



BSI Standards Publication

Low-voltage electrical installations

Part 8-1: Functional aspects – Energy efficiency (IEC 60364-8-1:2019)

National foreword

This British Standard is the UK implementation of HD 60364-8-1:2019. It is derived from IEC 60364-8-1:2019, incorporating corrigendum May 2019. It supersedes BS HD 60364-8-1:2015, which is withdrawn.

This standard is to be read in conjunction with BS 7671:2018. Appendix 17 of BS 7671:2018 provides an introduction to, and overview of, energy efficiency in electrical installation design and refers to this standard for full details and guidance.

At the time of publication it has been decided to continue to publish this standard and BS 7671 separately.

The UK participation in its preparation was entrusted to Technical Committee JPEL/64, Electrical Installations of Buildings - Joint Committee.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Amendments/corrigenda issued since publication

Date	Text affected
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English Version

**Low-voltage electrical installations - Part 8-1: Functional aspects
- Energy efficiency
(IEC 60364-8-1:2019)**

Installations électriques à basse tension - Partie 8-1:
Fonctionnalité - Efficacité énergétique
(IEC 60364-8-1:2019)

Errichten von Niederspannungsanlagen - Teil 8-1:
Funktionale Aspekte - Energieeffizienz
(IEC 60364-8-1:2019)

This Harmonization Document was approved by CENELEC on 2019-03-13. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document at national level.

Up-to-date lists and bibliographical references concerning such national implementations may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This Harmonization Document exists in three official versions (English, French, German).

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 64/2353/FDIS, future edition 2 of IEC 60364-8-1, prepared by IEC/TC 64 "Electrical installations and protection against electric shock" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as HD 60364-8-1:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2019-12-14
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-06-14

This document supersedes HD 60364-8-1:2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60364-8-1:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60034-30-1	NOTE	Harmonized as EN 60034-30-1
IEC 60364 (series)	NOTE	Harmonized as HD 60364 (series)
IEC 60364-5-52:2009	NOTE	Harmonized as HD 60364-5-52:2011 (modified)
IEC 60364-5-55:2011	NOTE	Harmonized as HD 60364-5-55:2012 (modified)
IEC 60364-5-55:2011/A1:2012	NOTE	Harmonized as HD 60364-5-55:2013 (not modified)
IEC 60364-6	NOTE	Harmonized as HD 60364-6
IEC 60947-6-1:2005	NOTE	Harmonized as EN 60947-6-1:2005 (not modified)
IEC 60947-6-1:2005/A1:2013	NOTE	Harmonized as EN 60947-6-1:2005/A1:2014 (not modified)
IEC 61800-9-1	NOTE	Harmonized as EN 61800-9-1
IEC 61800-9-2	NOTE	Harmonized as EN 61800-9-2
IEC 62052-11	NOTE	Harmonized as EN 62052-11
IEC 62586-1	NOTE	Harmonized as EN 62586-1
IEC 62962 ¹	NOTE	Harmonized as EN 62962 ²
IEC 62974-1	NOTE	Harmonized as EN 62974-1
ISO 50001	NOTE	Harmonized as EN ISO 50001

¹ To be published. Stage at the time of publication: IEC PRVC 62962:2018.

² To be published. Stage at the time of publication: prEN 62962:2017.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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)	EN 61557-12	2008
IEC 61869-2	-	Instrument transformers - Part 2: Additional requirements for current transformers	EN 61869-2	-
IEC 62053-21	-	Electricity metering equipment (a.c.) - Particular requirements - Part 21: Static meters for active energy (classes 1 and 2)	EN 62053-21	-
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)	EN 62053-22	-
IEC GUIDE 118	-	Inclusion of energy efficiency aspects in - electrotechnical publications		-
IEC GUIDE 119	-	Preparation of energy efficiency - publications and the use of basic energy efficiency publications and group energy efficiency publications		-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –**Part 8-1: Functional aspects – Energy efficiency****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60364-8-1 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) revision of Annex B;
- b) revision of 4.2: Energy efficiency assessment for electrical installations;
- c) update of 8.3: Input from loads, sensors and forecasts;
- d) introduction of new definitions.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
64/2353/FDIS	64/2360/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

It has the status of a group energy efficiency publication in accordance with IEC Guide 118 and IEC Guide 119.

