (40.14 lei)	5.23 € (25.00 lei)	-37.71 %

Apples (1kg)	0.97 € (4.62 lei)	0.73 € (3.47 lei)	-24.82 %
Banana (1kg)	1.09 € (5.22 lei)	1.05 € (5.00 lei)	-4.21 %
Oranges (1kg)	1.43 € (6.85 lei)	0.97 € (4.61 lei)	-32.67 %
Tomato (1kg)	2.30 € (10.99 lei)	1.17 € (5.57 lei)	-49.35 %
Potato (1kg)	0.43 € (2.05 lei)	0.52 € (2.50 lei)	+21.68 %
Onion (1kg)	0.32 € (1.51 lei)	0.63 € (3.00 lei)	+98.28 %
Lettuce (1 head)	1.35 € (6.45 lei)	0.58 € (2.75 lei)	-57.37 %
Water (1.5 liter bottle)	0.55 € (2.63 lei)	0.52 € (2.50 lei)	-4.87 %
Bottle of Wine (Mid-Range)	8.00 € (38.22 lei)	3.66 € (17.50 lei)	-54.22 %
Domestic Beer (0.5 liter bottle)	1.27 € (6.05 lei)	0.72 € (3.46 lei)	-42.82 %
Imported Beer (0.33 liter bottle)	1.73 € (8.24 lei)	1.26 € (6.00 lei)	-27.20 %
Cigarettes 20 Pack (Marlboro)	4.20 € (20.07 lei)	3.66 € (17.50 lei)	-12.80 %
Transportation	[Edit]	[Edit]	
One-way Ticket (Local Transport)	1.50 € (7.17 lei)	0.52 € (2.50 lei)	-65.12 %
Monthly Pass (Regular Price)	15.34 € (73.29 lei)	15.70 € (75.00 lei)	+2.33 %
Taxi Start (Normal Tariff)	2.80 € (13.38 lei)	0.52 € (2.50 lei)	-81.31 %
Taxi 1km (Normal Tariff)	0.65 € (3.11 lei)	0.48 € (2.30 lei)	-25.94 %
Taxi 1hour Waiting (Normal Tariff)	13.00 € (62.11 lei)	4.81 € (23.00 lei)	-62.97 %
Gasoline (1 liter)	1.36 € (6.49 lei)	1.18 € (5.66 lei)	-12.85 %
Volkswagen Golf 1.4 90 KW Trendline (Or Equivalent New Car)	19,732.50 € (94,282.48 lei)	15,696.85 € (75,000.00 lei)	-20.45 %
Toyota Corolla 1.6l 97kW Comfort (Or Equivalent New Car)	18,576.67 € (88,759.87 lei)	15,750.55 € (75,256.60 lei)	-15.21 %
Utilities (Monthly)	[Edit]	[Edit]	
Basic (Electricity, Heating, Cooling, Water, Garbage) for 85m2 Apartment	170.63 € (815.29 lei)	91.24 € (435.96 lei)	-46.53 %
1 min. of Prepaid Mobile Tariff Local (No Discounts or Plans)	0.03 € (0.12 lei)	0.04 € (0.20 lei)	+62.56 %
Internet (60 Mbps or More, Unlimited Data, Cable/ADSL)	23.50 € (112.28 lei)	7.35 € (35.10 lei)	-68.74 %
Sports And Leisure	[Edit]	[Edit]	
Fitness Club, Monthly Fee for 1 Adult	37.20 € (177.74 lei)	24.07 € (115.00 lei)	-35.30 %
Tennis Court Rent (1 Hour on Weekend)	23.00 € (109.89 lei)	8.89 € (42.50 lei)	-61.33 %
Cinema, International Release, 1 Seat	7.00 € (33.45 lei)	4.19 € (20.00 lei)	-40.20 %

Childcare			
Preschool (or Kindergarten), Full Day, Private, Monthly for 1 Child	170.25 € (813.46 lei)	209.29 € (1,000.00 lei)	+22.93 %
International Primary School, Yearly for 1 Child	10,600.00 € (50,647.12 lei)	4,331.40 € (20,695.57 lei)	-59.14 %
Clothing And Shoes			
1 Pair of Jeans (Levis 501 Or Similar)	71.81 € (343.09 lei)	39.28 € (187.69 lei)	-45.29 %
1 Summer Dress in a Chain Store (Zara, H&M, ...)	27.81 € (132.89 lei)	28.78 € (137.50 lei)	+3.47 %
1 Pair of Nike Running Shoes (Mid-Range)	66.05 € (315.60 lei)	49.18 € (235.00 lei)	-25.54 %
1 Pair of Men Leather Business Shoes	81.92 € (391.43 lei)	58.25 € (278.33 lei)	-28.89 %
Rent Per Month			
Apartment (1 bedroom) in City Centre	383.00 € (1,829.99 lei)	156.97 € (750.00 lei)	-59.02 %
Apartment (1 bedroom) Outside of Centre	290.00 € (1,385.63 lei)	115.11 € (550.00 lei)	-60.31 %
Apartment (3 bedrooms) in City Centre	669.33 € (3,198.09 lei)	277.31 € (1,325.00 lei)	-58.57 %
Apartment (3 bedrooms) Outside of Centre	436.67 € (2,086.41 lei)	219.76 € (1,050.00 lei)	-49.67 %
Buy Apartment Price			
Price per Square Meter to Buy Apartment in City Centre	2,149.94 € (10,272.46 lei)	965.88 € (4,615.00 lei)	-55.07 %
Price per Square Meter to Buy Apartment Outside of Centre	1,334.22 € (6,374.93 lei)	808.91 € (3,865.00 lei)	-39.37 %
Salaries And Financing			
Average Monthly Net Salary (After Tax)	**1,041.70 € (4,977.28 lei)**	**403.09 € (1,926.00 lei)**	**-61.30 %**
Mortgage Interest Rate in Percentages (%), Yearly, for 20 Years Fixed-Rate	2.48	5.50	+121.77 %

Appendix V – Brief presentation of pilot objectives to tenants

Regional Policies Towards Greening the Social Housing Sector,
Acronym SOCIAL GREEN

„Regional Policies Towards Greening the Social Housing Sector" – Acronym Social Green represents a project funded by the European Union through the European Regional Development Fund (ERDF) within the INTERREG EUROPE IVC program, which is implemented by Alba Iulia Municipality as project partner. The transnational project consoritum is coordinated by the Innovation and Innovation Intelligence Centre - INTELI from Portugal.

The stages of the Pilot Action developed within the SOCIAL GREEN project are the following:

- observation of the interior/exterior state of the building;
- installation of multiple sensors and intelligent energy consumption metering devices;
- monitoring smart devices and data collection;
- data analysis and comparison between the "before" and "after" implementation scenario of the pilot project (the comparison will be based on data collected through intelligent sensors);
- proposal for specific measures to optimise energy consumption at building level and also proposal for measures aiming to change the behaviour of tenants living in social housing.

What do we want?

The implementation of the pilot project aims **to reduce energy consumption and the costs of corresponding bills at the level of the social housing.** The proposed objective can be achieved only with the help of active involvement of people living in social housing.

For more information, please call the following phone number: ***0372.586.428 - Drâmbărean Tudor.***

Appendix VI - Questionnaire

Apartment: ____

Please provide an answer for the following questions/statements:

1	Assign a number from 1 to 10 which describes the importance of ensuring the necessary utilities:	

2	Assign a number from 1 to 10 for the existing comfort degree:	

3	Utilities are provided permanently, without interruptions, at normal parameters. Check an option:		
	☐ True	☐ Partially true	☐ False

4	You are an independent user with very high utilities consumptions. Check an option:		
	☐ True	☐ Partially true	☐ False

5	Utility costs have a large share in the family budget. Check an option:		
	☐ True	☐ Partially true	☐ False

6	Check the most expensive utility for your budget:				
	☐ Cold water	☐ Hot water	☐ Natural gas	☐ Electricity	☐ Heating

7	Do you consider that you are careful with the use of utilities and waste management? Check an option:		
	☐ True	☐ Partially true	☐ False

8	Do you know relevant information about efficiency use of energy within your family and methods to reduce your costs? Check an option:		
	☐ True	☐ Partially true	☐ False

9	Assign a number from 1 (not interested) to 10 (highly interested) for your interest to find out methods of reducing consumption and changing consumer behavior through the Social Green project.	

10	Assign a number from 1 (unlikely) to 10 (surely) for your interest to test and apply reducing consumption methods for lower bills.	

11	Assign a number from 1 (unlikely) to 10 (surely) for the probability to lower your consumption having access to specific information and also access to current consumption data (not only the ones provided by the official bills).	

12	Assign a number from 1 (not interested) to 10 (highly interested) for your interest and commitment degree within the Social Green project.	

Appendix VII – GDPR Template

Declaration agreement for the collection and processing of personal data under the Personal Data Protection Regulation (GDPR), Declaration agreement on the entry into the home of the person using it and its involvement in the implementation of SOCIAL GREEN project

I, the undersigned, ..., identified with the Personal Number Code ...., telephone:..................................., as a data subject, hereinafter referred to as the **subject**, **hereby declare that I agree with the following**:

1. The collection and procession of the subject's personal data made by Alba Iulia Municipality in order to implement the Regional Policies Towards Greening the Social Housing Sector Project (Acronym Social Green), a project which is founded by the European Union through FEDR within the European program INTERREG EUROPE IVC, approved by Alba Iulia Local Council through the Decision no. 54 from 25.02.2016 and implemented by Alba Iulia Municipality;
2. Ensuring access of Alba Iulia Municipality`s employees inside the subject`s home located in Alba Iulia municipality, Alba county, ……………..................……… street (including home number, flat number etc.), taking into consideration the subject`s involvement in the Social Green project implementation. In this regard,

- The solicitation to enter inside the subject`s home will be made at least 24 hours before before the entry. It is estimated to organize 1 entry per home every month;
- The subject will provide the information required by the beneficiary within the agreed deadlines;
- The subject will express its agreement on potential equipment works (intervention upon existing equipment/new installation).

Collected data

The data collected from the subject will be found within the official documentation of the project, such as: name and surname of the subject, identification data of the subject, contact data of the subject, information about the energy and heat consumption, photos, housing images and any other personal data of the subject.

The purpose for which this Declaration Agreement will be used will be used

The data covered by the present declaration will be used only for the following legitimate purpose: *implementation of the SOCIAL GREEN project*.

The statistical statements and any elaborated documents containing personal data of thes subject have anonymous charater with respect to the colaboration with the project partners and third parties. Namely, each apartment will have assigned a letter (for example: apartment no. 1 = a, apartment no. 2 = b etc.), the real names of the participants involved in the project will not be used, etc.

The subject`s rights

The subject is protected by the Personal Data Protection Regulation (GDPR) and has the following rights: the right to information and access; the right to rectification; the right to erasure of data; the right to restriction of data processing; the right to opposition; the right not to be the subject to a decision based solely on automatic processing, including profiling creation. Mentioned rights may be exercised by a request to the Data Protection Officer (DPO).

The data transfer to a recipient in Romania or to a third country or to an international organization will be carried out to entities with a legal personality which are empowered to perform the activities foreseen in the European Program INTERREG EUROPE IVC

Data storage period

Personal data (PD) is collected and processed for a period of 14 months, after which it is archived together with the project documents, according to the law.

Declaration

The subject consents to Alba Iulia Municipality regarding the use of personal data for the above mentioned purposes.

The use of data for purposes other than those described above is strictly prohibited.

Location: Date: Name, surname and Signature

Appendix VIII – Information regarding energy consumption and costs

Information about energy consumption at apartment level > considering the bills emitted by ELECTRICA for electricity

		Apartment number =	
		kWh	Cost, lei
	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
2018	Dec		
	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
2019	Dec		
	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
2020	Dec		

Information about natural gas consumption at apartment level > considering the bills emitted by EoN

		Apartment number =	
		m3 or kWh	Cost, lei
	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
2018	Dec		
	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
2019	Dec		
	Jan		
	Feb		
	Mar		
	Apr		
	May		
	Jun		
	Jul		
	Aug		
	Sep		
	Oct		
	Nov		
2020	Dec		

Appendix IX – Identifying main energy consumers from an apartment

Apartment: ____

Identification of major consumers - electricity

Each room will be scanned and accurate data will be filled in

Lighting (chandeliers, lamps, wall sconces, etc.)						
	Bulb type: incandescent, neon, LED Power bulb, W	No. pcs	Bulb power, W	Operating hours / day	How many days per week	Location / Room (living room, hallway, kitchen, bedroom)
Type 1						
Type2						
Type 3						
Type 4						
Type 5						
Type 6						
Type 7						
Type 8						
Type 9						
Type 10						

Electrical appliances						
	Type, model, years	No.pcs	Power W	Operating hours / day	How many days per week	Location / Room (living room, hallway, kitchen, bedroom)
Mixer						
Hairdryer						
Electric clothes dryer						
Coffee maker						
Dishwasher						
Mixer preparation						
Iron						
Machine washing vertical shaft						
Machine wash horizontal shaft						
Fruit / vegetable juicer						
Kitchen robot						
Electric chopping machine						
Electric stove						

Microwave						
Refrigerator						
Vacuum cleaner						
Boil the water						
Grill / electric hob						
Microwave						
Faucet with electric heating						
Other appliances?						
Climate conditioning						
	Type, model, years	No.pcs	Power W	Operating hours / day	How many days per week	Location / Room (living room, hallway, kitchen, bedroom)
Fan						
Heating fan (air heater)						
Dehumidifier						
Electric heater						
Radiant electric heater						
Air conditioning						
Other						

Electronic devices						
TV						
Radio / CD						
Audio system						
Tuner / CD						
Cable TV tuner						
satellite antenna						
Computer desk						
laptop						
Printer						
Scanner						
Internet router						
Cordless phone						
Games console						
Other electronics?						
Other devices/ Tools						

ex. Electric pillow						
ex. hammer drill						
Total						

Natural gas consumers						
Resource gas						
Clothes dryer						
Heater						
Gas cooker						
Oven						
Water boiler						
Other						

Appendix X – System technical requirements

1) **Home Controller / Gateway**

Gateway station capable of communicating radio with all sensors and the elements of automation (can control over 50 system elements) throughout the controlled area (min 30m radius); to be able to control sensors / equipment from various providers using the same communication standard, including the use of "virtual sensors".

Interrogates, saves periodically - recommended 10 minutes, sensor data / status, or recorded values; possesses data back-up and recovery;

Can be connected to the local WiFi router for internet access and remote control / monitoring; can manage one or more apartments; a user / tenant must have the user and the password of access only to his equipment, mounted in his apartment; the control panel must allow remote admin configuration; the control unit must allow the configuration of dispatcher users, who are responsible for the project from the mayor's office, who can access, save and process data and reports of all sensors, power stations and equipment for the purpose of presenting 12 months evolution reports and graphs.

Software for configuring and programming system elements;

Can work independently, or in master-slave regime;

The radio communication between the control unit, sensors, system elements and remote via the Internet will be secured;

Allows flexible configuration and reporting for each network element, alert scheduling; the status or consumption reports can be completed with a cost report, where appropriate; the status or evolution reports can be downloaded and presented graphically;

Connection for configuration; includes communication software;
Can be configured and work via the internet with mobile devices; there is software for laptop / mobile available;
Keeping data at power loss and returning to operation;
Indoor installation; operation 0 - 40C; 230Vac power supply.

2) Smart electricity meter

Single phase electronic meter, min. 35A / 230Vac / 50Hz; depending on size, it will be mounted in the fuse panel or insulated in a dedicated / insulated box, next to the fuse panel, protected, without external electrical wires that can be reached.
It has clamp / clamp type voltage and current inputs;
Radio communication (standardized protocol) with the control panel / remote on mobile;
Measurement of at least the active power, class 1 (optional can be models with several parameters - reactive energy, voltage, current);
Configuring reporting at pre-set time intervals and / or exceedances; the normal reading period is 10 min;
Ability to repeat the report and repeat the signal of other compatible sensors;
Indoor operation, 0-40 C, IP20 min insulation;
Power supply from 230Vac network, consumption <5W.

3) Smart electricity plug
Indoor equipment;
Remote on / off function;
230Vac power supply;
Active energy consumption reporting;
Controlled power> 2kW;
Radio connection with the intelligent / remote home control unit on mobile; can repeat the signal of other sensors.

