



*NSF International Standard /
American National Standard*

NSF/ANSI 457 - 2019

Sustainability Leadership Standard
for Photovoltaic Modules
and Photovoltaic Inverters



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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”.

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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.

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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.wbcds.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>

3.2 Acronyms

CAS: chemical abstract number

DOE: Department of Energy

DRE: destruction or removal efficiency

ECHA: European Chemicals Agency

EMAS: European Union Eco-Management and Audit Scheme

EMS: environmental management system

EnMS: energy management system

EOL: end-of-life

EPA: Environmental Protection Agency

EU: European Union

F-GHG: fluorinated greenhouse gases

GHG: greenhouse gas

GHS: Global Harmonization System

GWP: global warming potential

IAF: International Accreditation Forum

IEA: International Energy Agency

IGBT: insulated gate bi-polar transistor

IMDS: International Material Data System

LCA: life cycle assessment

LCI: life cycle inventory

PCF: processed chlorine-free

PEFCR: Product Environmental Footprint Category Rules

PVPS: photovoltaic power systems

PV: photovoltaic

RBA: Responsible Business Alliance

SASB: Sustainability Accounting Standards Board

SEC: Securities and Exchange Commission

SEIA: Solar Energies Industry Association

SEP: superior energy performance

SVHC: substances of very high concern

TCF: totally chlorine-free

URL: uniform resource locator

4 Conformance, evaluation and assessment

This Standard is divided into seven performance categories consisting of required and optional criteria:

- management of substances;
- preferable materials use;
- LCA;
- energy efficiency & water use;
- EOL management & design for recycling;
- product packaging; and
- corporate responsibility.

4.1 Criteria

A summary of all criteria in this Standard, including required and optional criteria, is provided in Annex I-1. A few criteria are applicable either to only PV modules or only to PV inverters, and such is noted in the title of the criterion.

4.1.1 Required criteria

The following required criteria must be met in order for a product to conform to this Standard.

Section and criteria		Applicable to PV modules	Applicable to PV inverters
5	Management of substances		
5.1.1	Required – List of declarable substances	x	x
5.1.2	Required – List of declarable substances used in manufacturing	x	x
5.2.1	Required – Disclosure of substances on the European Union REACH Regulation Candidate List of Substances of Very High Concern (SVHC)	x	x
5.2.5	Required – Avoidance or reduction of high global warming potential (GWP) gas emissions	x	x
5.2.6	Required – Conformance with provisions of European Union RoHS Directive (applicable only to PV inverters)	—	x
6	Preferable materials use		
6.1.1	Required – Declaration of recycled content in product	x	x
7	Life cycle assessment (LCA)		
7.1.1	Required – Conducting LCA	x	x
8	Energy efficiency and water use		
8.1.4	Required – Weighted efficiency reporting (applicable only to PV inverters)	—	x
8.1.5	Required – Tare loss reporting (applicable only to PV inverters)	—	x
8.2.1	Required – Water inventory	x	x
9	End of life management & design for recycling		
9.1.1	Required – Product take-back service and processing requirements (corporate)	x	x
10	Product packaging		
10.1.1	Required – Elimination of substances of concern in product packaging	x	x
10.1.2	Required – Elimination of chlorine in processing packaging materials	x	x
10.2.1	Required – Enhancing recyclability of packaging materials	x	x
11	Corporate responsibility		
11.1.1	Required – Environmental management system (EMS) certification (corporate)	x	x
11.1.2	Required – Manufacturer conformance with occupational health and safety performance (corporate)	x	x
11.2.1	Required – Reporting on key performance indicators (corporate)	x	x
11.3.1	Required – Commitment to environmental and social responsibility (corporate)	x	x
11.4.1	Required – Public disclosure of use of conflict minerals in products (corporate)	x	x

4.1.2 Optional criteria

Once the required criteria are met, products may achieve higher levels of conformance, i.e., Silver or Gold, by meeting a specified percentage of optional criteria.

4.1.3 Product and corporate criteria

This Standard includes two types of criteria.

- product criterion: applies to the product declared to conform to the Standard; and
- corporate criterion: applies to the manufacturer that declares products to conform to this Standard.

These criteria are noted in the Standard.

4.1.4 Country or region-specific criteria

The manufacturer shall declare or certify conformance to the Standard by country, region, or globally. Unless specified otherwise, criteria must be met wherever the product is declared or certified to conform to the Standard. For select optional criteria, as noted in the criterion, the manufacturer has the flexibility to meet the criterion in countries or regions as designated by the manufacturer.

NOTE — Region means countries and territories whose independence may not be recognized by all countries (e.g., Taiwan).

4.1.5 Units of measure

Unless specified otherwise, units of measure within this Standard shall be reported in metric units.

4.1.6 Declare, disclose, and document

Within this Standard, these three terms are used as follows.

- **declaration / declare:** 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 the Standard.
- **disclosure / disclose:** Information made available to the audience specified in criterion (e.g., purchasers, public, etc.).
- **documentation / document:** Information to be provided at time of verification or certification.

4.2 Levels of conformance

There are three levels of conformance.

- **Bronze:** meets all required criteria.
- **Silver:** meets all required criteria plus at least 50% of the optional criteria points.
- **Gold:** meets all required criteria plus at least 75% of the optional criteria points.

The optional points can come from any of the performance categories. If the option of declaring "Not Applicable (NA)" is provided in an optional criterion, for product registrations that declare NA, the calculation of the total number of available optional criteria points shall not include that criterion.

5 Management of substances

5.1 List of declarable substances

5.1.1 Required – List of declarable substances in product

Manufacturer shall list the presence of IEC 62474 declarable substance groups and declarable substances in the product at or above the reporting threshold amounts stated in the IEC 62474 Standard, using the version of IEC 62474 which is current at the time the product is declared to conform to this Standard. The list shall consist of all declarable substance groups and declarable substances designated in Criteria 1, 2 and 3 of IEC 62474, and the following industry-specific substances: arsenic compounds, antimony compounds, and beryllium compounds.

The manufacturer shall have a process to manage, maintain, and update all data received on declarable substances as listed in IEC 62474.

Verification requirements:

- a) a list of IEC 62474 declarable substance groups and declarable substances (designated 1, 2, and 3) and the above industry-specific substances in the product at or above the reporting threshold; and
- b) documentation of a process and evidence of implementation of process (1) to collect and manage data on IEC 62474, and (2) to keep the data current.

5.1.2 Required – List of declarable substances used in manufacturing

Manufacturer shall list the presence of substances in the ECHA database used in the manufacturing process of the product.

Verification requirements:

- a) a list of ECHA database substances used in the manufacturing process of the product; and
- b) documentation of a process and evidence of implementation of process (1) to collect and manage data, and (2) to keep the data current.

5.1.3 Optional – Disclosure of declarable substances

Manufacturer shall make publicly available on their website a list of declarable substances in the product and in manufacturing the product generated for conformance with Sections 5.1.1 and 5.1.2. The list shall contain the CAS number for each declarable substance (not including declarable substance groups) and ECHA database substance used in the manufacturing process of the product. The link to the list shall be placed on the product specification or documentation web page. The manufacturer shall declare the URL of the public disclosure.

Point value: 1

Verification requirements:

- a) declaration of URL of the public disclosure; and
- b) list generated for conformance with Sections 5.1.1 and 5.1.2, that:
 - includes the CAS number for each declarable substance in the product and ECHA database substance used in the manufacturing process of the product, and

— is located on the product specification or documentation web page.

5.1.4 Optional – Database of substances in product

The manufacturer shall have a database of substances, including the substance standardized number (e.g., CAS, EC, MITI, ECHA), in the products / components supplied to the manufacturer from its suppliers, as specified in Table 5.1 below.

Table 5.1

Data acquired on substance list	Points
minimum of 70% of total product mass	1
minimum of 99% of total product mass	2

The manufacturer shall have a system for recording information, calculating percentages of data acquired, and validating reports or other substance ingredient declarations from its suppliers.

Point value: maximum 2

Verification requirements:

- documentation that the database includes the substances in the products / components supplied to the manufacturer from its suppliers, including a substance standardized number;
- calculation demonstrating the percentage of total product mass for which the manufacturer has a complete list of the substances; and
- evidence supporting the existence of a system for recording information and validating reports or other substance ingredient declarations from its suppliers.

5.1.5 Optional – Alternatives assessment

Manufacturer shall document that it, a supplier, or an independent third party has performed an alternatives assessment on at least one substance of concern included in the product or manufacturing process as documented in Section 5.1.1 – List of declarable substances. Manufacturer shall consider exposure and risk throughout the product life cycle as part of the substance selection process.

This assessment shall be performed consistent with one of the following frameworks:

- 1) California Safer Products Alternatives Analysis – CA Code of Regulations Title 22, Division 4.5, Chapter 55, Article 5, Sections 69505.5-69505.7;⁶
- 2) Interstate Chemicals Clearinghouse *Alternative Assessment Guide*, Hybrid or Sequential Frameworks;⁴⁵ or
- 3) Report of the National Academies of Science project, *A Framework to Guide Selection of Chemical Alternatives*.⁴⁶

⁴⁵ Northeast Waste Management Officials' Association. 89 South Street, Suite 600, Boston, MA 02111. <www.newmoa.org>

⁴⁶ The National Academy of Sciences. 500 Fifth Street NW, Washington, DC 20001. <www.nap.edu>

An alternatives assessment performed on a substance application from a prior-shipped product is considered sufficient if the application is demonstrated to be relevant to the product to which this Standard is being applied.

Manufacturer documentation of the alternatives assessment shall include:

- a) framework used;
- b) date of completion of the assessment; the assessment shall have been completed no more than five years prior to the date the product is declared to conform to this criterion;
- c) substance(s) evaluated; and
- d) which of the following outcomes resulted from their alternative assessment:
 - a safer alternative was identified and used as the substitute for the original substance; or
 - the original substance was determined to be safer than, or as safe as, the evaluated potential alternatives per the requirements of the framework used; or
 - a safer alternative was identified but is not commercially or technically viable for that application per the requirements of the framework used; or
 - the need for the function provided by the substance was eliminated.

An alternative assessment performed under Sections 5.2.3 and 5.2.4 shall not be eligible for this optional criterion.

Manufacturer may claim one point for performing an alternatives assessment on at least one substance of concern included in the product or manufacturing process, and two points for more than one alternatives assessment.

Point value: maximum 2

Verification requirements:

- a) evidence supporting that the manufacturer or a supplier or a third party has performed an alternatives assessment on at least one substance of concern (as described in the criterion) included in the product or manufacturing process;
- b) documentation that the alternatives assessment includes the requirements listed in the criterion; and
- c) documentation of outcomes resulted from the alternative assessment (see d) in criterion).