The reader's attention is drawn to the fact that Annex C lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

A list of all parts in the IEC 60364 series, published under the general title *Low-voltage electrical installations*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of May 2019 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 has therefore to take into account inputs from users, suppliers and utilities.

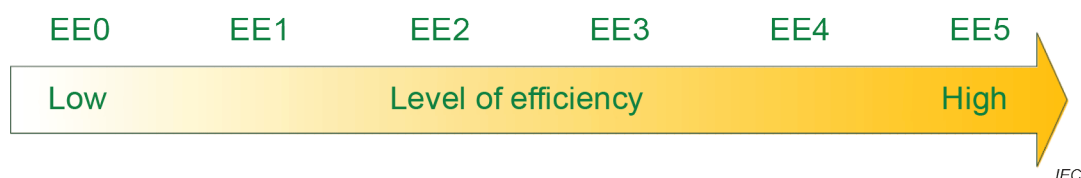
It is important that this document covers existing electrical installations in buildings, in addition to new installations. It is in the refurbishment of existing buildings that significant overall improvements in energy efficiency can be achieved.

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 by redesign or equipment replacement. The aim is to provide a design for an efficient electrical installation which allows an energy management process to suit the user's needs, and in accordance with an acceptable investment. This document first introduces the different measures to ensure an energy efficient installation based on kWh saving. It then provides guidance on giving priority to the measures depending on the return of investment; i.e. the saving of electrical energy and reducing of electrical power costs divided by the amount of investment.

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

It introduces requirements, recommendations and methods for the design and the energy efficiency assessment 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.

The assessment method described in Annex B based on the electrical energy efficiency of the installation allows a classification of energy efficiency installation according to the following levels:



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

This document introduces requirements and recommendations to design the adequate installation in order to give the ability to improve the management of the energy 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 IEC 60364 series.

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

Part 8-1: Functional aspects – Energy efficiency

1 Scope

This part of IEC 60364 provides additional requirements, measures and recommendations for the design, erection, operation 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, recommendations and methods for the design and the energy efficiency (EE) assessment 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, recommendations and methods apply, within the scope of IEC 60364 (all parts), for new installations and modification of existing installations.

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

Where another standard provides specific requirements for a particular system or installation application (e.g. manufacturing system covered by ISO 20140 (all parts)), those requirements may supersede this document.

This document does not specifically address building automation systems.

This group energy efficiency publication is primarily intended to be used as an energy efficiency standard for the low voltage electrical installations mentioned in Clause 1, but is also intended to be used by technical committees in the preparation of standards, in accordance with the principles laid down in IEC Guide 119 and IEC Guide 118.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61557-12, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 12: Power metering and monitoring devices (PMD)*

IEC 61869-2, *Instrument transformers – Part 2: Additional requirements for current transformers*

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)*

IEC Guide 118, *Inclusion of energy efficiency aspects in electrotechnical publications*

IEC Guide 119, *Preparation of energy efficiency publications and the use of basic energy efficiency publications and group energy efficiency publications*

3 Terms, definitions and abbreviated terms

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 General

3.1.1

zone

area (or surface) defining a part of an installation

Note 1 to entry: Examples of a zone can be a kitchen of 20 m² or a storage area of 500 m².

3.1.2

current-using equipment

electric equipment intended to convert electric energy into another form of energy, for example light, heat, mechanical energy

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

3.1.3

electrical installation

assembly of associated electric equipment having co-ordinated characteristics to fulfil specific purposes

[SOURCE: IEC 60050-826:2004, 826-10-01]

3.1.4

usage

type of application for which electricity is used

EXAMPLE Lighting, heating.

3.1.5

load energy profile

figure representing the energy consumption (Y-axis) within a period of time (X-axis) based on measurements for a mesh or a group of meshes

EXAMPLE Hourly consumption of energy for a period of a week.

