भारतीय मानक
Indian Standard

IS 16996 : 2018
IEC 60364-8-1 : 2014

निम्न-वोल्टता के विद्युत संस्थापन — ऊर्जा दक्षता

Low-Voltage Electrical Installations — Energy Efficiency

ICS 13.020.01; 91.140.50

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NATIONAL FOREWORD

This Indian Standard which is identical with IEC 60364-8-1 : 2014 'Low-voltage electrical installations — Part 8-1: Energy efficiency' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on recommendation of the Electrical Installations Sectional Committee and approval of the Electrotechnical Division Council.

This standard provides additional requirements, measures and recommendations for the design, erection and verification of all types of low-voltage electrical installation including local production and storage of energy for optimizing the overall efficient use of electricity.

This standard is applicable to the electrical installation of a building or system and does not apply to products. The energy efficiency of these products and their operational requirements are covered by the relevant product standards.

This standard does not specifically address building automation systems.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60034-30 Rotating electrical machines — Part 30: Efficiency classes of single speed, three phase, cage-induction motors (IE-code)	IS 12615 : 2011 Energy-efficient induction motors — Three phase squirrel cage	Technically Equivalent with IEC 60034-30 : 2008
IEC 600364-5-52 : 2009 Low-voltage electrical installations — Part 5-52: Selection and erection of electrical equipment — Wiring systems	IS 732 : 2018 Code of practice for electrical wiring installations (*fourth revision*) (*under print*)	Technically Equivalent
IEC 600364-5-55 : 2011 Low-voltage electrical installations — Part 5-55: Selection and erection of electrical equipment — Other equipment	IS 732 : 2018 Code of practice for electrical wiring installations (*fourth revision*) (*under print*)	Technically Equivalent
IEC 60364-7-712 : 2002 Electrical installations of buildings — Part 7-712: Requirements for special installations or locations — Solar photovoltaic (PV) power supply systems	IS 16997 : 2018 Requirements for Low-Voltage Special Electrical Installations or Locations — Solar photovoltaic (PV) power supply systems (*under print*)	Identical

(*Continued on third cover*)

INTRODUCTION

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 takes into account inputs from users, suppliers and utilities.

The rate of replacement of existing properties is low, between 2 % and 5 % annually, depending on the state of the local economy. It is therefore important that this standard covers existing electrical installations in buildings, in addition to new installations. It is in the refurbishment of existing buildings that significant overall improvements in energy efficiency can be achieved.

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 through major investment or by an incremental method. 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 standard 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 of investment, i.e. the saving of electrical energy costs divided by the amount of investment.

This standard is intended to provide requirements and recommendations for the electrical part of the energy management system addressed by ISO 50001 [1][1].

Account should be taken, if appropriate, of induced works (civil works, compartmentalization) and the necessity to expect, or not, the modifiability of the installation.

This standard introduces requirements and recommendations to design the adequate installation in order to give the ability to improve the management of performance of the installation by the tenant/user or for example the energy manager.

All requirements and recommendations of this part of IEC 60364 enhance the requirements contained in Parts 1 to 7 of the standard.

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1 Numbers in square brackets refer to the Bibliography.

Indian Standard

LOW-VOLTAGE ELECTRICAL INSTALLATIONS — ENERGY EFFICIENCY

1 Scope

This part of IEC 60364 provides additional requirements, measures and recommendations for the design, erection and verification of all types of low-voltage electrical installation including local production and storage of energy for optimizing the overall efficient use of electricity.

It introduces requirements and recommendations for the design of an electrical installation within the framework of an energy efficiency management approach in order to get the best permanent functionally equivalent service for the lowest electrical energy consumption and the most acceptable energy availability and economic balance.

These requirements and recommendations apply, within the scope of the IEC 60364 series, for new installations and modification of existing installations.

This standard is applicable to the electrical installation of a building or system and does not apply to products. The energy efficiency of these products and their operational requirements are covered by the relevant product standards.

This standard does not specifically address building automation systems.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-30, *Rotating electrical machines – Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code)*

IEC 60287-3-2, *Electric cables – Calculation of the current rating – Part 3-2: Sections on operating conditions – Economic optimization of power cable size*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-55:2011, *Low-voltage electrical installations – Part 5-55: Selection and erection of electrical equipment – Other equipment*

IEC 60364-7-712:2002, *Electrical installations of buildings – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*

IEC 61557-12:2007, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 12: performance measuring and monitoring devices (PMD)*

IEC 62053-21, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

IEC 62053-22, *Electricity metering equipment (a.c.) – Particular requirements – Part 22: Static meters for active energy (classes 0,2 S and 0,5 S)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 General

3.1.1
zone
area (or a surface) defining part of an installation

Note 1 to entry: Examples of a zone can be a kitchen of 20 m^2 or a storage area of 500 m^2.

3.1.2
current-using equipment
electrical equipment intended to convert electrical energy into another form of energy, for example light, heat, mechanical energy

[SOURCE: IEC 60050-826:2004, 826-16-02] [2]

3.1.3
electrical distribution system
set of coordinated electrical equipment such as transformers, protection relays, circuit-breakers, wires, busbars, etc. for the purpose of powering current-using equipment with electrical energy

3.1.4
usage
type of application for which electricity is used such as lighting, heating, etc.

3.1.5
distribution system design
design of cabling and associated electrical equipment for the distribution of electrical energy

3.1.6
load energy profile
electrical energy consumed over a specified period of time for a mesh or a group of meshes

3.1.7
electrical energy efficiency
EEE
system approach to optimize the efficiency of electrical energy use

Note 1 to entry: Energy efficiency improvement measures take into account the following considerations:

– both the consumption (kWh) and the price of electricity technology;
– environmental impact.

Note 2 to entry: “Energy efficiency” is considered to represent “Electrical energy efficiency” in this standard.

3.1.8
mesh
group of electrical equipment powered from one or more circuits of the electrical installation for one or more zones including one or more services for the purpose of electrical energy efficiency

3.1.9
active electrical energy efficiency measures
measures for the optimization of electrical energy produced, supplied, flowing and consumed by an electrical installation for the best permanent functionally equivalent service

Note 1 to entry: In this context, the word “measure” is to be understood as “provision”.

3.1.10
passive electrical energy efficiency measures
measures for the choice of parameters of electrical equipment (type, location, etc.) in order to improve overall electrical energy efficiency of the electrical installation while not affecting initial construction parameters such as limiting air penetration, water penetration, and thermal insulation, and other parts of the structure of the building

Note 1 to entry: In this context, the word “measure” is to be understood as “provision”.

3.1.11
electrical energy efficiency profile
set of criteria defining the electrical energy efficiency of an electrical installation

3.1.12
electrical installation efficiency class
EIEC
combination of efficiency measures (EM) and energy efficiency performance levels (EEPL)

3.1.13
efficiency measures
EM
level of implementation of measures to improve energy efficiency of an electrical installation

3.1.14
energy efficiency performance level
EEPL
level of energy efficiency improvement attained by measures implemented for improving the energy efficiency of an electrical installation

3.1.15
energy efficiency parameter
influencing factor on the energy efficiency of the installation

3.2 Electrical energy management

3.2.1
installation monitoring and supervision system
set of coordinated devices for the purpose of controlling and supervising electrical parameters in an electrical distribution system

Note 1 to entry: Examples of devices are

- current sensors,
- voltage sensors,
- metering and monitoring devices,
- power quality instruments,
- supervision software tools.

3.2.2
electrical energy management system
EEMS
system comprising different equipment and devices in the installation for the purpose of energy efficiency management

3.2.3
rational use of energy
energy use by consumers in a manner best suited to the realization of economic objectives, taking into account technical, social, political, financial and environmental constraints

3.2.4
electrical energy management and efficiency
system approach to optimize the efficiency of energy used to perform a given service, activity or function and taking care of inputs from user needs, utilities needs and energy pricing, availability of local storage or production of electrical energy

3.2.5
load shedding
approach where the electrical loads are switched off for variable periods of time to optimize demand

3.3 Energy measurement

3.3.1
energy measurement
process of obtaining one or more values that can be attributed to a quantity of energy

3.3.2
metering
applying a device measuring energy or other consumption

3.3.3
estimation
process of judging one or more values that can be attributed to a quantity

Note 1 to entry: Estimation by a competent person can provide data of a reasonable accuracy.

3.3.4
monitoring
continuing procedure for the collection and assessment of pertinent information, including measurements, for the purpose of determining the effectiveness of the plans and procedures

[SOURCE: IEC 60050-881:1983, 881-16-02 [3], modified – the words "for radiation protection" have been omitted]

3.3.5
evaluation
comparison of monitored results against targets

3.3.6
forecast
an estimate of the expected value of a parameter at a given future date

3.3.7
total harmonic distortion of the voltage wave
THDu
ratio of the r.m.s. value of the harmonic content of an alternating quantity (voltage) to the r.m.s. value of the fundamental component of the quantity (voltage)

3.3.8
total harmonic distortion of the current wave
THDi
ratio of the r.m.s. value of the harmonic content of an alternating quantity (current) to the r.m.s. value of the fundamental component of the quantity (current)

3.4 Sectors of activities

3.4.1
residential buildings (dwellings)
premises designed and constructed for private habitation

3.4.2
commercial buildings
premises designed and constructed for commercial operations

Note 1 to entry: Examples of commercial buildings are offices, retail, distribution, public buildings, banks, hotels.

3.4.3
industrial buildings
premises designed and constructed for manufacturing and processing operations

Note 1 to entry: Examples of industrial buildings are factories, workshops, distribution centres.

3.4.4
infrastructure
systems or premises designed and constructed for transport or utility operations

Note 1 to entry: Examples of infrastructures are airport terminals, port facilities, transport facilities.

4 General

4.1 Fundamental principles

4.1.1 Safety of the electrical installation

The requirements and recommendations of this part of IEC 60364 shall not impair requirements included in other parts of the IEC 60364 series. The safety of persons, property and livestock remains of prime importance.

Active electrical energy efficiency measures shall not impair the passive energy efficiency measures of the building.

4.1.2 Availability of electrical energy and user decision

Energy efficiency management shall not reduce electrical availability and/or services or operation below the level desired by the user.

The user of the electrical installation shall be able to take the final decision over whether they accept or not to use a service at nominal value, or optimized value or not to use it for a certain time.

At any time the user shall be able to make an exemption and to use the service in accordance with his needs while being aware that this can be more costly than expected from the electrical energy point of view.

NOTE Examples are if someone is ill, the user may decide to heat the room at a higher temperature, even during peak consumption; if a company receives an urgent delivery order, the workshop may need to work at an unexpected hour.

4.1.3 Design requirements and recommendations

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

- load energy profile (active and passive);
- availability of local generation (solar, wind, generator, etc.);
- reduction of energy losses in the electrical installation;
- the arrangement of the circuits with regard to energy efficiency (meshes);
- the use of energy according to customer demand;
- the tariff structure offered by the supplier of the electrical energy;

without losing the quality of service and the performance of the electrical installation.

