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Chapter 8
Electricity management systems and energy efficiency in the context of current standards

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Abstract: The article presents two standards related to energy efficiency PN-EN ISO 50001:2012 Energy management systems – Requirements and recommendations for use, and PN-HD 60364-8-1 Low-voltage electrical installations. Part 8–1: Functional aspects – Energy efficiency. In terms of the standards, it was considered how energy management systems represent electricity, and also verified whether the requirements they represent are compatible and not mutually exclusive.

Keywords: electrical efficiency, efficiency management, electrical installations, compatibility standards.

Introduction

The subject of energy efficiency is an urgent and necessary issue. Rising electricity prices and climate change are forcing consumers to minimize their electricity consumption. Standards are created in order to improve the assessment of actions aimed at reducing electricity consumption. Such standards include PN-EN ISO 50001:2012 Energy management systems – Requirements and recommendations for use, and PN-HD 60364-8-1 Low-voltage electrical installations. Part 8–1: Functional aspects – Energy efficiency. The implementation of these standards is intended to help create the systems and processes necessary to improve the energy result of electricity consumers.

The first of these standards relates to electricity management systems and is applicable to organizations of all types and sizes, regardless of the purpose of organizations. This standard discusses how an electricity management system should be built and on what it should be based and how the elements of this system correlate with each other.

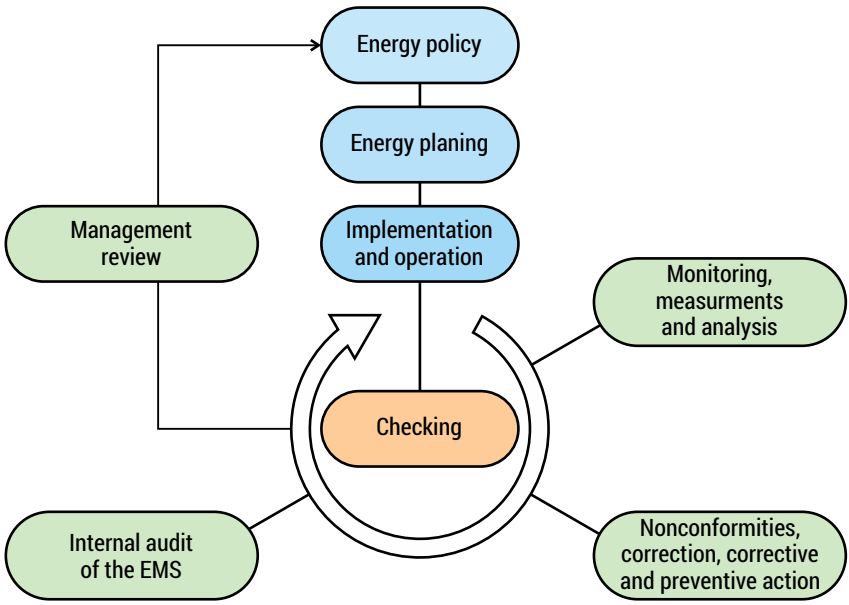
The second standard gives guidelines on how to optimize electricity consumption through the design and modernization of new and existing electrical installations. This standard specifically introduces areas where measures should be taken to reduce the electricity consumption of a company.

It is worth checking whether the two standards are compatible and not mutually exclusive since the incompatibility or mutual exclusion of standards and legislation is a frequent problem in technology.

PN-EN ISO 50001:2012 standard

The PN-EN ISO 50001:2012 standard Energy management systems – Requirements and recommendations for use primarily specifies the requirements for an energy management system (EMS). Thanks to such a system, any organization or company can develop and implement an energy policy for its institution. With such a policy, the company is able to define its goals, objectives and an action plan, which, after taking into account legal requirements, will lead to an improvement in energy efficiency.

This standard is based on the continuous improvement principle Plan-Do-Check-Act (PDCA). The cycle of this principle is illustrated in Figure 8.1. As can be seen in the figure, the first step in creating a management system is energy planning, followed by the implementation of the planned actions, checking the effects of the implemented actions and re-analyzing and planning new actions.



FIGUR E 8.1. PDCA management system model

The application of this International Standard contributes to the efficient use of available energy sources, increasing the competitiveness of companies and reducing greenhouse gases. A definite advantage of this standard is the lack of definition of the energy result – the fulfilment of normative requirements does not result in a concrete outcome, as a result two similar companies with similar activities may obtain different energy results and both will be correct.

