Smart Energy Managament Tools

Interreg CENTRAL EUROPE
European Union European Regional Development Fund
TOGETHER

Step-by-step procedure handbook for EnMs in Institutional buildings D.T2.1.4

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TOGETHER

TOwards a Goal of Efficiency THrough Energy Reduction

Step-by-step procedures' handbook for EnMS in Institutional buildings

D.T2.1.4

- PP3 – University of Maribor
- PP4 – City of Zagreb
- PP5 – Association of Municipalities Polish Network

Executive summary

Energy efficiency is a key point in EU energy policies, and the building sector is one of the main sectors in terms of energy consumption. Institutional buildings are special players in this context, since there is the opportunity to involve users (mostly permanent staff) in generating savings and increasing awareness of the importance of energy efficiency (EE).

This tool has been provided to be utilized by all potential users in institutional buildings concerned with energy conservation, and providing them necessary overview of Energy Management System (EnMS) that could be implemented with a common aim of improving energy efficiency. In addition, it is not considered as standalone because it can not provide all needed information for optimal implementation of energy management, therefore it is recommended to use it along with other tools as part of the Together project. For more information, please visit Together Library available at:
http://www.pnec.org.pl/en/together-library

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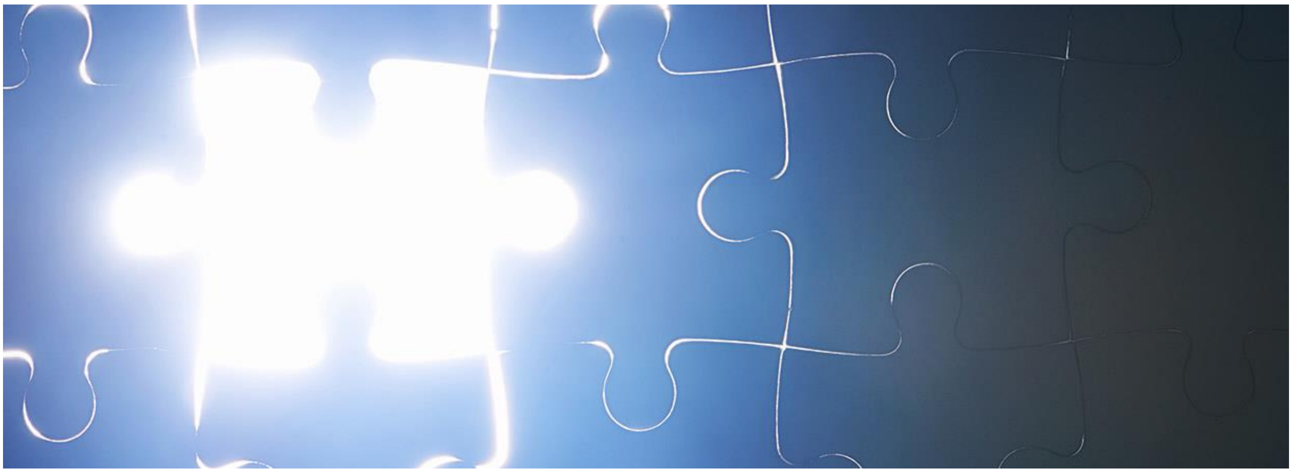
1. Introduction

The Project TOGETHER offers a transnational capacity building platform, where partners with different levels of knowledge can strengthen their competences together, thus reducing their disparities and promoting actions on both the supply and demand side, in the context of planning EE in public buildings. The main goal of the project is improving energy efficiency and energy saving in public buildings by changing behaviour of building users and promoting energy efficiency measures.

This tool is contextualized within the framework of the second objective of the project TOGETHER: if the first project objective “To increase energy efficiency and secure investments thanks to improved multidisciplinary in-house staff skills and thanks to an Alliance system with more engaged and motivated buildings users” calls for the observation and learning of possible tools to be combined together for achieving energy efficiency in public buildings, and the second one “To produce and test the most appropriate combinations of technical, financial and Demand Side Management tools for the improvement of the energy performance of public infrastructures” calls for the practical and concrete implementation of the possible identified measures.



1.1. Project TOGETHER

The three main objectives of the project TOGETHER consist in:

1. Increasing public buildings energy efficiency and securing investments, through the improved multidisciplinary in-house staff capacity building of Public Administrations and the establishment of a system of alliances with more engaged and motivated building users;

2. Producing and pilot testing the most appropriate combinations of technical, financial and Demand Side Management tools for the improvement of the energy performance of public infrastructures, currently in the 8 regional Pilot Actions involving a total of 85 buildings;

3. Codifying the project outcomes into a comprehensive policy package for a large-scale implementation, bringing local buildings governance practices to the centre of ambitious energy saving policies.

In its inception, TOGETHER plans the organisation of an interdisciplinary “Training of Trainers” course for building owners, managers and public decision makers that integrates the traditional technical inputs on energy management and buildings retrofitting with targeted contributions from behavioural science, economics and psychology, aiming to engage the end users in the building energy performance goals.

The “Training of Trainers” course is completed by the provision of an Integrated Smart Toolkit, including:

1. Guidelines for implementing the innovative EPIC (Energy Performance Integrated Contract) scheme, combining technological devices and behavioural-based components;

2. A set of exemplary models of Energy Management Systems in schools, institutional and other type of buildings;

3. An innovative Building Alliance concept among building owners/managers/users who cooperate within a Negotiating Panel to achieve energy savings to be reinvested through a Reinvestment Action Plan.

Additionally, and by the project’s end, the Partners will jointly elaborate a Transnational Strategy and Mainstreaming Programme, including policy/strategic and operational recommendations for an appropriate follow-up and a sustainable take-up of the project outputs.

1.2. Purposes of Step-by-step procedure handbook for EnMs in Institutional buildings

In institutional buildings exists a huge potential to increase energy efficiency. Usually buildings are old, not renovated and the building users are not familiar with EnMS, which can lead to increase of energy efficiency in the building. Therefore, the aim of this tool is to encourage institutional building users to act in a more efficient way through introduction of theoretical part, best cases and most appropriate measures and tips for energy efficiency. The topics as energy policy, energy management, technical systems and ultimately the inclusion of building users in the planning of energy efficient measures are covered. The main concept of EnMS implementation is not only giving technical support such as smart meters introduction, but also to teach building users on more efficient everyday behaviour and habits.

1.3. Usage of Step-by-step procedure handbook for EnMs in Institutional buildings

This tool has been developed to be introduced in the pilot actions under the project Together. It will be tested among other tools in all 85 pilot buildings spread in 7 different countries. Under the 8 pilot clusters of different project partners, institutional/administrative buildings represent 13% as illustrated in Figure 1.

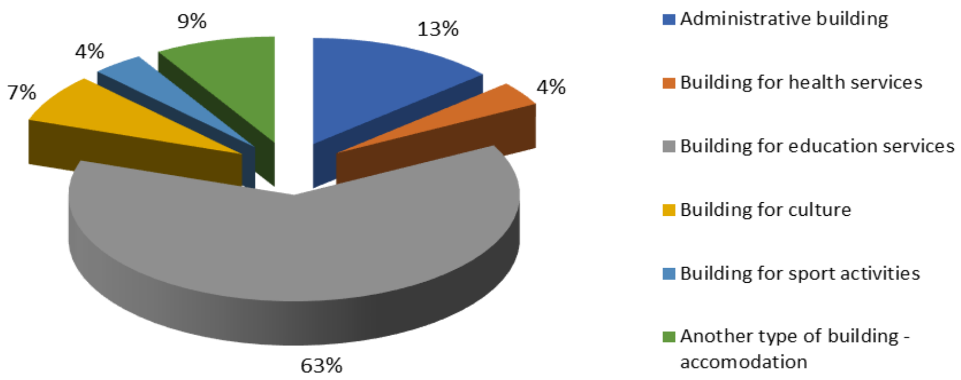


Figure 1: Demonstration of the purposes of pilot buildings

For better usage of this tool, it is recommended to read the following other tools as well:

- D.T2.1.3 – Step-by-step procedure handbook for EnMs in School buildings
- D.T2.1.5 – Step-by-step procedure handbook for EnMs in Public buildings
- D.T2.2.4 – Set of financial instruments integrated with Demand Side Management
- D.T2.3.1 – The negotiating panel concept

2. Encouraging energy efficiency in Institutional buildigns

2.1. Introduction

Energy efficiency is a key point in EU energy policies, and the building sector is one of the main sectors in terms of energy consumption. EU confers to public sector an exemplary and promoting role in energy efficiency, and public administrations residing in institutional buildings should gather this indication as an opportunity rather than an obligation: acting in an energy efficiency way means stimulating new economic activities and job opportunities, it means using public resources in a more efficient way, avoiding wastes and complying in the same time with the global needs of environmental protection that are more and more a priority for the sustainable and durable development of current and future generations.

The institutional buildings are special players in this context, since in these type of buildings mostly permanent users are involved and not so much visitors. This means that, the majority of the users can be motivated for energy efficient behaviour with long lasting effect since the users are still the same. This could be a key element in these buildings in order to reduce the energy consumption.

2.2. Why encourage energy efficiency

Energy efficiency is a cornerstone of the European energy policy and one of the main targets of the Europe 2020 Strategy for smart, sustainable and inclusive growth (see chapter 3). As energy related emissions account for almost 80% of total EU greenhouse gas emissions, the efficient use of energy can make an important contribution to achieving a low-carbon economy and combating climate change. Environmental problems associated with energy consumption are both of local and global nature: they include air pollution, smog, climate change, degradation of ecosystems, water pollution and radioactive hazards.

However it’s not only an environmental issue: energy efficiency measures are increasingly recognised as means not only of achieving a sustainable energy supply, cutting greenhouse gas emissions, but also of improving security of supply, reducing import bills (Europe imports more than half of energy required, which makes it dependent from non-EU countries) and promoting the competitiveness of European economies.

As the European Commission states, buildings account for approximately 40% of final energy consumption, thus investing in Energy Efficiency measures in this sector is a fundamental strategy to support economic growth, sustainable development and creating jobs. Furthermore, greater use of energy-efficient appliances and technologies, combined with renewable energy, are cost effective ways of enhancing the security of energy supply.

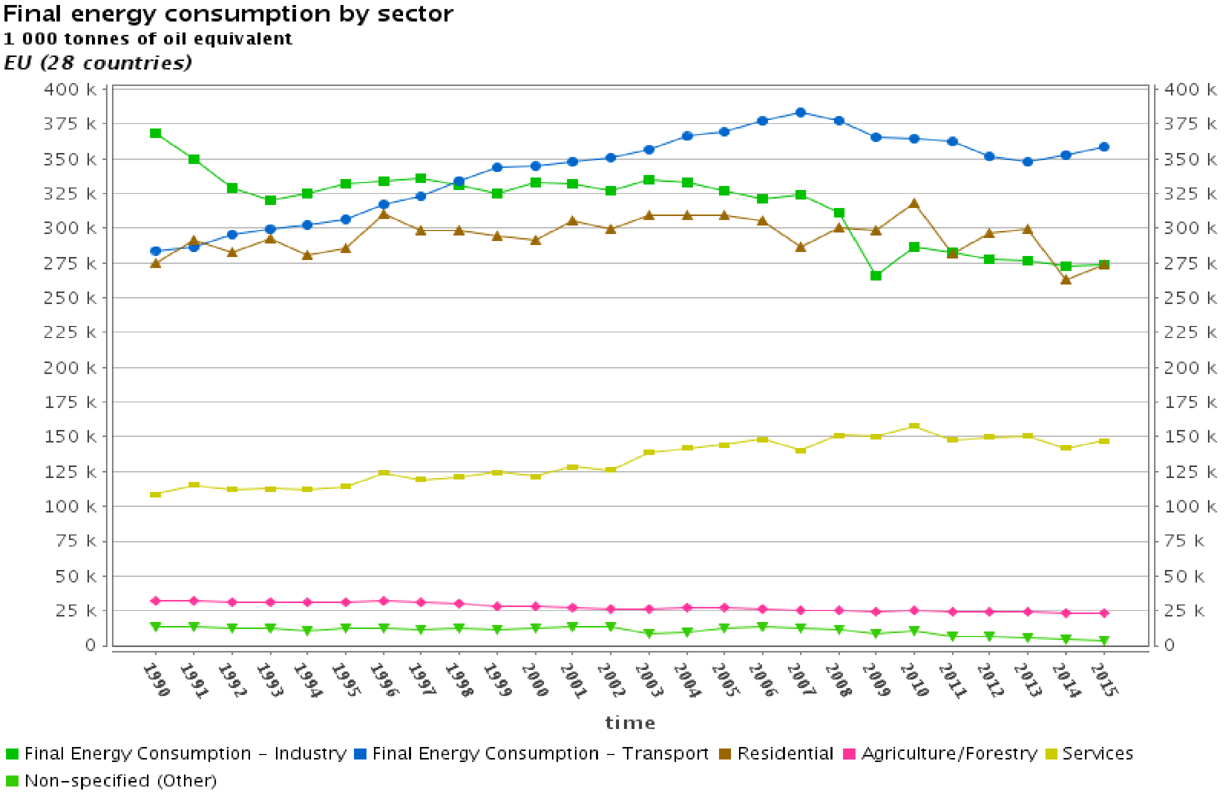


Figure 2: Final energy consumption by sector in the European Union from 1990 to 2015 (Source: Eurostat 2017)

In this context, the aptitude of public authorities is crucial and they should perform an "exemplary role" as energy consumers, which is not to be understood only as an obligation, but also as an opportunity to stimulate a sustainable development: the public sector, due to its multiple position of purchaser, investor and regulator, can lead by example through energy efficient public procurement and ambitious targets for its own buildings, thereby paving the way for the other sectors to follow. Energy efficiency measures can also support other national programmatic priorities such as public housing, the health sector and education, as they reduce costs and improve comfort levels.

As public bodies, Municipalities are involved in improving EE measures together with central governments, as they manage a lot of buildings, usually rather old or not energy efficient. In local contexts, the refurbishment of institutional buildings produces, beyond environmental improvement, a remarkable advantage in terms of cost savings and, by the consequence, the possibility to better allocate public funds for community welfare.

2.3. Potential limitations – Inherited attitudes, motivation, administrative difficulties

In public administrations, many barriers can slow down the transition from a vicious to a virtuous model of energy consumption. They are limitations of various types that can make it difficult even the most simple or inexpensive intervention. Among different countries, two types of difficulties are generally observed: there are countries where problems are related to the lack of enabling conditions (lack of strategy, lack of commercial financing), and there are countries with actual barriers (pricing, lack of control over revenues), which are fewer but more serious.

Three main frequently occurring limitation groups can be identified in **public administrations**:

- **Lack of policies and targets**
  Political and regulatory barriers derive firstly from a lacking perception of energy efficiency as a priority, often due to a non-comprehension of the connection between EE issues and those of energy security improvement and economic benefits. Moreover, policies can be incomplete or unclear. Lastly, the so-called "implementation gap": legislation, when approved, is not followed by implementation plans or is too ambitious for an existing energy department or office on energy efficiency to implement.

- **Capacity shortages**
  The expertise required to start and manage energy efficiency processes in institutional buildings is often insufficient in public administrations: staff is frequently scarce or not adequately trained on technical, organisational, behavioural and financial themes, which are all fundamental aspects for an appropriate planning of EE interventions. The risk is to overlook important and cost-effective interventions, which can reduce the energy consumption, such as energy consumption monitoring, use of space reorganisation, and the users empowerment.
  Furthermore, it must be considered that buildings owned or managed by public administrations are often very different from one another, in construction characteristics, organizational models and ways of using, and this variety demands a wider choice of EE interventions to adapt the best case for each case.

- **Financial barriers**
  Financial barriers refer to the difficulty and/or inability to find economic resources to support the interventions identified, such as the scarce knowledge of ESCo model, a weak use of European, national and regional funds for EE in public sector, the Stability Pact which ties up a part of the available economic resources, and a lacking propensity to use or imagine innovative financial tools (public-private partnership, Project Bond, etc.).

Although not all the limitations listed above are under the competence of local authorities, it should be noted that the major obstacle in the activation of energy efficiency processes is often represented by people themselves, because of their inadequate or not updated knowledge and/or a lacking awareness and sense of responsibility. From national to local level, from the political to the technical role, a reorganization and training of internal staff could remove or at least reduce many regulatory, technical, relational and financial barriers that impede EE goals achievement.

2.4. Expected results from implementing energy efficiency measures

Regardless of quantitative results that a public administration could and should set while launching energy efficiency interventions, which can vary from case to case depending on starting point, available resources and final goals, in this framework qualitative results are in the main focus.

