IEC TS 62994

Edition 1.0 2019-01

TECHNICAL SPECIFICATION

colour inside

Photovoltaic (PV) modules through the life cycle – Environmental health and safety (EH&S) risk assessment – General principles and nomenclature

IEC TS 62994:2019-01(en)

IEC Central Office
3, rue de Varembé
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 It also gives information on projects, replaced and withdrawn publications.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.

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 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC TS 62994

Edition 1.0 2019-01

TECHNICAL SPECIFICATION

colour inside

Photovoltaic (PV) modules through the life cycle – Environmental health and safety (EH&S) risk assessment – General principles and nomenclature

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-6419-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

PHOTOVOLTAIC (PV) MODULES THROUGH THE LIFE CYCLE – ENVIRONMENTAL HEALTH AND SAFETY (EH&S) RISK ASSESSMENT –

General principles and nomenclature

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.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62994, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/1370/DTS	82/1504/RVDTS

Full information on the voting for the approval of this technical specification 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.

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.

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

This Technical Specification establishes definitions of terms of environmental health and safety (EH&S) risk assessment and also basic principles and general methods for the EH&S risk assessment for the PV module through its life cycle.

EH&S risk assessment is a method to characterize and evaluate potential adverse impacts to human health or environment in order to develop policies to control and reduce them. Although PV technologies have environmental advantages over conventional energy technologies, PV modules can contain some hazardous materials. Therefore, EH&S risk assessment of PV modules is very important for the safe and sustainable manufacture, use, and end-of-life treatment of PV modules.

Though there are many standards relating to EH&S and risk assessment, there is no published IEC standard for the EH&S risk assessment of the PV module at present.

This technical specification was developed in cooperation with IEA PVPS task 12 (PV Environmental, Health and Safety Activities). The objectives of the task are to ‘quantify the environmental profile of PV in comparison to other energy technologies’ and ‘to define and address EH&S and sustainability issues that are important for PV market growth’. IEA PVPS task 12 and IEC TS 62994 Project team had joint meetings and established a liaison officer to work on this technical specification on the EH&S for the PV.

