CE51 TOGETHER

TRAINING MATERIAL ON ENERGY EFFICIENCY IN PUBLIC BUILDINGS

DSM aspects

The training material, which is included in this publication, has been developed within the **TOGETHER** project (full name: **Towards a goal of efficiency through energy reduction**), co-funded by the Interreg CENTRAL EUROPE programme, which encourages cooperation on shared challenges in Central Europe. The project, implemented from June 2016 till May 2019, aims at promoting the concept of integrated energy management in public buildings through implementation of selected technical, DSM and financial measures in 85 pilot buildings from different EU countries. The training material focuses on analytical and behavioural aspects (called together DSM) related to the overall topic of energy efficiency in public buildings. It is completed with 2 other publications - focusing respectively on technical and financial issues.

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INTRODUCTION

This publication contains the training material on energy efficiency in public buildings developed within the TOGETHER project, co-funded from the Interreg CENTRAL EUROPE programme. The project supports implementation of the concept of **integrated energy management** in public buildings through implementation of selected technical, DSM and financial measures in 85 pilot buildings from different EU countries. The measures implemented will lead to significant reduction of energy consumption and change of behaviour of building users.

An important part of the project was focused on the development of a comprehensive, transnational training model and material that could be used to increase knowledge, capacities and skills of building owners, managers and decisions makers, enabling them to successfully implement sustainable energy measures in their buildings and to engage users in this process.

The training material prepared by the consortium discusses wide variety of topics, which fall under three main categories: technical aspects, financial aspects and DSM aspects, where DSM stands for "demand side management" and concerns users' behaviours and energy management practices. This publication contains the training material focusing on the latter, i.e. **analytical and behavioral measures and solutions** that can be implemented in public buildings to optimise energy consumption. It is complemented by two other publications - one concentrating on technical aspects of the process (such us an energy audit, thermal retrofitting of the envelope, modernisation of internal installations, installation of RES, choosing optimal EE improvement scenario) and the other one - on financial aspects (such us choosing funding for energy renovation projects and economic and financial assessment of planned interventions).

The **DSM training material** aims at increasing trainees' knowledge, skills and capacities regarding:

- analytical aspects related to EE in public buildings, with the specific focus on most efficient methods and tools for monitoring energy consumption, standard and smart energy management systems, as well as ICT technologies that may be implemented in buildings to optimise energy use.
- behavioural aspects related to EE in public buildings, with the specific focus on understanding rationale behind people's behaviours and consumption patterns and then - on the basis of this understanding - finding most effective ways to approach building users and motivate them to change their behaviours and engage in energy-related initiatives.

The material has been divided into 16 training modules presented in the table below:

Module no	Module topic
Analytical DSM	
Module 1	Collection, analysis, verification and presentation of the consumption data
Module 2	Development of energy-related data bases
Module 3	Standard energy monitoring / management systems
Module 4	Smart energy monitoring / management systems
Module 5	Advanced energy mangement systems (e.g. BEMS)

Module 6	Using ICT to analyse and reduce energy consumption in buildings
Module 7	Practical use of monitoring data - development of energy optimisation and adaptation scenaris
Module 8	Practical use of monitoring data - educating and involving building users
Behavioural DSM	
Module 1	Behavioural and psycholgical science related to consumers habits and behavius
Module 2	Methods and tools for communicating and cooperating with building users
Module 3	Development of successful educational and information campaigns addressed at building users
Module 4	Methods and tools for changing habits and behaviours of building users
Module 5	Different incentive schemes for energy saving
Module 6	Monitoring of building users' behaviours
Module 7	No-cost and low-cost energy saving measures
Module 8	Integration of behavioural measures with other EE solutions

For each module there is a comprehensive theoretical introduction accompanied by at least one exercise and a set of guiding questions allowing the trainees to test new knowledge gained. In order to support the trainers in the preparation of respective training sessions there are also included further suggestions concerning e.g.:

- list of reference material that can be consulted to elaborate specific topics in more detail;
- other relevant issues that could be raised and discussed with the trainees
- suggestions for further exercises and practical application of new knowledge and skills.

The publication is also accompanied by **model PPT slides** that may be used by trainers during their work.

What is very important about the TOGETHER training material, is that it not only provides knowledge but also addresses practical aspects related with using data analysis, ICT solutions and user engagement methods to optimise energy consumption in buildings. For those, who would like to learn more about the issues raised here, the TOGETHER consortium developed special on-line library, which is a repository of existing materials and tools on energy use and energy efficiency in public buildings. It can be accessed from the project website:

http://www.interreg-central.eu/Content.Node/TOGETHER.html

LIST OF CONTENT

PART 1:
TRAINING MODULES

INTRODUCTION TO DSM

Demand side management (DSM) traditionally means controlling quantity of energy used at specific times to:

- Reduce system peak demand (load levelling)
- Reduce overall system demand (reduce energy consumption through energy efficiency)
- Balance system supply and demand (by managing demand response)

Within TOGETHER project, the coverage of DSM is focused on a change brought by implementing measures of behaviour change (Behavioural DSM) and analysing that impact of these changes through energy consumption and related data gathering and analysis (Analytical DSM).

The purpose of this material is to provide a basis for understanding, stimulating and implementing DSM activities at a building level. The material is to be combined with Power Point presentations and practical exercises that will be delivered through training.

ANALYTICAL DSM

Analytical DSM focuses on building and energy data analysis and using the results to optimise energy use. The data may be also used to show building users results of their energy-saving actions.

MODULE 1: COLLECTION, ANALYSIS, VERIFICATION AND PRESENTATION OF THE CONSUMPTION DATA

Without the introduction of a technical instrument for energy monitoring of consumption, savings are impossible to achieve. People should be encouraged to take energy efficient measures based on the continuous data monitoring according to the available Energy Management System (EnMS).

The first step to undertake when talking about energy and water consumption in buildings is gather information about physical characteristics of a building. Building project documentation and bills are collected through performing energy audit, while results of data analyses are summarised and presented in building energy performance certificate.

Energy audits and certificates are a regulated system for collection, analysis, verification and presentation of consumption data and the Methodology for Performing Energy Audits is usually stipulated by the competent authorities in each EU country, due to the obligations that arise from the Energy Performance of Buildings directive (EPBD). Methodology usually prescribes that monthly energy and water consumption data for the previous calendar year should be gathered, however data collection for the past 3 years is recommended. Collecting energy and water consumption bills is the simplest way for energy consumption and costs monitoring, if there is no more advanced EnMS in place.

An example of a form for collecting data about building and its energy consumption is provided in separate **Excel sheet as an Annex 1 to this document**.

After data is gathered, they are analysed within preparation of an energy audit report, which includes:

1. Analysis of physical characterises of a building in terms of thermal envelope (analysis of thermal characteristics of the outer shell of the building),
2. Analysis of the energy properties for heating and cooling system,
3. Analysis of the energy properties for air conditioning and ventilation system,
4. Analysis of the energy properties for water cooling system,
5. Analysis of the energy properties of the electrical installation and lighting system and other energy consumers that have a significant share in total energy consumption of the building depending on the building purpose,
6. Drive analysis of all technical building systems,
7. Required measurements where is necessary to establish the energy characteristics and properties,
8. Analysis of possibilities for replacing existing energy sources,
9. Analysis of the possibilities for using renewable energy sources and efficient systems,

10. Suggestions of measures for improving energy performance of buildings that are economically justified, achievable savings, estimation, and period for return of investments,
11. Report with recommendations for the optimal operation and sequence of priority measures to be implemented through one or more phases.

Energy certificate is the result of an energy audit and is mandatory for every public building or mixed-use building which is used as a stand-alone for public use purposes and the total useful area exceeds 250m^2 and every other building which is sold, leased or leases or its stand-alone unit is built or for sale (these are obligations arising from EPBD and should be transposed into national legislation).

The verification and presentation of energy consumption data is set in energy certificates which must be accompanied by recommendations for cost effective improvement options to raise the performance and rating of the building.

Residential and non-residential buildings are classified into energy classes according to the energy rankings A+ to G, with A+ being the most energy-efficient and the G most energy unfavourable label. The system of energy labelling may differ from country to country. Hereafter, example from Croatia is given. However, it has to be emphasised that this example should be adjusted for each country in order to educate building managers and user how to read and understand energy performance certificate.

In Croatia, energy labels are reported for reference climatic data. The energy label of non-residential building depends on the relative annual required heating energy expressed in %. For calculating this data, we should first calculate the permissible value of the allowed value of specific annual energy demand for heating for non-residential buildings, $Q'_{H,nd,dop}$ [kWh/(m^3a)] and the specific annual demand heat demand for reference climatic data $Q'_{H,nd,ref}$ [kWh/(m^3a)]. $Q'_{H,nd,dop}$ is defined as the allowed specific value of annual energy demand for heating calculated under the conditions prescribed for the new non-residential buildings according to a specific regulation which prescribes technical requirements for rational use of energy and thermal protection of new and existing buildings and $Q'_{H,nd,ref}$ is the specific annual demand heat demand for reference climatic data per unit of heated part of a building. Thus, the relative annual demand of energy for heating $Q_{H,nd,rel}$ [%] is the ratio between the specific annual demand heat demand for reference climatic data ($Q'_{H,nd,ref}$ [kWh/(m^3a)]) and specific annual energy demand for heating for non-residential buildings ($Q'_{H,nd,dop}$ [kWh/(m^3a)]). Energy labels ranking for non-residential buildings are shown in Table 1.

Table 1 Energy labels for non-residential buildings in Croatia

Energy label	Relative annual demand of energy for heating $Q_{H,nd,rel}$ [%]
A+	≤ 15
A	≤ 25
B	≤ 50
C	≤ 100
D	≤ 150
E	≤ 200
F	≤ 250
G	> 250

Energy certificate, contains the basic data of the building and the energy label, but it also contains the proposal for measures to improve the energy performance of the buildings that are economically reasonable for existing buildings, or recommendations for building usage related to the fulfilment of essential energy savings requirements and thermal protection of the building.

Considering that in Croatia energy audits and certificates are mandatory for public building which surface exceeds $250m^2$, it is advisable to follow recommended measures set in the certificate. Once an energy audit is performed by a competent professional and possible measures for energy efficiency improvements are listed in energy certificate, energy management in each building becomes more realistic and progress can be monitored against set benchmarks.

In case that energy audit is older than 5 years or doesn't exist at all is necessary to perform a detailed data check and to supplement it with new data through the next steps:

- collection of energy and water consumption bills from the past 3 years;
- physical characteristics of a building (exc. floor area);
- purpose and frequency of use;
- information about energy systems and energy consumption in a building;
- condition of a building and equipment;
- calculation of water and heat consumption of a building per square meter and;
- significant investments in the previous 3-5 years.

Once the basic information is collected, it is important to follow the paths of energy consumption with some type of EnMS reporting energy consumption data to the top management and building users for stimulating consumption behaviour change.

MODULE 2: DEVELOPMENT OF ENERGY-RELATED DATA BASES

Development of comprehensive energy related data bases is a challenging task because of multiple energy related data for a building. Firstly, three types of energy consumption data should be distinguished:

1. historical data or energy bookkeeping data (different sources, tariffs, costs);
2. data from energy audit (lots of physical and consumption data for a building);
3. higher resolution data (real-time or near real-time) from BMS and SCADA.

For achieving quality energy management, the use of all three types of data is necessary.

While bills and energy audit data have been previously explained, higher resolution data allows the identification of consumption paths and dynamics that would not otherwise be observed if only historical data or bookkeeping data was available. Existing building EnMS are monitoring tools rather than analytics engines with self-learning capabilities, not being capable to automate more complex optimization or reinforcement learning algorithms.

A common problem is the multiplicity of units such as W, kW, Wh, kWh and data resolutions (1 min, 15 min, 1h, 1 month) being collected by different devices and bookkeeping data. Complex EnMS to overcome the problem are able to transform it into a unique resolution unit, the main issue is to transform lower resolution data into higher resolution data, nevertheless several implementation options and capabilities of developers should be considered.

Another problem that occurs is that data from audit, historical and higher resolution data are usually monitored separately even they should be mutually dependent. For good energy management, it is important to follow the sequence in data acquisition from different types of data and to interconnect all data types in an EnMS for efficient DSM.

In energy-related data-bases, as any data-base, each data-base record, in this case each building, must have its own identification number. Every building shall be entered separately. In the case of complex buildings, it is possible to associate the building being entered to another building, if they have the same meter (listing the account, a notice that more buildings are connected to the same meter is given) and enter more meters for the same building as well. Principle scheme of this system, is shown in the Figure 2.

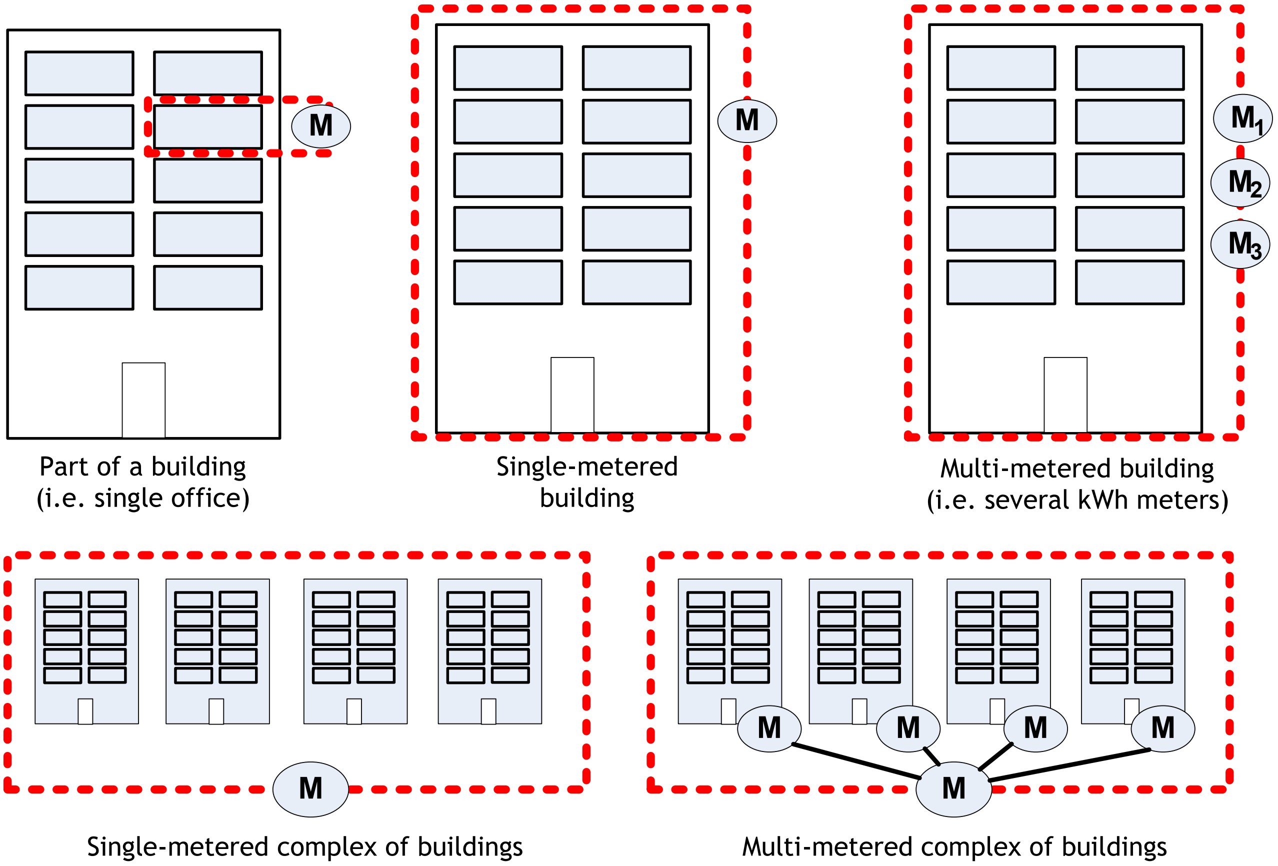


Figure 1 - Principle schemes on possible architecture of measurements and buildings for self-standing single and complex sets of buildings

Furthermore, data-base will have their static and their dynamic part. An example of records, i.e. information about building, in a static and dynamic part of data-base are provided in the tables below and are based on Croatian example of EnMS applied in public buildings.

