



*NSF International Standard /
American National Standard*

NSF/ANSI 457 - 2019

Sustainability Leadership Standard
for Photovoltaic Modules
and Photovoltaic Inverters



Document Sharing Hub

NSF International, an independent, not-for-profit, nongovernmental organization, is dedicated to being the leading global provider of public health and safety-based risk management solutions while serving the interests of all stakeholders.

This Standard is subject to revision.
Contact NSF to confirm this revision is current.

Users of this Standard may request clarifications and interpretations, or propose revisions by contacting:

Chair, Joint Committee on Sustainability Leadership Standard
for Photovoltaic Modules and Photovoltaic Inverters
c/o NSF International
789 North Dixboro Road, PO Box 130140
Ann Arbor, Michigan 48113-0140 USA
Phone: (734) 769-8010 Fax: (734) 769-0109
Email: info@nsf.org
Web: www.nsf.org

NSF International Standard /
American National Standard
for Sustainability –

Sustainability Leadership Standard for Photovoltaic Modules and Photovoltaic Inverters

Standard Developer
NSF International

Designated as an ANSI Standard
July 22, 2019
American National Standards Institute

Prepared by
**The NSF Joint Committee on Sustainability Leadership Standard
for Photovoltaic Modules and Photovoltaic Inverters**

Recommended for adoption by
The NSF Council of Public Health Consultants

Adopted by
NSF International
October 2017

Revised October 2019

Published by
NSF International
PO Box 130140, Ann Arbor, Michigan 48113-0140, USA

For ordering copies or for making inquiries with regard to this Standard, please reference the designation
“NSF/ANSI 457 – 2019”.

Copyright 2019 NSF International

Previous editions © 2017

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 NSF International.

Printed in the United States of America.

Disclaimers¹

NSF International (NSF), in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of NSF represent its professional judgment. NSF shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. NSF shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard. It is the responsibility of the user of this standard to judge the suitability of the ANS for the user's purpose.

NSF Standards provide basic criteria to promote sanitation and protection of public health and the environment. Provisions for mechanical and electrical safety have not been included in this Standard because governmental agencies or other national standards-setting organizations provide safety requirements.

Participation in NSF Standards development activities by regulatory agency representatives (federal, local, state) shall not constitute their agency's endorsement of NSF or any of its Standards.

Preference is given to the use of performance criteria measurable by examination or testing in NSF Standards development when such performance criteria may reasonably be used in lieu of design, materials, or construction criteria.

The illustrations, if provided, are intended to assist in understanding their adjacent standard requirements. However, the illustrations may not include all requirements for a specific product or unit, nor do they show the only method of fabricating such arrangements. Such partial drawings shall not be used to justify improper or incomplete design and construction.

At the time of this publication, examples of programs and processes were provided for general guidance. This information is given for the convenience of users of this Standard and does not constitute an endorsement by NSF International. Equivalent programs and processes may be used.

Unless otherwise referenced, the annexes are not considered an integral part of NSF Standards. The annexes are provided as general guidelines to the manufacturer, regulatory agency, user, or certifying organization.

¹ The information contained in this Disclaimer is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Disclaimer may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

This page is intentionally left blank.

Contents

1	General	1
1.1	Purpose	1
1.2	Scope	1
2	References	3
2.1	Normative references	3
2.2	Informational references	7
3	Definitions and acronyms	7
3.1	Definitions	7
3.2	Acronyms	12
4	Conformance, evaluation and assessment	13
4.1	Criteria	13
4.2	Levels of conformance	15
5	Management of substances	16
5.1	List of declarable substances	16
5.2	Reduction of substances of concern	19
6	Preferable materials use	22
6.1	Recycled content	22
7	Life cycle assessment (LCA)	25
7.1	Life cycle assessment (LCA)	25
7.2	Reduction in LCA impacts	27
8	Energy efficiency and water use	28
8.1	Energy efficiency and management system	28
8.2	Water use metrics	34
9	End of life management and design for recycling	36
9.1	End-of-life (EOL) management	36
9.2	Design for recycling	40
10	Product packaging	41
10.1	Eliminate substances of concern	41
10.2	Recyclability of packaging	41
10.3	Recycled content in packaging	42
11	Corporate responsibility	42
11.1	Environmental, health and safety management systems	42
11.2	Corporate reporting	43
11.3	Corporate social performance	47
11.4	Conflict mineral sourcing	48
	Informative Annex 1 Summary of criteria	51
	Informative Annex 2 Section 7.1.1 system boundaries	55
	I-2.1 Example flow	55

This page is intentionally left blank.