Energy efficiency is certainly determined by a proper construction (or refurbishment) of buildings from the technical point of view, starting from the design of spaces, selection of materials, a correct sizing of heating and cooling systems, use of renewable resources, etc. However, recent studies confirm that technical innovation, even though it is necessary, is not enough to reach an optimal energy performance of buildings, and the role of users in the organization and use of spaces is fundamental.

Intervention	Range of energy savings
Feedback	5–15 %
Direct feedback (including smart meters)	5–15 %
Indirect feedback (e.g. enhanced billing)	2–10 %
Feedback and target setting	5–15 %
Energy audits	5–20 %
Community-based initiatives	5–20 %
Combination interventions (of more than one)	5–20 %

Figure 3: Potential energy savings due to measures targeting behaviour (Source: Achieving energy efficiency through behaviour change: what does it take? EEA technical report n. 5/2013)

Involving users in energy efficiency of buildings implies a shared assumption of responsibility through which the success of energy efficiency process is not delegated to a single person (for example: the technical expert in charge of the refurbishment, or the owner of the building), but it concerns all the stakeholders involved in the use of building, contributing, by adopting the technical, behavioural, organizational and financial actions required in an integrated and complementary way, to a more efficient and smarter use of buildings.

That means activating a process for the involvement, dialogue and raising awareness of owners, managers and building users. It means then to train all these players on the causes of inefficiency and the possible ways of interventions.

In this way, an energy efficiency programme involving institutional buildings represents an important opportunity to trigger a long-lasting process of awareness: working with EE in schools means putting together politics, technicians, teachers, students, auxiliary school staff and, indirectly, parents and families, working for the same goal of energy efficiency.

The expected result from the activation of an integrated approach for energy efficiency in institutional buildings, is then not only the achievement of a better level of energy consumption. A further, and not less important, expected result is the creation of a more pro-active, trained, responsible and aware citizenship.

3. Energy Policy in Institutional buildings

3.1. Introduction

The pillar of the EU policy on energy efficiency is the “2020 climate & energy package”: a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020. The package sets three key targets:

- 20% cut in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewables
- 20% improvement in energy efficiency

Starting from this basis, a further step has been developed, with the “2030 climate & energy framework” that strengthens the 2020 goals as follows:

- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
- At least 27% share for renewable energy
- At least 27% improvement in energy efficiency

The long-term purpose of the roadmap underway is the reduction of 80-95% of CO_2 from 1990 levels by 2050.

With its 40% of energy consumption and 36% of CO_2 emissions, the building sector is considered a key element to achieve the EU Climate & Energy objectives, and a crucial role is conferred to the public sector, due to its function in public purchasing, refurbishment of institutional buildings and encouragement of higher building standards in cities and communities. The public sector can also create new markets for energy-efficient technologies, services and business models.

The EU has therefore implemented in the last decades a set of directives and recommendations in order to support Member States in the elaboration of a strategy for energy efficiency in buildings, to finally achieve its 2020, 2030 and 2050 targets.

3.2. Legal basis

Directive 2002/91/EC on the energy performance of buildings provides a method to calculate the energy performance of buildings, minimum requirements for new and existing buildings with a useful area over 1000 m^2, and energy certification.

The European Commission launched in 2006 its **Action Plan for Energy Efficiency: Realising the Potential**[1]. It was intended to mobilise the general public, policymakers and market actors, and transform the internal energy market in a way that would provide EU citizens with the most energy-efficient infrastructure (including buildings), products (including appliances and cars) and energy systems in the world. The objective of the Action Plan is to control and reduce energy demand and to take targeted actions on consumption and supply in order to save 20% of annual consumption of primary energy by 2020.

[1] COM(2006)545

This Action Plan identified the most cost-effective possibilities in energy saving in the buildings sector, making evident that the Directive 2002/91/EC must be adapted in order to reach the goals set.

The directive 2002/91/EC was then repealed by the recast **Directive 2010/31/EU**. The main objective of this recast directive was to streamline certain provisions of the former directive and to strengthen the energy performance requirements with regard to:

- the common general framework for calculating the integrated energy performance of buildings and building units;
- the application of minimum requirements to the energy performance of new buildings and new building units, establishing, for instance, that by 31st December 2020 all new buildings must be nearly zero-energy buildings;
- the application of minimum requirements to the energy performance of: existing buildings, building elements that are subject to major renovation, and technical building systems whenever they are installed, replaced or upgraded;
- energy certification of buildings or building units, regular inspection of heating and air-conditioning systems in buildings and independent control systems for energy performance certificates and inspection reports.

Nonetheless, when recent estimates suggested that the EU was on course to achieving only half of the 20% objective, the Commission responded by developing a new and comprehensive **Energy Efficiency Plan 2011**[2]. The plan focuses on instruments to trigger the renovation process in public and private buildings and to improve the energy performance of the components and appliances used in them. It promotes the exemplary role of the public sector, proposing to accelerate the refurbishment rate of institutional buildings through a binding target and to introduce energy efficiency criteria in public spending. It also foresees obligations for utilities to enable their customers to cut their energy consumption.

Recommendations of the *Energy Efficiency Plan 2011* led to a new **Energy Efficiency Directive (2012/27/EU)**. Through this latest Directive, the Member States are required to establish indicative national energy efficiency targets for 2020, based on either primary or final energy consumption. The directive also sets legally binding rules for end-users and energy suppliers. The directive includes, inter alia, the following requirements:

- the renovation of at least 3% of the total floor area of buildings owned by central governments each year from 2014;
- the purchase of buildings, services and products with high energy-efficiency performance, thus the public sector is leading the way;
- the establishment of national long-term strategies to promote investment in the renovation of residential and commercial buildings and the drawing-up of national energy efficiency obligation schemes or equivalent measures to ensure an annual 1.5% energy saving for end-use consumers;
- the assessment by the end of 2015 of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling in all Member States;
- mandatory regular energy audits for large companies to be conducted at least every four years, with the exception of companies with certified energy and environmental systems;
- the rollout of smart grids and smart meters and the provision of accurate information on energy bills, to empower consumers and encourage more efficient energy consumption.

[2] COM(2011)109

Box 3.1 – Energy Efficiency Directive: Obligation schemes and alternative measures

Article 7 is a key pillar of the Energy Efficiency Directive (EED), which requires Member States to introduce Energy Efficiency Obligation Schemes (EEOSs). This scheme requires energy companies to achieve yearly energy savings of 1.5% of annual sales to final consumers.
In order to reach this target, companies need to carry out measures which help final consumers improve energy efficiency. This may include:

- improving the heating system in consumers' homes;
- installing double glazed windows;
- better insulating roofs to reduce energy consumption.

'Alternative measures' are those undertaken by the government or other public authorities that have the effect of reducing end-use consumption, such as:

- energy or carbon taxes;
- financing instruments or fiscal incentives;
- regulations or voluntary agreements, training, education or information measures etc.

In December 2013, Member States reported to the European Commission the implementation plans for Article 7 and they have or are planning to introduce EEOS and/or alternative measures to reach the 1.5 % energy saving goal. Member States have planned a variety of routes to meeting the energy saving target of Article 7:

EEOS only: Bulgaria, Denmark, Luxembourg and Poland (among these countries, only Denmark has long and successful experience of an EEOS policy).
EEOS plus alternative policies: Austria, Belgium, Croatia, Estonia, France, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Slovenia, Spain, UK.
Alternative policies only: Cyprus, Czech Republic, Finland, Greece, Germany, The Netherlands, Portugal, Romania, Slovakia and Sweden.

According to the Commission Staff Working document dated 30/11/2016 *Evaluation of articles 6 and 7 of the Energy Efficiency Directive (2012/27/EU)*, a great variety of alternative measures in addition to the energy efficiency obligation schemes were notified by Member States under Article 7 (resulting in total of 477 measures). The highest amount of savings (34 % or 86.1 Mtoe) is expected to come from EEOSs, which are the default instrument of Article 7 (see table below).

	Energy efficiency obligation scheme	Energy Efficiency National Fund	(a) Energy or CO2 taxes	(b) Financing schemes or fiscal incentives (including grants)	(c) Regulations or voluntary agreements	(d) Standards and norms mandatory and applicable in MS under EU law71	(e) Energy labelling schemes	(f) Training and education in reducing end-use energy consumption	i) Any other policy measures, and/or category not clear	Total number of policy measures
Austria	1	0	1	4	1	1	0	0	1	9
Belgium	0	1	0	14	4	3	0	0	0	22
Bulgaria	1	0	0	0	0	0	0	0	0	1
Croatia	1	0	0	9	0	0	0	1	0	11
Cyprus	0	0	0	3	0	0	0	0	2	5
Czech Republic	0	0	0	23	0	0	0	0	0	23
Denmark	1	0	0	0	0	0	0	0	0	1
Estonia	1	0	1	1	0	0	0	0	0	3
Finland	0	0	1	3	2	1	0	0	1	8
France	1	0	0	1	0	0	0	1	0	3

Germany	0	1	2	26	3	0	1	13	66	112
Greece	0	0	0	17	1	1	0	1	0	20
	Energy efficiency obligation scheme	Energy Efficiency National Fund	(a) Energy or CO2 taxes	(b) Financing schemes or fiscal incentives (including grants)	(c) Regulations or voluntary agreements	(d) Standards and norms mandatory and applicable in MS under EU law71	(e) Energy labelling schemes	(f) Training and education in reducing end-use energy consumption	i) Any other policy measures, and/or category not clear	Total number of policy measures
Hungary	0	0	0	3	0	0	0	0	0	3
Ireland	1	0	0	2	0	4	0	1	2	10
Italy	1	0	0	2	0	0	0	0	0	3
Latvia	1	0	0	4	1	0	0	0	1	7
Lithuania	1	0	0	1	0	7	1	3	2	15
Luxembourg	1	0	0	0	0	0	0	0	0	1
Malta	1*	0	0	12	19	0	0	0	0	35*
Netherlands	0	0	2	3	4	3	1	1	15	29
Poland	1	0	0	0	0	0	0	0	0	1
Portugal	0	0	0	2	3	2	3	1	13	24
Romania	0	0	0	18	1	0	0	2	7	28
Slovakia73	0	0	0	21	1	0	0	0	44	66
Slovenia	1	1	0	0	0	0	0	0	0	2
Spain	1	1	1	9	0	0	0	2	0	14
Sweden	0	0	1	0	0	0	0	0	0	1
UK	3**	0	1	5	6	3	0	0	2	20
Total [number of measures]	**21**	**4**	**10**	**183**	**46**	**25**	**6**	**26**	**156**	**477**
Total [number of MS]	**16**	**4**	**8**	**22**	**12**	**9**	**4**	**10**	**12**	**28**

Overview of policy measures notified by Member States (per measure type)[3]

The results of the Energy Efficiency Directive 2012 have been assessed in order to verify the outcome of the policies implemented in the European Union and update them for achieving the 2030 objectives. It is now underway a **proposal for amending Directive 2012/27/EU**[4], that extends to 2030 the energy saving obligation while retaining the rate of 1.5% and the possibility to use both energy efficiency obligation schemes and alternative measures.

[3] SWD(2016)402

[4] COM(2016)761

Box 3.2 – Agenda of energy efficiency commitments for Public Administrations[5]

1st January 2014 →Refurbishment of buildings with a total useful floor area over 500 m^2, owned by central governments of Member States, that do not meet the national minimum energy performance requirements set in application of Energy Performance Building Directive 2010/31/EU, at a rate of 3% each year (Directive 2012/27/EU);

1st January 2015 → The threshold for the refurbishment of public buildings is lowered to 250 m^2 (Directive 2012/27/EU);

31st December 2016 → In multi-apartment and multi-purpose buildings with a central heating/cooling source, individual consumption meters shall also be installed (Directive 2012/27/EU);

31st December 2018 → New buildings occupied and owned by public authorities are nearly zero-energy buildings (Directive 2010/31/EU);

31st December 2020 → All new buildings are nearly zero- energy buildings (Directive 2010/31/EU).

3.3. Goals

The cheapest energy, the cleanest energy, the most secure energy is the energy that is not used at all. Energy efficiency needs to be considered as a source of energy in it own right. It is one of the most cost effective ways to support the transition to a low carbon economy and to create growth, employment and investment opportunities. (Proposal for a directive of the European Parliament and of the Council amending Directive 2012/27/EU on energy efficiency)[6]

The energy efficiency policy of the EU carried out for building sector in these last decades is part of a wider framework in which issues like energy, economic competitiveness and environmental crisis are strictly interconnected.

There are two major challenges in the energy sector: lack of sufficient, reliable and affordable supplies, and environmental issues associated with energy production and consumption. Key objectives are to reduce the demand for fossil fuels, diversify sources of supply geographically, foster alternative energies to allow for a wider distribution of energy resources and reduce greenhouse gas (GHG) emissions.

In this framework the public sector has to set an example. Ambitious objectives ought to be set for the energy consumption of the public sector. Public procurement should support energy efficient outcomes. Innovative integrated energy solutions at local level contributing towards transition to so-called ‘smart cities’ should be supported. Municipalities represent a major actor of the required change, thus their initiatives like the Covenant of Mayors should be further strengthened. Cities and urban areas, which consume up to 80% of the energy, are at the same time part of the problem and part of the solution to greater energy efficiency.

[5] Translated from IEFE Bocconi, *Promuovere l’efficienza energetica negli edifici. Guida pratica per gli amministrtori comunali*, 2016

[6] COM(2016)761

Box 3.3 – The 5 priorities of the *Strategy for competitive, sustainable and secure energy "Energy 2020"*[7]

1. **An efficient use of energy**, which needs to be mainstreamed into all relevant policy areas, including education and training, to change current behavioural patterns. Energy efficiency criteria must be imposed in all spheres, including the allocation of public funds.
2. **Ensuring the free movement of energy** by creating a more integrated, interconnected and competitive market in order to enable citizens to benefit from more reliable, competitive prices as well as more sustainable energy.
3. **Providing secure, safe and affordable energy** for citizens and businesses, by making energy policies more consumer-friendly and continuously improving safety and security.
4. **Making a technological shift** towards innovative low carbon technologies.
5. **Strengthening the external dimension of the EU energy market** by integrating regulatory frameworks with neighbours and establishing partnerships with key partners

3.4. Achievements

As stated in the Communication from the European Commission ***A policy framework for climate and energy in the period from 2020 to 2030***[8], current energy and climate policies are delivering substantial progress towards these 20/20/20 targets. The key achievements of the current energy and climate policy framework are the following:

- GHG emissions in 2012 decreased by 18% relative to emissions in 1990 and are expected to reduce further to levels 24% and 32% lower than in 1990 by 2020 and 2030 respectively on the basis of current policies.
- The share of renewable energy has increased to 13% in 2012 as a proportion of final energy consumed and is expected to rise further to 21% in 2020 and 24% in 2030.
- The EU had installed about 44% of the world's renewable electricity (excluding hydro) at the end of 2012.
- The energy intensity of the EU economy has reduced by 24% between 1995 and 2011 whilst the improvement by industry was about 30%.
- The carbon intensity of the EU economy fell by 28% between 1995 and 2010.

As a result of energy efficiency measures, buildings are consuming less energy, inefficient equipment is being phased out from the market and labels applied to household appliances, such as televisions and boilers, have enabled consumers to make informed purchasing choices. Public authorities, industry, SMEs and households are becoming more aware of energy-saving possibilities and a growing propensity behind energy efficiency policies and measures is evident both at national and at EU level.

It should be noted that about one third of the progress towards the 2020 target will be due to the lower than expected growth during the financial crisis. It is therefore important to avoid complacency about

[7] COM(2010)639

[8] COM(2014)15

reaching the 20% target and avoid underestimating the efforts that will be required in respect of any new target for the period after 2020.

Box 3.4 – Setting the 3% target for public building renovation[9]

The Energy Efficiency Directive (2012/27/EU) stresses that governments shall undertake an exemplary role in the energy retrofit of their countries' building stock, and sets a binding renovation target for public buildings. Article 5 of the Directive stipulates that each Member State shall ensure that, as from 1st January 2014, 3% of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least the minimum energy performance requirements. The objective of the EED Article 5 is to boost energy refurbishment in the central government sector, this way showcasing deep renovation of public buildings and inspiring the sub-national government level. Therefore, Article 5 is seen by NGOs and construction sector organisations advocating energy refurbishment and an increased energy performance of the European building stock, as a great opportunity to kick-start the deep energy retrofit market.

At present, renovation monitoring is poor and for the moment there is no data to assess if the 3% target has been reached. However, some studies reveal that the current average building energy renovation rate in the EU for non-residential is below 1%.

