

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage electrical installations –
Part 8-1: Functional aspects – Energy efficiency**

**Installations électriques à basse tension -
Partie 8-1: Aspects fonctionnels – Efficacité énergétique**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage electrical installations –
Part 8-1: Functional aspects – Energy efficiency**

**Installations électriques à basse tension –
Partie 8-1: Aspects fonctionnels – Efficacité énergétique**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 13.020.01; 27.015; 91.140.50

ISBN 978-2-8322-9410-9

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Terms, definitions and abbreviated terms	10
3.1 General.....	10
3.2 Electrical energy management.....	11
3.3 Energy measurement.....	12
3.4 Sectors of activities.....	13
3.5 Abbreviated terms.....	13
4 General	14
4.1 Fundamental principles	14
4.1.1 Safety of the electrical installation	14
4.1.2 Availability of electrical energy and user decision	14
4.1.3 Design principles	14
4.2 Energy efficiency assessment for electrical installations	15
4.2.1 General	15
4.2.2 Action plan following an assessment according to Annex B	15
5 Sectors of activities	15
6 Design requirements and recommendations	15
6.1 General.....	15
6.2 Determination of load energy profile.....	16
6.3 Determination of the transformer and switchboard location with the barycentre method.....	16
6.4 HV/LV substation	16
6.4.1 General	16
6.4.2 Optimum number and location of HV/LV substations.....	16
6.4.3 Working point of the transformer.....	17
6.4.4 Efficiency of the transformer.....	17
6.5 Efficiency of local production and local storage.....	17
6.6 Losses in the wiring	17
6.6.1 Voltage drop.....	17
6.6.2 Cross-sectional areas of conductors	17
6.6.3 Power factor correction.....	18
6.6.4 Reduction of the effects of harmonic currents	18
7 Determination of the zones, usages and meshes	18
7.1 Determining the zones	18
7.2 Determining the usages within the identified zones	19
7.3 Demand response.....	19
7.4 Determining the meshes	19
7.4.1 General	19
7.4.2 Meshes.....	20
7.4.3 Criteria for considering meshes	20
7.5 Driving parameters.....	21
7.5.1 General	21
7.5.2 Occupancy	22

7.5.3	Operating time	22
7.5.4	Environmental conditions	22
7.5.5	Cost of electricity	22
7.6	Impacts on the design of an electrical installation	22
8	Energy efficiency and load management system	22
8.1	General	22
8.2	User specification	23
8.2.1	General	23
8.2.2	Requirements on the loads	23
8.2.3	Requirements on the supplies	23
8.3	Inputs from loads, sensors and forecasts	24
8.3.1	General	24
8.3.2	Communication	28
8.3.3	Data logging	29
8.3.4	Loads	29
8.3.5	Forecasts	31
8.4	Inputs from the supplies: energy availability and pricing	31
8.5	Monitoring the performance of the electrical installation	31
8.6	Management of loads through meshes	31
8.6.1	General	31
8.6.2	Electrical energy management system (EEMS)	31
8.7	Multi-supply source management: grid, local electricity production and storage	32
9	Maintenance and enhancement of the performance of the installation	32
9.1	Methodology	32
9.2	Installation life cycle methodology	34
9.3	Energy efficiency life cycle	34
9.3.1	General	34
9.3.2	Performance maintenance programme	34
9.3.3	Verification	35
9.4	Data management	35
9.5	Maintenance	35
10	Parameters for implementation of efficiency measures	35
10.1	General	35
10.2	Efficiency measures	35
10.2.1	Current-using-equipment	35
10.2.2	Electrical installation	37
10.2.3	Implementation of management systems	38
10.2.4	Local power supply	40
10.3	Energy efficiency actions	41
Annex A (informative)	Determination of transformer and switchboard location using the barycentre method	42
A.1	Barycentre method	42
A.2	Total load barycentre	45
A.2.1	General	45
A.2.2	Sub-distribution board locations	46
A.2.3	Iterative process	46
A.3	Method of average route length	46