Foreword²

This American National Standard, NSF/ANSI 457 Sustainability Leadership Standard for Photovoltaic Modules and Photovoltaic Inverters has been developed as part of the ongoing efforts of a number of interested parties to document and improve the sustainability performance profile of photovoltaic modules and inverters using established and advanced scientific principles, practices, materials, and standards.

This edition of the Standard contains the following revisions:

Issue 2

This revision expands the scope of this Standard to include photovoltaic inverters, and also updates Sections 1 through 7 and Annex I-1.

Issue 3

This revision updates Section 8 to include photovoltaic inverters.

Issue 4

This revision updates Sections 9 and 11 to include photovoltaic inverters.

This revision also includes an editorial update to the names of the Annexes within. The Annexes are being changed from alpha characters to numeric, preceded by a 'Normative' or 'Informative'. The table below shows the previous name of the Annex with the corresponding new name of the Annex:

Previously known as:	Now known as:
Annex A	Informative Annex 1 (I-1)
Annex B	Informative Annex 2 (I-2)

The purpose of this Standard for photovoltaic modules and inverters is to establish product sustainability performance criteria and corporate performance metrics that exemplify sustainability leadership in the market. These performance criteria are intended to form the basis of conformity assessment programs, such as third-party certification or registration.

Suggestions for improvement of this Standard are welcome. This Standard is maintained on a Continuous Maintenance schedule and can be opened for comment at any time. Comments should be sent to: Chair, Joint Committee on Sustainability Leadership Standard for Photovoltaic Modules and Photovoltaic Inverters at standards@nsf.org, or c/o NSF International, Standards Department, PO Box 130140, Ann Arbor, Michigan 48113-0140, USA.

² The information contained in this Disclaimer is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Disclaimer may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

This page is intentionally left blank.

NSF/ANSI Standard
for Sustainability –

Sustainability Leadership Standard for Photovoltaic Modules and Photovoltaic Inverters

1 General

1.1 Purpose

The purpose of this Standard for photovoltaic (PV) modules and PV inverters is to establish product sustainability performance criteria and corporate performance metrics that exemplify sustainability leadership in the market.

The Standard provides a framework and standardized set of performance objectives for manufacturers and the supply chain in the design and manufacture of PV module and PV inverters components. For purchasers, this Standard provides a consensus-based definition of key sustainability attributes and performance metrics, alleviating individual purchasers from the arduous and complex task of defining sustainability performance for PV modules and PV inverters. This Standard can be used within an established system for the identification of sustainability / environmentally preferable products by purchasers, and to provide market recognition for conforming products and brand manufacturers.

This Standard was developed based on the principle that only sustainability leadership products, those in the top-third of the market, are expected to qualify to the Standard at the Bronze level at the date of publication of this Standard. Only a few products are expected to meet the highest performance level (Gold) at the date of publication of this Standard.

This Standard will be continually maintained and periodically reviewed to ensure that the definition of sustainability leadership, as reflected in the performance criteria, progresses with the evolution of technology and services and sustainability/environmental improvements in the product sector.

1.2 Scope

This is a sustainability leadership Standard for PV modules and PV inverters. The scope of this Standard includes:

- 1) PV modules for installation on, or integral with buildings, or to be primarily used as components of free-standing power-generation systems, including, but not necessarily limited to:
 - PV cells that generate electric power using solar energy;
 - interconnects (materials that conduct electricity between cells);
 - encapsulant (insulating material enclosing the cells and cell interconnects);
 - superstrate (material forming primary light-facing outer surface) and substrate (material forming back outer surface) (e.g., glass, plastic films);

- wires used to interconnect PV modules and connect junction boxes to the balance of system equipment; and
- frame or integrated mounting mechanism, if present.