4) Smoke sensor
Indoor equipment; Smoke detector, with testing at least every 30s;
Operating 0 - 40 C, humidity min 50%;
Radio coupling with smart home / remote control unit on mobile;
Battery or battery power;
Autonomy min 12 months.

5) Climate monitor
Indoor, wall or wall mounting; LCD display of climatic parameters;
CO_2 - 0 - 2000ppm;
Temperature min 0-40grC;
Humidity 0-95%;
Warning when exceeding the comfort parameters;
Parameter recording and sending data to the switchboard via radio / remote on mobile; must save the evolution, recommended at 10 min;
Power supply from 230Vac; optional battery / accumulator back up.

6) Mechanical thermostat

Mechanical equipment for the replacement of the current faucet; thermostat valve; Example: M30 x 1.5, Danfoss RTD-N, Danfoss RA-N, etc.

7) Smart heat controller

Indoor operation, operating temperature> 80grC, D15, 1/2;
Manual, automatic programmed adjustment and room temperature control (0 - 24 C; drive motor);
Radio coupling with smart home / remote control unit on mobile;
Power supply with batteries or accumulators;
Autonomy min 6 months.

8) Temperature sensor for heat controller

Temperature sensor, 0-40C, precision 0.5C, radio coupled to the heat controller;
Power supply with batteries or accumulators;
Autonomy min 12 months; in the case of accumulators, it can be charged with an adapter.

9) LED bulbs

LED bulb, warm white (2700K), energy class A +, E27 socket, min. 14W/11W, operating> 15,000 hours, 230Vac

SOCIAL GREEN - REGIONAL POLICIES TOWARDS GREENING THE SOCIAL HOUSING SECTOR

MID TERM REPORT FOR PILOT ACTION IN ALBA IULIA

"Improving energy efficiency in social apartments using smart monitoring solutions"

August - 2020

Author: Alba Iulia Municipality (Romania)

Partner: Tartu Regional Energy Agency (Estonia)

SUMMARY

The initial report for the pilot of the Social Green project in Alba Iulia prepared the next phase, implementation of a Smart Home concept in 8 social apartments, offering an overview of the main aspects, like:

- Energy consumption analysis and associated costs;

- Existing technical devices for measuring utilities and system configuration;
- Identification of main consumers;
- Social data, profile of the tenants, openness to smart metering solutions;
- Technical and personal constrains and requirements;
- Preparing solutions, requirements and the acquisition process;

which are defining a consistent "before implementation" model.

The present pilot mid-term report, includes evolutions on installing the technical system, data related to the energy consumption, together with user's feedback after first months of usage of the system.

This is consistent with assumed monitoring of pilot evolution, based on acquisition of data related to utilities consumption and organising surveys for signalling possible changes in attitude or consumption behaviour of tenants from social apartments.

As in the initial stage we have identified that utilities bills are complicated and difficult to understand, we prepared a dedicated information material for tenants. Also, in order to ease their evolution related to consumption behaviour, we are going to use several materials (including some from other dedicated EU projects) for preparing a material dedicated to simple solutions for lowering utilities consumption and bills. In the next couple of months, we will test their impact and adoption.

During last months, due to the impact of the Covid 19, we were obliged to limit face to face interactions with tenants, opting instead to phone and online communication, without an impact on project evolution.

As a conclusion, pilot has a good evolution to the next planned stage.

Table of Contents

Cap. I. Introduction

The pilot in Alba Iulia implements in 8 social apartments a series of good practices in the area of Building Performance Monitoring and Assessment (BPMA) framework (as defined by the Estonian good practice) who addresses several major aspects used for building energy performances assessments.

Following this framework, in first pilot months we gathered information on the conditions of living in social buildings, energy consumption and tenant's behaviour or attitude towards energy and new monitoring solutions. The present mid-term report, covers other BPMA aspects, like:

- Installing several sensors and smart monitoring devices;
- Collecting data for a relevant period;
- Offer info regarding utility bills and preparing measures for optimising energy consumption;
- Measure changes in behaviour of tenants living in the social housing dwellings.

As pilot has just few months after implementation, another important BPMA aspect, related to analysing data and comparing scenario "before implementation" and "after implementation", can offer just preliminary results at this moment.

Following this model of approach, the Pilot Action in Alba Iulia will analyse and monitor both technical and behaviour data, based on existing data, new data gathered by smart home systems or questionnaires and surveys used periodically, being also focused with main project objectives. The present mid-term report, covers the following main tasks, activities and implementations:

Task	Months	Activity	Brief description
T2	M2 - M3	**Organizing public tenders**	Acquisition of smart-metering devices, sensors and other smart appliances and tools for measuring energy efficiency at the level of 8 public housing flats.
T3	M3 - M4	**Installing the smart-metering monitoring system**	Installing sensors, smart-metering devices, smart appliances, tools etc. at the level of 8 targeted social housing apartments with the consent of the tenants which volunteer for the proposed pilot, systems being monitored and managed by the municipality, using the adequate software and communication tools. The system will be installed by technical experts from the municipality and from private companies which deal with smart-metering systems.
T4	M4 - M16	**Organizing surveys**	After installing all technical components, team will organize a first survey, capturing the initial feedback from the tenants and their interest in the appliances and smart-metering devices installed in their homes ("attractiveness" of smart solutions, attitude and perceptions on technology, satisfaction, technical difficulty).
T5	M4 - M16	**Monitoring the energy parameters of the social housing flats**	Monitoring energy parameters and organizing monthly meetings with the tenants in order to present the monthly statistics, data acquired and discussing options for behavioural change in order to obtain optimal results in terms of energy consumption and increased comfort.

T6	M10	**Half period reporting**	Analysing of results of the pilot in a workshop, including partners and tenants; based on feedback, system can be improved for eliminating dysfunctionalities and achieve a successful implementation.

Table.1. Social Green pilot in Alba Iulia – main activities covered by the present report

Cap.2. Monitoring system acquisition and installation

2.1. Acquisition process

The initial report of the Social Green pilot in Alba Iulia includes technical system constrains and decision regarding technical requirements (Appendix X). Other requirements were imposed by short installation time, tenant's schedule, availability of data reports and budget.

Following prescriptions of legislation related to public acquisitions, the process was based on public announcements and invitations sent to major authorized smart home distributors.

Aspects related to acquisition process:

- Smart Home field isn't yet of major importance on the local market, impression being that is reserved for enthusiasts that can afford a system that is not considered critical;
- Domain is under development, being characterized by rapid changes;
- In contrast to industrial smart metering solutions, characterised by a multitude of customized professional solutions, smart home solutions are cheaper but with low guarantees or limitations in terms of "delicate" measurements (like those for natural gas) or automations;
- There are a lot of distributors, but few are delivering "turnkey" systems (being in fact device sellers);
- Actual systems reflect a vision of a producer, but sometimes more complex requirements involve combinations from different producers, not always fully compatible;
- Technical consultancy during defining technical architecture and system configuration are of major importance; that's why, authorized distributors are recommended; even claimed, equipment are not "plug and play", requiring extra configuration, and usage of signal "relays" (sensors which are also re-transmitting signals from other sensors), in order to ensure system coverage;
- Many times, supplementary clarifications during acquisition are useful and needed, imposing longer acquisition periods;
- Equipment is much easier to install and test when building is not under living constrains; that's why, is recommended to install such systems from the very beginning or during rehabilitation works.

As an example, one company considered that reports are real time values displayed, but long term values database with all parameters was not available. Considering all those aspects, the system acquisition was longer than expected and required a repeated process, in order to find the proper installation partner, able to respond also to installation and budgetary constraints.

2.2. System delivery and installation

Delivery and installation included the following steps:

- Import of equipment (2-3 weeks) from producers;
- In house configuration for each apartment, in order to minimise installation time;
- Delivery of all system components – 3 weeks;
- Installation of smart heat controllers and electricity meters – 2 days;

- Installation of rest of sensors and gateways – 1 day;
- System configuration and test – 1 day
- Mobile application installed on tenants smartphones and training – 1 day
- Reports applications and admin training - same day

Special attention was dedicated to individual schedule of heat controllers, according to tenants programme and preferences.

System became operational in February 2020 (in 4 weeks), receiving positive feedback regarding careful installation and respecting tenants schedule and privacy, as well as for ease of access and usage.

Cap.3. Smart Home system description

3.1. Main components

Due to limited installation time and availability from several producers, all sensors and equipment are using short range and low power radio communication, based on Z-Wave standard. With the exception of two devices (Z-Wave climate meter and electricity meter), the rest of equipment is from the same producer, in order to ensure system compatibility.
System main components for each apartment:

- Smart Home Gateway (one for 2 apartments with different access); due to necessity of reports, simple smart gateways were excluded, because don't provide sufficient configuration tools and possibility to work with virtual sensors from other providers; due to budgetary constraints, we adopted a configuration in which 1 smart gateway covers 2 apartments, separated by software configuration and access
- 1 climate meter (temperature, CO_2, humidity with dedicated display)
- 3 Smart Heat Controllers (placed on thermostats for 3 radiators)
- 3 Smart temperature sensors working in pair with heat controllers
- 2 Smart plugs with on/ off and electricity meter (including radio relays for improving coverage)
- 1 Smart electricity meter
- 1 Smoke sensor
- LED bulbs (for replacing incandescent ones)

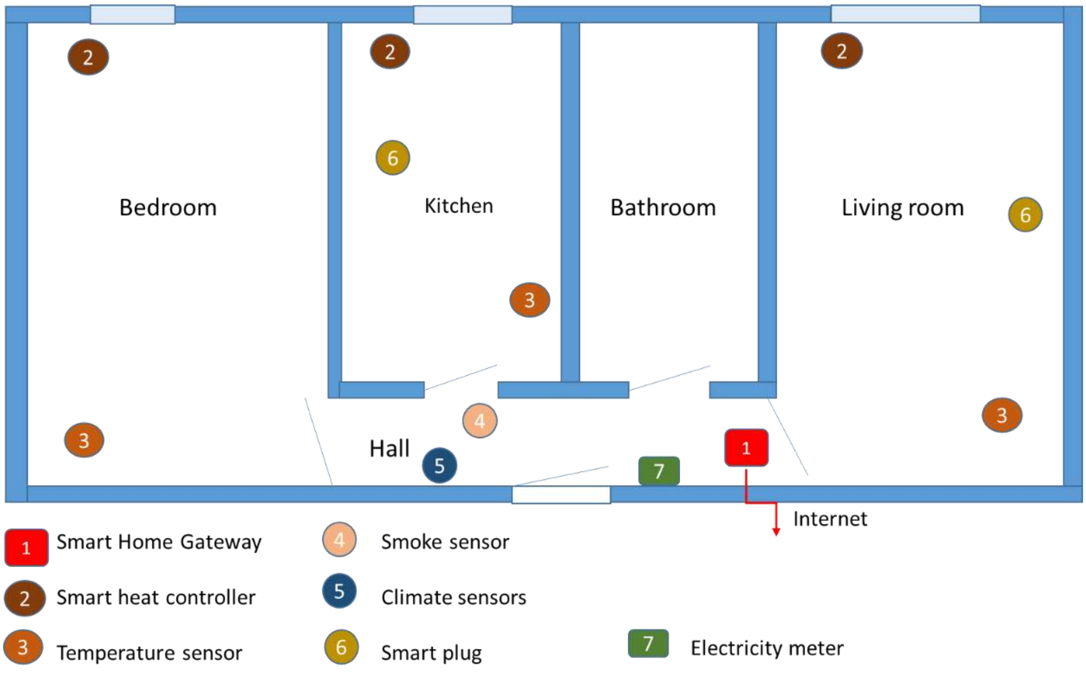
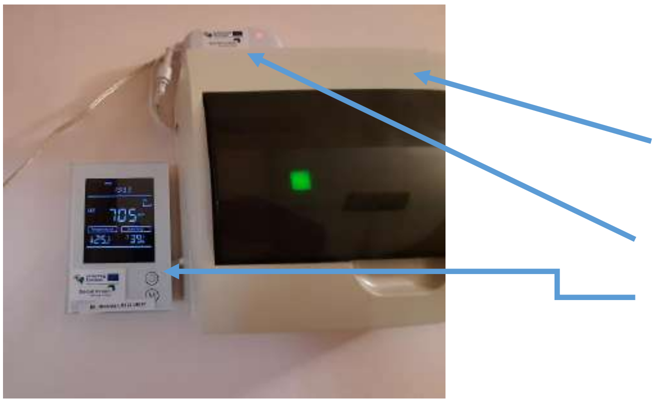


Fig. 1. System elements and their installation in apartment

List of purchased equipment and services is presented in Appendix I.

Elements were labelled and received an inventory number according to project requirements, as in the following examples.

Fig.2. Smart Home Gateway – in 2 configurations, connected to internet using Ethernet cable; antenna is for Z-Wave communication with sensors



Electricity general panel at apartment entrance – near fuse box

Electricity smart meter

Climate unit

Fig. 3 – Electricity Smart Meter and Climate (Temp, Humidity, CO2) unit with display

Fig.4 – Smart Heat controller paired with temperature sensor

Fig. 5 – Electricity fuse panel, Smart Electricity meter, climate unit and smoke detector

3.2. Other aspects related to installation, usage and maintenance

- Final offers were configured after onsite tests regarding radio coverage and tests related to dedicate and secured access for each apartment;

- Pre – configuring sensors, gateway and applications for each apartment are critical in terms of installation time;

- If access to reports and datasets is critical (as in our case), special attention to cloud data saving, security and data availability is of major importance;

- Probably a secondary application is needed for monitoring and aggregate data coming from different producers (this is our case for climate data);

- There are different options for ensuring system power supply: power outlet (for gateway, electricity meters and climate unit), rechargeable batteries (heat controller - mini USB charger; one charge is enough for 6 months) and long life batteries (3-5 years) easy to change for temperature and smoke sensors;

- As new equipment or software updates appear each month, is recommended to program periodic saving of recorded data (by administrators);

- During first months there were not gateway or system miss functions; minor interventions were made for charging heat controllers batteries, reconfiguring a smart plug for a new location and change of a heat controller;

- After saving data, a gateway update was performed in May 2020 (recommended by producer).

4. Software applications

4.1. Mobile application used by tenants of social apartments and climate info

System installation was eased by the fact that tenants from selected apartments already have broadband internet access with WiFi routers and Android smartphones.

After producer's Smart Home Application for Android was installed for at least one tenant from each social apartment, individual training and demo was ensured, followed by a common session of questions and answers.

Application is simple and offers easy access on mobile to main data, as presented in pictures bellow.

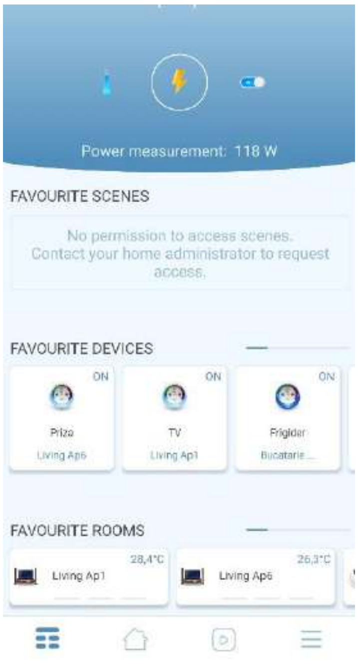


Fig. 6. Start screen shows general electricity power (118W), smart plugs (are on), room selection.