9 https://ec.europa.eu/energy/en/eu-buildings-factsheets

4. Energy Management System (EnMS)

4.1. Introduction

In institutional buildings exists a huge potential to increase energy efficiency. Usually buildings are old, not renovated and the users are not familiar with energy efficiency measures. Therefore, without major investments in such facilities, with the rational use of energy and with adequate organization, energy consumption can be reduced by up to 15%. With implementation of adequate energy efficiency awareness of building users, energy reduction can be reduced by a further 5%. If we add the appropriate technical and investment measures, according to expert estimates the total potential of energy efficiency can amount up to 50%.

This chapter is intended to present the most important steps, which lead to higher energy efficiency in institutional buildings. Contents goes from introducing energy management system according to the ISO 50001, which specifies requirements for establishing, implementing, maintaining and improving an EnMS, from simple energy management solution as energy auditing, energy bookkeeping, to more advanced technical solutions as digital monitoring system or even more complex SCADA system for digital monitoring and controlling of energy consumption. EnMS is not a linear path, but it is a closed loop, meaning all steps are following continuously and each circle means some kind of improvements compared to the previous one. For that reason, it is necessary to introduce periodical checks, and one possibility for this is to perform an energy audit.

EnMS is directly connected with both sides of the Demand Side Management (DSM), the analytical and the behavioural part. Smart metering systems, as a part of analytical DSM, give the availability of energy usage data with data analytics, which can be integrated with the behavioural part of DSM.

4.2. Energy management system according to ISO 50001

Providing funding for energy rehabilitation is generally associated with identifying energy indicators, which have to be determined prior the investments. The consumption data have to be monitored after the investment, thus the energy savings can be compared to the set goals.

There are various approaches to monitor these indicators, one of these approaches is the EnMS defined by the standard ISO 50001:2011 established in 2011. ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an EnMS, which purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption. Also, it specifies requirements applicable to energy use and consumption, including measurement, documentation and reporting, design and procurement practices for equipment, systems, processes and personnel that contribute to energy performance.

This standard enables a systematic approach, in order to achieve continual improvement of energy performance, energy efficiency and energy conservation that consequently lead to energy savings or in other words, to reducing costs related to energy. General aims of EnMS are:

1. Knowledge of energy use: energy review and baseline
2. Improvement of energy performance
3. Determination of energy performance indicators
4. Monitoring and continuous improvements

ISO 50001 focuses on a continuous improvement process to achieve the objectives related to the environmental performance of an organization (enterprise, service provider, administration, etc.). The process follows a plan – do – check – act approach (PDCA), as illustrated in Figure 4.

In the context of energy management, the PDCA approach can be outlined as follows:

- **PLAN:** conduct the energy review and establish the baseline, energy performance indicators, objectives, targets and action plans necessary to deliver results that will improve energy performance in accordance with the organization's energy policy.
- **DO:** implement the energy management action plans.
- **CHECK:** monitor and measure processes and the key characteristics of operations that determinate energy performance against the energy policy and objectives, and report the results.
- **ACT:** take actions to continually improve energy performance and the EnMS.

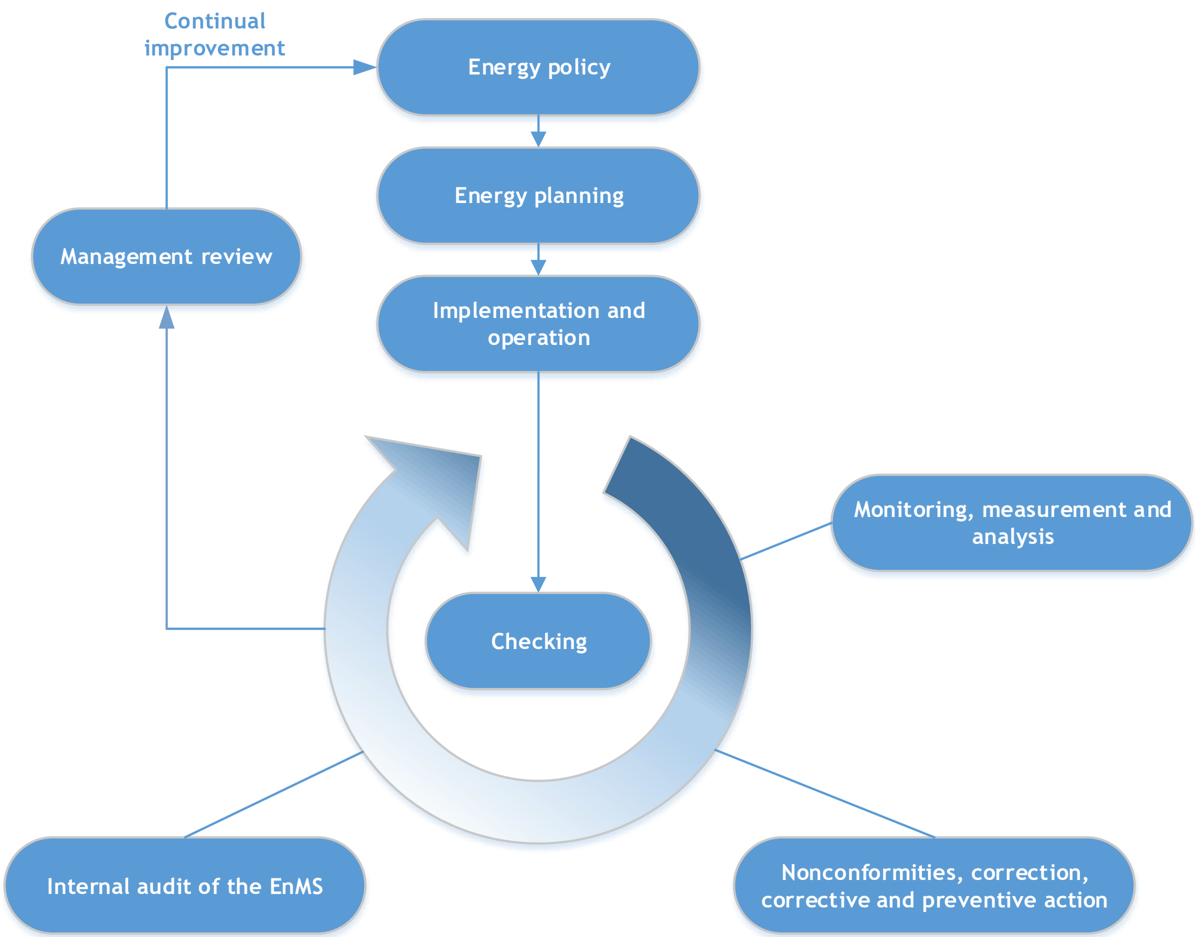


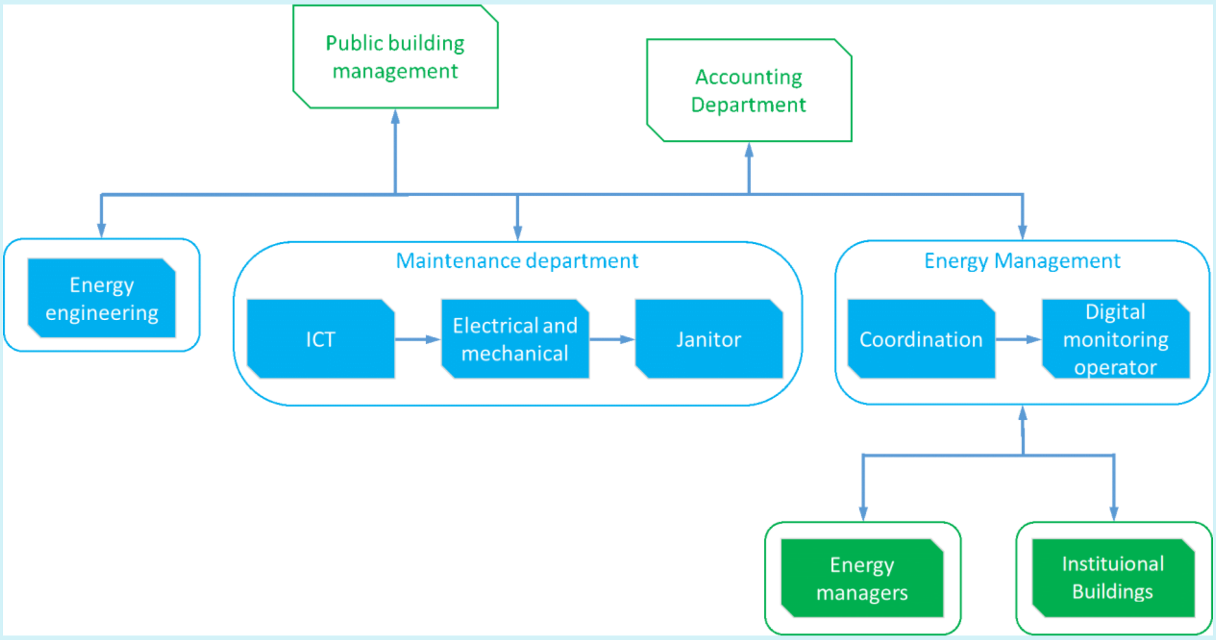
Figure 4: Energy management system model for ISO 50001

According to this standard, it is clear that EnMS has to be implemented systematically. These steps should follow up and it is crucial to do all of them:

1. Identification of top management responsibilities

In case of institutional buildings, such body is the building management. They shall demonstrate their commitment and support to the EnMS and to continuously improve its effectiveness. They shall appoint a management representative or establish an "energy team" with appropriate skills and competence, which main tasks are to ensure the EnMS is established, implemented, maintained and improved according to changes. It is important that energy management system involve all segments of the institutional building: regular users and visitors.

Box 4.1 - Example of energy management system implementation in institutional building



Responsibility for the area of energy management in institutional buildings is the energy manager's with other energy managers of individual buildings with direct involvement of other departments. This way communication is better, therefore he has control on all parts of energy management system.

Energy managers are entirely energy managing all involved buildings and they are responsible to achieve proper energy savings without disturbing the energy comfort in building. A good example of energy manager is teacher, who can actively involve students into all energy activities. It is important that energy management system involve all segments of the building: managers, renters, administrative cleaning and technical staff.

2. Energy policy preparation

Energy policy is a commitment to:

- Continuous improvement of the energy performance
- Accessibility to resources and information
- Ensure that EnMS is compatible with existing legal and other requirements

It is important to be aware that energy policy is not equal to energy action plan! Energy action plan is a tool for energy policy implementation.

3. Energy planning

This is a review of actions, which can influence the energy performance. This review can lead to identify the improvement possibilities. Within this step following are recommended:

- Review and familiarization with all legal and other requirements in the field of energy efficiency on local, national and international level.
- Energy review, which includes energy use analysis (current energy sources, past and present energy use, estimation of future energy use), identification of significant energy use, identification and prioritization of energy performance improvements.
- Determination of EPIs, which covers all fields of energy consumption of the building.
- Set of energy baseline: based upon the amount of energy used in a determined time period; energy consumption shall be measured and recorded, thus it is comparable to the baseline.
- Objectives, targets and energy action plan should be taken into consideration (with timeframes, resources and verification methods).

All these segments may be checked as part of an energy audit, for more information, see chapter 4.3.

4. Implementation and operation:

- Outputs from the energy planning phase (include action plan) are put into practice.
- Ensure competences of employees/EnMS users (verification of competences, trainings if needed) and ensure awareness of the energy policy, EnMS procedures, roles and results.
- Communication - interior (eg. every employee can comment/suggest improvements) and exterior (facultative - if yes, describe information flow).
- EnMS documentation - descriptions of procedures, objectives, targets, energy action plan, and all required regulations; supervision procedure for documentation acceptation, changes review, updates).

5. Checking

All crucial issues related to the energy performance (e.g. energy consumption, outputs from energy review, indicators, effectiveness of action plan) shall be measured, monitored and analysed in defined periods:

- Compliance with legal obligations and other requirements shall be ensured.
- Internal audits - systematic review of the EnMS to assess whether EnMS operates (in accordance with the organization's own requirements together with those of the ISO Standard) and if the EnMS improves the energy performance.
- Conducting inspections of non-compliance or potential non-compliance, determination of corrective and preventive actions.
- Controlling records: ensure that the necessary documentation is provided to demonstrate the achievement of targets, action plans and other requirements of the EnMS.

6. Management review

Ensure suitability, adequacy and effectiveness of the EnMS. The management review shall be planned at predefined intervals (e.g. once or twice per year). During the review all EnMS crucial issues (e.g. energy review, performance, legal compliance etc.) has to be presented, and according to them, review inputs and outputs shall be defined. It shall provide confirmation of the energy performance improvements for the latest period.

4.3. Energy auditing

The energy audit is one of the first tasks to be performed in order to accomplish higher energy efficiency and reducing energy costs for any building, company, or industry. An energy audit consists of a detailed examination of how a facility uses energy, what the facility pays for that energy, and finally, a recommended program for changes in operating practices or energy-consuming equipment that will cost-effectively save money on energy bills.

Institutional buildings are very special buildings from the energy consumption aspect, because in most cases they are large facilities with no or low level of EnMS implemented. These facilities often in addition to heating require other technologies as ventilation (HVAC), cooling or even compressed air or steam. There is usually lack of control over this complicated machinery and broad potential in savings by just tuning the system or implementing energy management. Energy audit is a first step to identify the potential in this savings. Energy auditor is often first person to investigate this potential after many years of operation and neglection.

4.3.1. Energy Audit services

The energy auditor plays a key role in the successful conduct of an audit, and also in the implementation of the audit recommendations. Energy audit could be conducted by using external technical experts or internal technical staff. Normally external experts perform energy audits, because in institutional buildings – in most cases – there are no properly educated or trained internal staff for carrying out whole procedure of an energy audit.

In case of employing an external contractor to perform the energy audit it is important to select an appropriate one with significant experience in the field. On the market, there are many auditors who can offer this kind of service, so minimal criteria should be set up for selecting an appropriate one. The main criteria in this case are references, and it is also important that the contractor is an accredited energy auditor.

4.3.2. Energy audit standards, methodologies and national laws

Energy audit content and its process performance are not things that are self-explanatory, but they are written and explained in standards, methodologies, laws or even regulations. This rules can be found on international level and also on national, so it is up to each country specifics which rules has to be taken into consideration for performance of energy audits. Normally each country has their own national rules, which are in most cases linked to European rules.

In the scope of the project Together, project partners have done the analysis of their national laws and methodologies for performance of energy audits, which are presented in

Table 1.

Table 1: Methodologies, standards and laws for performance of energy audits on project partner's national level

PP/ Country	Methodologies	Standards / Laws
LP Treviso, **Italy**	ENEA - Definition of a methodology for Energy audits in residential and office buildings	UNI/TS 11300 (Parts 1 - 2 - 3 - 4 - 5 - 6); UNI 10349 (Parts 1-2-3)
PP2 EAV, **Czech Republic**		Energy Management Act n. 406/2000 Coll.
PP3 UM, **Slovenia**	Rules on the methodology for the production and content of energy audits (Official Gazette of the Republic of Slovenia Act Nr. 41/2016)	SIST ISO 50002; SIST EN 16247 (Parts 1-2-3-4-5) - Energy Audit
PP4 ZAGREB, **Croatia**	Energy Efficient Law and Regulation for the Energy Audits and Energy Certification of the Buildings	Article 47 of the Law on Construction (NN 153/2013)
PP5 PNEC, **Poland**	Regulation of 27 February 2015 on the methodology for determining the energy performance of a building or part of a building and on energy performance certificates.	Energy Efficiency Act, Act on energy performance of buildings
PP6 STRDA/Paks, **Hungary**	7/2006 (V.24.) TNM statute; 40/2012. (VIII. 13.) BM statute; 176/2008. (VI. 30.) statute	EN 15459 - Economic evaluation procedure for energy systems in buildings; MSZ EN ISO 15900 - Energy efficiency services, definitions and requirements; EN 16231-2012 Energy efficiency benchmarking methodology; EN 16212:2012 Energy Efficiency and Savings Calculation; MSZ EN 16247/1 (2, 3, 4, 5) - Energy Audit EN ISO 50001 (2, 3, 4, 6, 15, 47)
PP7 HEGDYVIDEK, **Hungary**	7/2006 (V.24.) TNM statute; 40/2012. (VIII. 13.) BM statute; 176/2008. (VI. 30.) statute	EN 15459 - Economic evaluation procedure for energy systems in buildings; MSZ EN ISO 15900 - Energy efficiency services, definitions and requirements; EN 16231-2012 Energy efficiency benchmarking methodology; EN 16212:2012 Energy Efficiency and Savings Calculation; MSZ EN 16247/1 (2, 3, 4, 5) - Energy Audit EN ISO 50001 (2, 3, 4, 6, 15, 47)
PP8 SIEA, **Slovakia**	Directive of Ministry of Economy 179/2015	EN ISO 50001, EN ISO 14001, STN 73 0550, STN EN 16247, STN 73 0540, STN EN 12831

Table 1 represents a summary of international and national laws, and directives, which are existing in the partner's country. Each country has its own national laws/directives regarding the energy audits. The most commonly used are International Standardization Organization (ISO) standards and European Standard (EN).