The following are not included in the definition of PV module:

- balance of system equipment, such as cabling and mounting structures, equipment intended to accept the electrical output from the array, such as power conditioning units (inverters) and batteries, unless they are contained in the PV module;
- a PV cell that is a part of another device for which it produces the electricity, such as consumer or industrial electronic products (e.g., calculators, lights, textile) where the PV cell primarily provides the energy needed to make the electronic product function; and
- mobile PV cell where the inverter is so integrated with the PV cell that the solar cell requires disassembly before recovery.

2) PV inverters to convert and condition electrical power of a PV module to AC. The PV inverter is all the devices necessary to implement the PV inverter function. If separated devices are required to perform this function, the PV inverter is defined as their sum.

Including, but not limited to:

- PV-string inverters with included maximum power point trackers;
- central inverters;
- micro inverters;
- bi-directional inverters; and
- a combination of a DC optimizer plus the inverter in systems where both are necessary.

The following are not included in the definition of PV inverter (these devices may be included with the PV inverter, but are not in the scope of this Standard):

- PV module;
- cabling and mounting structures;
- external disconnects;
- communication equipment;
- combiners without power conversion or conditioning equipment function;
- batteries and other energy storage components;
- external transformers; and
- other devices not required to perform the PV inverter function.

This Standard establishes measurable criteria for multiple levels of sustainability / environmental leadership achievement and performance throughout the life cycle of the product. This Standard addresses multiple attributes and environmental performance categories, including management of substances, preferable materials use, life cycle assessments (LCAs), energy efficiency and water use, responsible end-of-life (EOL) management, and design for recycling, product packaging, and corporate responsibility.

2 References

2.1 Normative references

The following referenced documents are required for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies. European Union Directives, which contain the adoption date in their title, shall not be treated as “dated standards or regulations”. Unless explicitly indicated otherwise, when a European Union Directive is referenced in this Standard, a new or updated European Union Directive shall apply as the referenced Directive upon its enforcement date.

ANSI/AIHA/ASSE Z10, *Occupational Health and Safety Management Systems*³

ANSI/MSE 50028-1, *Superior Energy Performance 50001 Program – Additional Requirements for Energy Management Systems*⁴

ANSI/MSE 50028-2, *Superior Energy Performance 50001 Program – Requirements for verification bodies for use in accreditation or other forms of recognition*⁴

California Energy Commission & California Public Utilities Commission, *Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems*⁵

California Safer Products Alternatives Analysis, CA Code of Regulations Title 22, Division 4.5, Chapter 55, Article 5, Sections 69505.5-69505.7⁶

Candidate List of Substances of Very High Concern (SVHC)⁷

Conflict-free Sourcing Initiative (CFSI)⁸

DIN 6120-1, *Marking of packaging and packaging materials for recycling purposes – Plastics packaging and packaging materials – Part 1: Graphical symbols*⁹

Ecospol v.2¹⁰

EPA/600/R-06/060, *Life Cycle Assessment: Principles and Practice*, 2006 edition.¹¹

European Chemicals Agency database⁷

³ ASSE International. 18927 Hickory Creek Drive, Suite 220, Mokena, IL 60448. <www.asse-plumbing.org>

⁴ US Department of Energy. 1000 Independence Avenue SW, Washington, DC 20585. <www.energy.gov/eere/amo/superior-energy-performance>

⁵ California Energy Commission, California Solar Initiative. 505 Van Ness Avenue, San Francisco, CA 94102. <www.gosolarcalifornia.ca.gov>

⁶ California Department of Toxic Substances Control (DTSC). 8800 Cal Center Drive, Sacramento, CA 95826. <www.dtsc.ca.gov>