3.1.6

power demand profile

figure representing the power demand (Y-axis) for a given integration period within a period of time (X-axis) based on measurements for a mesh or a group of meshes

3.1.7**electrical energy efficiency****EEE**

system approach for optimizing the efficiency of electricity usage

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.

3.1.8**mesh**

one or more circuits of the electrical installation for one or more zones including one or more services supplying a group of electrical equipment for the purpose of electrical energy efficiency

3.1.9**active electrical energy efficiency measure**

operational measure, either manually or automatically controlled, for optimizing the energy efficiency of the electrical installation

EXAMPLE Thermostat control, occupancy lighting control, building optimization control systems.

3.1.10**passive electrical energy efficiency measure**

measure for optimizing the energy efficiency of the electrical installation by selection and erection of electrical equipment other than control equipment

EXAMPLE Selection and location of transformer, cross section of cables, routing of wiring system, sub-division of circuits.

3.1.11**electrical installation efficiency class**

defined level of energy efficiency for an electrical installation

Note 1 to entry: See Annex B.

3.1.12**driving parameter**

external factors that affect energy efficiency

EXAMPLE Regulation, environmental conditions, occupancy, energy prices and management requirements, mode of operation, duty cycle, load curves, state, operating, parameters, indoor temperature, lighting levels, production volume.

3.1.13**barycentre method**

procedure to optimize the position of energy source(s) and loads in consideration of energy efficiency

3.1.14**EE assessment**

process to determine the electrical installation efficiency class of an installation

3.2 Electrical energy management**3.2.1****electrical energy management system****EEMS**

system monitoring, operating, controlling and managing energy resources and loads of the installations

3.2.2

load shedding

method(s) of optimizing demand by controlling the electrical loads for variable periods of time

3.2.3

demand response

changes in electric usage by end-user customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized

3.2.4

user interface

means that allow the user to monitor and/or control the electrical installation, locally or remotely

EXAMPLE Visual or audible signal, local display, remote display, push button.

3.3 Energy measurement

3.3.1

measurement

process of obtaining value(s) that can be attributed to a quantity

3.3.2

monitoring

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

[SOURCE: IEC 60050-881:1983, 881-16-02, modified – Addition of "identifying deviations and"; deletion of "for radiation protection".]

3.3.3

power metering and monitoring device

PMD

combination in one or more devices of several functional modules dedicated to metering and monitoring electrical parameters in energy distribution systems or electrical installations, used for applications such as energy efficiency, power monitoring and network performance

3.3.4

billing

process that allows energy suppliers or their representatives to invoice their customers according to a defined contract

Note 1 to entry: These applications can be covered by international standards, regulations such as MID in Europe or NMI in Australia, and/or utility specifications.

3.3.5

sub-billing

process that allows the property manager to allocate an energy invoice from the energy supplier and charges as appropriate to specific tenants

3.3.6

cost allocation

process that allows a facility manager to account for energy costs from internal cost centres that consume energy

EXAMPLE Process line, test and inspection, administration.

3.3.7**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.

3.3.8**forecast**

estimate of the expected value of a parameter at a given future date

3.3.9**total harmonic distortion of the voltage wave**

THD_U

ratio of the RMS value of the harmonic content of an alternating quantity (voltage) to the RMS value of the fundamental component of the quantity (voltage)

3.3.10**total harmonic distortion of the current wave**

THD_I

ratio of the RMS value of the harmonic content of an alternating quantity (current) to the RMS value of the fundamental component of the quantity (current)

3.3.11**degree day**

unit used to determine the heating requirements of buildings, representing a fall of one degree below a specified average outdoor temperature (usually 18 °C) for one day

3.4 Sectors of activities**3.4.1****residential installations**

premises designed and constructed for private habitation and including associated areas

Note 1 to entry: Associated areas include common areas, garages, gardens, pools.

3.4.2**commercial installations**

premises designed and constructed for commercial operations

EXAMPLE Offices, retail, distribution centres, public buildings, banks, hotels, hospitals, schools.

3.4.3**industrial installations**

premises designed and constructed for manufacturing and processing operations

EXAMPLE Factories, workshops.