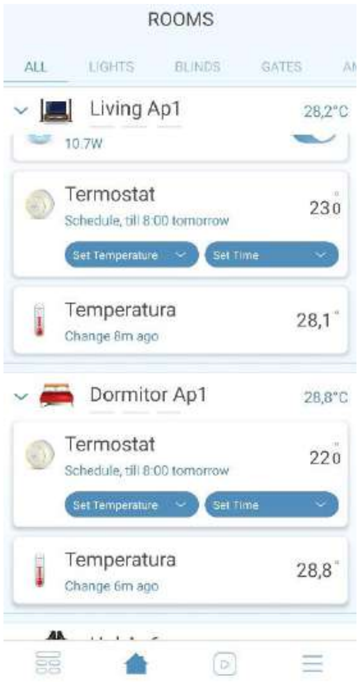


Fig. 7. In living room, TV is on stand by (10.7W) and temperature is 28 °C; thermostat is closed

Fig. 8. In kitchen, fridge has 107W

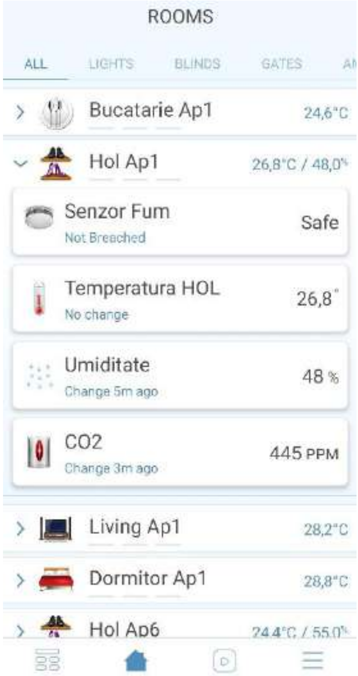


Fig.9. Hallway – smoke sensor is safe, temperature is 26 °C, Humidity is 48% and CO2 has 445 ppm

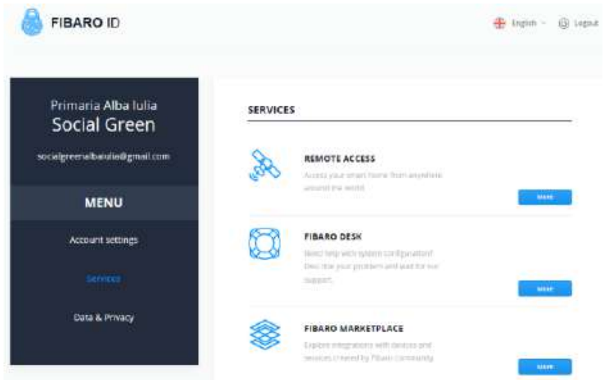
With simple navigation and selection, users can switch off electricity smart plugs, or temporary change temperature settings for heat controllers (not active on this screenshots).

Supplementary, climate info are available also on local display:

Fig. 10. Climate unit displays CO2, temperature, humidity and qualitative info for VOC

4.2. Smart Home gateways remote reports

After logging as Admin, application gives access to remote data and system settings.



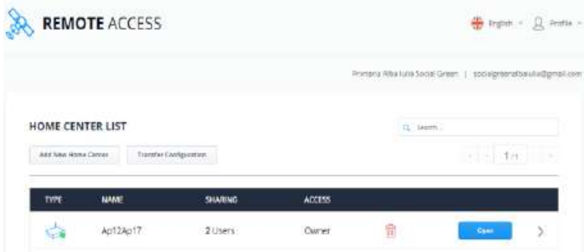


Fig.11. Admin app start screen

Fig.12. Selection of gateway

Fig.13. Access to each gateway

Fig.14. Climate and smoke sensors

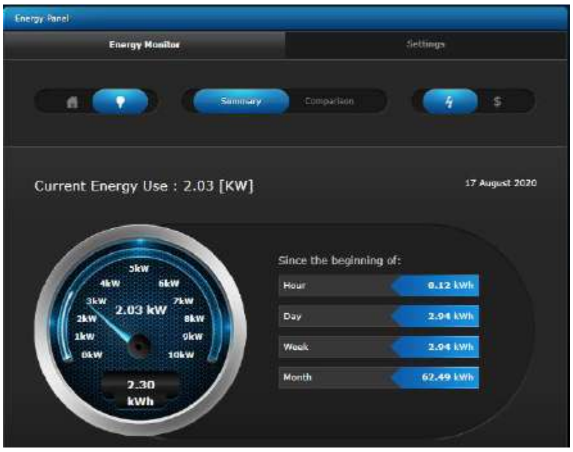
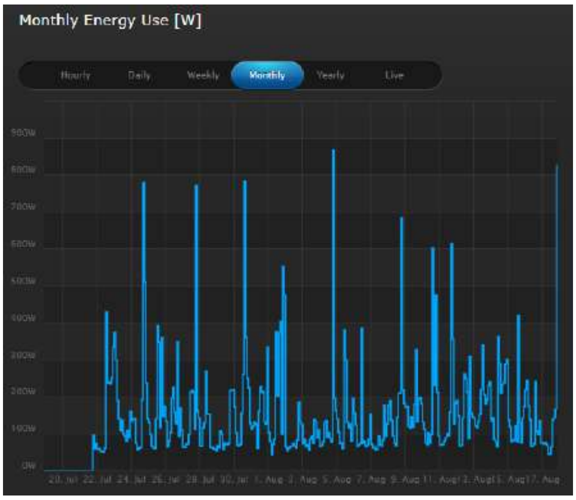


Fig.15. Temperature, heat control and smart plugs

Fig.16. Energy panel shows instant power and electricity consumption (hour, day, week, month)



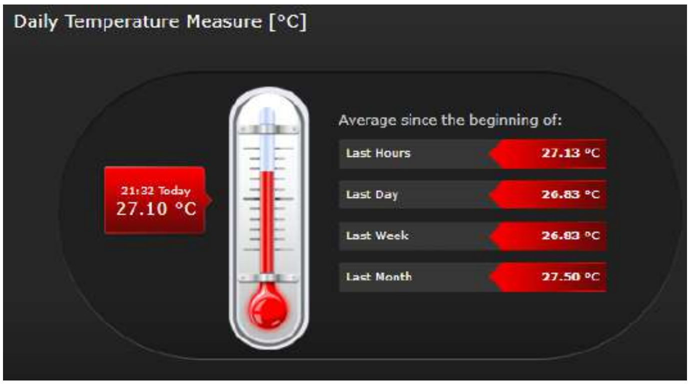


Fig.17. Energy graph for 1 month

Fig. 18. Temperature panel (one room selected)

Fig. 19. Temperature graph

After selecting a period, a room, a sensor and a parameter (electricity or temperature), application permits the download of historical data as a csv file, which requires conversion of the timestamp (from Unix time) and to an excel file for further analysis.

As a general observation, application is easy to use in terms of displaying main data, but downloading data from each sensor for 8 apartments and converting them is a time consuming activity. Also, it must be mentioned that system configuration and change requires deeper system and programming knowledge and experience.

4.3. Other application and reports

Smart Home gateway give access to instant climate data, but historical reports are not available (because climate sensors and unit are from a different producer). That’s why, we are using a separate application, able to provide climate reports.

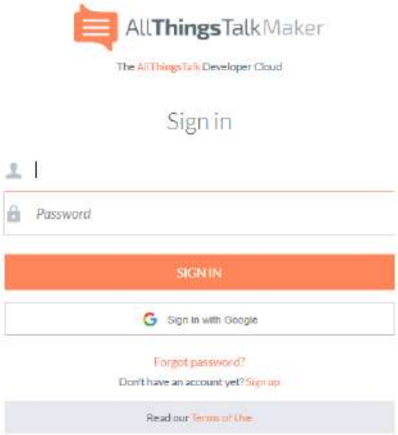


Fig. 20. Access to third party app, dedicated to internal climate reports

Fig.21. One month temperature evolution in 3 rooms of an apartment

Fig.22. One month humidity evolution in one apartment

Fig. 23. One month CO2 evolution in one apartment (several days are over accepted level of max.1000ppm)

This application also permits climate data downloads to csv files.

5. Evolutions of consumptions and recorded parameters

As presented in initial report, we had to change apartments with some technical problems or not willing to install system anymore. That's why, we had to partially change initial data for the before implementation stage.

5.1. Electricity consumption

As electricity is paid directly by tenants to the electricity company, we had to ask for historical consumption based on existing bills, for at least 12 previous months (when more data were available, an average was calculated).

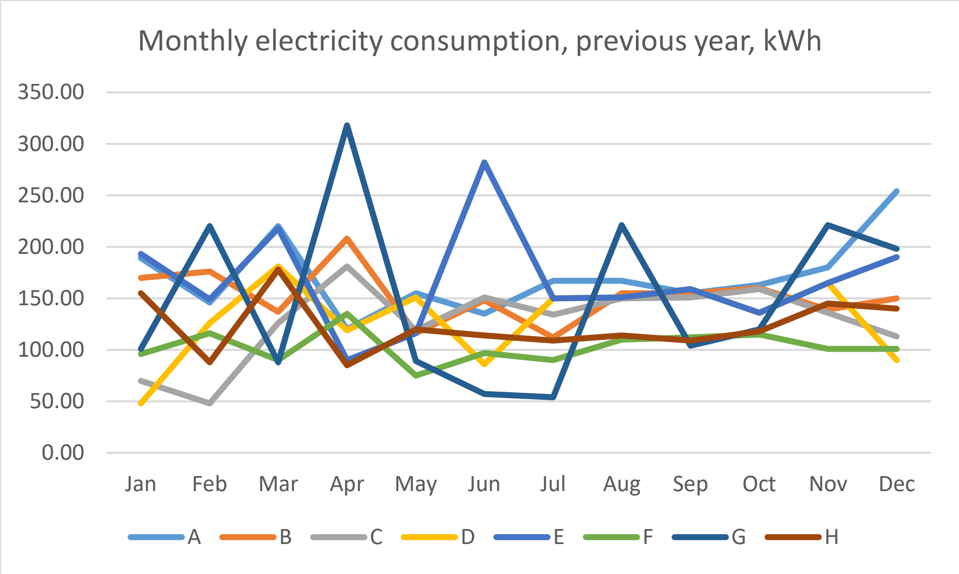


Fig.24 Variation of monthly electricity consumption in 8 social apartments, before project

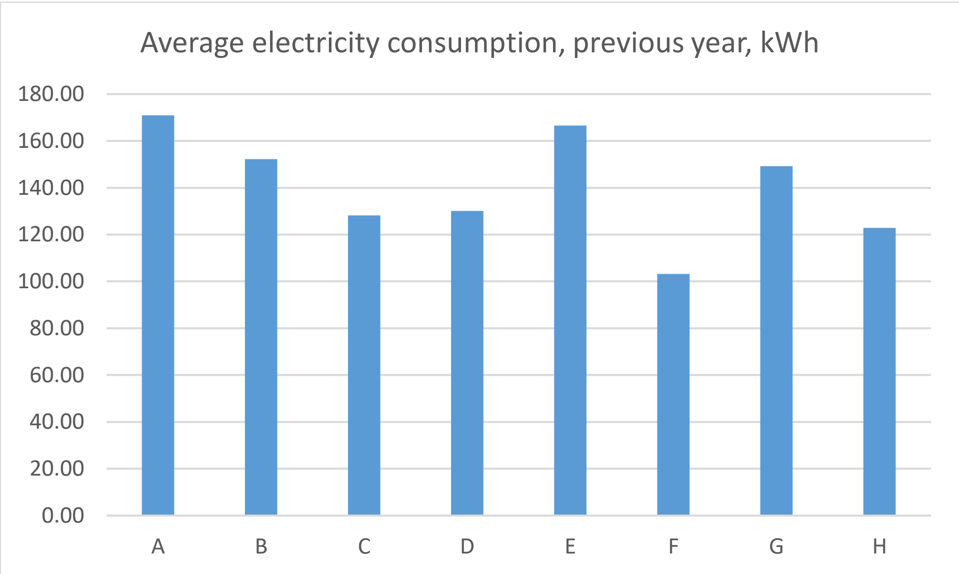


Fig.25 Average monthly electricity consumption/ social apartment, before project

Previous figures demonstrate existence of important monthly electricity consumption variation and big differences (up to 70%) between social apartments. This can be explained by different consumption habits, occupancy and presence of different electric/ electronic devices, from which most important are refrigerators and washing machines, present in all apartments.

For measuring evolutions of electricity consumption after system installation, we used data from gateways for all 8 apartments, after filtering, conversion of timestamp and extrapolation of partial missing data (like for February, when system was installed, or few day in May, when gateways were upgraded).

Results for February – August 2020, compared with previous monthly average are shown below.

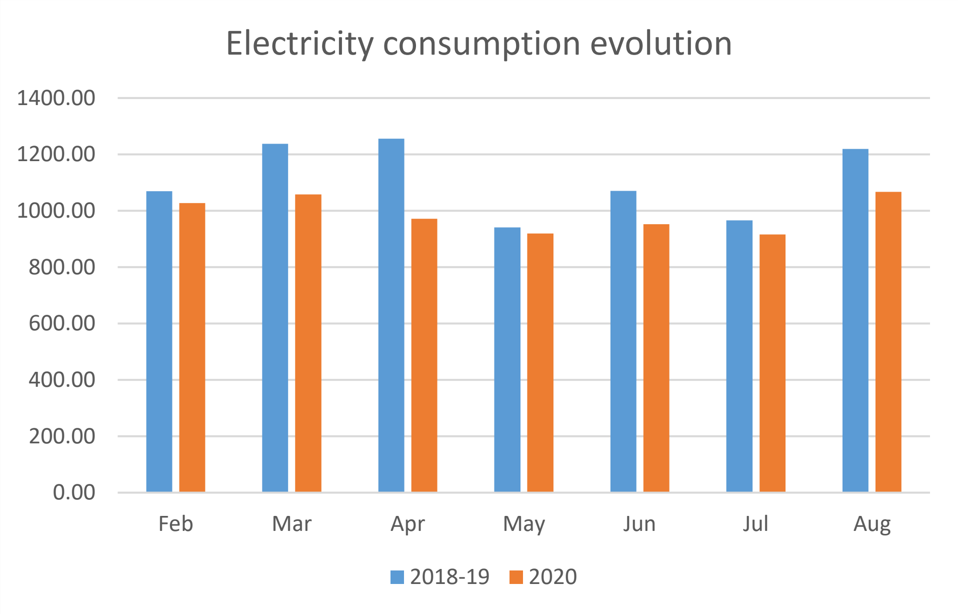


Fig.26. Monthly electricity consumption, kWh, before and after implementation, for all apartments

For this period of 7 months, electricity consumption was lower than the previous one with an estimated 11% for all 8 social apartments, but also with big variations between apartments.

5.2 Energy for heating

Heating is ensured centralized, using a natural gas boiler for the entire building. As presented in Initial report of the project, each apartment has a digital heat meter (Gcal), but without possibility to automate remote reading. That's why, we have manual readings for each month, in order to monitor energy consumption for heating. This is important, because we used heat controllers and temperature sensors for 3 rooms of each apartment. Existing data and result for first months are presented bellow.

