MANUAL ON ENERGY MANAGEMENT IN PUBLIC BUILDINGS

LIR Evolution
European Center for Renewable Energy Güssing

BACID.eu
BUILDING ADMINISTRATIVE CAPACITIES IN THE DANUBE REGION

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KDZ

Manual on energy management in public buildings

Project IMPROEN - *IMPROvement of ENergy efficiency in public buildings*

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Contents

Abbreviations

Abbreviation	Definition
Manual	Manual on energy management in public buildings
IMPROEN	IMPROvement of ENergy efficiency in public buildings project
BACID	Building Administrative Capacities in the Danube Region Programme
EnMS	Energy management system
PDCA	Plan – Do – Check – Act

1. Introduction

The Manual on energy management in public buildings (Manual) is produced in the framework of the project IMPROEN funded within the BACID Programme with financial support of the Austrian Development Cooperation.

Overall objective of the project is to transfer knowledge and Austrian best practices in field of energy efficiency, and improve energy efficiency in public buildings in Republika Srpska and Bosnia and Herzegovina. Specific objectives are: (1) to conduct research and prepare a Position paper on quality of reconstruction materials and financing sources for energy efficient rehabilitation of public buildings; (2) to prepare a Manual with guidelines on efficient energy management in public buildings; (3) to deliver a 2-days Webinar on energy efficiency improvement, energy management and related best practices in public buildings dedicated to energy managers and municipal officials.

Financing heating costs of energy inefficient public buildings is a significant challenge and a major burden on municipal budgets in Bosnia and Herzegovina. Improving energy efficiency and better energy management is of great importance for the project area. Energy efficiency means using less energy to perform a job or certain activity. Energy efficient buildings consume less energy to meet residing needs, in terms of maintaining a comfortable temperature, necessary lighting and other needs for people to stay and work indoors. An energy efficient building saves energy and its lifespan is longer. By improving energy efficiency in buildings, we contribute to protection of the environment and reduction of harmful gas emissions caused by combustion of energy resources for space heating.

The purpose of this Manual is to be used by public building officers and users concerned with energy management process and provide overview of appropriate energy management process in public buildings.

There is an ample potential for improvements of energy efficiency in public buildings in Bosnia and Herzegovina. Numerous public buildings are old, not renovated and building users are not familiar with energy management process. The aim of this Manual is to encourage public building users to act and behave in a more energy efficient manner and contribute to energy efficiency improvements.

At the present moment the building sector in Bosnia and Herzegovina is very energy intensive and responsible for 50% of the total final energy consumption. Public buildings are focus of the project IMPROEN as this type of buildings apart from the few permanent users have a lot of visitors on a daily basis, meaning that a number of users are hard to be motivated for energy efficient behavior as a key element in order to reduce energy consumption in public buildings.

2. Energy management system

Energy management system (EnMS) represents an approach to monitor energy indicators, that should be determined prior to investments in energy efficiency improvements. The EnMS is defined by the standard ISO 50001:2011, established in 2011.

ISO 50001:2011 specifies requirements for establishing, implementing, maintaining and improving an energy management system. The purpose of EnMS is to enable an organization to follow a systematic approach in achieving continuous improvement of energy performance, including energy efficiency, energy use and consumption. Furthermore, 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.

ISO 50001 focuses on a continuous improvement process to achieve the objectives related to the environmental performance of an organization. The process follows a so-called plan – do – check – act approach (PDCA). 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 plan necessary to deliver results of improving 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 determining energy performance against the energy policy and objectives, and report the results.
- ACT: take actions to continually improve energy performance and the EnMS.

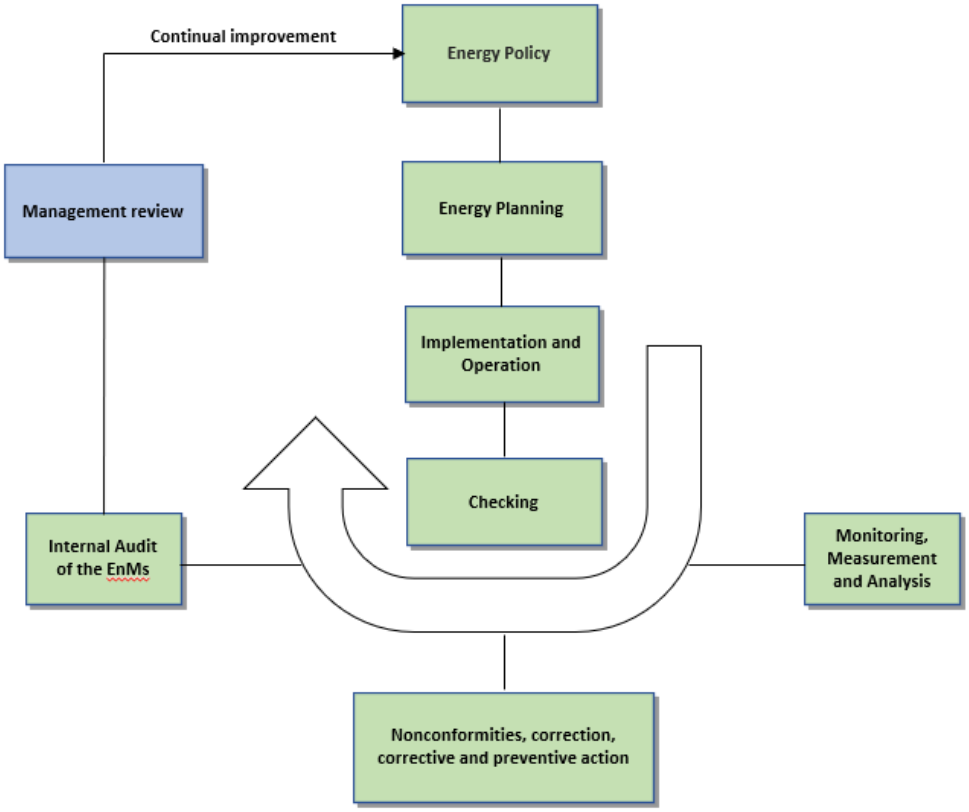
The purpose of an energy management system is to enable organization to follow a systematic approach in achieving a continuous improvement of energy performance, including energy efficiency, energy use and consumption.