5.1.6 Optional – Making alternatives assessment publicly available

The manufacturer shall publicly disclose the manufacturer documentation (as specified in Sections 5.1.5.a through 5.1.5.d) for at least one of the alternatives assessments required for conformance with Sections 5.1.5, 5.2.3, or 5.2.4 used in the alternative assessment by either:

- 1) posting on a publicly available database such as the Substitution Support Portal (SUBSPORT)³⁰ or the Interstate Chemicals Clearinghouse Database²¹; or
- 2) making the documentation publicly available on the manufacturer's website.

In the case of an assessment done as part of a partnership or industry consortium, the other participating parties shall be named.

The manufacturer shall declare the URL of the public disclosure.

Point value: 1

Verification requirements:

- a) declaration of the URL of public disclosure;
- b) public disclosure of the manufacturer documentation for at least one of the alternatives assessments required for conformance with Section 5.1.5, 5.2.3, or 5.2.4, by either:
 - posting on a publicly accessible database such as the Substitution Support Portal (SUBSPORT)³⁰ or the Interstate Chemicals Clearinghouse Database,²¹ or
 - making accessible on the manufacturer's website.
- c) if the assessment is done as part of a partnership or industry consortium, the public disclosure identifies the other participating parties.

5.2 Reduction of substances of concern

5.2.1 Required – Disclosure of substances on the European Union REACH Regulation Candidate List of Substances of Very High Concern (SVHC)

Manufacturer shall make publicly available on their website a list of substances on the Candidate List of SVHC above 0.1% by weight per "article"; and for a product made up of more than one article, for each article if substance is present in a concentration above 0.1% by weight of that article, as per Article 33 paragraph 1 of the REACH regulation and interpreted according to the European Chemicals Agency *Guidance on requirements for substances in articles* and Judgement C-106/14 of the European Court of Justice.⁷

The link to the list shall be placed on the product specification or documentation web page. The manufacturer shall declare the URL of the public disclosure.

NOTE — The European Chemicals Agency *Guidance on requirements for substances in articles* will eventually reflect the Judgment of the European Court of Justice on the amendment of the thresholds for sub-articles. At current edition of this Standard, this is not the case, and the Judgment is referenced.

Verification requirements:

- a) declaration of URL of the public disclosure.

5.2.2 Optional – Presence of substances on the European Union REACH Regulation Candidate List of Substances of Very High Concern (SVHC)

The product shall not contain substances on the Candidate List of SVHC⁷ above 0.1% by weight per "article"; and for a product made up of more than one article, to determine for each article whether such substance is present in a concentration above 0.1% by weight of that article, as per Article 33, paragraph 1 of the REACH regulation and interpreted according to the European Chemicals Agency *Guidance on requirements for substances in articles*⁵ and Judgement C-106/14 of the European Court of Justice.⁷ All SVHCs with a date of inclusion one year or more before the product is declared to conform to this criterion are subject to this requirement.

NOTE — The European Chemicals Agency *Guidance on requirements for substances in articles* will eventually reflect the Judgment of the European Court of Justice on the amendment of the thresholds for sub-articles. At current edition of this Standard, this is not the case and the Judgment is referenced.

Manufacturer shall document that a system is used to ensure that the product does not contain these substances above 0.1% by weight per “article”, as per Article 33, paragraph 1 of the REACH regulation and interpreted according to the European Chemicals Agency *Guidance on requirements for substances in articles*⁵ and Judgement C-106/14 of the European Court of Justice.⁷

Point value: 1

Verification requirements:

a) documentation that a system is used to ensure that the product does not contain these substances as required in the criterion. The system shall include one or more of the following:

- supplier management and grading procedures;
- supplier material declaration and disclosure; and
- analytical testing.

5.2.3 Optional – Bromine, chlorine, and fluorine content in electric cables

If the product contains electric cables which contain greater than 5,000 ppm chlorine or bromine, or greater than 1,000 ppm fluorine, as determined by test method IEC 62321-3-1 and IEC 62321-3-2, the manufacturer shall conduct an alternatives assessment on the substance(s) responsible for the observed bromine, chlorine and/or fluorine levels in accordance with Section 5.1.5.

Point value: 1

Verification requirements:

a) a list of electric cables; and

b) documentation that electric cables meet one of the options below:

- test data showing that the cable contains less than 5,000 ppm chlorine, 5,000 ppm bromine, and 1,000 ppm fluorine, or
- an alternatives assessment on the chlorine, bromine and/or fluorine present at levels above those stated in the previous option. that meets the requirements for conducting an alternatives assessment in Section 5.1.5.

5.2.4 Optional – Bromine, chlorine, and fluorine content in plastic parts

If the product contains any plastic part exceeding 25 g in weight, which contains greater than 5,000 ppm chlorine or bromine or greater than 1,000 ppm fluorine, as determined by test method IEC 62321-3-1 and IEC 62321-3-2, the manufacturer shall conduct an alternatives assessment on the substance(s) responsible for the observed chlorine, bromine and/or fluorine levels in accordance with Section 5.1.5.

The following exemptions apply:

- electric cables; and
- printed circuit boards (for PV inverters only).

If the product does not contain plastic parts > 25 g “NA” may be declared.

Point value: 1

Verification requirements:

- a) a list of any plastic part (other than exempted parts) exceeding 25 g in weight; and
- b) documentation of any plastic part (other than exempted parts) exceeding 25 g in weight that meets one of the options below:
 - test data showing that the part contains less than 5,000 ppm chlorine, 5,000 ppm bromine, and 1,000 ppm fluorine, or
 - an alternatives assessment on the chlorine, bromine and/or fluorine present at levels above those stated in the previous option. that meets the requirements for conducting an alternatives assessment in Section 5.1.5.

5.2.5 Required – Avoidance or reduction of high global warming potential (GWP) gas emissions

The manufacturer shall ensure that in the facilities listed in Table 5.2, that either:

- 1) high-GWP gases are not used or emitted for any manufacturing or reactor cleaning operations; or
- 2) if any high-GWP gas is used, that specifically designed abatement systems are installed, operated, and maintained.

Table 5.2

Product	Facilities in scope
PV modules	Facilities manufacturing PV modules, including solar cells
PV inverters	Facilities manufacturing semiconductor components used in the PV inverter (at least 50% of facilities)

The intent of this criterion is to prevent use of high-GWP gases in the facilities in scope in Table 5.2 and, if this is not possible, to facilitate destruction of high-GWP gas emissions that may result from either manufacturing or cleaning operations.

NOTE — A list of high-GWP gases can be found in Table 8.A.1 in the Appendix of the Intergovernmental Panel on Climate Change's Fifth Assessment Report.¹⁹

Verification requirements:

- a) documentation that high-GWP gases are not used or emitted for any manufacturing or reactor cleaning operations for facilities specified in Table 5.2; or
- b) evidence consistent with the requirements listed in the criterion that abatement and leak management systems are installed which are designed, operated, and maintained specifically to destroy or remove F-GHGs and N₂O used in manufacturing at facilities specified in Table 5.2.

5.2.6 Required – Conformance with provisions of European Union RoHS Directive (applicable only to PV inverters)

The product shall meet the substance restriction requirements of the European Union RoHS Directive and its amendments in effect at the time the product is declared to conform to this Standard. All exemptions to the substance restrictions as defined by the Directive are applicable.

Verification requirements:

- a) technical documentation in accordance with EN 50581 or IEC 63000 as required by the European Union RoHS Directive.

NOTE 1 — The European Union RoHS Directive stipulates maximum concentration values (MCVs) by weight for the presence of each substance within homogeneous materials.

NOTE 2 — Technical documentation, as required in Article 7(b) of the European Union RoHS Directive, can be generated per Standard EN 50581, Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances or IEC 63000. Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.

6 Preferable materials use

6.1 Recycled content

6.1.1 Required – Declaration of recycled content in product

Manufacturer shall declare the minimum percentage by weight of recycled content in the product and for each of the following components, as applicable:

PV modules	PV inverters
<ul style="list-style-type: none"> — semiconductor material (feedstock, powder, or wafer); — glass; — frame material; — transparent conductive layer; — metal pastes and contacts; — ribbon; — solder; — encapsulant; and — backsheet. 	<ul style="list-style-type: none"> — enclosure (housing); — printed circuit board assembly including capacitors; — display; — power semiconductor and packaging (e.g., IGBT, silicon carbide and gallium nitride); — choke or inductor; — cables and switches; and — other plastic parts.

The following equation shall be used to calculate the percentage:

$$\frac{\text{recycled material by weight}}{\text{total material (of the type in the numerator) by weight}} \times 100 = \% \text{ recycled content}$$

Only material derived from recycled feedstock shall be included in the numerator.

NOTE 1 — No minimum recycled content is required. A value of 0 may be declared.

NOTE 2 — If a component has multiple suppliers, the minimum recycled content shall be declared.

Verification requirements:

- a) supplier documentation stating minimum percentage of recycled content in material supplied to manufacturer or to manufacturer's part supplier; and
- b) documentation of the calculation of recycled content for the product and each of the components listed in the criterion, as applicable.

6.1.2 Optional – Recycled content in product

The use of recycled material in the product shall be awarded points according to Tables 6.1 and 6.2 below. Manufacturer may claim the designated number of points for each achievement listed in the table.

Table 6.1

Minimum percentage recycled content (PV modules)	Points
≥ 10% recycled semiconductor material	1
≥ 10 % recycled glass material	1
Achieve 4 out of 8: <ul style="list-style-type: none"> — ≥ 25 % recycled frame material; — ≥ 10% recycled transparent conductive layer; — ≥ 10 % recycled paste and contact material; — ≥ 10 % recycled ribbon material; — ≥ 10 % recycled solder material; — ≥ 10 % recycled encapsulant material; — ≥ 10 % recycled backsheet material; — Demonstrated conformity with a material traceability standard⁷ 	1
≥ 10 % postconsumer recycled content for any of the above categories	1

Table 6.2
Minimum percentage recycled content (PV Inverters)

Central inverters	String inverters	Micro & other inverters	Points
≥ 70 % recycled enclosure material	≥ 50 % recycled enclosure material	≥ 50 % recycled enclosure material	1
≥ 90 % recycled enclosure material	≥ 70 % recycled enclosure material	≥ 70 % recycled enclosure material	1
Achieve 3 out of 6 internal components: <ul style="list-style-type: none"> — ≥ 10% printed circuit board assembly including capacitors — ≥ 10% display — ≥ 10% power semiconductor and packaging (e.g. IGBT, silicon carbide and gallium nitride) — ≥ 10% choke or inductor — ≥ 10% cables and switches — ≥ 10% other plastic parts 	Achieve 2 out of 5 internal components: <ul style="list-style-type: none"> — ≥ 10% printed circuit board assembly including capacitors — ≥ 10% display — ≥ 10% choke or inductor — ≥ 10% cables and switches — ≥ 10% other plastic parts 	Achieve 2 out of 4 internal components: <ul style="list-style-type: none"> — ≥ 10% printed circuit board assembly including capacitors — ≥ 10% choke or inductor — ≥ 10% cables and switches — ≥ 10% other plastic parts 	1
≥ 10 % postconsumer recycled content	≥ 10 % postconsumer recycled content	≥ 10 % postconsumer recycled content	1

The equation in Section 6.1.1 shall be used to calculate the percentage.