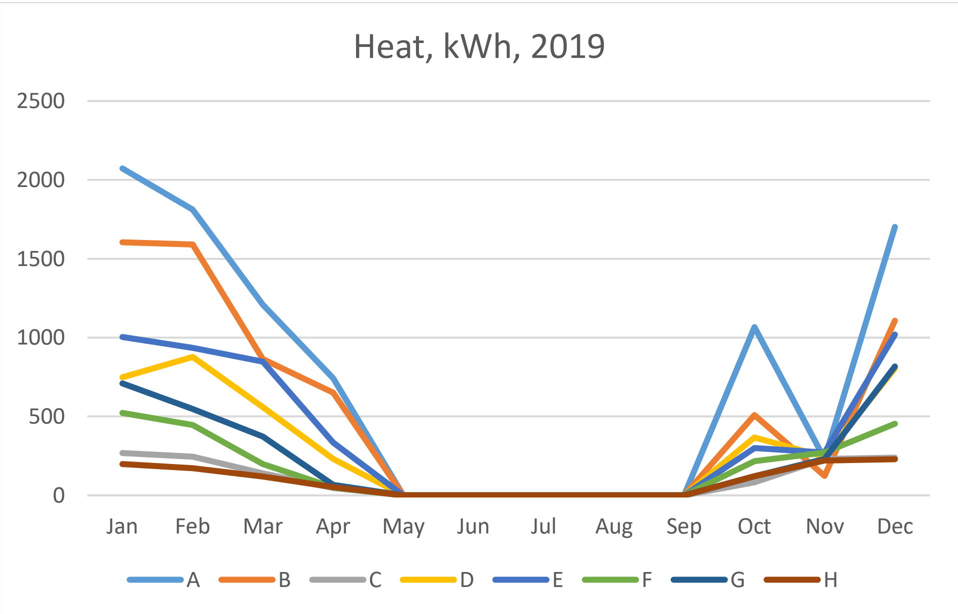


Fig 27. Monthly heat consumption, kWh, for each apartment before project implementation

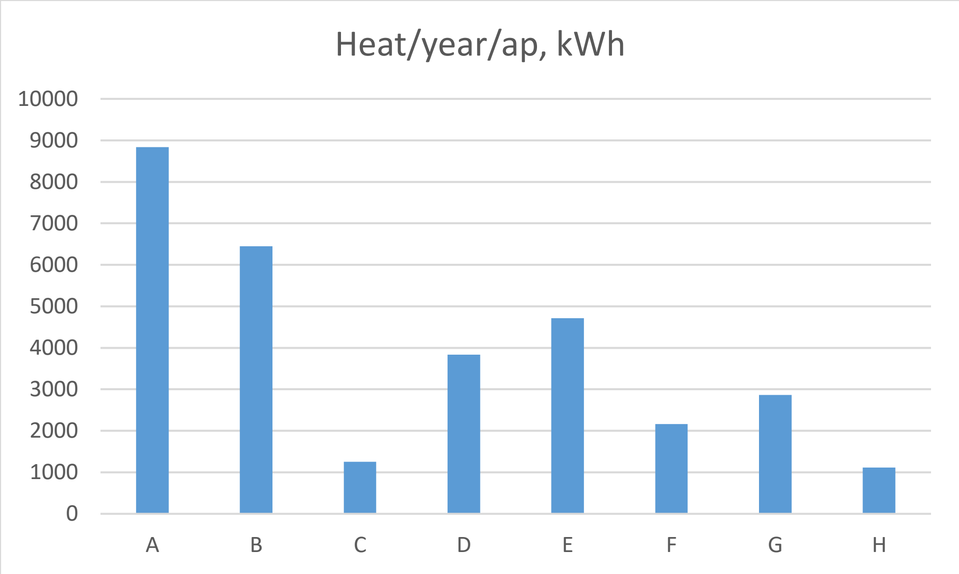


Fig.28. Yearly energy consumed for heating by each apartment, 2019, kWh

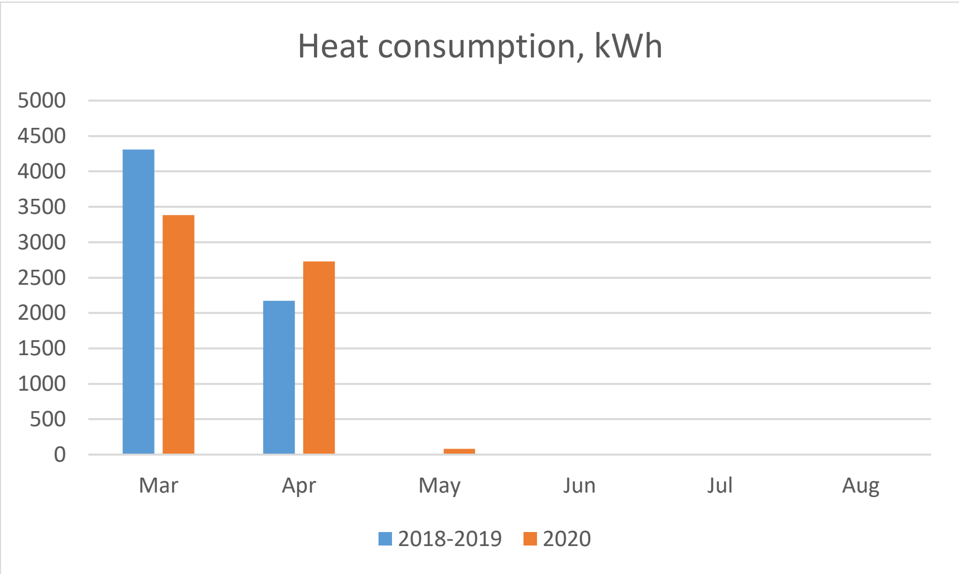


Fig.29. Monthly energy consumed for heating before and after project implementation, kWh

Figures demonstrate that there are huge differences between apartments in terms of energy consumed for heating (5-8 times higher for 2 apartments) and that probably some apartments are limiting their consumption. Because beginning with May heating was completely closed, till now we don't have a relevant comparison with previous consumption, data for 2 months revealing a reduction of 5%.

5.3 Energy consumed for hot water

Initial report revealed that hot water, together with electricity are major contributors to energy consumption and utilities costs in social apartments. As consumption and energy consumed for hot water have just analogue meters, without remote reading, we calculated energy consumed for hot water based on manual monthly readings of water consumption and average energy consumed for 1 m3 of hot water, results being presented in following diagrams.

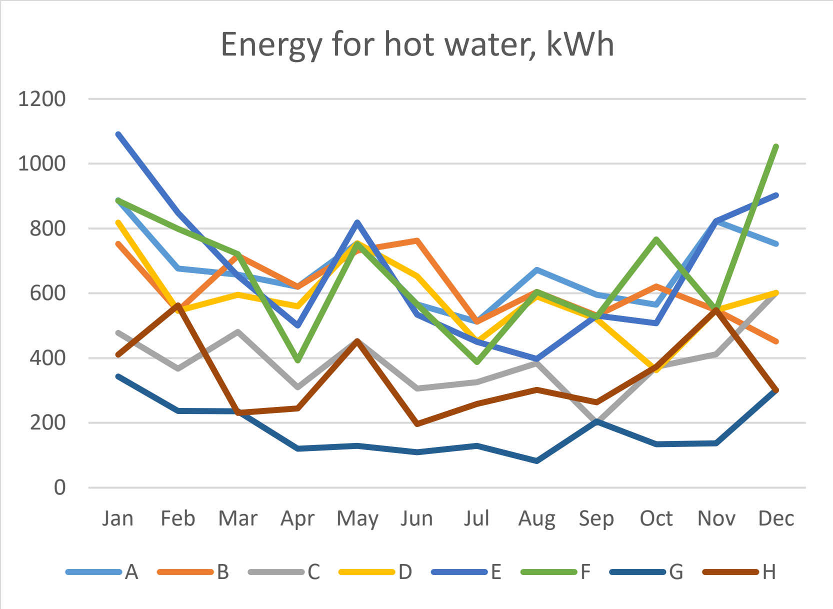


Fig.30. Monthly energy consumption of each apartment, kWh, for producing hot water

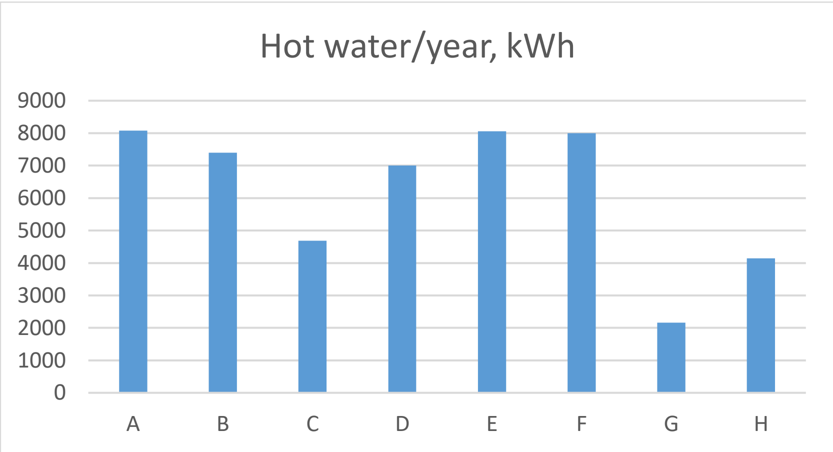


Fig.31. Yearly energy consumption of each apartment, kWh, for producing hot water

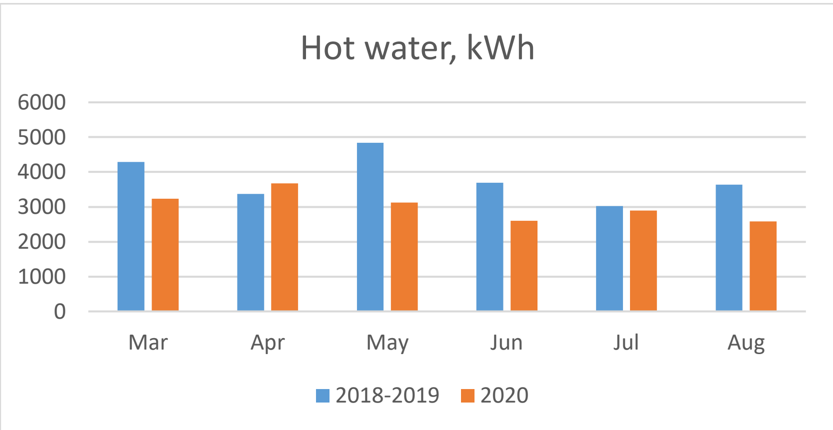


Fig.32. Monthly energy consumed for hot water in all social apartments, kWh, before and during project

Diagrams show major variations of hot water consumption and necessary energy for producing it during an entire year and between apartments (up to 4 times). For the analysed period of 6 months, necessary energy for hot water is estimated to be with 20% lower than a similar period of the previous year.

5.4 Gas

Each social apartment has an analogue meter for natural gas, which is used just for cooking and has a minor contribution to energy consumption and costs. As invoices are based on manual readings, transmitted usually at 3 months, we have data for previous year, allowing just overall consumption for each apartment. As sensors and remote meters for natural gas are difficult to approve and install, we will gather further data based on info transmitted by tenants in order to compare consumption in the next report.

5.5 Interior climate

Information regarding quality of interior climate are available just after system and sensors instalments.

Figures bellow are for a common apartment in the social building.

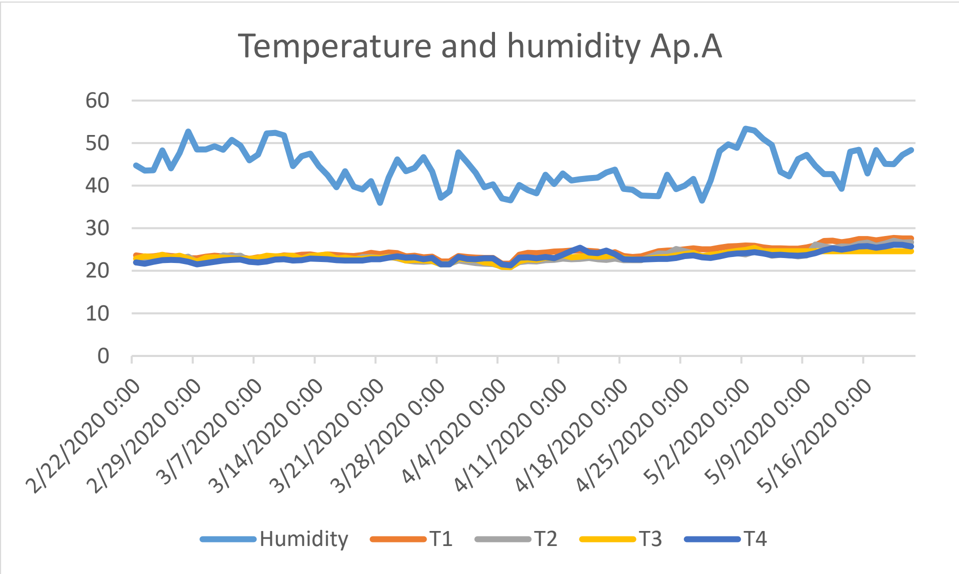


Fig. 33. Evolution of temperatures and humidity in a social apartment (3 months)

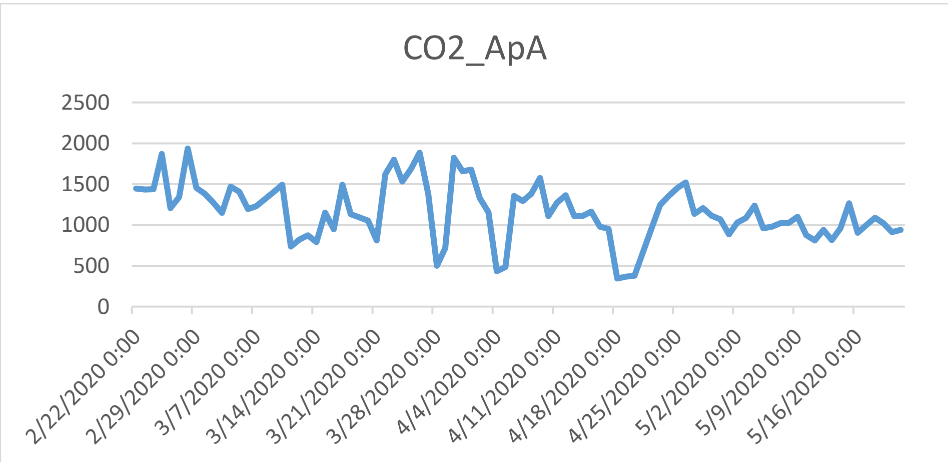


Fig.34. Evolution of CO2 in a social apartment (3 months)

Graph show that temperature and humidity are in the comfort zone, but many days, concentration of CO2 is too high compared with normal (which is up to 1000ppm). This impose more frequent apartment ventilation, but we must also consider that sensor is installed on the entrance hall, without windows and direct outdoor access.

6. User's feedback and behaviour

After the installation of all the relevant smart components at level of 8 social housing apartments, the management team organized, with the involvement of 1 Decembrie 1918 University Alba Iulia, a first survey in order to analyze the initial feedback from the tenants of the 8 apartments and their interest in the appliances and smart-metering devices installed in their homes. The first perceptions of the impact of smart solutions on users were the following:

- all 8 respondents were familiar with “smart home” or “smart systems” concepts before being involved in the European Social Green project;

- the quality of the system installation, the training and the ability of the respondents to manage the system were highly rated;

- all respondents expressed high interest in the smart systems that were installed, most considering that the comfort of the house after installing the systems increased;

- among the most important benefits of smart systems installed according to respondents are: consumption efficiency, lower bills, temperature control on the phone application;

- after the installation of the smart system, the reception of all the equipment and their use, a change was observed regarding the behaviour of the respondents, most of them becoming very interested regarding: attention to utility consumption, interest in smart systems, the desire to share information about smart systems and its benefits to others, attention to the control of equipment in the house;

- out of the 8 respondents, only 4 respondents would be willing to make an investment in a smart system in the future for the comfort of their home;

- all respondents used the intelligent heating system (including the mobile application) at least once a day.

During the 12 months of monitoring, periodic surveys will be organized in order to identify any potential drawbacks of the experiment and to measure the satisfaction and difficulty of use of the smart tools by the tenants of the 8 apartments. In first month after installation, personal feedback was requested, with focus on system functioning and ease of utilisation.

Until the reporting period, three questionnaires were applied (for April, May and June).

The opinion and involvement of the tenants regarding the installed smart products related to **April** was:

- 5 tenants used the intelligent heating system (including the mobile application) once a day, 2 tenants never used the system during April and 1 tenant used the system twice a day;

- the quality of the installed smart system was highly rated by users;

- all involved tenants would recommend the smart system to other persons;

- during April, the involved tenants did not encounter problems with the installed smart products, except for a tenant who encountered some technical problems. Due to the establishment of the state of emergency in Romania (because of COVID19 disease), no technical experts could be sent to the apartment in order to solve the problem, so the tenant received helpful information by telephone;

- the mode of operation and use of the smart system were highly rated by users;

- the tenants are highly satisfied about the installed smart system, the involvement of the technical experts who installed the system and the personal who implement the project from the Alba Iulia Municipality.

Starting with May, the inhabitants of the social apartments no longer used the smart heating system, the heating of the apartments being turned off at the level of the entire block of flats during spring and summer. During this period, the tenants involved in the Social Green project did not encounter problems with the installed smart products.

During June, the involved social apartments did not encounter problems with the installed smart products. Also, the operation of charging the batteries from the sensors did not seem complicated to them.

Based on tenants initial answers and the fact that utility bills are quite complicated, **in July** we have prepared an informative material, including explanation of utility bills (Appendix II). Majority of tenants (5) considered that information received is interesting and clarified part of uncertainties related to bills and price for utilities, or possible alternative providers.