General aims of EnMS are:

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

The basic steps of energy management system are energy policy, energy planning, implementation and operation, checking (monitoring measurement and analysis as well as internal audit of the EnMS), eventual corrective and preventive actions, management review closing the cycle of continual energy management improvements (Figure 1).

Figure 1. Energy management system model for ISO 50001

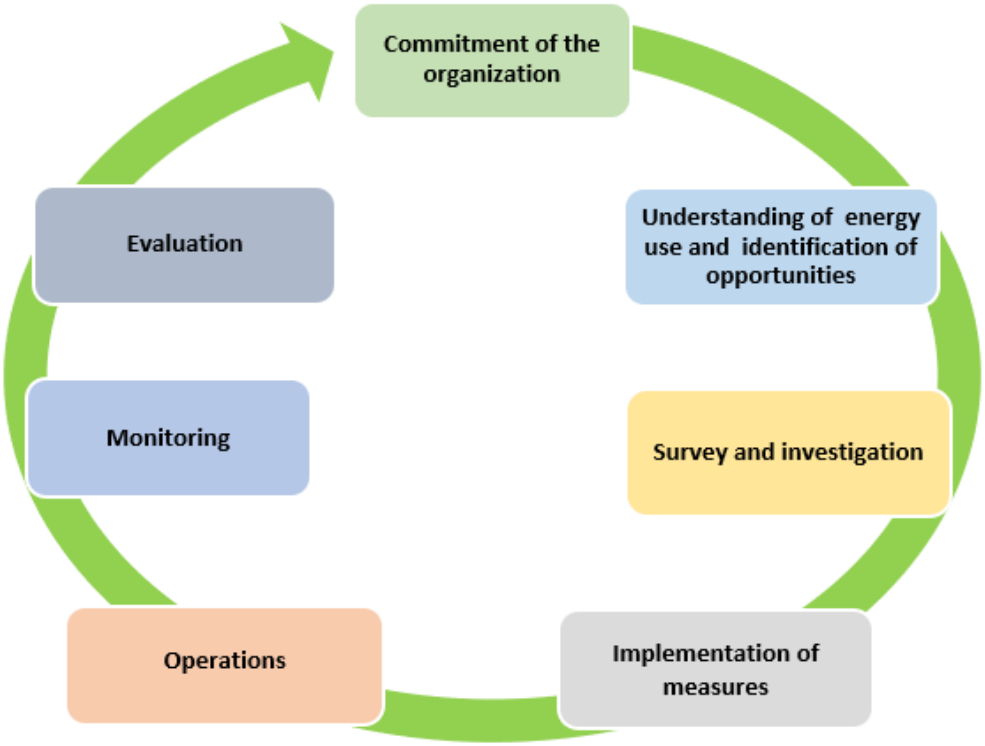


3. Energy management cycle

Energy Management Cycle represents a cycle of continuous improvement of energy management and energy efficiency based on the Plan-Do-Check-Act approach. This cycle contains different steps that are all important to be implemented for appropriate process of energy management in an organization. Energy management cycle consists of the following steps:

- ✓ Commitment of the organization to improve energy efficiency;
- ✓ Understanding of energy use and identification of opportunities;
- ✓ Survey and investigation including energy audits;
- ✓ Implementation of energy efficiency measures;
- ✓ Operations;
- ✓ Monitoring;
- ✓ Evaluation.

Figure 2. Energy management cycle



Energy management is the proactive, organized and systematic coordination of procurement, conversion, distribution and use of energy to meet the requirements, taking into account environmental and economic objectives. Energy management process in a public building is not finalized by implementation of a single rehabilitation measure, a series of measures or one energy management cycle. It is a continuous process that will finalize in a long run when public buildings become zero emission and energy independent buildings.

4. Commitment of the organization

Commitment by the building owner is a key starting point for improvement of energy efficiency in public buildings. People in charge of the organization should decide to engage in the process of energy management and commit to improve energy performance of the building. Energy should be viewed as a key strategic issue by the people in organization and capacity for energy management should be assessed by the highest management levels. It is necessary to have adequate capacities and skills by the people involved as well as sufficient financial funds dedicated to energy management and energy efficiency improvement. It is very important to have reliable and efficient monitoring and reporting system. The consumption data should be monitored after the investment in energy efficiency measures, so that the energy savings can be compared to set targets. Energy and equipment procurement should be coordinated and proactive.

There is a big push towards Green Public Procurement by the EU as a process where public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would

otherwise be procured. People in charge of organization should plan to fulfill existing and upcoming regulations (e.g. laws, bylaws, strategic documents) and address them in internal documentation related to improvements of energy efficiency. There should be focus towards increase and maintenance of energy efficiency awareness and knowledge throughout the organization as a continuous process, that is very important for appropriate energy management. There should be active engagement of all employees on energy issues in an organization. Every user of the public building should be informed and aware of energy issues. Energy management should be integrated with other management systems within organization. Energy management as such represents an opportunity for an organization to operate more efficiently, save resources and increase its overall performance and comfort for the building's users.

5. Understanding of energy use and identification of opportunities

In order to understand energy use and identify possibilities for energy savings in organization, it is necessary to conduct systematic energy management. Systematic energy management means to monitor consumption, to analyze and interpret results of analysis in order to know, in every moment answers to the following questions:

- WHERE do we consume energy?
- HOW do we consume energy?
- WHICH energy sources and fuels do we consume?
- HOW MUCH energy do we consume and how much does it cost us?
- WHO is responsible for energy management?
- WHAT can we do to decrease energy consumption while keeping needed level of comfort or service?