The general requirements include measures that the organization should take in its management system to improve energy efficiency.

The organization shall:

a) establish, document, implement maintain and improve an energy management system in accordance with the standard;
b) define and document the scope and boundaries of its EMS;
c) determine how it will meet the requirements of the standard in order to continually improve its energy performance and RES.

Above all, the standard indicates that the greatest responsibility related to the energy policy of a plant lies with the company's management. The standard also specifies all the steps that the top management should take to support the energy management system. These are mainly to:

a) define, establish, implement and maintain an energy policy;
b) appoint a management representative and approve the creation of an energy management team;
c) establish human resources, specialized skills or technologies needed to establish, implement, maintain and improve the EMS and the resulting energy outcome;
d) identify the scope and boundaries to be covered by the EMS;
e) communicate the importance of energy management within the organization;
f) make sure that energy objectives and targets have been set;
g) make sure that the energy result indicators are appropriate for the organization;
h) consider the energy result in long term planning;
i) ensure that performance is measured and reported at specified intervals;
j) conduct management reviews.

In addition, a management representative should be appointed to oversee all activities, report on energy performance and on the effectiveness of the EMS in place so as to identify a responsible person.

According to the standard, the company's energy policy should be tailored to the nature, scale and consumption of the organization; it should include a commitment to continuous improvement of energy performance, and it should include a commitment to provide all the necessary resources, both financial and material, to achieve the targets.

In addition, it is worth carrying out and documenting an energy planning process – this will help to analyze the effects that the implementation of specific solutions has had. It should be coherent with the energy policy and lead to a reduction in the energy output. A diagram of conceptual energy planning is shown in Figure 8.2 to define the organization's commitment to the result.

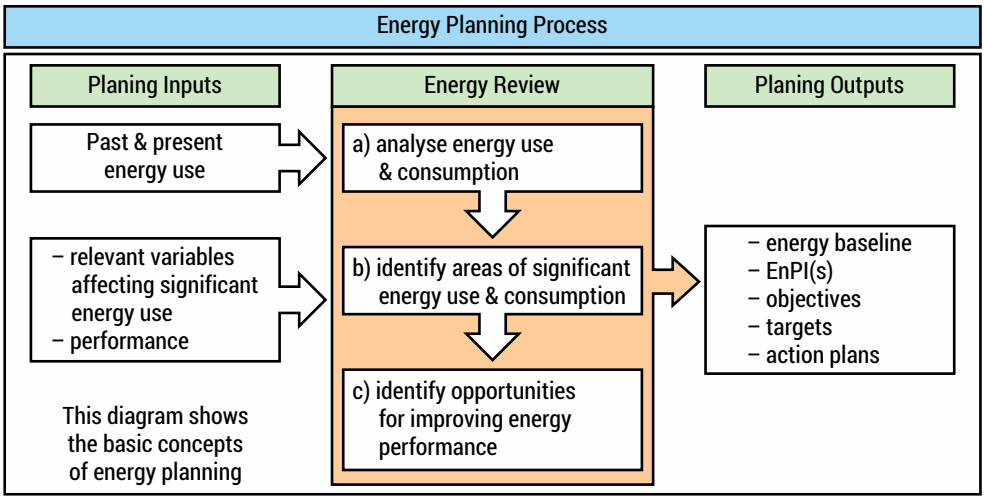


FIGURE 8.2. Energy Planning Conceptual Diagram[1]

An equally important aspect concerning energy management is the fulfilment of legal requirements. The organization must identify, implement and have access to all applicable legal requirements and other currently valid legal documents related to energy consumption and use. The organization should identify how these requirements relate to the organization and its energy management system, and energy efficiency. It should also be remembered that legal requirements should be reviewed at specific intervals so that the organization is always aware of the currently applicable conditions.

For the proper functioning of the energy management system it is necessary to perform energy reviews to make updates. To prepare an energy review, the organization should analyze energy use and consumption by measuring and identifying energy sources, as well as assessing past and present energy consumption. For the correct preparation of the energy review it is also necessary to prepare an analysis of the energy use and consumption. Having such data makes it possible to find solutions to reduce the energy output.

Another important aspect for the preparation of a well-functioning energy management system is the proper training of the staff that deal with it. It is necessary to organize training to improve the skills and knowledge of the staff working on the energy management system. The basis for this is proper education as well as the experience of the staff.