Annex B (normative) Method to assess the energy efficiency of an electrical installation	49
B.1 General.....	49
B.2 Electrical installation efficiency classes.....	49
B.3 Determination of the electrical installation efficiency class	49
B.3.1 General	49
B.3.2 Industrial, commercial buildings and infrastructures.....	50
B.3.3 Residential	64
Annex C (informative) List of notes concerning certain countries	70
Bibliography.....	71
Figure 1 – Energy efficiency and load management system overview	23
Figure 2 – Electrical distribution scheme.....	26
Figure 3 – Example of measurement equipment selection in an installation	28
Figure 4 – Iterative process for electrical energy efficiency management.....	33
Figure A.1 – Example 1: floor plan of production plant with the planned roads and calculated barycentre.....	44
Figure A.2 – Example 2: barycentre calculated	45
Figure A.3 – Example of location of the barycentre in an industrial building	46
Figure A.4 – Example of location of the barycentre using the average route length method	48
Figure B.1 – Level of efficiency of the electrical installation efficiency classes	49
Table 1 – Measurement applications.....	25
Table 2 – Overview of the needs for power metering and monitoring.....	26
Table 3 – Process for electrical energy efficiency management and responsibilities.....	33
Table A.1 – Cable length for supply of DF.....	47
Table B.1 – Electrical installation efficiency classes.....	50
Table B.2 – Energy efficiency measures	51
Table B.3 – Determination of energy consumption: coverage	52
Table B.4 – Main substation: consumption.....	52
Table B.5 – Main substation: location.....	53
Table B.6 – Voltage drop	53
Table B.7 – Efficiency of transformer	54
Table B.8 – Efficiency of fixed installed current using equipment	55
Table B.9 – Zones	55
Table B.10 – Usages	56
Table B.11 – Demand response: coverage.....	56
Table B.12 – Demand response: duration	56
Table B.13 – Meshes	57
Table B.14 – Measurement by usages	58
Table B.15 – Occupancy coverage.....	58
Table B.16 – Occupancy measurement.....	58
Table B.17 – Energy management system (EEMS)	59
Table B.18 – HVAC control	59

Table B.19 – Lighting control	60
Table B.20 – Performance maintenance process	60
Table B.21 – Frequency of the performance verification process.....	60
Table B.22 – Data management.....	61
Table B.23 – Working point of transformer	61
Table B.24 – Presence of continuous monitoring for large energy using systems	62
Table B.25 – Power factor.....	62
Table B.26 – THD_U	63
Table B.27 – THD_I	63
Table B.28 – Renewable energy	64
Table B.29 – Electrical energy storage.....	64
Table B.30 – Energy efficiency measures parameters.....	65
Table B.31 – Determination of energy consumption	65
Table B.32 – Zones.....	66
Table B.33 – Demand response coverage.....	66
Table B.34 – Meshes	67
Table B.35 – HVAC control	67
Table B.36 – Lighting control	68
Table B.37 – Measurement by usage	68
Table B.38 – Renewable energy	69
Table B.39 – Electrical energy storage.....	69
Table C.1 – Notes concerning certain countries	70

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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://web site 3.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.

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.

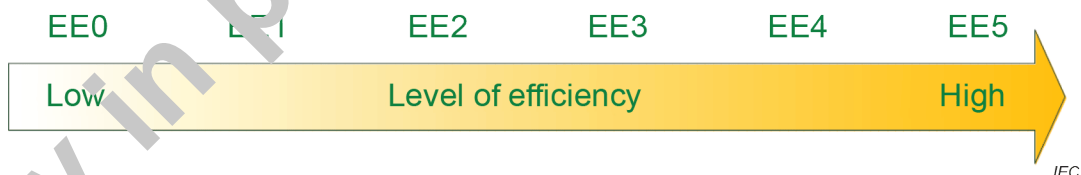
It is important that this document covers existing electrical installations in buildings, in addition to new installations. It is in the refurbishment of existing buildings that significant overall improvements in energy efficiency can be achieved.

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)*