4.3.3. Types and basic components of energy audit

Depending on the type of facility, industrial processes, problems, purpose and scope of energy audits, energy audits can be classified into three groups:

1. Walk-through (or) preliminary energy audit
2. Simplified energy audit
3. Extended energy audit

Preliminary energy audit represents the simplest form of energy audit, which presents generally the basis for a simplified or extended energy audit. The analysis is made on the basis of a one-day visit and on the basis of energy consumption data collected through a questionnaire. Following this type in complexity is the simplified version, which is enough for simple and easy to understand buildings such as offices, small industrial processes, where it is not necessary to do many measurements and inquiries, because most of consumers are already known. Extended energy audit is the most common form of inspection, containing accurate economic indicators for recommended energy efficiency measures. The total consumption of energy products and electricity, according to all consumers, wherever possible. Extended energy audit constitutes a relevant basis for decision-making on investments by the management company or owners [5].

Box 4.2 – Energy audit for Institutional buildings

Extended version of energy audit is an appropriate decision in case of institutional buildings for the following reasons:

- Institutional buildings are in most cases large and complicated structures, which are though to investigate (it takes a lot of time and knowledge of the buildings).
- There are usually complicated HVAC systems in order to ensure a comfortable indoor environment and to provide the requirements of different special areas (swimming pool, theatre, museum, etc.)
- Mixed structure of users (regular users and visitors).

Based on the previous reasons the basic components of an extended energy audit will be presented below. While the details of energy audits vary between different building types, the basic elements stay the same for all energy audits:

1. Initial contact and a preliminary meeting.
2. Data collection - analysis of the energy situation and energy management.
3. Fieldwork.
4. Analysis of gathered information and selection of potential energy efficiency measures.
5. Report.
6. Final meeting and presentation of energy audit report.

Performance of energy audit is a step-by-step procedure in which the whole building, users and owners are involved. The procedure is presented in Figure 5.

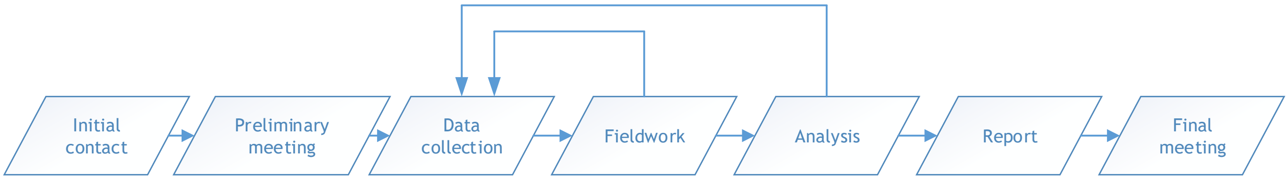


Figure 5: Energy audit step.by-step procedure

All steps are very important for a comprehensive overview and can be visualized as puzzle to form a complete picture. The aim of this chapter not to describe all steps but to give an overview of what are the most important parts from the aspect of institutional buildings.

On the initial contact and preliminary meeting, the expectations, goals, limitations and the time frame should be defined. This way, it is ensured that everything will be done according to the set expectations. Figure 6 presents different energy audits levels of thoroughness.

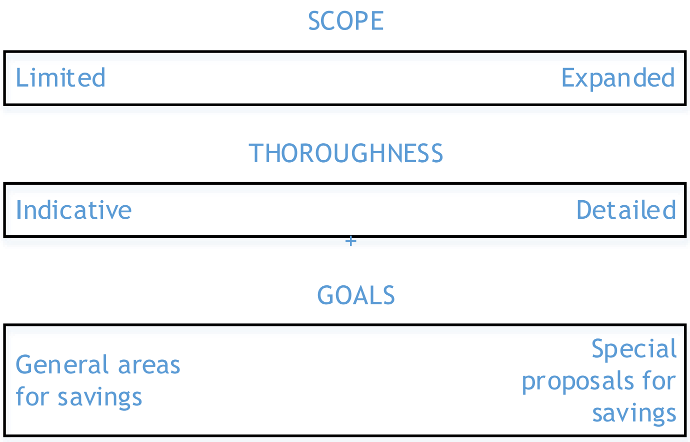


Figure 6: Different levels of energy audits thoroughness

Data collection, fieldwork and analysis are the core and most important steps for an auditor to define energy consumption and energy efficiency measures, thus the establishment of a good communication with the auditor and providing access to all information and data required are important.

On the final meeting, all results are presented by the auditor. Therefore, this is basically the key point of energy audits, since the auditor has to do a detailed presentation, in which the focus is on the performed analysis and the potential energy efficiency measures. These two areas are further presented in following sections.

4.3.4. Data analysis and potential energy efficient measures

Data analysis is to determine the current state of energy efficiency of the building and on this basis to determine the possible energy measures for improving energy efficiency. It is important to know that current/existing state becomes a benchmark in measuring improvements after successful implementation of measures.

Analysis of the energy situation must include:

- Calculation and breakdown of energy consumption depending on the purpose and source
- Energy flows and energy balance
- Ratio between the energy consumption and adjustment factors
- Energy efficiency indicators
- Set of measures intended to increase energy efficiency and their feasibility
- The financial savings and the necessary investment on the basis of measures

Determination of energy flows is important for understanding the functioning of processes within the organization and for identification of possible measures. An example of energy flows is shown on Figure 7.

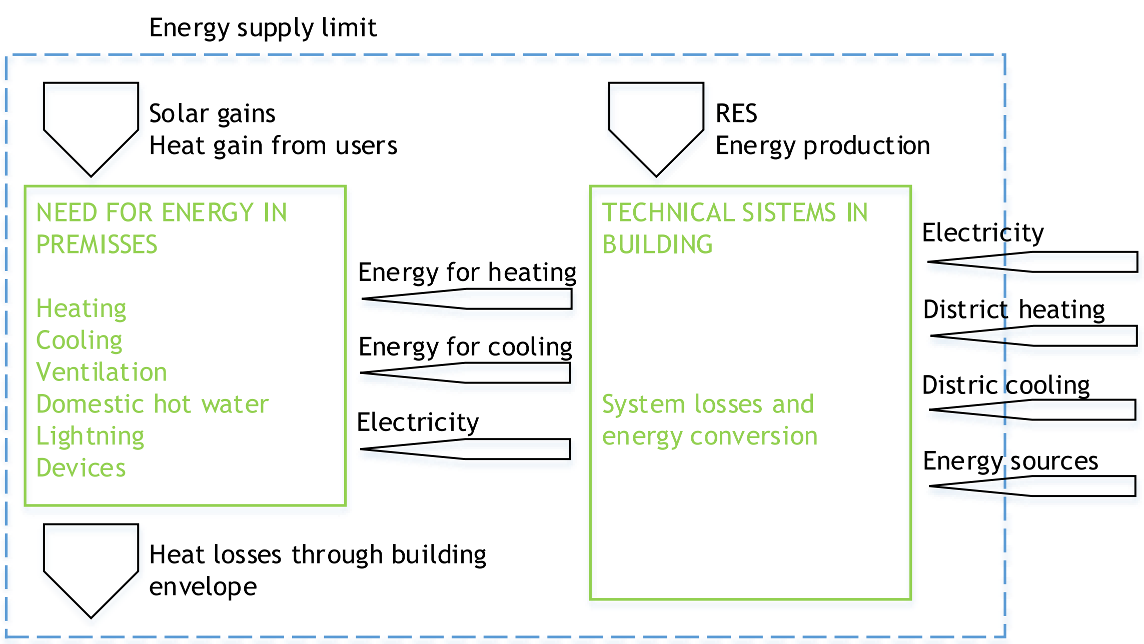


Figure 7: Determination of energy flows in the building

Through the understanding of energy flows in the building, a priority order can be set for the different energy efficiency measures. A range of measures are broadly divided into organizational and investment ones. All measures have to be considered from feasibility and financial point of view. Organizational measures are not normally do requiring financial input, or the required amount is insignificant compared to the possible energy reduction and savings. Therefore, these measures are feasible in the short term and allow small and medium-sized savings. On the other hand, investment measures which involve financial input have to be evaluated by the auditor with regards to the payback period and the possibility of implementation. The most common organizational and investment measures in case of institutional buildings are shown in Table 2.

Table 2: The most common organizational and investment measures

Organizational measures	Investment measures
Awareness programs and education in the field of EE for managers and permanent, cleaning and technical staff, workshops to transfer of knowledge on information panels, signs, and posters placed for visitors.	Measures on the building envelope (replacing of windows, installation of blinds, installation of additional insulation etc.)

Introduction of proper natural ventilation, avoiding unchecked airflows (checking regularly and closing windows and external doors; keeping windows shut in case of mechanical ventilation	Measures on the heating system (installation of regulation, boiler replacement, replacement of energy source etc.))
Introduction of proper lighting and appliance use (turning off lights in case of sufficient daylight, non-use of facilities etc.; switching off technological equipment when not used; avoiding hidden consumption; useing shading devices in a proper way)	Measures in the field of cooling and air-conditioning (installation of HVAC system, ventilation system or cooling system on local or central level)
Introduction of energy bookkeeping, or even energy management system	Changing to energy efficient appliances (replacement old lighting with LED technology)

4.3.5. Report on energy audit

The final report is crucial because the energy auditor presents the results of an energy audit. The purpose of the report is to present qualitative organizational measures and ideas for investments in energy efficiency measures, which are competitive to other investment opportunities in the organization. The report should be brief, concise, clear and also convincing.

In most cases this kind of presentations are not sufficient, so the potential of energy audit is not exploited. There are at least two main reason for this:

- Presentation is not adopted to the audience, therefore the presented results are not understood. Results must be presented in an understandable way to achieve maximal output.
- Audience is not carefully chosen from the side of managers. This prevents transmission on people, which could have the most impact on implementation and also on dissemination of accepted energy efficient measures. The relevant staff are the cleaning and maintenance.

4.4. Energy monitoring

Several external factors are affecting the energy consumption of buildings, such as changing weather conditions, temperature fluctuations, the size and insulation characteristics of buildings, energy consumers, energy prices etc. Although, a major influence on energy consumption can be made by raising the awareness of energy efficient behaviour, renewable energy and ecology. However, significant progress in this area is definitely the introduction of regular monitoring of the consumption and energy costs in buildings. Energy monitoring is an information system for energy management that can be presented on three different levels, which are collected below and visualized on Figure 8.

1. level: Energy accounting
2. level: Digital monitoring system
3. level: Supervisory Control And Data Acquisition (SCADA)

Different information systems are not mutually exclusive, but complementary and reinforcing. For example if the Digital monitoring system can monitor real time energy consumption, that does not mean that it allows access to financial data from invoices like the Energy bookkeeping system does. The functionality of each system is shown in Table 3.

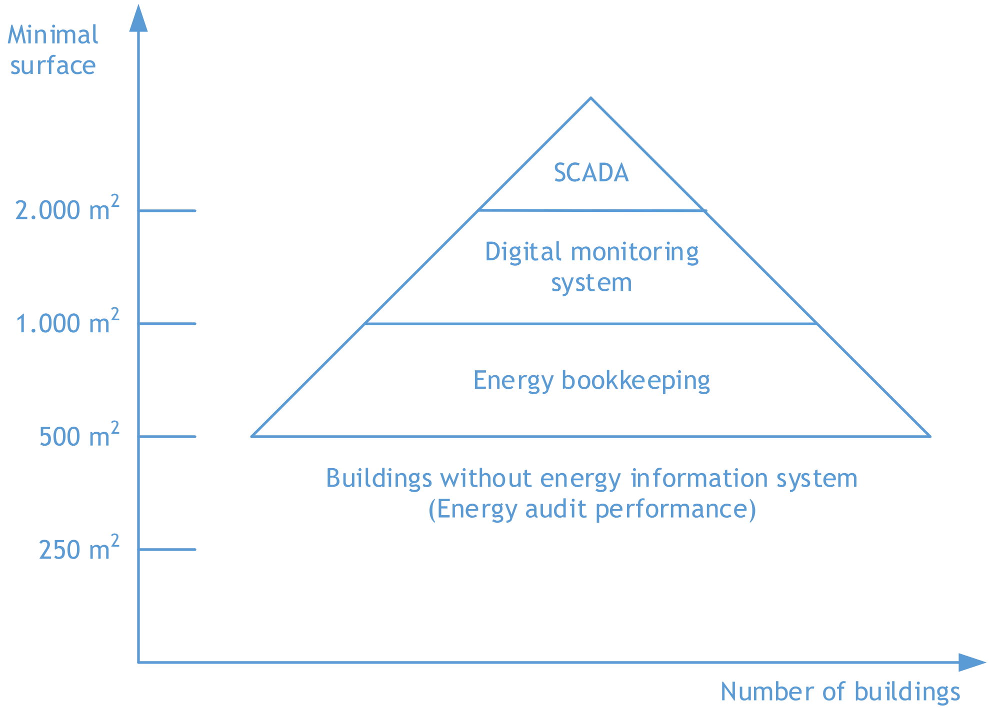


Figure 8: Levels of information systems for EnMS

Table 3: Functionality of different EnMS systems

	EA	DS	SCADA
Investment costs in EUR	Few hundred	Few thousand	Few thousand
Monitoring data from bills	YES	NO	NO
Refresh interval of displayed data	/	15 min	15 min or less
Comparison charts for past years	Depends	YES	Depends
Manual entering monthly data	YES	NO	NO
Regulation of system	NO	NO	YES

Box 4.3 - Energy monitoring savings

Practice shows that the introduction and proactive use of information system for energy management contributes to additional savings. It is estimated that **each level can contribute up to 5% of savings, in case of implementing all three levels, we can achieve savings up to 15%. Additional 5% can be achieved with proper involvement of building users (behavioural DSM)!**

Energy monitoring is directly connected with a phrase Demand Side Management (DSM), to be more specific with analytical DSM, which finds opportunities for savings through equipment monitoring and data analytics. The new availability of energy usage data and software platforms with data analytics have provided the basis for behavioural and analytical DSM. This trend has been driven by both the growth of the smart grid and the deployment of smart meters.

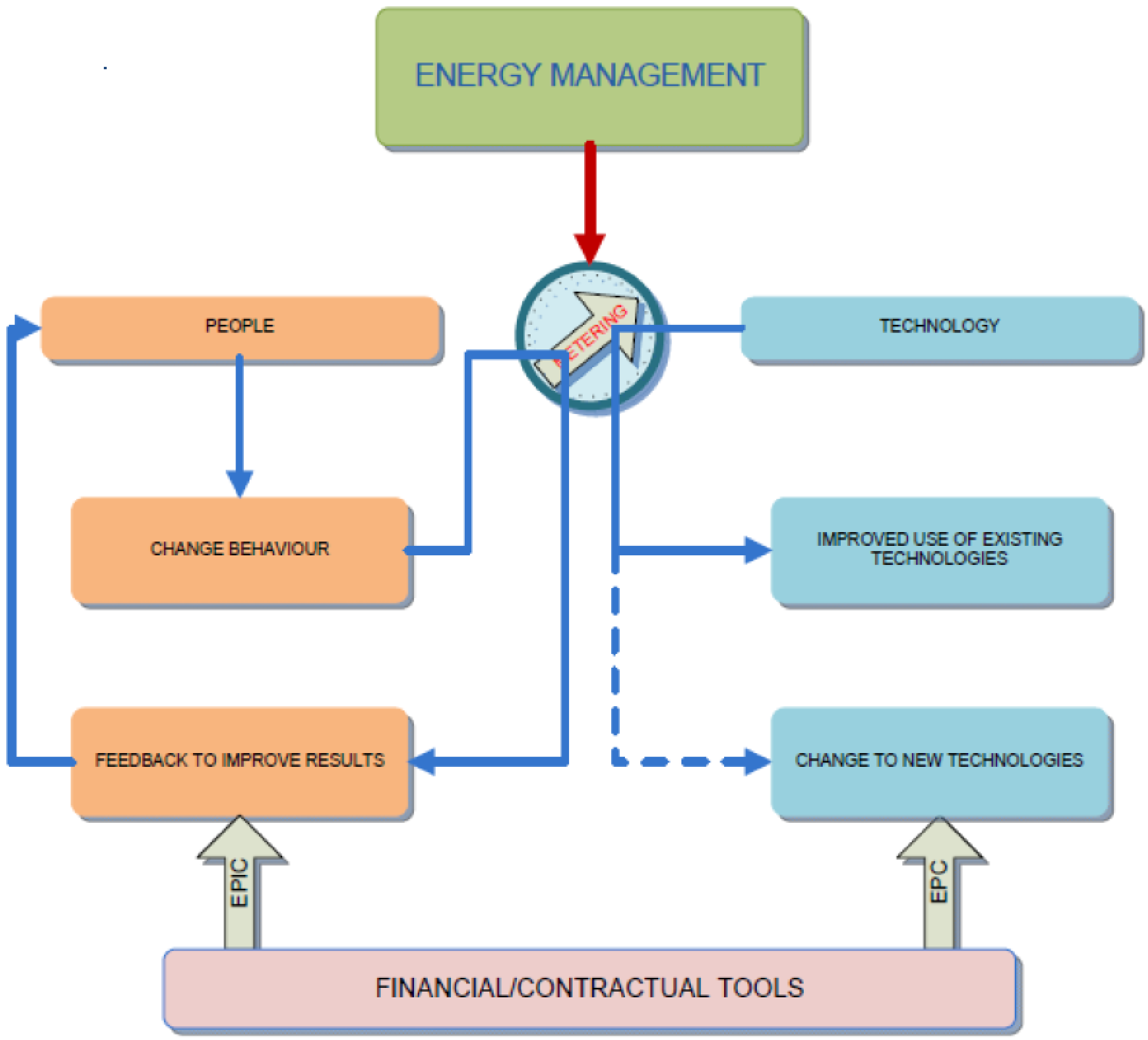


Figure 9: EnMS presented as analytical and behavioural DSM supported by financial tools

The scheme represents an EnMS based on smart metering and, as a consequence, on Demand Side Management. The left part represents the behavioural DSM: Users change behaviour, and check the effectiveness of the change through smart metering system, which provides a feedback that enables a further behavioural improvement, opening a virtuous loop. The right part represents the analytical DSM: the use of existing technology is improved with the feedback continuously provided by an effective smart metering system. The process can also lead to detect the need for technological improvements, or new technologies (dotted line). The lower part represents the possibility of triggering both improvement mechanisms with the aid of financial/contractual tools. The right part represents the EPC (Energy Performance Contract), which can be integrated with behavioural DSM measures (EPIC - Energy Performance Integrated Contract).