One of the soft skills that should also be developed in management is communication. With the right communication it is much easier to manage the energy system in the organization. The organization should establish and implement a process or communication path where each employee can make comments or suggestions about the ESA. It is also up to the organization to decide whether data related to the energy management system and energy performance are communicated outside the organization, and if they are, the method of such communication must also be established.

The standard also includes how to establish and maintain records related to the energy management system. The organization shall establish, implement and maintain information in electronic, paper or other media so that those who use it have easy access to it. Such documentation should include the scope and boundaries of the SHE, the energy policy, energy objectives and targets, action plans, and other necessary documents. The scope of such documentation depends on the size, scale and nature of the organization concerned. Proper supervision of the documents is also necessary.

The standard also includes a subsection on design. It states that the organization should consider opportunities for energy performance improvement and operational oversight in the design of new, modified and refurbished facilities, system equipment and processes that may affect energy performance. However, the document does not specify exact actions or solutions that can be introduced.

Standard PN-HD 60364-8-1 Low-voltage electrical installations. Part 8–1: Functional aspects – Energy efficiency

One of the primary objectives that electrical designers have when working on a project is to minimize electricity consumption, while maintaining the required level of service and safety. Electricity management should not restrict electrical availability and should not cause difficulties in using the electrical installation. There is now a strong emphasis on reducing losses in the installation system and its use. The document mentioned in the title not only covers new installations, but also refers to existing installations where, as part of a renovation or refurbishment of a building, changes can be implemented and, as a result, energy efficiency can be improved. The standard PN-HD 60364-8-1 Low-voltage electrical installations. Part 8–1: Functional aspects – Energy efficiency shows how to increase energy efficiency in electrical installations.

Optimization of electricity consumption is mainly based on energy efficiency management, which in turn is based on electricity prices and electricity consumption. In existing electrical installations, energy efficiency is checked by carrying

out periodic measurements. Measurements of the parameters of electrical installations are carried out throughout the lifetime of the installation and are intended to identify potential problems in the installation, and thus enable corrections and improvements to be made to the installation. Such improvements may be realized by redesigning the installation, or by replacement of faulty or inappropriate electrical apparatus.

The aim of introducing PN-HD 60364-8-1 Low-voltage electrical installations. Part 8–1: Functional aspects – Energy efficiency is to present the requirements and recommendations for the electrical part of the energy management system presented in the ISO 50001 standard. This standard is a set of requirements, recommendations and methods for designing and assessing the energy efficiency of an electrical installation. The electrical efficiency of the installation is classified into levels and the classification scale is shown in Figure 8.3.

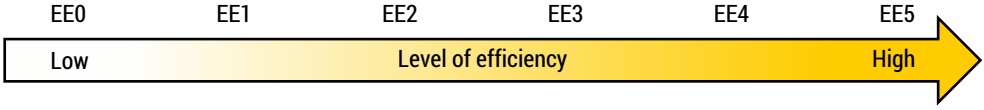


FIGURE 8.3. Scale for assessing the energy efficiency of an electrical installation [2]

In striving to optimize electricity consumption, basic principles of electrical design should be followed, which should take into account:

- the energy profile of the load;
- the availability of local generation (renewable energy sources);
- reduction of energy losses in the electrical installation;
- circuit layout for energy efficiency;
- the distribution over time of the customer's energy use;
- the tariff structure of the operator;
- maintenance, quality of service and efficiency of the electrical installation.

The aforementioned measurements of the electrical installation, and more specifically their frequency, should be determined individually for each installation depending on the nature of the facility. The frequency of periodic tests is influenced by the type and equipment of the installation, its use and operation, the frequency and quality of maintenance, factors which may affect energy efficiency and external factors to which the electrical installation is exposed. The results of each periodic inspection should be compared with the previous ones in order to see how the installation's parameters have changed and to identify the elements to be improved. In addition to the basic electrical parameters of the installation, forcing such parameters as human presence, temperature, air quality, daylight, operating time and energy cost must also be taken into account.

The standard in question includes a developed energy efficiency and load management system. It aims to control the energy consumption taking into account loads, local energy generation and storage. When designing or equipping a building,

the energy efficiency of loads must be taken into account; priority must be given to the load and the intended use of the installation to ensure an energy-efficient design. A diagram of the energy efficiency and load management system is shown in Figure 8.4.