Such systematic approach to energy management will provide full understanding of energy use in the building and appropriate identification of opportunities for introduction of energy savings measures.

6. Survey and investigation

Before conducting a survey and investigation, it is necessary to define the following aspects:

- Determine the current energy status of the organization (e.g. institution, municipality), understanding of organizational structure and procedures that influence on energy issues.
- Definition of starting situation by gathering the data on energy production, distribution and consumption. This may include inventory of greenhouse gases (GHG) emissions.
- The starting points should be followed by legal regulations (laws, bylaws, decisions) and strategic documents (strategies, action plans, e.g. SECAP).

Process of the survey and investigation starts with registration of the energy consumption (and/or production). Key parameters should be defined as indicators of energy consumption. These parameters serve as a measure to show us if something is wrong with energy use in the organization.

Key parameters could be the following:

- payed bills for heating or cost for heating per square meter of a building surface;
- cost of energy for lighting;
- bills for water consumption; etc.

Defined key parameters are compared to the standards and their deviations are identified. In this way it is possible to plan measures that will lead to improvement of energy efficiency. The Table 1. demonstrates examples of some indicators that can help us to analyze if something is wrong with the energy use. For instance, if the building is consuming more energy for heating per net heated surface of the building than an average what we can compare from energy classification of the building used as a reference point, we should try to reduce energy consumption while keeping the level of comfort of the building use. Indicators of consumption can provide us with a hint that something is wrong, e.g. we are spending more energy than we need, thus we have larger bills for electricity than necessary. Indicators of consumption can help us to track if the building users have adequate comfort/service and if the energy management process in the building is appropriate.

Table 1. Examples of indicators of energy consumption

Indicators of consumption	Formula	Unit
Consumption of energy for heating (Et) per net heated surface of the building	$ICts=Et/A_{tot}$	kWh_{th}/m^2
Consumption of energy for heating (energy equivalent of fuel for heating) per volume of heated space	$ICtv=Et/V_{tot}$	kWh_{th}/m^3
Consumption of energy for heating (energy equivalent of fuel for heating) per occupation	$ICto=Et/T_{occ}$	kWh_{th}/number
Consumption of electrical energy (Eel) per net surface of used space	$ICelt=Eel/A_{utot}$	kWh_{el}/m^2
Consumption of energy for heating (Et) (energy equivalent of fuel for heating) per outside temperature	$ICtst=Et/T$	$kWh_{th}/^oC$

Usual practice is that when excessive energy costs occurred in an organization, an audit is conducted. Following the audit, some single measures are implemented and the energy costs subsequently decreased. In a short run everything is under control, but after some time elapsed, the costs of energy have risen again. Then organization implements another audit followed by other single measures resulting in decrease of energy costs. Then again with the passage of time, energy costs have risen. This is a situation when energy management is not optimal and is not an integral part of organization's policy (Figure 3).

Figure 3. Energy management is not a part of organization's policy

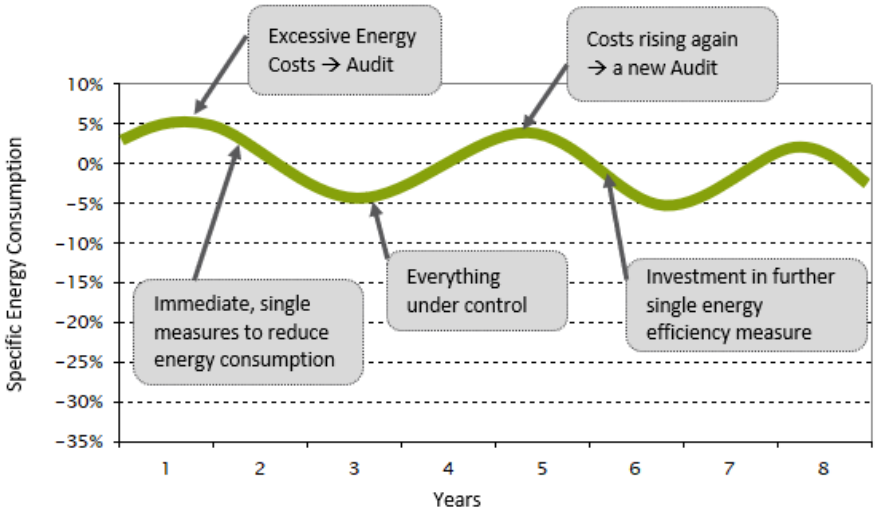
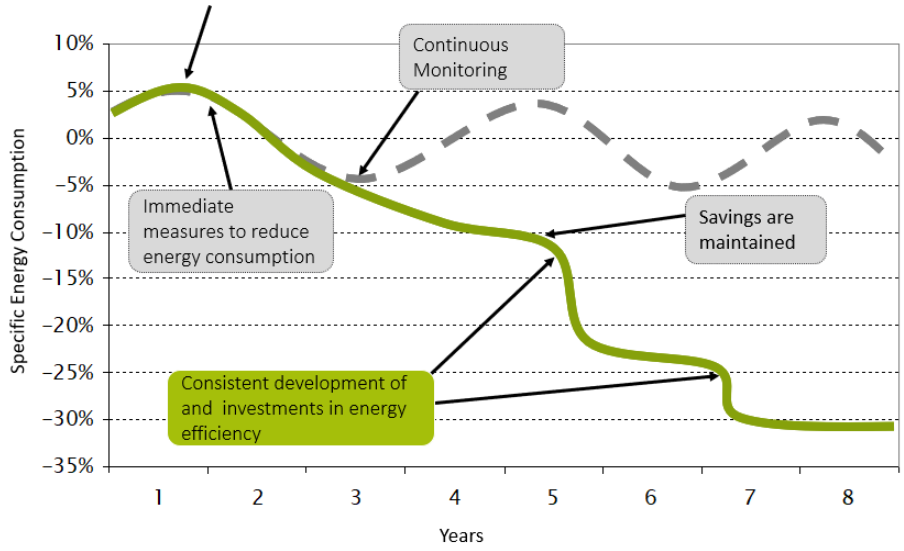