4.4.1. Energy bookkeeping

The introduction of energy bookkeeping is one of the most important measures and at the same time one of the simplest solutions for implementing an EnMS. It represents a basic instrument that allows us a better view in energy usage and their costs. This approach includes monitoring and analysis of the energy consumption based on gathering bills on monthly basis, so this way the energy consumption in the building is controlled.

This approach assures a regular monthly record of energy consumption, the calculation of basic indicators (electricity consumption, consumption of energy in dependency of the average outdoor temperature, water consumption, etc.) and comparison of the consumption data with data from previous periods. Based on the differences the causes of higher consumption can be revealed and with appropriate measures the excessive use can be reduced. In this way, the mistakes and the excessive use of energy can be eliminated, but this instrument, due to the monthly periods of data collection, is not appropriate to reveal important hidden consumptions, such as the stand-by consumptions of appliances. In order to make energy bookkeeping a well-organized spreadsheet is required, where the energy consumption data can be collected and visualised on monthly and yearly basis for comparison with previous periods.

Main advantage of this kind of EnMS is its simplicity, recording and monitoring of monthly consumption, but this can be also a big disadvantage for the data analysis. All data are presented on a monthly basis, so there is no insight to weekly, daily or even hourly consumptions. In case energy consumption differs from expected values, this can present difficulties to determinate real reasons and in that case, we depend on our experience.

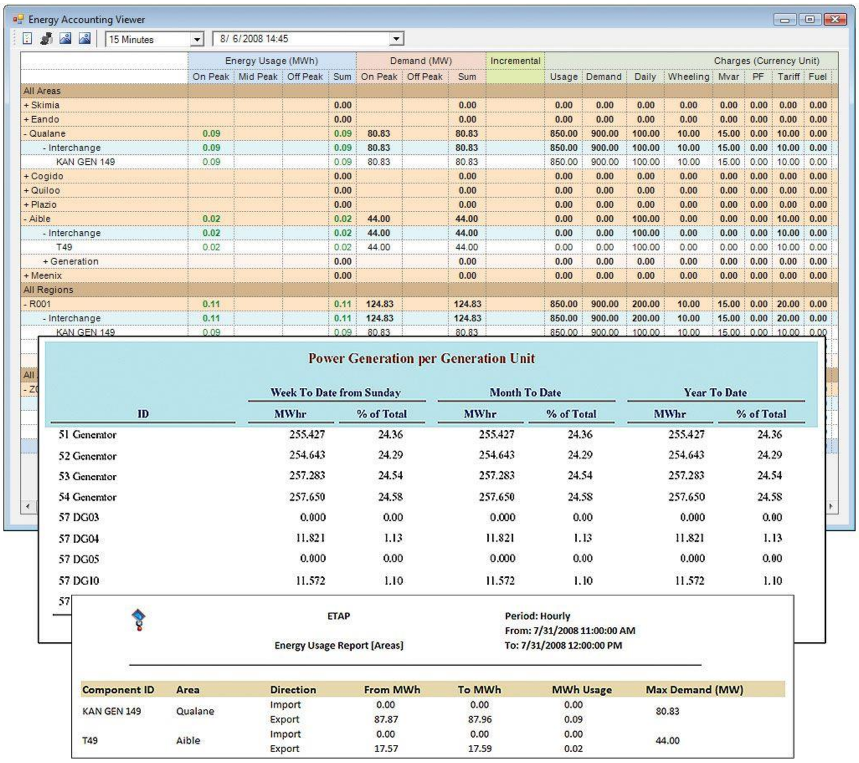


Figure 10: An example of software for energy bookkeeping

Box 4.4 - Shortcuts to energy bookkeeping system

The most favourable solution of energy bookkeeping is to implement it with internal personnel. For this purpose MS Excel or other free of charge or payable programs can be used. In most cases such programs are not free, but their biggest advantage is that everything is prepared for data entry. Some of them are even aligned with ISO 50001 Energy Management System.

Top list of recommended programs from Capterra:

1. Wattics / http://wattics.com/Events2HVAC
2. eSight / http://www.esightenergy.com/
3. digitalenergy professional / http://www.digitalenergy.org.uk/
4. Entronix EMP / https://entronix.io/
5. ePortal / http://eportal.eu/
6. EnergyDeck / https://www.energydeck.com/
7. Energy Elephant / https://energyelephant.com/
8. Utilibill / http://www.utilibill.com.au/
9. AVReporter / http://www.konsys-international.com/home

4.4.2. Digital Monitoring System (DS)

Digital monitoring system is a solution where data on energy consumption and thermal comfort are monitored in the building and recorded in an online database. This is made by using several digital sensors and meters. The system includes at least the installation of external and internal temperature sensors, electrical and thermal energy consumption through electricity and heat meters installed in the necessary places. The 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 for the user. This enables the energy manager to take action in any case of anomaly, such as unnaturally high consumption. Also it is possible to enter on energy consumption data based on bills. Digital monitoring system is combined system, which is able to present and compare digitally acquired data with manually inserted ones (from bills).

Main parts of Digital monitoring system are:

- Functional part.
- Graphical user interface.
- Info point.

The functional part consists of all mechanical and electrical elements that allows energy consumption monitoring and analysis. This includes all sensors, meters and databases which were explained above. In other words, this is the heart of the system, which is responsible for data acquisition, data processing and displaying them on graphical user interface.

The graphical interface is the most important part from users' aspect. It is connected directly to the functional part and enables monitoring of energy consumption remotely at any time. Normally it presents all indicators of energy consumption in graphical (charts) and tabular view. Normally it allows displaying the data listed below. An example for DMS user interface is presented in Figure 11.

- Basic information about the monitored building (address, picture, construction characteristics etc.).
- Weather and temperature information.
- Current, daily, weekly, monthly and yearly energy consumption.
- Comparison in energy consumption with set baseline.

Figure 11: an example of DMS user interface which presents information data, data on monthly, weekly, daily, hourly and instantly energy consumption[10]

[10] SmartBuilt project

Another example for the graphical display is the energy info point. The energy info point is a desirable component of such a system, since it allows a direct connection with the users of the building. It is just a normal monitor, which displays information about annual, monthly, daily and current consumption of all energy consumption and energy savings. It can be a powerful tool to impact users' behaviour. Normally it is placed in a building where most of the people can see it, thus this way the maximum impact can be achieved. An example of energy info point is presented on Figure 12.

Figure 12: An example of energy info point's graphical interface

4.4.3. SCADA

SCADA is a control system architecture that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management. It also uses other peripheral devices such as programmable logic controllers and discrete PID controllers to operate the different systems. The operator interfaces, which enable monitoring, and the issuing of process commands, such as controller set point changes, are handled through the SCADA supervisory computer system.

Key advantages of using a SCADA system are:

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

An example of SCADA structure is shown in Figure 13. This is the so called advanced system, which is divided into 4 parts: 1 - IoT Endpoints, where control and acquisition of data is made, 2 - Aggregated Device Management, where data is filtered, 3 - IoT platform including the analytical data processing, 4 - User interfaces (web platforms, mobile etc.). On Figure 14 an exemplary SCADA user interface is shown.

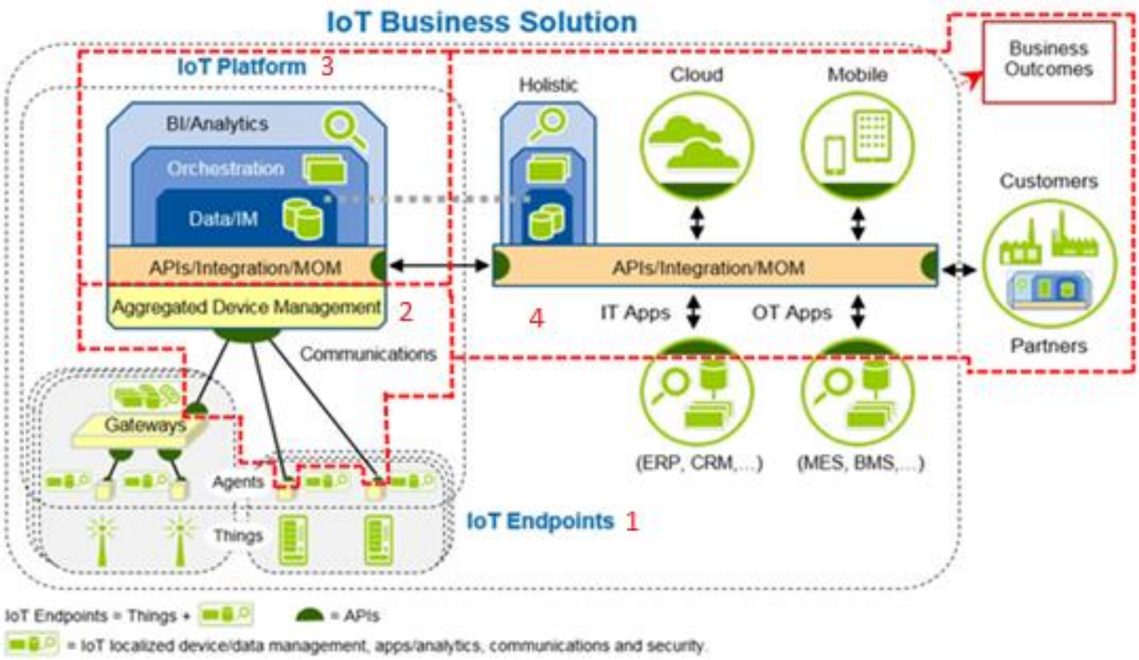


Figure 13: An example of an advanced SCADA structure

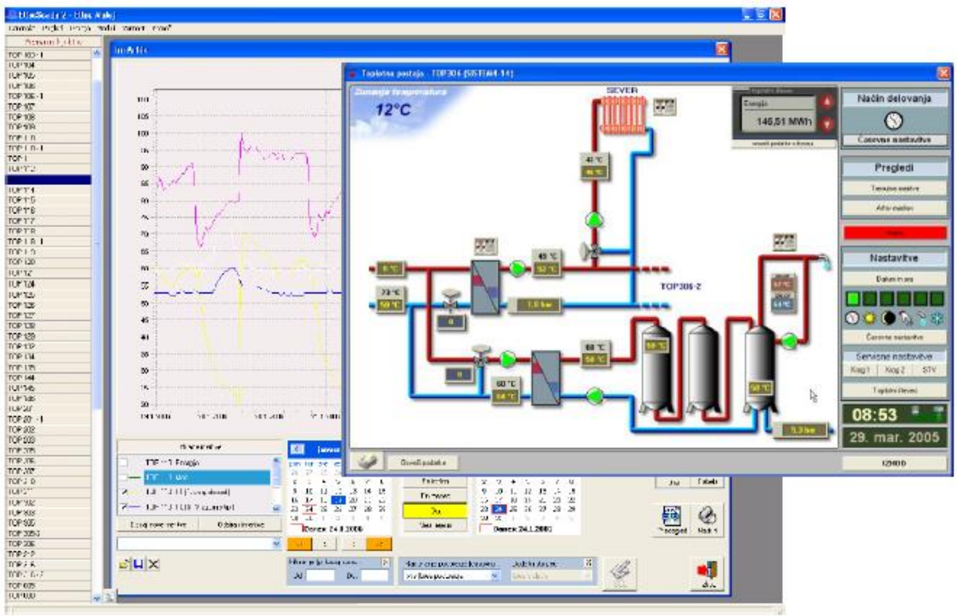


Figure 14: SCADA user interface for desktop monitoring and controlling (www.Petrol.si)

The main difference between Digital Monitoring System and SCADA is the ability of system controlling. The SCADA system is allowing to set daily operation of the facility and synchronize the operation of various system components, noting anomalies and deviations and allows immediate action, thereby optimizing the operating costs of the facility. Such solution can contribute up to additional 5% energy savings. There are two main disadvantages of such a system:

- High investment costs, which is reflecting on payback period.
- Management is limited to the certain number of buildings, because of its complexity (see Figure 8).

4.5. Energy report

Energy report is a document, which refers to the energy consumption, its goals and efficiency to evaluate energy efficiency measures which were implemented through a specific period. Normally the report is generated on a yearly basis, so the presentation of similarities and differences is easy. It is usually produced by the energy manager, or in some cases by external services. The main points of an energy report shall be:

- Information about the building and the EnMS.
- Energy baseline and measurements taken in the period.
- Energy consumption analysis.
- Conclusion.
- Annexes.

Firstly information about the examined building has to be presented, which includes: basic information on location, manager etc.; EnMS with its energy policy, energy action plan and implemented measures on energy efficiency. This gives an overview of the energy efficiency of the building.

Baseline serves as an initial point. Usually it is an average energy consumption of the past three years. In the measurements part the monitored and documented data are presented. This contains information about heating and electricity energy consumption, measurements of indoor comfort (e.g. temperature) etc. for better visualization all data should be presented in charts.

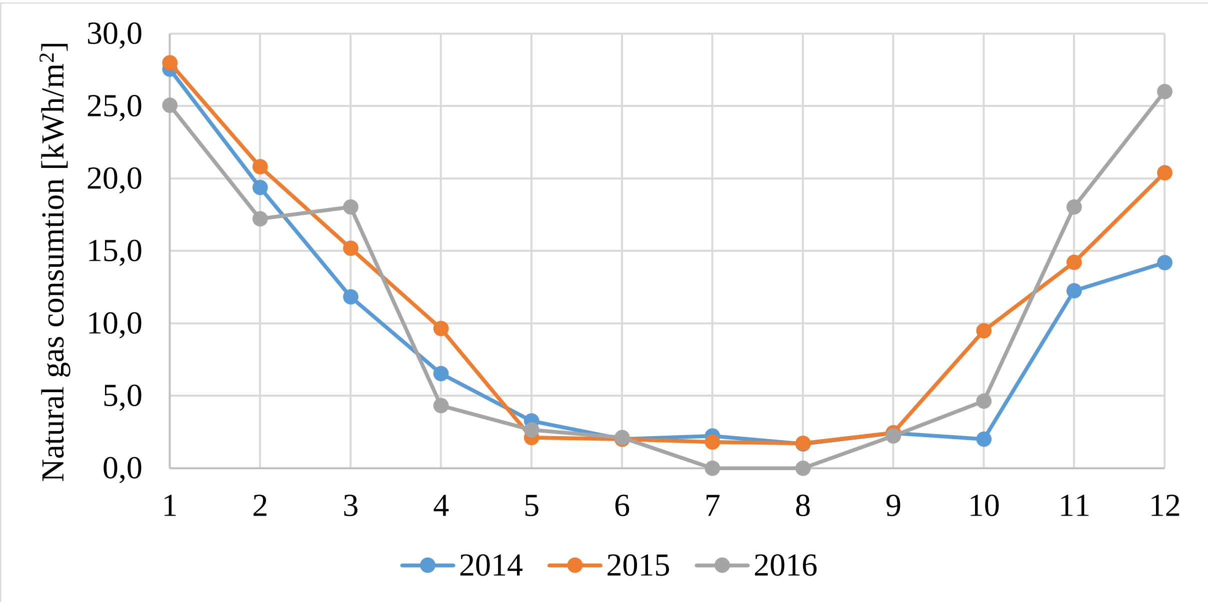


Figure 15: Natural gas consumption in years 2014, 2015 and 2016 for a municipality building

In the analysis part, all monitored data for the examined year are compared to the baseline. The comparison should include detailed analysis of the data, not just visual presentation. For proper analysis the reasons of deviations should be found and all has to be properly justified according to implemented energy efficient measures and goals.