Table 2 Static data about the building in the energy-related data base

Nr.	Category name	Explanation, remarks
0	**Annex**	**The possibility of entering remarks near boxes**
0.1	Enable upload of documents (pdf, doc, xls, jpg) and their storage on the server	Upload documents pertinent to the building (blueprints, sketches, licenses, etc.)
0.2	Building picture upload	Upload picture of the building
1.	**General information about the building**	
1.1	Identification number:	
1.2	Name	
1.3	Location (address; city/block/municipality/ county):	According to the selected sites, the program automatically selects the reference weather station for that building from which the data is taken.
1.4	Purpose:	Selected from the offered.
1.5	User:	Possible choices: city, county, Ministry, other government institutions, national company, private company, etc.
1.6	Ownership:	The user is the owner, or the building is in the lease of the natural / legal person, city, county, state
1.7	Share of the use of total building area [%]:	In the event that the whole building is not on the overall use or ownership.
1.8	Number of the energy certificate according to the ECZ registry	
1.9	Energy class according to the current energy certificate	
1.10	Cultural heritage buildings (yes/no):	If yes, then add category protection.
1.11	Year of completion of construction:	
1.12	Year of last restoration:	
1.13	What has been renovated:	
1.14	Contact person:	persons responsible for monitoring energy consumption in the building
1.15	Phone:	
1.16	Fax:	
1.17	E-mail:	

Nr.	Category name	Explanation, remarks
1.18	Flat gross floor area of the building [m^2]:	The sum of the floor surface for all levels of the building and is calculated according to point 5.1.3. HRN EN ISO 9836:2002. The definition can be found in the Rules of the energy certification of buildings (NN 113/08).
1.19	Useful area surface of the building, Ak [m^2]:	The total area of net floor heated surfaces of the building. The definition can be found in the Rules of the energy certification of buildings (NN 113/08).
1.20	Heated surface area of the building, A [m^2]:	Total area of building components that separate heated part of the building from the outside space, land or unheated parts of the building (heated layer of the building). The definition can be found in the Rules of the energy certification of buildings (NN 113/08).
1.21	Heated volume area of the building, Ve [m^3]:	Heated volume of the building where the surface area is A. The definition can be found in the Rules of the energy certification of buildings (NN 113/08).
1.22	Useful area surface of the building, Ak c [m^2]:	The total area of net floor cooled surfaces of the building.
1.23	Cooled surface area of the building, Ah [m^2]:	
1.24	Cooled volume area of the building, Ve c[m^3]:	
1.25	Number of floors:	"Pull down" menu
1.26	Reference weather stations selection	Connected to a database for reference climatic stations…
1.27	General remarks about the building	
2.	**Building usage**	
2.1	Number of employees:	Permanently employed persons.
2.2	Number of users:	Users of building’s space. Monthly average.
2.3	Number of working days per week:	
2.4	Number of working days per year:	
2.5	Number of working hours per working day:	
2.6	General remarks on the use of the building	

Nr.	Category name	Explanation, remarks
3.	**Thermal characteristics of the outer envelope of the building**	**There must be a possibility of calculating the average value of (3.10) and (3.11) in Croatia, according to the climatic zone, city, county, etc.**
3.1	Short description of the composition of the outer wall:	(For example, full or hollow brick, concrete, insulation)
3.2	Type and condition of doors and windows:	(For example, single or double windows, single glass, isoglass, wooden, PVC or aluminum frame)
3.3	Short description of the roof or ceiling to the exposed roof:	(For example, the composition of the ceiling, there is the attic insulation or roof, roof condition, possible leakage)
3.4	Short description of the ground floor:	(For example, the composition of the floor to the ground, problems with moisture)
3.5	Coefficient of heat passing through the outer walls [W/m^2K]:	From "Technical regulations about the rational use of energy and heat protection in buildings (NN 110/08)" program must take over the maximum coefficient allowed the passage of the heat and facilitate comparison. Coefficient is calculated through the energy review and then implementing into the system.
3.6	Coefficient of heat passing through windows (openings) [W/m^2K]:	Every time one of the coefficients is entered, or HT ratio, there must be shown ratio for that particular building, the average national ratio, the average ratio for that weather region and maximum allowed coefficient according to "Technical regulations about the rational use of energy and heat protection in buildings (NN 110/08)". Coefficient is calculated through the energy review and then implementing into the system.
3.7	Coefficient of heat passing through floors [W/m^2K]:	Coefficient is calculated through the energy review and then implementing into the system.
3.8	Coefficient of heat passing through the ceiling [W/m^2K]:	Coefficient is calculated through the energy review and then implementing into the system.
3.9	Coefficient of heat passing through walls to unheated spaces [W/m^2K]:	Coefficient is calculated through the energy review and then implementing into the system.

Nr.	Category name	Explanation, remarks
3.10	Transmission coefficient of heat loss per unit of surface area of heated buildings, HT' [W/m^{2}K]:	Coefficient is calculated from form factor (ff) and equation given by "Technical regulations about the rational use of energy and heat protection in buildings (NN 110/08)"
3.11	Annual thermal energy needed for heating [kWh]:	Computationally determined a certain amount of heat that heating system should over one year bring the building to maintain the internal project temperature in the building during the period of heating the building. It is calculated over the volume of the heated building and the maximum allowable transmission coefficient of heat loss per unit of surface area of heated part of the building. Coefficient is calculated through the energy review and then implementing into the system.
3.12	Share of windows surface in total front surface [%]:	Quotient surfaces of windows, doors and trans-parent elements of facades (building opening) and the total area of the facade (wall + window, etc.). By heated attic, area of roof windows is added to the window surface, and corresponding slant roof with roof windows surface is added to the total surface area.
3.13	General remarks on the outer envelope and building state of the building.	
4.	**Building heating system**	**The program should enable the calculation of efficiency indicators. One of the indicators of efficiency is the quotient (4.5)/(4.10). which must be within 0.8 to 1.1. If less than 0.8, it is undersized boiler and if the coefficient is more than 1.1, boiler is oversized.** **If the (4.12)>0, and (4.2) is selected "central" option, test of balance and dimension of the system is required. In each case program shows the "Alarm" and gives advice and possible next steps.**

Nr.	Category name	Explanation, remarks
4.1	Fuel/heat source:	Selects between the wood, light fuel oil, extra light fuel oil, natural gas, liquefied petroleum gas, electricity, heat or other options for registration. Also, if "other" is chosen, there must be the possibility of entry the calorific value of fuel in an agreed unit.
4.2	Type of heating system (individual / central):	If "central" program is selected opens the possibility to choose: 1. own boiler, 2. boiler room in a separate building, 3. connection to the district heating system 4. number of small gas-fired boilers
	Central heating system	
4.3	Type of boiler / heat substations:	In the case of central heating.
4.4	Year of manufacture of boiler / heat sub-stations:	In the case of central heating.
4.5	The total heat capacity of boiler / heat substations [kW]:	In the case of central heating.
4.6	Whether the central heating system using heat pump: (option YES or NO)	In the case of central heating (water and air)
4.7	Type of heat pump	Air-air, water-air, water -water, ground-water
4.8	Type of refrigerant	
4.9	The total heat capacity of heat pump [kW]:	
	Individual heating system	
4.10	The total installed thermal power of heaters [kW]:	User writes the installed power of radiators and fan-centralized system. In the event of individual room heating the total thermal power of individual thermal devices is written.
4.11	Whether the primary heating system using electrical heaters: (option YES or NO)	

Nr.	Category name	Explanation, remarks
4.12	Installed capacity of electric heater [kW]:	Thermal power additional devices for heating the building, if any.
4.13	Whether the primary heating system using an additional split systems for heating: (option YES or NO)	
4.14	Installed electric power of split systems [kW]:	
4.15	Year of manufacture of boiler / heat substations:	
5.	**Building cooling system**	**The program should enable the calculation of efficiency indicators. One of the indicators of efficiency is the quotient (5.3)/(5.7) which must be within 0.7 to 1.1. If less than 0.7, the system is undersized and if the coefficient is more than 1.1, it is oversized.** **If the (5.7)>0, and (5.2) is selected "central" option, test of balance and dimension of the system is required. In each case program shows the "Alarm" and gives advice and possible next steps. It is also a proposal to compare that particular COP with some particularly effective solutions.**
5.1	Energy-generating product:	
5.2	Way of cooling (individual / central):	
5.3	The total cooling capacity of cooling stations [kW]:	
5.4	COP:	Coefficient of performance.
5.5	Year of manufacture of cooling devices:	
5.6	Refrigerant in the refrigeration device:	
5.7	The total installed cooling power of coolers (cooling appliances) [kW]:	
5.8	Installed electric power of split systems [kW]:	
5.9	General remarks on the building cooling system	

Nr.	Category name	Explanation, remarks
6.	**Air-conditioning and ventilation system**	
6.1	Volume of ventilated and conditioned space [m^3]:	
6.2	Number of AHU	
6.3	Total air flow [m^3/h]:	
6.4	Total heating capacity [kW]:	
6.5	Total cooling capacity [kW]:	
6.6	The total installed electric power of AC/ ventilation system [kW]:	
6.7	Heat recovery (yes/no):	
6.8	Percentage of recirculated air, %	
6.9	Humidification (yes/no)	
6.10	General remarks on the building AC/ ventilation system:	
7.	**Domestic hot water preparation system (DHW)**	
7.1	Fuel:	The possibility of choosing more energy-generating products at the same time.
7.2	Mode (single / central / combined):	
7.3	The total installed thermal power of DHW system [kW]:	
7.4	The total installed electric power of DHW system [kW]:	
7.5	Set temperature in accumulation system	
7.6	General remarks on the preparation of DHW system:	
8.	**Plumbing system of the building:**	
8.1	Mode of supply of drinking water (public water supply, well, etc.):	
8.2	General notes on building water supply system:	

Nr.	Category name	Explanation, remarks
9.	**Electric lighting system of the building**	**The program must enable the display of indicators (for external and internal lighting) and comparison with other facilities:**
	System of internal electric lighting	i. kW/m^2 (Total and individually by type of lighting)
9.1	Total installed power of incandescent lamps [kW]:	ii. kW/lamp (Total and individually by type of lighting)
9.2	The total number of luminaries with incandescent lamps:	iii. If 1.>0 "Alarm"
9.3	Total installed power of compact fluorescent luminaries [kW]:	iiii. If 5.>0 "Alarm"
9.4	The total number of compact fluorescent luminaries:	iiiii. If 9.i 16.>0 "Alarm"
9.5	Total installed power of compact fluorescent luminaries with electromagnetic ballast [kW]:	
9.6	The total number of compact fluorescent luminaries with electromagnetic ballast	
9.7	Total installed power of compact fluorescent luminaries with electronic ballast [kW]:	
9.8	The total number of compact fluorescent luminaries with electronic ballast :	
9.9	The total installed power of high-pressure mercury luminaries [kW]:	
9.10	The total number of high-pressure mercury luminaries:	
9.11	Total installed power of halogen luminaries [kW]:	
9.12	Total number of halogen luminaries:	
9.13	Total installed power of metal halide luminaries [kW]:	
9.14	Total number of metal halide luminaries:	

Nr.	Category name	Explanation, remarks
9.15	Total installed power of other types of lighting[kW]:	
9.16	Total number of other types of luminaries:	
9.17	General remarks on the internal lighting system:	
	External electric lighting system	
9.18	The total installed power of high-pressure mercury luminaries [kW]:	
9.19	The total number of high-pressure mercury luminaries:	
9.20	The total installed power of high-pressure sodium luminaries [kW]:	
9.21	The total number of high-pressure sodium luminaries:	
9.22	Total installed power of other types of lighting [kW]:	
9.23	Total number of other types of luminaries:	
9.24	General remarks on the external lighting system:	
10.	**Other electricity consumers:**	
10.1	Total installed power of office equipment [kW]:	
10.2	Total installed power of kitchen equipment [kW]:	
10.3	The total installed power of other consumers [kW]:	
10.4	General remarks on other electric energy consumers:	

Table 3 Dynamic data about the building in the energy-related data base

Nr.	Category name	Explanation, remarks
11.1	Consumption of energy and water meters	■ Weekly readings of energy and water. ■ Monthly inputs of bills received from suppliers. ■ Update of the possible selection of energy and calorific value Is required. Calorific values should be taken from Rules of the energy certification of buildings (NN 113/08). ■ …
11.2	Outside temperature taken from reference weather stations	
11.3	Indoor temperature	Temperature of the referent room. Possible input from smart meters
11.4	Possible input of average number of people during the week	If 3. or 4. = 0, application refers to "Building usage". Building users must be able to change or/ and enter correct number of people (users) of the building in the observed week.
11.5	Possible input of working hours during the week	

Energy data-base, i.e. data collected and organised to enable their analysis, is a key element of any EnMS, as nicely demonstrated in the Figure below.