Point value: maximum 4

Verification requirements:

- a) a list of achievements claimed in Tables 6.1 and 6.2; and
- b) for each achievement claimed:
 - a letter from the supplier of the material stating the origin(s) of recycled material and the minimum percentage of recycled content supplied to the manufacturer or manufacturer's fabricated parts supplier. Information on origin of materials (e.g., material type / form, product type, sourcing) shall be sufficient to demonstrate that materials are traceable to recycled sources; and
 - documentation of the calculation of recycled content.

7 Life cycle assessment (LCA)

7.1 Life cycle assessment (LCA)

7.1.1 Required – Conducting LCA

The manufacturer shall conduct a LCA of the product or a manufacturer defined representative core product in accordance with the standards and guidance in the table below:

PV modules	PV inverters
<ul style="list-style-type: none"> — ISO 14040/14044²²; and — European Union Product Environmental Footprint Guide¹⁴ or the IEA PVPS Task 12 <i>Methodology Guidelines on Life Cycle Assessment of Photovoltaic Electricity</i>¹⁷ 	<ul style="list-style-type: none"> — ISO 14040/14044²²

NOTE 1 — For PV inverters the European Union Product Environmental Footprint Guide¹⁴ may be used for additional guidance.

The LCA shall include all stages (see Annex I-2) of the product life-cycle, from extraction of raw materials through end-of-life, and shall quantify, at a minimum, the following mid-point impact indicators using US EPA TRACI 2.1³⁵, or CML-IA 2016, or ILCD 2011¹⁰, or LIME2²² impact assessment methodologies or equivalent methodologies (and clearly reporting which was chosen):

- a) cumulative energy demand (CED);
- b) global warming potential (GWP) (GWP-100 and GWP-20); report GWP values assumed for methane and, when possible, fraction of fossil vs. biogenic methane;
- c) acidification potential (AP);
- d) photochemical ozone creation potential (POCP) (i.e., smog);
- e) ozone depletion potential (ODP);
- f) eutrophication potential (EP);
- g) human health impact indicators; and
- h) ecotoxicity impact indicators.

To qualify under this criterion, the LCA must have been reviewed in accordance with ISO 14044 Section 6.1 by an independent third party external to the manufacturer, or must have been published in a peer-reviewed journal, and must be based on Life Cycle Inventory (LCI) data collected no more than five years prior to product registration or certification. The manufacturing site represented in the LCI should be reported. The LCA may be based on the LCI from a single representative manufacturing site for the product, or on a mixture of manufacturing sites weighted according to their production capacity.

Reporting shall be in accordance with the transparency requirements in the reporting and communication section of the IEA PVPS Task 12 *Methodology Guidelines on Life Cycle Assessment of Photovoltaic Electricity*.

An updated LCA will be required if:

- the previously submitted LCA is greater than five years old; or
- changes have been made to the product manufacturing or design that make the LCA of the core representative product obsolete.

NOTE 2 — For the purposes of this criterion, a “representative core product” is a product that is expected to perform similarly to the product declared to conform to this Standard during evaluation (e.g., having the same general construction, materials, and manufacturing processes).

Verification requirements:

- a) documentation of independent third-party review of LCA in accordance with ISO 14044 Section 6.1, along with its third-party review comments and response to those comments, or peer-reviewed journal publication;
- b) if LCA is on a representative core product, demonstration of relevance of LCA to the declared product and documentation of the differences between the representative core product and the declared product; and
- c) documentation of the manufacturing sites included in LCI including the percentage of total product production capacity for the products included in the LCA.

7.1.2 Optional – Public disclosure of LCA results

The LCA produced in Section 7.1.1 shall be made publicly available on the manufacturer’s website using one of the following documents:

- 1) third-party report of the LCA as defined in section 5.2 of ISO 14044;
- 2) peer-reviewed journal paper; or
- 3) environmental product declaration (EPD) Type III label in accordance with ISO 14025.

This criterion may be satisfied by the manufacturer providing a link on its website to another publicly available website.⁴⁷ The manufacturer shall declare the URL of the public disclosure.

For publication in a peer-reviewed journal, acceptance for publication is acceptable; provided the prepublication (in press) paper is publicly available.

Point value: 1

Verification requirements:

- a) URL for the publicly-available LCA results on the manufacturer’s website.

7.1.3 Optional – Public disclosure of LCI inventory data

Manufacturer shall be awarded one point for each of the following LCI data disclosures for the LCA conducted in Section 7.1.1:

- reporting of original process material, energy, and emissions data used to characterize the manufacturing life-cycle stage of the product system. The LCI data include data that derive from and are specific to elementary or product flows; and

⁴⁷ Some journals may require a fee for access to published material.

- reporting inventory data representing scenarios for product recycling or disposal at EOL. Scenarios must be fully documented in the LCA report in Section 7.1.1, including all assumptions and sources of information upon which the data are based.

LCI data shall be made publicly available through one of the following formats:

- publication of the LCI in a peer-reviewed journal, or acceptance of a submittal to a peer-reviewed journal that is in prepublication; or
- acceptance of the LCI by a national or international database that undergoes critical review in accordance with ISO 14044. In such cases data shall be provided in Ecospol v.2¹⁰ or ILCD10 formats; or
- publication in a publicly available report that undergoes critical review in accordance with ISO 14044.

The manufacturer shall declare the URL of the public disclosure.

Point value: maximum 2

Verification requirements:

- a) documentation of LCI data disclosure in one of the referenced formats; and
- b) URL of the public disclosure.

7.2 Reduction in LCA impacts

7.2.1 Optional – Environmental hot spot identification

Manufacturer shall identify and publicly disclose the environmental hotspots in the product life cycle based on the LCA conducted in Section 7.1.1. Disclosure may be in the LCA disclosure in Section 7.1.2 or on the manufacturer's website.

NOTE — “Hotspots” are the largest contributors to or drivers of the environmental impact results identified through an LCA.²¹

Verification requirements:

- a) identification and public disclosure of environmental hotspot(s) for the LCA in Section 7.1.1; and
- b) public disclosure in formats consistent with Section 7.1.2 or URL for manufacturer's website.

7.2.2 Optional – Environmental leadership compared to industry average (applicable to PV modules only)

The environmental performance of the product shall outperform the EU PEFCR screening study results (v. 2.0 or more current)¹⁴ for the corresponding PV technology with points awarded as specified in Table 7.2. The LCA shall be conducted in accordance with the methodology for the “product stage” of the EU Product Environmental Footprint Category Rules for Photovoltaic Electricity Generation (v. 1.3 or more current).¹⁴

The LCA results shall be compared to the sum of weighted results for the “product stage” (in points per kWh) for the corresponding technology in the EU PEFCR screening study.

If the product being certified does not correspond to one of the technology types in the EU PEFCR screening study, it should be compared to one of the thin film technologies in the EU PEFCR screening study if the product being certified is a thin film technology, and it should be compared to one of the crystalline silicon technologies in the EU PEFCR screening study if the product being certified is a crystalline silicon technology. If the product being certified is neither thin film nor crystalline silicon, and is not one of the technology types in the EU PEFCR, the manufacturer shall declare “NA” for this criterion.

Table 7.2

Percent outperformance	Points
≥ 5%	1
≥10%	2

NOTE 1 — The EU PEFCR screening study evaluates the following technologies: thin film technologies (CdTe and CIS) and crystalline silicon technologies (micromorphous Si, multi-crystalline Si, mono-crystalline Si).

NOTE 2 — Outperformance is defined as achieving a lower impact score.

Point value: maximum 2

Verification requirements:

- a) documentation of LCA in accordance with EU PEFCR; and
- b) demonstration of outperformance in accordance with Table 7.2.

8 Energy efficiency and water use

8.1 Energy efficiency and management system

8.1.1 Optional – Energy management system for manufacturing facilities

Manufacturer shall ensure that the:

- 1) PV module, including solar cells; or
- 2) PV inverter assembly process and the component with the highest CED, based on the LCA conducted under Section 7.1.1, of the following:
 - capacitors;
 - semiconductors including power semiconductors and packaging (e.g. IGBT, silicon carbide and gallium nitride);
 - magnetics (e.g. choke, inductor); and
 - enclosure (housing)

are manufactured in facilities that have implemented and maintain an energy management system demonstrating conformance to one of the following options:

- Option 1: US DOE 50001 Ready program or self-declaration to the ISO 50001 Energy management system (EnMS) standard; or

- Option 2: US EPA ENERGY STAR Guidelines for Energy Management and ENERGY STAR Challenge for Industry certificate of achievement.

Optional points shall be awarded based on the percentage of product manufactured in facilities with energy management systems according to Table 8.1 (column 1 is for PV modules and column 2 is for PV inverters).

Table 8.1

Percentage of global capacity for PV module and solar cell manufacturing	Percentage of global capacity or percent spend for PV inverter assembly and the selected component manufacturing (see NOTE 3)	Optional points
≥ 50%	≥ 50%	1
≥ 90%	≥ 90%	2

A two-year grace period from the date of commissioning is available for implementing energy management systems at new manufacturing facilities. Manufacturer shall declare “NA” for this criterion if the product is manufactured only in new facilities without energy management systems conforming to this criterion.

NOTE 1 — For PV modules, at a minimum, this criterion covers PV module manufacturing operations, including solar cells, and other manufacturing operations at the same facility. For example, manufacturing of polysilicon wafers and cells would be included if in the same facility as PV module assembly. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its energy management system.

NOTE 2 — For PV inverter assembly and components, at a minimum, this criterion covers the PV inverter assembly and component manufacturing operations and other manufacturing operations at the same facility. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its energy management system.

NOTE 3 — Percent calculations are applied:

- separately to PV module assembly capacity and solar cell manufacturing capacity; or
- separately to capacity or spend of pv inverter assembly and the selected component.