The conclusion part provides an overview in energy consumption measurements and analysis, so it has to present the state of art and also has to point out, if the implemented EnMS is sufficient, where are the main weaknesses and also strengths. At the end, clear guidelines on energy efficiency should be presented.

5. Implementation of EnMS and measures

5.1. Introduction

The technical framework has been explained in the previous chapter. The link between monitoring consumption data and behavioural change of end users should be emphasized either for energy accounting, digital monitoring system or SCADA system. For comprehensive data analyses energy managers should achieve adequate education about energy efficiency measures which should be undertaken for reducing energy consumption.

5.2. Data analysis

The first step of data analysis is correct data comprehension. Energy managers must achieve adequate education about basic energy knowledge, daily and monthly energy consumption trends, costs, and tariffs. There are three types of data in energy consumption:

1. Historical data (monthly consumption data) or energy bookkeeping data;
2. Data from energy audit (building envelope, existing equipment and time of usage);
3. Higher resolution data (real-time or near real-time) from DMS and SCADA.

Higher resolution data allows the identification of consumption paths and dynamics that would not otherwise be observed, if only historical data or bookkeeping data were available. High resolution data are also key for performing automated control schemes (if available) or manual control, whenever and wherever an action is required in real-time. Benchmarking with other facilities from the same sector is also very important for quality data analysis, because comparison with others can be a strong stimulus for actions.

EnMS in existing building are addressing the needs of energy and building managers, but do not address the objectives of the behavioural change of users. They are monitoring tools rather than analytics engines with self-learning capabilities. They are not capable of more complex optimization or self-learning.

Box 5.1.- Education for good data apprehension

Being educated about energy consumption in order to manage it efficiently means having the answer to the following questions:

1. Where energy is consumed (cultural centres, sport centres, etc.)?
2. How do we consume energy (cooling, heating, ventilation, lighting, cooking, etc.)?
3. Which forms of energy we use (electrical energy, gas, fuel oil, wood, district heating and water)?
4. How much energy we use (kWh of electrical and thermal energy, litres of fuel oil, m^3 gas, and other energy sources including its costs)?
5. Who is in charge of monitoring energy consumption (energy manager, custodian, etc.)?
6. How to manage energy consumption (monitoring with data acquisition, DMS or SCADA, analyse consumption, planning and realisation of EE measures, continuous education of all building users)?

A common problem in EnMS 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. To overcome the problem, it is useful to either transform it into a unique resolution unit (main issue is to transform lower resolution data into higher resolution data) or guarantee that every module that works with the data has the ability to convert it and interpret it. Several implementation options exist for data analytics modules. In selecting the most suitable option, licensing costs and capabilities of developers should also be considered.

The visualisation layer interacts with the end user (energy manager) and should provide monitoring capabilities, but also additional added-value features, which support the decision-making process such as tariff optimization modules, sub-metering, abnormal consumption alarms (e-mail), benchmarking and report generation.

Data analytics models and monitoring systems 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. Demand Side Management (balancing demand, supply and storage for RES, controlling shift able loads, guarantee that not useful consumption is turned OFF during non-operational hours, optimization of HVAC, time of use tariffs (ToU), weather forecast and daylight harvesting).
6. Foster user engagement to trigger behavioural change (share of energy information like benchmarking with users of the same activity sector to create competition or co-opetition).
7. Load desegregation models.
8. Identification of specific EE measures.

5.3. Corrective measures – determining measures to be suggested with the purpose of reducing consumption on a specific object

A good example for achieving EE measures 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 16.

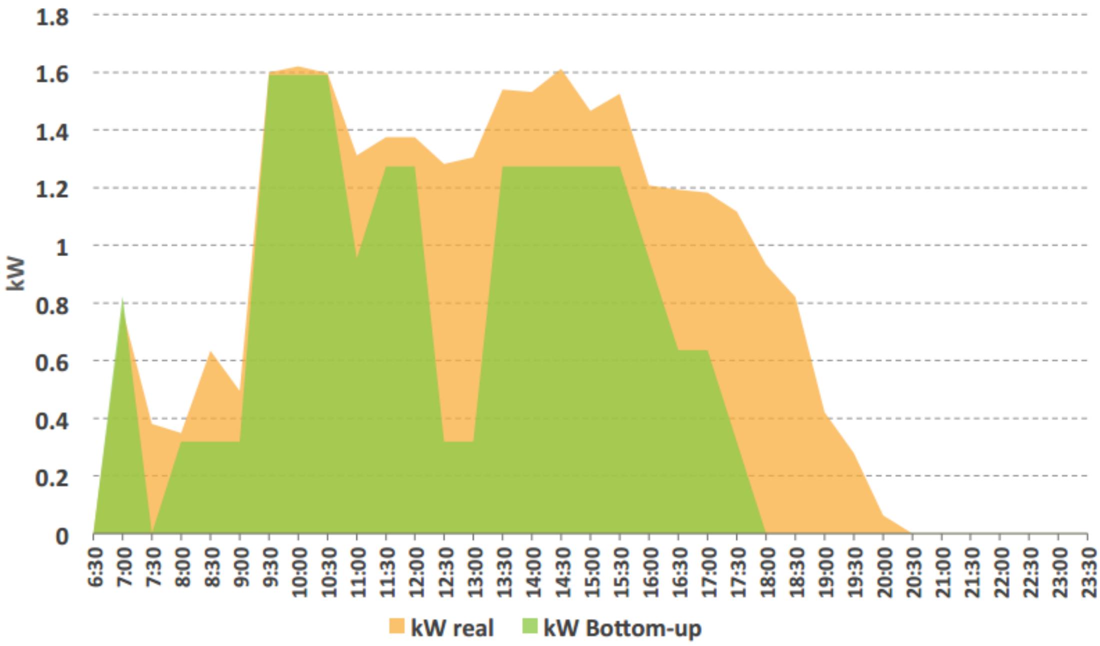


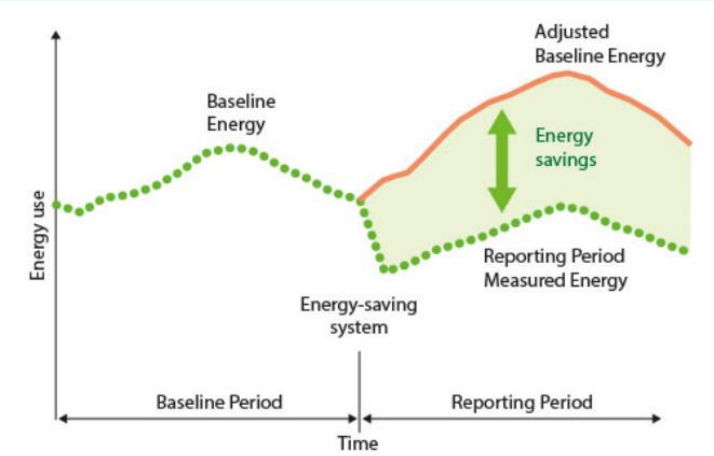
Figure 16: Lighting appliances load example in class amphitheatre

In the example from Figure 16 the cleaning process starts at 6:30 and finishes at 7:30 but lights are left on, even though there is no need for it before 9:00. During lunchtime, lights are also left ON in empty spaces. In most of the days, the consumption should drop by 17:30, however the consumption decreases significantly only between 18:30 and 19:00.

Only by acquiring knowledge about the effective energy consumption and expected energy consumption through a bottom-up approach deviations can be found and corrective plans can be derived. 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 being achieved by the identification of abnormal consumption patterns.

Box 5.2- We can only correct what we can measure

Several norms (such as IPMVP-International Performance and Verification Protocol) determine quantification of savings measures by comparing consumption evolution by control groups and baseline consumption.



5.4. Selecting measures for the improvement of energy efficiency on the object – deciding on measures that can be implemented on an object

Efficient energy management is a set of measures directly linked with technology and user's behaviour. It is necessary to act on every inefficient systems. However, it is even more important to educate all the building users to reduce energy consumption.

Education of building users is crucial to achieve a comprehensive approach. Humans with their actions directly and indirectly decide whether to behave according to the energy efficient measures and thus stimulate sustainable development or not. The purpose of the education is aware building users about the importance and severity of their actions and to change all bad energy consumption behaviours connected with irrationally and inefficient use of equipment, devices, elements and building premises.

The implementation of educational activities for energy efficient measures is decisive for achieving savings and it applies on the utilization of installed equipment and mode of usage. Education can be carried out in form of workshops, seminars, and lectures etc. It is extremely important to continuously maintain awareness about the need to adhere to the measures for achieving energy efficiency and continuously monitor and educate building users about energy efficient measures to be taken.

There is a set of simple measures that can be achieved without complex EnMS such as DMS or SCADA 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 check regularly and don't open windows in case of mechanical ventilation.

2. Use of windows and shadings in relation to heat and light gains: besides increasing comfort, rising, and lowering shutters depending on the season can lead to considerable energy savings; by lowering shutters, temperature in the room can decrease by 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 temperatures 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 devices, thermostatic valves enable temperature control inside the premise according to use, people. The work of the boiler room is mainly automatized with regular supervision of a qualified person. For solar collectors the instructions should be followed. For air conditioning control it is important that the difference between inner and outer temperature is not higher than 6°C.

4. Electric appliances and lights should be switched off when they are not needed. It is best to install sensors for lighting in appropriate areas. The taps should also be closed properly after use.

These measures should be the first to consider for implementation. Measures that require higher investment costs will be analysed and recommended in detailed energy audit reports. Deciding on implementation of these measures highly depend on their cost-effectiveness and even more on the availability of up-front capital in the public institution needed to undertake the investment. Possibilities for financing of capital-intensive EE measures are presented in detail in the Deliverable D.T2.2.4 - Set of financial instruments integrated with Demand Side Management.

Box 5.4- Saving energy by using lighting dimmers

Light dimmers save energy by reducing the flow of electricity to the bulb and allowing lights to operate with lower power outputs. Since lights under less stress shine longer, dimmers are known to extend the life span of the bulbs as well. Most modern dimmers work the same way, but each dimmable light source offers different advantages.

- Halogen bulbs use about 20% percent less energy when dimmed. However, the more these incandescent lights are dimmed, the less efficient they will be.
- Compact fluorescent lamps (CFLs) consume much less energy than halogen bulbs and retain their reputation for efficiency when used with dimmers. However, before investing in a dimmer switch, it is critical to ensure that the installed CFL bulbs are compatible. Using non-dimmable CFLs with a light dimmer can be a serious fire hazard.
- LEDs are already energy efficient, so investing in a dimmer can maximize the energy savings. Dimmed LEDs produce much less heat than incandescent lights and will retain their colour regardless of how low their light output is. As with CFLs, it is important to use LED lights, which are specially designed to work with dimmers.

5.5. Implementation of remote reading for consumption

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

Remote systems allow continuous monitoring of consumption patterns for one or multiple buildings. By comparing single indicators a possibility for prompt reaction is available in case of a sudden high consumption. By monitoring energy consumption patterns significant savings could be achieved through identifying unnecessary consumers, for example the stand-by consumption of appliances. Figure 17 shows an example of remote reading and implemented measures for reducing unnecessary consumption.

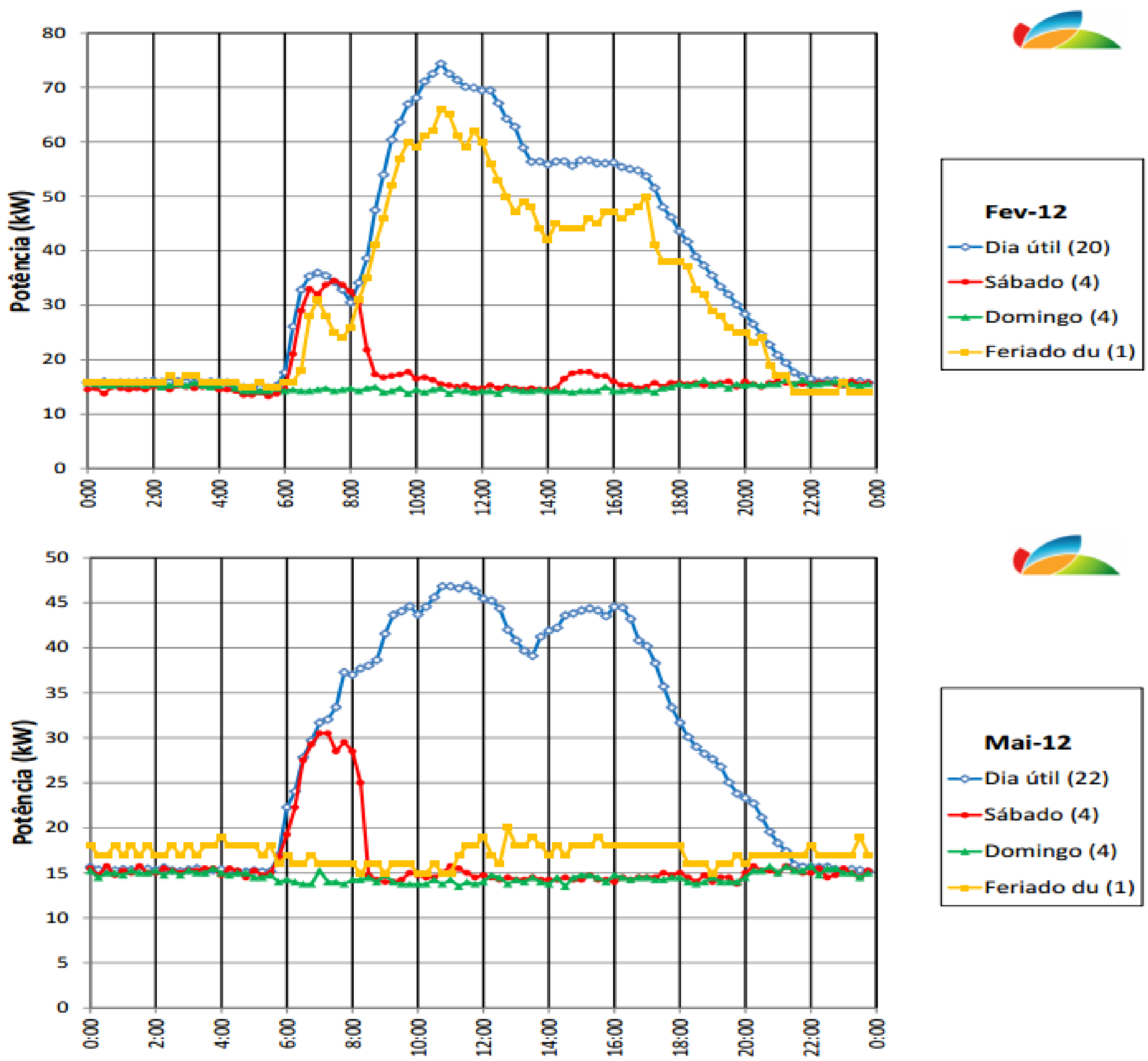


Figure 17: Energy consumption paths changes through behaviour change in energy consumption

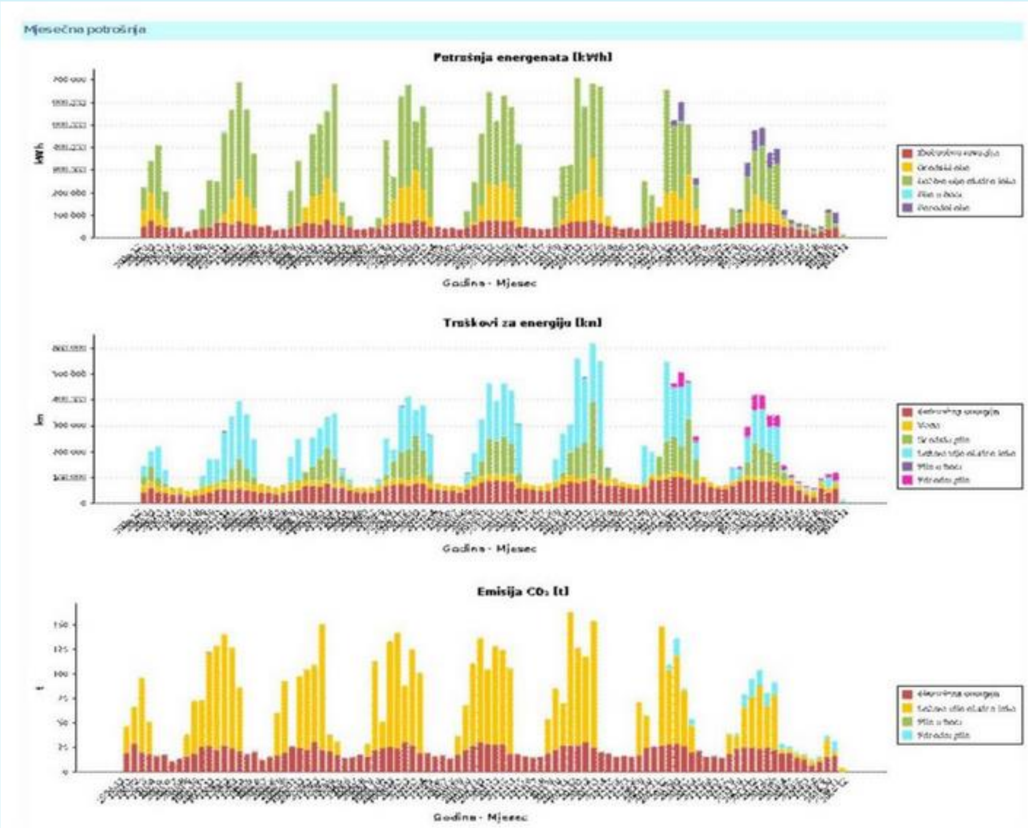
As shown in Figure 17, after the introduction of a monitoring system the peak load has decreased by 36% from February 2012 untill May 2012, without any additional measure, which is suggestive.