5 Sectors of activities

For a general approach to electrical energy efficiency, four sectors may be identified, each having particular characteristics requiring specific methodology of implementation of EEE:

- residential buildings (dwellings);
- commercial buildings;
- industrial buildings;
- infrastructure.

6 Design requirements and recommendations

6.1 General

This clause gives the design principles of the installation, taking into account:

- the load energy profile (active and passive);
- the minimization of energy losses in the electrical installation by means of
  - optimal location of the HV/LV substation, local energy production source and switchboard (barycentre),
  - reduction of losses in wiring.

6.2 Determination of load profile

The main load demands within the installation shall be determined. The loads in kVA, together with their durations of operation, and/or an estimate of the annual load consumption (in kWh) should be identified and listed.

6.3 Determination of the transformer and switchboard location with the barycentre method

Account shall be taken of the building’s use, construction and space availability for the best position to be obtained, but this should be determined with the building's designers and owners prior to construction. To keep losses to a minimum, transformers and main distribution switchboards shall be located (where possible) in such a way as to keep distances to main loads to a minimum. The methods used for determining the position can be used to determine the optimal available site for the distribution equipment and transformers.

The barycentre method is one solution which identifies if the load distribution is uniform or of localized type and determines the total load barycentre location. See examples of calculations in Annex A.

6.4 HV/LV substation

6.4.1 General

To find the optimal solution for the transformer, consideration of the following topics shall be taken into account:

- the optimum number of HV/LV substations;
- the working point of the transformer;
- the efficiency of the transformer.

As an LV consumer, it is important to have an early discussion with the utility on the number and location of the substations, transformers and switchboards.

As an HV consumer, it is important to consider the number and location of substations, transformers and LV switchboards.

6.4.2 Optimum number of HV/LV substations

Depending on several criteria such as the required power, the building surface and the load distribution, the number of HV/LV substations and the distribution layout will have an influence on the lengths and cross-sectional areas of cables.

The barycentre method is one solution which identifies if the load distribution is uniform or of localized type and determines the total load barycentre location. See examples of calculations in Annex A.

If the barycentre is located in one building side, it is advised to choose one substation close to this barycentre; on the other hand, if the barycentre is located in the middle of the building layout, it may not be possible to locate the HV/LV substation near to the load centre. In such cases, it is advised to divide the electrical distribution among several HV/LV substations located to their respective barycentre. This enables the optimization of LV cable lengths and sizes.

6.4.3 Working point of the transformer

The maximum efficiency of a transformer is when the iron and copper losses are equal.

NOTE 1 Usually, the maximum efficiency of a transformer corresponds to 25 % to 50 % of maximum power rating of the transformer.

NOTE 2 Efficiency calculation can be accomplished using any appropriate standard for transformers, e.g. IEC 60076-20 [4], NEMA guide TP1 [5] and IEEE C57.12 standards [6]

6.4.4 Efficiency of the transformer

Transformers are inherently efficient electrical machines. Their environmental impact mainly depends on the working point energy losses.

The choice of an energy efficient transformer may have a significant impact on the energy efficiency of the whole installation.

Energy efficiency of the transformers may be classified on the basis of their load and no-load energy losses.

The choice of the top energy efficiency class results in increased cost. However, the payback time can be estimated to be relatively short (few years) compared to the average lifetime (more than 25 years) of the transformer.

Where located within the building, energy efficient transformers can reduce the energy consumption of the air conditioning or mechanical ventilation required to limit the ambient temperature in the transformer location.

The placement of transformers may be subject to further safety constraints in the case of oil-immersed transformers.

Reference should be made to manufacturers' information for more details on energy efficient transformers, including design guidelines, estimated payback time, heat dissipation needs and installation constraints in the presence of other heat-dissipating equipment.

6.5 Efficiency of local production

Under consideration.

6.6 Efficiency of local storage

Under consideration.

6.7 Losses in the wiring

6.7.1 Voltage drop

Reducing the voltage drop in the wiring is achieved by reducing the losses in the wiring.

Recommendations on the maximum voltage drop in the installation are provided in Clause 525 of IEC 60364-5-52:2009.

6.7.2 Cross-sectional areas of conductors

Increasing the cross-sectional area of conductors will reduce the power losses. This decision shall be made by assessing the savings within a time scale against the additional cost due to this over-sizing.

For cables, the chosen size shall be determined taking into account the cost of losses that will occur during the working life of the cable against the initial cost of the cable. A calculation method can be found in IEC 60287-3-2.

The I^2Rt losses and limitations on future expansion of fed loads need to be considered for smaller conductors.

NOTE In some applications (particularly industrial), the most economical cross-sectional area of conductor may be several sizes larger than that required for thermal reasons.

6.7.3 Power factor correction

Reduction of the reactive energy consumption at the load level reduces the thermal losses in the wiring.

A possible solution to improve the power factor could be the installation of a power factor correction system at the respective load circuits.

NOTE A power factor correction could be made at the load level or centrally, depending on the type of application. The complexity of the issue leads to consideration of each individual application.

6.7.4 Reduction of the effects of harmonic currents

Reduction of harmonics at the load level, e.g. selection of harmonic-free products, reduces the thermal losses in the wiring.

Possible solutions include:

– reducing harmonics by the installation of harmonic filters at the respective load circuits;
– reducing the effect ofharmonics by increasing the cross-sectional area of the conductors.

NOTE A reduction of harmonics could be made at the load level or centrally, depending on the type of application. The complexity of the issue leads to consideration of each individual application.

7 Determination of the zones, usages and meshes

7.1 Determining the zones

A zone represents a surface area in m^2 or a location where the electricity is used. It may correspond for example to

– an industrial workshop,
– a floor in building,
– a space near windows or a space far from windows,
– a room in a dwelling,
– a private swimming pool,
– a hotel kitchen.

Designers, electrical contractors or the building owner shall agree on the zones within the building.

Identification of the zones is needed to enable correct determination of the meshes (see 7.3.1).

7.2 Determining the usages within the identified zones

Identification of the usage for a particular circuit or zone is needed to enable accurate measurement and analysis of its energy consumption.

Different usages could be the following:

– hot water production;
– HVAC (cooling and heating);
– lighting;
– motors;
– appliances.

7.3 Determining the meshes

7.3.1 General

A mesh is a circuit or a group of circuits identified with respective current-using equipment as useful for energy efficiency management.

A mesh may belong to one or several zones (see 7.1).

A mesh determines one or several usages (see 7.2) in one or several zones.

Meshes shall be managed to use electrical energy to always fulfil the need, taking into account factors such as the availability of daylight, occupation of a room, availability of energy, external temperature, others aspects linked to the building construction and passive energy efficiency.

One circuit belongs to one mesh.

The determination of the meshes in the installation shall be 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 defined in 7.3.2.

7.3.2 Criteria for considering meshes

7.3.2.1 General

The following criteria are necessary for defining the different meshes of an electrical installation from the point of view of energy management and monitoring with regards to efficiency.

In addition to criteria depending on the local price of energy, the following criteria are necessary for defining different meshes of an electrical installation from the point of view of energy management and monitoring with regards to efficiency.

7.3.2.2 Technical criteria based on external parameters (e.g. time, illuminance, temperature, etc.)

Interruption of certain services or applications should be avoided during certain periods of time. The designer, electrical contractor and/or end user should agree on the daily, weekly, monthly or yearly scheduling for when some services or applications shall be available or can be reduced or stopped. Identifying these applications and gathering them in a mesh are key from an energy efficiency point of view. For example, defining a mesh for luminaires near windows and a second one for luminaire(s) near the wall allows for switching off those near the windows when daylight is sufficient.

7.3.2.3 Technical criteria based on control

A mesh can gather together some loads functionally linked with one or more control devices. For example the thermostat of an electric heating system controlling radiators from several electrical circuits, so that those radiators belong to the same mesh.

7.3.2.4 Technical criteria based on critical points for measurement

The accuracy of a measurement is not the same if the objective is to follow a trend or to invoice a service. The purpose of measurement can help to decide the appropriate mesh.

7.3.2.5 Economic criteria based on ratio

In general, small meshes are not effective when pursuing energy efficiency improvements for an installation.

In a location where a group of utilisation equipment needs to operate all at the same time, creating a large mesh containing all this equipment is beneficial. In cases such as multiple luminaires in a single room, having several small meshes permits a more effective use of energy.

7.3.2.6 Economic criteria based on the variable cost of electricity

The cost of electricity may vary with the time of use (increase or decrease of the kWh cost at a given time), and with the maximum power allowed by the grid (demand/response may be necessary for monitoring the energy).

Depending on the price variability of the electricity for buying, selling and storage, it can be useful, when possible, to defer or anticipate certain uses or design meshes with this consideration, in mind.

7.3.2.7 Technical criteria based on energy inertia

It is not possible, or it is at least difficult, to introduce load shedding on a mesh dealing with lighting (no inertia), while it is easier on a mesh including water heating systems (large inertia). Considering inertia of loads is useful in deciding how to introduce load shedding between appropriate meshes.

Meshes including recharging of batteries, heating systems, air cooling, a fridge, etc. can be gathered against meshes including lighting, available socket-outlets for the IT equipment, etc. It will therefore be possible to introduce load shedding and rules for load shedding in meshes having a high inertia. This is an input for product standardization for product design and installation design.

A high inertia is generally associated with easier load shedding due to the fact that the status of the load is not really affected by the variation of the electrical supply.

7.3.3 Meshes

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 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 with regards to a solution for a service which is, and can be, compared to another solution.

It has also to be considered that the installation of a device to introduce modified operation or new functions designed to optimize electrical consumption for that product may result in an increase of electrical consumption for interrelated loads within the same system. It is therefore meaningless to separately consider only one or several devices where the assembly, which includes that device or all of those devices, within the system of a circuit or a mesh may experience optimized consumption, even though the consumption of some individual parts may increase.

Introducing electrical equipment or functions for reducing, measuring, optimizing and monitoring, energy consumption or any other use aiming to improve the use of electricity may increase the energy consumption in some parts of a system.

For example the use of a control device, e.g. a thermostat in an electric heating system, a human presence detector in an electric lighting system, etc. may increase the instant or global consumption of particular equipment for some devices but decrease the total consumption of the whole mesh.

According to this standard, the smallest mesh is limited to one electrical device and the largest mesh covers all electrical circuits used in the whole building for all services.

7.4 Impacts on distribution system design

Distribution system design of the electrical installation shall consider energy efficiency at every stage, including the impact of different load demands, usage, zones and meshes.

The installation of fixed equipment for metering, control and energy management shall be considered for new construction and future modifications.