Verification requirements:

a) for PV modules:

- capacity for PV module and solar cell manufacturing; and
- calculation of the percentage of manufacturer's global capacity for PV module and solar cell manufacturing with energy management systems conforming to US DOE 50001 Ready program; or ISO 50001 standard; or US EPA ENERGY STAR Guidelines for Energy Management and ENERGY STAR Challenge for Industry certificate of achievement.

b) for PV inverters:

- capacity or spend for PV inverter assembly and the selected component manufacturing; and
- calculation of the percentage of manufacturer's global capacity or spend for PV inverter assembly and the selected component manufacturing with energy management systems conforming to US DOE 50001 Ready program; or ISO 50001 standard; or US EPA ENERGY STAR Guidelines for Energy Management and ENERGY STAR Challenge for Industry certificate of achievement.

c) to demonstrate conformance, one of the following:

- third-party certification to either ISO 50001 or US EPA ENERGY STAR Facilities Management Program; or
- copy(ies) of completed ENERGY STAR Facility Energy Management Assessment Matrix demonstrating that all elements of the ENERGY STAR Guidelines for Energy Management are either “fully implemented” or have “some elements / degrees” of implementation and copy(ies) of the ENERGY STAR Challenge for Industry certificate of achievement for each facility (see NOTE 2); or
- copy of 50001 ready recognition certificate(s), or by providing all of the following consistent with ISO 50001 requirements:
 - copy of the EnMS policy;
 - document demonstrating top management commitment to the EnMS;
 - description of context and scope of the EnMS;
 - energy review within the EnMS, scope and resulting significant energy uses, and at least 24 months of energy consumption data prior to the time product declaration;
 - list of energy objectives, energy performance indicators (EnPIs), energy baseline(s) and action plans to achieve objectives;
 - demonstration of process to manage and implement annual internal ISO 50001 audits and summary of results of annual internal ISO 50001 audits;
 - documentation of annual management review and management decisions of effectiveness and suitability of the EnMS; and
 - evidence of continual improvement of the organization’s energy performance through the results of the implemented action plans.
- when claiming a two-year grace period for new facilities, the date when the new facility began PV module or solar cell production.

NOTE 4 — The ENERGY STAR Facility Energy Management Assessment can be downloaded at <www.energystar.gov/assessfacility>. Facilities that participate in the ENERGY STAR Challenge for Industry pledge to reduce their energy intensity by 10% within five years or less. See: <www.energystar.gov/industrychallenge>.

8.1.2 Optional – Certified energy management system

Manufacturer shall ensure that the:

- 1) PV module, including solar cells; or
- 2) PV inverter assembly process and the component with the highest CED, based on the LCA conducted under Section 7.1.1, of the following:
 - capacitors;
 - semiconductors including power semiconductors and packaging (e.g., IGBT, silicon carbide and gallium nitride);

- magnetics (e.g., choke, inductor); and
- enclosure (housing)

are manufactured in facilities that are third-party certified to ISO 50001 or a nationally adopted version of ISO 50001.

Optional points shall be awarded according to Table 8.2 (column 1 is for PV modules and column 2 is for PV inverters).

Table 8.2
Facilities with Certified Energy Management Systems

Percentage of global capacity for PV module and solar cell	Percentage of global capacity or percent spend for PV inverter assembly and the selected component manufacturing (see NOTE 3)	Optional points
≥ 50%	≥ 50%	1
≥ 90%	≥ 90%	2

Optional points may be claimed for Section 8.1.1 in addition to Section 8.1.2, if applicable.

A two-year grace period from the date of commissioning is available for certifying energy management systems at new manufacturing facilities. Manufacturer shall declare “NA” for this criterion if the product is manufactured only in new facilities without energy management systems conforming to this criterion.

NOTE 1 — For PV modules, at a minimum, this criterion covers PV module manufacturing operations, including solar cells, and other manufacturing operations at the same facility. For example, manufacturing of polysilicon wafers and cells would be included if in the same facility as PV module assembly. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its energy management system.

NOTE 2 — For PV inverter assembly and components, at a minimum, this criterion covers the PV inverter assembly and component manufacturing operations and other manufacturing operations at the same facility. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its energy management system.

NOTE 3 — Percent calculations are applied:

- separately to PV module assembly capacity and solar cell manufacturing capacity; or
- separately to capacity or spend of PV inverter assembly and the selected component.

Point value: maximum 2

Verification requirements:

a) for PV modules:

- global capacity for PV module and solar cell manufacturing; and
- calculation of the percentage of manufacturer's global capacity for PV module and solar cell manufacturing with energy management systems certified to ISO 50001.

b) for PV inverters:

- capacity or spend for PV inverter assembly and the selected component manufacturing; and

— calculation of the percentage of manufacturer's global capacity or spend for PV inverter assembly and the selected component manufacturing with energy management systems certified to ISO 50001.

c) documentation of current certification to ISO 50001 or nationally adopted version of ISO 50001. Certification(s) shall be obtained from a certification body accredited by an accreditation body that is a signatory to the IAF Multilateral Recognition Arrangement (MLA) with the appropriate scope of accreditation. Where a corporate certification is achieved to ISO 50001 in accordance with a multisite certification, confirmation that the certificate includes all facilities identified in the scope of the ISO 50001 certification(s); and

d) when claiming a two-year grace period for new facilities, the date when the new facility began PV module or solar cell production.

8.1.3 Optional – Certified energy management system energy performance improvement

Manufacturer shall ensure that the:

- 1) PV module, including solar cells; or
- 2) PV inverter assembly process and the component with the highest CED, based on the LCA conducted under Section 7.1.1, of the following:
 - capacitors;
 - semiconductors, including power semiconductors and packaging (e.g., IGBT, silicon carbide and gallium nitride);
 - magnetics (e.g., choke, inductor); and
 - enclosure (housing)

are manufactured in facilities that are third-party certified to the SEP 50001 program by an ANAB-accredited SEP 50001 verification body(ies) (see NOTE 4), or a nationally equivalent EnMS energy performance improvement program that meets the requirements of the US DOE 50001 program (see NOTE 5).

Optional points shall be awarded according to Table 8.3 (column 1 is for PV modules and column 2 is for PV inverters).

Table 8.3
Facilities certified to the US DOE SEP Program or equivalent

Percentage of global capacity for PV module and solar cell manufacturing	Percentage of global capacity or percent spend for PV inverter assembly and the selected component manufacturing (see NOTE 3)	Optional points
≥ 50%	≥ 50%	1
≥ 90%	≥ 90%	2

Optional points may be claimed for Sections 8.1.1 and 8.1.2, in addition to Section 8.1.3, if applicable.

A two-year grace period from the date of commissioning is available certifying energy management systems for new manufacturing facilities. Manufacturer shall declare "NA" for this criterion if the product is manufactured only in new facilities without energy management systems conforming to this criterion.

NOTE 1 — For PV modules, at a minimum, this criterion covers PV module manufacturing operations, including solar cells, and other manufacturing operations at the same facility. For example, manufacturing of polysilicon wafers and cells would be included if in the same facility as PV module assembly. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its energy management system.

NOTE 2 — For PV inverter assembly and components, at a minimum, this criterion covers the PV inverter assembly and component manufacturing operations and other manufacturing operations at the same facility. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its energy management system.

NOTE 3 — Percent calculations are applied:

- separately to PV module assembly capacity and solar cell manufacturing capacity; or
- separately to capacity or spend of PV inverter assembly and the selected component.

NOTE 4 — The SEP 50001 program requirements for certification include:

- ISO 50001, *Energy Management Systems – Requirements with Guidance for Use*;
- ANSI/MSE 50028-1, *Superior Energy Performance 50001 — Additional Requirements for Energy Management Systems*;
- ANSI/MSE 50028-2, *Superior Energy Performance 50001 – Requirements for verification bodies for use in accreditation or other forms of recognition*; and
- Superior Energy Performance 50001 Program Certification Protocol, Superior Energy Performance 50001 Program Measurement and Verification (M&V) Protocol, SEP 50001 Scorecard.

NOTE 5 — The SEP 50001 program defines national equivalent energy performance programs (e.g., Korea Superior Energy Management System [Superior EnMS]) at: <www.energy.gov/eere/amo/SEP-equivalency>.

Point value: maximum 2

Verification requirements:

a) for PV modules:

- global capacity for PV module and solar cell manufacturing; and
- calculation of the percentage of manufacturer’s global PV module and solar cell manufacturing that are third-party certified per the criterion.

b) for PV inverters:

- capacity or spend for PV inverter assembly and the selected component manufacturing; and
- calculation of the percentage of manufacturer’s global capacity or spend for PV inverter assembly and the selected component manufacturing are third-party certified per the criterion.

c) documentation of current SEP 50001 program certification(s) or certification(s) to a nationally equivalent SEP 50001 program. Certifications have been obtained from third-party certification body(ies) accredited by an IAF member accreditation body whose scope of accreditation includes the specified standard. Where a corporate certification is achieved to ISO 50001 in accordance with a multisite certification, confirmation that the certificate includes all facilities identified in the scope of the SEP 50001 Certification(s);

d) if an equivalent SEP 50001 program is used, the manufacturer shall provide documentation that the national program meets SEP 50001 program equivalency; and

- e) When claiming a two-year grace period for new facilities, the date when the new facility began PV module production.

8.1.4 Required — Weighted efficiency reporting (applicable only to PV inverters)

The manufacturer shall make the weighted efficiency of the product publicly available, calculated using the current version of the California Energy Commission & California Public Utilities Commission *Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems*.⁴⁸

NOTE — Weighted efficiency is defined in Section 5 – Test Procedures and Criteria of *Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems*.⁵³

Verification requirements:

- a) documentation that the weighted efficiency of the product has been tested and calculated according to the relevant requirements of California Energy Commission & California Public Utilities Commission verification process; and
- b) demonstration that the weighted efficiency of the product is publicly available (e.g., California Energy Commission website⁴⁹ or manufacturer website).

8.1.5 Required – Tare loss reporting (applicable only to PV inverters)

The manufacturer shall make the tare loss of the product publicly available, calculated using the current version of the California Energy Commission & California Public Utilities Commission *Performance Test Protocol for Evaluating Inverters Used in Grid-Connected Photovoltaic Systems*.⁴⁷

Verification requirements:

- a) documentation that tare loss of the product has been tested and calculated according to the relevant requirements of California Energy Commission & California Public Utilities Commission verification process; and
- b) demonstration that tare loss of the product is publicly available (e.g., California Energy Commission website⁴⁸ or manufacturer website).

8.2 Water use metrics

8.2.1 Required – Water inventory

The manufacturer shall ensure that the:

- 1) PV module, including solar cells; or
- 2) PV inverter assembly

are manufactured in facilities that have compiled an inventory of water use and wastewater effluent. The inventory shall include and identify:

- the volume of total water withdrawals by country, river basin, and withdrawal source (e.g., surface water, groundwater, sea water, municipal water, wastewater from another organization, rainwater collected onsite, delivered water);
- the volume and percentage of water that is recycled and reused;

⁴⁸ <www.gosolarcalifornia.ca.gov/equipment/documents/2004-11-22_Test_Protocol.pdf>

⁴⁹ <www.gosolarcalifornia.ca.gov/equipment/inverters.php>

- the destination of discharge should be specified: surface water, groundwater, sea water, municipal treatment plant, hazardous waste treatment plant; and
- statement of percentage of product manufactured at facilities in water stressed areas (< 1700 m³ water/person/yr) as identified with the WBCSD Global Water Tool.⁴⁰

NOTE 1 — At a minimum, this criterion covers PV module manufacturing operations, and other manufacturing operations at the same facility. For example, manufacturing of polysilicon wafers and cells would be included if in the same facility as PV module assembly. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its water and wastewater inventory.