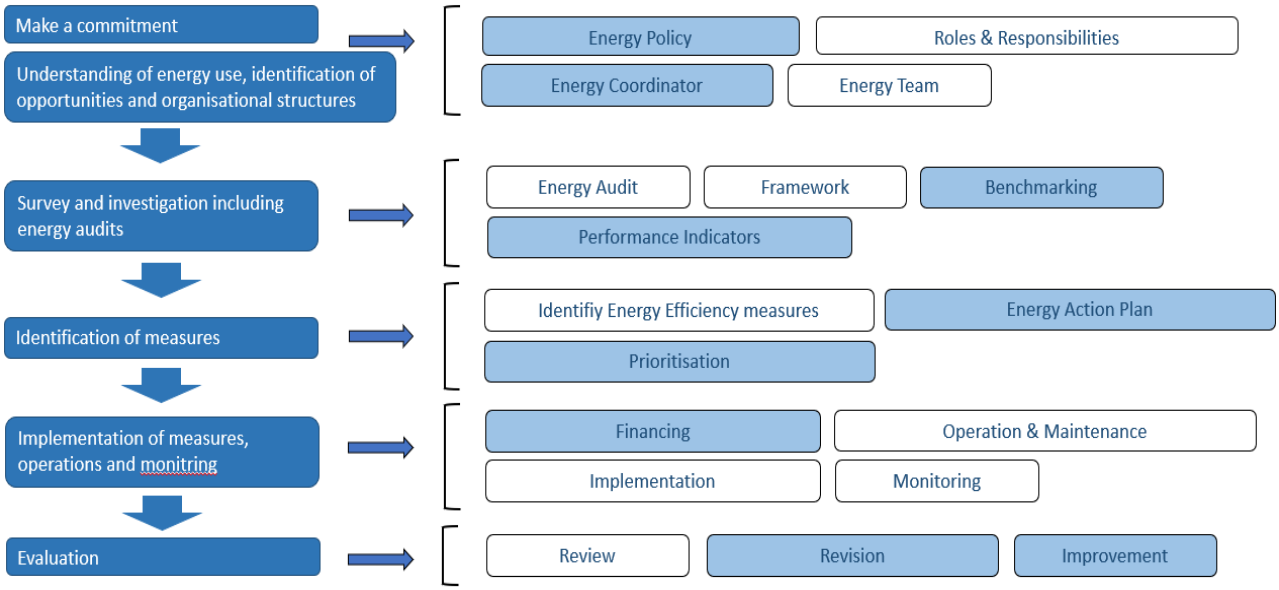
Figure 4. Energy Management and continuous improvement is a part of organization's policy



On the other hand, situation can be different if energy management is optimal and continuous improvements are part of organization's policy (Figure 4). The main change is in introduction of continuous monitoring process resulting in consistent development, proper operations and investments in energy efficiency. Such an approach is contributing to the savings that are maintained with time and there is no unpredictable rise in the energy costs. In such a situation, an organization will be able to continuously decrease energy consumption and maintain its level resulting in continuous improvement in energy policy and practice of energy use.

Figure 5 shows the continuous improvement process of energy use in an organization and different stages of activities that can be implemented in order to continuously improve energy efficiency and energy management in a public building.

Figure 5. Energy Management as a continuous improvement process



7. Energy auditing

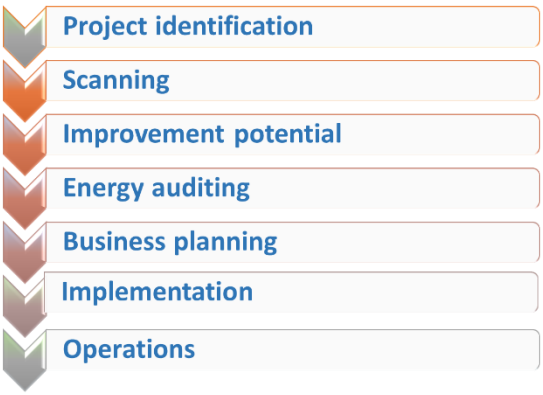
The total energy consumption in a system (e.g. building) can be determined, while the energy flows in an organization or the energy efficiency of individual processes or operations performed in the system cannot be easily estimated. Information on energy flows in an organization and the efficiency of individual processes are very important, in order to determine the possibilities for energy savings, and in order to collect this information, energy audits are conducted.

Energy audit is an established procedure that helps in the analysis of energy consumption in the system (e.g. building), and aims to establish how energy is consumed and is necessary in:

- energy efficiency assessment;
- determining opportunities for energy savings;
- determining the implementation plan of energy saving projects.

An energy audit consists of the collection and processing of data concerning the energy use. The procedure is performed by experienced experts (so-called energy auditors) who are trained to use the instruments and equipment necessary to conduct energy audits. Energy audits vary, depending on the degree of complexity of the building/object, the level to which the analyses progress and the scope of the analyses performed. Energy audit should help to decision makers to choose the most profitable energy efficiency measures.

In general, important steps related to energy auditing are as follows:



Project identification is followed by scanning (preliminary audit) and definition of improvement potential of energy use in the building. Further can be implemented simplified or detailed energy audit, depending on the complexity of the building. After completion of energy audit, business planning for implementation of energy efficiency measures can be implemented. Finally, energy efficiency measures are implemented and new energy systems are put in operation.