APPENDIX I - Purchased equipment and services

	Description	Producer / Model	Quantity
1	Smart home central control unit, for Radio sensors, software and remote control; download sensor status and evolution reports - preferably at 10 min.	Fibaro Home Center 2	4 pieces
2	Intelligent single phase electricity meter	Qubino ZMNHTD1	8 pieces
3	Smart plug - Schuko type	Fibaro Wall Plug	16 pieces
4	Smoke sensor	Fibaro Smoke Sensor	8 pieces
5	Smart indoor climate unit with display	MCO Home	8 pieces
6	Mechanical thermostatic valve (tap)	Heimeier T K	24 pieces
7	Intelligent radiator controller with temperature control	Fibaro Heat Controller	24 pieces
8	Indoor temperature sensor / radiator, works with the controller	Fibaro Temperature Sensor	24 pieces
9	Interior light bulbs 14W (warm white, A++)	Hoff	32 pieces
10	Interior light bulbs 11W (warm white, A++)	Hoff	32 pieces
11	Interior light bulbs 5.5W (warm white, A++)	Hoff	24 pieces
12	Mounting accessories (set / apartment)	Various types	8 sets

Services

1. Installation, configuration, commissioning services for the purchased equipment – turnkey system

2. Laptop / mobile software installation, training for users (tenants) and dispatchers (admin).

3. Maintenance and support services for 12 months.

APPENDIX II – INFO 1 for tenants of social apartments

Social Green
Interreg Europe

https://www.interregeurope.eu/socialgreen/

Social Green – pilot project in Alba Iulia
"Improving energy efficiency in social apartments through intelligent monitoring solutions"

Informative material - INFO 1:
What do utility bills include?
Can costs be reduced?

European Union
European Regional Development Fund

1. Electricity invoice

- In the absence of online communication by consumers of consumption (meter index, kWh), the bill in the example is an estimate based on previous consumption, and the adjustment will be made quarterly, after a meter reading;
- Because the billed period is 2 months, the total energy is divided into periods for each month
- As can be seen, the prices per kWh are different for the 2 periods (0.45901 / 0.45115 lei / kWh); they include the real price of electricity production (which is much lower), to which are added transmission and distribution costs; the cost for 235 kWh active energy is 107.66 lei (22.15 euro)
- To the active energy costs, taxes are added: cogeneration expenses (4.46 lei), green certificates (15.31 lei), excises (1.19 lei) and VAT (24.43 lei), totaling 45.39 lei out of a total invoice of 153.05 lei, the unit price reaching 0.65 lei / kWh (0.13 euro/kWh)

CONCLUSIONS
- In the absence of a monitoring system, no measures can be taken to limit consumption, and the invoice received will be paid; self-control and personal saving measures can be taken;
- Without self-reading, real consumption is found in bills only at 3 months
- The high share of taxes (the production price being only 35% of the final price), pays off the investments in renewable energy sources when consumption is high
- Market liberalization, allows the choice of electricity supplier - see next page

Price comparator for electricity from different suppliers

Nr. crt	Denumire furnizor	Denumire oferta	Tip pret oferta	Tip produs	Detalii	Energie regenerabila	Valoare factura(lei)	Rezultat comparatie valoare factura furnizor concurential/FUI optional - valoare factura FUI obligat
1	Societatea Electrica Furnizare	Oferta FUI obligat	Tarif reglementat	Clienti serviciu universal	Vezi detalii	-	149.66	-
2	Enel Energie Muntenia S.A.	Oferta FUI optional	Tarif reglementat	Clienti serviciu universal	Vezi detalii	-	146.53	↓ 2.10 %
3	EON Energie Romania	Oferta FUI optional	Tarif reglementat	Clienti serviciu universal	Vezi detalii	-	142.29	↓ 4.93 %
4	Tinmar Energy	Oferta FUI optional	Tarif reglementat	Clienti serviciu universal	Vezi detalii	-	141.02	↓ 5.77 %
5	Enel Energie	Oferta FUI optional	Tarif reglementat	Clienti serviciu universal	Vezi detalii	-	146.53	↓ 2.10 %
6	CEZ Vanzare	CEZ EFICIENT STANDARD - ZONA DEO	Nediferentiat	Pret fix pe intreaga perioada contractuala	Vezi detalii	0%	171.17	↑ 14.37 %

- Go to the ANRE information comparator https://www.anre.ro/ro/info-consumatori/comparator-de-tarife
- NOTE: this comparator is informative, a written, updated offer must be obtained from suppliers
- I used the data from the previous example - 235 kWh / month, Alba county, household consumer, printed monthly invoice and reading at 3 months
- The estimated value is very close to that paid by such a consumer (150 compared to 153 lei)
- Changing the supplier can bring savings of about 5%, representing about 100 lei / year (21 euro)
- In the case of social apartments, where the average registered consumption is lower than in presented example, the savings are reduced accordingly.

2. Natural gas invoice

Produse și servicii	Perioadă de facturare	Cantitate	u.m.	Preț unitar fără TVA [Lei/u.m.]	Valoare fără TVA [Lei]	Valoare TVA (19%) [Lei]
Consum gaze naturale estimare	15.04.20 - 15.05.20	1.675,818	kWh	0,13419	224,88	42,73
Total					224,88	42,73
Total valoare consum gaze naturale, TVA inclus [LEI]						267,61

Date contor

Serie contor	Perioadă de consum	Index vechi	Index nou	Consum [mc]	Pcs [kWh/mc]	Cantitate [kWh]*	Categorie consum	Zone de calitate
2405913/2019	15.04.20 15.05.20	3.217 (estimare)	3.374 (estimare)	157	10,674	1.675,818	C1	49.0

*Mod de calcul consum gaze naturale:
Energie gaze naturale [kWh] = Volum gaze naturale consumat [mc] x Puterea calorifică superioară (Pcs) [kWh/mc]

- As you can see, it is an estimation invoice, based on previous consumptions, and will be read and regularized at 3 months.
- Only 2 information, consumption and unit price are presented
- The price for 1 kWh is double that of electricity (0.13 kWh), but this price already includes the price of gas, transport tariffs, storage tariffs, distribution tariffs, supplier surcharge, excise duties
- At this price, just VAT is added
- After July 1, 2020, through the liberalization of the gas market, consumer can choose different offers, but the transmission, distribution tariffs (ANRE for each operator), excises and VAT remain regulated.

CONCLUSIONS

- The way prices are formed is not very clear
- The high share of tariffs and taxes makes profitable the use of renewable energies when consumptions are very high
- In the absence of a personal monitoring, the real consumption values are presented only at 3 months, on the real consumption invoice (regularization).
- You can use the price information comparator in choosing the supplier

Natural gas price comparator (from different suppliers)

	Furnizor	Price wo. taxes/ MWh
1	Nova Gas	96.1
2	Restart Energy	106.1
3	Nova Power	106.1
4	Electrica Furnizare	106.82
5	Aik Energy	107.1
6	Engie	110.3
7	Mihoc Oil	112.1
8	Romgaz	113.18
9	Distrigaz Vest	115.92
10	Engie Romania	116.1
11	CEZ	116.6
12	EON	117.6
13	Hargas	119.3
14	Tinmar	119.5
15	Gaz Vest	119.9
16	C Gas	122
17	Restart	122.52
	....	
58	Getica 95	258

- You can use the ANRE information comparator (https://www.anre.ro/ro/info-consumatori/comparator-oferte-tip-de-furnizare-a-gn), but a written offer must be requested
- There are a large number of suppliers (58 offers), but "apartment" companies should be avoided, which may have difficulties in complying with contracts and customer support services.
- The differences are enormous (2.5 times), but offers that are too low or too high must be excluded (are for short periods)
- Domestic offers far exceed the necessary (based on a consumption of 2800MWh / year)
- For a house with its own natural gas boiler for hot water and heating, it can be considered an annual consumption of about 50MWh
- In this case, a change of supplier can generate a price reduction of 5 - 10% (about 500 lei / year, equivalent of 100 euro/ year)
- In the case of social apartments, where natural gas is used only in the kitchen and the average bills lead to an annual cost of 200-250 lei, the **estimated discounts are minor** (25-30 lei / year, 5-6 euro/ year)
- NOTE: attention will also be paid to commercial clauses (payment term, inclusion of services, etc.)

3. Water and wastewater invoice

Nr. crt.	Denumirea produselor, serviciilor sau lucrarilor	U.M.	Cantitatea	Pret unitar (fara TVA)	Valoare - lei -	Valoare TVA - lei -	TVA [%]
0	1	2	3	4	5 (3x4)	6	7
1	Apa potabila	MC	26.000	3.82	99.32	8.94	9.00
2	Evacuare canal	MC	26.000	3.63	94.38	8.49	9.00
3	Apa meteo (cantitate 05.2020 0.0749 mc/mp)	MC	5.393	3.63	19.58	1.76	9.00

In cazul neachitarii se vor aplica penalitati conf. legii 241/2006 modificata si republicata

- At the level of Alba Iulia Municipality, the prices for water and wastewater are regulated; there are no local alternative suppliers
- Because the metering is done on the supply, and the discharge part is difficult to measure (being fluctuating and without having constant pressure on the pipes), practically 1 m3 of water costs 7.45 lei (1.53 euros, which includes water and wastewater)
- To these costs are added those with rainwater, which in the case of apartments, are minor (the calculation area being very small)
- The average consumption in social apartments is below 5 m3 / month of hot water (60m3 / year, 532 lei, 109 euro/ year) and 5.8m3 / month cold water (70m3 / year, 620 lei, 127 euro/ year)
- To the hot water, are added the costs of water heating, which amounts to about 1120 lei / year (230 euro/ year), so that 1 m3 of hot water costs on average over 18 lei (3.7 euro/m3 of hot water)
- Consumption monitoring and waste avoidance are the main measures to reduce costs

4. Conclusions

In the case of social apartments in Alba Iulia, alternative suppliers for electricity and gas can be approached, but given the low average consumption, the financial effects are not important. Consumption and costs related to natural gas are low (gas is used just for cooking). Electricity and hot water costs have already been identified as major in social apartments, with a share of about 35% each of the total utility costs.

Savings and cost reductions must be achieved by monitoring consumption, avoiding waste, changing consumption behavior and changing large consuming and costly equipment.

SOCIAL GREEN - REGIONAL POLICIES TOWARDS GREENING THE SOCIAL HOUSING SECTOR

FINAL REPORT FOR PILOT ACTION IN ALBA IULIA

“Improving energy efficiency in social apartments using smart monitoring solutions”

February - 2021

Author: Alba Iulia Municipality (Romania)

Partner: Tartu Regional Energy Agency (Estonia)

European Union
European Regional Development Fund

SUMMARY

Based on best practices regarding building monitoring (BPMA) discovered during SOCIAL GREEN – INTERREG meetings, the pilot approved for social apartments from Alba Iulia, tested and demonstrated in a real life setting, the important effects of smart monitoring, informing and involving citizens on energy efficiency improving activities.

The initial report on pilot, was using existing technical inventory, historical consumption and social data for creating a snapshot on before implementation situation, as a baseline for a comparison to future evolutions.

More than that, based on existing technical constrains, a smart home configuration was designed, together with decision on type of apartments involved and comprehensive data regarding most important consumers, in order to identify possible consumption patterns and tenants attitude regarding participation in project.

The following mid-term report, included a detailed presentation on technical system installed in social apartments, preliminary consumption reports, monitored technical maintenance and tenant's attitude and consumption behaviour based on information materials and periodic feedback.

The present final report, presents results of technical and social monitoring, together with some conclusions and best practices identified. Because during this period we faced restrictions caused by Covid 19 pandemic impact, we continued to interact with tenants and other interested participants mainly online, with minimum impact on project evolution. In this conditions, we were also forced to collaborate on-line, cancelling the study and change experience meetings with our partner - Tartu Regional Energy Agency, but obtained the approval to use allocated budget for extending the technical system in 2 new apartments, reaching a significant total of 10 social apartments with smart home systems installed.

The encouraging pilot results, in both areas (technical - possibility for implementation of smart monitoring systems in social apartments and social – adoption rate, usage, importance for tenants, consumption behaviour change) were appreciated during online events with partners and other interested parties, creating an important argument for our final objective, of including and recommending such solutions in energy efficiency financing calls.

Social Green
Interreg Europe

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Cap. I. Introduction

Based on good practices in the area of Building Performance Monitoring and Assessment (BPMA) framework, the Social Green pilot for improving energy efficiency in social apartments from Alba Iulia is testing the importance of technical solutions from smart monitoring area and social aspects, like better informing, implication, usage and changes in tenant's consumption behaviour in order to demonstrate that this kind of solutions have an important role in energy efficiency projects and should be integrated in financing calls dedicated to energy efficiency in buildings.

Based on technical and social data, a smart home system including 8 social apartments (10 in the final stage) was installed and used beginning with February 2020, configuration and preliminary results being presented in initial and mid-term reports. After implementation, we entered in the monitoring period of the system, data needed for technical reports and consumption behaviour being gathered from sensors in smart home gateways software and cloud platform. In the same time, social monitoring involved informative campaigns, periodic questionnaires and surveys, regarding usage and perceived importance of system, in order to identify tenant's attitude on utilities consumption behaviour and importance of energy efficiency and interior climate on health and living costs.

The present final report, covers the following main tasks, activities and implementations:

Task	Months	Activity	Brief description
T4	M4 - M16	**Organizing surveys**	After installing all technical components, team will organize a first survey, capturing the initial feedback from the tenants and their interest in the appliances and smart-metering devices installed in their homes ("attractiveness" of smart solutions, attitude and perceptions on technology, satisfaction, technical difficulty).
T5	M4 - M16	**Monitoring the energy parameters of the social housing flats**	Monitoring energy parameters and organizing monthly meetings with the tenants in order to present the monthly statistics, data acquired and discussing options for behavioural change in order to obtain optimal results in terms of energy consumption and increased comfort.
T6	M10 – M16	**Continuing the monitoring and survey activities**	This period is important for perfecting the system and resolving any dysfunctionalities identified. The tenants living in the social housing apartments will further utilize the smart metering devices and online tools (smart phone application). Informative materials and periodic surveys will provide feedback on system functioning and propose energy efficiency solutions for the tenants, but also with the aim of identifying any possible behaviours that could be changed.
T6	M17	**Final report and workshop**	Final Report of the pilot project will be presented to all the relevant stakeholders and will be sent to all the project partners for greater dissemination and for supporting the transfer of good practices in the field of energy efficiency at the level of social housing.

T7	M17	**Sending the final Report of the PA**	The final Report of the pilot, together with the recommendations for changing the policy instrument ROP Axis 3 and Axis 9 will be sent to the Regional Development Agency - ADR Centru in order for future calls to include eligible activities drawn from the PA results.

Table.1. Social Green pilot in Alba Iulia – main activities covered by the present report

Cap.2. Monitoring and extension of the smart home system

2.1. System extension

The initial report of the Social Green pilot in Alba Iulia detailed technical system and social constrains and requirements (like short installation time, tenant's schedule, availability of data reports and budget).

The following mid-term report, included detailed system configuration, acquisition, installation, usage and reporting, consisting in an easy to replicate smart home solution.

As Covid 19 restrictions forced us to cancel partner's visits in Alba Iulia, we were forced to move our meetings online and we have obtained the approval to use the remaining budget for an extension of the smart home system from 8 to 10 social apartments.

The 2 new apartments have 3 rooms, are in the same social building and were equipped after a public acquisition process with similar sensors and equipment like the previous ones, in February 2021.

Due to limited budget and considering the limited radio system coverage (based on Zwave, with a maximum 30 m radius without obstacles) a coverage test was conducted, revealing the possibility to use existing gateways coverage and existing smart plugs radio data repeaters for integrating the new apartments.