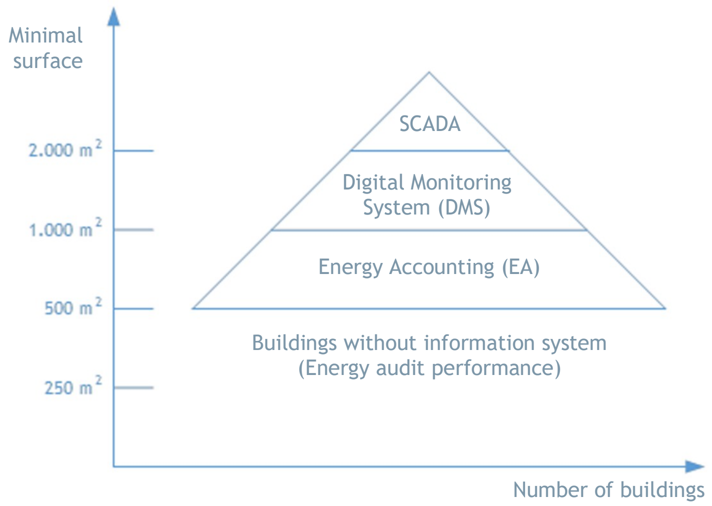


Figure 2 Levels of information systems for EnMS

MODULE 3: STANDARD ENERGY MONITORING/ MANAGEMENT SYSTEMS

Energy accounting or energy bookkeeping represent standard energy monitoring system. Energy bookkeeping assures a regular monthly record of energy consumption, the calculation of basic indicators (electricity, heating, cooling and water consumption) and comparison of the consumption data with data from previous periods.

By monitoring bills, excessive consumption can be easily identified and thus reduced. This should be easily done by organizing a spreadsheet for energy consumption and costs data input, thus prices and energy consumption can be easily visualized and compered from month to month. Consumption is directly linked with prices so is important to individually gather by energy sources and the associate energy tariffs and costs.

For example, monthly there are two types of bills for electrical energy, one is for supply and the other one is for grid fees, so tariffs and calculation methodology differs by each. Additionally, when gathering from district heating from bills and water consumption data the result is a lot of unsorted data in terms of costs and is very difficult to find a common denominator. The conclusion is that costs (€/kWh etc.) should be monitored individually depending on the source. The most favourable solution of energy bookkeeping is to implement the system by yourself. Verification and presentation of energy consumption patterns should be summarized in simple reports.

For buildings that still do not have energy accounting/bookkeeping system, here are some useful links (important note: for such buildings, training includes demonstration of the use of selected system, while in buildings that have such system in place, training should include education about that system).

Table 4 Available energy accounting/bookkeeping systems

Name	Link
Wattics/	http://wattics.com/Events2HVAC
eSight	http://www.esightenergy.com/
digitalenergy professional	http://www.digitalenergy.org.uk/
Entronix EMP	https://entronix.io/
ePortal	http://eportal.eu/
EnergyDeck	https://www.energydeck.com/
Energy Elephant	https://energyelephant.com/
Utilibill	http://www.utilibill.com.au/
AVReporter	http://www.konsys-international.com/home

MODULE 4:
SMART ENERGY MONITORING/ MANAGEMENT SYSTEMS

Smart or Digital Monitoring/Management System is a solution where data on energy consumption and thermal comfort in the building are monitored and recorded in an online database. This is made by using several adequate digital sensors and meters. System includes at least the installation of external and internal temperature sensors, electricity consumption with digital counters monitoring and a digital monitoring of thermal energy consumption through heat meters installed in the boiler room. System is usually monitoring all parameters in a 15 minutes interval, then all parameters are transmitted over the communication link to the common database, where all data are being processed and immediately available to the user. This allows immediately reaction of user or energy manager, which is important for optimum energy efficiency. Second way of monitoring data is to entry data on energy consumption based on bills, so this is practically energy accounting. Digital monitoring system is combined system, which is able to present and compare digitally acquired data with manually inserted ones (from bills). A general concept of smart monitoring/management system is shown in the Figure below (based on example from Croatia).

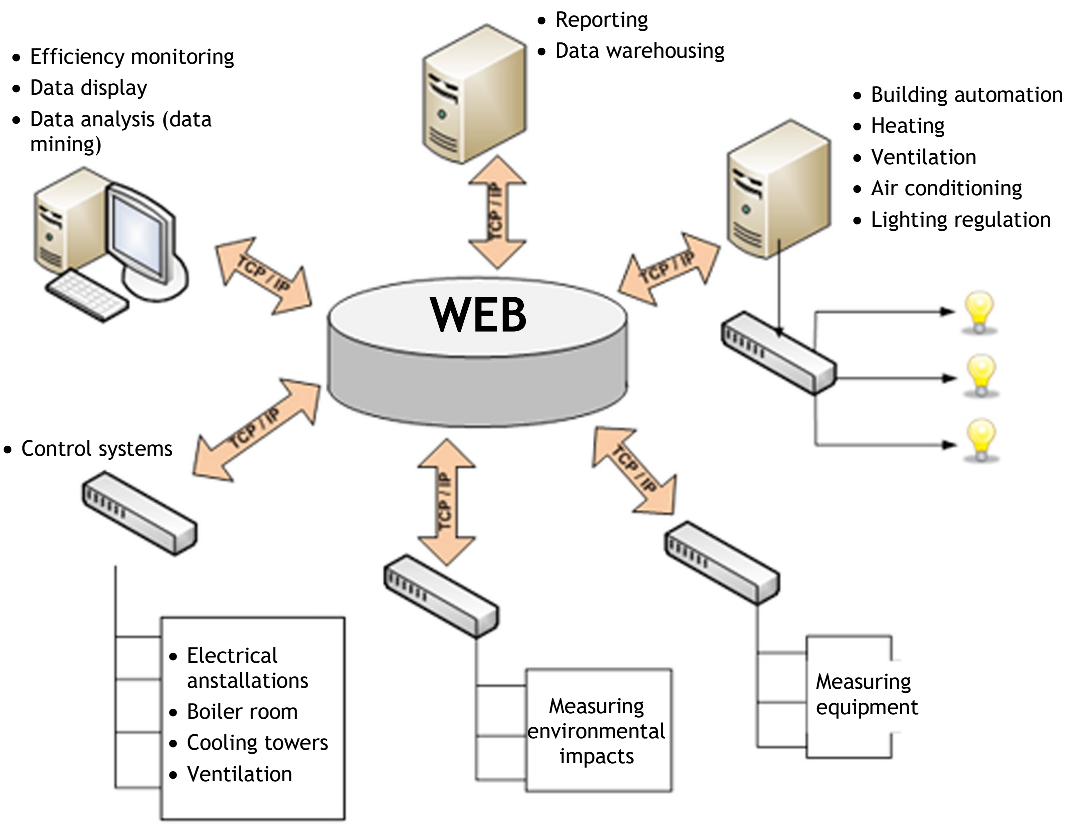


Figure 3 Architecture of smart energy monitoring/management system

These kinds of systems are computer programs which can be accessed from the internet using a username and password and provides data storage and access the information of energy and water consumption in all buildings that are included in the energy management system. Basic functions are:

- Collection and entry of basic building data, controlling energy and water consumption on a monthly, weekly, or daily basis (bookkeeping or meter reading);
- Easy access to energy and water consumption, paths, and points of energy consumption;
- Calculation and analyses with the aim of detecting the unwanted, excessive, and irrational consumption and identifying the opportunities for achieving energy and financial savings
- Verification of realized savings;
- Automated warning of critical events and malfunctions.

In the database, after the entry of physical and construction characteristics of a building, dynamic data from monthly consumption from bills and data from meters are collected. The system is designed to accept almost instantaneous energy consumption data from facilities where remote energy consumption meters are installed.

Data entered into the system are used for a series of calculations, analyses and monitoring energy and water consumption, compare consumption in similar buildings (benchmarking), as well as identify excessive and irrational consumption. Part of the consumption analysis and monitoring is automated and critical data (for example, drastic increase in energy or water consumption) is notified to competent persons, which prevents unwanted and unnecessary costs. Additionally, based on information obtained through the conducted analyses, experts responsible for energy management identify and implement the necessary measures to increase energy efficiency, ultimately resulting in energy and financial savings. Monthly consumption paths are shown at the graphical interface from a web application (Figure 3) with access with login and password.

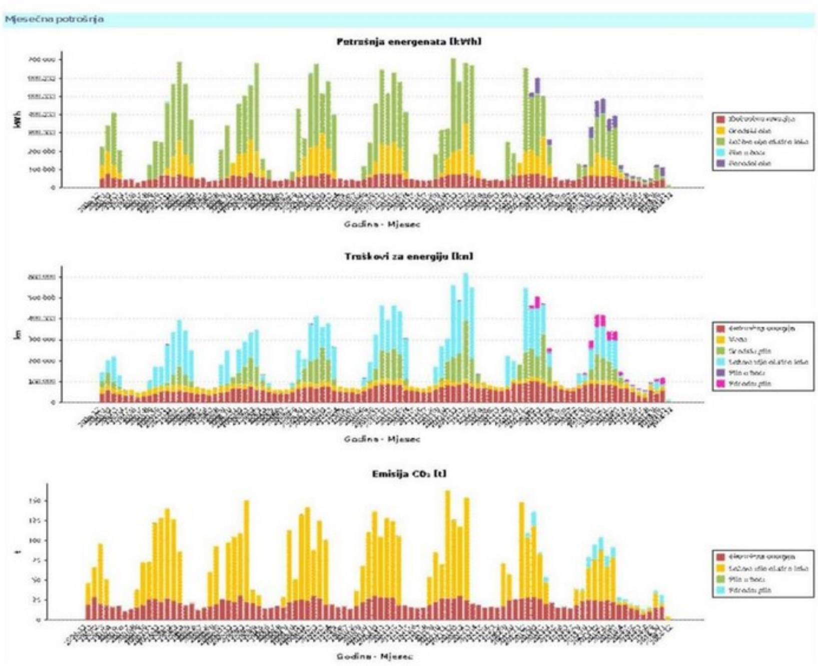


Figure 4 Monthly consumption data in EnMS

With Digital Monitoring Systems users are enabled to view basic information about monitored building (address, picture, construction characteristics etc.), weather and temperature information, real-time, daily, weekly, monthly, and yearly energy consumption and to comparison energy consumption with set baseline. Remote reading of consumption allows monitoring of consumption paths through technical systems for remote reading, collection of impulse and meter data collection, and forwarding them to remote stations where they are transferred and collected. DMS allows continuous monitoring of consumption paths and analyse on one or multiple buildings, which is the aim of every EnMS. By comparing single indicators achieved through analyses, insight monitoring of energy consumption is provided and prompt reactions in case of too high consumption.

(important note: at the training, users should be introduced with the system applied in their building and if such a system does not exists, than proposed information of systems available in other countries, e.g. Croatia should be presented).

MODULE 5: ADVANCED ENERGY MONITORING/ MANAGEMENT SYSTEMS

An example of advances energy monitoring system is supervisory control and data acquisition (SCADA) which is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management, but uses other peripheral devices such as programmable logic controllers and discrete PID controllers to interface to the process plant or machinery. SCADA allows setting daily operation of the facility and synchronize the operation of various elements of the system, noting anomalies and deviations and allows immediate action and thereby optimizing the operating costs of the facility.

Optimized Building Energy Management Systems (BEMS) can provide savings between 10 and 30%, and can be particularly valuable where no other interventions in terms of building envelope can be made (historical buildings). More complex BEMS are offering the following features:

- Visualisation and reporting (benchmarking with other buildings, heat mapping, interactive portals, mobile applications)
- Fault detection and diagnostics (HVAC and alerts, software analytics for equipment management)
- Predictive maintenance and continuous improvement (proactive system improvements, forecasting and financial scenarios)
- Optimization (automated demand response, dynamic energy procurement, peak demand management).

A problem that occurs is the multiplicity of data and resolution units being collected by different devices. To overcome this problem is usually useful to either transform it into a unique internal resolution unit or to guarantee that every module that works with data has the capability to convert it and interpret it.

Data analytic module comprise relational and time-series database. Relational database ensures persistence of energy data over time in a usual rational model and provides data analytics features that do not require real-time (or near real-time), capabilities such as benchmarking, energy tariffs optimization, energy efficiency measures and baseline modelling. Time-series database are real-time analytics that enable real-time notifications (abnormal consumptions, appliances or equipment left ON, actuation by switching ON and OFF energy loads either by hour periods or by co-relating with exogenous variables (changing HVAC ventilation by temperature forecast).

Advanced energy management system is not just a two-way system, but is a closed loop meaning that all steps are following continuously and each circle means improvements in relation to the previous one, for that reason, it is necessary to introduce periodical checks. The main difference between smart and advanced energy system is in controlling and regulating.

MODULE 6:
USING ICT TO ANALYSE AND REDUCE ENERGY CONSUMPTION IN BUILDINGS

The collection, but even more important the understanding of all collected data and their links with energy consumption can be useful for:

1. consumption baseline modelling;
2. identification of past consumption profiles;
3. calculation of most suitable energy efficient tariffs;
4. intelligent alarms;
5. technical systems DSM (balancing demand, supply and storage between distributed, RES and the grid, controlling shift able loads, guarantee that not seful consumption is turned OFF during non-operational hours, optimization of HVAC, time of use tariffs (ToU) and weather forecast and daylight harvesting);
6. foster user engagement to trigger behaviour change (share of energy information like benchmarking with users of the same activity sector to create competition or co-opetition);
7. load desegregation models and
8. identification of specific EE measures.

With graphical interfaces users are enabled to view basic information about monitored building (address, picture, construction characteristics etc.), weather and temperature information, real-time, daily, weekly, monthly, and yearly energy consumption and to compare energy consumption from period to period and with set baseline.

Therefore, the first step in data analysis is to model energy consumption baseline. This is important as any future developments of energy consumption will be compared to that baseline. One of the methods for determining the baseline is regression analysis. The regression analysis (to be more precise least squares regression analysis) is a method that determines the function to best fit a set of data. This technique is used to determine the relationship between energy and variable influence it. It will provide equation which will be used as standard performance equation or curve. In buildings, it is usually ET (energy-temperature, better yet energy-degree day) curve as presented in the Figure below.

