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Solar energy - Solar thermal collectors - Test methods (ISO 9806:2025)

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Énergie solaire - Capteurs solaires thermiques - Méthodes d'essai (ISO 9806:2025)

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European foreword

This document (EN ISO 9806:2025) has been prepared by Technical Committee ISO/TC 180 "Solar energy" in collaboration with Technical Committee CEN/TC 312 “Thermal solar systems and components” the secretariat of which is held by NQIS/ELOT.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2026, and conflicting national standards shall be withdrawn at the latest by April 2026.

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The text of ISO 9806:2025 has been approved by CEN as EN ISO 9806:2025 without any modification.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 180, *Solar energy,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 312, *Thermal solar systems and components,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 9806:2017), which has been technically revised.

The main changes are as follows:

— Subclause 5.2: language used concerning maximum operating conditions is harmonised by introducing the concept of the design operating range;

— description of the testing of tracking collectors, such as parabolic trough collectors and Linear Fresnel collectors, is updated in several places to improve coherence with the standards of IEC/TC 117, *Solar thermal electric plants*;

— Clause 16: new clause is introduced to clarify the procedures for testing collectors with active self-protection mechanisms;

— mathematical model for the thermal performance is simplified; thermal performance parameter a_7 is removed without direct replacement;

— reduced wind speed u' is replaced by u;

— Annex I: new validation procedure (Valicol) introduced to allow verification of the measured thermal performance parameters;

— Introduction: comprehensive statement on the environmental impact of thermal solar collectors and their potential contribution to achieving the United Nations Sustainable Development Goals (SDGs) is added;

— Annex B: gross yield concept is introduced to allow for a standardized rating of the possible energy yield of solar thermal collectors;

— Annex G: material use assessment is now a mandatory part of the final inspection.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

0.1 Solar thermal collectors

According to the International Energy Agency (IEA), heat is the largest end-use of energy, accounting for nearly 50 % of global final energy consumption. This is significantly more than the shares of electricity and transport, which are approximately 20 % and 30 %, respectively. More than 50 % of the total heat consumption is used in industrial processes, with the rest consumed in buildings for space and water heating, and other applications. Furthermore, heat generation is responsible for over 40 % of global energy-related carbon dioxide emissions. This significant contribution to CO_2 emissions is primarily due to the continued reliance on fossil fuels for heat production, with renewable sources meeting less than a quarter of global heat demand.

Solar thermal technologies directly use the sun's energy to produce heat for various applications. Solar thermal technologies are, therefore, key technologies for reducing global carbon dioxide emissions. The core element of any solar thermal system is the solar thermal collector. There are several different types of solar thermal technologies and solar thermal collectors, with typical characteristics and applications such as the following.

— Solar thermal water heaters use solar collectors to heat a fluid to heat water stored in a tank for domestic or commercial use. These systems can be active, using pumps to circulate the fluid, or passive, using natural convection to move the fluid.

— Solar thermal space heating systems use solar collectors to generate heat, which is then transferred to indoor spaces for heating purposes. These systems can use liquids or air as heat transfer fluid.

— Solar thermal process heat systems provide heat for industrial processes such as drying, food processing, pasteurisation, washing, cleaning and all other manufacturing processes at medium temperatures.

— Solar thermal district heating (SDH) uses solar thermal collectors to provide heat to centralised heating systems serving entire neighbourhoods or communities. This approach enables greater efficiency and cost-effectiveness by exploiting economies of scale and maximising the use of solar energy.

— Solar thermal pool heaters use solar collectors to heat water in swimming pools, extending the swimming season and reducing the need for conventional pool heating methods.

Solar thermal applications are also used to power many other technologies, such as solar thermal desalination, solar thermal electricity generation, ground source regeneration or as a source for heat pumps, to name only a few. Solar thermal technologies can be used wherever heat is used, either as a replacement or as a supporting technology to reduce the use of other energy sources.

Various solar thermal collector technologies can be used for the applications listed above. The most common products are given in the list below.

— Flat plate collectors consist of a flat absorber plate with tubes or channels through which a heat transfer fluid flows. These collectors are manufactured with transparent glazing for higher-temperature applications or without for lower-temperature applications.

— Evacuated tube collectors consist of rows of parallel glass tubes, each containing an absorber. The space between the absorber and the outer glass tube is evacuated to reduce heat loss.

— Concentrating collectors, such as parabolic trough collectors or linear Fresnel collectors, use reflectors to concentrate sunlight onto a receiver to achieve higher temperatures.

Some solar thermal collectors combine the generation of heat with the direct generation of electricity, usually by using photovoltaic elements as absorbers.

The heat transfer fluid in solar thermal collectors is usually plain water, water-based antifreeze or air. For some specific applications, other media such as high-temperature oils or evaporating liquids are used.