Main distribution switchboards shall be so designed as to segregate circuits supplying each zone or each mesh defined in 7.3. This requirement shall also apply to other distribution switchboards, where necessary.

8 Energy efficiency and load management system

8.1 General

An energy efficiency and load management system (see Figure 1) provides guidance on how to optimize the usage of the energy consumed, taking into account the loads, local production and storage and user requirements.

For an installation where an energy efficiency system is to be applied, a possible implementation of this system can be created as described in the following clauses.

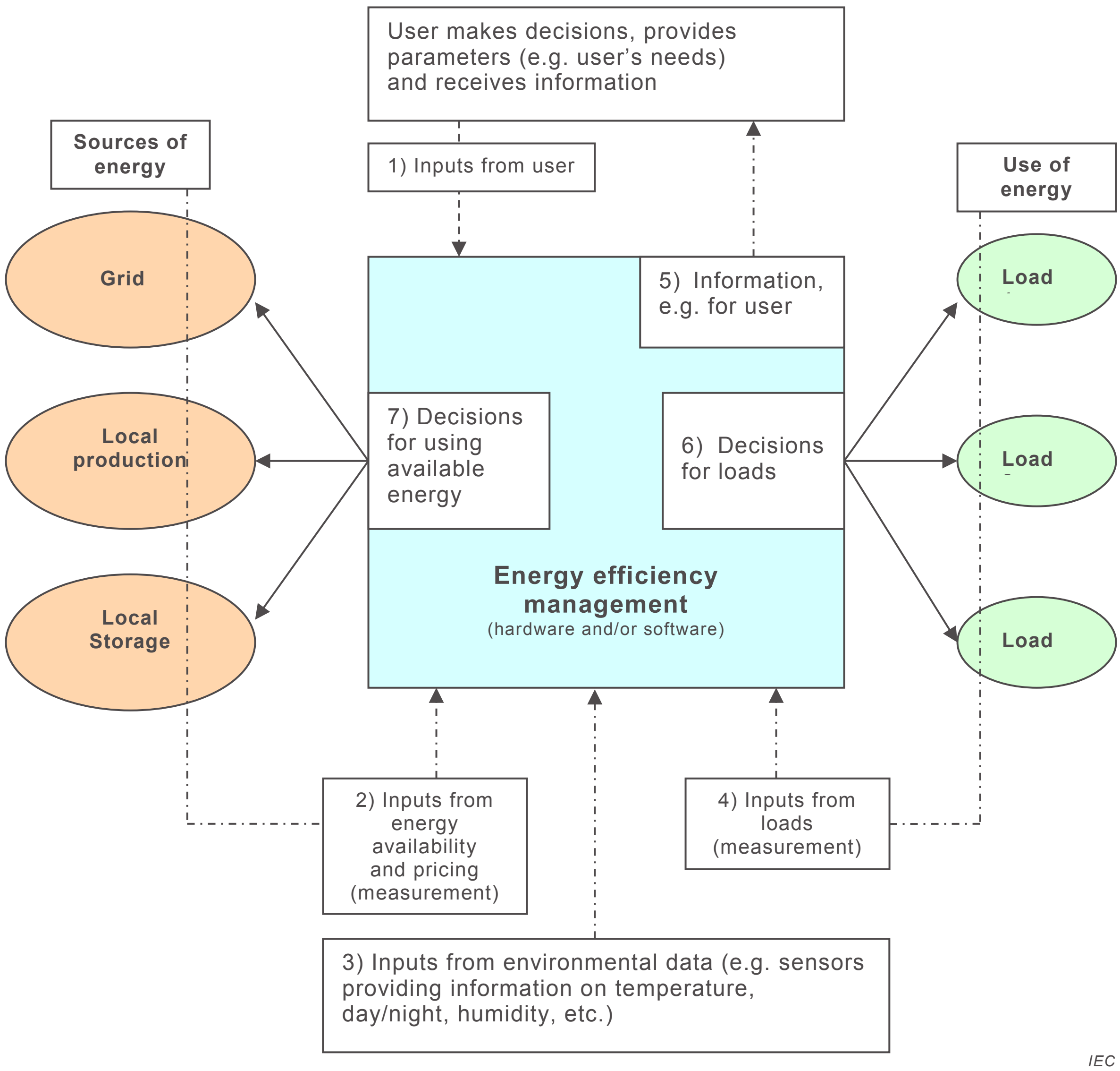

Figure 1 – Energy efficiency and load management system

NOTE The proportion of renewable energy in the grid supply and the amount of local renewable energy may be determined by national and local requirements.

8.2 Requirements from the user

8.2.1 General

Requirements from the user are the first input to take into consideration. These requirements will be the key input to design the energy efficiency management system.

8.2.2 Requirements on the loads

The designer and installer shall take into account the user decisions on selection of energy efficient appliances (freezer, lamps, etc.).

The user may give priority to the usage of the different loads as an input of the load optimization process (e.g. load shedding).

The designer shall take into account the use of the installation in providing an energy efficient design.

The installer shall provide a manual override facility which enables the user to take control from the automatic functions.

8.2.3 Requirements on the supplies

The decisions taken by the user on the pattern of usage regarding the loads will affect the requirements on the supplies.

8.3 Inputs from loads, sensors and forecasts

8.3.1 Measurement

8.3.1.1 Requirements on accuracy and measuring range

Measurement is a key parameter to determine the efficiency of the installation giving the subscriber an awareness of his consumption. Consequently, device accuracy and measuring range shall be adapted to the intended use, as close as possible to the loads.

From a general point of view (general use in buildings such as dwellings, shops, public buildings, offices, etc.), the highest metering accuracy is important at the origin of the installation where it is used for invoicing or similar purposes, but also to measure and assess the efficiency of the whole installation, or to enable assessment of the whole installation efficiency by summation of the component parts. A lower level of accuracy is generally sufficient downstream. For the lowest level, at the final circuit level, it is enough to provide the durations of consumption or follow a trend or to monitor a load.

NOTE There are exceptions to this principle: for example, in cement production where a unique very powerful load may justify a particular accuracy measurement.

Accuracy of measurement shall at least comply with the following:

– the meter at the origin of the loads shall be accurate for billing purposes and can be used for the measurement of the efficiency of the whole installation;
– at a lower level, for example for some important meshes it may be necessary to provide measurement with an accuracy allowing sub-billing within the same entity. For example, a company such as a hotel may wish to sub-invoice the department for catering seperately from the department in charge of entertainment,
– at the lowest level of the final circuit directly powering loads it can be enough to provide information for following trends without precise needs for current to power conversion.

The device measuring range shall be adapted to the maximum values measured in the mesh.

Device accuracy should be consistent when used for comparison for similar loads on different meshes and is dependent on the use of the information required.

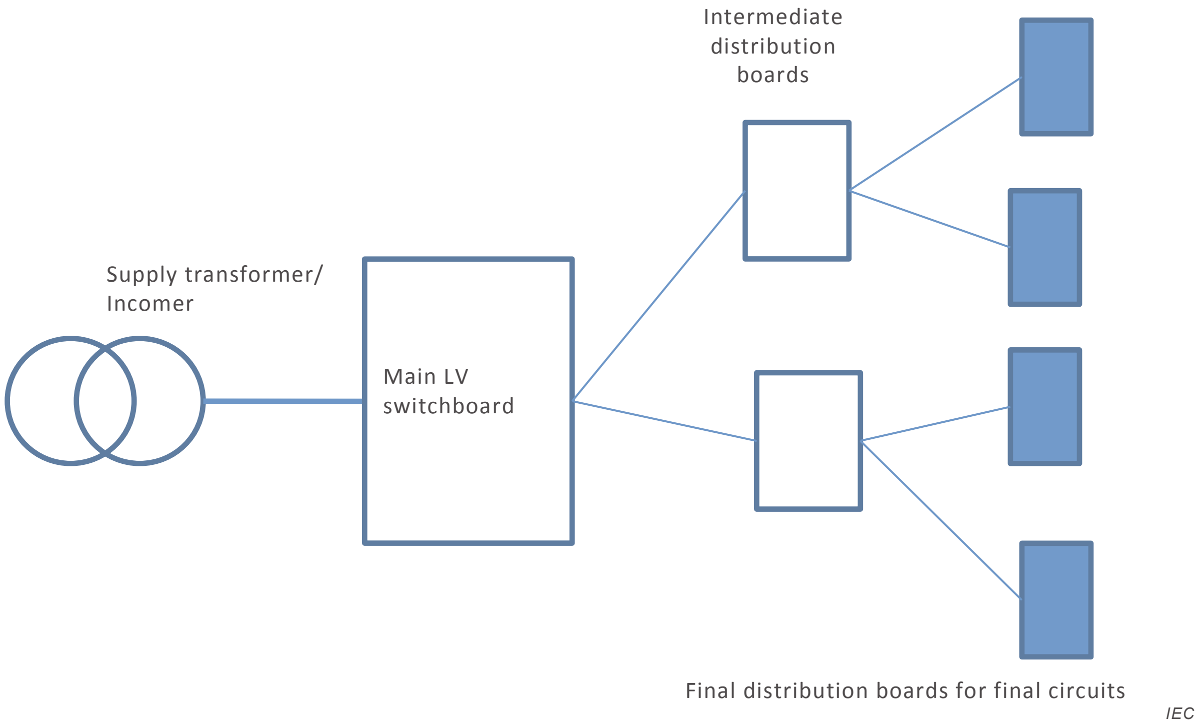

Figure 2 – Power distribution scheme

If the distribution system is conveniently structured as shown for example in Figure 2, then the energy/power measurement and monitoring shall be structured consequently as shown in Table 1.

Table 1 – Overview of the needs

	Incomer	**Main LV switchboard**	**Intermediate distribution boards**	**Final distribution board**
Possible meshes	The whole installation	Homogeneous entities (e.g. swimming pool, workshop, office)	Zones and/or usages (e.g. heating of the lobby)	Circuits
Ratio between current in loads and nominal current	In general, medium to important: 30 % to 90 %	In general medium: 30 % to 70 %	In general rather low: 20 % to 40 %	In general very low: <20 %
Possible measurement objectives for network management	Contractual power quality monitoring. Network monitoring	Network monitoring	Power metering	Power metering See Note 1

	Incomer	Main LV switchboard	Intermediate distribution boards	Final distribution board
Measurement objectives for cost management	Revenue metering. Bill checking. Energy usage analysis and optimization. Contract optimization. Regulatory compliance	Cost allocation. Energy usage analysis and optimization. Efficiency assessment. Contract optimization. Regulatory compliance	Cost allocation. Energy usage analysis and optimization. Efficiency assessment. Contract optimization. Regulatory compliance	Energy usage analysis and optimization. Energy usage trends assessment See Note 2
Overall system accuracy of active energy measurement	In general, excellent accuracy, e.g. class 0.2 to class 1	In general, good accuracy, e.g. class 0.5 to class 2	In general, medium accuracy, e.g. class 1 to class 3	In general, reliable indication should be more important than accuracy. See Note 2
NOTE 1 In this case, the number of measured parameters may be limited. NOTE 2 In this case, only a trend assessment may be requested. Then, measurement accuracy may be much less important than reliable indication.				