3.4.4**infrastructure installations**

systems or premises designed and constructed for transport or utility operations

EXAMPLE Airport terminals, port facilities, transport facilities.

3.5 Abbreviated terms

BS bonus

DB distribution board

DSO distribution system operator

EEE Electrical energy efficiency

EM	energy management
HVAC	heating, ventilation and air conditioning
ICT	information and communications technologies
KPI	key performance indicator
MA	performance maintenance
PDS	power drive system
PEI	peak efficiency index
PM	power monitoring
PMD	power metering and monitoring device
PV	photovoltaic
THD	total harmonic distortion
UPS	uninterruptible power supplies

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.

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 electrical installation shall have provisions for overriding the energy efficiency management settings according to the user's decision.

EXAMPLE 1 If someone is ill, the user can decide to heat the room to a higher temperature, even during peak consumption.

EXAMPLE 2 If a company receives an urgent delivery order, there can be a need for the workshop to operate at an unexpected hour.

4.1.3 Design principles

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

- load energy profile (active and reactive energy);
- availability of local generation (PV, wind turbine, generator, etc.) and storage;
- reduction of energy losses in the electrical installation;
- the arrangement of the circuits with regard to energy efficiency (meshes, see 7.4);
- the customer's power use distribution over time;
- the tariff structure offered by the supplier of the electrical energy;

maintaining the quality of service and the performance of the electrical installation.

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

4.2 Energy efficiency assessment for electrical installations

4.2.1 General

Assessment of installations shall be performed according to Annex B. This assessment shall be achieved preferably by measurement. It may be also achieved by calculation.

The frequency of periodic inspection of an installation shall be determined having regard to the type of installation and equipment, its use and operation, the frequency and quality of maintenance, factors liable to influence energy efficiency and the external influences to which it is subjected. The results and recommendations of the previous report, if any, shall be taken into account.

The maximum interval for follow-up assessment is recommended to not exceed:

- five years for commercial;
- three years for industrial and infrastructure.

NOTE National committees may decide if the energy efficiency assessment is made as a requirement or a recommendation in their national standard.

4.2.2 Action plan following an assessment according to Annex B

Where assessment is performed on a new installation and the assessment identified an electrical installation efficiency class lower than required, the identified variances shall be corrected or other action shall be taken based on local regulation, if any.

Where periodic assessment identifies the electrical installation efficiency class is lower than the required value performed, an action plan is typically needed to achieve the required or desired electrical installation efficiency class.

5 Sectors of activities

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

- residential installations;
- commercial installations;
- industrial installations;
- infrastructure installations.

Categorization is intended to facilitate the comparison between similar installations.

Users of this document, such as local authorities, design institutes, building owners, architects, facility managers, should consider assigning specific installation types (sub-sectors) to one of the above sectors of activity.

6 Design requirements and recommendations

6.1 General

While designing an electrical installation, the following shall be taken into account:

- the load energy profile (active and reactive energy);
- the minimization of energy losses in the electrical installation by means of:
 - optimal location of the transformers, local production and switchboard (barycentre),
 - location of HV/LV substation,

- reduction of losses in wiring;
- local production and storage.

6.2 Determination of load energy profile

The prospective load energy profile within the installation shall be determined.

Synthetic profiles (typical load energy curves) from loads or load groups may be used from similar applications.

If measurements or synthetic profiles are not available, the main loads (based on equipment rating) including expected duration of operation should be identified. This consumption could then be summed to create a load energy profile.

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 buildings designers and owners prior to construction. To keep the wiring losses to a minimum, the main distribution transformers and switchboards shall be located, taking into consideration the building constraints, 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 an iterative approach that can be used to determine

- whether the load distribution is uniform, or of localized type,
- whether the loads or other equipment should be relocated, and
- 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, the following shall be considered:

- the optimum number and location of HV/LV substations;
- the working point of the transformer;
- the efficiency of the transformer;
- the load energy profile.

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

6.4.2 Optimum number and location of HV/LV substations

Depending on several criteria such as the required power, the building surface area 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 conductors.