NOTE 2 — For PV inverter assembly, at a minimum, this criterion covers the PV inverter assembly operations and other manufacturing operations at the same facility. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its water and wastewater inventory.

NOTE 3 — Analytical tools are available to identify regions subject to water stress, including: the WBCSD Global Water Tool⁴⁰, the WRI Aqueduct Global Water Risk Mapping Tool⁴¹, GEMI Local Water Tool³⁶, and the WWF-DEG Water Risk Filter⁴².

Verification requirements:

- a) list of facilities manufacturing the PV module and solar cells or PV inverter assembly including location; and
- b) evidence that the facility compiled an inventory of water use and wastewater effluent by manufacturing facility that included the parameters listed above.

8.2.2 Optional – Quality of wastewater discharges

The manufacturer shall ensure that the:

- 1) PV module, including solar cells; or
- 2) PV inverter assembly

are manufactured in facilities that have documented the quality of wastewater discharges. Wastewater discharges shall be specified by liquid volume and according to several water quality measures, including, but not limited to, chemical oxygen demand, biological oxygen demand, total suspended solids, heavy metals, and pH.

Point value: 1

Verification requirements:

- a) list of facilities manufacturing the PV module and solar cells or PV inverter assembly, including location; and
- b) documentation of wastewater discharges by manufacturing facility that included the parameters listed above.

8.2.3 Optional – Improved water use efficiency

The manufacturer shall ensure that the:

- 1) PV module, including solar cells; or
- 2) PV inverter assembly

are manufactured in facilities that have established a water management policy for efficient use of water in manufacturing operations. Manufacturing facilities shall demonstrate an average of 1% reduction per year of facility-wide total water withdrawal per unit of production (in MW or MW AC) from the inventory baseline. Reduction in water use may include a combination of water conservation, efficiency, recycling and reuse.

Optional points shall be awarded based on the percentage of product manufactured in facilities that demonstrate an average 1% reduction per year according to Table 8.4.

Table 8.4

Percentage of global capacity for PV module and solar cell manufacturing	Percentage of global capacity or percent spend for PV inverter assembly (see NOTE 3)	Optional points
≥ 50%	≥ 50%	1
≥ 90%	≥ 90%	2

NOTE 1 — For PV modules, at a minimum, this criterion covers PV module manufacturing operations, including solar cells, and other manufacturing operations at the same facility. For example, manufacturing of polysilicon wafers and cells would be included if in the same facility as PV module assembly. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its water management policy.

NOTE 2 — For PV inverter assembly, at a minimum, this criterion covers the PV inverter assembly operations and other manufacturing operations at the same facility. Manufacturer may choose to include an entire “campus” (i.e., all buildings) at a location for its water management policy.

NOTE 3 — Percent calculations are applied:

- separately to PV module assembly capacity and solar cell manufacturing capacity; or
- separately to capacity or spend of PV inverter assembly.

Point value: maximum 2

Verification requirements:

- a) water management policy for facilities manufacturing PV module, including solar cells or PV inverter assembly;
- b) location(s) of manufacturing facilities;
- c) water withdrawal per unit of production for baseline year; and
- d) calculation of the percentage of manufacturing facilities demonstrating an average 1% reduction per year from inventory baseline, and how the reduction was achieved (e.g., conservation, efficiency, recycling, reuse).

9 End of life management and design for recycling

9.1 End-of-life (EOL) management

9.1.1 Required – Product take-back service and processing requirements (corporate)

Manufacturers shall provide a nationwide product take-back service for recycling for products declared and formerly declared to conform to this Standard. In jurisdictions where there are existing laws, regulations, or both, which establish a program for the collection and recycling of products declared and formerly declared

to conform to this Standard, demonstration of compliance with those legal requirements meets the requirements of this criterion.

The take-back programs should consider the hierarchy of management of used and EOL products based on reuse, refurbishment, materials recovery, or a combination of all three.

Manufacturer shall make available information describing the product take-back service, including how to utilize the service:

- to customers in product promotional materials (e.g., product specifications, sales documents, product description) and product label or marking. The manufacturer may satisfy this requirement by providing the URL for the manufacturer's public website that describes the take-back service in at least one web-based product promotional material; and
- on the manufacturer's public website, the manufacturer shall declare the URL of the public disclosure.

Manufacturer shall disclose information publicly that identifies if there are any additional costs to the end-user associated with use of the product take-back service.

Manufacturer shall demonstrate the take-back program utilizes either:

- 1) manufacturer-owned recycling services (in-house) that are third-party certified to ISO 14001 and either OHSAS 18001 or ISO 45001; or
- 2) manufacturer-owned recycling services (in-house) with status as an authorized waste management facility in accordance with Article 8 and Article 9 of the EU WEEE Directive¹² and respective national transpositions;^{50,51} or
- 3) initial service providers that are third-party certified to ISO 14001 and either OHSAS 18001 or ISO 45001; or
- 4) initial service providers with status as an authorized waste management facility in accordance with Article 8 and Article 9 of the EU WEEE Directive and respective national transpositions.^{50,51}

A manufacturer may declare this criterion differently in each country or region for which the product is declared to conform to this Standard.

Manufacturers shall have a grace period until Jan. 1, 2020, to meet the requirements of this criterion. There is no grace period for products at the gold level.

Verification requirements:

- a) in jurisdictions within a country where the product is declared to conform to this Standard and where there are existing laws, regulations, or both, which establish a program for the collection and recycling of products, the manufacturer shall demonstrate compliance to those laws and/or regulations; or

⁵⁰ For example, Germany, Art. 56 (2) of the Circular Economy Law ('Kreislaufwirtschaftsgesetz') specifies requirements for certified waste treatment operators. Those requirements are further detailed in the Ordinance on Certified Waste Treatment Operators ('Verordnung über Entsorgungsfachbetriebe, technische Überwachungsorganisationen und Entsorgungsgemeinschaften'), published in 2016 and last modified 01 January 2019.

⁵¹ Certified waste management companies are typically listed in databases from certified waste treatment operator schemes. For example, <www.efb-register.de> offers access to a pan-EU list of certified waste treatment operators for Germany, Austria, Switzerland, the Netherlands, Slovakia and Czech Republic.

b) in jurisdictions within a country where the product is declared to conform to this Standard and where there are no existing laws and/or regulations which establish a program for the collection and recycling of products declared to conform to this Standard, the following shall apply:

- demonstration that product take-back service is provided;
- declaration of the URL for the manufacturer's public website that describes the product take-back service, including how to utilize the service;
- demonstration that information is disclosed publicly that identifies if there are any additional costs to the end user associated with use of the product take-back service; and
- for each of the country(s) / region(s) within which the manufacturer is declaring to conform to this criterion, the following shall be documented:
 - list of manufacturer-owned recycling services (in-house), if applicable, and valid third-party certification(s) to ISO 14001 and either OHSAS 18001 or ISO 45001; and/or
 - list of manufacturer-owned recycling services (in-house), if applicable, with status as an authorized waste management facility in accordance with Article 8 and Article 9 of the EU WEEE Directive and respective national transpositions; and/or
 - list of manufacturer's initial service providers, if applicable, and valid third-party certification(s) to ISO 14001 and either OHSAS 18001 or ISO 45001; and/or
 - list of manufacturer's initial service providers, if applicable, with status as an authorized waste management facility in accordance with Article 8 and Article 9 of the EU WEEE Directive and respective national transpositions.

9.1.2 Optional – Publicly available record of annual recycling and recovery achievement (corporate)

Manufacturer shall make publicly available on their website the annual recycling, recovery and reuse achievements (as separate percentages of their annual total weight returned) of the take-back service for each country into which the product is declared to conform to this Standard or globally. This criterion applies only to products taken back under Section 9.1.1. Products and equipment recovered and processed under national or regional collection schemes (mandated programs) may be included if the data is made available to the manufacturer.

Reporting shall include:

- total annual weight returned / collected;
- percentage of materials recovered / recycled (weight by weight):

PV modules	PV inverters
<ul style="list-style-type: none"> — metals (not including semiconductor materials); — semiconductor materials; — glass; and — other materials. 	<ul style="list-style-type: none"> — metals (not including printed circuit board assembly materials and choke); — electronic assembly; — choke / inductor; — plastic; and — other materials.

- percentage of materials disposed (weight by weight):
 - sent to a thermal with energy recovery facility; and
 - sent to a thermal or landfill facility for disposal.
- percentage products or components prepared for reuse (weight by weight).

NOTE — Calculation of the above percentages is based on the total annual weight returned/collected mass of product taken back each year.

Point value: 1

Verification requirements:

- a) public URL for manufacturer's website with reporting as outlined in criterion. At a minimum, the achievement must cover products collected under Section 9.1.1, but can include other products.

9.1.3 Optional – Material recovery targets (corporate) (maximum 2 points)

Manufacturer shall recover at least the following percentages outlined in Table 9.1, as reported in Section 9.1.2:

Table 9.1
Recovery achievements

Recovery achievement thresholds		Points awarded
PV modules	PV inverters	
<ul style="list-style-type: none"> — ≥ 80% glass; and — ≥ 80% metals (not including semiconductor materials); and — ≥ 30% semiconductor materials. 	<ul style="list-style-type: none"> — ≥ 80% metals (not including printed circuit board assembly materials and choke); and — ≥ 50% electronic printed circuit board electronic assembly; and — ≥ 50% choke/inductor; and — ≥ 80% plastic. 	1
<ul style="list-style-type: none"> — ≥ 90% glass; and — ≥ 90% metals (not including semiconductor materials); and — ≥ 60% semiconductor materials. 	<ul style="list-style-type: none"> — ≥ 90% metals (not including printed circuit board assembly materials and choke); and — ≥ 60% electronic printed circuit board assembly; and — ≥ 60% choke/inductor; and — ≥ 90% plastic. 	2

A manufacturer may declare this criterion differently in each country or region for which the product is declared to conform to this Standard.

Point value: maximum 2

Verification requirements:

- a) public URL for manufacturer's website with reporting as outlined in Section 9.1.3 with recovery achievements as listed in Table 9.1 above.

9.2 Design for recycling**9.2.1 Optional – Identification of materials for EOL management (only applicable to PV modules)**

Manufacturer shall make available to organizations that recycle EOL PV modules identification of the presence of the following substances in the manufacturer's product:

- 1) for conductor material:
 - metals and metal oxides.
- 2) for photoactive substances:
 - semiconductor materials;
 - metals and metal compounds;
 - organometallics; and
 - nonmetals that are used as photoactive substances.