8.3.1.2 Measurement applications requested for EE assessment

Energy efficiency of low-voltage installations mainly uses the following sorts of applications:

– energy usage analysis and cost allocation;

– energy usage optimization; efficiency assessment (coefficient of performance (COP), power usage effectiveness (PUE), etc.); contract optimization; regulatory compliance; energy management system policy, e.g. according to ISO 50001;

– network metering; network monitoring; contractual power quality monitoring.

8.3.2 Loads

8.3.2.1 General

Loads shall be classified regarding their user's acceptance of load shedding. Some loads such as information technology equipment systems, computers, TV sets are not suitable for load shedding. Some others like heaters, fridges, electric vehicles, can accept without any impact on their service a shedding up to a certain period of time.

For each type of load, an acceptable time of shedding in normal conditions should be determined. As examples, the acceptable time of shedding for a desktop computer is 0 ms, for a lamp is 50 ms, for a fridge or heater 15 min.

The maximum time of shedding for each mesh is determined by the individual load with the lowest rated off-time. For this reason it is recommended to specify meshes that have loads with similar rated off time.

Information on the ability of loads to accept or not a shedding, and the corresponding duration(s) is useful.

8.3.2.2 Load shedding and device choice

There are relationships between potential improvements in energy efficiency, lifetime and the maintenance of devices, systems and installation.

Some measures taken to improve the energy efficiency of the system in terms of energy management may have certain drawbacks if the device choice is not appropriate. Consideration should be given as to how the implementation of energy efficiency measures can impact the lifetime of the equipment. Equipment should be selected to be suitable with this management of the energy.

For example, incandescent lamps have been widely used with timers or presence detectors for corridors, stairs, etc. to improve the energy efficiency of the installation as the lamps are switched on only when people are present. Their replacement with lamps using another technology, which are far more sensitive to the number of switching opeartions, can dramatically reduce the life-time of these lamps, in some cases leading to a rejection of the timers which were used previously. The consequence is that lamps may now remain switched on day and night to avoid having to change them too often and by so doing, reduces the energy efficiency of the installation. This example illustrates how important it is to take into consideration the comprehensive cost sensitivity of the user: the cost of replacement of the lamps exceeds the savings on energy cost. The right choice regarding energy efficiency may be to use lamps with the right technology regarding the switching issue in order to offer a lower energy consumption of the installation and a normal expected lifetime of the lamps.

8.3.3 Energy sensors

Energy-sensing devices shall be of at least the same class as the energy performance and monitoring device defined in Annex D of IEC 61557-12:2007.

8.3.4 Forecasts

Forecasts are indicators to be used as inputs to the energy efficiency management system, such as weather and occupancy forecasts.

8.3.5 Data logging

Examination of historical data is an input for making energy demand forecasts (see 8.3.4).

With respect to the quality and effectiveness of the results in obtaining a high level of energy efficiency, a communication system of all required and foreseen data should be provided.

8.3.6 Communication

The energy management system for energy efficiency shall not impair communication for other purposes such as safety, control, or the operation of devices or equipment.

8.4 Inputs from the supplies: energy availability and pricing, smart metering

The user shall consider the information concerning the energy availability and pricing which may vary with time:

- where the supply is a local source, the user shall consider the minimum and/or the maximum available power and define the price of this energy based on the total cost of ownership including fixed and variable costs;
- where the supply come from a local store of energy (e.g. battery), the user shall consider the maximum available power, the quantity of energy available and define the varying price of this energy based on the total cost of ownership, including fixed and variable costs.

8.5 Information for the user: monitoring the electrical installation

The installation should be designed to enable the measurement of its total consumption in kWh for every hour of each day. This data, and the related cost of energy information, should be logged and stored for a minimum of one year and should be accessible to the user.

NOTE Multiple years of data can be useful for effective trend analysis.

In addition, (e.g. by use of submetering), the installation should be designed to enable the recording and saving of data for the consumption of individual loads or meshes totalling 70 % of the total load.

8.6 Management of loads through the meshes

8.6.1 General

An energy efficiency management system comprises monitors for the whole smart electrical installation including loads, local production and storage. It can manually (easiest cases) or automatically (most situations) monitor the electrical installation of the smart electrical installation so as to optimize permanently the overall costs and consumption of the system, taking into account the user requirements and the input parameters coming from the grid, local electricity production and storage, the loads, sensors, forecasts etc.

8.6.2 Energy management system

The energy management system shall be based on

– end user choices,
– energy monitoring,
– energy availability and cost,
– inputs from loads, local electricity production and storage, energy sensors and forecasts.

Energy management system shall include

– measurement of meshes,
– control,
– power quality,
– reporting,
– alarms: verification of good operation of the devices,
– tariff management, if any,
– security of data,
– display function for public awareness.

The requirements of the user define the inputs to the system, i.e. meters, sensors, control inputs etc., and the control methodology for determining the outputs and control parameters.

The outputs may control load management devices or may supply information from meters or other displays for the user to act on.

The system may be required to measure power quality, voltage levels and loads. It may also produce alarms, control loads or change tariffs if preset limits are exceeded.

8.7 Multi-supply source management: grid, local electricity production and storage

The overall power demand should be optimized as far as possible as an aid to the overall energy reduction of the installation.

NOTE The utilities and the grid balance the use of electrical energy by the end user with the production and transportation of this energy. As the number of sources of electrical energy increases, and will increasingly be based on renewable sources, the availability of electrical energy will become more transient. The solution that utilities will provide to maintain the right balance between unpredictable consumption and uncontrollable production will be to regulate the price of energy through the smart grid.

9 Maintenance and enhancement of the performance of the installation

9.1 Methodology

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.

The requirements and recommendations of this standard comply with the following statements:

– Measurement is one of the primary keys for electrical energy efficiency
  a) To audit energy consumption by measures that will provide an indication of the situation and the main avenues to pursue savings (where the main consumptions are, what the consumption pattern is). An initial assessment can be conducted based on a set of measurements for various meshes within the installation and a comparison to benchmarked energy usage criteria established for the combinations of equipment within the mesh or installation. While this can help point to areas that can be subjected to more detailed analysis, determination of whether the installation is efficient will depend on more precise measurements and assessment of parts of the installation in comparison with the overall energy usage.
  b) To optimize through permanent automation or control. As already highlighted, everything that consumes energy shall be addressed actively if sustained gains are to be made. Permanent control is critical for achieving maximum efficiency.
– The right energy produced and used at the right time (see point c) below
  c) To monitor, maintain and improve the electrical installation. As targets are fixed over a long time frame, electrical energy efficiency programmes represent a permanent improvement over time. See Figure 3.

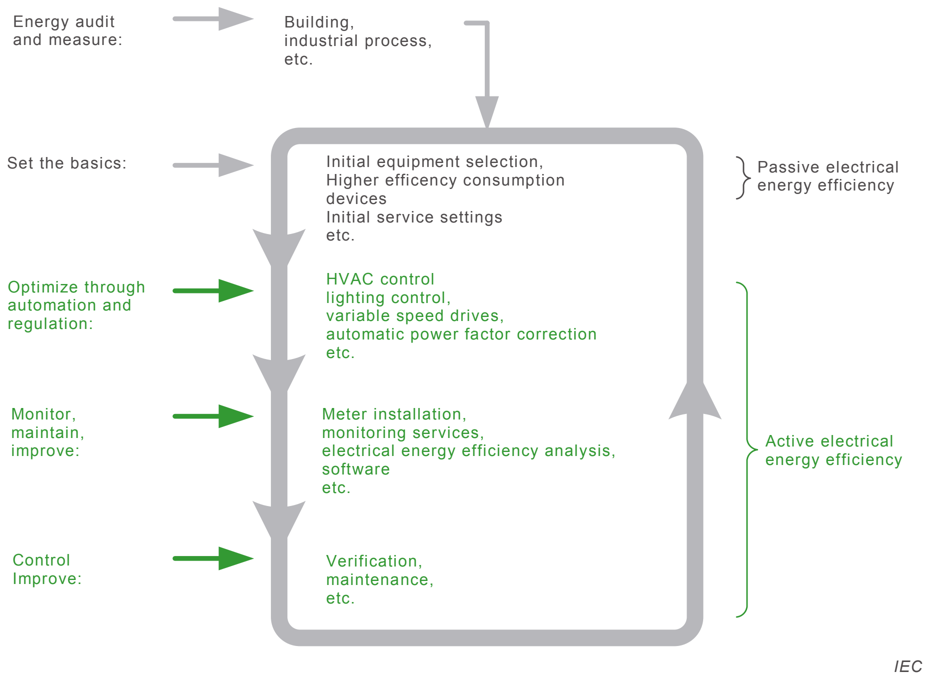

Figure 3 – Iterative process for electrical energy efficiency management

Table 2 – Process for electrical energy efficiency management and responsibilities

Action	Details	Generally performed by
Energy audit and measure		Auditor or energy manager
Set the basics	Initial equipment selection, higher efficiency consumption devices. Initial service settings, etc.	Installer
Optimize	HVAC control. Lighting control. Variable speed drives. Automatic power factor correction etc.	Installer/tenant or user, energy manager
Monitor, maintain the performance	Meters installation. Monitoring services. Electrical energy efficiency analysis, software, etc.	Energy manager/tenant or user
Control, improve	Verification, maintenance, etc.	Energy manager/tenant or user

9.2 Installation life cycle methodology

The electrical energy efficiency approach corresponds to a permanent cycle to be followed during the whole life of the electrical installation. Once measurements have been performed (once, occasionally or permanently), the provisions identified need to be implemented, following which verification and maintenance should be done on a regular basis. Measurement of indicators should be repeated, followed by new provisions and new maintenance.

NOTE 1 In existing installations, measurements per zone or per usage are typically performed only occasionally, due to the non-adaptable architecture of the electrical installation.

NOTE 2 Verification is not understood as in IEC 60364-6 [7], but is an ongoing monitoring associated with energy efficiency.

NOTE 3 Maintenance refers to the use of monitoring to identify opportunities for improvement.

In existing installations, measures for reducing electrical consumption should be considered. This requires a correct knowledge of electrical consumption per usage or per area. Analysis of electrical consumption is the first step to achieve electricity consumption reduction in existing installations. An iterative process shall be achieved for each existing installation.

NOTE 4 Simply understanding where and how energy is used can yield up to 10 % savings according to experience, without any capital investment, using only procedural and behavioural changes. This is typically accomplished by connection of measuring equipment to an energy management system presenting a synthesis of all key parameters of energy efficiency.