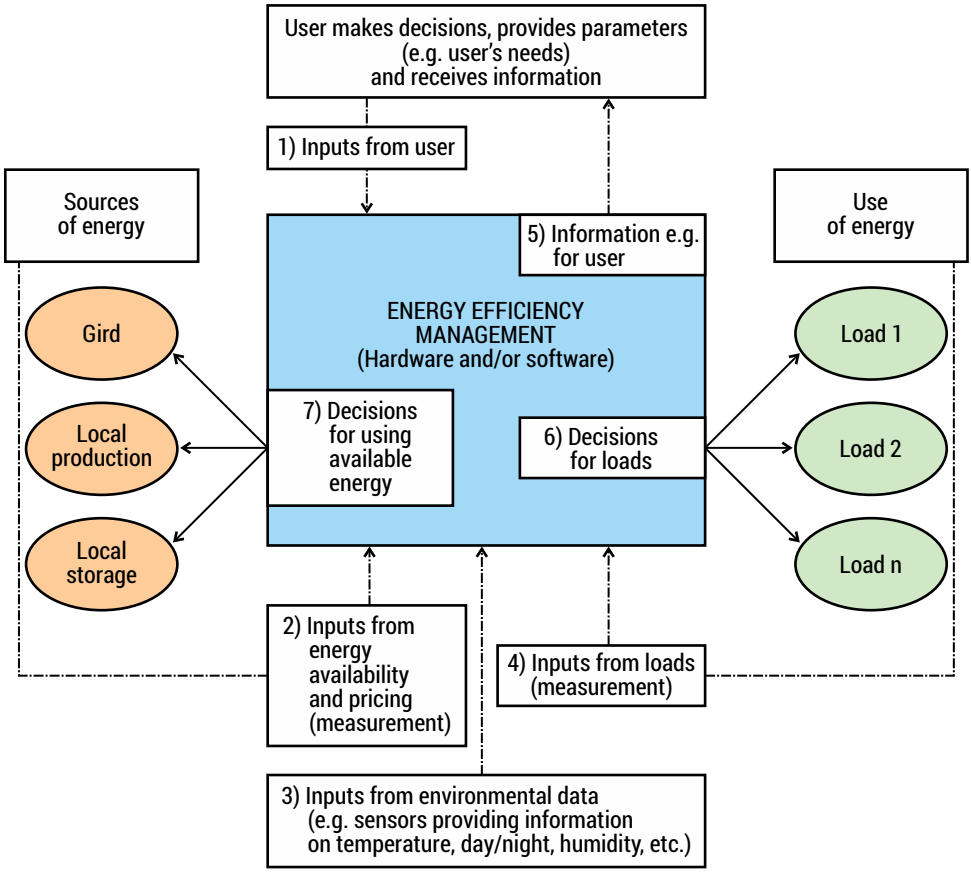


FIGURE 8.4. Energy efficiency and load management system [2]

System loads should be metered with a suitably selected electrical energy sensor, combined with external voltage and current sensors to form a complete metering system for assessing the energy efficiency of the system. Thanks to external sensors, one can anticipate other external factors – forecasts that may affect the management of electricity and which may include weather forecasts to predict temperature and renewable energy generation efficiency, occupancy forecasts, and processing forecasts to adjust generation. It is also important to remember that the meters and sensors used for measurements should be made in accordance with normative requirements so that their indications are reliable. As a result of the continuous improvement of the energy efficiency of the facility, the measurements taken at successive stages of the process will give increasingly smaller discrepancies due to the gradual achievement of the assumed objectives.

The standard also specifies what the electricity management system should be based on. These are:

- end-user selection;
- energy monitoring;
- availability and cost of energy;
- input data from loads, local electricity production and storage, energy sensors and forecasts.

Moreover, the electricity management system should include:

- mesh measurement and monitoring;
- power quality;
- reporting;
- warnings;
- tariff management, if any;
- data security;
- message function to the user and/or the public.

The process of iterative energy efficiency management is illustrated in Figure 8.5. This process shows how the optimization of electricity consumption should proceed sequentially from the consideration of measurements and audits, through the selection of equipment, optimization by means of automation and regulation, through monitoring to the control and verification of activities.