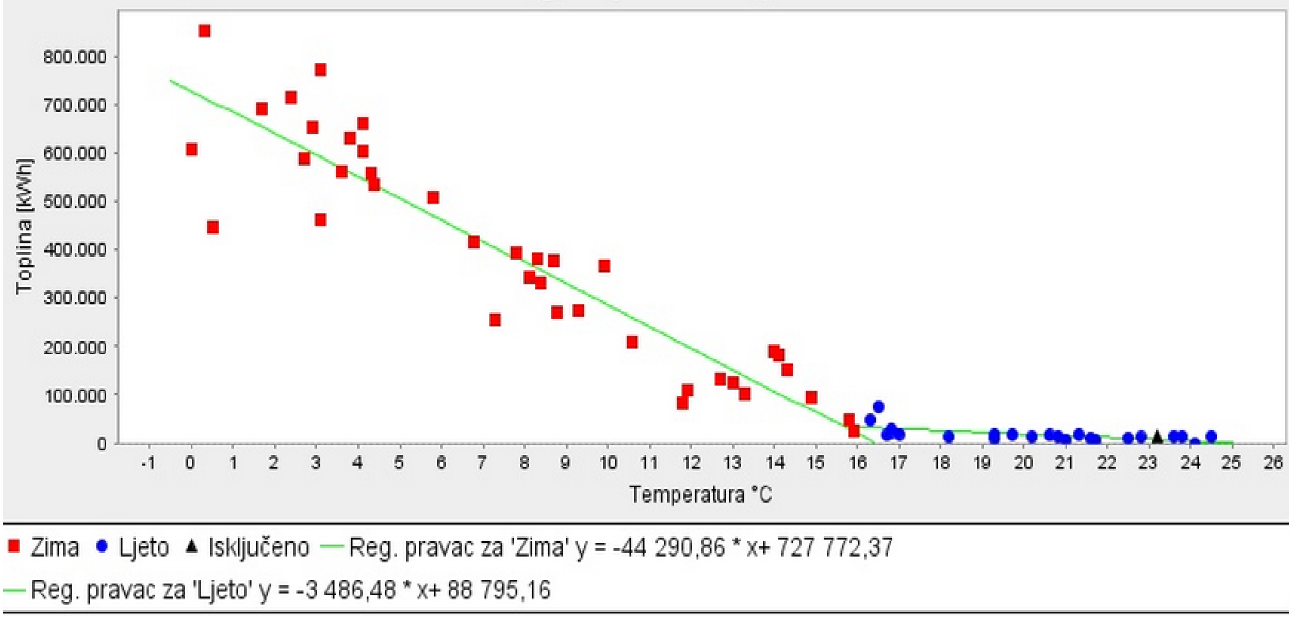


Figure 5 Example of baseline energy consumption presented by regression curve

Regression analysis is statistical technique and needs to be treated with care. If it fails to produce relationship between energy and variable(s) it doesn't necessary mean that one does not exist, and also sometimes the calculated relationship can be misleading. Results highly depend on variables chosen and quality of data used. Any suspicious points should be checked, and if necessary eliminated from analysis.

If it is suitable, correlation can be a straight line described with simple equation:

E = C+mP

E - total energy consumption

C – base-load energy consumption (does not depend on production level or degree day)

m – multiplying factor

P – variable related to energy

This simple equation is usually used for single process (energy accounting centre), but if it is going to be applied to the complex of buildings, then multi-variable regression analysis must be carried out:

E=C+m1P1+m2P2+…+mnPn

Ones that standard equation is obtained (standard line), it is used to predict energy consumption for a given level of variable. It can be compared with the actual consumption to provide a measure of energy performance. Additional analysis can be undertaken to determine target line, which will represent a planned improvement on standard performance and can be a good basis for setting energy budget. Targets can be set in percentages or more sophisticated analysis can be conducted to determine different reduction measures for both, fixed and variable energy consumption. The results from regression analysis can be used to set targets, by drawing the target line which will represent the wanted energy consumption reduction (e.g. as black dashed line in Figure 4).

Regression analysis is useful, but it is not sensitive enough to show systematic trends in energy consumption. In that sense, techniques like Cumulative Sum (CUSUM) are more informative. CUSUM originates from statistical quality control. In order to calculate CUSUM it is necessary to have target value. By calculating the cumulative sum from this target (sum of the differences from standard performance), a trend line can be plotted and it will give a clear indication of performance and changes in performance. The numerical value of CUSUM gives the savings made to date, and slope of the curve gives information on the performance trend. CUSUM represents the difference between the base line and the actual consumption data points over the base line period of time. A CUSUM graph therefore follows a trend which represents the random fluctuations of energy consumption and should oscillate about zero. This trend will continue until something happens to alter the pattern of consumption such as the effect of an energy saving measure or, conversely, a worsening in energy efficiency (poor control, housekeeping or maintenance). It has a number of useful properties:

- When its trend is horizontal, it means that the monitored process is operating near the current target;
- An upward trend signifies over-consumption, while a downward trend signifies persistently using less then expected;
- Change in direction of the curve means a change in the way the monitored process is behaving.

The change in value over any period of time represents the cumulative loss or saving. As it can be seen in Figure 7, this building continuously decreases its energy consumption. In April, something has happened that caused the change in this trend. Significant deacrese occurred in 2014, which in this concrete case coincide with implementation of EE measures (thermal insulation of external envelope and reconstruction of heating system).

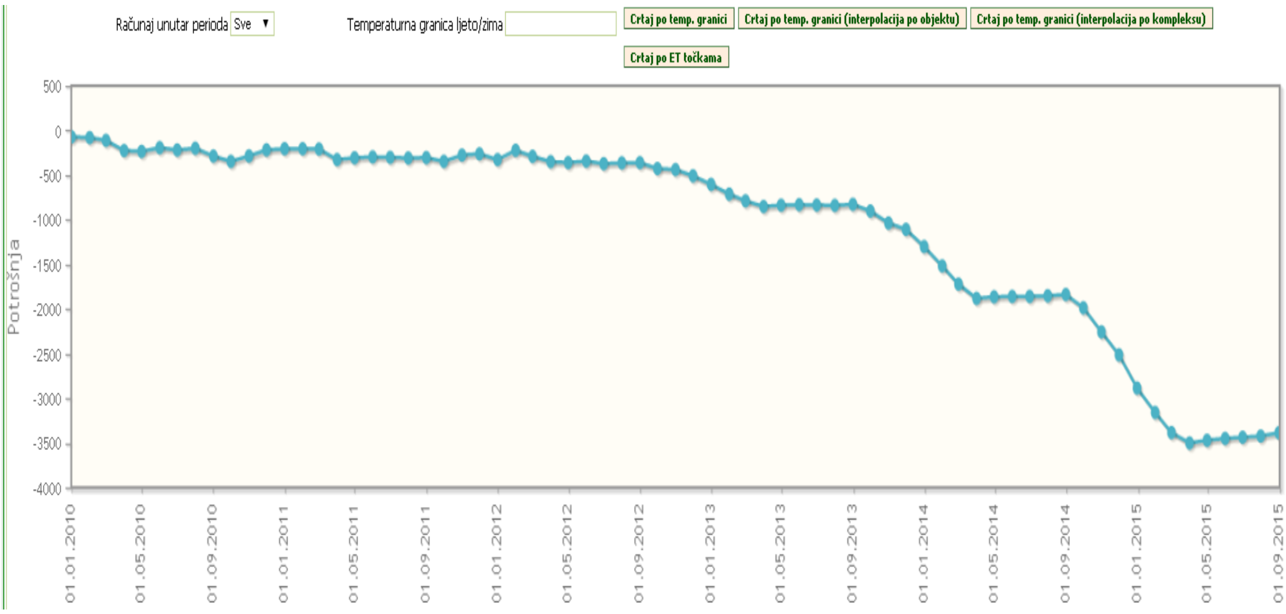


Figure 6 CUSUM chart

All these techniques for data analysis are in the service of informing users about results of some implemented actions with the final purpose to change the behaviour of consumers. Our actions are generally dependent on the questions that are asked and answered by our sub-conscious mind: 1) Is there a problem?; 2) Do I care?; 3) Do I know what to do about it?; 4)Will the solution work? and 5) What will others think about what I do?

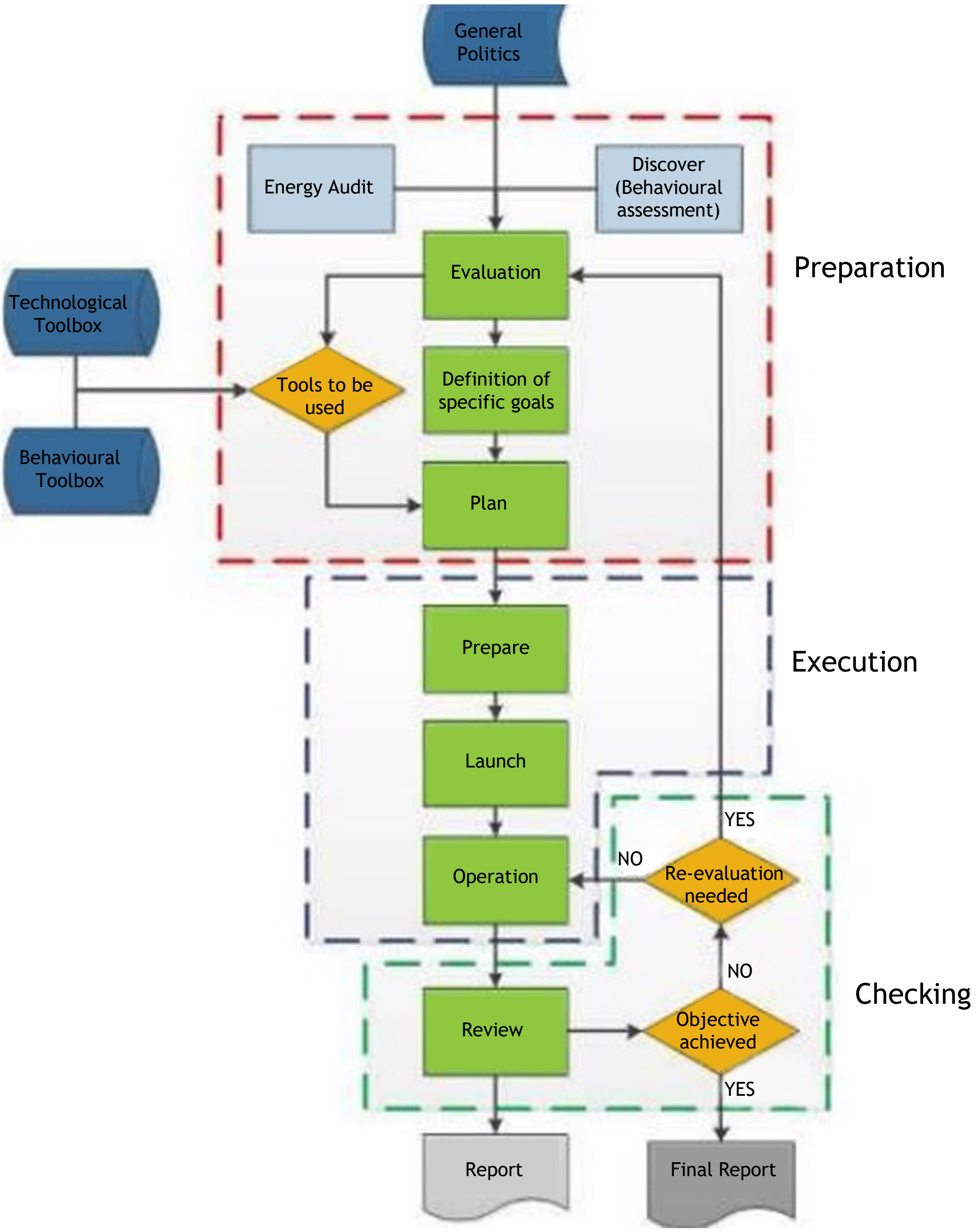


Figure 7 Behaviour Transformation Methodology [Motivating for Change, Snap Solution Portugal]

Data analysis and clear visualisation of results can help in answering these questions and provoke behaviour transformation as suggested in the Figure 6. In the execution phase of this transformation process, smart metering and monitoring of energy consumption is important as it will exactly provide the basis to compare previous and present consumption data. When installing a real time metering device for the first time, it is impossible to have previous real time data, and in that case historical data from bills will be the first reference and use for the establishment of the baseline.

In the checking phase, analysis of intermediate results and review of progress is needed for performing adjustments and reviewing of goals as well as making of short intermediate reports about the progress. A final report should be issued stating the results compared to the goals. This is the key for behaviour change in energy consumption. ICT technology helps the user, as they can visualise effects of their behaviours. The example of comparison between planned and realised energy consumption is given in the Figure below, and such examples need to always be analysed with employees, explaining them how thise results were achieved and what was their role in it.

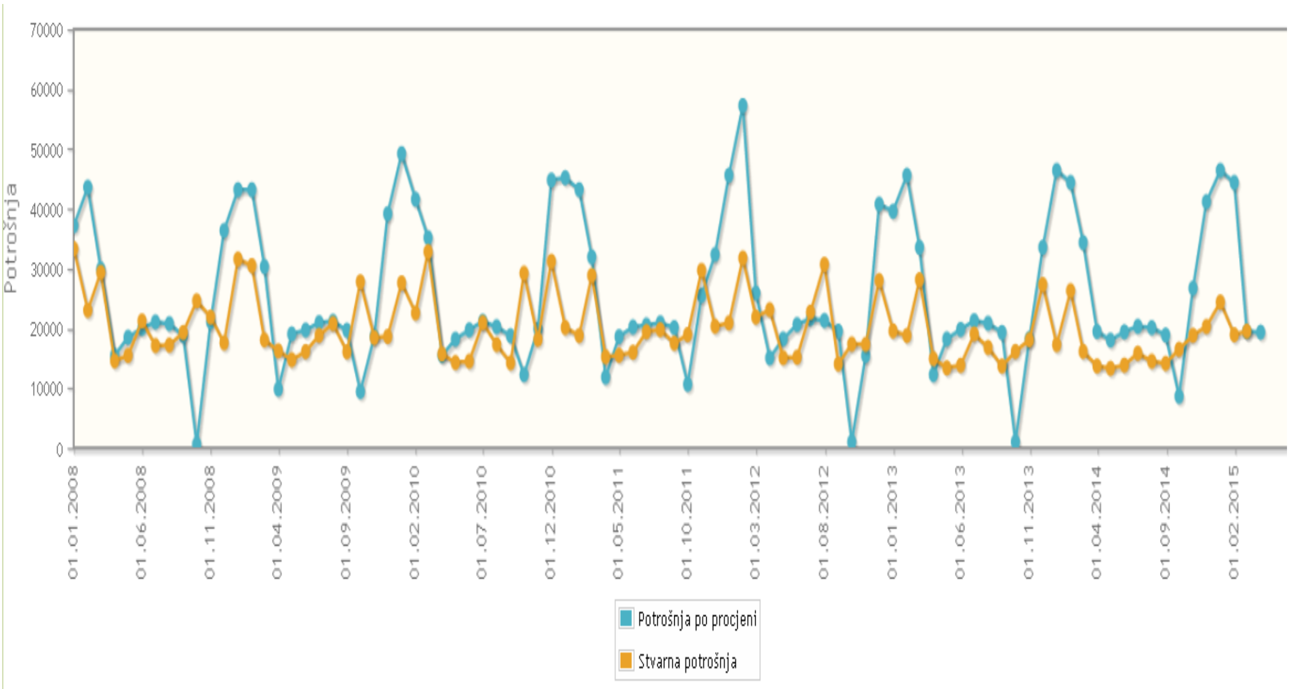


Figure 8 Analysis of planned (blue line) vs. achieved (orange line) energy consumption

MODULE 7: PRACTICAL USE OF MONITORING DATA - DEVELOPMENT OF ENERGY OPTIMIZATION AND ADAPTATION SENARIOS

A good example for achieving EE improvements is to apply bottom-up approach in energy management. The bottom-up approach was developed by the International Energy Agency, bottom-up methods are built up from data on a hierarchy of disaggregated components, which are then combined according to some estimate for their individual impact on energy usage. An example of a bottom-up approach for energy load is shown in Figure 8.