This allowed us to install the same configuration in new apartments, including:

- 1 Climate meter (temperature, CO2, humidity with dedicated display)
- 3 Smart Heat Controllers (placed on thermostats for 3 radiators)
- 3 Smart temperature sensors working in pair with heat controllers
- 2 Smart plugs with on/ off and electricity meter (including radio relays for improving coverage)
- 1 Smart electricity meter
- 1 Smoke sensor

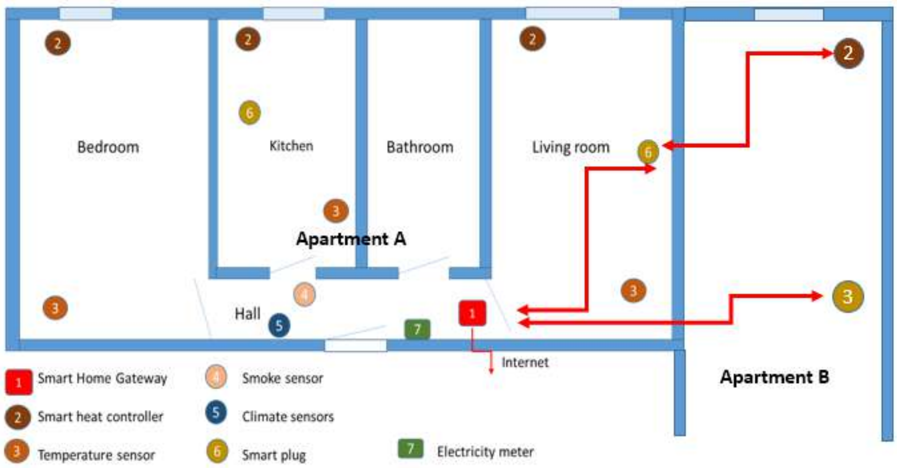


Fig. 1. System extension using direct and repeated through smart

plugs radio transmission (Zwave) to smart gateway

After installation, testing and configuration, smart phone application was installed, users trained and apartments were integrated into the same reporting platform.

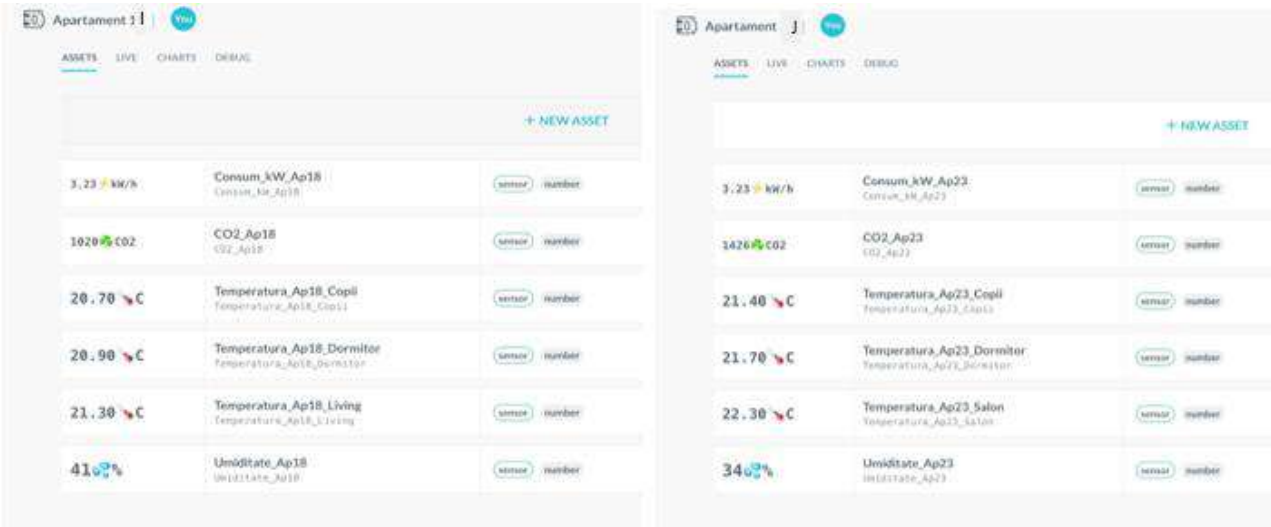


Fig.2. New apartments, I and J, were integrated in reporting platform

NOTE: as new apartments were installed in the last pilot month, data being available for just few days, we have not considered them for general reports or include them in calculus of energy and costs evolution.

2.2. System usage, maintenance and data availability

As presented in previous reports, the system installed was mainly conceived for individual homes. It can be considered as a good compromise between monitored utilities, ease of installation and allocated budget. On other hand, some systems characteristics required special attention.

a) Hardware
   Sensors and gateways generally proved to be viable, only one heat controller being replaced.
b) Power
   Gateways and climate units are powered from electric network, without back-up. In several cases, after power was off, some daily data were lost, but system get back to initial programme. Heat controllers need battery charging after 6 months and probably this was the most important, but simple maintenance activity made by users. In case of temperature sensors, 3 batteries had to be changed after 6 – 9 months.
c) Improper usage – most of cases required reprogramming of some heat controllers after cancelling the initial programme. Also, for same sensors and for several days data were lost, as smart plugs used as transmission relays were pulled out of outlet by users.
d) Lack of internet – minimal in general, but affected (data loss) for over 2 weeks 2 apartments serviced by the same gateway, tenants being in their annual leave.
e) Software updates and data saving

This applies mainly to gateways, was performed for 2 times (at provider's recommendation) and it is not recommended without previous complete data saving. During the pilot, periodical data saving from provider platform was performed. However, after a provider platform update, data for several days were lost. After this event, as a special measure, data were configured to be also sent to a third party platform provider.

As mentioned in mid-term report, smart home solutions are usually displaying instant data on user's smart phones, but mid and long terms report on consumption are requiring high volume of work, as data are saved as a csv file including readings at each 5 seconds, with Unix system time reference. This data have to be processed in order to obtain monthly consumption, and completed with extrapolated data for missing data, when is the case.

Fig.3. Instant electricity power for all apartments in 3-rd party app

Integration with third party platform, made possible configuration of instant electricity reports, as presented in fig.3. This shows big differences between apartments for instant electricity power, from 1.76 kW to 7.74 kW (over 4 times).

As a general observation, system proved to be viable and easy to maintain, but system administration and intervention must be insured by a specialized provider.

3. Consumption of energy and utilities

The previous mid-term report, included preliminary data till August 2020. The present one is uses data available in February 2021, together with comparison to previous year's average consumption (2018-2019 - before implementation stage).

3.1. Electricity consumption

As electricity is paid directly by tenants to the electricity company, we had to ask for historical consumption based on existing bills, for at least 12 previous months (when more data were available, an average was calculated for 2018-2019). After pilot implementation, monthly csv readings were used for calculating electricity consumption for each apartment. Beginning with November 2020, we successfully implemented electricity reporting with direct graph in third party platform.

Fig.4. Daily electricity consumption for one month, apartments D and H

These graphs, demonstrated big differences between apartments in case of electricity consumption.

In order to check the pilot results on electricity consumption, we compared average of previous years (2018-2019, before pilot) with measured electricity consumption in pilot period (February 2020 – January 2021) for all 8 monitored apartments.

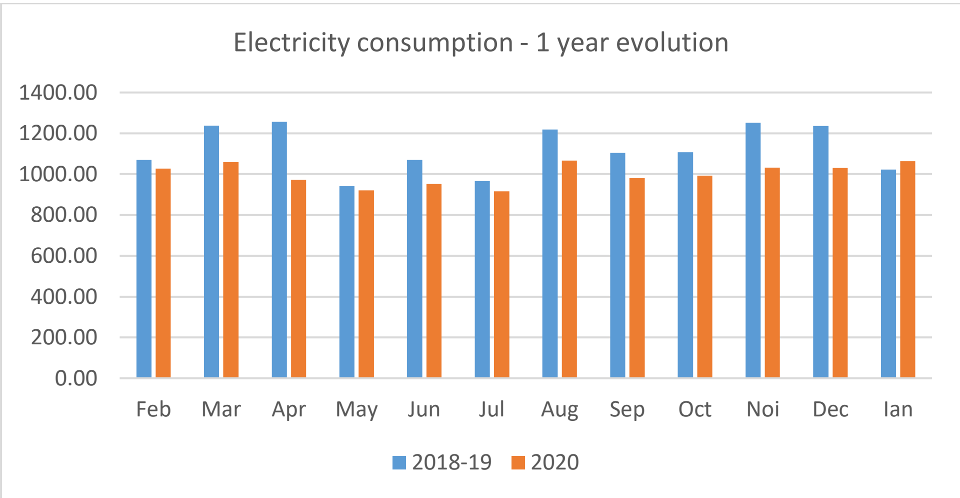


Fig.5. Comparison before and during pilot for total electricity consumption, kWh, all apartments

On average, yearly electricity consumption for an apartment is lower with 11% compared with before implementation consumption (125.1 vs 140.4 kWh/ap/month), but with big variations between apartments (from 7% to 17% lower consumption). In terms of costs, compared with previous average invoice (19.67 euro) a reduction of 1.98 euro is expected.

3.2. Energy for heating

Heating is ensured centralized, using a natural gas boiler for the entire building. As presented in Initial report of the project, each apartment has a digital heat meter (Gcal, from which kWh are calculated), but without possibility to automate remote reading. That's why, we have manual readings for each month, in order to monitor energy consumption for heating. At present report, data are available for 11 months.

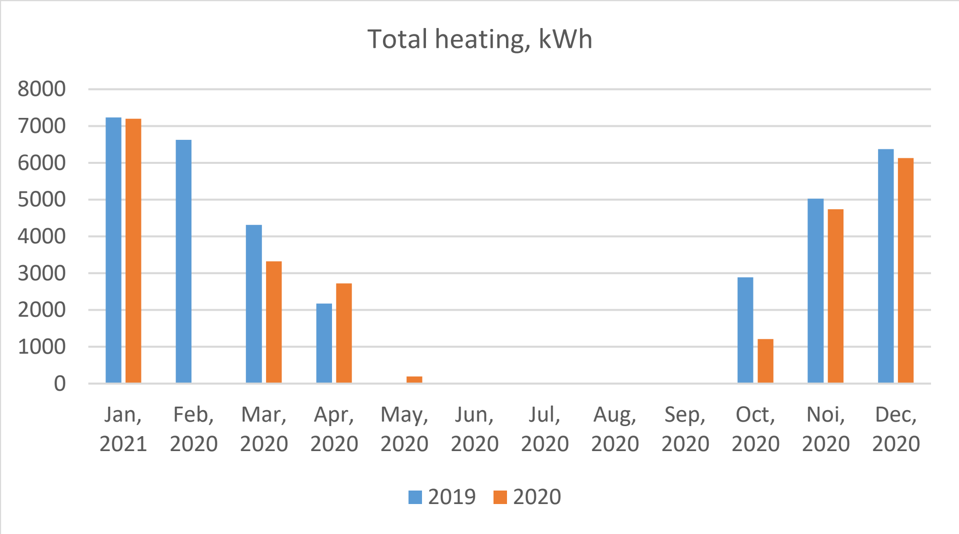


Fig.6. Monthly energy consumed for heating before and after project implementation, kWh

Overall, for 11 months, energy used for heating in all apartments is with 7% lower than for precedent year, resulting in fact in a reduction of about 15 euro/apartment/11 months.

Entering in details, there are major differences between apartments, affecting final results. The two apartments from the ground floor, occupied by families with small children, have 55% of total heating energy, with minor reductions compared with previous year, because heat controllers were placed at 22-23 Celsius, over normal temperature of 20-21 Celsius degrees.

Other 4 apartments, used heat controllers and have experienced an over 20% reduction, but their overall consumption is much lower compared with the rest.

As during entire year social restrictions together with learn from home or work from home were applied, possible heating reductions were majorly affected by continuous occupancy.

3.3. Energy consumed for hot water

Considered the most important contributor to energy consumption and utilities costs in social apartments, the hot water had a special attention on informing about simple measures related to better usage.

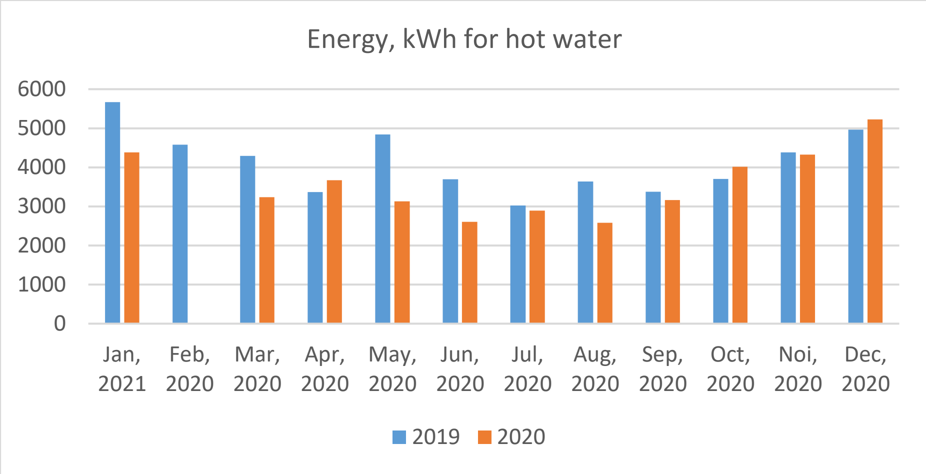


Fig.7. Monthly energy consumed for hot water in all social apartments, kWh, before and during project

Overall, in 11 months, energy for hot water was with 13% lower than previous year, which can be considered a good result. In order to check this result, we also compared hot water consumption and conclusion is that majority (5 apartments) experienced a reduction on hot water consumption, mainly based on their improved consumption behaviour.

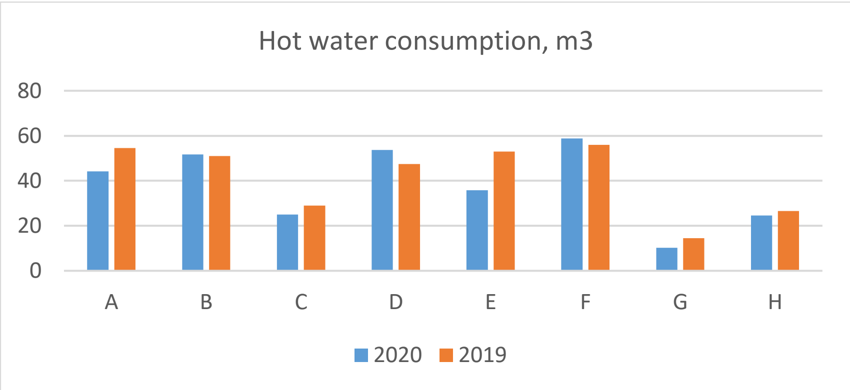


Fig.6. Comparison of hot water consumption (m3) for each apartment for 11 months

In this case, consumption of water, in m3 is with 11% lower. Considering that for hot water tenants are paying for water and energy, there is an estimated cost reduction of 45 euro/year / apartment, but with big differences between apartments.

5.4. Natural Gas

Because each social apartment has an analogue meter for natural gas, which is used just for cooking and has a minor contribution to energy consumption and costs, we didn't experienced reductions in consumed energy and cost, which is on average of just 3-5 euro/ month/ apartment.

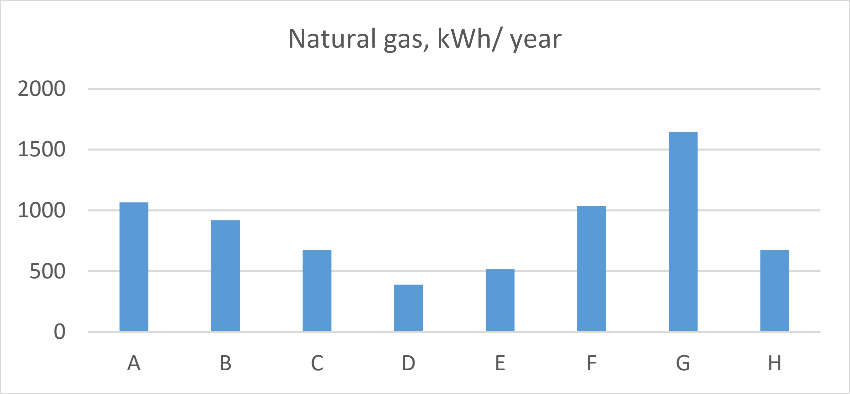


Fig. 7. Natural gas consumption, kWh/year/ apartment

Availability of data was difficult in case of manual readings at 3 months, and revealed differences of up to 4 times between apartments.

3.5. Interior climate

Information is based on temperature sensors in 3 rooms and climate unit with temperature, humidity and CO2 sensors.

