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IEC Advisory Committee on energy efficiency (ACEE)

Case study: low-voltage electrical installations

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INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

Case study: low-voltage electrical installations

This case study is provided to illustrate a practical example (in practice) on how IEC Guide 118 concepts can be applied/found in low-voltage electrical installations and in product standards and, more generally, on how International Standards can support the energy efficiency market and national energy efficiency policies.

1 Energy efficiency of low-voltage electrical installations

Buildings represent 40 % of the global energy demand. A significant part of this energy is supplied by electricity. Therefore, the overall efficiency of the low-voltage electrical installation is key.

IEC 60364-8-1 is an International Standard based on the concepts of IEC Guide 118, which gives guidance and methods in order to:

– improve by design the efficiency of the installation;
– control the usage of equipment;
– benefit from the tariff of the supplied electricity;
– measure the consumption of relevant loads;
– maintain the energy performance of the installation;
– assess the efficiency of the installation.

IEC 60364-8-1 is also a group energy efficiency publication (GEEP) according to IEC Guide 119. Therefore, it can be used by other IEC Technical Committees in order to design the functions to be implemented in their product to contribute to the implementation of energy efficiency measures in low-voltage electrical installations.

2 Standardization and energy efficiency: IEC approach

IEC set up an Advisory Committee on Energy Efficiency (ACEE) to coordinate its activities in this domain.

ACEE has developed two Guides (IEC Guide 118 and IEC Guide 119) with the aim of defining the concept of Energy Efficiency Aspects (EEAs) to provide guidance to IEC Technical Committees (TCs) on how to approach energy efficiency standardization, promoting a systems approach and defining procedures for the preparation of such standards.

IEC Guide 118 proposes a general approach to energy efficiency standardization by defining the concept of EEAs as all those elements/services that a standard can provide to support a generic "energy efficiency improvement" process. Five categories of EEA that should be considered when developing a standard have been proposed:

– energy efficiency definition;
– energy efficiency design;
– energy efficiency measurement;
– energy efficiency assessment;
– energy efficiency improvement;
– energy efficiency enabling.

EEAs should ensure the development of a rational and effective standardization process in the energy efficiency domain as they provide a systematic approach to identify the relevant scope for standardization and might serve as a taxonomy to map existing standards to identify standardization gaps and areas where standards can support regulation and to streamline the activity of IEC TCs.

3 Energy efficiency of low-voltage electrical installations: boundaries

Boundary definition is key for defining the scope for energy efficiency.

The best boundary to be used is the whole low-voltage electrical installation. In this case, the overall efficiency of the installation is optimised.

The concept of local boundary is also introduced in IEC 60364-8-1 as a mesh or a group of meshes. The determination of the meshes in the installation is defined so that they deliver the associated usage, while allowing effective management of the consumption of energy, and considering at least one of the criteria having a technical and/or economical aspect.

Electrical management for energy efficiency is a system approach aiming to optimize the management of energy used for a specific service within a defined "electrical mesh", taking into account all necessary information concerning the technical and economic approaches.

It is seldom the case that the optimum of a system equals the sum of the optima of each part of the system. It is therefore necessary to consider the most appropriate meshes of the electrical installation from the electrical energy efficiency point of view.

This shall be considered in order to get the lowest electrical energy consumption and/or cost with regards to a solution for a service which is, and can be, compared to another solution.

4 Energy efficiency of low-voltage electrical installations: EEAs

4.1 General

The optimization of electrical energy usage can be facilitated by appropriate design and installation considerations. An electrical installation can provide the required level of service and safety for the lowest electrical consumption. This is considered by designers as a general requirement of their design procedures in order to establish the best use of electrical energy.

In addition to the many parameters taken into account in the design of electrical installations, more importance is nowadays focused on reducing losses within the system and its use. The design of the whole installation therefore has to take into account inputs from users, suppliers and utilities.

The optimization of the use of electricity is based on energy efficiency management which is based on the price of electricity, electrical consumption and real-time adaptation. Efficiency is checked by measurement during the whole life of the electrical installation. This helps identify opportunities for any improvements and corrections. Improvements and corrections may be implemented by redesign or equipment replacement. The aim is to provide a design for an efficient electrical installation which allows an energy management process to suit the user's needs, and in accordance with an acceptable investment. This document first introduces the different measures to ensure an energy efficient installation based on kWh saving. It then provides guidance on giving priority to the measures depending on the return on investment, i.e. the saving of electrical energy and reducing of electrical power costs divided by the amount of investment.

4.2 Design principles

The design principles of this document take into account the following aspects:

– load energy profile (active and reactive);
– availability of local generation (PV, wind turbine, generator, etc.) and storage;
– reduction of energy losses in the electrical installation;
– the arrangement of the circuits with regard to energy efficiency (meshes);
– the customer's power use distribution over time;
– the tariff structure offered by the supplier of the electrical energy;
– maintaining the quality of service and the performance of the electrical installation.

In order to verify the achievement of electrical energy efficiency measures, an overall energy efficiency assessment should be made.