0.2 Application range of this document

Collectors tested according to this document represent a wide range of applications, e.g. glazed flat plate collectors and evacuated tube collectors for domestic hot water and space heating, collectors for heating swimming pools or other low-temperature systems or tracking concentrating collectors for thermal power generation and process heat applications. This document applies to liquids, air, and heat transfer fluid collectors. Similarly, collectors using external power sources for regular operation and/or safety purposes (overheating protection, environmental hazards, etc.) and co-generating devices generating thermal and electrical power are also considered.

This document defines procedures for testing fluid heating solar collectors for thermal performance, reliability, durability and safety under well-defined and repeatable conditions. It contains outdoor test methods using solar irradiance and natural or simulated wind. as well as indoor procedures using simulated irradiance and simulated wind. Outdoor tests can be performed either as steady-state or as quasi-dynamic measurements.

This document intentionally does not specify any product requirements, as these depend on the intended use and place of installation. Specific local standards, building codes, certification schemes, tax rebates and incentive schemes define applicable requirements as appropriate. This document is intended to provide a solid basis for these schemes with harmonised and reliable product testing.

Climate change is expected to accelerate the degradation of all exposed products, such as also solar thermal collectors, potentially undermining their performance, reliability and safety. Requirements should be re-evaluated and adapted from time to time to future operating conditions to lower degradation rates and the chances of failure using the methods set out in the ISO 14090. This process also ascertains solar thermal collectors' durability, functionality, and safety amidst changing climate patterns and reinforces the commitment to advancing sustainable and adaptable technologies to environmental and climatic shifts.

0.3 Environmental impact of Solar thermal collectors

By providing the tools to assess the materials used in the production of solar thermal collectors and their potential for energy savings and greenhouse gas reductions, this document is aligned with the principles of the ISO 14000 series on environmental management, with the ISO 50000 series on energy management systems and with the ISO 59000 series on circular economy.

The annual yield and the efficiency of converting incoming solar radiation into useful heat can reach more than 80 %, depending on the temperature required and the technology chosen. In fact, the annual energy yield per area is higher with solar thermal collectors than with any other technology. The yield per area is around three times higher than photovoltaic power generation and 50 to 100 times higher than photosynthesis for biomass production. Given the range of products and applications, it is impossible to quantify this technology's greenhouse gas reduction or climate change mitigation potential in general terms. The greenhouse gas reduction potential of a solar thermal collector depends on the environmental conditions and the application in which it is used. It is recommended to make this quantification using the global warming potential (GWP) for each greenhouse gas (GHG) as per Table 7.15 of the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) by aggregating the reduction potential in CO_2 equivalent emissions.[1] Quantification should be made for the whole heating system's lifecycle in analysis, from raw material extraction to end-of-life disposal. It should account for direct (scope 1) and indirect (scope 2 – from electricity, heat, or steam use; scope 3 – all other indirect GHG emissions in the value chain) GHG emissions. Special care should be taken regarding GHG emissions if supplementary external power sources are used, which can lead to indirect GHG emissions that should be considered. Special care should also be taken regarding other GHGs, such as freon-charged solar heating systems, as these systems are associated with the potential release, intentional or unintentional, of fluorinated gases (F-gases). Quantification should first define the baseline GHG emissions associated with a specific system's most commonly used technology (e.g., conventional water heater – natural gas or electric). Comparing the projected GHG emissions of the system when using solar thermal collectors using the methods defined in Annex B with the baseline GHG emissions will give the potential GHG reduction.

Solar thermal collectors are typically made of separable and clean materials such as glass, copper and aluminium, which have a high potential for recycling and reuse. Considering the potential energy yield and the greenhouse gas emissions associated with producing solar thermal collectors, typical carbon and energy payback times are 6 months to 2 years. To further reduce the environmental impact of solar thermal collectors, no material, form of construction, fixture, appurtenance, or items of equipment is employed that can introduce toxic substances, impurities, bacteria, or toxic chemicals into potable water and air circulation systems in quantities sufficient to cause disease or harmful physiological effects. Following circular economy and green procurement principles, all goods and services used in solar thermal collectors, instrumentation, test installation, and facilities should seek to incorporate as much as possible reused and recycled content, make efficient use of energy and materials, promote waste reduction, and the use of renewable energy to minimise overall environmental impact. Adopting a comprehensive eco-design strategy that encapsulates the entire product lifecycle, from material sourcing to end-of-life management, is recommended for the design and production of solar thermal collectors. this approach should include the application of life cycle assessment (LCA) methodologies to systematically evaluate and aim to minimise the environmental impacts associated with all lifecycle stages of solar thermal collectors. Such impacts include but are not limited to greenhouse gas emissions, resource depletion, and energy consumption. Materials and components selected for the construction and testing of solar thermal collectors should be scrutinised for their environmental certifications and performance characteristics. This scrutiny ensures that these materials contribute positively to the collectors' sustainability profile, thus aligning with the broader objectives of climate change mitigation. It is advisable to prioritise materials that offer a balanced compromise between minimising environmental impacts and maintaining or enhancing solar thermal collectors’ performance efficiency, durability, and reparability. This selection process should particularly consider materials with lower embodied carbon, higher recyclability potential, and those that adhere to recognised environmental standards and certifications.