PHOTOVOLTAIC (PV) MODULES THROUGH THE LIFE CYCLE – ENVIRONMENTAL HEALTH AND SAFETY (EH&S) RISK ASSESSMENT –

General principles and nomenclature

1 Scope

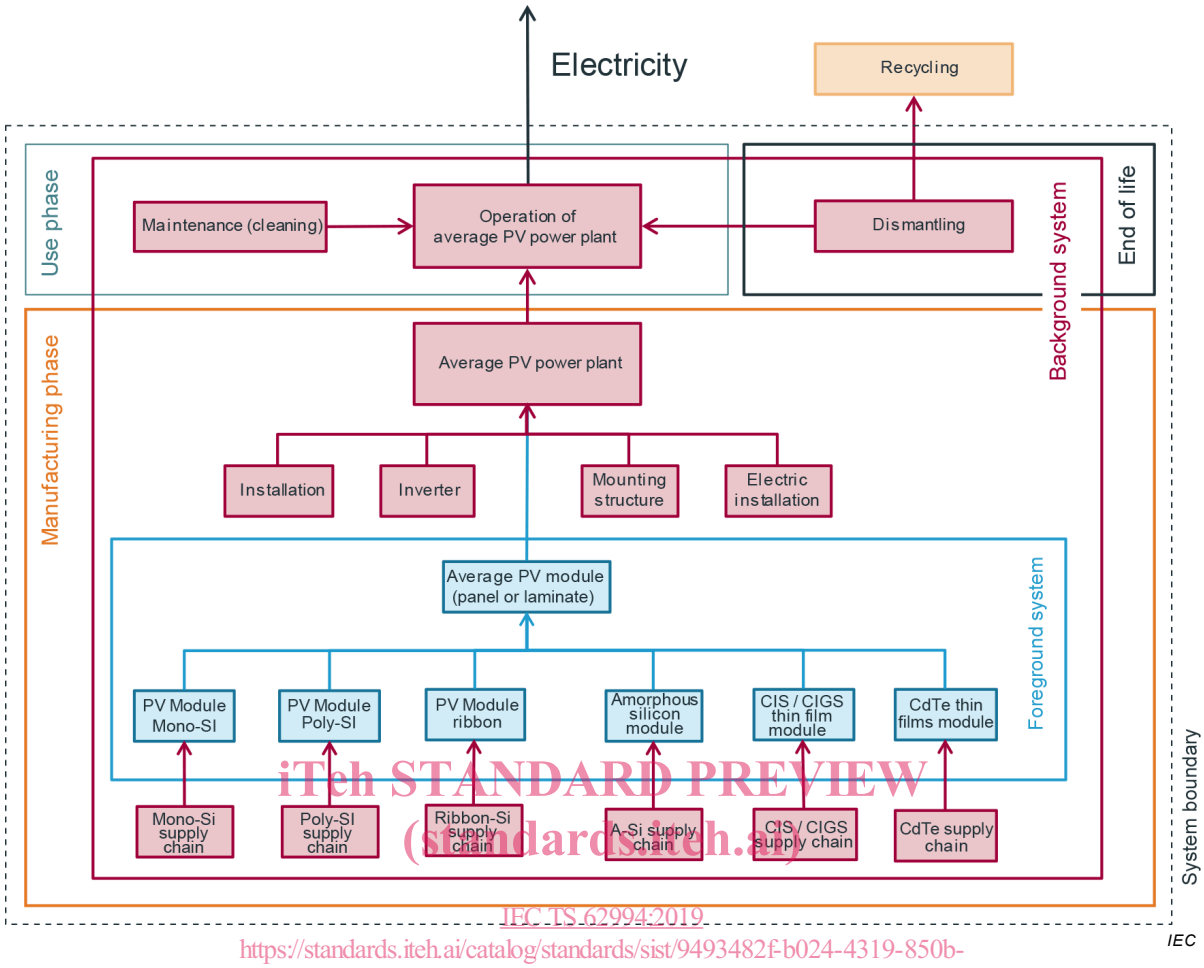
This document specifies definitions of terms and introduces evaluation methods for EH&S risk assessment for the PV module over the product life cycle. Environmental health and safety (EH&S) risk assessment is a method to characterize and evaluate potential adverse impacts to human health or environment and make it possible to take measures to reduce them. EH&S risk assessment of PV modules is very important for the safe and sustainable manufacture, use, and end of life treatment of PV modules. The definition of terms can be applied to the EH&S risk assessment through the life cycle of PV modules. Generally, evaluation methods for the EH&S risk assessment can be divided in two cases:

- ordinary foreseen routine operation, in which life cycle assessment method is applied;
- abnormal non-routine operation, in which risk assessment method is applied.

The scope of the two general cases is described below.

When assessing the environmental impacts of routine operation of PV electricity production with life cycle assessment, the product system includes the manufacturing phase, the use phase and the end of life phase (see Figure 1). Electronic installation, mounting structure and power conversion equipment (such as inverters) are included as part of the PV system to be analysed.

When assessing the risk of non-routine operation of PV modules, the system analysed is limited to the PV module, its supply chain, operation and end of life treatment, and its direct electrical and mechanical interfaces with the balance of system, i.e. the electric installation, mounting structure and inverters.



Processes of the foreground and background system are marked with blue and red colour, respectively (lighter coloured line and darker coloured line respectively for monochrome printed version).

Figure 1 – Product system of electricity produced with photovoltaic modules

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 61724-1, *Photovoltaic system performance – Part 1: Monitoring*

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

ISO/IEC Guide 51, *Safety aspect – Guidelines for their inclusion in standards*

ISO 14001, *Environmental management system – Requirements with guidance for use*

ISO 14004:2016, *Environmental management systems- General guidelines on implementation*

ISO 14040, *Environmental management -Life cycle assessment – Principles and framework*

ISO 14044:2006, *Environmental management – Life cycle assessment – Requirements and guidelines*

OHSAS 18001: 2009, *Guide to implementing a Health & Safety Management System*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14001, OHSAS 18001, IEC TS 61836 and ISO/IEC Guide 51 as well as the following 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
Life Cycle Assessment
LCA
compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

[SOURCE: ISO 14044:2006,3.2]

3.2
Life Cycle Impact Assessment
LCIA

phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product

[SOURCE: ISO 14044:2006, 3.4]

3.3
Energy Pay Back Time
EPBT
period required for an energy system to generate the same amount of energy (in terms of primary energy equivalent) that was used to produce the system itself

[SOURCE: Frischknecht R., Heath G., Raugei M., Sinha P. and de Wild-Scholten M.,2015, Methodology Guidelines on Life Cycle Assessment of Photovoltaic Electricity, 3rd edition. International Energy Agency, IEA, Paris]

3.4
environmental impact mitigation potentials
quantity of environmental mitigation achievable relative to a baseline or reference case. Mitigation means the elimination or reduction of frequency, magnitude or severity of exposure to risks, or minimization of a threat.