During the design phase, it is key to consider the implementation of measures which are going to affect the energy efficiency of the low-voltage electrical installation during its overall lifetime.

First, the consumption and/or the load profile of the equipment shall be determined in order to determine the loads or groups of loads having the highest consumption. These loads using around 80 % of the total consumption, shall then be used for the application of the energy efficiency measures.

Such measures are:

– reduction of the voltage drop by:
  - reducing the length of the wiring thanks to the barycentre method;
  - oversizing the wiring;
– usage of efficient transformers and close to their efficient working point;
– controlling the power factor and the level of harmonics;
– defining the optimal circuits with regard to energy efficiency, called meshes.

4.3 Driving parameters

Driving parameters having the most influence on energy efficiency shall be identified.

Driving parameters should be assessed to evaluate their relative influence on the overall consumption of the installation.

Dedicated indicators should be analysed to verify the energy efficiency of the installation according to the influence of the driving parameters.

EXAMPLE kWh per m^2 per degree days.

Usually, at least the following driving parameters are considered:

– occupancy;
– operating time;
– environmental conditions;
– cost of the electricity.

4.4 Energy efficiency and load management system

An energy efficiency and load management system controls the usage of the energy consumed, taking into account the loads, local production and storage and user requirements, (see Figure 1).

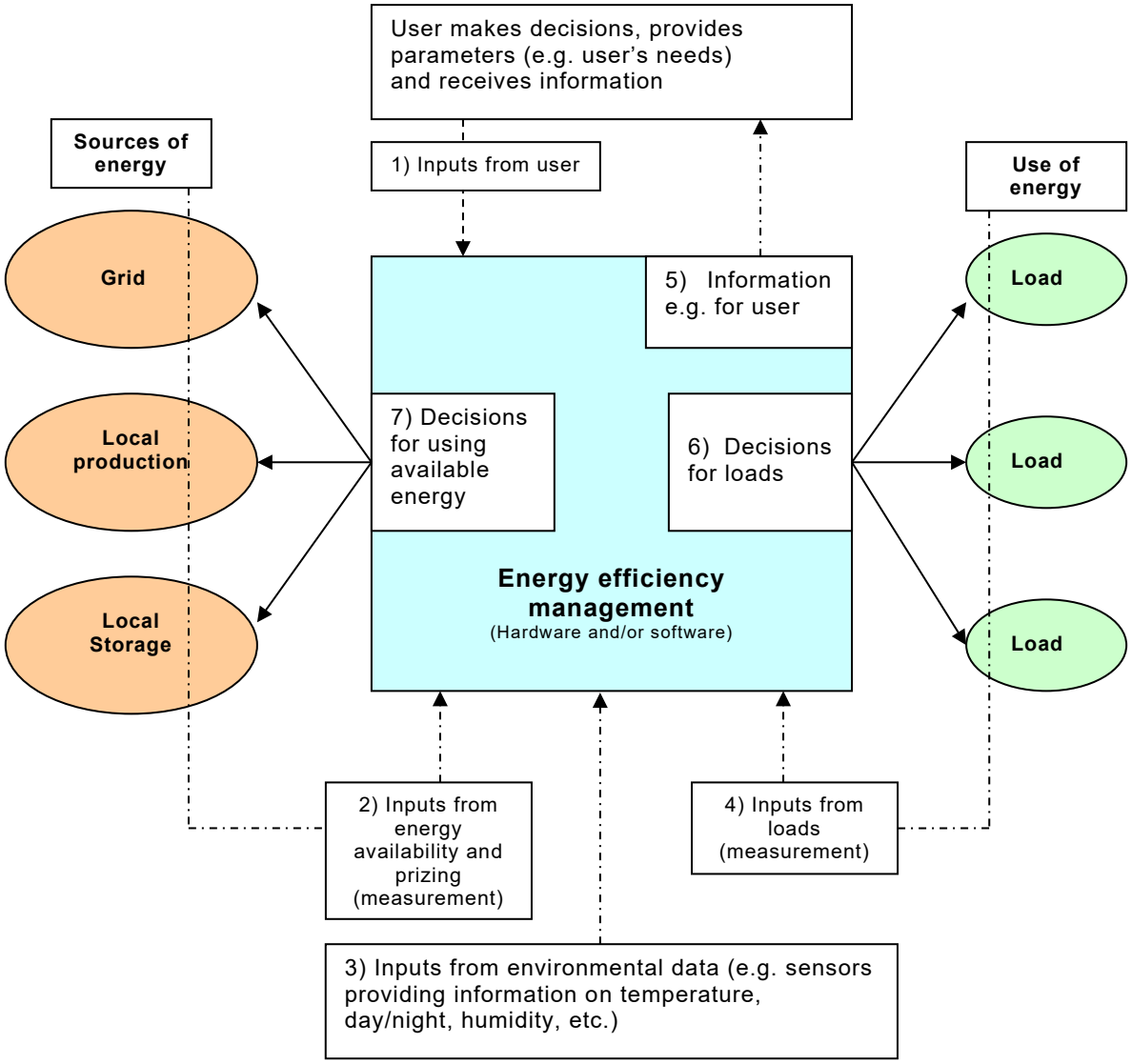


Figure 1 – Energy efficiency and load management system overview

4.5 Measurement

Making measurements is key to determine and assess the efficiency of a building. The measurement of electrical parameters is required in determining the electrical consumption and needs to be supplemented by the measurement of relevant driving parameters such as the presence of people, temperature, quality of air, daylight, operating time, cost of energy.