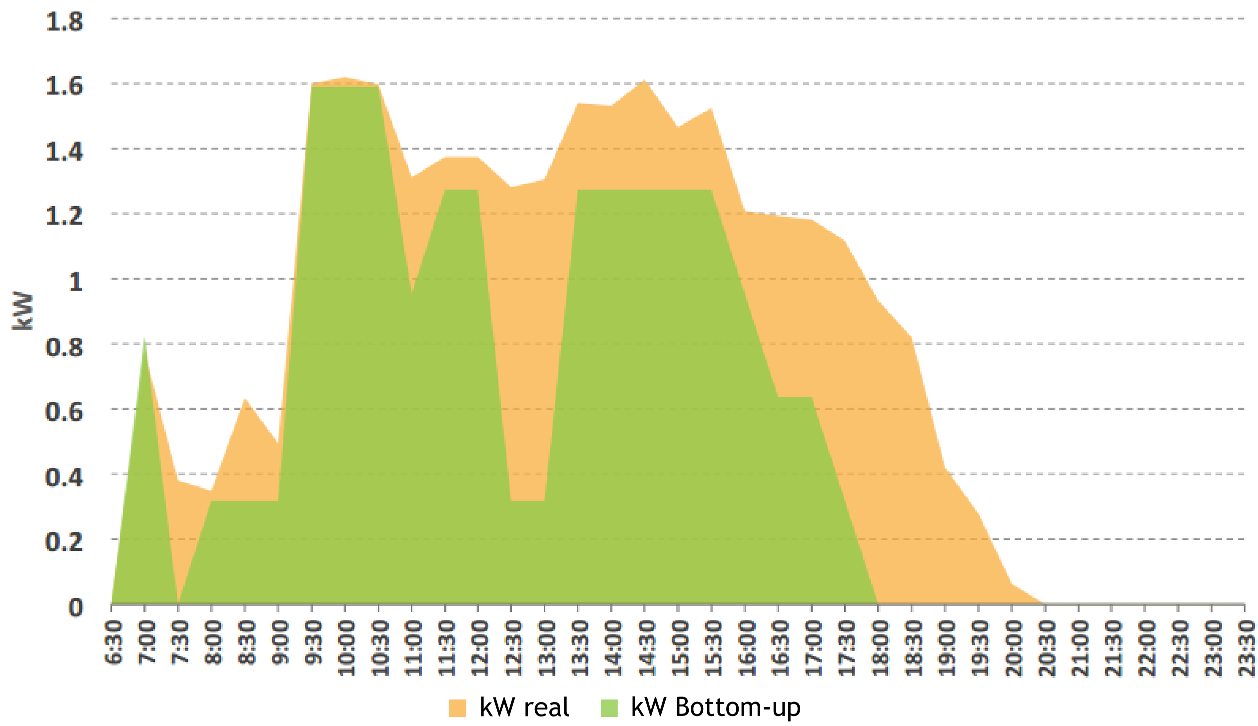


Figure 9 Lighting appliances load example in class amphitheatre

In the example from the Figure the cleaning process starts at 6:30 and finishes at 7:30 but lights are left on, even though there are no classes before 9:00. During lunchtime, lights are also left ON while no classes are being taught. In most of the day's classes end before 17:30, nevertheless only between 18:30 and 19:00 consumption decreases significantly.

Only by acquiring knowledge about the effective energy consumption and expected energy consumption through a bottom-up approach we can analyse deviations and derive corrective plans. The previous example has shown a waste in electrical energy consumption at the time where no lighting is needed which may lead to the conclusion that energy saving should firstly be achieved by the identification of abnormal consumption patterns and change of these patterns through education and awareness raising of relevant users.

MODULE 8: PRACTICAL USE OF MONITORING DATA: EDUCATING AND INVOLVING BUILDING USERS

Educating building users about energy consumption is the key for achieving energy savings. There is a set of simple measures by which users should be educated about that can be achieved without complex EnMS for energy efficient energy consumption in building set in the Deliverable D.T2.3.1. The Negotiation Panel Concept. Efficient and sustainable management of the building, all its elements and equipment may be achieved by:

1. airing of building space: ventilation 2-3 times per day opening all windows completely to have air exchanges and maintain necessary hygienic conditions and after major physical activities, ventilation of premises must be done as quickly as possible by opening all elements, but taking care about the draft;
2. use of windows and shadings in relation to heat and light gains: besides increasing comfort, lifting, and lowering shutters depending on the season can lead to considerable energy savings; by lowering shutters, temperature in the room can decrease for 8°C, which directly reduces electrical energy consumption for cooling, in winter, lowering shutters allows heat retention inside the room which reduces consumption for heating;
3. use of heating valves, adjusting heating and cooling temperature will be stressed as well as need for regular control and maintenance of these systems; quality and rational use of energy is not possible without installation of thermostatic valves on heating elements, thermostatic valves enable temperature control inside the premise according to use, people, and personal will of workers; the work of the boiler room is mainly automatized with regular supervision of a qualified person; for making solar collectors use instructions should be followed; for air conditioning control is important that the difference between inner and outer temperature is not higher than 6°C;
4. a valid choice of electrical appliances and equipment as well as rational and responsible behaviour of the users allows for achieving significant savings of energy; when purchasing electrical appliances, energy efficiency classes must be considered thus buying more energy efficient devices; maximise the use of daylight illumination and turning appliances off when not in use.

Nevertheless, standard, smart metering, and advanced system management tools enables people to measure savings and manage consumption. People should meet technology, employees responsible for energy monitoring should be educated to use IT tools for monitoring consumption as smart meters for electricity, heating and cooling and water consumption and interpret the obtain data and thus manage consumption. For reducing energy and water consumption the first step is to measure it because without measuring something you cannot manage it.

With graphical interfaces users are enabled to view basic information about monitored building (address, picture, construction characteristics etc.), weather and temperature information, real-time, daily, weekly, monthly, and yearly energy consumption and to comparison energy consumption with set baseline. Remote reading of consumption allows consumption paths monitoring through technical systems for remote reading, collection of impulse and meter data collection, and forwarding them to remote stations where they are transferred and collected. Remote consumption reading systems allows continuous monitoring of consumption paths and analyse on one or multiple buildings, which is the aim of every EnMS. By comparing single indicators achieved through analyses, insight monitoring of energy consumption is provided and prompt reactions in case of too high consumption. By monitoring energy consumption paths and understanding the provided, significant saving could be achieved.

Therefore, data available in the EnMS should be used for explaining the employees the consequences of their behaviours, example of which is provided in the example of amphitheatre in Figure 5.

CHECK LIST ON ANALYTICAL DSM

The following check list serves as a reminder of the most crucial steps in introducing and implementing analytical DSM measures into an organisation.

- Analyse organisational culture and behavioural habits of employees and building users and develop gather information about physical characteristics of a building (energy audit or not);
- gather energy and water consumption data from bills (bookkeeping);
- distinguish three types of energy consumption data (historical, energy audit and high-resolution data);
- define a methodology for gathering consumption data in buildings due the physical characteristics (complex of buildings, single building etc.);
- collect static data about the building in the energy-related data base;
- entry of basic building data (from audit) and energy and water consumption data from bills in EnMS (if exists);
- analyse consumption and set of alarms in case of excessive consumption in EnMS;
- in case of advanced system monitoring continuously monitoring data and improve EE measures;
- bottom-up approach in energy monitoring to identify unnecessary consumption;
- educate building users about their consumption for achieving successful energy savings targets.

BEHAVIOURAL DSM

Behavioural DSM focuses on changing energy behaviours of building users and using different incentive schemes to actively engage them in energy-saving activities.

MODULE 1: BEHAVIOURAL & PSYCHOLOGICAL SCIENCE RELAED TO CONSUMERS' HABITS & PRACTICES

Energy efficiency is a function of technology used, external influences (weather, geographical position) human behaviour. Behavioural patterns employed by the staff operating and controlling technical systems within a building as well as behavioural patterns of building users (public sector employees) and final users (e.g. students in schools) can significantly reduce or increase energy consumption. Energy management should find proper ways to motivate and raise awareness of employees regarding to energy consumption. In order to do so, basics of behavioural and psychological science related to consumers' habits and practices need to be understood.

A large body of research from behavioural economics suggests that the traditional rational actor model may, in some situations, be incomplete as a way to think about how individuals make decisions. In particular, decisions about how to act are guided not only by financial and informational influences (external factors), but by psychological and sociological factors such as cognitive processes and social norms. Human behaviour is influenced by the complex interplay of three key sets of drivers:

- external factors, such as monetary and non-monetary costs;
- internal factors, such as cognitive processes and habitual behaviours; and
- social factors, such as social norms and cultural attitudes.

An examination of internal factors recognises that cognitive limitations affect our ability to make "rational" decisions; for example, much of everyday behaviour is habitual and routinized rather than the result of active decision-making. This is because many of our everyday decision-making does not involve objectively weighing up all the information in order to reach a decision – we are not really consciously making decisions at all. Consequently, much of our habitual behaviour will be strictly "irrational": for example, many people regularly leave electrical devices on standby even though this leads to increased energy bills. Equally, cognitive limitations mean that we are incapable of processing too much complex information and rely instead on rules of thumb, and are influenced by emotional appeal and the way information is framed. Providing too much non-structured information may cause information/choice overload. Choosing to do nothing in the face of choice overload reflects a sense of incapability in making an appropriate decision; likewise, people may feel that they do not have enough control over their ability to change their behaviour because of a lack of confidence and self-efficacy, or because their ability to influence a problem is seemingly too remote (for example in the case of climate change). People will react the best at simple, clear and consistent messages. Moreover, it is also important how information is presented, as our emotions have a profound effect on our actions and decisions (which is clearly recognised by advertising industry). Finally, decision-making is affected by a number of cognitive biases which systematically distort our decision making. These include effects like loss aversion (e.g. people are therefore likely to place additional value on what they currently possess, particularly when asked to exchange it), hyperbolic discounting (e.g. people tend to discount the future too highly, making it more difficult to justify investments or actions that involve future pay-offs), procrastination/inertia (people often seek to postpone/avoid active decisions) and favouring the status quo.

An examination of the influence of social factors on human behaviour reveals that our decisions and behaviour are heavily influenced by social norms: by the way those around us act and the way we believe those around us think we should act; that is, our decision-making occurs within a collective or social setting. The power of social norms stems partly from the fact that they guide our learned behaviour – we look to those around us for guidance on how to behave when faced with choice and uncertainty. Behaviour is also influenced by pervasive societal values such as reciprocity and loyalty. This means, that often people tend to undertake some actions that society views as "rewarding", despite, or even because of, the lack of associated financial reward. Social norms can form a powerful tool for behavioural change, and in this way pre-existing norms can be utilised to encourage socially desirable behaviour. Those who publicly accept these norms, whether verbally or contractually, are more likely to attempt to fulfil this norm. Hence, cultivating new social norms that will lead to mora energy efficient behaviour should be initiated by policymakers and often the role of an early adopter taken over by the government/local authority would have positive impact on consumers' behaviour.[1]

The complexity of factors influencing consumers' behaviour is shown in Figure 9.

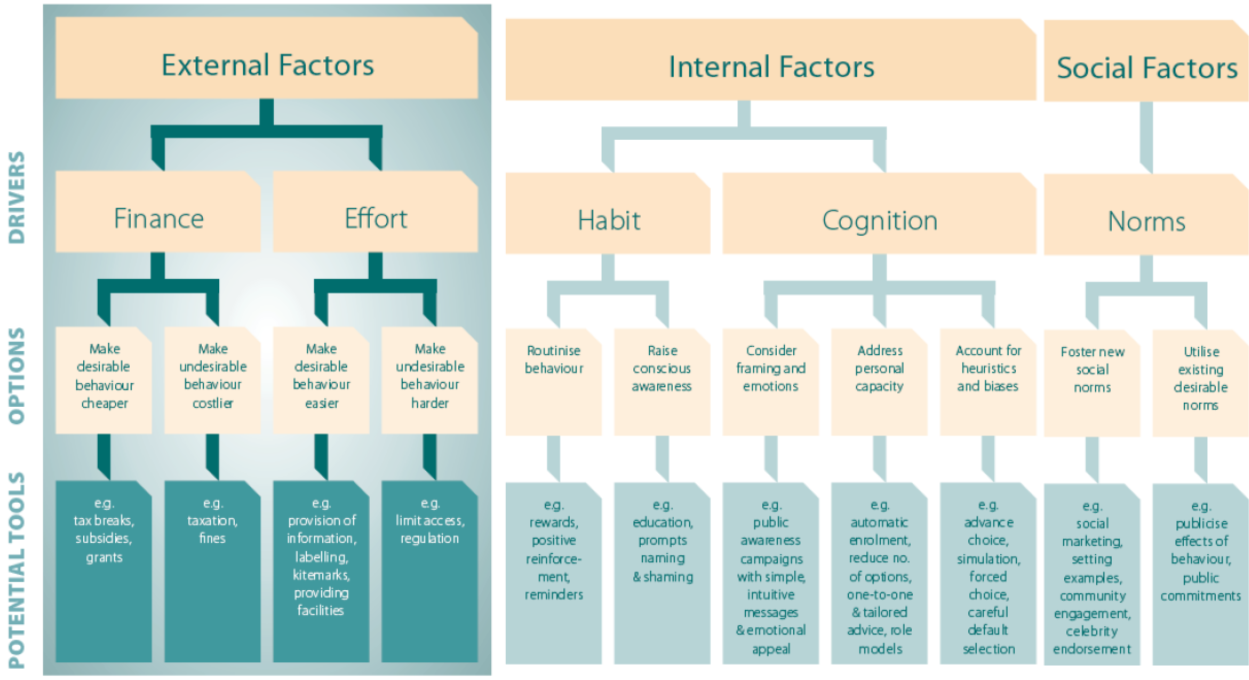


Figure 10 Framework for behaviour change[1]

[1] Jessica Prendergrast, Beth Foley, Verena Menne and Alex Karalis Isaac: "Creatures of Habit? The Art of Behavioural Change", The social Market foundation, May 2008

The Figure shows that policy efforts and measures are usually only focused on providing instruments that are affecting consumers' behaviour externally, like financial subsidies or information provision. However, due to the fact that consumers' behaviour is much more complex and governed by our own internal capacities and capabilities as well as our position in the society, in defining activities that are aimed at provoking lasting behaviour change, all factors as presented in Figure 9 should be taken into account in a holistic approach that would combine all available tools for addressing all three behaviour influencing factors.