⁷ European Chemicals Agency (ECHA). PO Box 400, 00121 Helsinki, Finland. <www.echa.europa.eu>

⁸ CFSI. 1737 King Street, Suite 330, Alexandria, VA 22314. <www.conflictreesourcing.org>

⁹ European Standards. Krimicka 134, 318 13 Pilsen, Czech Republic. <www.en-standard.eu>

¹⁰ ecoinvent. Technoparkstrasse 1, 8005 Zurich, Switzerland. <www.ecoinvent.org>

¹¹ US EPA National Risk Management Research Laboratory, Office of Research and Development, US Environmental Protection Agency, Cincinnati, OH 45268.

European Chemicals Agency, *Guidance on requirements for substances in articles and Judgement C-106/14 of the European Court of Justice*⁷

European Commission Joint Research Centre, *International reference Life Cycle Data System (ILCD) Handbook*¹²

European Commission, *Waste Electrical & Electronic Equipment (WEEE)*¹²

European Union, *Eco-Management and Audit Scheme (EMAS)*¹³

EU Product Environmental Footprint Category Rules (PEFCR) Pilots, 24 April 2016 – v.2.0¹⁴

EU Product Environmental Footprint Category Rules for Photovoltaic Electricity Generation (v.1.3 or more current)¹⁴

European Union, *European Commission Directive 94/62/EC of the European Parliament and of the Council on Packaging and Packaging Waste*¹⁵

European Union Product Environmental Footprint Guide¹⁴

European Union Regulation (EC) No. 1907/2006, *Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)*¹²

GRI Sustainability Reporting Standards¹⁶

International Energy Agency (IEA), *Photovoltaic Power Systems (PVPS) Methodology Guidelines on Life Cycle Assessment of Photovoltaic Electricity Task*¹⁷

IEC 62321-3-1, *Determination of certain substances in electrotechnical products – Part 3-1: Screening – Lead, mercury, cadmium, total chromium and total bromine using X-ray fluorescence spectrometry*¹⁸

IEC 62321-3-2, *Determination of certain substances in electrotechnical products – 3-2: Screening – Total bromine in polymers and electronics by Combustion – Ion Chromatography*¹⁸

IEC 62474, *Material declaration for products of and for the electrotechnical industry*¹⁸

Intergovernmental Panel on Climate Change's Fifth Assessment Report¹⁹

International Accreditation Forum (IAF)²⁰

¹² European Commission - Joint Research Centre (JRC), Directorate D, Bio-Economy Unit (D1). Via Enrico Fermi, 2749, I - 21027 Ispra (VA) Italy. <eplca.jrc.ec.europa.eu>

¹³ European Commission, Environment DG. B - 1049 Brussels, Belgium. <ec.europa.eu/environment/emas>

¹⁴ European Union Product Environmental Footprint Guide. <eur-lex.europa.eu>

¹⁵ European Union Directives. <www.europa.eu>

¹⁶ Global Reporting Initiative. PO Box 10039, 1001 EA, Amsterdam, The Netherlands. <www.globalreporting.org>

¹⁷ International Energy Agency. Waldweg, 8, CH 1717 – St. Ursen, Switzerland. <iea-pvps.org>

¹⁸ International Electrotechnical Commission. 3, rue de Varembé, 1st floor, PO Box 131, CH - 1211 Geneva 20, Switzerland. <www.iec.ch>

¹⁹ Intergovernmental Panel on Climate Change. 7 bis Avenue de la Paix, CP 2300, CH – 1211 Geneva 2, Switzerland. <www.ipcc.ch>

²⁰ International Accreditation Forum. <www.iaf.nu>

Interstate Chemicals Clearinghouse (IC2), *Alternatives Assessment Guide, Hybrid or Sequential Frameworks*²¹

Interstate Chemicals Clearinghouse Database²¹

IPCC Guidelines for National Greenhouse Gas Inventories, 2006¹⁹

ISO 9001, *Quality management systems – Requirements*²²

ISO 14001, *Environmental management systems – Requirements with guidance for use*²²