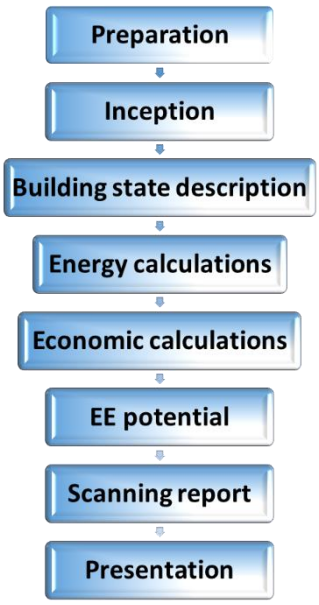
7.1 Energy auditing in public buildings

Public buildings are special from the consumption aspect, as often are large facilities without or with low level of energy management system implemented. Public buildings as large and complicated structures with mixed structure of users (regular users/employees and visitors), are complex to investigate. There are usually complicated HVAC systems in order to ensure a comfortable indoor environment.

There are several types of energy audits based on the complexity of public buildings and energy systems:

- ✓ Walk-through or preliminary energy audit (scanning)
- ✓ Simplified energy audit
- ✓ Extended (detailed) energy audit

Preliminary audits are the simplest forms of energy audits, essentially representing a basis for simplified and extended energy audits. Typically, it is conducted based on a 1-day visit and analysis of energy consumption data collected through questionnaires. It provides preliminary insight and fast scanning of situation of energy use in the public building. The aim of scanning is to identify the total energy efficiency potential and, if the potential is profitable, to convince the building owner or manager to continue with the project development process. If measures are easy to identify and clearly visible such as some low-cost measures, these measures can be implemented immediately after the preliminary audit. Occasionally, simple low-cost or no cost measures can save up to 10% of the energy. After scanning, management can decide that further in-depth energy audit is not needed. Preliminary audit should demonstrate if further more detailed energy audit is needed and what is a potential for improvement. Steps of preliminary audit are as following:



Scanning Preparation includes the following steps:

- ➢ Signing of Scanning Contract
- ➢ Gathering of technical drawings and descriptions from the building owner

- Evaluation of the gathered information
- Preparation for inspection

Scanning Inspection should review all the elements of the building to analyze the possibilities for energy efficiency improvements covering:

- Building envelope
- Heating system
- Ventilation system
- Domestic hot water system
- Fans and pumps
- Lighting system
- Air conditioning system
- Operation and maintenance routines
- User pattern.

Table 2. Energy scanning: Energy consumption and prices – example

Year 20xx	District heating	Electricity	<Gas> <Oil>	Other	Total
Energy costs					€
Energy consumption					kWh
Specific consumption					kWh/m²
Water consumption			m^3		€
Year 20yy	**District heating**	**Electricity**	**<Gas> <Oil>**	**Other**	**Total**
Energy costs					€
Energy consumption					kWh
Specific consumption					kWh/m²
Water consumption			m^3		€
Present tariffs					***€/kWh (incl. VAT)***
Other costs *)					<indicate unit>
Tariffs valid since	<date.month.year>				

It is necessary to distinguish different types of energy consumption during preliminary audit and analyze basic information that will help in creation of indicators and make decision on requirements related to implementation of detailed energy audit.

Simplified energy audit is sufficient for simple buildings, offices or small industrial processes where it is not necessary to do many measurements and inquiries as most of energy consumers are already known.

Extended (detailed) energy audit is the most common form of inspection for public buildings containing accurate economic indicators for recommended energy efficiency measures. The total consumption of energy products according to all consumers is included whenever possible. Extended energy audit constitutes relevant basis for decision making on investment in energy efficiency measures by the management of the organization. Detailed energy audit can be very complex.

During detailed energy audit of the public building should be covered the following aspects:

- General data on building (e.g. year of construction, type, climatic data, drawings, technical documentation);
- Building operation (e.g. operations and management, installed meters); indoor environment, occupancy and heating schedules;
- Energy consumption (e.g. monthly consumption, tariffs, records, using bills and metering);
- Water consumption (e.g. monthly consumption, tariffs);
- Building envelope (external walls, windows, doors, roof, roof windows, floor);
- Heating system (heat supply/heat generation, automatic control, distribution system, emission system;

- Ventilation system (type, automatic control, equipment); Quality of indoor air is very important, as data suggest that people spend about 90% of their time indoors.
- Domestic hot water (heat supply/heat generation, automatic control, distribution system, consumption);
- Fans and pumps;
- Lighting system (luminaries, operations);
- Various exploitable and equipment;
- Cooling (air conditioning) system (cooling supply / Cooling generation, distribution);
- Outdoor (lighting, snow melting).

Following the implemented energy audit, collected data should be analyzed and calculation provided regarding financial aspects of identified energy efficiency improvement measures and their potential to check if the investment would result in energy savings and costs reduction. In BiH current price of electricity is lower than in other regions, especially in comparison to EU countries. On the other hand the cost of implementation of energy efficiency measures is simlar to costs of energy projects implementation in other countries. Thus, the pay off period is typically longer in BiH then in other countries, and return of the investment is extended. Financial calculations should encompass:

- ✓ Payback Period (Payback period in capital budgeting refers to the time required to recoup the funds expended in an investment, or to reach the break-even point);
- ✓ Net Present Value (NPV) is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present moment. NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time);
- ✓ Net present value quotient;
- ✓ Pay-off;
- ✓ Internal Rate of Return.

The profitability of energy efficiency measures should be compared not only to current prices of energy, but also to fulfilling the standards of comfort in public buildings with the existing system, due to the fact that the comfort in public buildings in Bosnia and Herzegovina is below the level that it should be.