3.5
harm
physical injury or damage to persons and livestock

[SOURCE: IEC Guide 116:2010, 3.2, IEC 60050-903:2013, 903-01-01]

3.6
hazard
potential source of harm

[SOURCE: ISO/IEC Guide 51:1999, 3.5, IEC 60050-903:2013, 903-01-02, modified: “Note 2” deleted]

3.7
risk
combination of the probability of occurrence of harm and the severity of that harm

[SOURCE: IEC Guide 116:2010, 3.13, IEC 60050-903:2013, 903-01-07, modified: “Note 1” deleted].

3.8
risk analysis
systematic use of available information to identify hazards and to estimate the risk

[SOURCE: ISO/IEC Guide 51:1999, 3.10, IEC 60050-903:2013, 903-01-08]

3.9
risk evaluation
procedure based on the risk analysis to determine whether the tolerable risk has been achieved

[SOURCE: ISO/IEC Guide 51:1999, 3.11, IEC 60050-903:2013, 903-01-09]

3.10
risk assessment
overall process comprising a risk analysis and a risk evaluation

[SOURCE: IEC Guide 116:2010, 3.15, IEC 60050-903:2013, 903-01-10]

3.11
sustainability
endurance of systems and processes, and in ecology it refers to how biological systems remain diverse and productive. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, and that permit fulfilling the social, economic and other requirements of present and future generations

4 Basic principles of EH&S risk assessment for the PV module

4.1 Basic concepts

Although PV technology has environmental advantages over conventional energy technologies, the PV industry also uses hazardous materials. Substances that are the subject of EH&S risk assessment for the PV include flammable, explosive, corrosive, or toxic materials used in PV industry. Understanding environmental health and safety impacts during the routine product life cycle and prevention of accidental release of hazardous substances during non-routine events and reduction of adverse effects are very important for the sustainability of PV modules. EH&S risk assessment of PV focuses on the emissions of such substances during the life cycle of PV (usually by the LCA) to characterize environmental health and safety impacts. EH&S risk assessment for PV also includes consideration of adverse health or environmental effects resulting from exposures to hazardous agents or situations (by the Environmental Health & Risk Assessment; EHRA).

4.2 Life cycle assessment (LCA) of PV

4.2.1 Fundamentals

4.2.1.1 General

These fundamentals describe the basis for the subsequent requirements in this document. The quantification and reporting of an LCA in accordance with this document are based on the principles of the LCA methodology provided in ISO 14040 and ISO 14044.

4.2.1.2 Life cycle perspective

The development of LCA quantification and communication takes into consideration all stages of the life cycle of PV electricity production, including raw material acquisition, production, use and the end of life stage.

4.2.1.3 Iterative approach

When applying the four phases of LCA (goal and scope definition, life cycle inventory analysis, life cycle impact assessment and interpretation, see 4.2.3 to 4.2.5) to a LCA study, use an iterative approach (continuous reassessment as needed when refining the LCA study). The iterative approach will contribute to the consistency of the LCA study and the reported results.

4.2.1.4 Scientific approach

When making decisions within a LCA, give preference to natural science (such as physics, chemistry, biology). If that is impossible, use other scientific approaches (such as social and economic sciences) or refer to approaches contained in conventions relevant and valid within the geographical scope valid for the LCA study. Permit decisions within a LCA based on value choices, as appropriate, only if neither a natural scientific basis exists nor a justification based on other scientific approaches or international conventions is possible, and explain the rationale for such value choices.

4.2.1.5 Relevance

Select data and methods appropriate to the assessment of the emissions and resource consumptions arising from the product system being studied.

4.2.1.6 Completeness

Include all emissions and resource consumptions, unit processes and life cycle stages that provide a significant contribution to the environmental impacts of the product system being studied.

4.2.1.7 Consistency

Apply assumptions, methods and data in the same way throughout the LCA study to arrive at conclusions in accordance with the goal and scope definition.

4.2.1.8 Coherence

Select methodologies, standards and guidance documents already recognized and adopted for PV electricity production to enhance comparability between LCA studies within this specific product category.

4.2.1.9 Accuracy

Ensure that LCA quantification and communication are accurate, verifiable, relevant and not misleading and that bias and uncertainties are reduced as far as is practical.