ISO 14021, *Environmental Labels & Declarations – Self-declared environmental claims (Type II environmental labelling)*²²

ISO 14025, *Environmental labels and declarations—Type III environmental declarations—Principles and procedures*²²

ISO 14040, *Environmental management—Life cycle assessment—Principles and framework*²²

ISO 14044, *Environmental management—Life cycle assessment—Requirements and guidelines*²²

ISO 45001, *Occupational health and safety*²²

ISO 50001, *Energy management systems — Requirements with guidance for use*²²

ISO 50003, *Energy management systems — Requirements for bodies providing audit and certification of energy management systems*²²

LCA Society of Japan, *Life-cycle Impact Assessment Method based on Endpoint modeling*²³

Model Toxics in Packaging Legislation (compilation was developed by CONEG and is administered by the Toxics in Packaging Clearinghouse [TPCH])²⁴

National Academies of Science, Design and Evaluation of Safer Chemical Substitutions – A Framework to Inform Government and Industry Decisions²⁵

Responsible Business Alliance (RBA) Code of Conduct²⁶

OHSAS 18001, Occupational Health and Safety Management²⁷

Superior Energy Performance 50001 Program (SEP 50001) Certification Protocol⁴

²¹ Interstate Chemicals Clearinghouse (IC2). 89 South Street, Suite 600, Boston, MA 02111-2651. <www.theic2.org>

²² International Organization for Standardization. Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland. <www.iso.org>

²³ LCA Society of Japan. LCA Development Office. 2-1, Kajicho 2-chome, Chiyoda-ku, Tokyo, 101-0044. <lca-forum.org>

²⁴ Model Toxics in Packaging Legislation. c/o NERC, 139 Main Street, Suite 401, Brattleboro, VT 05301. <www.toxicsinpackaging.org>

²⁵ National Academies of Science. 500 Fifth Street NW, Washington, DC 20001. <www.nap.edu>

²⁶ Responsible Business Alliance. 1737 King Street, Suite 330, Alexandria, VA 22314. <www.responsiblebusiness.org>

²⁷ The BSI Group. 389 Chiswick High Road, London, W4 4AL, United Kingdom. <www.bsigroup.com>

Superior Energy Performance 50001 Program (SEP 5001) Measurement and Verification (M&V) Protocol⁴

Superior Energy Performance 50001 (SEP 50001) Scorecard⁴

Social Accountability (SA) 8000²⁸

Solar Energy Industries Association (SEIA), *Solar Industry Environmental & Social Responsibility Commitment*²⁹

Substitution Support Portal (SUBSPORT)³⁰

Sustainability Accounting Standards Board (SASB) Solar Energy Sustainability Accounting Standard³¹

University of Leiden Institute of Environmental Sciences (CML), Handbook on LCA³²

US Department of Energy (DOE) Superior Energy Performance 50001™ (SEP 50001) program⁴

US EPA ENERGY STAR® Guidelines for Energy Management³³

US EPA GHG Reporting Rule, Subpart I³⁴

US EPA Protocol for Measuring Destruction or Removal Efficiency (DRE) of Fluorinated Greenhouse Gas Abatement Equipment in Electronics Manufacturing (US EPA DRE Protocol)³⁴

US EPA Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) 2.1³⁴

US Securities Exchange Act of 1934, Rule 13p-1³⁵

²⁸ Social Accountability International. 9 East 37th Street, 10th floor, New York, NY 10036. <www.sa-intl.org>

²⁹ Solar Energy Industries Association. 1425 K Street NW, Suite 1000 Washington, DC 20005. <www.seia.org>

³⁰ Substitution Support Portal. Kooperationsstelle Hamburg IFE GmbH Harburger Schlossstrasse 6-12 D-21079 Hamburg, Germany. <www.subsport.eu>

³¹ Sustainability Accounting Standards Board. 1045 Sansome Street, Suite 450, San Francisco, CA 94111. <www.sasb.org>