8. Implementation of measures and operations

After energy auditing is completed and financial calculations are made, it is important to make decision on implementation of selected energy efficiency measures and how to find financial funds for energy efficiency project. After audit, the current state becomes a benchmark in measuring improvements after successful implementation of measures. In making the decision the following aspects should be taken into account:

- ➢ 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.

All energy efficiency measures should be taken into consideration based on their feasibility and financial point of view. Typically measures can be divided into organizational and investment measures. Organizational measures are low cost in comparison to potential savings of energy to be achieved by their implementation or even such measures do not require financial resources input. These measures are feasible in the short run and have an immediate effect on reduction of energy costs and achievement of energy savings, allowing small and medium-sized savings. On the other hand, investment measures involve financial resources and have a potential for larger savings. However, investment measures should be evaluated by the energy auditor with regards to the payback period and the feasibility of their implementation.

Table 3. Low-cost vs High-cost measures

Organizational measures (Low-cost)	Investment measures (High cost)
Awareness raising and education on energy efficiency for energy managers and employees, workshops to transfer knowledge, posters placed for visitors.	Measures on the building envelope (refurbishment of windows, installation of blinds, additional insulation etc.).
Introduction of natural ventilation, avoiding unchecked airflows (checking 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)
Introduction of proper lighting and appliance use (turning off lights in case of sufficient daylight, non-use of facilities, switching off technological equipment when not used)	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 energy management system	Changing to energy efficient appliances (replacement old lighting with LED technology)

9. Energy monitoring and evaluation

Energy monitoring refers to periodic (e.g. weekly) registrations of the energy consumption (e.g. electricity, district heating, used fuels) and corresponding mean outdoor temperatures. Registrations can be made by using metering or from bills. One approach to monitoring is to observe ET curve (energy temperature curve) demonstrating how the energy consumption is related to outdoor temperature. During the winter, an organization is consuming more energy for heating and ventilation. During the summer an organization is consuming more energy for air-conditioning and cooling. Consumption of hot water, lightning, equipment (e.g. computers) in public buildings typically should be equal through entire year.

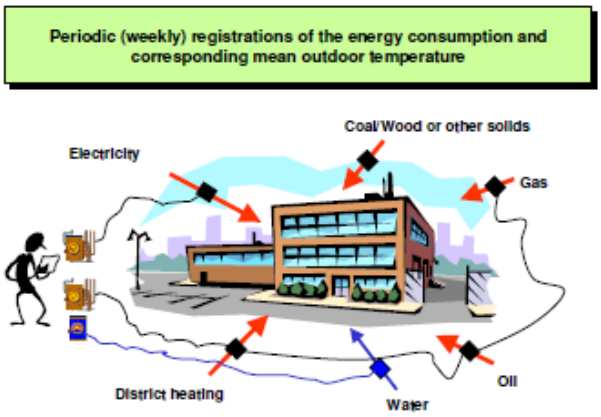
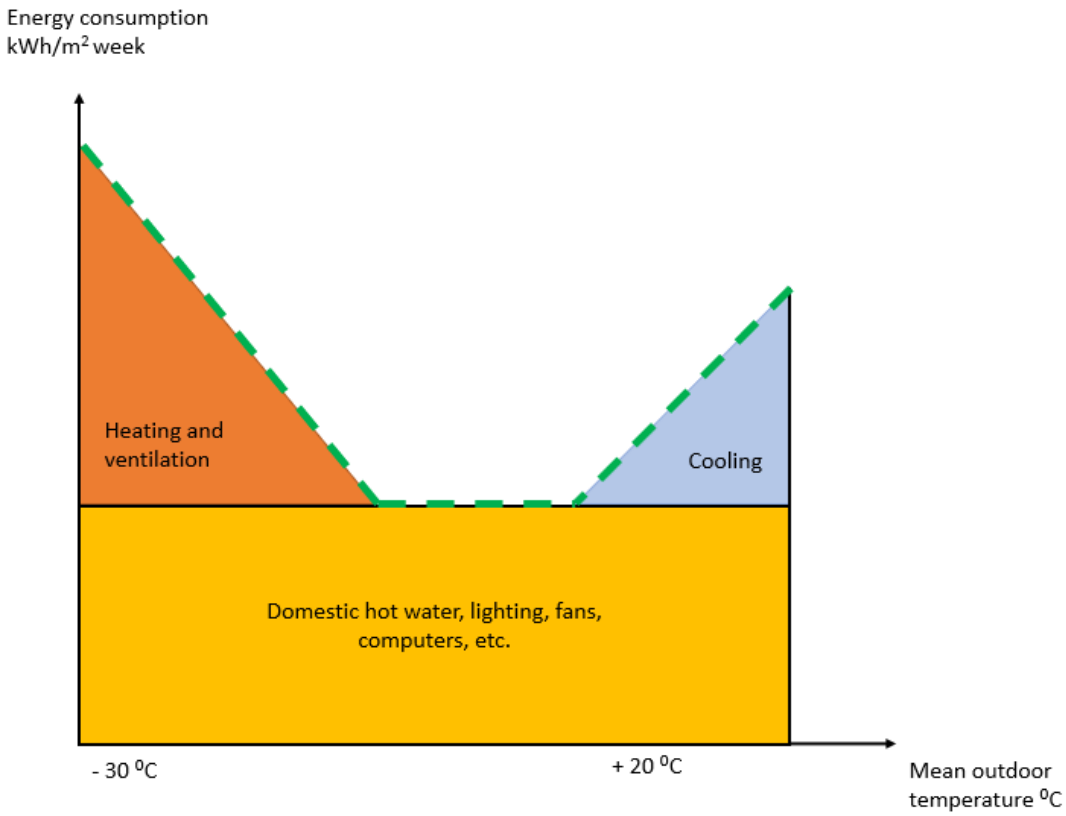


Figure 6. Energy monitoring, Training Programme on Energy Auditing of Buildings, ENSI, 2008

Figure 7. Energy-Temperature curve, Training Programme on Energy Auditing of Buildings, ENSI, 2008



If there is a sudden increase in energy consumption (e.g. due to hot water leakage), energy manager can see that something is wrong, react and take a remediation action.