For products 60 kg or less, substances below 2 g in the product are not required to be identified; and for products greater than 60 kg, substances below 4 g in the product are not required to be identified.

Point value: 1

Verification requirements:

- a) demonstration that this information is made available to organizations that recycle EOL PV modules; and
- b) the list of substances present in each of the applicable components and materials as required in the criterion.

9.2.2 Optional – Replacement components availability (applicable only to PV inverters)

An option to purchase product replacement components and/or product service through the manufacturer or an authorized third party for at least five years (1 point) or ten years (2 points) after the date of sale shall be made available. This option may be available free of charge or at separate charge.

Replacement components shall include, at a minimum, fans, fuses, switches and printed circuit board assemblies. Information regarding the availability of product replacement components and/or product service shall be publicly available on the manufacturer's website.

The URL for the manufacturer's public website disclosing this information shall be provided during product registration, certification or self-declaration, and made publicly available.

Point value: maximum 2

Verification requirements:

- a) manufacturer's website URL; and
- b) demonstration that the website contains information regarding:

- the availability of product replacement components and/or product service for at least five or ten years after the date of sale; and
- how to obtain product replacement components and/or product service through the manufacturer or an authorized third party.

10 Product packaging

10.1 Eliminate substances of concern

10.1.1 Required – Elimination of substances of concern in product packaging

Product packaging shall not contain lead, mercury, cadmium or hexavalent chromium above a total of 100 ppm for the four metals combined in any packaging component, in accordance with the European Union Packaging Directive¹³ and the Model Toxics in Packaging Legislation.

Verification requirements:

- a) supplier statement for each packaging component or for all packaging materials provided by the supplier that the sum of the combined concentration of the four metals does not exceed 100 ppm by weight, or
- b) documentation of a conformance assurance system that demonstrates conformity to this criterion through effective control of the supply chain.

10.1.2 Required – Elimination of chlorine in processing packaging materials

Manufacturer shall document with supplier letter(s) that any paper-based materials used in product packaging was not bleached with chlorine compounds. This requirement applies to the bleaching of paper-based materials (including recycled fiber) and their fabrication into packaging for products declared to conform to this Standard, and not to prior uses of the paper-based material.

NOTE — Packaging that is PCF or TCF meet the requirements of this criteria.

This criterion does not apply to invoices or other shipping documents.

Verification requirements:

- a) supplier letter(s) for paper-based materials used in product packaging.

10.2 Recyclability of packaging

10.2.1 Required – Enhancing recyclability of packaging materials

Product packaging shall meet the following requirements:

- 1) all nonreusable packaging components ≥ 25 g shall be separable by material type, including by plastic material type specified in b of the verification requirements below, without the use of tools, with the exception of labels affixed to plastics bags or wraps, staples, and nails in pallets; and
- 2) all plastics ≥ 25 g shall be clearly marked with material type in accordance with ISO 11469/1043, ASTM D7611/D7611M, or DIN7, with the exception of plastic films and plastic strapping.

Verification requirements:

- a) documentation from manufacturer:
 - for requirement 1) manufacturer's packaging part or assembly drawing, or photographs; and
 - for requirement 2) photographs or physical evidence of plastic markings.

10.3 Recycled content in packaging**10.3.1 Optional – Recycled content paper-based packaging (optional)**

Paper-based packaging materials shall contain a minimum 25% recycled content fiber (by fiber weight). Paper-based packaging materials derived from alternative sources to traditional paper mill products (including, but not limited to, bamboo, mushrooms, bagasse and straw) are exempt from this recycled fiber requirement and shall not be included in the calculation of recycled content.

A manufacturer may declare this criterion differently in each country or region for which the product is declared to conform to this Standard.

Point value: 1

Verification requirements:

- a) list of applicable packaging materials and weights; and
- b) supplier documentation with recycled content percentage for each applicable packaging material.

10.3.2 Optional – Postconsumer recycled content plastic in packaging

Packaging shall contain 10% or greater postconsumer recycled plastic based on the percent by mass of postconsumer recycled plastic content used as a percentage of total mass of plastic packaging (excluding plastic protective and stretch wraps).

If the product packaging does not contain any plastics, "NA" may be declared.

A manufacturer may declare this criterion differently in each country or region for which the product is declared to conform to this Standard.

Point value: 1

Verification requirements:

- a) list of plastic packaging materials and weight;
- b) supplier letter stating the percentage recycled content in plastic materials; and
- c) calculation of percentage of total recycled content plastic.

11 Corporate responsibility**11.1 Environmental, health, and safety management systems****11.1.1 Required – Environmental management system (EMS) certification**

The following shall be manufactured in facilities certified to either ISO 14001 or EU EMAS by an accredited third-party certification body:

- 1) PV module including solar cells; or

2) PV inverter assembly

Certification bodies shall be accredited by an IAF member accreditation body²⁰ to certify to the specific standard identified.

This criterion applies to manufacturing facilities in operation for 12 months or longer.

Verification requirements:

- a) copy of ISO 14001 or EU EMAS certification for facilities manufacturing the PV module and solar cells or PV inverter assembly; and
- b) list of all facilities manufacturing the PV module and solar cells or PV inverter assembly, and their date of commissioning.

11.1.2 Required – Manufacturer conformance with occupational health and safety performance (corporate)

Conformance to ANSI/AIHA/ASSE Z10, *Occupational Health and Safety Management Systems*, OHSAS 18001 or ISO 45001 shall be maintained for those operations covered by Section 11.1.1.

Verification requirements:

- a) list of all facilities manufacturing the PV module and solar cells or PV inverter assembly and their date of commissioning; and
- b) a copy of certification to ANSI/AIHA/ASSE Z10 OHSAS 18001 or ISO 45001, applicable to operations in a).

11.2 Corporate reporting

11.2.1 Required – Reporting on key performance indicators (corporate)

Manufacturer shall publicly disclose annually the key performance indicators listed in Table 11.1. The disclosure shall define the reporting boundary by specifying which regions and manufacturing processes are covered in each metric in Table 11.1

Table 11.1

Key performance indicators	Reference Source of Key Performance Indicator		
	GRI Standards ¹⁴	SASB solar energy sustainability accounting standard ³⁰	SEIA Commitment ²⁸
PV modules produced or sold in MW or PV inverters produced or sold in MW AC in reporting period	—	RR0102-A or RR0102-B	included
recycled input materials used	301-2	RR0102-10	—
energy consumption within the organization	302-1	—	included
energy consumption in manufacturing	—	RR0102-01.01	—
energy intensity	302-3	—	—
total water withdrawal from all sources	303-1	RR0102-02.08	included
direct GHG emissions (Scope 1)	305-1	—	included
energy indirect GHG emissions (Scope 2)	305-2	—	included
waste by type and disposal method	306-2	—	included
type of injury and rates of injury, occupational diseases, lost days, and absenteeism, and number of work-related fatalities	403-2	—	included

Reporting format and frequency:

— disclosures shall be publicly available on the manufacturer's website. The manufacturer shall declare the URL of the public disclosure;

— data shall be reported consistent with the topic-specific Standards in the GRI Sustainability Reporting Standards (GRI Standards), Solar Energy Industry Association (SEIA) Solar Industry Environmental and Social Responsibility Commitment (SEIA Commitment) or Sustainability Accounting Standards Board (SASB) Solar Energy Sustainability Accounting Standard (SASB Standard) that are in effect at the time the disclosures are made as described in Table 11.1;

— publication of a full report or reports 'in accordance' with the GRI Standards or SASB Standard is not required but would meet this criterion if the report(s) covers the indicators specified in this criterion; and

— performance against these indicators shall be reported and publicly disclosed annually; data included in the report must be from within the last two years.

Verification requirements:

- a) URL for public disclosure on manufacturer's website; and
- b) demonstration of annual disclosure of all the indicators in Table 11.1 consistent with GRI Standards, SEIA Commitment, or SASB Standard and using data from within the last two years.

11.2.2 Optional – Reporting additional key performance indicators (corporate)

Manufacturer shall publicly disclose annually additional key performance indicators. The disclosure shall define the reporting boundary by specifying which regions and manufacturing processes are covered in each metric in Table 11.2 and using the same reporting format and frequency in Section 11.2.1.

Manufacturer may claim up to 2 points for this criterion. To claim 1 point, any six of the indicators listed in Table 11.2 shall be publicly disclosed. To claim 2 points, all of the indicators listed in Table 11.2 shall be publicly disclosed.

Table 11.2

Key performance indicators	Reference source of key performance indicator		
	GRI Standards	SASB Solar Energy Sustainability Accounting Standard	SEIA commitment
materials used by weight or volume	301-1	—	—
reduction of energy consumption	302-4	—	—
water withdrawn in water stressed areas	303-2	RR0102-02.11 & RR0102-02.12 (or WBSCD Global Water Tool ⁴⁰)	—
water recycled and reused	303-3	—	—
GHG emissions intensity	305-4	—	—
reduction of GHG emissions	305-5	—	—
water discharge by quality and destination	306-1	—	—
significant spills and transport of hazardous waste	306-3 & 306-4	—	—
noncompliance with environmental laws and regulations	307-1	—	—
product recycling program in place	—	—	included
freedom of association and collective bargaining for operations and suppliers	407-1	—	—
operations and suppliers with risk for forced or compulsory labor	409-1	—	—

Point value: maximum 2

Verification requirements:

- a) URL for public disclosure on manufacturer's website; and
- b) demonstration of annual disclosure of indicators in Table 11.2 consistent with GRI Standards, SEIA Commitment, or SASB Standard and using data from within the last two years:
 - 6 indicators for 1 point; or
 - all indicators for 2 points.

11.2.3 Optional – Reporting on screening of Tier 1 suppliers (corporate)

Manufacturer shall publicly report on corporate environmental and social responsibility performance of Tier 1 suppliers using the key indicators of the GRI Standards listed in Table 11.3 and using the reporting format and frequency specified in Section 11.2.1.

Public disclosure shall include the details outlined for all GRI aspects in Table 11.3.

Table 11.3

Indicator & GRI Standards reference		Disclosure on indicator must, at a minimum:
Code	Title	
414-1	New suppliers that were screened using social criteria	Disclosure must specify which social impacts were used for screening and evaluation of these indicators.
414-2	Negative impacts on social impacts in supply chain and actions taken	<p>Labor practice criteria for screening and assessments, at a minimum, must include compliance with laws on:</p> <ul style="list-style-type: none"> — minimum wages; — working hours; — compensation for overtime; — health and safety practices; — nondiscrimination; — freedom of association and collective bargaining; — humane treatment / incidents (such as of verbal, psychological, physical, or sexual abuse, coercion or harassment); — child labor; — forced or compulsory labor.
308-1	New suppliers that were screened using environmental criteria	Disclosure must specify which environmental impacts were used for screening and evaluation of these impacts.
308-2	Negative environmental impacts in the supply chain and actions taken	

Point value: 2

Verification requirements:

- a) URL for public disclosure on manufacturer's website;
- b) list of Tier 1 Suppliers who perform manufacturing or assembly functions for the product declared to conform to this Standard;

NOTE — this does not require public disclosure of list of suppliers.