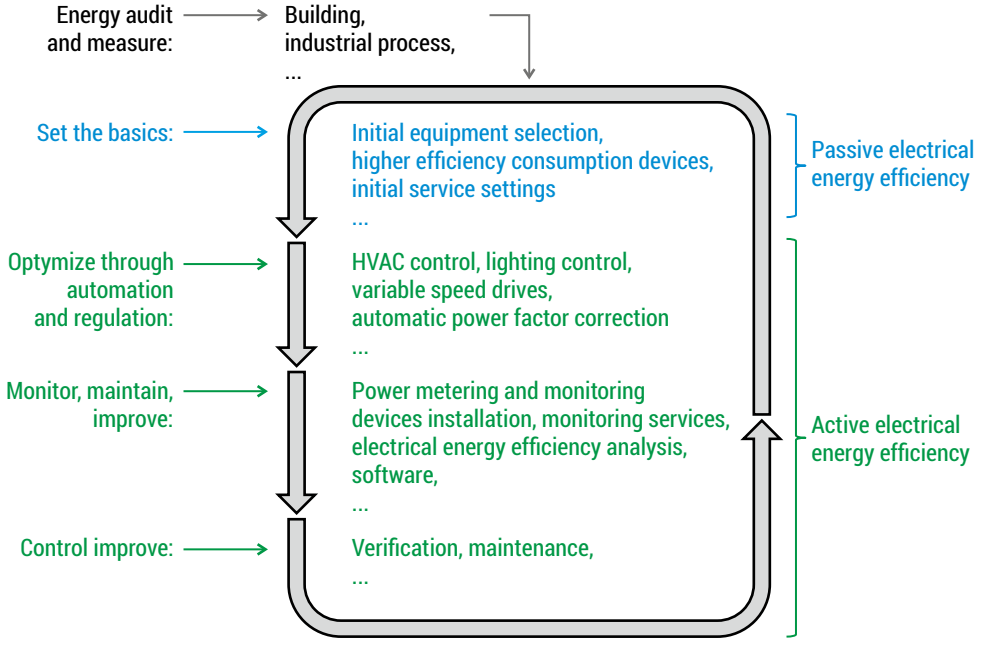


FIGURE 8.5. Iterative process for electrical energy efficiency management [2]

An electricity management system has various objectives, but first and foremost it is to control the overall power and energy efficiency and to test electricity consumption. In addition, its purpose is to determine the impact of forcing parameters, identify control indicators, identify deviations and changes in consumption patterns, and monitor the power quality of the electrical installation. The implementation of an electricity management system is required in buildings with more than 250 occupants or in buildings where electricity consumption exceeds 100,000 kWh/year.

As can be seen, the standard specifies the requirements for an energy management system and discusses the solutions that should be implemented to increase the energy performance of an electrical installation.

Conclusions

Both standards present electricity management systems. The first of the discussed standards presents the system from the general side, based on communication and management. The data contained in the standard are an introductory base for the arrangement of any management system, and the standard itself is structured to enable its implementation in many organizations of different nature. It mainly refers to how a management system should be organized.

The second standard discussed clarifies purely electrical concepts and provides more specific guidelines to be followed for electrical energy management systems. The system presented in the standard can be applied in facilities for various purposes. Specific guidelines are given, which should be followed by designers of new electrical installations and technologists developing a plan for the modernization of existing electrical installations.

The most important aspect is the mutual compatibility of the documents. The standards do not contain contradictory information. PN-HD 60364-8-1 Low-voltage electrical installations. Part 8–1: Functional aspects – Energy efficiency is only a specification of the standard PN-EN ISO 50001:2012 Energy management systems – Requirements and usage recommendations for electrical installations. The guidelines contained in these documents should be implemented in every enterprise in order to reduce electricity consumption as much as possible, and to take care of the surrounding climate.

Streszczenie: Systemy zarządzania energią elektryczną a efektywność energetyczna w świetle obowiązujących norm. W tekście przedstawione zostały dwie normy związane z efektywnością energetyczną PN-EN ISO 50001:2012 Systemy zarządzania energią – Wymagania i zalecenia użytkowania oraz PN-HD 60364-8-1 Instalacje elektryczne niskiego napięcia. Część 8–1: Aspekty funkcjonalne – Efektywność energetyczna. W normach rozpatrzono jak przedstawiają systemy zarządzania energią elektryczną i sprawdzono również, czy wymagania, jakie reprezentują są ze sobą zgodne i nie wykluczają się wzajemnie.

Słowa kluczowe: efektywność elektryczna, zarządzanie efektywnością, instalacje elektryczne, kompatybilność norm.

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