9.3 Energy efficiency life cycle

9.3.1 General

This life cycle is how the energy efficiency of the installation can be improved and/or maintained.

9.3.2 Performance programme

Where users of the installation require an energy efficiency rating, they are invited to agree on an energy efficiency performance programme which should include:

– initial and periodic audit of the installation;

– appropriate accuracy of measuring equipment;

– implementation of measures to improve the efficiency of the installation;
– periodic maintenance of the installation.

NOTE ISO 50001 gives best practices for energy management systems.

9.3.3 Verification

The general purpose of electrical energy efficiency measures is to optimize the total electrical energy consumption. Therefore it is necessary ensure the efficiency of all measures implemented in the electrical installation for the entire life of the installation. This can be improved by permanent monitoring and periodic control.

9.3.4 Maintenance

In addition to safe operation as stated in in various parts of the IEC 60364 series, maintenance is needed to keep the installation in an acceptable condition. Maintenance of this kind shall be reviewed on an economic and energy efficiency basis.

10 Parameters for implementation of efficiency measures

10.1 General

Clause 10 gives requirements for analysis or means that the designer of an electrical installation or facility manager has to use to determine efficiency measures and to achieve an energy efficiency performance level. These measures and levels are used to build the installation profile (IP) and the electrical installation efficiency class. These requirements are organized into three topics:

– efficiency of current-using/carrying equipment;
– efficiency of the electrical distribution system;
– installation of control, monitoring and supervision systems.

NOTE Informative examples concerning a method for achievement levels, energy efficiency performance levels, installation classes and installation profiles are given in Annex B.

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

10.2 Efficiency measures

10.2.1 Current-using/carrying equipment

10.2.1.1 Motors and controls

An a.c. induction motor can consume more energy than it actually needs, especially when operated at less than full-load conditions. This excess consumption of energy is dissipated by the motor in the form of heat. Idling, cyclic, lightly loaded or oversized motors consume more power than necessary. A better choice of motor and motor control will improve the global energy efficiency of the electric motor system.

As about 95 % of the operating cost of a motor comes from its electrical energy consumption, adopting a higher energy efficiency class according to IEC 60034-30, especially for high-duty applications, saves significant energy.

Consideration shall be given to the use of motor starters, or other motor control devices such as variable speed drives, to achieve higher energy efficiency, particularly for efficient management of energy for intensive consumption applications (e.g. flow control of fans, pumps, air compressors).

Examples of aspects to be considered are

– reducing electrical energy consumption,
– optimizing the rated power,
– reducing the inrush current,
– reducing noise and vibration, in this way avoiding mechanical damage and failures within the air conditioning or heating system,
– better control and better accuracy in achieving required flow and pressure.

NOTE In industry, 60 % of consumed electricity is used to turn motors and 63 % of this energy is used for applications such as pumps and fans.

10.2.1.2 Lighting

Lighting can represent a large amount of energy consumption in an electrical installation depending upon the type of lamps and luminaires for their application. Lighting control is one of the easiest ways to improve energy efficiency. Therefore, careful consideration should be given to lighting control. The type of lamp, ballast switchgear and controlgear should be taken into consideration when applying lighting control.

Solutions for lighting control can improve the energy efficiency by more than 50 %. These systems should be flexible and designed for the comfort of the users. The solutions can range from very small and local, such as with timer and occupancy sensors, up to sophisticated customized and centralized solutions that are part of complete building automation systems.

To operate lighting only when and where needed, permanent control of lighting may be implemented by using for instance:

– movement detectors;
– dimming controls;
– timed switches;
– clock switches;
– light-sensitive switches;
– constant brightness controls.

10.2.1.3 Heating, ventilation and air conditioning

Consideration should be given to

– the choice of HVAC equipment depending on the installation structure and usage,
– the appropriate control system to optimize environment control (e.g. temperature, humidity, etc.) depending on the usage and occupancy of individual spaces.

NOTE An example is a heating system controlled by a timer monitoring the temperature threshold according to the expected occupancy.

10.2.2 Distribution system

10.2.2.1 General

Efficiency of an electrical distribution system is based on the following principles:

– intrinsic efficiency of electrical equipment such as transformers or reactors and wiring systems;
– topology of the electrical distribution system at all levels of voltage, e.g. location of primary transformer and length of cables.

10.2.2.2 Transformers and reactors

Where one or more transformers are used to supply the electrical installation, special care shall be taken concerning the type of transformer and its efficiency.

NOTE This subclause does not apply to public power grid transformers.

Transformer efficiency depends on load. Full-load losses and no-load losses shall be optimized according 6.4, taking into consideration the daily, weekly and annual load profile if known or estimated.

LV/LV transformers also generate energy losses and often operate at reduced load. These losses shall be estimated.

As described in 10.2.3.4, a voltage level close to the nominal level (U_n), or slightly higher is preferable. The transformer shall be used for voltage adjustment so that current-using equipment is supplied at rated voltage.

10.2.2.3 Wiring systems

The cross-sectional areas of conductors and integrated architecture may be optimized to reduce losses.

To optimize the integrated architecture by locating the power source at an adequate location and optimized route of wiring system, 6.3 shall be applied.

To reduce losses in the wiring by increasing the cross-sectional areas of the wiring system cables compared to the minimum sizes provided by IEC 60364-5-52 and/or reducing reactive and harmonic currents, 6.5 shall be applied.

To optimize the number and allocation of circuits, 7.3 shall be applied.

The impact of thermal losses, off-load consumption and on-load energy consumption of equipment connected in series with the wiring system, e.g. switchgear and controlgear, power monitors and relays included in an electrical circuit, is negligible regarding the energy used in the load and in the energy transportation (typically less than 1/1 000 of the load energy consumption).

10.2.2.4 Power factor correction

Reduction of reactive energy consumption improves electrical energy efficiency as maximum electrical energy will be transformed into active energy. Reduction of reactive energy will also reduce thermal losses in wiring systems, particularly in the low-voltage public distribution system, and reduce energy losses in the HV transmission, HV distribution network and the customer's network.

Where a reduction of reactive power is required, the optimized level of reactive energy consumption shall be determined. This level is generally determined according to the utility contract requirements.

In order to reduce reactive energy consumption the following may be implemented:

– selection of current-using equipment with low reactive energy consumption;
– systems for compensation of reactive energy by using capacitors.

NOTE Harmonic distortion rate is an important consideration for selecting capacitor banks.

10.2.3 Installation of monitoring systems

10.2.3.1 General

The electrical distribution system needs to meet the monitoring capability requirements.

In the case of measurement by zone, each zone needs to have a dedicated feeder, allowing the installation monitoring system to perform the relevant measurements.

In the case of measurement by usage, each usage needs to have a dedicated feeder, allowing the installation monitoring system to perform the relevant measurements.

An installation monitoring system has three main objectives:

a) Control of performance and benchmarking of consumption pattern

   An annual measurement of the total kWh consumption based on utility meters can be used. Timed data measurements (e.g. measurement every 30 min) can also be used, from which load profiles may be produced. It shall be possible to consolidate this information with other energy consumption data and external factors such as degree-day data, occupancy rate, etc. Some focus on particular energy use may be necessary according to national regulation (e.g. lighting, heating, etc.)

b) Identification of energy use and any changes of consumption pattern

   This is necessary

   – to build an action plan and check the effectiveness of actions,

   – to check the operation of control systems used to optimize consumption.

c) Power quality survey

   Power quality may influence energy efficiency performance in several ways: extra losses or abnormal ageing of equipment.

   For these objectives, designers and electrical contractors shall develop a measurement and monitoring strategy that includes:

   – devices measuring relevant parameters such as: energy, active power, power factor, voltage, power quality indicators (harmonic distortion, reactive energy, etc.);

   – supervision tools, building energy management system (communication system and software) when permanent measurement and data storage is required.

Accuracy for measurements shall be adapted to the accuracy needed regarding the efficiency measures.

Acceptable limits of accuracy in measurement may be greater when the point of measurement is far from the origin of the installation or zone:

– at the origin of the installation or zone defined for efficiency measures, accuracy shall be the greatest and shall comply with an accuracy class defined in IEC 62053-21 and IEC 62053-22. Accuracy class shall be aligned with the requested efficiency measurement;

– at the main switchboard level, accuracy shall better than 5 %;

– at sub-distribution boards or final distribution boards and downstream, accuracy shall be better than 10 % from 5 % to 90 % of the nominal unit.

10.2.3.2 Energy

It is of prime importance, in term of electrical energy efficiency, to first measure current-using equipment electricity consumption.

10.2.3.3 Load profile

Measurement of the energy used over short periods of time is necessary to give a load profile. This should be over a period of a minimum of 24 h to give a reasonable estimate of load profile.

NOTE The time period of measurement is typically from every 10 min to 1 h maximum. The time period varies depending on the usage, zone and the sector of activity, and also the season (especially for lighting and HVAC).

10.2.3.4 Voltage drop

Voltage drop has an impact on the electrical energy efficiency of the electrical installation.

Where the voltage drop measurement is required, the installation voltage measurement shall be made on the current-using equipment and at the origin of the circuit powering the current-using equipment.

The recommendation on maximum voltage drop within the consumer's installation is provided in Table G 52.1 of IEC 60364-5-52:2009.

10.2.3.5 Power factor

Where power factor measurement is relevant, it shall be implemented.

10.2.3.6 Harmonics

Non-linear electrical equipment such as power electronic systems including power drives systems (PDS), inverters, uninterruptable power supplies (UPS), other power converters, arc furnaces, transformers and discharge lamps generate voltage distortion or harmonics. These harmonics stress insulation, overload cables and transformers, cause outages and disturb many types of equipment such as computers, telephones and rotating machines. The life of equipment can be reduced.

Harmonics provoke overheating and as a consequence generate additional power losses through the wiring system. Therefore the measurement of THDU at the installation level and THDI at the current-using equipment level for harmonics is recommended. Appropriate measurement for other harmonics should also be performed.

10.2.3.7 Renewable and local production of energy

On-site renewable energy sources and other local production sources do not of themselves increase the efficiency of the electrical installation, but to reduce the overall utility network losses as the consumption of the building from the utility is reduced, this may be considered an indirect energy efficiency measure.

For installation of photovoltaic power sources, see Clause 551 of IEC 60364-5-55:2011 and Clause 712 of IEC 60364-7-712:2002.

11 Actions

Measurements shall be analysed and then direct or programmed actions shall be undertaken:

– direct action consists of making energy efficiency improvements immediately, such as operating windows, or controlling temperatures;
– programmed actions consist of analysing previous measurements over a period of time (for example, a year) and comparing the results with defined objectives. Then actions shall consist of:
  - maintaining existing solutions,
  - implementing new solutions.

Energy management is required to achieve sustainable and maximum reductions of electricity consumption by

– setting energy targets,
– designing energy management measures to optimize electricity consumption.