- c) copy of public disclosure of GRI data in Table 11.3 for Tier 1 suppliers; and

- d) demonstration of annual disclosure of c). Public disclosures for the Tier 1 suppliers in c) must be available at the time of first declaration to the criterion, and annually thereafter.

11.3 Corporate social performance

11.3.1 Required – Commitment to environmental and social responsibility (corporate)

- 1) Manufacturer shall commit to continuous improvement in environmental, and social responsibility including labor and human rights, demonstrated by a written public commitment by a company officer. The commitment shall cover both its operations and its suppliers; or
- 2) Participation in one of the following:
 - Solar Energy Industries Association (SEIA) Solar Industry Commitment for Environmental and Social Responsibility; or
 - Responsible Business Alliance (RBA) Code of Conduct; or
 - equivalent internationally-recognized program that promotes continuous improvement in environmental and social responsibility by manufacturers and their supply chain.

Verification requirements:

- a) written public commitment by a company officer, or
- b) participation in either SEIA Solar Industry Commitment for Environmental and Social Responsibility or RBA Code of Conduct, or
- c) demonstration of public commitment and participation in an equivalent internationally-recognized program, including documentation demonstrating that the program is equivalent to either of the above referenced programs

11.3.2 Optional – Auditing or certification to social responsibility performance standard (corporate)

Manufacturer shall implement or participate in a program that audits suppliers to promote social responsibility and business ethics. The manufacturer shall have a process in place for evaluating the risk for negative environmental and social impacts of its suppliers and determining which suppliers for the product declared to conform to this Standard should undergo onsite environmental and social audits. The manufacturer's process for evaluating suppliers shall include specific environmental and social evaluation criteria and a methodology for determining which suppliers must undergo onsite audits based on the manufacturer's criteria ("at risk" suppliers). "At risk" suppliers shall undergo onsite audits at least every three years.

Any one of the following shall meet this criterion:

- 1) manufacturer program that audits all facilities of "at risk" suppliers, at a minimum, against internationally recognized standards, including but not limited to, the ILO Declaration on Fundamental Principles and Rights at Work and the UN Universal Declaration of Human Rights. (1 point); or
- 2) all facilities of "at risk" suppliers certified by accredited certification bodies to Social Accountability (SA) 8000²⁸. Certification bodies shall be accredited by an authorized accreditation body to certify to the SA8000. The certification shall be no older than three years. (2 points); or

All facilities of "at risk" suppliers audited to the RBA Code of Conduct²⁶ using the validated audit process (VAP).

Point value: 1 or 2

Verification requirements:

- a) documentation of process for identification of “at risk” suppliers and/or supplier facilities; and
- b) any one of the following:
 - documentation that manufacturer performs on-site audits of all facilities of “at risk” suppliers at least every three years, and demonstration that the audit protocol addresses the issues covered by the ILO Declaration on Fundamental Principles and Rights at Work and the UN Universal Declaration of Human Rights;
 - demonstration of valid certification to SA8000 for all facilities of “at risk” suppliers for the product declared to conform to this criterion; or
 - demonstration of RBA VAP audits for all facilities of “at risk” suppliers conducted within three years.

11.4 Conflict mineral sourcing

11.4.1 Required – Public disclosure of use of conflict minerals in products (corporate)

Manufacturers shall:

- determine whether any of their products that they manufactured or contracted to have manufactured contain conflict minerals that are necessary to the functionality or production of those products and prepare disclosures on use and sources of these minerals in conformance with Rule 13p-1 under the US Securities Exchange Act of 1934, regardless of the applicability of Rule 13p-1 to the company, with the exception of small business status; and
- make such disclosures publicly available on their websites and shall declare the URL of the public disclosure.

Small businesses are exempt from this criterion. A small business shall be defined as one that:

- is not a subsidiary of a larger company, and
- showed annual revenues of less than \$50 million during the most recently completed fiscal year (at the time of product registration) for which audited financial statements are available.

Verification requirements:

- a) public disclosure on the company website of conflict minerals found in its products in conformance with Rule 13p-1 under the US Securities Exchange Act of 1934;
- b) declaration of the URL of the public disclosure on the company website; and
- c) for small businesses exempt from this criterion, a declaration that the organization is not a subsidiary of a larger company and a copy of its most recent (but not more than three years old) audited financial statements, indicating that annual revenues were below \$50 million.

11.4.2 Optional – Conflict mineral sourced only from validated conflict-free smelters (corporate)

Manufacturers shall conduct due diligence in good faith to determine all sources of conflict minerals used in all their products and conclude that they are from either:

- 1) recycled or scrap sources; or
- 2) smelters, refiners, or both, which have been determined to be compliant with the Conflict-free Smelter Program (CFSP) by the Conflict-free Sourcing Initiative (CFSI), or one of CFSP's mutually recognized assessment programs, and appear on CFSI's list of validated smelters and refiners, consistent with the definitions provided for in Rule 13p-1 under the U.S. Securities Exchange Act of 1934.

Starting in 2016 (or 2018 for smaller companies), if manufacturer is voluntarily claiming "conflict-free", for the purposes of conformance to this criterion, an independent private sector audit (IPSA) is required to verify manufacturer's control systems and justification for determination, conducted in accordance with Rule 13p under the US Securities Exchange Act of 1934.

NOTE 1 — For this criterion, "recycled or scrap sources" are defined as recycled metals are reclaimed end-user or postconsumer products, or scrap processed metals created during product manufacturing. Recycled metal includes excess, obsolete, defective, and scrap metal materials which contain refined or processed metals that are appropriate to recycle in the production of tin, tantalum, tungsten and/or gold. Minerals partially processed, unprocessed or a bi-product from another ore are not recycled metals.³⁹

NOTE 2 — For CFSI list, see <www.conflictreesourcing.org/conflict-free-smelter-refiner-lists>.

Point value: 1

Verification requirements:

- a) copy of the independent private sector audit report, as specified in the criterion, verifying the manufacturer's determination of conflict-free sourcing.

11.4.3 Optional – Participation in in-region conflict-free sourcing program (corporate)

Manufacturer shall participate in or source minerals from at least one of the in-region conflict-free controlled chain-of-custody sourcing programs which are validating and/or sourcing minerals from certified conflict-free sources in the Great Lakes region of Africa.

Point value: 1

Verification requirements:

- a) evidence of participation in at least one in-region conflict-free sourcing program, including:
 - Solutions For Hope;
 - Conflict-free Tin Initiative;
 - Public Private Alliance for Responsible Mineral Trade; or
 - other initiatives that meet the following criteria:
 - multi-stakeholder participation (i.e., more than just one organization);
 - is endorsed, recognized, funded, or contracted by the International Conference of the Great Lakes Region (ICGLR), European Union, OECD, United Nations or US government agency / stakeholder (USAID, state department);
 - increases the supply of conflict-free minerals (3TG or other raw minerals) or reduces human rights abuses associated with mineral extraction;
 - has a system of oversight and public reporting; and
 - does not give manufacturer credit for donation, participation or activities by their foundation.

or

b) documentation that the manufacturer sources a defined amount of conflict minerals for any of its products from certified conflict-free sources in the Great Lakes Region of Africa, including:

- name of sourcing program and evidence of manufacturer sourcing from program;
- name of conflict mineral sourced from sourcing program; and
- component and product that the conflict-free mineral is used.

Informative Annex 1

Summary of criteria

Criteria and section		Required or optional	PV modules points	PV inverters points
5	Management of substances			
5.1	List and assessment of substances			
5.1.1	Required – List of declarable substances in product	Required	R	R
5.1.2	Required – List of declarable substances used in manufacturing	Required	R	R
5.1.3	Optional – Disclosure of declarable substances	Optional	1	1
5.1.4	Optional – Database of substances in product	Optional	2	2
5.1.5	Optional – Alternatives assessment	Optional	2	2
5.1.6	Optional – Making alternatives assessment publicly available	Optional	1	1
5.2	Reduction of substances of concern (SVHC)			
5.2.1	Required – Disclosure of substances on the European Union REACH Regulation Candidate List of Substances of Very High Concern (SVHC)	Required	R	R
5.2.2	Optional – Presence of substances on the European Union REACH Regulation Candidate List of Substances of Very High Concern (SVHC)	Optional	1	1
5.2.3	Optional – Bromine, chlorine, and fluorine content in electric cables	Optional	1	1
5.2.4	Optional – Bromine, chlorine, and fluorine content in plastic parts other than electric cables	Optional	1	1
5.2.5	Required – Avoidance or reduction of high global warming potential (GWP) gas emissions	Required	R	R
5.2.6	Required – Conformance with provisions of European Union RoHS Directive (applicable only to PV inverters)	Required (PV inverters only)	R	R
6	Preferable materials use			
6.1	Recycled content			
6.1.1	Required – Declaration of recycled content in product	Required	R	R
6.1.2	Optional – Recycled content in product	Optional	4	4
7	Life cycle assessment (LCA)			
7.1	PV module LCA			
7.1.1	Required – Conducting LCA	Required	R	R
7.1.2	Optional – Public disclosure of LCA results	Optional	1	1
7.1.3	Optional – Public disclosure of LCI inventory data	Optional	2	2
7.2	Reduction in LCA impacts			
7.2.1	Optional – Environmental hot spot identification	Optional	1	1

Criteria and section		Required or optional	PV modules points	PV inverters points
7.2.2	Optional – Environmental leadership compared to industry average (applicable to PV modules only)	Optional PV modules only	2	—
8	Energy efficiency and water use			
8.1	Energy efficiency and management system			
8.1.1	Optional – Energy management system for manufacturing facilities	Optional	2	2
8.1.2	Optional – Certified energy management system	Optional	2	2
8.1.3	Optional – Certified energy management performance improvement	Optional	2	2
8.1.4	Required – Weighted efficiency reporting (applicable only to PV inverters)	Required (PV inverters only)	R	R
8.1.5	Required – Tare loss reporting (applicable only to PV inverters)	Required (PV inverters only)	R	R
8.2	Water use metrics			
8.2.1	Required – Water inventory	Required	R	R
8.2.2	Optional – Quality of wastewater discharges	Optional	1	1
8.2.3	Optional – Improved water use efficiency	Optional	2	2
9	End of life management and design for recycling			
9.1	End-of-life (EOL) management			
9.1.1	Required – Product take-back service and processing requirements (corporate)	Required	R	R
9.1.2	Optional – Publicly available record of annual recycling and recovery achievement (corporate)	Optional	1	1
9.1.3	Optional – Material recovery targets (corporate)	Optional	2	2
9.2	Design for recycling			
9.2.1	Optional – Identification of materials for EOL management (only applicable to PV modules)	Optional (PV modules only)	1	—
9.2.2	Optional – Replacement components availability (applicable only to PV inverters)	Optional (PV inverters only)	—	2
10	Product packaging			
10.1	Eliminate substances of concern			
10.1.1	Required – Elimination of substances of concern in product packaging	Required	R	R
10.1.2	Required – Elimination of chlorine in processing packaging materials	Required	R	R
10.2	Recyclability of packaging			
10.2.1	Required – Enhancing recyclability of packaging materials	Required	R	R