As already pointed out, our actions are generally dependent on the questions that are asked and answered by our sub-conscious mind: 1) Is there a problem?; 2) Do I care?; 3) Do I know what to do about it?; 4)Will the solution work? and 5) What will others think about what I do? When attempting to change behaviour of other people, we must educate them in order to capacitate them to answer questions 1, 3 and 4 (i.e. we need to improve their knowledge, hence awareness about energy related issues) and we need to motivate them to answer questions 2 and 5 (i.e. we need to use appropriate communication and information tools that will address both individuals but that will also provoke broader social acceptance of energy efficient behaviour). These educational, informational and motivational tools will be discussed in more details in the following sections.

MODULE 2: METHODS AND TOOLS FOR COMMUNICATING AND COOPERATING WITH BUILDING USERS

As has already been mentioned, education of the target group about the topic at hand is vital if anything is to be achieved. When working with people, it is important to keep in mind the subconscious level which, when faced with a problem, inevitably asks “Do I care about this?”. If the answer to this question is “Yes”, the following question will be “Do I know enough about this problem?” If an average person is to be interested in a specific topic, they must first be made aware of the problem and the ways it influences their lives. Only after the person has been made aware of this, will they try to find a solution or at least learn more about it.

There are a number of methods and tools that can be used for communicating and cooperating with building users, however they may vary according to the target group. If the communication is intended for children, we may be more concentrated on games or applications, while an older target group will probably be best responsive to a lecture or a round table discussion. According to these two target groups, the methods and tools to be used may be classified as follows:

1. Methods and tools for communicating and cooperating with children

In this case, a classic communication method consisting of possibly city light posters, lectures or info points will not be effective. Most 5-15-year-olds would find such an approach tedious and boring and would walk away from it retaining nothing. When communicating with children, it is imperative to focus on an interactive approach, such as:

- **Interactive events -** an exhibition in a local museum may not be first choice for most children today, but an opportunity for them to perhaps mount their own exhibition on a specific subject may be more attractive. This would also allow them to learn more and also act as teachers to visitors of their exhibition.
- **Creative workshops -** this approach is quite popular among younger target groups. Mounting their own creative campaign will raise greater interest for the topic of savings and will also allow the children to express themselves creatively.
- **A day without… -** Learning is always easier when it is done through experience. Shutting down all electrical appliances in a school may seem a bit harsh, but it is a great way to communicate to children that electricity is not to be taken for granted and make them aware of just how important it is in their lives.

- **Field trips -** A visit to the local power plant is also an effective method of communicating with children. We must bear in mind that in order to pique the interest of children, it is important to have them experience something. Simple repetition will have a certain influence, but an experience will always be a better teacher.
- **Applications and social networks -** There are not a lot of children today that are not “online”. Reaching them on this level can also prove successful.

2. Methods and tools for communicating and cooperating with adults

As we all know, the world we live in today is very rushed and most adults have little time for themselves, let alone for thinking about anything more than what is right in front of them. This is a target group that is constantly on the move and busy, so when communicating with them, the trick is repetition, ex:

- **Media -** regardless of the power of social networks, which cannot be disputed, it would be wise to include the traditional media as well. A radio show or a clip on the TV can do wonders for raising awareness and interest in a specific topic.
- **Info-points, galleries in frequent areas of institutions, flyers, posters, banners -** Although they might seem a bit out-dated, these tools are still extremely useful for communication with target groups.
- **Open door days -** Once interest raised, the people will undoubtedly try to find out more about the subject at hand, in which case they will be prompted to find out everything they can “from the horse’s mouth”.
- **Internet -** an informative website.
- **Educational workshops -** aside from being a mandatory part of the project, educational workshops are probably the best communication method, as they allow the participants to ask questions about specific issues they may have.

The main objective of communication is to familiarize the users with the issue, provide explanations and allow for insight into possible results achieved through behaviour change. In most cases, the employees are themselves already aware of the need of saving energy, however more often than not, they may not be aware of the impact their actions may have, no matter how small they seem to them.

MODULE 3: DEVELOPMENT OF SUCCESSFUL EDUCATIONAL & INFORMATION CAMPAIGNS ADDRESSED AT BUILDING USERS

Energy Educational and information campaigns are nothing new. They have been used since man has invented a printing press which allowed for spreading word about specific issues and will undoubtedly continue to be used in the future. Educational and information campaigns play an important role in affecting change, raising awareness and influencing a shift in opinions. An educational campaign is only as good as has been the preparation for it. We must bear in mind that without a good and sometimes lengthy preparation and analyses, the campaign may not be successful. In preparing for the campaign, it is necessary to consider the following:

- What message do we want to convey? What is the objective of the campaign? What are the weak points?
- Who is the campaign intended for? Who is the target group?
- How to reach the designated target group? Which message carrier to use?
- What challenges can be expected?
- How to measure the campaign’s success?

Only after having considered the above-mentioned questions, we can proceed with the steps for a successful campaign:

- **Market research –** a campaign can’t be successful, if you don’t know who you are launching it for. Without researching how much the users know about the problem of saving energy, you may risk an abundance or lack of information in the campaign. It is therefore imperative to conduct a good market research and find out just how deep into detail it is necessary to go. A questionnaire or interview may prove a helpful tool for market research.
- **SWOT analysis –** when working on a market campaign, aside from conducting a thorough market research and getting to know your target group, it is always preferable to do a SWOT analysis. A SWOT analysis is a concise overview of the strengths, weaknesses, opportunities and threats that gives a detailed overview of a specific subject (in this case, the state of a building, the level of knowledge of the target group and the situation in the country regarding the issue of energy saving). A SWOT analysis allows the users to, after just a quick glance, know the situation the building is in and which points can be improved by their activities.

- **Identification of the ideal message carrier -** Again, this step calls for a good, in-depth knowledge of the target group. In this case, the focus is on children as well as adults, so the message needs to be delivered in a way that will interest children, but also include adults. At first glance, this may seem a bit difficult, but there exists an easy solution: have the children act as promoters and creative power behind a campaign, with the adult employees offering a helping hand when needed.
- **Launching the campaign -** a good example can be found in an approach taken by one secondary school in a different project:
  - In order to facilitate savings, the school energy team has been divided into seven groups: PRACTITIONERS – measuring temperature, light and consumption in all school rooms; CREATIVITY – making promotional materials (posters, presentations, IDs, brochures...); SHOWMASTERS – informing the public on project goals; oral dissemination; ANALYSTS –processing of data obtained by measurements; PAPARAZZI – photographing all project activities; REPORTERS – commenting the activities and the project in writing; MACHINERY – production of material for the needs of the project. The showmasters presented the idea to all students, teachers and other school employees and the public. Thereafter, it was time to take action. The practitioners investigated each part of the school in order to measure the energy consumption. Then there were the analysts who analysed the state of the school as a whole. All that was left to do was encourage the 2000 other school users to save energy. This task was undertaken by the creative section of the group who created interesting and fun solutions for promotion. The promotion itself was undertaken by the machinery section who realized the ideas of the creative team. Naturally, someone had to survey all this and who would be better than the paparazzi? They photographed all of the project activities, while the reporters wrote reports about everything that was done. Such an approach has indeed been successful, as the school has achieved significant energy savings in two years of project duration.
- **Evaluation -** the level of a campaign success can only be measured by an evaluation. A carefully structured questionnaire will show if the awareness of a specific topic has risen and to what extent, while the “cold, hard facts” of how much energy has been saved will be revealed through the use of smart metering.

The above listed steps are to be kept in mind when considering launching any campaign, but they alone will not be enough to ensure the success. The key ingredient, as always, is the people behind the campaign. If the individuals included in the project activities are motivated and interested, the success of the campaign will be much greater than in case the actors as just “going through the motions”, because they have been so instructed. An educational campaign launched at the school level can prove to be an immense success, but only if the attitude and mind-set of the people included in the activity is positive. As opposed to the analytical part and monitoring of cold, hard facts, in this part of the Demand Side Management we have the human factor. Whether the project as a whole will be successful depends for the most part on the people conducting it. If the team is positive, energetic and willing, even an old building will not be an obstacle to achieving a set goal. However, if the prevailing attitude in the team is that of lethargy and negativity, the results will be poor. A campaign therefore, needs to be energetic and lively, in order to attract even the most sceptic among the building users.

MODULE 4: METHODS & TOOLS FOR CHANGING HABITS AND BEHAVIOURS OF BUILDING USERS

It is unlikely that a person's attitudes and views will change overnight just because they have been given an analysis that shows the possible impacts of their behaviour change. This would be too optimistic to expect, because as the saying goes "Old habits die hard". Simply pointing something out will not be enough to affect permanent change. The habits and attitudes may change for the duration of the project because of a) participating in a given project or b) possible consequences if the job is not done. Still, this will not be enough to affect permanent change of behaviour which would bring about durable results. In order for the change to be more permanent and last far beyond the duration of the project, it is necessary to organize work carefully, in steps described as follows.

Defining strategies

Each building, just as a person, is an individual with its own sets of problems and advantages. It is not possible to say that there are two buildings with exactly the same situation. A crucial problem in one location may prove to be almost insignificant in a different location. Therefore, it is necessary to identify the strategy which is best-suited for each building. The strategy must match the situation and hold answers for a given problem which is to be addressed. What is the best way to go about bringing change? A competition? A formal rule? A new procedure? Is one method sufficient or will more approaches be necessary? All these issues should be considered when deciding upon a strategy for a specific building.

Developing implementation plan

For the implementation of the project activities to be successful, it is helpful to create a Plan of activities with a workflow and timeframe when a specific activity will be carried out. Such a document should contain deadlines and analyses that will help define the points to be addressed. A Plan of activities should cover the following:

- SWOT analysis – if you aim to achieve energy saving in a specific building, it would be a good idea to know some basic facts about the building itself. How old is it? What kind of energy source does it use? What is the condition of the joinery? Is it possible to regulate heating? What can the occupants do to minimize energy spending? Are there leaks in the water pipes? A SWOT analysis will give a detailed "blood work analysis" of the building and identify the weak points that need to be specially addressed.

- **Raising awareness -** Each strategy needs to have a specific purpose. After a detailed SWOT analysis, the next step would be to number the activities that can be implemented in a given building in order to achieve savings. This section shall outline the planned actions and their expected results. If a visual aid is required, it should be described and its benefits listed. For example, one of the activities may be organizing a play/exhibition or creating a game.
- **Project workflow -** the majority of people are visual types, so a table representation of tasks would prove helpful. An example is provided hereunder.

Year	**2017/2018**												
Month	June	July	August	September	October	November	December	January	February	March	April	May	June
Activity and purpose													
Organizing Negotiating panel	■	■											
Creation of a Plan activities		■	■	■	■	■	■						
Marketin campaign				■	■	■	■	■	■	■	■	■	

- **Analysis of energy consumption -** Where is energy wasted? Can energy consumption be influenced? If so, in what way? Analysing the energy situation of the building provides yet another way of raising awareness of building users. Whereas before they may not have been aware of just how much can be done to improve their building's energy situation, an analysis which they themselves worked on can provide just the right incentive. The analysis on this level can be done by building users with the help of measuring instruments (such as thermal camera, hygrometer, luxmeter, thermometer, energy consumption meter…).
- **Long-term measures -** are there any long-term measures that can be undertaken to minimize wasting energy? If so, what are they? Can they be incorporated in daily functioning of the building? How?
- **Dissemination activities -** Can we include the wider community? Is the ripple effect possible? How can we achieve it?

The Plan of activities is envisaged as a "living" document which can be changed or have activities and tasks added to it. Some envisaged activities may prove difficult to realize or they may not have the desired effect. In any case, this document can serve as a guideline for a building in the future as well.

Roles, rules and tools approach

As has already been mentioned, change doesn't happen overnight nor will it be long-lasting. In order to make a change durable, it is necessary to insist on a given issue, until it has become almost second nature to the users. Although the old habits are hard to break, they are by no means impossible to get rid of or at least amend. In this respect, it can be helpful to rely on the roles, rules and tools approach for help.

- **Roles:** Who are the main players with the power to make a difference?
  - When implementing a big or even any – change in a building where the occupants already have their own method of functioning, the best way is to identify the "movers and shakers" of the institution (D.T2.3.1). Who has the power? Who is the leader? These two roles needn't necessarily be the same person. For example, the leader may be the principal of a school or a very motivated teacher. In any case, it is usually a person who visibly advocates a specific issue. Their energy can be great and can result in sparking interest and positive attitude in otherwise dormant individuals.
  - The power usually lies with the principal, but the caretaker is usually the one with all the knowledge. A disinterested caretaker or building manager can cause more damage than a disinterested principal. There are also information technology specialists to consider; are they not the most apt to do battle with that quiet enemy of energy saving, the stand-by mode? If any behaviour is to change and for that change to take root, it is necessary to correctly identify those who will be most helpful in the process.
- **Rules:** Are there any rules on energy saving? If so, are there any consequences to not adhering to them?

Each institution operates according to a given set of formal rules. These rules proscribe the manner of behaviour, dress and conduct in a specific situation. Any desired change can be introduced through a formal rule, however until it has been accepted by informal rules, it will remain short-term. Informal rules are those that have been accepted unconsciously and can best influence the long-term changes. Once a certain type of behaviour has been accepted as part of informal rules, this will mean that it is desirable and widely accepted. Only then can it be said that the desired behaviour change has become permanent.

- **Tools -** Are there any tools already in place? Are they sufficient? If not, what else is needed?

As is the case with rules, each organization also has a set of tools for promoting its values. These can include standard procedures, education or awards for desired behaviour. Tools are necessary to promote change and also to make it stick. Some of the tools available include:

  - "Soft" measures and suggestions: training and awareness raising campaigns, financial and economic incentives, leaflets, posters, direct feedback system, success stories/newsletter, energy saving tips, social networking – sharing experiences, games and competitions, peer educations, social rewards. More details on these tools are available in D.T2.1.6.
  - Official rules concerning changes in energy management of a building

As has been stated before, the introduction of a desired change through its inclusion as an official, formal rule of an organization will undoubtedly speed up its acceptance by the users. However, while this is an effective tool and one that will surely guarantee that the users respect the new rule, there is a risk that the change will be abandoned once the project has ended. People are not too keen on having new regulations "forced" on them, so this approach, while at first glance effective, is not always the best for affecting long-term change.

Tools could also include the use of measuring equipment and metering devices in order to provide feedback to the users.