12 Assessment process for electrical installations

12.1 New installations, modifications and extensions of existing installations

Under consideration.

12.2 Adaptation of existing installations

Under consideration.

Annex A
(informative)

Determination of transformer and switchboard location using the barycentre method

A.1 Barycentre method

When designing an installation, consideration should be given to locating transformers and switchboards as closely as possible to high energy consumption equipment and systems in order to minimize losses within the installation electrical distribution system.

The barycentre method provides a way of defining the most energy efficient location of the transformers and switchboards in an installation thanks to the reduction of the electrical losses.

The objective of this method is to install the transformer and switchboard at a location based on a relative weighting due to the energy consumption of the loads, so that the distance to a higher energy consumption load is less than the distance to a lower energy consumption load.

The barycentre enables the equipment location to be defined in order to minimize as much as possible the lengths and cross-sectional areas of conductors. Increasing the size of cables in order to meet voltage drop limitations can thus be avoided for high rating feeders. See also 6.7.2.

This method considers electrical energy efficiency only in order to define a theoretical location of the source, even if other aspects (e.g. construction requirements, aesthetic considerations, environmental conditions, etc. should be considered.

Each load shall be identified by

– the coordinates of its location: (x_i, y_i) or (x_i, y_i, z_i) depending on whether 2D or 3D vision is available,
– the estimated annual consumption in kWh, EAC_i.

If the estimation of the annual consumption is unknown, the power of the load in kVA should be used instead.

The location of the barycentre defined by its coordinates (x_b, y_b, z_b) or (x_b, y_b) shall be determined by the appropriate formula:

$$(x_b, y_b, z_b) = \frac{\sum_{i=1}^{i=n}(x_i, y_i, z_i) \cdot EAC_i}{\sum_{i=1}^{i=n} EAC_i}$$

or

$$(x_b, y_b) = \frac{\sum_{i=1}^{i=n}(x_i, y_i) \cdot EAC_i}{\sum_{i=1}^{i=n} EAC_i}$$

The transformer or the switchboard feeding this group of n loads should be located as close as possible to the barycentre of these electrical loads.

Example 1: calculation of the barycentre in a production plant

The example production plant has the following loads (see Figure A.1):

1) Logistics storage EAC_1 = 120 kWh at the position x_1 = 4 m; y_1 = 4 m
2) Utilities EAC_2 = 80 kWh at the position x_2 = 9 m; y_2 = 1 m
3) Office EAC_3 = 20 kWh at the position x_3 = 9 m; y_3 = 8 m
4) Production EAC_4 = 320 kWh at the position x_4 = 6 m; y_4 = 12 m

According to the barycentre formula:

$$(x_b, y_b) = \frac{\sum_{i=1}^{i=n}(x_i, y_i) \cdot EAC_i}{\sum_{i=1}^{i=n} EAC_i}$$

the x position of the barycentre is given by:

$$x_b = \frac{4\,\text{m} \cdot 120\,\text{kWh} + 9\,\text{m} \cdot 80\,\text{kWh} + 9\,\text{m} \cdot 20\,\text{kWh} + 6\,\text{m} \cdot 320\,\text{kWh}}{120\,\text{kWh} + 80\,\text{kWh} + 20\,\text{kWh} + 320\,\text{kWh}} = \frac{3300}{540} = 6.11\,\text{m}$$

similarly, the y position of the barycentre is given by:

$$y_b = \frac{4\,\text{m} \cdot 120\,\text{kWh} + 1\,\text{m} \cdot 80\,\text{kWh} + 8\,\text{m} \cdot 20\,\text{kWh} + 12\,\text{m} \cdot 320\,\text{kWh}}{120\,\text{kWh} + 80\,\text{kWh} + 20\,\text{kWh} + 320\,\text{kWh}} = \frac{4560}{540} = 8.44\,\text{m}$$

The resulting barycentre location is shown in Figure A.1, at point B.

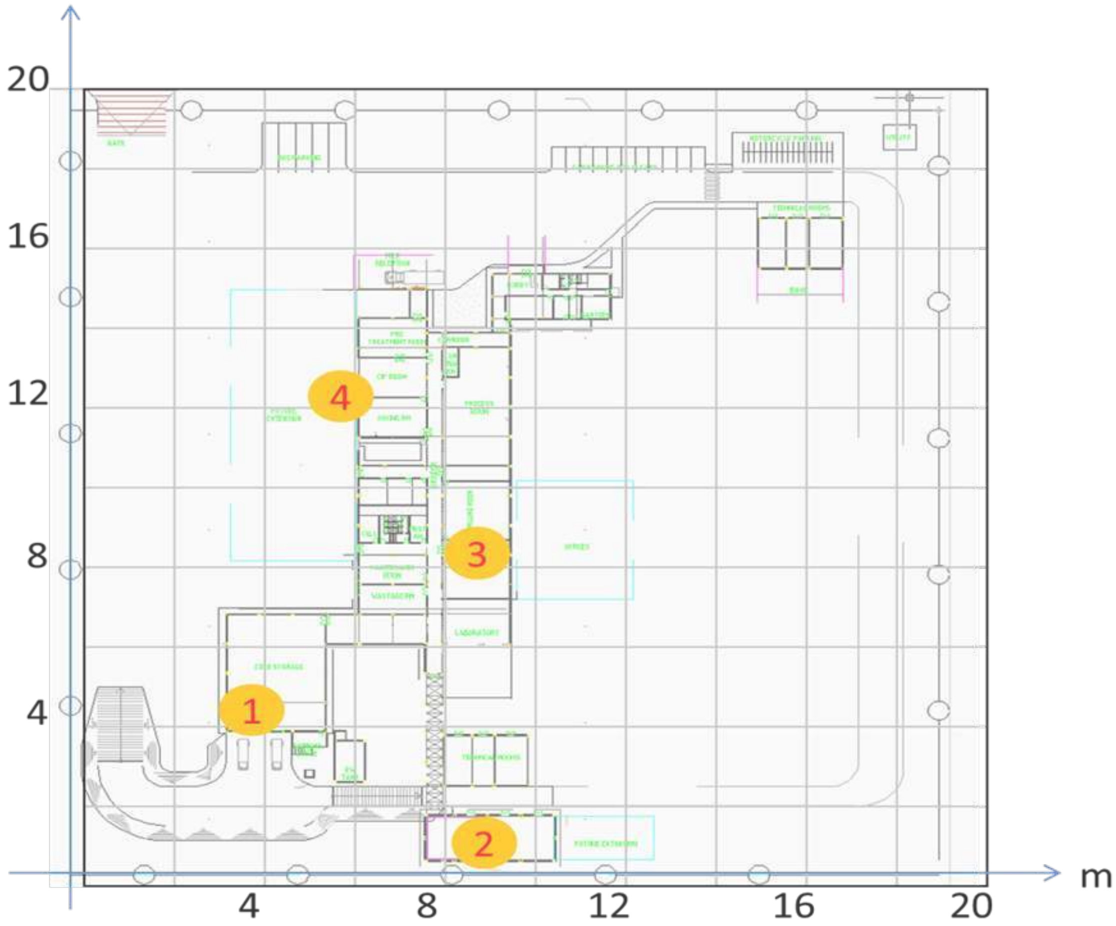

Figure A.1 – Example 1: Floor plan of production plant with the planned loads and calculated barycentre

Example 2: calculation of the barycentre of three different loads with different usage:

The barycentre of three different loads with the following annual consumption (see Figure A.2):

– load 1: position: (1, 1), consumption: 80 kWh;
– load 2: position: (9, 9), consumption: 80 kWh;
– load 3: position: (20, 5), consumption: 320 kWh.

Coordinates of the barycentre:

$$(x_b, y_b) = \frac{(1,1)\cdot 80 + (9,9)\cdot 80 + (20,5)\cdot 320}{80 + 80 + 320} = (15.5)$$

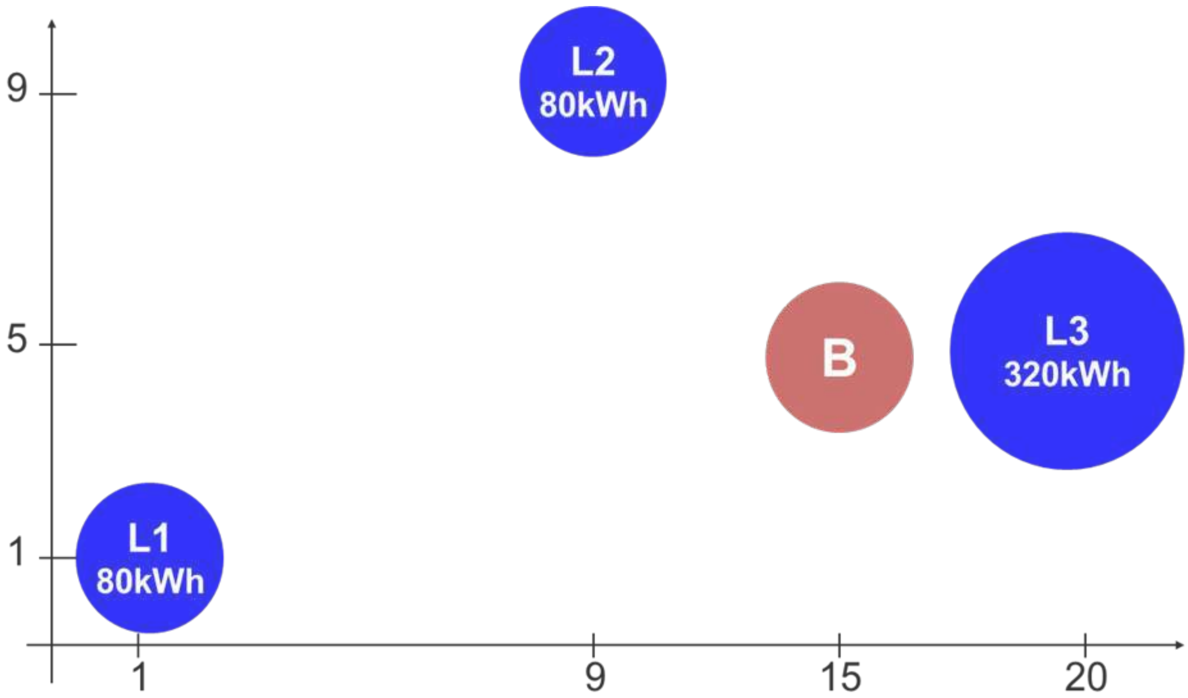

Figure A.2 – Barycentre – Example 2: Calculated

A.2 Total load barycentre

A.2.1 General

The total load barycentre is calculated, taking into account all the loads implemented in the installation.

The "source" means the main switchboards of the installation when using the barycentre method.

The source should be located as close as possible to the total load barycentre.

Example 1: industrial building

The building layout in Figure A.3 shows the building topology. Without using the barycentre tool, the switchboard rooms were originally located in position ①.