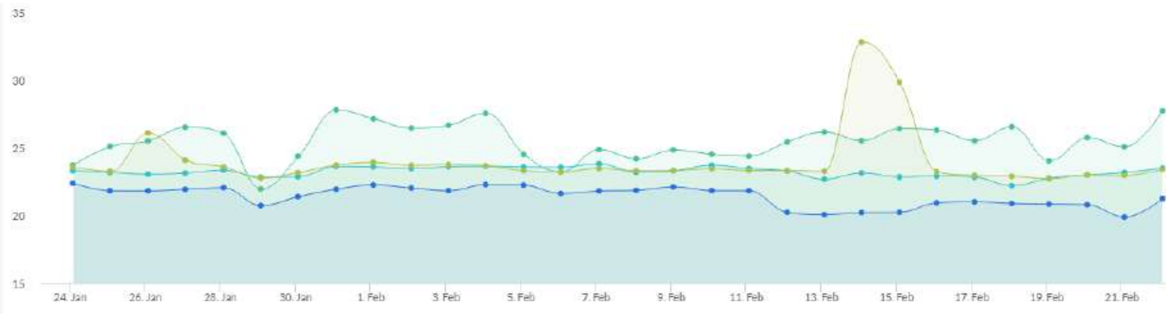


Fig.8. Evolution of temperatures and humidity in a social apartment (1 month, winter)

Graph shows that interior temperature has 20 – 24 Celsius degrees, which can be considered many times higher than normal. As a result, apartments are well heated during winter.

Fig. 9. Evolution (1 month) of humidity in an apartment

This graph reveals that many times, humidity caused by washing or cooking is much higher than normal (55% instead of 40-45%), which can cause walls sweat.

Last measured parameter is concentration of CO2 in interior.

Fig.10. Evolution (1 month, winter) of CO2 in an apartment

Is easy to observe that majority of time, concentration of CO2 is over normal value of 1000ppm. This can be partially explained by the position of the sensor on hallway, without windows or easy ventilation.

As a conclusion, values of humidity and CO2 will impose a better ventilation of apartments (mechanical ventilation or air conditioning not being present).

3.6. Cold water

Not considered directly for energy efficiency, cold water represents a very important utility.

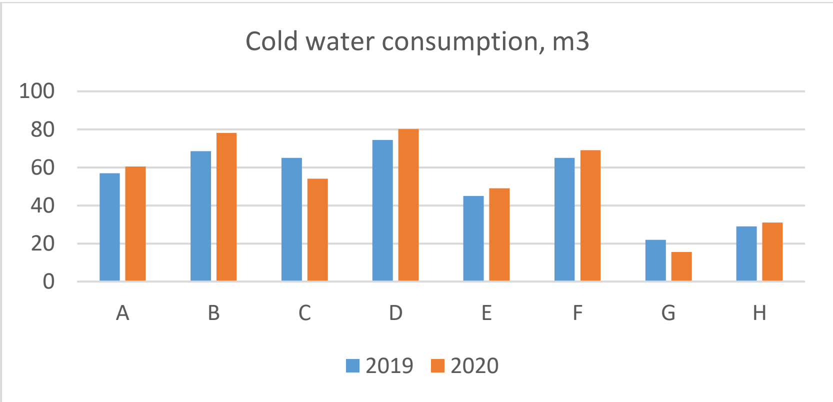


Fig.11. Evolution of cold water consumption (m3)

As seen in diagram, cold water consumption is a little bit higher than in previous year, main factor being high occupancy during the last year.

4. User feedback and behaviour

As users get acquainted with the system and after several months on checking the usage and utility of the info and controls on smartphones, we have provided in June and July information related to utilities invoices (presented in mid-term report), alternative providers and costs, which were appreciated by majority of users as useful and very useful, some of them requesting some extra materials.

That's why, in our attempt to improve tenant's consumption behaviour and attitude on energy efficiency, we have prepared a second material (presented in Appendix I) which includes results of the preliminary analysis made before implementation, identification of main consumers and costs in their apartments and a comprehensive list of "tips" for reducing consumptions and costs, based on EU ("Reduce energy and consumption at home", "Economy at energy") and other materials.

Majority of tenants considered that info provided was important, as containing data regarding their utilities costs and simple advices on reducing consumption and costs.

Furthermore a number of Questionnaires were sent to the tenants in order to obtain their feedback on the utility and functionality of the smart home equipment installed and whether there are potential issues regarding the functioning of the systems.

In the following month, we have checked if some measures were applied, and it seems that info and advices regarding hot water consumption were applied by several tenants, with good results after September 2020.

In October, our collaboration with tenants and provider, included system check, upgrade, recharging batteries for heat controllers and changing few sensors batteries, in order to prepare system for winter and heating.

During the pilot project implementation, the involved tenants have constantly received information and tips for reducing consumption in their apartment, and support in any problem that has occurred in the smart system installed. Other steps in order to actively involve tenants in the pilot project and to try to change their behaviour were: discussions about energy efficiency goals, providing regular information and raising awareness about electricity and energy consumption, and interior climate aspects, maintaining regular contact with them. Due to these aspects, the relationship between the project implementation team (including the technical team that installed the smart system) and the tenants have been strengthened.

The existence of a relationship based on trust (between the tenants and the project implementation team) also implies the existence of positive results. Among the other concrete results of the pilot is the following: one of the participating tenant bought a new refrigerator (from a higher energy class), after noticing the high consumption of the old refrigerator, based on the information provided by the installed smart system.

At pilot end, the final feedback was very positive regarding system importance in monitoring energy, climate and costs in apartments, together with ease of use, control and information, such a system being considered as important and recommended for majority of future projects related to energy efficiency in social buildings.

For more information on user feedback, some of the feedback questionnaires sent to the tenants of the social housing involved in the Pilot Action were attached to the Appendix II of this report.

5. Social Green pilot results dissemination

Considering the social restrictions caused by Covid 19 pandemic, we have presented the implementation and results of the Social Green pilot in social apartments from Alba Iulia in two online events:

a) Local event (Nov.18, 2020); invited: Regional Development Agencies (Centru and Muntenia), partners (Tartu Regional Energy Agency, ALEA – Local Agency for Energy Alba), 1 Decembrie University Alba Iulia, Technical University Cluj, energy auditors, companies, technical department of Alba Iulia city hall, tenants in social apartments;
b) Social Green Final Event (Dec.16, 2020), where all project partners participated.

During both events, Social Green pilot implementation and results in Alba Iulia received a positive feedback, being considered as an example of good practice and a good start for implementing larger scale smart monitoring systems for increasing results of energy efficiency projects in buildings in any European city.

6. Specific measures which can be included in ROP

At the regional level, the ROP Axis 3 and Axis 9 are the envisaged policy instruments addressed through the Social Green pilot proposed. Usually, these two axis address:
- Priority Axis 3: Supporting the transition to a low-carbon economy (potential beneficiaries: central and local public authorities)
    3.1.A - Residential buildings
    3.1.B - Public buildings
- Priority Axis 9 - Supporting the economic and social regeneration of disadvantaged communities in the urban environment
    9.1. Local development under the responsibility of the community

At this moment, some actions implemented during Social Green pilot cannot be supported by local, regional or national funds due to two main reasons:

1) Type of costs: For the initial analysis/ energy audit, development of the prototype, implementation of surveys, analysis of the social building specificity and tenants profile, installing smart monitoring systems (sensors, smart metering devices, gateways, software, web and tools) and staff costs are needed but not eligible under the Regional Operational Program (ROP) Axis 3 and Axis 9;

2) Nature of the action: Potential local, regional and national funds do not support this type of actions aimed at assessing citizen's reaction to certain types of technology while such a pilot action in the area of social housing combined with smart solutions for improving energy efficiency and changing consumer behaviour is a premiere in Romania.

The future ROP calls launched could have a bigger impact at the regional level if certain measures and results of the Social Green pilot action would be adopted in the mentioned policy instruments.

Possible improvements of ROP Axis 3 and Axis 9:

a) Include equipment, installation, software and maintenance for smart monitoring, automation and reporting systems in buildings as eligible costs; in most cases, improvements of energy efficiency in buildings projects include an envelope insulation, new joinery, new thermal power plant/ installations and sometimes equipment for renewable (solar thermodynamic, photovoltaic or heat pumps) energy, able to improve energy efficiency, minimise consumption and costs with usual 30-50%; for minimising social impact, implementation of smart monitoring systems should be performed in parallel with other rehabilitation activities;
b) Include initial energy analysis/ audit and possible technical solutions together with implementation management for building smart monitoring systems as eligible costs;
c) Include information, training, feedback and support for final users, together with allocated staff costs, as eligible costs;
d) Clarify possible access of users/ administrators to data provided by meters owned by energy and utilities providers, in order to not duplicate (whenever possible) investments in smart meters;

e) Internal climate sensors used during Social Green pilot, demonstrated that many times, CO_2 and humidity are over normal values; knowing that those parameters are not so important for energy efficiency but considering their importance for inhabitants health, automated ventilation systems should be proposed together with building smart monitoring and automation projects;
f) Considering that smart monitoring and consumer's behaviour can usually bring a supplementary improvement of 10-25% to energy efficiency projects in buildings (Social Green results being close to those mentioned, but in high occupancy conditions), an 15-20% of the total project budget can be allocated to such systems and activities, and 5-10% of total budget can be allocated for improving building ventilation.

7. Final conclusions

Pilot of Social Green project in Alba Iulia started from an idea of testing best practices identified during the project in area of building monitoring systems and apply them in local social apartments.

Project revealed that social apartments from Alba Iulia ensure good living conditions, and started with a comprehensive situation on available technical equipment, consumption and costs, representing a snapshot of the before implementation situation and providing possible systems configurations, as identified in initial pilot report.

After successful system implementation in 8 apartments (finally in 10 apartments) and training, data became available for users and administrators in dedicated applications, and we entered in a 12 month period of monitoring and periodic feedback from tenants, together with information able to improve their consumption behaviour.

On technical part, system proved to be viable and provided needed information and reports with minimum maintenance, but we can consider future developments, as technical restrictions allowed usage just for heating, electricity and climate, rest of data being provided manually.

After 12 months of system monitoring and periodic information provided to participants, we obtained a reduction of 11% for electricity consumption, 7% of energy for heating and 13% for energy of hot water (11% hot water quantity), which are exceeding our expectations, because due to Covid 19 restrictions, occupancy rate was higher than in previous years (almost constant). This is a proof of importance of providing access to consumption data using smart home monitoring systems and to general information regarding simple methods for minimizing energy and utilities consumption and cost, in order to obtain a positive change in consumer's consumption behaviour, especially in case of tenants of social apartments.

On social aspects, the high participation and usage rate (67%), together with positive feedback regarding system importance and ease of use, creates an important start point for larger scale developments.

The results of the pilot project are encouraging, demonstrating the positive effects of information and monitoring on user behaviour and energy consumption. In addition, an important result of the pilot project is represented by the installed smart home system, an investment of about 1000 EUR / apartment, which will remain in the participating social apartments even after the closure of the project. In this way, the tenants will still be able to use the smart system, an investment that many of them could not afford.

As a final conclusion, during a "special" period, Social Green pilot in Alba Iulia successfully implemented all major project activities with good results, demonstrating the importance of smart monitoring and information on improving energy efficiency in buildings and recommending such solutions for changing the policy instrument ROP Axis 3 and Axis 9 to the Regional Development Agency - ADR Centru and to the Managing Authority of the ROP.

APPENDIX I – INFO MATERIAL 2

Social Green
Interreg Europe

https://www.interregeurope.eu/socialgreen/

Social Green pilot project in Alba Iulia
"Improving energy efficiency in social apartments through intelligent monitoring solutions"

INFO 2:
Tips on reducing consumption of energy and utility costs

This material uses information and graphic presentations from:
European Commission recommendations - "Reduce consumption and emissions at home"(https://ec.europa.eu/clima/citizens/tips_ro) and from EU project
- "Economy at energy" (www.economielaenergie.eu, https://www.anre.ro/ro/info-consumatori/economie-la-energie)
- Other sources

European Union
European Regional Development Fund

Social Green
Interreg Europe

Why?

- In Europe - average utility costs are 7% of salary
- In Romania, utility costs reach over 9% (and more for low-income families, which leads to the phenomenon of energy poverty)
- Eurostat: 14% of Romanians save on heat due to costs
- Housing generates about a quarter of the direct CO2 emissions currently generated in the EU
- 75% of the energy used by homes in the EU is used for heating and cooling
- In Romania, almost 70% of the housing stock is over 30 years old and has a low energy efficiency

How?

1) Changing consumer behavior (NO INVESTMENT!) With small gestures, you can save energy and money, while helping to protect the environment by reducing emissions.
2) By replacing old eqipments with more efficient ones (INVESTMENT IS NECESSARY)
3) By monitoring consumption and adopting the best measures to reduce them

Specific aspects related to social apartments in Alba Iulia

- The apartments are in very good condition, being built in 2013
- The block has additional insulation (polystyrene 10cm) and double glazing, ensuring energy efficiency close to Class A
- The block has its own central heating for heating and hot water, as well as solar panels for hot water during the summer
- The tenants have individual contracts for natural gas (kitchen) and electricity; the rest of the utilities (cold / hot water, heating) are paid by distribution, according to the individual meters

1) Electricity

- In general, electricity consumption is lower in the summer months (apartments do not have air conditioners)
- The average consumption (2019) in the 8 monitored apartments was 132kWh / month (20 € cost), but with large differences between tenants (1230 - 2060 kWh per year, 180 - 280 € / year)

2) Natural gas

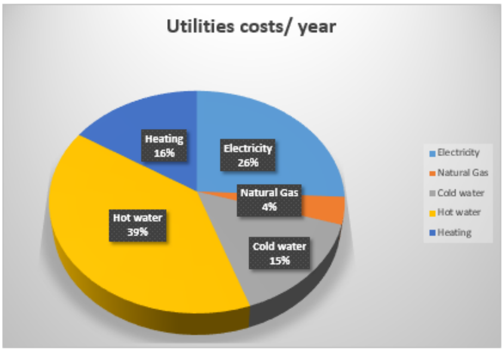
- The meters display the gas consumption in m3; the conversion is done as follows: 1m3 natural gas = 10.71 kWh
- Invoicing is done at 3 months, being difficult to monitor monthly; consumption is much higher in winter
- The average consumption is 1041 kWh / year / apartment with an average cost of 35 € / year (880 - 1160 kWh / year, 29-39 € / year).