³² Universiteit Leiden Institute of Environmental Sciences. Rapenburg 70, 2311 EZ Leiden, The Netherlands. <cml.leiden.edu>

³³ US Environmental Protection Agency, ENERGY STAR Program. 1200 Pennsylvania Ave NW, Washington, DC 20460. <www.energystar.gov>

³⁴ US Environmental Protection Agency. 1200 Pennsylvania Avenue NW, Washington, DC 20460. <www.epa.gov>

³⁵ US Securities and Exchange Commission. 100 F Street NE, Washington, DC 20549. <www.sec.gov>

2.2 Informational references

Conflict-free Tin Initiative³⁶

GEMI Local Water Tool³⁷

Public Private Alliance for Responsible Mineral Trade³⁸

Solutions for Hope³⁹

OECD, Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas⁴⁰

World Business Council for Sustainable Development (WBCSD) Global Water Tool⁴¹

World Resource Institute's Aqueduct Global Water Risk Mapping Tool⁴²

WWF-DEG Water Risk Filter⁴³

3 Definitions and acronyms

3.1 Definitions

3.1.1 conflict-free: A product that does not contain conflict minerals, necessary to the functionality or production of that product, that directly or indirectly finance or benefit armed groups in the Democratic Republic of the Congo (DRC) or an adjoining country. Conflict minerals that a manufacturer or its supplier(s) obtains from recycled or scrap sources, are considered conflict-free.

NOTE — The term “armed group”³⁵ means an armed group that is identified as perpetrators of serious human rights abuses in the annual Country Reports on Human Rights Practices under sections 116(d) and 502B(b) of the Foreign Assistance Act of 1961 (22 USC 2151n(d) and 2304(b)) relating to the DRC or an adjoining country.

3.1.2 conflict minerals³⁵

- columbite-tantalite (coltan), cassiterite, gold, wolframite, or their derivatives, which are limited to tantalum, tin, and tungsten; and
- any other mineral or its derivatives determined by the US Secretary of State to be financing conflict in the DRC or an adjoining country.

³⁶ Global Solder Solutions. 25 Kenney Drive, Cranston, Rhode Island 02920. <www.aimsolder.com>

³⁷ GEMI. 1155 Fifteenth Street NW, Suite 500, Washington, DC 20005. <gemi.org/localwatertool>

³⁸ Public-Private Alliance for Responsible Minerals Trade. 1255 23rd Street NW, Suite 275, Washington, DC 20037. <www.resolv.org/site-ppa>

³⁹ Solutions for Hope. 1255 23rd Street NW, Suite 275 Washington, DC 20037. <solutions-network.org/site-solutionsforhope/>

⁴⁰ OECD. 2, rue Andre Pascal 75775 Paris Cedex 16, France. <www.oecd.org/corporate/mne/mining.htm>

⁴¹ World Business Council for Sustainable Development. Chemin Eugène-Rigot, 2B, Case Postale 2075, CH-1211, Geneva 1. <www.wbcd.org>

⁴² Aqueduct. 10 G Street NE, Suite 800, Washington, DC 20002. <www.wri.org/our-work/project/aqueduct>

⁴³ World Wildlife Federation. Avenue du Mont-Blanc 1196, Gland, Switzerland. <waterriskfilter.panda.org>

3.1.3 declaration: Information made publicly available:

- by the manufacturer on a publicly available registry; or
- on the manufacturer's or certifying organization's website in the form of a certification report, or equivalent, issued by the certifying organization; or
- on the manufacturer's website, if the product is self-declared to conform to this Standard.

3.1.4 disclosure: Information made available to the audience specified in criterion (e.g., purchasers, public, etc.).

3.1.5 documentation: Information to be provided at time of verification or certification.

3.1.6 end-of-life (EOL): Life-cycle stage of a product when it is no longer intended for use and are destined, or intended to be destined for, dismantling, material recovery, recycling or disposal.

3.1.7 energy recovery: An operation where the material is used principally as a fuel or to generate energy.

3.1.8 energy management system (EnMS)⁴: A set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve those objectives.