Energy measurement provides the subscriber with an awareness of its consumption.

Consequently, device accuracy and measuring range shall be adapted to the intended use.

Usually, the highest metering accuracy is necessary at the origin of the installation where it is used for billing or similar purposes, but also to measure and assess the efficiency of the whole installation, or to enable assessment of the whole installation.

A lower level of accuracy is generally sufficient downstream. For the lowest level, at the final circuit level, it is adequate to provide the durations of consumption, or to follow a trend, or to monitor a load.

Table 1 gives the measurement equipment to be used according to the application.

Table 1 – Measurement applications

Measurement application	Applicable IEC product standards	Device name according to standards	Usual device name	Complementary explanations
Billing (Contractual)	or IEC 62053-21 or IEC 62053-22	Electricity metering equipment	Revenue meter, electricity meter, utility meter	Energy metering for billing applications (e.g. utility invoicing a landlord or a mall owner, sub-billing to tenants)
Energy usage analysis	IEC 61557-12	Power metering and monitoring device (PMD-I or PMD-II or PMD-III)	Power meter, energy meter	Energy cost and usage analysis (for cost allocation or sub-billing within a company or for energy efficiency purposes)
Power monitoring	IEC 61557-12	Power metering and monitoring device (PMD-II or PMD-III)	Power meter, energy meter	Demand side power quality analysis and energy cost and usage analysis
Energy estimation		Indicator or sensor	Energy estimator	Devices for giving information needed to correctly operate the energy management system, for example running time of equipment, number of operations, basic measurement

4.6 Maintenance of the performance of the installation

The implementation of electrical energy efficiency measures requires an integrated approach to the electrical installation as optimization of the electrical energy consumption requires consideration of all modes of operation of the installation. See Table 2.

Table 2 – Process for electrical energy efficiency management and responsibilities

Action	Details	Generally performed by
Energy audit and measure	Analysis of data from installed power metering and monitoring devices and/or non-installed measurement equipment	Auditor or energy manager
Set the basics	Initial equipment selection, higher efficiency consumption devices Initial service settings, etc.	Designer and/or installer and/or client and/or tenant and/or end-user
Optimize	HVAC control Lighting control Variable speed drives Automatic power factor correction, etc.	Installer/tenant or end-user, energy manager
Monitor, maintain the performance	Power metering and monitoring devices installation Monitoring services Electrical energy efficiency analysis, software, etc.	Energy manager/tenant or end-user
Control, improve	Verification, maintenance, etc.	Energy manager/tenant or end-user

4.7 Implementation of efficiency measures

To achieve an energy efficiency performance level, the designer of an electrical installation or facility manager has to make an analysis or to use means to determine efficiency measures to be implemented. These measures and levels are used to build the installation profile and electrical installation efficiency class as follows:

a) efficiency of current-using/carrying equipment;

b) efficiency of the electrical installation;

c) implementation of monitoring systems;

d) installation of local power supply.

Current-using/carrying equipment efficiency is based on the specification and use of that equipment.

5 Assess the energy efficiency of an electrical installation

IEC 60364-8-1 provides a method to assess the energy efficiency of an electrical installation based on the relevant parameters influencing this efficiency. This method applies to both new and existing installations, in premises used for purposes including industrial, commercial, infrastructure and residential.

The way in which the method is applied for residential premises differs in some ways from the way it is applied for other types of premises.

The method assesses the different parameters having an impact on the efficiency of the installation, based on the level of implementation of the energy efficiency measures described in the standard for:

– initial installation;

– energy management;

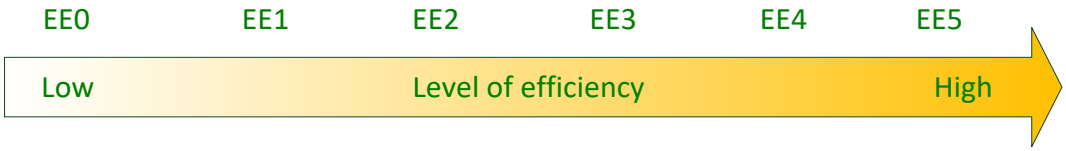
– performance maintenance;

– power monitoring;

– bonus.

For each parameter, some points are given depending on the level of implementation, the efficiency of the installation, and on the type of premises.

The energy efficiency of an electrical installation is rated into one of the following classes from lower efficiency to higher efficiency: EE0, EE1, EE2, EE3, EE4, and EE5.



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