Box 5.5- Example of EnMS in Public Buildings in Croatia (ISGE)

In accordance with the Energy Efficient Act (Official Gazette 127/14) and the Order Energy Management in the Public Sector the use of the EnMS (in Croatian: ISGE) as a systematic energy management tool is compulsory for public sector entities (such as administrative buildings, schools, kindergartens etc.).

- ISGE is a computer program, which can be accessed from the internet 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 ISGE 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 analysis 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.

Monthly consumption paths are shown at the graphical interface from a web application with access with login and password.



5.6. Implementing the selected measures – continuous implementation of measures

Continuous implementation of selected measures should be achieved. Monitoring, repeated analysis and corrections are crucial. As stated in the chapter 5.4, measures to undertake can be simple, but with continuous monitoring of consumption there should be continuous improvement of the primarily selected measures.

At the first stage energy bookkeeping can be satisfying and simple measures can lead to savings. However, with the increasing tendency for achieving better and better EE goals, more complex EnMS should be installed despite the required expenditures, for remote automated regulation and control of lighting and HVAC systems. E.g., through the use of algorithms with self-improvement, in case of lighting 12% savings could be achieved.

5.7. Monitoring, repeated analysis and corrections

Energy management for institutional buildings provides a quick "win" for cities and builds long-term capacity to develop EE projects, monitor and control energy consumption as well as to fulfil the obligation of 1.5% energy savings each year set in the EED.

In EnMS it is important to continuously implement measures to achieve energy savings, as stated in the Standard energy management system ISO 50001. All crucial issues related to the energy performance (e.g. energy consumption, outputs from energy review, indicators, effectiveness of energy action plan) shall be measured, monitored, and analysed in defined periods. The simplest way to monitor the implementation of measures for energy consumption reduction is regular monitoring of the building's energy performance.

Benchmarking of a building's energy performance is a comparison how efficiently a building uses energy compared to a baseline energy management. Benchmarking is useful for state and local government property owners and facility operators, managers, and designers. It facilitates energy accounting, comparing a facility's energy use to similar facilities to assess opportunities for improvement, and quantifying and verifying energy savings.

For the benchmarking the following processes need to be defined and documented:

- Methodology for comparing a building energy performance needs to be clearly defined and simple to use.
- A date should be chosen as a deadline for the first submittal of benchmarking data and schedule defined for future submissions.
- The reporting system on how and where reports should be submitted should be clear.
- Different points can trigger disclosure of building performance information.
- Enforcement of the policies is essential to ensure participation of stakeholders (penalties etc.).
- Stakeholders should be educated regularly on energy efficient measures to undertake.

Achieving energy savings through correct measures requires strong leadership of top-management to orchestrate the necessary efforts to overcome the knowledge, institutional and financial challenges.

Box 5.6– The exemplary role of Public Building in EPBD

Conforming to the Energy Performance for Building Directive (2010/31/EU) buildings occupied by public authorities and buildings frequently visited by the public should set an example by showing that environmental and energy considerations are being considered and therefore those buildings should be subject to energy certification on a regular basis. Exchange of experience between cities, towns and other public bodies should be encouraged with respect to the more innovative experiences.

Articles 6 and 7 of the EPBD state that the Member State have to take the necessary measures to ensure that new and existing buildings (undergoing major renovation) meet minimum energy performance requirements, taking into account the use of high-efficiency alternative systems (e.g. decentralised energy supply systems based on energy from renewable sources; cogeneration; district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources; heat pumps).

In line with Article 9 Member States shall ensure that by 31st December 2020, all new buildings are nearly zero-energy buildings (nZEB) after 31st December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings (nZEB).

6. User inclusion in Institutional buildings

6.1. Introduction

Building users may play important role in improving energy management in their buildings, when encouraged and motivated properly. By changing their everyday behaviours and practices, e.g. by making sure that all unnecessary lights are off or that rooms are aired properly, they can contribute to significant energy and financial savings. Combining this with organisational changes introduced by building managers (but sometimes also by the users themselves), like rearranging the rooms or modifying the work schedule, these savings can come up to even 15% or even 20% of the initial energy consumption. Something worth reaching for!

All this is especially relevant for institutional buildings, where there are many "permanent" users, focusing on their work. Their combined efforts can bring results that may be difficult to achieve in other types of buildings (with many single visitors). With permanent users, comprehensive and long term behaviour changing actions and tools are applicable (such as trainings, competitions, group discussions, group works). However there are still groups of visitors in these buildings which should not be left behind. Visitors might think they have the right to use as much energy and water as they wish. The message to the visitor should be well designed and transferred. Humour, emotional messages or unexpected ways of communication can be effective ways to achieve the goals.

However, although there are only a small number of possible actions there realisation is not as easy as it seems. Practice shows that although many institutional buildings are implementing various awareness raising activities and share energy-saving tips with visitors, these rarely result in real energy savings. The most difficult step is to convince and engage the people not only to see, but also to apply the message. Most common and efficient ones have been discussed in the next chapters, together with some examples of successful projects and initiatives mobilizing public communities to save energy.

6.2. Identification of users in Institutional buildings

Institutional buildings include different types of users: permanent staff on first place, but there are also some visitors, administrative, cleaning and maintenance staff and specific staff related to the building function. Large institutional buildings often employ building energy managers as well, often required by law. Some buildings are working 24 hours a day, but most according to limited time schedule. Weekdays, weekends and holidays might be different. All these people have to be addressed and involved in energy-saving efforts if the institutional building really wants to reduce its energy consumption and improve energy management practices. However visitors have the main influence on energy efficiency so their engagement is crucial.

Of course, each group has different sources of motivation and capacities to act, which should be taken into consideration when planning communication activities and activation methods. Natural leaders of the building’s energy transition will be the energy managers and administrative managers, supported by representative of the municipality (whenever possible). But also other groups may have significant influence on energy consumption, e.g. a lot of water and electricity is used during evening cleaning. Often the security staff prefers to keep the lights on in the whole building. So it is important to train them how they can save energy in their work and motivate them to do so.

Below there is more detailed description of different user groups and their role. They have been divided into: **primary users** (leaders of energy saving efforts), **secondary users** (contributors to energy saving efforts) and **supporters** (facilitators of energy saving efforts).

6.2.1. Primary users (leaders)

Permanent staff working in the building and specific staff related to the function of the building: they have a significant responsibility on energy use. They turn on and turn off lights, computers, open and close windows and doors, they are the main users of most oft parts of the buildings (offices, dress rooms, kitchens, lavatories , etc.). They as permanent users know the building (or parts of the building) and users' habits well and can help to discover how and where energy is used or wasted, where does it come from and how it can be saved with simple measures. They can work on energy issues themselves or within various environmental projects coordinated by local authorities, NGOs and other organisations. Staff should also give good example by following rules of efficient energy use themselves. Focusing on education of this group will have greatest impact.

Visitors: they are the group in the building which is not so significant since not many visitors come to institutional buildings. But there are still some. As explained above they are also the least motivated actors for the proper use of the building as they visit the building only occasionally. At first sight they have absolutely no financial interest in saving energy and operational costs in the building. However, it is not completely true: high energy costs might result in higher fees (or taxes), although this is usually not obvious. However, one way of engagement visitors can be transferring this message: if they help keeping energy costs low the entrance fees can be kept low as well. They might be motivated not only by cost, but also by environmental (help to save energy to decrease global warming), health (use stairs instead of elevators) or comfort arguments (do not open the window when air conditioning is on in order to keep temperature pleasant).

Energy manager: has very important role to play in reducing energy consumption, although this role is not always adequately appreciated. Since he (or she) knows everything about the building and its relevant systems, he can help other users involved in the process, e.g. permanent staff, to understand better its technical state and energy situation. He can also implement many energy saving measures, e.g. conducting necessary reparations (like fixing leaking taps and toilets), sealing windows, placing silver foil behind the radiators or rearranging the rooms to make better use of natural light.

When planning users' involvement activities it is important to ensure good communication and cooperation between permanent staff members the energy manager who can support other actors in their own energy saving efforts and resolve many doubts about what measures are feasible in the building and how they can be applied. Energy manager is responsible for monitoring and optimizing energy consumption in the building. Energy managers should be supported by adequate trainings and should take a key role in the DSM actions.

6.2.2. Secondary users (contributors)

Except for permanent staff, visitors and energy managers, e.g. primary users, who will be involved in energy saving efforts, there are also other groups influencing energy consumption in a institutional building, who need to be addressed in order to ensure reduction of this consumption. These are:

Cleaning and maintenance staff: this group includes technical staff and cleaning staff and gardeners. Especially the two latter - when performing their duties - use a lot of energy and water. Therefore, it is important to involve them in energy saving process. They should be adequately informed that the building is making efforts to optimise energy consumption, trained how to save energy in their particular line of work and helped in development of new, more resource-efficient practices and procedures.

External users: many institutional buildings are renting a part of their premises to external groups like restaurants, coffee shops, sports clubs, ticket selling offices, who use them in parallel to or in the frame of the main function. Also they should be encouraged and capacitated to improve their habits and support energy saving efforts. It is worth to organise a meeting with the representatives of these groups, explaining objectives and how they can contribute to them by using resources more efficiently.

6.2.3. Supporters (facilitators)

The last group are the supporters, i.e. people who should supervise, facilitate and coordinate energy saving efforts undertaken by other groups of users. They include:

Building management staff: Director's/CEO's role is to initiate, supervise and monitor energy optimisation processes in the building. Together with representatives of other relevant stakeholders, he (or she) should decide which methods and tools will be used to improve energy management (e.g. 50/50 methodology), assign roles and responsibilities, facilitate the process and monitor its results.

Municipal representative: it is recommended that also representative of a municipality is somehow involved in activities implemented in the building. He (or she) should supervise the process, provide useful guidelines and resources, ensure that the users actually have the possibility to improve their practices (e.g. by installing thermostatic valves on the radiators), help to resolve all doubts and problems and help to obtain funds for relevant activities (e.g. organisation of joint initiatives or competitions between different other buildings).

Experience shows that it is the easiest to engage primary permanent staff, who can participate in long-term complex DSM actions. It is more difficult with other users, who are not so much attached to the building, e.g. visitors, cleaning staff or external users. However, it is still possible to approach them and encourage to change at least some of the behaviours. Especially if they are treated as equal partners of the energy management process and regularly communicated with.

Regardless of the group, there are always different types of attitudes within. There are "**frontrunners**", who are always the first to engage and come up with their own ideas how to approach the topic. There are "**followers**", who follow the frontrunners, gladly engage in common activities and implement all tasks assigned, "**observers**", who watch the situation, learn from it but do not engage, and "**opposers**", who are always against and unwilling to change their behaviours. To develop a good users' involvement plan it is necessary to map these groups, identify frontrunners and followers, think how to engage them in practical action, as well as to think how to change "observers" into at least "doers". In the 50/50 approach "frontrunners" and most motivated "followers" are considered as a part of the energy team responsible for improving the building's energy situation and encouraging "observers" to contribute to energy saving efforts.

6.3. Organization of Energy manager and energy team in Institutional buildings

Efficient energy management requires an energy manager or an energy management team that would have adequate skills and capacities to analyse and improve building's energy situation. This is the case in all types of buildings, including schools. Permanent staff as the biggest group should be involved in energy management and optimisation processes mainly because they have significant potential to influence building's energy consumption. This should be taken into consideration when planning energy management structures in the buildings. Three basic options are possible, with the third one associated with the highest energy saving potential but also most difficult to implement:

- Appointing energy manager.
- Establishing energy team.
- Appointing energy manager, responsible for organisational measures, and energy team, responsible for change of behaviours, and ensuring their efficient collaboration.

Option 1: Appointing energy manager

In large institutional buildings often there is an energy manager already appointed. For certain buildings there are legislative requirements on employing an energy manager. If it is not the case usually there is a maintenance team which is responsible for maintaining and operating the building. This team has a good knowledge about the building, thus selecting from this team would be a natural and good choice, since he/she knows the building and its energy systems well, as well as has competences and tools to implement some of the possible improvements.

Regardless of who will be appointed as an energy manager, the person should be adequately trained to be able to manage energy efficiently. The training should cover all relevant technical, financial, behavioural and analytical aspects and should capacitate the manager to adapt and apply different energy optimisation measures in his/her particular building. The manager should have assigned specific competences, tasks and tools, with the tasks including:

- Establishment of the database for collecting and updating data necessary for energy management (consumption data, technical data, etc.).
- Monitoring and analysing energy consumption data (based on invoices, manual meter readings, smart meter readings).
- Planning and implementing energy optimisation measures.
- Reacting to any failures, sudden rises in consumption, etc. by identifying sources and implementing corrective measures.
- Engaging the building in different energy-related projects and initiatives (e.g. initiated by NGOs, local and regional authorities, etc.).
- Searching for funds for smaller energy-saving measures (larger investments are within the competence of local authorities who own the building(s)).
- Ensuring efficient communication on energy issues with all relevant stakeholders, including local authorities, public utilities, etc..
- Engaging building users in energy saving efforts.
- Constant learning and improving own skills and capacities in the area of energy management and saving.

Of course all these additional duties need to come together with additional benefits, like a salary supplement.

Having a trained energy manager it is worth to consider implementation of a structured energy management system, e.g. following ISO 50001. Such system establishes frameworks, procedures and discipline to implement technical and management solutions cutting energy consumption and related costs. Based on PDCA approach as the operating principle, the system ensures continuous improvement of the building's energy situation. The manager could be responsible for system's implementation and activation of building users (see chapter 4.2).

The latter is very important. When assigning manager's tasks it needs to be remembered that his (or her) role is not only to implement organisational measures optimising energy consumption but also to work closely with building users, raising their energy awareness and changing behaviours. Energy manager should be also the person that they can consult about different energy issues and ask for advice and feedback about the results of their efforts.

Option 2: Establishing energy team

Another option for users' involvement in energy saving efforts is establishment of an energy team that would gather representatives of different groups of users and would be responsible for analysing and improving building's energy situation. Such team should involve representatives of all groups of permanent users. Below are some recommendations to be considered when creating the team:

- Ideally the team should have a leader or supporter (e.g. the energy manager) who could show the others around the building, explain how it operates and help in implementation of energy saving measures;
- Number of team members will depend on the size of the building and organization of the team's work. The team should be big enough to ensure successful implementation of all tasks but not too big to enable regular meetings and efficient communication and collaboration.
- The team's task will be to analyse and discuss energy situation of the building (where, how and how much energy is used, how much does it cost?), come up with an energy saving plan (how energy consumption can be reduced? who should be involved?), implement all planned measures and organize widespread communication campaign addressed to the rest of the building community (particularly visitors) and aiming to engage them in energy saving efforts. In warmer months the team can also work on other environmental aspects as water saving or waste management.
- Before starting practical activities, members of the team should be trained to increase their knowledge about climate and energy issues. Relevant topics can be introduced both during team meetings, common building visits and brainstorming sessions..
- The team should meet at least twice a month to discuss and analyse results of up-to-date activities and plan next steps. Majority of work should be done during regular working hours, as this is when it is possible to follow and improve most of the consumption patterns. It needs to be noted, though, that also after public opening hours (cleaning staff, external groups renting premises, etc.) need to be somehow involved in energy saving efforts.
- Energy team's work can be organized in annual cycles (analysis-planning-implementation-monitoring) with energy and financial savings calculated and announced after each year.
- Energy consumption patterns change with the season, thus it is recommended to have meetings in summer, winter and spring / autumn.
- It is best if the team is composed of staff of different ages. Then, when the older staff members retire or leave, younger members of the team stay and share their knowledge and experience with the newcomers ensuring continuation of the process.