3.1.9 environmental management system (EMS)²²: Part of the management system used to manage environmental aspects, fulfil compliance obligations, and address risks and opportunities.

NOTE 1 — **Management system:** set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives. A management system can address a single discipline or several disciplines (e.g., quality, environment, occupational health and safety, energy, financial management). The system elements include the organization's structure, roles and responsibilities, planning and operation, performance evaluation and improvement. The scope of a management system can include the whole of the organization, specific and identified functions of the organization, specific and identified sections of the organization, or one or more functions across a group of organizations.

NOTE 2 — **Environmental aspects:** element of an organization's activities or products or services that interacts or can interact with the environment.

3.1.10 feedstock: Raw material used in a manufacturing process.

3.1.11 fiber-based: Cellulose material derived from trees and other plants.

3.1.12 greenhouse gas (GHG) inventory: Identification and quantification of emissions and removals of greenhouse gases from manufacturing processes.

3.1.13 impact assessment categories¹¹: Classifications of human health and environmental effects caused by a product throughout its life cycle.

3.1.14 initial service providers: Company that performs recycling and/or refurbishment services for product / equipment / components; and that contracts directly with the manufacturer, or indirectly through a manufacturer's agent, and is the first party to provide one or more initial take-back services.

3.1.15 inventory data¹¹: The identification and quantification of energy, resource usage, and environmental emissions for a particular product, process, or activity.

3.1.16 life cycle assessment (LCA): A framework for the compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle, from the

extraction of resources and the production of raw materials, to product manufacturing, transportation / distribution, use and reuse, maintenance, and recycling and/or disposal.

3.1.17 manufacturer: The legal entity that is the owner or the licensee of the brand or trademark under which the product in the scope of this Standard is placed on the market, and:

- manufactures a product; and/or
- has a product designed or manufactured; and/or
- acquires a product for sale under their brand or trademark.

3.1.18 packaging: All materials of any nature to be used for the containment, protection, handling, delivery and presentation of products from the manufacturer to the user or the customer.

NOTE — for the purposes of this Standard, unless otherwise noted, the term “packaging” only applies to sales packaging or primary packaging, i.e., packaging that contains and protects and is designed to deliver a product unit to the final user or customer and does not include pallets.

3.1.19 packaging component²⁴: Any individual assembled part of packaging such as, but not limited to, any interior or exterior blocking, bracing, cushioning, weatherproofing, exterior strapping, coatings, closures, inks, and labels.

3.1.20 PV inverter: The PV inverter function is to convert and condition electrical power of a PV module to AC. The PV inverter is all the devices necessary to implement the PV inverter function. If separated devices are required to perform this function, the PV inverter is defined as their sum.

Including, but not limited to:

- PV-string inverters with included maximum power point trackers;
- central inverters;
- micro inverters;
- bi-directional inverters; and
- combination of a DC optimizer plus the inverter in systems where both are necessary.

The following are not included in the definition of PV inverter⁴⁰:

- PV module;
- cabling and mounting structures;
- external disconnects;
- communication equipment;
- combiners without power conversion or conditioning equipment function;
- batteries and other energy storage components;
- external transformers; and
- other devices not required to perform the PV inverter function.

3.1.21 PV module: A PV module for installation on, or integral with buildings, or to be primarily used as components of free-standing power-generation systems, including, but not limited to:

- PV cells that generate electric power using solar energy;
- interconnects (materials that conduct electricity between cells);
- encapsulant (insulating material enclosing the cells and cell interconnects);
- superstrate (material forming primary light-facing outer surface) and substrate (material forming back outer surface) (e.g., glass, plastic films);

- wires used to interconnect PV modules and connect junction boxes to the balance of system equipment; and
- frame or integrated mounting mechanism, if present.

The following are not included in the definition of a PV module:

- balance of system equipment, such as cabling and mounting structures, equipment intended to accept the electrical output from the array, such as power conditioning units (inverters) and batteries, unless they are contained in the PV module;
- a PV cell that is a part of another device for which it produces the electricity, such as consumer or industrial electronic products (e.g. calculators, lights, textile) where the PV cell primarily provides the energy needed to make the electronic product function; and
- mobile PV cell where the inverter is so integrated with the PV cell that the solar cell requires disassembly before recovery.