If the barycentre is located in one building side, it is advised to choose one substation close to this barycentre; or if the barycentre is located in the middle of the building layout, it may not be possible to locate the HV/LV substation near the load centre. In such cases, it is recommended to split the electrical distribution into several HV/LV substations located close to their respective barycentres. This facilitates the optimization of LV conductor 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. This occurs at a load less than the rated power of the transformer, typically between 30 % and 50 %.

6.4.4 Efficiency of the transformer

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 is classified on the basis of their load and no-load energy losses.

The choice of the top energy efficiency class results in increased initial cost. However, the payback time can be estimated to be relatively short (a 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.

Reference should be made to manufacturers' information for more details on energy efficient transformers with respect to IEC TS 60076-20, including design guidelines, estimated payback time, heat dissipation needs, installation constraints in the presence of other heat-dissipating equipment.

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

6.5 Efficiency of local production and local storage

Renewable energy and associated storage contribute to the overall electrical energy efficiency of the installation.

To achieve high values of energy coverage with local energy generation, adequate local storage and/or reverse feeding into the network of the utility should be considered.

6.6 Losses in the wiring

6.6.1 Voltage drop

The energy losses in the wiring are reduced by reducing the voltage drop.

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

6.6.2 Cross-sectional areas of conductors

Increasing the cross-sectional area of conductors determined according to IEC 60364-5-52 will reduce the losses.

The cross-sectional area of conductors for distribution circuits (feeders) and final circuits supplying loads having a high consumption shall be based on a technical and economical assessment considering the cost of:

- the conductor(s),
- the erection and mounting of the conductor(s), and

- the energy losses in the conductor(s) over the expected life time.

The expected life time will vary depending on the type of load, installation and the expected use of the installation.

The cross-sectional area of other conductors should be determined assessing the savings within a time scale against the additional cost.

A calculation method can be found in IEC 60287-3-2.

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

6.6.3 Power factor correction

Consideration shall be given to power factor improvement.

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

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

NOTE A power factor correction can 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.

6.6.4 Reduction of the effects of harmonic currents

Reduction of harmonics at the load level, for example the selection of harmonic-free products, reduces the losses in the wiring.

Possible solutions include:

- reducing harmonics by the installation of harmonic filters at the respective load circuits;
- reducing the effect of harmonics by increasing the cross-sectional area of the conductors;
- using methods that produce less harmonics, like sinusoidal pulse width modulation (SPWM), in the renewable energy resources' inverters connected to the point of connection (POC).

NOTE A reduction of harmonics can 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

Identification of the zones is needed to enable the correct determination of the meshes (see 7.4).

A zone represents an area or a location where electricity is used. It may correspond for example to:

- an industrial workshop;
- a floor in a building;
- an area of a room near windows or an area of a room away 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.

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, power flow and other electrical parameters.

Different usages could be the following:

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

7.3 Demand response

Demand response is the management of the electricity demand in response to supply conditions.

Demand response is intended to adapt the consumption of energy to the generated power, especially when generation with renewable energy (e.g. windpower, photovoltaic) is present, and to guarantee system stability. Demand response programs may include dynamic pricing/tariffs, price-responsive demand bidding, contractually obligated and voluntary curtailment, and direct load control/cycling.

Methods of demand response are:

- time-based rates such as time-of-use pricing (e.g. critical peak pricing, variable peak pricing, real time pricing, critical peak rebates);
- limitation of the supply of energy;
- real-time load energy curves.

The energy efficiency and load management system gives response to the supply conditions from the grid (see Clause 8).

NOTE Real time (pricing) refers to typical time intervals from 5 min to 60 min, deepening on national conditions.

7.4 Determining the meshes

7.4.1 General

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

A more effective solution concerning energy monitoring and controlling is to assign a complete mesh to one zone.

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

Meshes shall be designed such that they may be managed to use electrical energy to always fulfil the need, taking into account driving parameters such as the availability of daylight, occupation of a room, availability of energy, outdoor temperature, other aspects linked to the building construction and passive energy efficiency.

One circuit belongs to one mesh or a cluster of meshes.