- Use of measuring equipment
  - **Thermal camera -** a device that forms an image using infrared radiation, similar to a common camera that forms an image using visible light. Although the users may be aware that the building is in a bad state and energy is being wasted, it is often only after actually seeing the wasted energy will they become aware of the extent of the problem.
  - **Hygrometer -** a device used for measuring the moisture percentage in specific room/place (better results in closed environment).
  - **luxmeter -** a device used for measuring the light in a specific room or area. Many times, the building users are not aware of the recommended amount of light per a specific room. For example, a classroom needs to be well illuminated, while some other rooms in a school (such as toilets or hallways) require less light. Using a luxmeter can help the building users reduce the consumption of electrical energy by reducing the amount of light spent in areas where it is not necessary.
  - **Thermometer -** a device that measures temperature in a given room. People often tend to heat up the rooms too much and then open windows to air them out. This can result in a lot of heating energy being spent needlessly. By using a thermometer themselves, the building users will become better aware of the amount of heating energy being spent in vain, which will make them pay more attention to regulating heating.
  - **Device for measuring electricity consumption -** in many cases, people are not aware of how much energy is spent when devices are left in the stand-by mode. Some will even argue that they are saving energy by using the sleep mode on a computer. However, they are not aware that the sleep or stand-by mode also spends energy. By using the device for measuring electricity consumption, they will become more aware of the fact that the red light of the stand-by mode is actually costing them money and energy, rather than saving it.
- **Remote reading -** devices for measuring consumption in “real time”. You can set time period even in seconds, but for calculation a one hour period is enough. They are installed on the energy meters (also water meter) and they send information through various protocols into the information system or some kind of database for analysis of energy and water consumption. This information gives us better response time in case of possible errors (leaking water – broken pipe), or you can see if there is energy consumption in periods when the object is closed (somebody is stealing energy or in case of weekends you forgot to turn of the heating/cooling).

MODULE 5: DIFFERENT INCENTIVE SCHEMES FOR ENERGY SAVING

Behavioural research is clear in showing that offering a reward for a behaviour can increase its frequency. Reward may come in monetary (financial incentive) or non-monetary terms (prizes, reputation, etc.).

If cost is a barrier to the target behaviour, then offering a financial incentive can reduce the difficulty of the action. Incentives have been widely used as a behaviour change tool, and in fact, individuals often point to incentives as primary reason for engaging in the behaviour. Incentives can take a variety of forms, but they universally involve a desirable consequence following the behaviour. Examples of incentive strategies include direct rebates for purchasing an energy efficient appliance, or discounted prices for an LED light bulb. However, incentive strategies can also involve increasing costs for an undesirable behaviour, such as higher prices for gasoline. Not surprisingly, research has shown that financial incentives can exert a powerful influence on behaviour and the larger the incentive or disincentive, the greater the amount of behavioural change. However, there is a question about durability of changes in behaviour that were mainly driven by financial incentive, as behaviour may revert once the incentive is removed. A second limitation is that behaviours changed through financial incentives general do not spill-over into other domains, e.g. large incentives for energy efficient light-bulbs, will not cause switching off computers when not in use.

When it comes to public sector, behavioural change is needed among employees and users of public buildings. Applying financial incentives in this context is somewhat different than discussed above. Money savings achieved through improved energy efficiency may be used as incentives in direct or indirect way. Direct way envisages shared savings model as usually applied in ESCO model, in which management of the building clearly see monetary benefits from reduced energy bills, hence may be stimulated to undertake additional activities. However, from the perspective of an employee or users, this will be of little significance, unless the money saved is used to purposes that will be beneficial to all (e.g. new equipment in a sports gym, new educational tools, teambuilding fund for financing joint activities, etc.). Hence, the ability to make decision about distribution of saved money can be very powerful incetive. This is especially good stimulus for long-lasting behaviour change, i.e. for adopting energy efficiency as a way of living. Excellent example of this kind of “empowerment” incentive is found in 50/50 project[2], which is briefly presented as in inspiration in the Box 1.

[2] http://www.euronet50-50max.eu/en/about-euronet-50-50-max/what-is-the-euronet-50-50-max-about

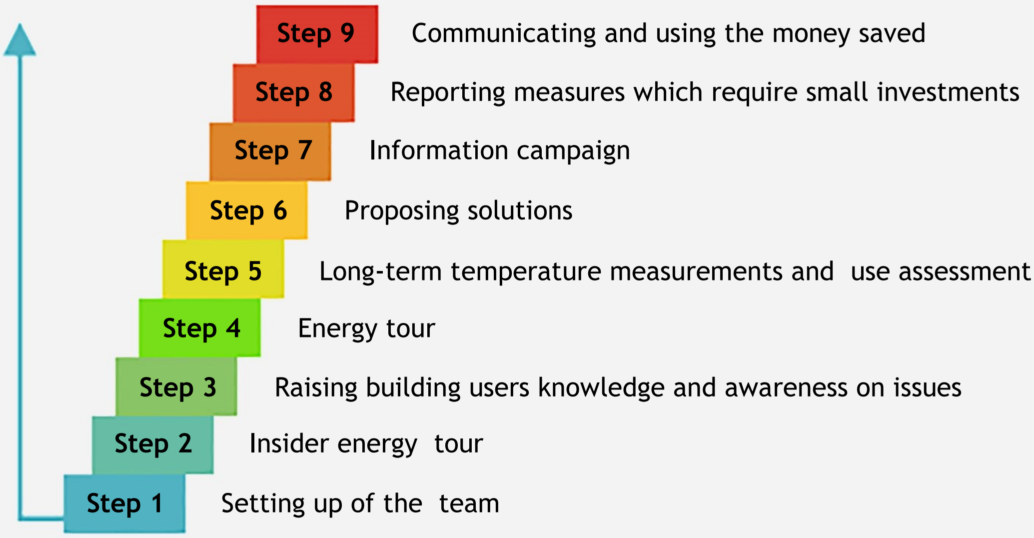
Box 1: EURONET 50/50 MAX project - increasing energy efficiency in public buildings through change of behaviours

EURONET 50/50 MAX is a continuation of the very successful EURONET 50/50 project which tested the implementation of the 50/50 methodology in over 50 European schools. The main concept is as follows:

- 50% of the financial savings achieved thanks to the energy efficiency measures taken by pupils and teachers is returned to school through a financial payout;
- 50% of the financial savings is a net saving for the local authority that pays the energy bills.

As a result everybody wins! The school teaches pupils how to save energy by changing their behaviour and gets additional financial resources, the local authority has lower energy costs and the local community gets cleaner local environment.

The 50/50 methodology is a 9-step methodology that actively involves buildings' users in the process of energy management and teaches them environmentally friendly behaviour through practical actions. The steps in the methodology are presented in the Figure below.



The methodology includes educational and motivational techniques. Pupils are gathered in a energy team, which also includes at least one teacher and school caretaker. They learn about forms of energy, using energy in everyday life and its impact on the environment, greenhouse effect, climate change and climate protection, energy saving, energy efficiency, use of renewable energy sources. They use the gathered knowledge to reveal potentials for energy savings in their school and to propose solutions, focusing on change of behaviour and small investments. The energy team shares what they have learned during project implementation with the rest of the school, as well as their proposals what all energy users in school can do to save energy. The team may use different communication channels, including: making posters and bulletin board displays, making presentations during class time and at school events, organization of an Energy Saving Day, creating a dedicated website, etc. Finally, when energy and cost savings are realised, pupils are involved in the decision-making process on how to use the money, which is a powerful incentive for their involvement and dedication. This way they will really feel that their actions have positive and measurable results. Therefore, after each year of 50/50 implementation it is necessary to calculate and inform the school society, how much energy, CO_2 and money was saved, and then discuss with the pupils about what shall be done with the money saved.

The EURONET 50/50 MAX project offers an excellent example of behaviour change based energy efficiency programme. Not only that energy savings is achieved, but the behaviour change accomplished by pupils is a guarantee that they will take that behaviour out of the school as well and take care of their energy consumption in their homes.

More info about the project can be found at: http://www.euronet50-50max.eu/en/about-euronet-50-50-max/the-50-50-methodology-9-steps-towards-energy-savings

Rewards may be of social nature, i.e. not based on financial or other gains, but rather a sense o achievement, for example the provision of positive descriptive comments in employee reviews. Social rewards tend to be given in relation to meeting pre-established targets or goals around performance of energy saving actions, although goal-setting (with no expectation of reward) is itself also a form of incentivisation. Reward may be given to employees on an individual basis or based on groups of employees working together. Publicly given rewards outperform ones given privately, and social rewards outperform monetary ones; in fact, public social rewards generated energy savings of 6.4% whilst private monetary rewards led to an increase in energy use. Also, competition between employees, with no tangible rewards beyond social recognition, provide also satisfactory results.

Competitions based on on-line games are becoming increasingly used. One such game is “IChoose”[3]. It engaged groups of employees in competition with each other. Although organised through their work, this intervention crossed the domestic/non-domestic divide as employees were encourage to register saving activities in their own homes, and in doing so gained points for themselves and their team at work. There were small monthly cash prizes for individuals in the lead and team prizes at the end of the game. Estimated savings of 463 megawatt hours of electricity were made, although notably energy saving activities subsided once the game had finished. Another example is on-line game called ‘Energy Chickens’[4] in which the health of a pet chicken related to plug-load energy use of the employee. As a result of the game, average energy use reduced by 13% (23% over weekends, and 7% on work days i.e. Monday-Friday) and 69% of employees said the game helped increase their energy awareness, including outside of work.

Methods which involve Incentivisation are often based on groups of employees working together and invoke a sense of competition and comparison, for example competitions between groups of employees on different floors of an office building (e.g. through public display of energy savings generated by each floor) or comparison with individual colleagues.[5]

[3] https://coolchoices.com/

[4] http://energychickens.weebly.com/

[5] Sam C. Staddon, Chandrika CycilMurray Goulden, Caroline Leygue, Alexa Spence “Intervening to change behaviour and save energy in the workplace: A systematic review of available evidence”, Energy Research & Social Science, Volume 17, July 2016, Pages 30–51

MODULE 6: MONITORING OF BUILDING USERS' BEHAVIOURS

Studies have shown that monitoring consumption and costs has the highest impact method on behaviour change, education, and motivation for end users. Without approaching consumers with their actual consumption in real time is impossible to achieve savings. With real time monitoring consumption systems users have a direct approach with consumption trends and costs which is the first step for behaviour change. According to some case studies, with good demand side management global savings of 40% electrical energy and 10% of HVAC can be achieved. Proportionally by decreasing consumption, cost reduce which is very important for users to have immediate financial benefit. Meanwhile, by reducing annual consumption for 1,5 % obligations in Article 7 of EED for reducing energy consumption are fulfilled. With consumption, GHG emission also reduces which is important for achieving 2020, 2030 and 2050 EU targets.

High resolution data allows better monitoring of energy consumption and thus related costs. By monitoring energy consumption patterns, it is possible to take better actions in user's behaviour change. An example from the Croatian EnMS is shown in Figure 10, energy consumption has increased significantly almost by 80% during June when air conditioning systems are working at full capacity, the pattern decreases till July when most of workers are on holidays and increases gradually till middle of August. This type of consumption is directly linked with seasonal climate conditions. Repetitive drops in consumption represent weekend consumption, and from Figure 10 it is evident that there is little consumption during the weekends necessary for maintaining energy requirements.

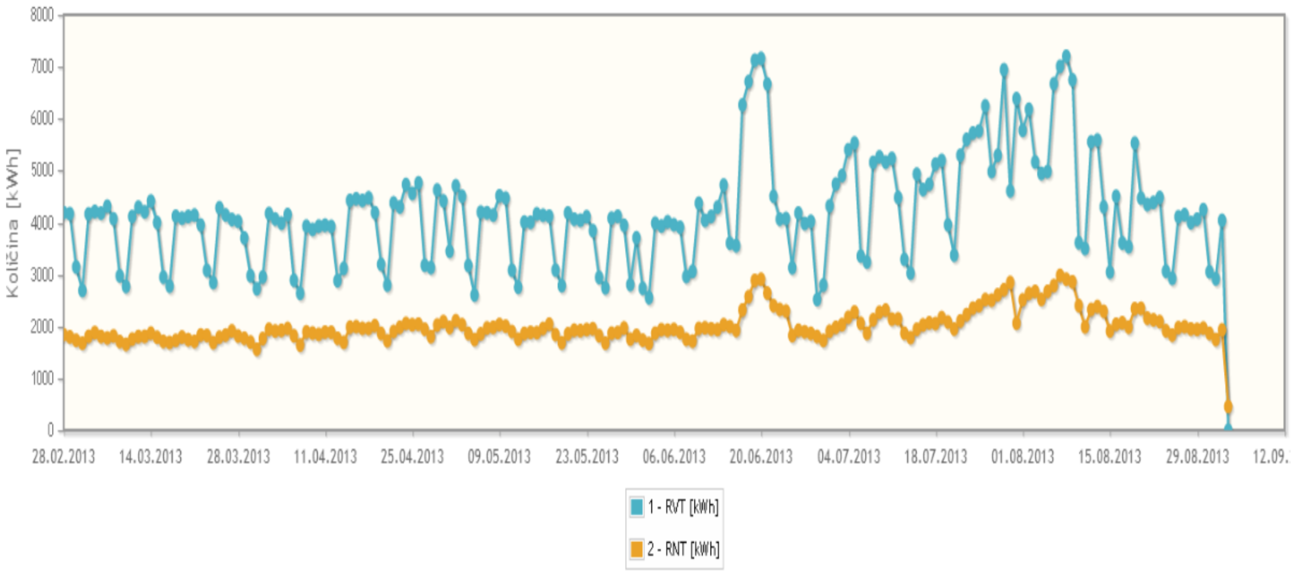


Figure 11 Energy consumption patterns monitored through EnMS

Remote reading of consumption enabled by the ISGE allows real-time or nearly real-time consumption monitoring as shown in Figure 11. This allows monitoring of the current consumption and identification of possibilities for savings. Figure 11 shows water consumption in a building, greenish cells are low consumption, yellowish are medium-low, orangish are medium, and reddish are high consumption with a boundary for excessive consumption and alarms. By using this type of monitoring with alarms, exaggerated consumption can be easily recognized and immediate actions undertaken.

