

This document is a preview generated by EVS

Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 2: Grid connected systems - Maintenance of PV systems

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN IEC 62446-2:2020 sisaldab Euroopa standardi EN IEC 62446-2:2020 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 62446-2:2020 consists of the English text of the European standard EN IEC 62446-2:2020.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 15.05.2020.	Date of Availability of the European standard is 15.05.2020.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 27.160

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Koduleht www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Homepage www.evs.ee; phone +372 605 5050; e-mail info@evs.ee

EUROPEAN STANDARD

EN IEC 62446-2

NORME EUROPÉENNE

EUROPÄISCHE NORM

May 2020

ICS 27.160

English Version

**Photovoltaic (PV) systems - Requirements for testing,
documentation and maintenance - Part 2: Grid connected
systems - Maintenance of PV systems
(IEC 62446-2:2020)**

Systèmes photovoltaïques (PV) - Exigences pour les
essais, la documentation et la maintenance - Partie 2:
Systèmes connectés au réseau électrique - Maintenance
des systèmes PV
(IEC 62446-2:2020)

Photovoltaik(PV)-Systeme - Anforderungen an Prüfung,
Dokumentation und Instandhaltung - Teil 2: Netzgekoppelte
Systeme - Instandhaltung von PV-Systemen
(IEC 62446-2:2020)

This European Standard was approved by CENELEC on 2020-04-22. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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 82/1656/FDIS, future edition 1 of IEC 62446-2, prepared by IEC/TC 82 "Solar photovoltaic energy systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62446-2:2020.

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) 2021-01-22
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-04-22

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 62446-2:2020 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 60300-3-3	NOTE	Harmonized as EN 60300-3-3
IEC 60891	NOTE	Harmonized as EN 60891
IEC 60904-1	NOTE	Harmonized as EN 60904-1

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.

Clause 2 of IEC 62446-1:2016 is applicable, except as follows:

Add the following references:

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC/TS 61724-2	-	Photovoltaic system performance - Part 2: Capacity evaluation method	-	-
IEC/TS 61724-3	-	Photovoltaic system performance - Part 3: Energy evaluation method	-	-
IEC/TS 61836	2016	Solar photovoltaic energy systems - Terms, definitions and symbols	-	-
IEC 62020	-	Electrical accessories - Residual current monitors for household and similar uses (RCMs)	-	-
IEC 62446-1	2016	Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests and inspection	EN 62446-1	2016
IEC/TS 62446-3	2017	Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 3: Photovoltaic modules and plants - Outdoor infrared thermography	-	-
IEC 62548	-	Photovoltaic (PV) arrays - Design requirements	-	-

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	8
3 Terms and definitions	8
4 System documentation requirements	10
4.1 General.....	10
4.8 Operation and maintenance information.....	10
4.10 Performance benchmarking	11
4.11 Documentation of records	11
5 Verification	11
6 Test procedures – Category 1.....	11
7 Test procedures – Category 2.....	11
8 Test procedures – Additional tests.....	11
9 Verification reports	12
10 Maintenance protocols.....	12
10.1 General.....	12
10.2 Verification intervals and triggers.....	12
10.3 Other considerations for determining specific verification intervals.....	17
11 Verification tasks	17
11.1 General.....	17
11.2 General site visual inspection	17
11.2.1 All systems	17
11.2.2 Rooftop systems.....	18
11.2.3 Ground-mount systems.....	18
11.3 Component inspection and safety related maintenance.....	18
11.3.1 Inverter and main electrical equipment pad.....	18
11.3.2 Combiner boxes, disconnects and isolators	18
11.3.3 Modules.....	20
11.3.4 PV connectors	20
11.3.5 Wiring.....	21
11.3.6 Mounting system	21
11.3.7 Conduits and cable trays	22
11.3.8 Weather station	22
11.4 Performance related maintenance.....	22
11.4.1 General	22
11.4.2 Wiring connection resistance	22
11.4.3 Shade evaluation.....	22
11.4.4 Module string or wiring harness testing.....	22
11.4.5 Vegetation management.....	24
11.4.6 Soiling and array cleaning	24
12 Troubleshooting and corrective maintenance.....	26
12.1 General.....	26
12.2 Shutdown of equipment in response to hazardous failures	26
12.3 Troubleshooting non-hazardous failures.....	26

12.4	Troubleshooting incident or event-triggered issues	26
12.5	Diagnosing performance related issues	27
13	Additional procedures	28
13.1	General	28
13.2	Safety procedures	28
13.2.1	General	28
13.2.2	Safe operation of switch disconnectors	28
13.3	Isolation procedures	28
13.3.1	Emergency shutdown	28
13.3.2	Non-emergency shutdown	29
13.4	Inspection and preventive maintenance procedures	30
13.4.1	Inverter manufacturer specific procedures	30
13.4.2	Tracker manufacturer specific procedures	31
13.4.3	Data acquisition system specific procedures	31
13.5	Electrical test procedures	32
13.5.1	Earth fault testing	32
13.5.2	Fuse tests	34
13.5.3	Bypass diode tests	34
13.6	Diagnostic procedures	35
13.6.1	Validation of data acquisition systems (DAS)	35
13.6.2	Inverter diagnostics	38
Annex E	(normative) Safety considerations	40
E.1	Qualified persons	40
E.2	General safety considerations	40
E.3	Personal protective equipment	41
E.4	Isolation procedures	41
E.5	Lock-out tag-out	41
E.6	PV specific signs and labelling	42
Annex F	(informative) Example preventive maintenance schedule	43
F.1	General	43
F.2	Example system description	43
Annex G	(informative) PV system operations	50
Bibliography	51
Table 3	– Verification and maintenance tasks and basis for determining task intervals	13
Table 4	– Common reported inverter errors	38
Table F.1	– Preventive maintenance schedule for XYZ plant	44

INTERNATIONAL ELECTROTECHNICAL COMMISSION

—————

**PHOTOVOLTAIC (PV) SYSTEMS –
REQUIREMENTS FOR TESTING, DOCUMENTATION AND MAINTENANCE –**

Part 2: Grid connected systems – Maintenance of PV systems

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 62446-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/1656/FDIS	82/1676/RVD

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

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

A list of all parts in the IEC 62446 series, published under the general title *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance*, can be found on the IEC website.