3) Hot water / cold water

- On average, 8.9 m3 water / month are consumed in a social apartment, with an average distribution of 4.7 m3 / month cold water and 4.2 m3 / month hot water
- The costs with cold water amount to an average of 86 € / year, and with water for hot water to 77 € / year
- To these costs are added canal water (85 € / year) and the cost of gas needed for heating (227 € / year)

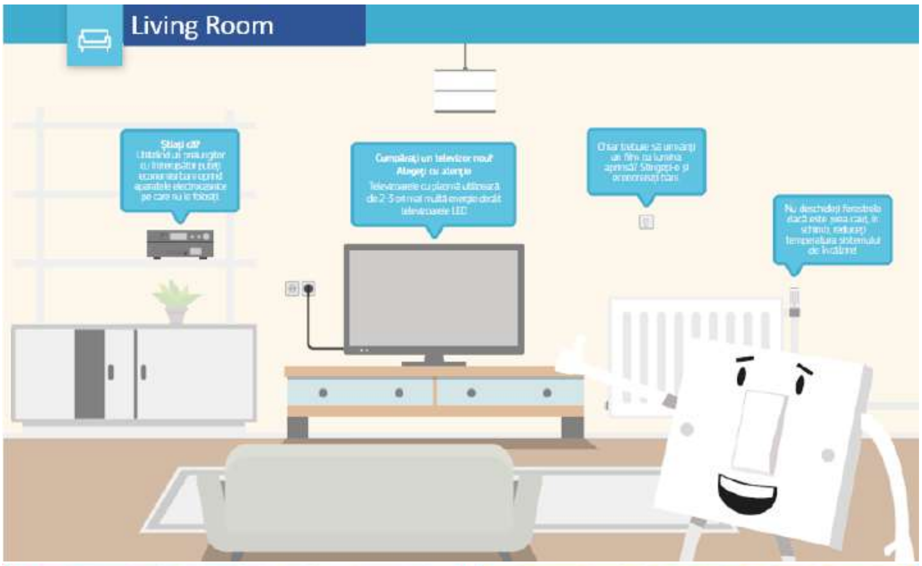
4) Heating

- The building boiler works with natural gas; the average consumption is 2085 kWh / year / apartment, at an average cost of 139 € / year, but with big differences between apartments (some apartments have consumption and double costs



Average distribution of main costs

- On average, the highest monthly costs are with hot water and electricity
- The share of heating costs are strongly felt in the winter months (November - March), the value appearing low due to the annual average which includes the warm months

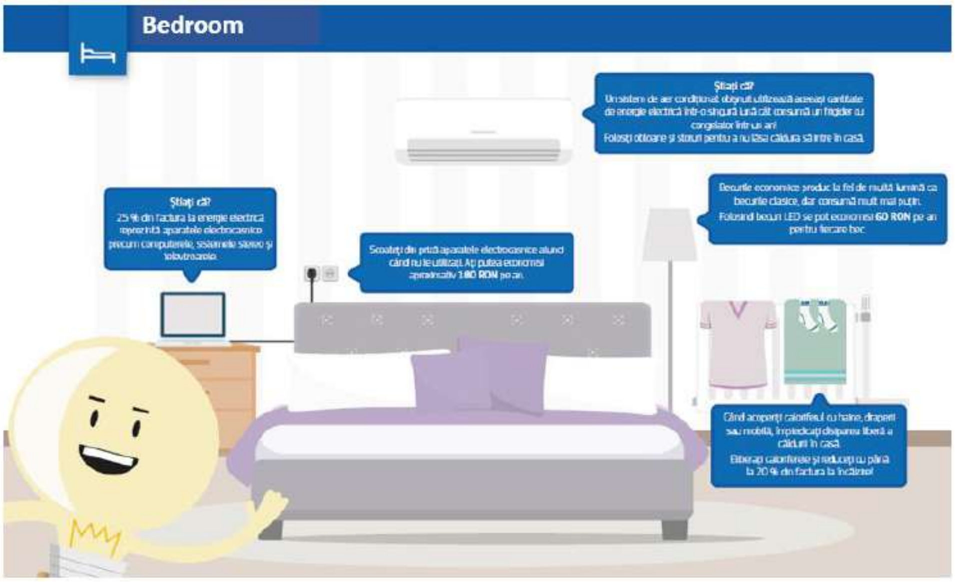

Living Room
Știați că?
Cumpărați un televizor nou? Alegeți cu atenție
Televizoarele cu plasmă utilizează de 2-3 ori mai multă energie decât televizoarele LED
Chiar trebuie să urmăriți un film cu lumina aprinsă? Stingeți-o și economisiți bani
Nu deschideți ferestrele dacă este prea cald, în schimb, reduceți temperatura sistemului de încălzire


Când acoperiți caloriferul cu haine, draperii sau mobilă, împiedicați disiparea liberă a căldurii în casă.
Eliberați caloriferele și reduceți cu până la 20 % din factura la încălzire!
economielaenergie.eu
Comisia Europeană


Nu lăsa aparate în modul așteptare (stand-by) și poți economisi până la 180 RON pe an.
Dacă oprești alimentarea la curent a tuturor electrocasnicelor când acestea nu sunt în uz, poți reduce semnificativ factura la curent.
economielaenergie.eu
Comisia Europeană


Prea cald? Ține ferestrele închise dacă nu bate vântul
și dacă temperatura de afară este mai mare decât temperatura din casă. De asemenea, ține perdelele trase și storurile coborâte când vremea este însorită.
economielaenergie.eu
Comisia Europeană


Un sistem de aer condiționat obișnuit utilizează aceeași cantitate de energie electrică într-o singură lună cât consumă un frigider cu congelator într-un an!
Folosiți obloane și storuri pentru a nu lăsa căldura să intre în casă.
economielaenergie.eu
Comisia Europeană

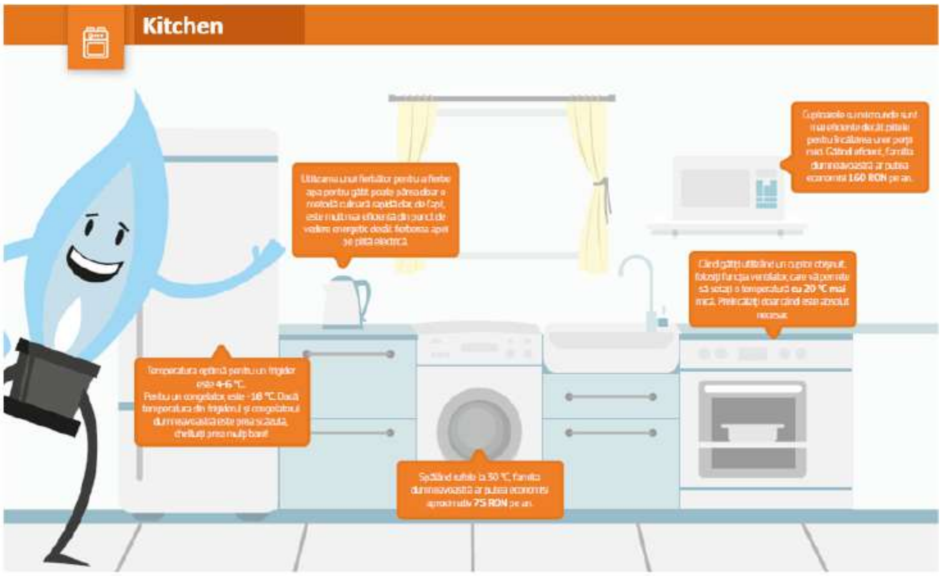

Bedroom
Știați că?
Un sistem de aer condiționat obișnuit utilizează aceeași cantitate de energie electrică într-o singură lună cât consumă un frigider cu congelator într-un an!
Folosiți obloane și storuri pentru a nu lăsa căldura să intre în casă.
Becurile economice produc la fel de multă lumină ca becurile clasice, dar consumă mult mai puțin.
Folosind becuri LED se pot economisi 60 RON pe an pentru fiecare bec.
Știați că?
25 % din factura la energie electrică reprezintă aparatele electrocasnice precum computerele, sistemele stereo și televizoarele.
Scoateți din priză aparatele electrocasnice atunci când nu le utilizați. Ați putea economisi aproximativ 180 RON pe an.
Când acoperiți caloriferul cu haine, draperii sau mobilă, împiedicați disiparea liberă a căldurii în casă.
Eliberați caloriferele și reduceți cu până la 20 % din factura la încălzire!

Climate (heating and cooling)

- The radiators must be clear, to ensure an efficient flow of warm air to the rest of the room
- It is not recommended to keep clothes on the radiator for a long time (decreases their efficiency by 20%)
- Curtains and blinds are effective means of ensuring a good climate, especially in summer
- Air conditioning is a very large consumer; it is recommended to use fans and humidifiers
- The efficiency of a radiator increases by more than 10% if a reflective panel (Izoflex) is mounted behind it, which sends heat to the room
- The normal temperature in the rooms must be 21 degrees; each extra degree during winter, increases consumption by 5-10%
- If a thermostat is set to maximum, the room will not heat up faster than if it is in a normal position; the thermostat only serves to limit the maximum temperature in the room
- Highly loaded rooms, especially with furniture, have higher thermal inertia

Electricity

- Use lighting and equipment only when needed
- The stand-by electronic devices still have a consumption of 5-15W; in the case of several appliances, it is recommended to supply them with an extension cord with a switch, so as to turn them off when you are not at home (up to 35€ / year savings)
- Use step lighting, depending on needs; use low power lamps when you need diffuse / dim lighting
- Use efficient electronic devices (class A +++), with 40% lower consumption than those of older generations
- Use LED bulbs with "warm light", much more energy efficient (15W LED = 75W incandescent bulb); the economic effect is 12-15 € / year / bulb (depending on use)



Gas cooker

- Do not boil / heat larger quantities than necessary
- When cooking, use a larger burner to reach the boiling temperature, then move the pot to a smaller burner
- The oven door must be well insulated / closed; an energy class A oven, consumes less with the equivalent of 200 euros in 5 years of intense use; if the oven has a fan, the cooking temperature can be reduced by 20 degrees for cooking
- To boil small amounts of water, use an electric kettle
- For heating food in small quantities, the microwave is a quick and economical option

Washing dishes

- Do not wash each plate / cup individually; use the tub and stopper to wash with a small amount of warm water and rinse with cold water
- The water does not have to be very hot; mix with cold water, which is 3 times cheaper
- If you use a dishwasher, check the energy class, make sure it is filled to capacity and use the "eco" mode.

Washing laundry

- Use efficient machines (class A ++) and load them to capacity (check the laundry with a scale); in emergencies, use the "small amount" function
- Wash at 30 degrees, the current detergents are very effective; compared to washing at 35-40 degrees, save at least 15 € per year
- Avoid long washes, which include pre-wash and dry, energy-intensive functions

Refrigerator

- Use environmentally friendly A +++ refrigerators (without Freon)
- Periodically check the insulation and gaskets for good condition
- Choose the right temperature (4-6 degrees inside, -18 degrees in the freezer) and use a check thermometer; accentuated cooling consumes unnecessarily
- Do not overload the refrigerator with products and do not introduce several products with temperatures above 20 degrees at the same time.

Fan

- Adjust the fan together with the lighting; adjust the operation to a maximum of 5 minutes after using the toilet

Toilet

- Adjust the volume of water used as needed; use toilets with a 2-stage water use mechanism
- Check that there are no water leaks when the toilet is not in use

- **Washbasin**
- Use water at a temperature of 35 degrees, mix with cold water
- Turn off the tap or reduce the flow when not using water (eg. during brushing or shaving)
- Use faucets with air mixture to reduce water consumption

The shower

- Use the shower instead of the bathtub, which requires large amounts of water
- An efficient and shorter shower by 3 minutes, ensures savings of 3 € / month/ person
- Stop the shower when soaping yourself and use adjustable shower heads

Conclusions

- Although simple and relatively easy to apply, the measures presented can lead to savings of hundreds of euros per year
- Pay close attention to the consumption of hot water and electricity, and in the cold season to heating
- Use monitoring and control systems, avoid waste and try the methods presented simultaneously with responsible consumption - small changes in consumption behavior can generate major savings

We are waiting for your opinions regarding the ease with which you can apply the presented methods and the usefulness of this informative material.

APPENDIX II - QUESTIONNAIRES

Mid term questionnaire

Answers: 8

Apartment: ________

1. Were you familiar with "smart home" or "smart systems" concepts before you became involved in the European Social Green project, funded by the Interreg Europe program?

a. Yes **8**
b. No

8 persons answered YES (100%)

2. Write down the quality of the system installation, your training, and your ability to manage the system (check):

	Very poor	Poor	Average	Very good	Excellent	CONCLUSIONS
Short, professional installation, without affecting my apartment and schedule				3	5	Very good (37.5%) Excellent: (62.5%)
Application installation, configuration, training				4	4	Very good (50%) Excellent (50%)
Usage (I handle the application and system control)				4	4	Very good (50%) Excellent (50%)

3. Cât de interesat/ă ați devenit cu privire la următoarele elemente? (Marcați cu X sau completati)

	Remote temperature control	Smoke sensor (fire protection)	CO2 – air quality	Electricity	Lighting improvement	Internal climate/ comfort
Very interested	7	5	6	6	7	7
Interested	1	2		2	1	1
Neutral		1	2			
Less interested						
Not interested						
CONCLUSIONS	Very interested (87.5%) Interesat: 1 pers (12.5%)	Very interested (62.5%) Interested (25%) Neutral (12.5%)	Very interested (75%) Neutral (25%)	Very interested (75%) Interested (25%)	Very interested (87.5%) Interested (12.5%)	Very interested (87.5%) Interested (12.5%)

4. What is the most important benefit of smart systems from your point of view?

a. Consumption efficiency 3
b. Smaller costs/ bills 4

c. Remote temperature control 3
d. Improved safety
e. Other: 1 – comfort
Consumption efficiency (27.27%)
Smaller bills (36.36%)
Remote temperature control (27.27%)
Other - Comfort (9.09%)

5. How would you describe your interest in the smart systems that have been installed in your apartment?
a. High 8
b. Average
c. Low
HIGH (100%)

6. How much do you think the comfort of the house has increased after the smart system was installed?
a. Not very much
b. Very little 5
c. Quite a lot 3
d. Very much
Very little (62.5%)
Quite a lot (37.5%)

7. Have you noticed any changes in your behavior after installing the smart system, receiving all the equipment and using them? (please mark with an X)

	Attention to energy and utility consumption	Increased interest in smart systems	The desire to share information about smart systems and its benefits to others	Attention to the control of equipment and climate in the house
Very interested	**4**	**6**	**4**	**7**
Interested	**2**	**1**	**4**	**1**
Neutral	**2**	**1**		
Less interested				
NOT interested				
CONCLUSIONS	Very interested (50%) Interested (25%) Neutral (25%)	Very interested (75%) Interested (12.5%) Neutral (12.5%)	Very interested (50%) Interested (50%)	Very interested (87.5%) Interested (12.5%)

8. If you have noticed any change in your behaviour regarding electricity and heat consumption, please provide some examples.

- Increased attention to the consumption of electricity and heat, water
- These equipment's are very good because they turn on the heat in the house when it drops below the temperature set by us and stops when the temperature has reached the desired
- It hasn't changed
- Increased attention to electricity consumption and lower heat and temperature when no one is home
- Not important changes
- I told other people about the project
- There are no changes

9. Care ar fi suma de bani pe care ați fi dispus să o investiți într-un sistem smart, în viitor, pentru confortul locuinței dumneavoastră?
a. bellow 1000 euro 3
b. over 1000 euro, but bellow 2000 euro 1
c. I can't do such an investment 4

Bellow 1000 EURO (37.5%)
Bellow 2000 EURO (12.5%)
Can't do such an investment (50%)

10. How many times a day you used the intelligent heating system (including the mobile application
a. once a day 6
b. twice a day 1
c. 3 times or more 1

Once a day (75%)
Twice a day (12.5%)
3 times or more (12.5%)

11. If you have any suggestions / recommendations for improving the heating system installed in your apartment, please mention them below.

No answers

QUESTIONNAIRE IN THE LAST PERIOD OF THE PILOT

Ap. __

1. How satisfied are you with the smart system installed? Please choose just one variant

a) Very dissatisfied
b) Quite dissatisfied 1
c) Satisfied 2
d) Very satisfied 5

Quite dissatisfied (12,5%)

Satisfied (25%)

Very satisfied (62,5%)

2. How often do you use the smart heating system installed? Please choose just one variant

a. Not frequently 2
b. Once a day 5
c. Twice a day 1
d. 3 times or more

Not frequently (25%)

Once a day (62,5%)

Twice a day (12,5%)

3. What quality would you give to the smart system that has been installed for you? Just choose a variant

a. Very good quality 3
b. Good 5

c. Not very good
d. Poor

Very good (37,5%)

Good (62,5%)

4. Would you recommend this smart system to others?

a. Yes 8
b. No

Recommended (100%)

5. What do you think about the following aspects of the system that has been installed for you?

	Very poor	Poor	Average	Very good	Excellent	Conclusions
Way of operation			1	**3**	**4**	Average (12,5%) Very good (37,5%) Excellent (50%)
The ability of the product to function without failures to date		1		**3**	**4**	Poor (12,5%) Very good (37,5%) Excellent (50%)
Usage (I handle the application and system control)				**1**	**7**	Very good (12,5%) Excellent (87,5%)

6. What is the degree of satisfaction regarding the representatives of the City Hall of Alba Iulia and regarding the staff that installed your system?

	Very dissatisfied	Dissatisfied	Indifferent	Pleased	Very pleased	**Conclusions**
Involvement				1	1111111	Pleased (12,5%) Very pleased (87,5%)
Allocated support				1	1111111	Pleased (12,5%) Very pleased (87,5%)
Professionalism				1	1111111	Pleased (12,5%) Very pleased (87,5%)

7. Regarding information material 1 - "Invoice and supplier information", please let us know if the document received was:

a) very useful 4
b) I already know something 2
c) document should be more complex
d) I would like to receive more documents 1
e) other opinion:

8. Regarding information material 2 - "Tips on reducing energy consumption and other utilities", please tell us if the document received was:

a) very useful 5
b) I already know something 1

c) document should be more complex
d) I would like to receive more documents
e) other opinion:

9. To what extent do you think you will continue to use the smart system and apply the advice you received to reduce consumption and bills after the project is completed?
a) Frequently 4
b) Quite often 2
c) Sometimes 1
d) Never