3.1.22 postconsumer recycled material²⁴: Material generated by households or by commercial, industrial and institutional facilities in their role as end-users which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.

NOTE — This definition applies to materials such as plastic, fiber, metal, etc.

3.1.23 preconsumer material²⁴: Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

3.1.24 prepared for reuse: Equipment and components that have been checked, tested, cleaned, repaired, and determined to be safe and fully functional, to be placed back on the market in their original use or in their upgraded state, without further processing.

3.1.25 processed chlorine-free (PCF): Packaging material produced with pulp from virgin and/or recycled content that has been bleached without any type of chlorine, or that has not been bleached at all. Recycled content may have originally been bleached with chlorine or chlorine derivatives.

3.1.26 product: A marketing model of a PV module or PV inverter.

NOTE — See definition for *PV module* and *PV inverter*.

3.1.27 publicly available: Obtainable to the public without restriction of access; for example, cannot require member only access. A requirement to provide a name and/or organization to obtain access is not considered a “restriction of access”.

3.1.28 recovery: Operations that are part of a process to recapture elements, compounds, or materials and transform them into commodities.

3.1.29 recycled content²²: Proportion, by mass, of recycled material in a product or packaging. Only preconsumer and postconsumer materials shall be considered as recycled content.

NOTE — Recycled materials derived from any source, including, but not limited to, preconsumer and postconsumer PV products, qualify as recycled content.

3.1.30 recycling: Operations by which products, components, materials, or waste are processed and converted into raw materials for use in the production of new products or in processes, not including energy recovery or disposal.

3.1.31 refurbishment: Functional or aesthetic maintenance or repair of a product to restore to original or upgraded state.

3.1.32 reporting boundary: The area of operations and impact upon which the Global Reporting Initiative (GRI) disclosure is based. The boundary may be “within the organization” or it may include some part of the organization’s supply chain.

3.1.33 reuse: Using again, equipment or components for the originally intended purpose, a similar purpose, or in an upgraded state, possibly after refurbishment, repair or hardware upgrading.

3.1.34 semiconductor material:¹⁸ Substance, the conductivity of which, due to charge carriers of both signs, is normally in the range between that of conductors and insulating media, and in which the density of its charge carriers can be changed by external means.

NOTE 1 — The term “semiconductor” generally applies where the charge carriers are electrons or holes.

NOTE 2 — In order to increase the conductivity, the energy supplied must be greater than the band gap energy. See also “band gap energy” (IEC 62474).

NOTE 3 — Certain semiconductors, such as silicon, gallium arsenide, cadmium telluride, and copper indium diselenide compounds, to name a number of materials currently available, are well suited to the PV conversion process.

3.1.35 substance:⁴⁴ Matter of constant composition best characterized by the entities (molecules, formula units, atoms) of which it is composed. Physical properties such as density, refractive index, electric conductivity, melting point, etc., characterize the chemical substance.

3.1.36 supplier: Entity that provides goods or services.

3.1.37 Tier 1 suppliers: Companies that provide the manufacturer with materials, components, subassemblies, manufacturing services, or product assembly services, and with which the manufacturer has a contractual relationship.

3.1.38 tare loss: The total AC and DC power required for startup, shutdown and standby modes.

3.1.39 total water withdrawal: The sum of all water drawn into the boundaries of the organization from all sources for any use over the course of the reporting period.

NOTE — Sources of water withdrawal can include surface water, ground water, rain water, and municipal water supply.

3.1.40 totally chlorine-free (TCF): Packaging material produced with pulp from virgin content that has been bleached without any type of chlorine, or that has not been bleached at all.

⁴⁴ International Union of Pure and Applied Chemistry (IUPAC). PO Box 13757 Research Triangle Park, NC 27709. <iupac.org>