This International Standard is to be used in conjunction with IEC 62446-1:2016.

The requirements in IEC 62446-2 are to be used with the requirements in IEC 62446-1:2016, and supplement or modify clauses in IEC 62446-1:2016. All Clauses 1 to 9 of IEC 62446-1:2016 apply, including the applicable Annexes. When IEC 62446-2 contains clauses that add to, modify, or replace clauses in IEC 62446-1:2016, the relevant text of IEC 62446-1:2016 is to be applied with the required changes.

Clauses, subclauses, figures, tables and annexes additional to those in IEC 62446-1:2016 are numbered in continuation of the sequence existing in IEC 62446-1:2016.

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

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

INTRODUCTION

This Part 2 of IEC 62446 gives requirements and recommendations for the maintenance of PV systems, including periodic inspections, safety and performance related preventive maintenance, corrective maintenance and troubleshooting. Grid connected PV systems are generally considered to be a very low maintenance means of power generation. While this is true relative to conventional generation sources that utilize fuel and/or rotating machinery, PV systems do require some level of preventive and corrective maintenance to perform as anticipated over lifetimes that can exceed 20 years. The level of maintenance required or recommended for performance can vary considerably based on the owner's preference or contractual obligations for power production; however, a minimum level of monitoring or maintenance is critical for safety and reducing the risk of fire. Adherence to a minimum set of maintenance requirements is also integral to the goals of the IECRE Conformity Assessment system, which is intended to drive the licensing and certification of PV systems and plants from the design to the operations stage.

Conformity Assessment is a preview generated by EVS

PHOTOVOLTAIC (PV) SYSTEMS – REQUIREMENTS FOR TESTING, DOCUMENTATION AND MAINTENANCE –

Part 2: Grid connected systems – Maintenance of PV systems

1 Scope

This clause of IEC 62446-1:2016 is applicable with the following exception:

Addition:

This Part 2 of IEC 62446 describes basic preventive, corrective, and performance related maintenance requirements and recommendations for grid-connected PV systems. The maintenance procedures cover:

- Basic maintenance of the system components and connections for reliability, safety and fire prevention
- Measures for corrective maintenance and troubleshooting
- Worker safety

This document also addresses maintenance activities for maximizing anticipated performance such as module cleaning and upkeep of vegetation. Special considerations unique to rooftop or ground-mounted systems are summarized. This document does not cover off-grid systems or systems that include batteries or other energy storage technologies; however, parts may be applicable to the PV circuits of those systems.

This document also does not cover maintenance of medium and high voltage a.c. equipment that are sometimes integral to larger scale systems, as those requirements are not specific to PV systems.

Maintenance of PV systems is often lumped into the catch-all term operations and maintenance (O&M.) This document does not address business or management operational processes (e.g. forecasting, utility pricing incentives, etc.) or other considerations driven by factors outside of basic system working condition, safety and performance.

The confirmation of a system's compliance with the appropriate design and installation standards is covered in Part 1 and takes place during initial project commissioning.

The objectives of this document are to:

- Identify a baseline set of maintenance requirements which may differ by system type (residential, commercial, utility scale), owner, or financing requirements.
- Identify additional maintenance steps that are recommended or optional.
- Identify factors to be used to determine appropriate maintenance intervals.
- Ensure that remote diagnostic methods are allowed as means for periodic verification, problem identification and early failure detection.
- Ensure that alternate means of achieving maintenance related requirements are allowed to accommodate for innovation, manufacturer specific methods, evolving customer requirements, etc.

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.

This clause of IEC 62446-1:2016 is applicable, with the following exception:

Addition

IEC TS 61724-2, *Photovoltaic system performance – Part 2: Capacity evaluation method*

IEC TS 61724-3, *Photovoltaic system performance – Part 3: Energy evaluation method*

IEC TS 61836:2016, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 62020, *Electrical accessories – Residual current monitors for household and similar uses (RCMs)*

IEC 62446-1:2016, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests and inspection*

IEC TS 62446-3:2017, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 3: Photovoltaic modules and plants – Outdoor infrared thermography*

IEC 62548, *Photovoltaic (PV) arrays – Design requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 as well as those in Clause 3 of IEC 62446-1:2016 are applicable, with the following additions:

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>

Addition:

3.17 support structure

equipment (also known as “racking”) used to physically support modules or groups of modules and position them in a fixed or moving orientation relative to the path of the sun

3.18 equipment pad

foundation typically (but not exclusively) made of concrete or cement used for mounting and securing inverters, disconnectors, transformers, or other equipment associated with a PV system

Note 1 to entry: Equipment pads are typically installed in ground-mount systems, or adjacent to buildings for large rooftop systems where equipment is too large to be wall-mounted.