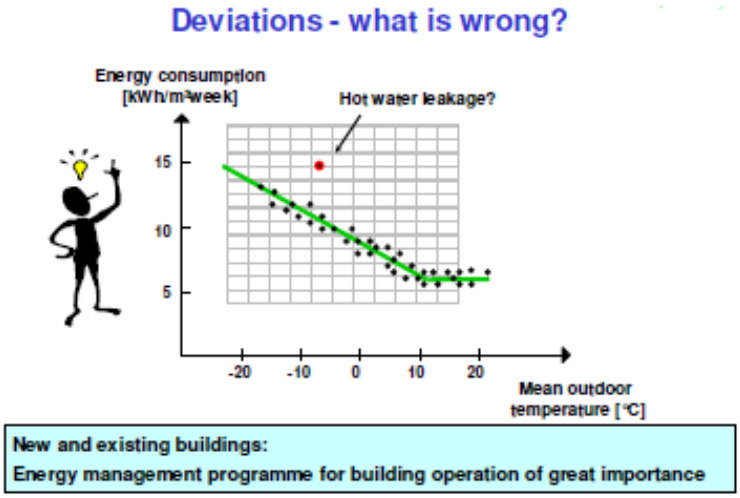


Figure 8. Energy consumption deviations, Training Programme on Energy Auditing of Buildings, ENSI, 2008

Before energy efficiency measures implementation, energy consumption in an organization is high. After implementation of energy efficiency measures, energy consumption decreases. However, due to improper operations, energy consumption often rises again. In order to avoid such situation, it is of crucial importance to have established an appropriate monitoring process. It is very important for management of the public building to have proper and detailed information on monitoring. Often decision makers are not engineers nor familiar with all the energy issues and aspects. Decision makers need straightforward and uncomplicated information on energy consumption issues and operations that should be on optimum level.

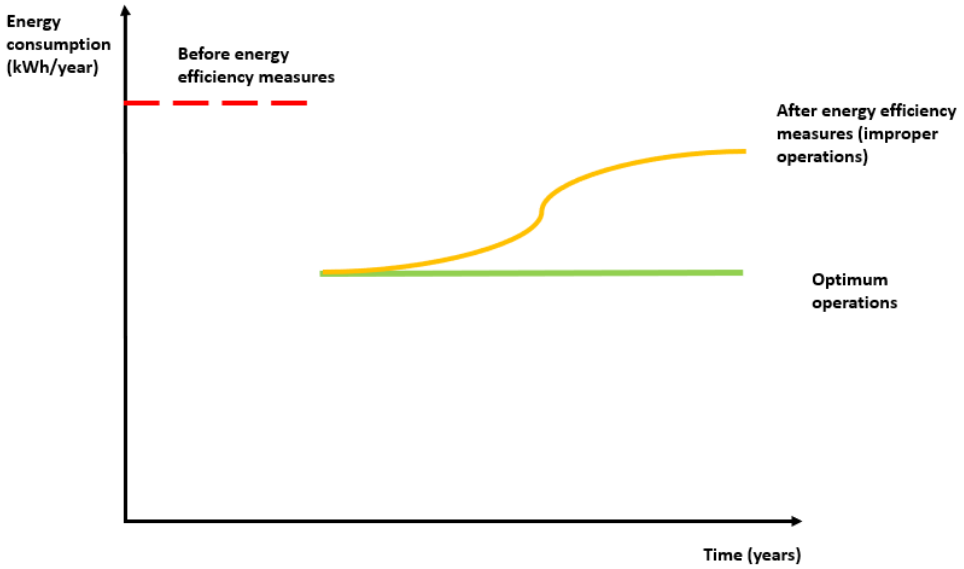


Figure 9. Energy consumption issues, Training Programme on Energy Auditing of Buildings, ENSI, 2008

Multiple external factors are affecting energy consumption in buildings, such as: temperature fluctuations, weather conditions, the size and insulation of buildings, energy prices, energy consumers etc. A significant influence on energy consumption can be made by raising awareness on importance of energy efficient behavior and proper energy management. Important progress in this area represents the introduction of regular monitoring of the consumption and energy costs in buildings. There are three levels of energy monitoring depending on the size of the building and complexity of the energy system in the building:

1. level: Energy accounting (e.g. 500-1000 m2): Introduction of energy bookkeeping is important measure for smaller buildings with relatively simple energy system, and at the same time one of the simplest solutions for implementation of the energy management systems. It represents a basic instrument that allows to users a better overview of energy use and related costs. This approach includes monitoring and analysis of energy consumption based on gathering bills on a monthly basis. In this way energy consumption in the building is controlled by looking into energy bills and following up on eventual increases of energy costs. As data are presented on the monthly level, there are no insights into weekly or daily consumption fluctuations, what can result in difficulties to determine underlying reasons of eventual differences in energy consumption.
2. level: Digital monitoring system (e.g. 1000-2000 m2): Introduction of a more complex monitoring process based on a digital monitoring system is relevant for larger buildings with more complex respective energy systems. Data on energy consumption and thermal comfort are monitored in the building and recorded in an online database. This is implemented by using several digital sensors and meters. The system is commonly monitoring all parameters in a time interval (e.g. 15 minutes), followed by transmission of parameters data via communication link to the database, where all data are processed and instantly available for the users. The energy manager can take a promptly action in any case of issue, such as unusually high consumption. In a number of BiH municipalities and public buildings is available a digital Energy Management Information System (EMIS) where the energy consumption data are inserted, collected and readily available to users.
3. level: Supervisory Control and Data Acquisition (SCADA) (e.g. more than 2000m2): SCADA represents control system architecture using computers, networked data communications and graphical user interfaces for high level process supervisory management. This system supports automatically transfer of information and data to follow on energy consumption level. The advanced system allows data archiving, online implementation, automatic remote monitoring in real time and alarming to potential issues/ errors what allows an immediate reaction by responsible person.