Osvježi Godina 2015 Mjesec 10 Voda [m³]

MTR: (456260) $ Godina:2015 Mjesec:10 Brojači:1 Voda [m³]

Sat / Dan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0.3	0.3	0.3	0.3	0.5	0.3	0.7	0.4	0.3	0.7	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.7
1	0.3	0.4	0.3	0.4	0.3	0.4	0.9	0.3	0.4	0.8	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.15	0.4	0.3	0.3	0.3	0.4	0.6
2	0.4	0.3	0.4	0.4	0.3	0.3	0.8	0.3	0.3	0.7	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.15	0.3	0.3	0.4	0.4	0.4	0.7
3	0.4	0.3	0.3	0.4	0.4	0.4	0.8	0.4	0.4	0.7	0.3	0.3	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.7
4	0.3	0.4	0.3	0.3	0.3	0.3	0.9	0.3	0.3	0.7	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.4	0.6
5	0.3	0.3	0.4	0.4	0.3	0.3	0.8	0.4	0.4	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.7
6	0.4	0.4	0.4	0.3	0.4	1.4	0.8	0.3	0.4	0.8	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.6
7	0.4	0.4	0.4	0.4	0.5	0.5	1.1	0.4	0.5	0.9	0.4	0.5	0.5	0.6	0.5	0.6	0.4	0.4	0.5	0.4	0.6	0.6	0.4	0.4	0.4	0.5	0.6	0.5	0.7	0.4	0.7
8	1.2	1.3	0.5	0.3	1.33	1.33	1.42	0.4	1.14	1.0	0.4	1.21	1.12	1.11	1.12	1.13	0.6	0.3	1.21	1.24	1.33	1.23	1.32	0.5	0.3	1.43	1.14	1.24	1.14	1.23	0.7
9	1.4	1.4	0.5	0.4	1.17	1.41	1.38	0.3	1.52	1.0	0.4	1.41	1.31	1.4	1.32	1.41	0.4	0.3	1.25	1.42	1.23	1.4	1.47	0.5	0.4	1.18	1.35	1.4	1.42	1.45	0.6
10	0.9	0.9	0.4	0.3	1.42	1.24	1.35	0.4	1.36	0.5	0.3	1.21	1.34	1.27	1.4	1.4	0.5	0.4	1.22	1.11	1.2	1.16	1.32	0.5	0.3	1.25	1.27	1.02	1.19	1.35	0.6
11	1.1	1.2	0.6	0.4	1.09	1.26	1.25	0.4	1.48	0.6	0.4	1.33	1.41	1.18	1.15	1.32	0.5	0.3	1.13	1.2	1.19	1.2	1.26	0.4	0.4	1.13	1.16	1.41	1.26	1.15	0.7
12	0.9	0.0	0.6	0.3	1.08	1.15	1.21	0.7	1.32	0.5	0.4	1.18	1.06	1.27	1.12	1.24	0.5	0.3	1.05	1.12	1.11	1.12	1.35	0.8	0.3	1.1	1.2	1.13	1.09	1.18	0.7
13	1.0	1.1	0.5	0.4	1.26	1.33	1.03	0.8	1.4	0.6	0.4	1.43	1.26	1.33	1.32	1.42	0.5	0.4	1.26	1.32	1.32	1.19	1.47	0.4	0.3	1.41	1.24	1.32	1.36	1.41	0.6
14	1.2	1.44	0.6	0.4	1.31	1.34	1.41	0.7	1.4	0.4	0.4	1.31	1.39	1.35	1.41	1.38	0.4	0.4	1.26	1.17	1.49	1.32	1.3	0.4	0.4	1.25	1.32	1.4	1.17	1.39	0.7
15	1.2	1.22	0.7	0.4	1.4	1.26	1.25	0.7	1.53	0.4	0.4	1.5	1.4	1.32	1.33	1.38	0.4	0.3	1.2	0.98	1.16	1.32	1.55	0.4	0.4	1.25	1.33	1.31	1.25	1.55	0.7
16	0.9	1.36	0.6	0.3	1.18	1.21	1.18	0.8	1.25	0.3	0.4	1.16	1.11	1.13	1.19	1.03	0.3	0.3	1.12	1.01	0.91	1.22	1.27	0.4	0.3	1.13	1.19	1.28	1.18	1.26	0.6
17	1.4	1.29	0.5	0.4	1.33	1.44	1.41	0.8	1.49	0.4	0.4	1.35	1.41	1.36	1.42	1.4	0.4	0.4	1.33	1.23	1.36	1.34	1.39	0.3	0.3	1.33	1.36	1.48	1.41	1.48	0.7
18	0.7	0.7	0.6	0.4	0.8	1.21	0.9	0.5	1.01	0.4	0.4	1.3	1.01	1.0	1.0	0.8	0.4	0.4	0.8	0.91	0.8	0.9	1.0	0.4	0.4	0.8	0.7	0.9	0.8	0.4	0.6
19	0.7	0.6	0.4	0.4	0.5	0.9	0.5	0.4	0.8	0.3	0.3	0.6	0.6	0.9	0.6	0.5	0.3	0.4	0.7	0.5	0.7	0.5	0.6	0.4	0.4	0.5	0.6	0.7	0.5	0.1	0.7
20	0.5	0.6	0.5	0.4	0.7	0.9	0.6	0.3	0.9	0.4	0.4	0.7	0.6	0.8	0.7	0.7	0.4	0.3	0.7	1.0	0.8	0.6	0.5	0.3	0.4	0.7	0.7	0.7	0.6	0.2	0.7
21	0.6	0.5	0.4	0.3	0.8	1.0	0.4	0.4	0.8	0.4	0.3	0.6	0.6	0.5	0.5	0.4	0.3	0.3	1.06	1.0	0.6	0.6	0.5	0.3	0.3	0.6	1.1	0.61	0.6	0.1	0.6
22	0.4	0.5	0.3	0.5	0.9	0.9	0.5	0.4	0.8	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.61	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.8	0.5	0.5	0.53	0.6
23	0.4	0.4	0.4	0.3	0.8	0.7	0.4	0.3	0.7	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.8	0.7

Figure 12 Water energy consumption patterns monitored through EnMS with alarms

For better approaching users with their actual consumption, energy info points are very useful because they have direct impact on the users of buildings and their energy management. They comprehend a monitor, which displays information about annual, monthly, daily, and current consumption and energy savings. It is a powerful tool for impact on user' behaviour. Normally it is placed in a building where the maximum movement of users occurs, so this way maximum impact can be achieved. An example of energy info point in Slovenia is presented in Figure 12.

Figure 13 An example of energy info point; on the right is a graphical interface, on the left is a monitor with a touch screen option

Energy monitoring is of significant importance for achieving energy savings, especially today with all the technologies available and should always be combined with other educational and motivational tool for behaviour change.

MODULE 7: NO-COST AND LOW-COST ENERGY SAVING MEASURES

Efficient and sustainable management of the building, all its elements and equipment may be achieved by applying no-cost and low-cost energy saving measures simply by educating end-users through simple guidelines. Below is a check-list of simple measures that should be carried out for obtaining energy savings:

- allow sunlight heating of premises, to make full use of daylight windows should be frequently cleaned, putting pots of plants and other objects near the windows and dark curtains should be avoided, tables should be positioned to maximise the daylight use;
- maximise the use of daylight for illuminating premises;
- closing doors, windows, and other places where heat is lost;
- regular maintenance of gas and oil installations, pressures, burners, and heat exchangers because unclean heat burners and heat exchangers cause insufficient fuel combustion, and low efficient operation of the whole system;
- heat exchangers should be scale free, because little ticker layer of soil reduces heat transfer, consumes more fuel and the space will be heated less;
- radiators must be cleaned frequently to ensure that impurities don’t prevent heat transfer, for enabling heat release, radiators should be regularly cleaned and ventilated to ensure good circulation of hot water hence saving of 3-5% can be achieved;
- prevent furniture, curtains, or other coverage of heating devices because in this way heat transfer is reduced, sun protection elements reduce heat radiation inside the space, their proper use can avoid additional costs for cooling in summer and for heating in winter;
- switch off the lights in the premises when people are out;
- use table lamps and lamp where the illumination is needed most;
- regularly cleaning lightbulbs, pendants, and lamps, impurities absorb more than 50% of light;
- when purchasing electrical appliances, energy efficiency classes must be considered thus buying more energy efficient devices, energy consumption difference between class A and D ranges between 30 and 45%;
- electrical appliances mostly be used during low tariffs periods, and should be plug off when not in use, avoiding “stand by” mode is also important because in this mode energy is consumed (computers must be turned off when not in use, if not possible, at least turning off the monitor), the key role is turning off appliances when not using them;
- important step in the reduction of water consumption rational use of it;

- frequently cleaning and replacing filters in air conditions to prevent that device becomes a pollutant;
- setting rationally the desired temperature in the premise, temperature difference between inner and outer temperature should be not higher then 6*C, besides it consumes much more energy it is harmful for the health. In summertime, optimal temperature of inner space is 5°C lower then outer. Decreasing temperature for 1°C, 5% more energy is consumed;
- closing doors and windows if cooling is on, when ventilating turn cooling off;
- all the premises in the building must be regularly cleaned and ventilate (it also applies to the premises that are not used daily), is important to ensure thoroughly 10 minutes' ventilation 2-3 times per day opening all windows completely to have air exchanges and maintain necessary hygienic conditions. The ventilation should perform by opening the lower parts of the window for the ingress of fresh air, and upper parts for the outlet of hot air, if it is technically possible. After major physical activities, ventilation of premises must be done as quickly as possible by opening all elements, but taking care about the draft;
- equipment in premises and installation elements should be used according to the intended purpose, rationally and economically;
- regular audits and services of the installed equipment to eliminate shortcomings on time.

The responsibility of building users is to consciously consume energy. The more building users will adhere to simple energy consumption rules, better energy savings targets will be achieved. Simple tools, like stickers, signage or e-mail prompts with energy saving tips, for reminding users to implement these simple measures may prove successful.

MODULE 8: INTEGRATION OF BEHAVIOURAL MEASURES WITH OTHER EE SOLUTIONS

Besides the fact that public buildings should set an exemplary role as standing EPBD and EED, public building stock in EU is not negligible and non-residential buildings are more energy intensive then residential. It is very important to focus on their consumption expenses highlighting the attention on the amount of public expenditures that could be better relocated in the case of reduction of energy consumption in public buildings.

Behavioural changes can be achieved only by educating building users about their actual energy consumption. The previous can be successfully achieved by using technologies for monitoring energy consumption and by educating users about energy consumption.

Regarding technology, smart metering and demand side management tools enables people to measure savings and manage consumption. People should meet technology, employees responsible for energy monitoring should be educated to use IT tools for monitoring consumption as smart meters for electricity, heating and cooling and water consumption and interpret the obtain data and thus manage consumption. For reducing energy and water consumption the first step is to measure it because without measuring something you cannot manage it. Involving all the participants in consumption and giving them the opportunity to participate in the systems development process of energy management is the key for a successful energy management systems.

CHECK LIST FOR BEHAVIOURAL DSM

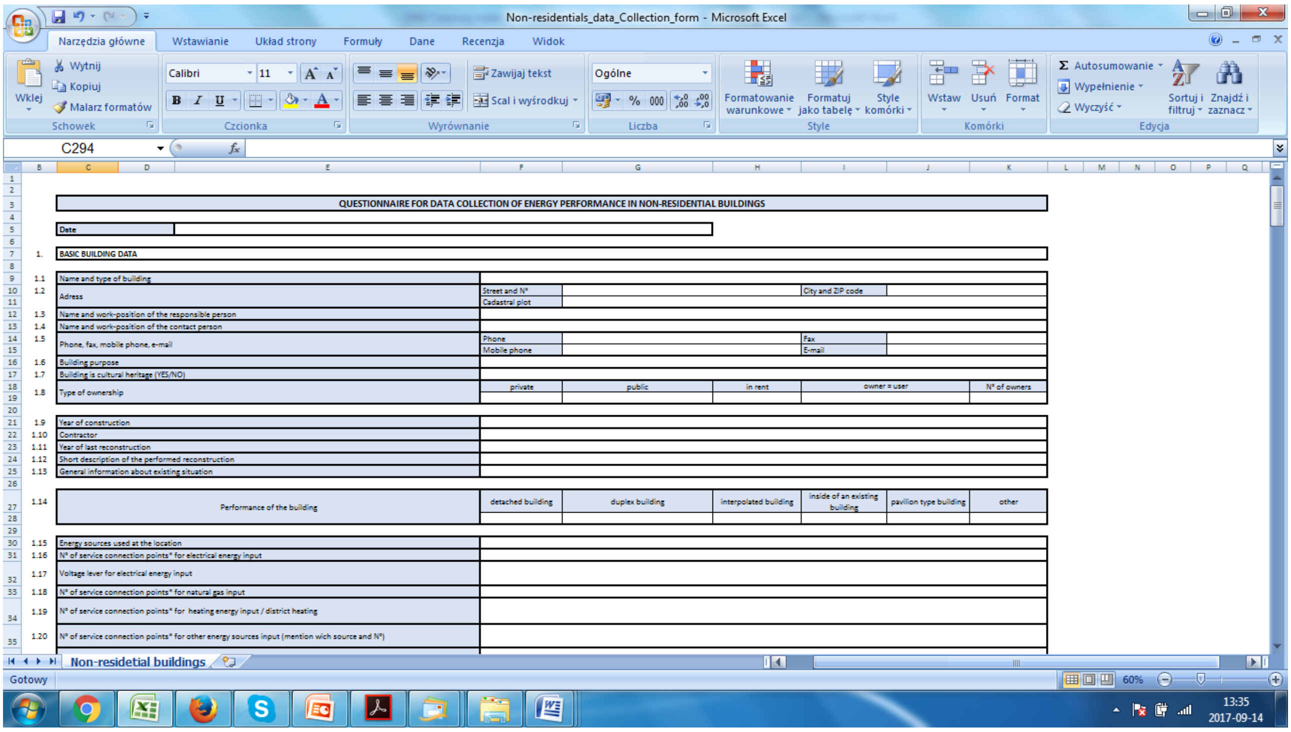
The following check list serves as a reminder of the most crucial steps in introducing and implementing behavioural DSM measures into an organisation.

- Analyse organisational culture and behavioural habits of employees and building users and develop a framework for behavioural change that considers all specificities of your organisation (use Figure 9 as guidance to create the framework);
- Thoroughly prepare educational and informational campaign encompassing all the following important issues:
  1) clearly defined goals of the campaign;
  2) clearly defined target group(s);
  3) selection of methods and tools for communicating with target group(s) and provoking the behavioural change among them that fit the best to the group's profile and needs (consider rules, trainings, competitions, gaming, incentives and other available tools)
- Ensure feedback to the employees and users of the building by using analytical DSM tools;
- Ensure continuity of energy efficient behaviour through simple reminders and guidelines.

PART 2:
EXERCISES

EXERCISE 1: BUILDING DATA COLLECTION

Complete the Excell sheet (attachment 1) with the data on energy performance of your building.



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GLOSSARY

BEMS - Optimized Building Energy Management Systems

DMS – Digital Monitoring System

DSM – Demand Side Management

EE – Energy Efficient/Efficiency

EED – Energy Efficiency Directive

EnMS – Energy Monitoring System

EPBD – Energy Performance of Buildings Directive

HVAC - Heating, ventilation, and air conditioning

SCADA - Supervisory control and data acquisition

LIST OF FIGURES

LIST OF TABLES

APPENDIX

- Appendix 1: Questionnaire for data collection on energy performance of non-residential buildings