To keep the team motivated and eager to undertake further energy saving efforts, it is important to give them feedback about the results achieved so far. At least once a year energy and financial savings obtained should be calculated and communicated to the team members and other building users. If the building has a smart metering system, such feedbacks should be given more regularly or if possible displayed permanently.

It is also important to remember to reward the team members for their efforts and achieved results. These should be publicly recognized and awarded, e.g. annual ceremony. As a reward, the team members could be invited to the study visit or educational trip that could be both fun and further improve their thematic knowledge. The most active team members could get some additional incentives like employee bonus, extra career points or better parking spaces.

Option 3: Appointing energy manager and energy team

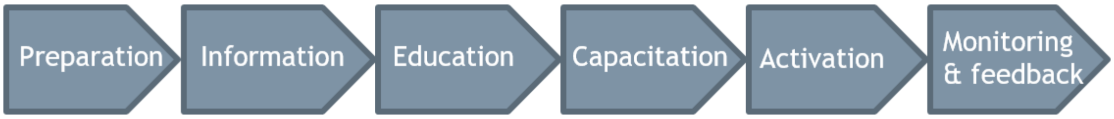
It is also possible to combine both approaches and appoint both an energy manager, who would be responsible for implementation of managerial and organizational measures, and an energy team, who would be responsible for behavioural measures and would actively engage pupils in energy saving activities. They should communicate and work closely together in a common effort to reduce energy consumption in the building. This is the most complex solution but also the one that can bring the best results in terms of energy and financial savings.

In any case, it is essential to ensure adequate preparation and training of the people involved (energy manager, energy team members), assign them clear roles, responsibilities and competences and combine additional tasks with adequate incentives.

6.4. Involvement and education of users in Institutional buildings

There are different methods for involving building users in energy management processes and changing their behaviour. The most efficient ones are those that let them explore possible energy efficient solutions themselves and give competences and tools to implement some of the measures. In each case, the process should start with adequate information and education to give context and theoretical background to practical activities. It should end with detailed feedback on the results of the efforts undertaken and possible improvements for the future.

Typically, users' activation process would consist in the following steps:



Preparation - each successful activity starts with careful preparation. It is the same with users' involvement initiatives, which should be based on:

- Decision on the intended outcomes of the process and priorities we want to achieve.
- Identification of main user groups and analysis of their characteristics (what do they already know? what motivates them? what changes in behaviour and everyday practices they can be introduced?).
- Decision on methods and tools for communicating with different groups of users.
- Decision on methods and tools for engaging different groups of users in energy-saving efforts.
- Decision on monitoring and follow-up procedures.
- Development of detailed engagement plan.

Information - all users should be adequately informed about the building's efforts to improve its energy management and about the background of these activities (e.g. participation in the TOGETHER project). They should learn what the objectives are, why it is important to save energy, what benefits can be gained and how they can contribute to the achievement of these goals and benefits. It is also important to explain them in details the next steps planned and possibilities to engage. A good idea would be the organisation of information meetings which would be an opportunity to ask questions and resolve all the doubts. To reach the most important target group, the visitors information boards, signs, pictograms, posters, video screens should be thoroughly planned, designed and well positioned. Other possible information channels are e.g. newspaper or radio. What is important is to keep communicating and giving feedback on the actions throughout the process.

Education - information activities should be followed by educational ones. Permanent building users should learn more about energy, the ways it is generated and consumed and possibilities of reducing its consumption.

In case of certain groups of users, who may not have time or will to participate in extensive educational activities, it may be enough to focus on more practical aspects, i.e. different technical, financial, analytical and behavioural measures optimizing energy consumption. It is also important to explain them how they can save energy in their particular line of work or activity. These knowledge can be transferred during series of internal trainings, meetings or via material disseminated (e.g. guidelines for cleaning up in an energy efficient way).

Capacitation - to change their behaviours and practices building users need both knowledge how to do it and tools enabling them to do it. If there are no thermostatic valves on the radiators (or other ways of regulating the temperature), they will not be able to turn down the heating when it is too warm. If there is only one light switch in the room, they will not be able to optimize artificial light use. Therefore, it is important to implement as many technical improvements as possible to actually enable the users to adopt more sustainable behaviour.

Except for technical capacities, the users also need organizational ones. They need to know what they are able/allowed to do, whom to consult if they have any doubts and whom to address when they find out that certain improvements beyond their capacities are needed or when they find a failure like a leaking tap.

Activation - this is the most difficult step, where people should be encouraged and motivated to use the knowledge and tools in order to change their behaviour and practices. Usually to do this they need to have specific tasks assigned with targets, deadlines and some benefits to be gained at the end (financial benefits, item rewards, "thank-you" event, public recognition, etc.). There are already several examples of successful projects and initiatives (like EURONET 50/50), where this activation worked and which can be used as reference. Although most of these projects have been carried out in schools many of the experience can be used in institutional buildings as well. Another way of activating may be gamification or creation of a competition between the employees.

Monitoring and feedback - this is the last but very important step. All energy saving measures, including organizational and behavioural ones, should be accompanied by careful and structured monitoring of the real results achieved, both in terms of energy and financial savings. Monitoring data will not only help to check if undertaken actions are effective but also to keep the users engaged and motivated to undertake further energy saving efforts. The users need feedback what works and what does not and see that their efforts actually bring positive outcomes (if not, the situation should be carefully analysed with them and corrective measures should be taken).

It is especially easy to observe monitoring data's impact on users behaviours in case of smart monitoring systems, which allow to follow energy consumption in real time and thus immediately check if a particular improvement works or not. When the users can observe in practice how their behaviours impact on energy consumption, they are more eager to change them.

It is important to remember that energy and financial savings are not the only indicators that should be monitored. Also qualitative aspects should be followed, like:

- Changes in users' recognition of energy issues (did their approaches and attitudes towards energy change?)
- Changes in users' everyday behaviour (what was modified? Are these permanent changes?)
- Changes in users' comfort (did the comfort improve or worsen?)

6.5. Change of user behavior

As already mentioned, to change user behaviour it is important to raise their overall energy awareness, increase capacities to take own action, motivate them to do so and give regular feedback on the results achieved. The users should be also guided in their efforts to save energy, learning what kinds of simple measures they can implement to improve the situation of their building.

Below there are some suggestions on what behavioural and organisational measures are feasible in institutional buildings and what possible barriers and incentives can either hinder or support the change-of-behaviour process.

What no-cost and low-cost energy saving measures can be introduced by the building community?

To achieve savings on electricity the permanent staff should make sure to:

- Turn of unnecessary lights and equipment;
- Turn of all lights and equipment when leaving the room for longer (it can be made easier for them by installing multiple outlet strips with one switch allowing to turn off all devices at the same time);
- Label light switches to enable easy turning on of only part of the lights (sometimes only a part of a large room is in use);
- Rearrange the rooms to use as much daylight as possible;
- Regularly clean the dust from the lamps and the bulbs (a heavy dust coat on light bulb can block up to 50% of light output);
- Use the equipment properly and ensure its proper maintenance;
- Turn off stand-by function of the equipment when function allows it;
- Turn on energy-saving mode, which is incorporated to many types of devices;
- Analyse further, building-specific opportunities for reducing energy consumption (like e.g. reducing light and cooling intensity in beverage machines, using stairs instead of elevator, making tea together to avoid boiling the water every few minutes, etc.);

To achieve savings on heating the permanent staff should make sure to:

- Check and adapt setting of thermostatic valves to make sure that temperatures in respective rooms are appropriate (not too warm and not too cold);
- Close the door after entering/leaving the room to keep warm air inside and colder air on the corridor;
- Remove all heavy curtains and furniture covering the radiators and preventing warm air from spreading around the room;
- Keep radiators and convectors clean;
- Air the rooms properly (windows wide open for few minutes and with the radiators closed);
- Don’t open windows when mechanical ventilation provides enough fresh air;
- Reporting all malfunctions of the heating system to the technical staff and the school principal;
- Organise warm sweaters & socks day proving that it is possible to feel comfortable in lower temperatures (again joining education with good fun).

To achieve savings on water the permanent staff should make sure to...

- Turn off water taps fully after using them.
- Report any dripping taps or leaking toilets immediately to the maintenance staff.
- Use "low-flush" button in the toilet whenever possible.
- Water the plants with rain water.

Visitors should be reminded the above mentioned manner in order to achieve savings to..

- Take short showers after sports activities.
- Turn off water taps fully after using them.
- Use "low-flush" button in the toilet whenever possible.
- Close entrance door behind them when not closing automatically.
- Turn off lights after using the bathroom in case of manual operation.
- Use stairs instead of elevators.

It is worth to consider organisation of the school's environmental service that would check if users all following these guidelines and report any failures detected to the management.

What communication tools can be used to spread energy-saving message among users?

Usually only the energy team will be directly and actively involved in energy-saving efforts. But it is important to address with the energy-saving message also the rest of the community and encourage them to contribute to the common goal with their own actions.

In institutional buildings there are available different communication channels and tools that can be used to promote energy efficient behaviour, including:

- Display current / past energy performance on a well visible place in a user friendly manner;
- Publication of energy-related articles on the building’s website, Facebook site and magazine.
- Preparation of thematic board displays and pictograms.
- Labelling lights switches, water taps and electric equipment with energy-saving tips.
- Development and dissemination of brochures encouraging to use energy more efficiently and explaining how to do it (preferably tailor-made for different types of users).
- Organisation of special lectures on energy, energy saving and RES use during staff meetings and workshops.
- Organisation of other thematic events (like energy days).
- Organisation of internal contests for the best energy-saving concept, poster, sticker, board game, song, photo, etc.
- Presentation of up-to-date activities and achievements to the public, etc.

What barriers can hinder change-of-behaviour efforts undertaken in schools?

- Lack of adequate coordination and support from the municipality.
- Lack of adequate preparation of the engagement campaign (setting targets, segmentation of the users, selection of appropriate messages, methods and tools, etc.).
- Limited possibilities to reduce energy consumption with behavioural measures, e.g. because there are unfavourable technical conditions (lack of thermostatic valves on the radiators, unseparated light switches, etc.) or the users’ community is expanding (more and more children attending the building each year which results in a more extensive use of the building and more work for the staff, for whom it is harder to engage in extra activities).
- Reluctance of some of the staff members to support energy-saving efforts undertaken.

- Multiple activities and projects already implemented in many buildings, which makes it hard for the staff to find time for other time-consuming activities like engaging people in energy-saving efforts.
- Lack of good example from the top (when management doesn't pay attention to their behaviours, they cannot expect the staff and visitors to change theirs).
- Lack of feedback on the results achieved.
- Lack of recognition and reward for the most engaged users.

What drivers support change-of-behaviour efforts undertaken in institutional buildings?

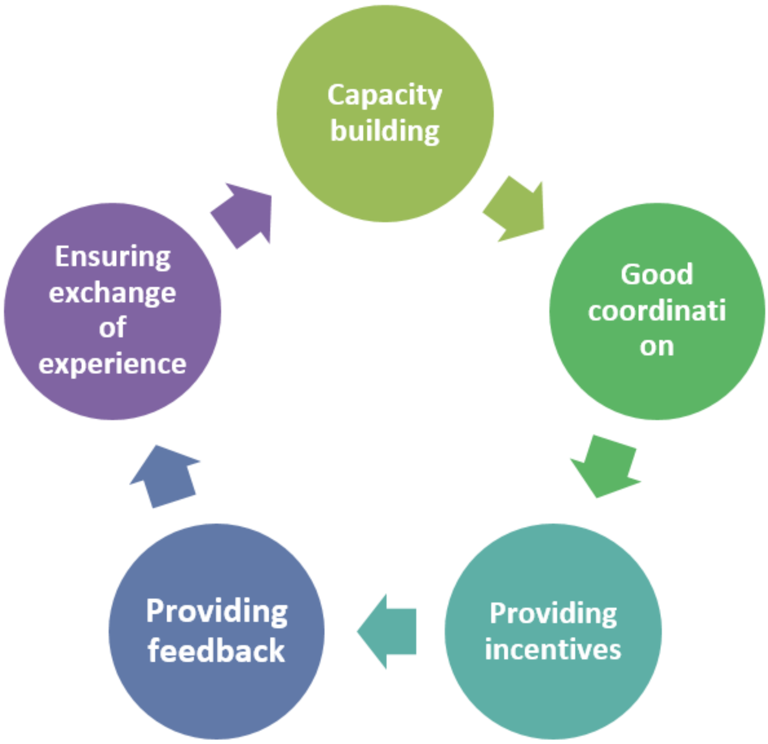


Figure 18: Drivers to support change-of-behaviour efforts

There are 5 main elements that need to be ensured to enable change of behaviours of the building community. These are:

Capacity building - building users will not change their behaviours if they are not capacitated to do so. It is important to start all users' involvement activities with increasing their energy awareness, teaching them how they can save energy in the building and giving them tools enabling and facilitating energy saving efforts.

Good coordination - each process to be successful requires a good coordinator. This coordinator, or coordinators, should be appointed at the early stage of the building's path towards better energy management. These should be motivated and communicative persons, understanding their role and benefits of changing users behaviours. It is important that they guide the users in their energy saving efforts giving them room for expressing own opinions and ideas.

Providing incentives - people need incentives to improve their behaviour and to get engaged in additional activities, which require time and efforts. For some of them (rather few) possibility to do something good for the environment and the local society is an incentive itself, but most of them will require something more. Different types of incentives are possible, including:

- Monetary incentives (e.g. gifts, salary supplement, percentage of financial savings achieved).
- Non-monetary incentives (e.g. extra "career points", better parking spaces, free carnets for the cinema or the gym, a trip, etc.).
- Public recognition of the efforts and achievements.

Providing feedback - it is essential that the building users get feedback about the results of their actions, including energy and financial savings achieved. These numbers should be carefully calculated, widely disseminated and commented on. What went well and what could be improved in the future? Such feedback will help to keep people motivated and interested in the energy-saving quest.

Ensuring exchange of experience and benchmarking - there is a great pool of experiences available concerning users' involvement in institutional buildings, particularly in schools. It is important to create forums, encourage and enable them to exchange experiences, opinions and ideas for energy saving measures. There are many ways to do it, including using both on-line communication tools (thematic Facebook profiles, discussion forums, blogs, publishing documents in Cloud, etc.) and more traditional ones (networking meetings). It is also worth considering to engage institutional buildings in benchmarking activities or thematic competitions that would further motivate them to improve their energy management.

It is important to remember that users' involvement is a cyclic process. Users need to be capacitated again and involved in energy-saving efforts from the beginning, while others will continue their quest. Therefore, it is essential to find a good balance between repeating already implemented actions and finding new tasks and new targets for those who are already involved to keep them interested and motivated to further improve their behaviour.

7. Conclusion

This tool has been provided to be utilized by all institutional building users concerned with energy conservation, and providing them necessary overview of Energy Management System (EnMS) that could be implemented with a common aim of improving energy efficiency.

Firstly, it presents deep view into the European energy policy and one of the main targets of the Europe 2020 Strategy for smart, sustainable and inclusive growth, which gives you enough information about current EU trends in the scope of energy efficiency in institutional buildings. In addition, the concept of EnMS is presented, going from simple, through smart, to advanced EnMS that can be implemented. This provides enough knowledge to decide, if there is a need to implement EnMS and what kind of energy efficient measures can be taken into consideration.

At the end, the user's inclusion is stated by providing a set of measures for changing their everyday behaviours and practices although the energy saving potential is challenging to exploit in this particular building type.

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Glossary

EU	-	European Union
EE	–	Energy Efficiency
EED	-	Energy Efficiency Directive
EEOSs	-	Efficiency Obligation Schemes
GHG	–	Greenhouse Gas
SME	-	Small and medium-sized enterprises
NGO	-	Non-governmental organization
EnMS	–	Energy Management System
DSM	–	Demand Side Management
PDCA	–	Plan – Do – Check – Act approach
SCADA	-	Supervisory Control And Data Acquisition
DS	–	Digital monitoring System
EPBD	-	Energy Performance of Buildings Directive

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