By calculation of the total load barycentre, the result shows clearly that position ② is much closer to receptors of high power (utilities) and consequently will improve cable utilization and thereby reduce cable losses.

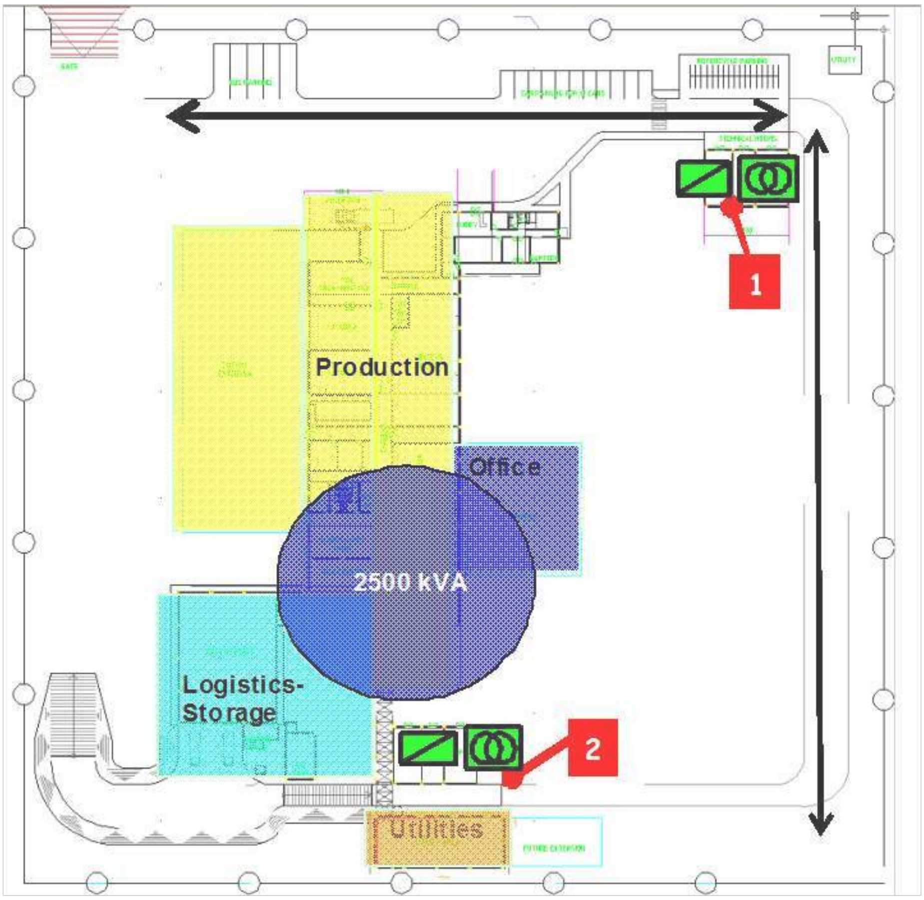

Figure A.3 – Example of location of the barycentre in an industrial building

A.2.2 Subdistribution board locations

The barycentre of each subdistribution board should be calculated, taking into account all the loads fed by this subdistribution board.

The location of each subdistribution board should be as close as possible to its barycentre.

A.2.3 Iterative process

The barycentre method may optimize the last stage of the location of the main power source (given by the calculation, see Clause A.1) by moving some main consuming loads. Then, new coordinates of these identified loads can be used for a new calculation of the barycentre. This can be repeated as necessary.

Annex B
(informative)

Example of a method to assess the energy efficiency of an electrical installation

B.1 Energy efficiency parameters

The energy efficiency measures are classified according to five levels (from 0 to 4). Level 4 is considered to be the highest level. Each level includes the preceding ones.

Table B.1 – Determination of load profile in kWh

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation
Commercial	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation
Industrial	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation
Infrastructure	No consideration	Load profile consumption of the installation for a day	Load profile consumption of the installation for each day of a week	Load profile consumption of the installation for each day of a year	Permanent data logging of the load profile consumption of the installation

Table B.2 – Location of the main substation

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
Commercial	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation is within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
Industrial	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation is within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
Infrastructure	No consideration	Position of the main substation is within 60 % of the distance from the optimum position to the most distant load	Position of the main substation is within 40 % of the distance from the optimum position to the most distant load	Position of the main substation is within 25 % of the distance from the optimum position to the most distant load	Position of the main substation is within 10 % of the distance from the optimum position to the most distant load
NOTE The optimum position is determined in accordance with the method described in Annex A.					

Table B.3 – Required optimization analysis for motors

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	To analyse and monitor motors efficiency class or drives for 30 % of installed power in common parts, if any	To analyse and optimize motors efficiency class or drives for 30 % of installed power in common parts, if any	To analyse and optimize motors efficiency class or drives for 50 % of installed power in common parts, if any	To analyse and optimize motors efficiency class or drives for 70 % of installed power in common parts, if any
Commercial	No consideration	To analyse and optimize motors efficiency class or drives for less than 50 % of installed power	To analyse and optimize motors efficiency class or drives for 50 % of installed power	To analyse and optimize motors efficiency class or drives for 70 % of installed power	To analyse and optimize motors efficiency class or drives for 90 % of installed power
Industrial	No consideration	To analyse and optimize motors efficiency class or drives for less than 50 % of installed power	To analyse and optimize motors efficiency class or drives for more than 50 % of installed power	To analyse and optimize motors efficiency class or drives for 70 % of installed power	To analyse and optimize motors efficiency class or drives for 90 % of installed power
Infrastructure	No consideration	To analyse and optimize motors efficiency class or drives for less than 50 % of installed power	To analyse and optimize motors efficiency class or drives for 50 % of installed power	To analyse and optimize motors efficiency class or drives for 70 % of installed power	To analyse and optimize motors efficiency class or drives for 90 % of installed power

Table B.4 – Required optimization analysis for lighting

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type
Commercial	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type
Industrial	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type
Infrastructure	No consideration	To consider lamp type and position	To consider lamp type and position with natural lighting	Control according to natural lighting source or building use or lamp type	Control according to natural lighting source and building use and to consider lamp type

Table B.5 – Required optimization analysis for HVAC

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	Temperature control	Temperature control at zone level	Time and temperature control at zone
Commercial	No consideration	Temperature control	Temperature control at zone level	Time and temperature control at zone	Time and full sensor control per zone
Industrial	No consideration	Temperature control	Temperature control at zone level	Time and temperature control at zone	Time and full sensor control per zone
Infrastructure	No consideration	Temperature control	Temperature control at zone level	Time and temperature control at zone	Time and full sensor control per zone
NOTE Full sensors include temperature, humidity, daylight, CO_2, etc.					

Table B.6 – Required optimization analysis for transformers

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	Selection of all transformers according to life- cycle cost on estimation of magnetic and copper losses or working point losses	Selection of all transformers according to life-cycle cost on estimation of magnetic and copper losses or working point losses	Selection of all transformers according to life-cycle cost on estimation of magnetic and copper losses and working point losses
Commercial	No consideration	No consideration	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses and working point losses
Industrial	No consideration	No consideration	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses and working point losses
Infrastructure	No consideration	No consideration	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses or working point losses	Selection of all transformers according to estimation of magnetic and copper losses and working point losses

Table B.7 – Required optimization analysis for wiring system

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	Wiring system was optimized with methods described in 6.3 or 6.7	Wiring system was optimized with methods described in 6.3 and 6.7	Wiring system was optimized with methods described in 7.3	Wiring system was optimized with methods described in 6.3, 6.7 and 7.3
Commercial	No consideration	Wiring system was optimized with methods described in 6.3 or 6.7	Wiring system was optimized with methods described in 6.3 and 6.7	Wiring system was optimized with methods described in 7.3	Wiring system was optimized with methods described in 6.3, 6.7 and 7.3
Industrial	No consideration	Wiring system was optimized with methods described in 6.3 or 6.7	Wiring system was optimized with methods described in 6.3 and 6.7	Wiring system was optimized with methods described in 7.3	Wiring system was optimized with methods described in 6.3, 6.7 and 7.3
Infrastructure	No consideration	Wiring system was optimized with methods described in 6.3 or 6.7	Wiring system was optimized with methods described in 6.3 and 6.7	Wiring system was optimized with methods described in 7.3	Wiring system was optimized with methods described in 6.3, 6.7 and 7.3

Table B.8 – Required optimization analysis for power factor correction

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	Level of maximum reactive power is defined	Compensation for large motors in common parts, if any	Compensation for large motors in common parts, if any
Commercial	No consideration	Level of maximum reactive power is defined	Central compensation	Central compensation (small commercial) or compensation by zone (with automation) (for large commercial)	Compensation by zone (with automation) and individual compensation
Industrial	No consideration	Level of maximum reactive power is defined	Central compensation	Compensation by zone or usage (with automation)	Compensation by zone and usage (with automation) and individual compensation
Infrastructure	No consideration	Level of maximum reactive power is defined	Central compensation	Central compensation (small commercial) or compensation by zone (with automation) (for large commercial)	Compensation by zone (with automation) and individual compensation

Table B.9 – Requirement for power factor (PF) measurement

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	Occasional measurement	Occasional measurement	Permanent measurement at main switchboard
Commercial	No consideration	Periodic measurement at main distribution board	Permanent measurement at main switchboard	Permanent measurement at main switchboard and distribution board(s)	Permanent measurement at main switchboard, distribution boards and at major loads
Industrial	No consideration	Periodic measurement at main distribution board	Permanent measurement at main switchboard	Permanent measurement at main switchboard and distribution board(s)	Permanent measurement at main switchboard, distribution boards and at major loads
Infrastructure	No consideration	Periodic measurement at main distribution board	Permanent measurement at main switchboard	Permanent measurement at main switchboard and distribution board(s)	Permanent measurement at main switchboard, distribution boards and at major loads

Table B.10 – Requirement for electrical energy (kWh) and power (kW) measurement

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	Measurement for large equipment in common parts, if any	Measurement for large equipment in common parts, if any, and measurement by zone or by usage	Measurement for large equipment in common parts, if any, and measurement by zone and by usage	Measurement for large equipment in common parts, if any, and measurement by zone, by usage and by mesh
Commercial	No consideration	Measurement for large equipment	Measurement for large equipment and measurement by zone or by usage	Measurement for large equipment and measurement by zone and by usage	Measurement for large equipment and measurement by zone, by usage and by mesh
Industrial	No consideration	Measurement for large equipment	Measurement for large equipment and measurement by zone or by usage	Measurement for large equipment and measurement by zone and by usage	Measurement for large equipment and measurement by zone, by usage and by mesh
Infrastructure	No consideration	Measurement for large equipment	Measurement for large equipment and measurement by zone or by usage	Measurement for large equipment and measurement by zone and by usage	Measurement for large equipment and measurement by zone, by usage and by mesh

Table B.11 – Requirement for voltage (V) measurement [a]

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	Occasional measurement	Occasional measurement	Permanent measurement at main switchboard
Commercial	No consideration	Periodic measurement at main distribution board	Permanent measurement at main switchboard	Permanent measurement at main switchboard and distribution board(s)	Permanent measurement at main switchboard, distribution boards and at major loads
Industrial	No consideration	Periodic measurement at main distribution board	Permanent measurement at main switchboard	Permanent measurement at main switchboard and distribution board(s)	Permanent measurement at main switchboard, distribution boards and at major loads
Infrastructure	No consideration	Periodic measurement at main distribution board	Permanent measurement at main switchboard	Permanent measurement at main switchboard and distribution board(s)	Permanent measurement at main switchboard, distribution boards and at major loads

[a] When voltage is measured, then the measuring equipment shall comply with IEC 61557-12.