Criteria and section		Required or optional	PV modules points	PV inverters points
10.3	Recycled content in packaging			
10.3.1	Optional – Recycled content paper-based packaging	Optional	1	1
10.3.2	Optional – Postconsumer recycled content plastic in packaging	Optional	1	1
11	Corporate responsibility			
11.1	Environmental, health, and safety management systems			
11.1.1	Required – Environmental management system (EMS) certification	Required	R	R
11.1.2	Required – Manufacturer conformance with occupational health and safety performance (corporate)	Required	R	R
11.2	Corporate reporting			
11.2.1	Required – Reporting on key performance indicators (corporate)	Required	R	R
11.2.2	Optional – Reporting additional key performance indicators (corporate)	Optional	2	2
11.2.3	Optional – Reporting on screening of Tier 1 suppliers (corporate)	Optional	2	2
11.3	Corporate social performance			
11.3.1	Required – Commitment to environmental and social responsibility (corporate)	Required	R	R
11.3.2	Optional – Auditing or certification to social responsibility performance standard (corporate)	Optional	2	2
11.4	Conflict mineral sourcing			
11.4.1	Required – Public disclosure of use of conflict minerals in products (corporate)	Required	R	R
11.4.2	Optional – Conflict mineral sourced only from validated conflict free smelters (corporate)	Optional	1	1
11.4.3	Optional – Participation in in-region conflict-free sourcing program (corporate)	Optional	1	1

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Informative Annex 2

Section 7.1.1 system boundaries

I-2.1 Example flow

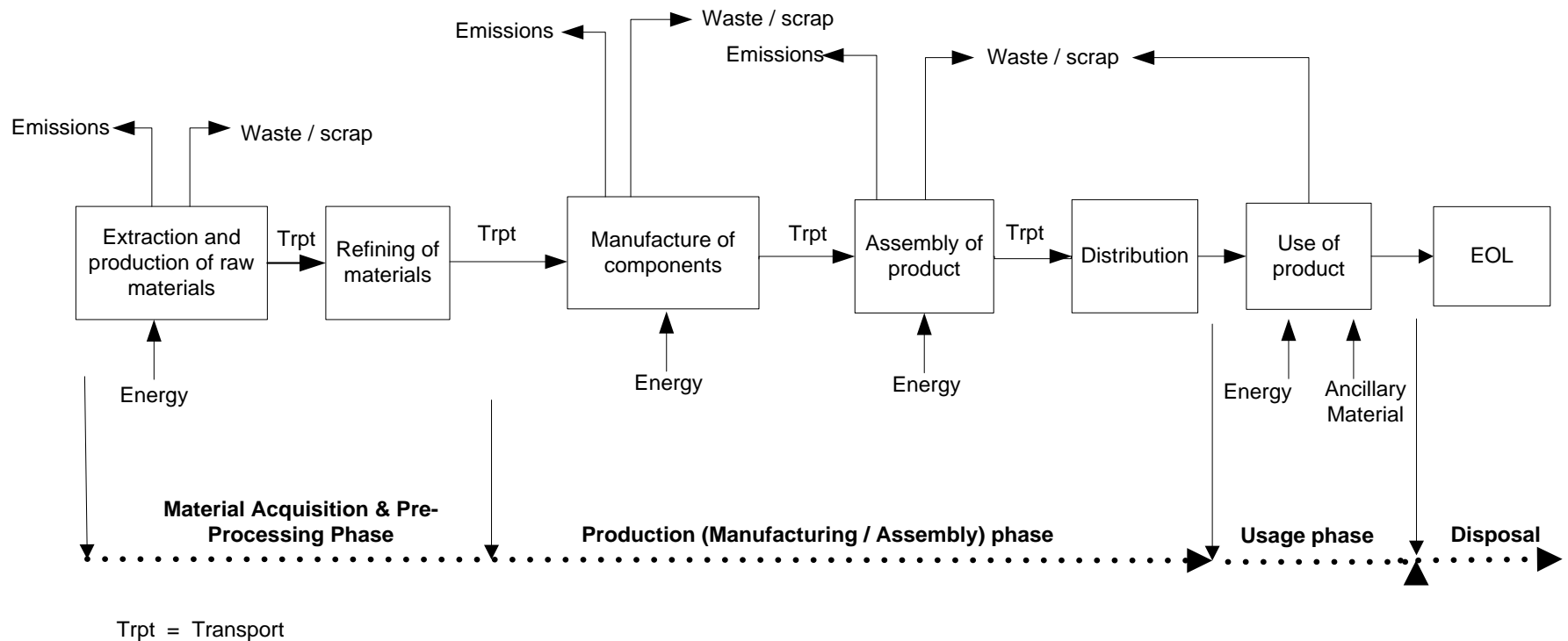


Figure 1
System boundaries, example flow

Standards⁵²

The following Standards established and adopted by NSF as minimum voluntary consensus Standards are used internationally:

Std. #	Standard title
2	Food Equipment
3	Commercial Warewashing Equipment
4	Commercial Cooking, Rethermalization, and Powered Hot Food Holding and Transport Equipment
5	Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
6	Dispensing Freezers
7	Commercial Refrigerators and Freezers
8	Commercial Powered Food Preparation Equipment
12	Automatic Ice Making Equipment
13	Refuse Processors and Processing Systems
14	Plastics Piping System Components and Related Materials
18	Manual Food and Beverage Dispensing Equipment
20	Commercial Bulk Milk Dispensing Equipment
21	Thermoplastic Refuse Containers
24	Plumbing System Components for Recreational Vehicles
25	Vending Machines for Food And Beverages
29	Detergent and Chemical Feeders for Commercial Spray-Type Dishwashing Machines
35	High Pressure Decorative Laminates (HPDL) for Surfacing Food Service Equipment
37	Air Curtains for Entrancesways in Food and Food Service Establishments
40	Residential Wastewater Treatment Systems
41	Non-liquid Saturated Treatment Systems
42	Drinking Water Treatment Units – Aesthetic Effects
44	Residential Cation Exchange Water Softeners
46	Evaluation of Components and Devices Used in Wastewater Treatment Systems
49	Biosafety Cabinetry – Design, Construction, Performance, and Field Certification
50	Equipment for Swimming Pools, Spas, Hot Tubs, and Other Recreational Water Facilities
51	Food Equipment Materials
52	Supplemental Flooring
53	Drinking Water Treatment Units – Health Effects
55	Ultraviolet Microbiological Water Treatment Systems
58	Reverse Osmosis Drinking Water Treatment Systems
59	Mobile Food Carts
60	Drinking Water Treatment Chemicals – Health Effects
61	Drinking Water System Components – Health Effects
62	Drinking Water Distillation Systems
140	Sustainable Carpet Assessment
169	Special Purpose Food Equipment and Devices
170	Glossary of Food Equipment Terminology
173	Dietary Supplements
177	Shower Filtration Systems – Aesthetic Effects

⁵² The information contained in this list of Standards 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 Standards page 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.

Std. #	Standard title
184	Residential Dishwashers
223	Conformity Assessment Requirements for Certification Bodies that Certify Products Pursuant to NSF/ANSI 60 Drinking Water Treatment Chemicals – Health Effects
240	Drainfield Trench Product Sizing for Gravity Dispersal Onsite Wastewater Treatment and Dispersal Systems
244	Drinking Water Treatment Units Supplemental Microbiological Water Treatment Systems – Filtration
245	Wastewater Treatment Systems – Nitrogen Reduction
305	Personal Care Products Containing Organic Ingredients
321	Goldenseal Root (<i>Hydrastis canadensis</i>)
330	Glossary of Drinking Water Treatment Unit Terminology
332	Sustainability Assessment for Resilient Floor Coverings
336	Sustainability Assessment for Commercial Furnishings Fabric
342	Sustainability Assessment for Wallcovering Products
347	Sustainability Assessment for Single-Ply Roofing Membranes
350	Onsite Residential and Commercial Water Reuse Treatment Systems
350-1	Onsite Residential and Commercial Greywater Treatment Systems for Subsurface Discharge
358-1	Polyethylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems
358-2	Polypropylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems
358-3	Cross-linked Polyethylene (PEX) Pipe and Fittings for Water-based Ground-Source (Geothermal) Heat Pump Systems
358-4	Polyethylene of Raised Temperature (PE-RT) Tubing and Fittings for Water-based Ground-Source (Geothermal) Heat Pump Systems
359	Valves for Cross-linked Polyethylene (PEX) Water Distribution Tubing Systems
360	Wastewater Treatment Systems – Field Performance Verification
363	Good Manufacturing Practices (GMP) for Pharmaceutical Excipients
372	Drinking Water Treatment System Components – Lead Content
375	Sustainability Assessment for Water Contact Products
385	Disinfection Mechanics
401	Drinking Water Treatment Units – Emerging Compounds / Incidental Contaminants
416	Sustainability Assessment for Water Treatment Chemical Products
418	Effluent Filters – Field Longevity Testing
419	Public Drinking Water Equipment Performance – Filtration
426	Environmental Leadership and Corporate Social Responsibility Assessment of Servers
455-1	Terminology for the NSF 455 Portfolio of Standards
455-2	Good Manufacturing Practices for Dietary Supplements
455-3	Good Manufacturing Practices for Cosmetics
455-4	Good Manufacturing Practices for Over-the-Counter Drugs
457	Sustainability Leadership Standard for Photovoltaic Modules and Photovoltaic Inverters
600	Health Effects Evaluation and Criteria for Chemicals in Drinking Water
14159-1	Hygiene Requirements for the Design of Meat and Poultry Processing Equipment
14159-2	Hygiene Requirements for the Design of Hand-held Tools Used in Meat and Poultry Processing Equipment
14159-3	Hygiene Requirements for the Design of Mechanical Belt Conveyors Used in Meat and Poultry Processing Equipment



***THE HOPE OF MANKIND rests in the
ability of man to define and seek out
the environment which will permit him
to live with fellow creatures of the
earth, in health, in peace, and in
mutual respect.***