Experiences in the use of energy monitoring suggest that active use of information system for energy management contributes to achievement of additional savings. It is evaluated that each level can contribute up to 5% of savings. When implementing all three levels, combined savings of up to 15% can be accomplished. Additional 5% can be achieved with appropriate involvement of building users. Good promotional tactic is to use clearly visible monitors showing energy consumption inside the public building, in order to reach building users and raise awareness on energy issues and proper energy use. Monitoring has multiple benefits such as:

- ✓ More correct operations of technical installations,
- ✓ Quick detection of errors / breakdowns of technical equipment,
- ✓ Quick feedback on consequences of changes in operational routines,
- ✓ Increased awareness on energy saving possibilities,
- ✓ Documentation of results from implemented measures,
- ✓ Better budgeting of costs for energy and water,
- ✓ Operational and maintenance personnel involved and motivated,
- ✓ Reduced energy consumption (5-15%),
- ✓ Better indoor climate and comfort, especially quality of indoor air.

Figure 10. Energy Management Information System (EMIS)

Following the monitoring, energy reporting is conducted to evaluate energy efficiency measures which were implemented during the specific period. The report should at least contain baseline descriptions, as well as energy consumption analysis along with related recommendations. Baseline as a starting point usually outlies average energy consumption over the past couple of years. Energy consumption analysis contains data about heating and electricity energy consumption, measurements of indoor comfort etc. The conclusion part provides an overview of conducted analysis, the main weaknesses, strengths and recommendations for energy efficiency improvements.

Energy reporting typically covers the following segments: Information about the building and the EnMS, Energy baseline and measurements taken in the period, Energy consumption analysis, Conclusion, Any Annexes.

10. Organization of energy management staff in public buildings

Implementation of appropriate and efficient energy management requires engagement of responsible persons that will manage the entire process of energy management. When making a decision on involvement of responsible persons there are more options available:

- engagement of energy manager;
- involvement of energy management team;
- appointing both, energy manager and energy management team.

Energy manager and energy management team should possess required skills and capacities to improve existing situation in the building. Engaged energy manager should be adequately trained in order to engage in energy management activities, and equipped with technical and organizational skills to apply various energy efficiency optimization measures. The tasks of energy manager are complex and various including monitoring and analysis of energy consumption data; planning and

implementing energy efficiency measures; taking actions in response to sudden fluctuations in energy consumption and introduction of possible corrective measures; involvement in energy related projects in the building; ensuring communication on energy efficiency with relevant stakeholders and building users; development of database for energy management data etc.

Involvement of energy management team would gather different groups of permanent users of the building responsible for analyzing and improving energy situation in the building. The team would need a leader (e.g. energy manager) and number of team members depends on size and complexity of the building. The team would be actively involved in analysis of energy related issues in the building and development of energy saving plan, implementation of planned measures and communication with building visitors regarding energy saving behavior. It is important for energy management team to increase their knowledge on energy issues through relevant trainings. The team should have regular periodical meetings to discuss energy aspects and plan further activities. It is important to keep the team motivated by providing them with feedback on achieved energy savings as a result of their activities. Appointing both energy manager and energy management team is the most complex approach, however can achieve the most optimal results in terms of energy and financial savings. It is important that they collaborate closely and regularly communicate in order to reach optimal solution.

Building users have an important role in contributing to energy management of public buildings if involved and motivated. Significant energy savings can be achieved by making sure appropriate energy management is introduced (e.g. rooms aired appropriately, unnecessary lights are off) and by motivating changing of behavior and energy efficient practices. When in addition organizational changes are introduced (such as modification in work schedule), achieved savings can reach up to 15%.

As in the public buildings, typically, visitors spending only short time in the building and visiting occasionally represent a significant number in the number of total users, the applicable actions for motivating them and turning their attention to energy efficiency are promo leaflets, information signs and displayed info on visible locations.

11. Conclusion

The term energy efficiency usually means a set of expressions describing the quality of energy use. Efficient use of energy suggests using less energy to obtain the same or higher level of energy services. For example, the insulation of the building allows to use less heating and cooling energy to achieve the thermal comfort.

In other words, energy efficiency means reducing energy requirements and needs without reducing the end-use benefits. Energy efficiency explains how to meet the same comfort needs while consuming less energy or achieving a higher comfort with the same energy consumption. Energy efficiency is related to different aspects: technical, financial, economic, social, environmental, development, sustainability, and others. The term energy efficiency is the most commonly encountered in two possible meanings, one of which refers to devices and other to measures and behaviors. An energy efficient device is the one that has a higher degree of useful effect, i.e. smaller losses during the transformation of one type of energy to another.

Energy efficiency measures are actions taken to reduce energy consumption, with identical or even better results. Whether it is a matter of technological or non-technological measures or changes in behavior, all measures imply the same, or even higher, level of comfort and standards achieved. So, the improvement of energy efficiency is considered to be the avoidance of energy losses without disturbing comfort, standards of living or economic activity in the field of energy consumption.

This Manual represents an overview of energy management process specifically focused on public buildings and dedicated to energy managers and officers employed in public buildings.

Project partners discuss energy management system, energy management cycle and its steps; commitment of the organization to improve energy efficiency; understanding of energy use and identification of opportunities; survey and investigation including energy audits; implementation of energy efficiency measures and operations; monitoring and evaluation; as well as organization of energy management staff in public buildings.

The aim of the Manual is to draw attention to important aspects of energy efficiency improvements and motivate better energy management by employees and users in public buildings.

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