Table B.12 – Requirement for harmonic and interharmonic measurement [a]

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	No consideration	No consideration	No consideration
Commercial	No consideration	No specific requirement	Occasional THDU and THDI measurement at the origin of the installation	Periodic THDU and THDI measurement and detailed harmonic spectrum at the origin of the installation	Permanent THDU and THDI measurement and detailed harmonic spectrum at the origin of the installation and for each main feeder
Industrial	No consideration	Occasional THDU and THDI measurement at the origin of the installation	Occasional THDU and THDI measurement at the origin of the installation and for each main feeder	Periodic THDU and THDI measurement and detailed harmonic spectrum at the origin of the installation (including inter-harmonics)	Permanent THDU and THDI measurement and detailed harmonic spectrum at the origin of the installation and for each main feeder (including inter-harmonics)
Infrastructure	No consideration	Occasional THDU and THDI measurement at the origin of the installation	Occasional THDU and THDI measurement at the origin of the installation and for each main feeder	Periodic THDU and THDI measurement and detailed harmonic spectrum at the origin of the installation (including inter-harmonics)	Permanent THDU and THDI measurement and detailed harmonic spectrum at the origin of the installation and for each main feeder (including inter-harmonics)

[a] Should harmonics or interharmonics be measured, then measurement shall comply with IEC 61557-12.

Table B.13 – Requirement for renewable energy

Sector of activity	EM0	EM1	EM2	EM3	EM4
Residential buildings (dwellings)	No consideration	No consideration	To consider renewable energy source	To install renewable energy source providing at least 4 % of the total installed electrical power available	To install renewable energy source providing at least 6 % of the total installed electrical power available
Commercial	No consideration	To consider renewable energy source	To install renewable energy source	To install renewable energy source providing at least 5 % of the total installed electrical power available	To install renewable energy source providing at least 10 % of the total installed electrical power available
Industrial	No consideration	To consider renewable energy source	To install renewable energy source	To install renewable energy source providing at least 1 % of the total installed electrical power available	To install renewable energy source providing at least 2 % of the total installed electrical power available
Infrastructure	No consideration	To consider renewable energy source	To install renewable energy source	To install renewable energy source providing at least 2 % of the total installed electrical power available	To install renewable energy source providing at least 4 % of the total installed electrical power available
NOTE Values introduced in this table may vary from country to country depending on the maximum total installed electrical power available.					

B.2 Energy efficiency performance levels

The performance levels are classified according to five levels, ranked from EEPL0 to EEPL4 (EEPL4 being the highest level). Each level includes the preceding ones.

Table B.14 – Minimum requirement for distribution of annual consumption

Sector of activity	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4
Residential buildings (dwellings)	No consideration	No consideration	No consideration	No consideration	No consideration
Commercial	No consideration	80 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	90 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	95 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	99 % of annual consumption can be split between usages (lighting, HVAC, process, etc.) and between zones
Industrial	No consideration	80 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	90 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	95 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	99 % of annual consumption can be split between usages (lighting, HVAC, process, etc.) and between zones
Infrastructure	No consideration	80 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	90 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	95 % of annual consumption can be split between usages (lighting, HVAC, process, etc.)	99 % of annual consumption can be split between usages (lighting, HVAC, process, etc.) and between zones

Table B.15 – Minimum requirement for reducing the reactive power

Sector of activity	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4
Residential buildings (dwellings)	No consideration	No consideration	No consideration	No consideration	No consideration
Commercial	No consideration	>0,85	>0,90	>0,93	>0,95
Industial	No consideration	>0,85	>0,90	>0,93	>0,95
Infrastructure	No consideration	>0,85	>0,90	>0,93	>0,95
NOTE Countries may adapt the values of this table to local requirements.					

Table B.16 – Minimum requirement for transformer efficiency

Sector of activity	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4
Residential buildings (dwellings)	No consideration	No consideration	No consideration	No consideration	No consideration
Commercial	No consideration	>95 %	>97 %	>98 %	>99 %
Industrial	No consideration	>95 %	>97 %	>98 %	>99 %
Infrastructure	No consideration	>95 %	>97 %	>98 %	>99 %
NOTE Countries may adapt the values of this table to local requirements.					

B.3 Installation profiles

The compilation of various levels (efficiency measures and energy efficiency performance levels) proposed by this standard may be used as a basis for building owners, factory managers, facility managers or end users to build a profile concept for improving the electrical energy efficiency of their electrical installation by using the following tables.

This profile may also be used as a basis for future labelling of electrical installations of buildings.

For each type of application it is possible to estimate the level for each proposed recommendation.

The result of Tables B.1 to B.13 with the relevant ranking value shall be reported within Table B.17, and the result of Tables B.14 to B.16 within Table B.18, by using shading or similar (see example in Clause B.5).

The following Tables B.17 and B.18 are a compilation of the outcomes from consideration of Tables B.1 to B.16. For each efficiency measure and energy efficiency performance level, the tables provide the level reached for each item and an allocated score is indicated in the last column according to the following method:

– EM0 and EEPL0 correspond to 0 points;
– EM1 and EEPL1 correspond to 1 point;
– EM2 and EEPL2 correspond to 2 points;
– EM3 and EEPL3 correspond to 3 points;
– EM4 and EEPL4 correspond to 4 points.

Each box of Tables B.17 and B.18 shall be completed after consideration of each efficiency measure and each energy efficiency performance level

Where it is not possible to evaluate the correct number of points for a particular energy measure or energy efficiency performance level, a rating of 2 points should be adopted (ex. dwelling without a transformer should be quoted 2 in the box for Table B.6).

The sum of all points included in the last column shall be made for estimating the electrical installation efficiency class (see Table B.19).

Table B.17 – Energy efficiency measures profile

Table	Requirement	EM0	EM1	EM 2	EM 3	EM 4	Points
B.1	Load profile						
B.2	Location of main substation						
B.3	Motors						
B.4	Lighting						
B.5	HVAC						
B.6	Transformers						
B.7	Wiring system						
B.8	Power factor correction						
B.9	Power factor measurement						
B.10	Energy and power measurement						
B.11	Voltage measurement						
B.12	Harmonics and inter-harmonics measurement						
B.13	Renewable energy						
Total EM							

Table B.18 – Energy efficiency performance profile for an industrial installation

Table	Requirement	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4	Points
B.14	Distribution of annual consumption						
B.15	Power factor						
B.16	Transformer efficiency						
Total EEPL							

B.4 Electrical installation efficiency classes

Five electrical installation efficiency classes, EIEC0 to EIEC4 (class EIEC4 being the highest), are defined as a mix of minimum of efficiency measures (EM) and minimum of energy efficiency performance levels (EEPL):

- EIEC 0: very low efficiency installation;
- EIEC 1: low efficiency installation;
- EIEC 2: reference efficiency installation;
- EIEC 3: advanced efficiency installation;
- EIEC 4: optimized efficiency installation.

The purpose of using these efficiency classifications of installations is to rate the electrical energy efficiency of installations with pre-defined classes, then to improve it.

The following Table B.19 shall be used for all sectors of activity.

The sum of the total number of points obtained for all energy measures and for all energy efficiency performance levels shall be compared with the number of points needed for each electrical installation efficiency class.

Table B.19 – Electrical installation efficiency classes

Total for dwellings	Total except for dwellings	Electrical installation efficiency class (EIEC)
<20	<16	EIEC0
<28	<26	EIEC1
<36	<36	EIEC2
<44	<48	EIEC3
<50	<58	EIEC4

B.5 Example of installation profile (IP) and electrical installation efficiency class (EIEC)

Table B.20 – Example of energy efficiency profile – Efficiency measures

Table	Requirement	EM0	EM1	EM 2	EM 3	EM 4	Points
B.1	Load profile						3
B.2	Location of main substation						3
B.3	Motors						3
B.4	Lighting						3
B.5	HVAC						2
B.6	Transformers						1
B.7	Wiring system						1
B.8	Power factor correction						2
B.9	Power factor measurement						2
B.10	Energy and power measurement						3
B.11	Voltage measurement						0
B.12	Harmonics and interharmonics measurement						2
B.13	Renewable energy						4
Total EM							29

Table B.21 – Example of energy efficiency profile – Energy efficiency performance levels

Table	Requirement	EEPL0	EEPL1	EEPL2	EEPL3	EEPL4	Points
B.14	Distribution of annual consumption						2
B.15	Power factor						1
B.16	Transformer efficiency						3
Total EEPL							6

The total number of points for this installation is 29 + 6 = 35. Referring to Table B.19, this installation is classified EIEC 2.

Bibliography

[1] ISO 50001, *Energy management systems– Requirements with guidance for use*

[2] IEC 60050-826:2004, *International Electrotechnical Vocabulary – Part 826: Electrical installations*

[3] IEC 60050-881:1983, *International Electrotechnical Vocabulary – Chapter 881: Radiology and radiological physics*

[4] IEC 60076-20, *Power transformers – Part 20: Energy efficiency for tranformers 36kV and below*[2]

[5] NEMA guide TP1, *Guide for Determining Energy Efficiency for Distribution Transformers*

[6] IEEE C57.12.00-2000, *IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*

[7] IEC 60364-6, *Low-voltage electrical installations – Part 6: Verification*

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2 Under consideration.

(*Continued from second cover*)

The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 60287-3-2	Electric cables — Calculation of the current ratings — Part 3-2: Sections on operating conditions — Economic optimization of power cable
IEC 60364	Low-voltage electrical installations (all parts)
IEC 61157-12 : 2007	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. — Equipment for testing, measuring or monitoring of protective measures
IEC 62053-21	Electricity metering equipment (a.c.) — Particular requirements — Part 21: Static meters for active energy (classes 1 and 2)
IEC 62053-22	Electricity metering equipment (a.c.) — Particular requirements — Part 22: Static meters for active energy (classes 0.2 S and 0.5 S)

Only the English language text has been retained while adopting it in this Indian Standard, and as such, the page numbers given here are not the same as in IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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