0.4 Supporting the UN Sustainable Development Goals (SDGs)

Achieving the Sustainable Development Goals (SDGs) established by the United Nations in 2015 has become a high priority for society. This document is aligned with the following United Nations Sustainable Development Goals 1, 3, 6, 7, 8, 9, 11, 12, 15 and 17 by promoting and supporting the following.

— Solar thermal collectors and solar thermal technologies to reduce dependence on energy prices to increase the resilience of humanity to climate-related extreme events and other economic, social and environmental shocks and disasters (SDG 1.5).

— Solar thermal collectors and solar thermal technologies for water treatment and disinfection to reduce water-borne diseases (SDG 3.3).

— Solar thermal collectors and solar thermal technologies as a clean and safe energy source to replace other energy sources to significantly reduce the number of deaths and illnesses from hazardous chemicals and polluted air caused by the combustion of fossil fuels (SDG 3.9).

— Solar thermal collectors and solar thermal technologies in water purification and desalination facilities to achieve universal and equitable access to safe and affordable drinking water for all (SDG 6.1).

— Solar thermal collectors and technologies as vital in developing countries' capacity-building programmes for water treatment activities (SDG 6.A).

— Solar thermal collectors to ensure access to affordable, reliable and modern energy for all (SDG 7.1).

— Solar thermal collectors to significantly increase the share of renewable energy for all (SDG 7.2).

— Solar thermal collectors in various applications to increase the overall global energy efficiency (SDG 7.3).

— International cooperation in solar thermal technologies to facilitate access to clean energy research and technology, especially in the fields of renewable energy, energy efficiency and fossil fuel-free technologies, as well as to facilitate investments in solar thermal-based energy infrastructure and clean energy technologies (SDG 7.A).

— Solar thermal collectors to develop infrastructure and technologies for modern and sustainable energy accessible to all in developing countries, particularly, least developed countries, small island developing states and landlocked developing countries, and to provide a sound basis for developing appropriate support programmes (SDG 7.B).

— Solar thermal collectors and solar thermal technologies as well-suited technologies for local production, thereby achieving higher levels of economic productivity through diversification, technological upgrading and innovation, focusing on high value-added and labour-intensive sectors (SDG 8.2).

— Solar thermal collectors and solar thermal technologies as locally manufacturable devices with low requirements for production technologies and financial investments to promote and support productive activities, decent job creation, entrepreneurship, creativity and innovation, and to promote the formalisation and growth of micro, small and medium-sized enterprises, including through access to financial services (SDG 8.3).

— Solar thermal collectors and technologies to progressively improve the global resource efficiency of consumption and production, and to endeavour the decoupling of economic growth from environmental degradation. (SDG 8.4).

— Solar thermal collectors as part of high-quality, reliable, sustainable and resilient infrastructure, thereby supporting economic development and human well-being with a focus on affordable and equitable access for all (SDG 9.1).

— Solar thermal collectors to contribute to inclusive and sustainable industrialisation and to significantly increase the industry's share of employment and gross domestic product, particularly in least-developed countries, according to national circumstances (SDG 9.2).

— Solar thermal collectors as a cost-effective means to increase the availability of energy and the predictability of energy costs by reducing dependence on fossil energy, thereby to facilitating the access of small industrial and other enterprises, particularly in developing countries, to financial services, including affordable credit, and to integrate these industries into value chains and markets (SDG 9.3).

— Solar thermal collectors to upgrade infrastructure and retrofit industries to make them sustainable, with increased efficiency in resource use and greater adoption of clean and environmentally sound technologies and industrial processes (SDG 9.4).

— Scientific research and technological capacity building in solar thermal technologies in all countries, particularly developing countries, including the promotion of innovation, research and development activities (SDG 9.5).

— Solar thermal collectors and solar thermal technologies to facilitate sustainable and resilient infrastructure development in developing countries and to provide financial, technological and technical assistance to African countries, least developed countries, landlocked developing countries and small island developing states (SDG 9.A).

— Solar thermal collectors as a way to enhance domestic technology development, research and innovation in developing countries. In addition, this document supports the development of an enabling policy environment for solar thermal technologies for industrial diversification and commodity value addition (SDG 9.B).

— Solar thermal collectors for fossil and biomass-free production of heat and hot water to reduce the adverse per capita environmental impact of cities and, in particular, by contributing to better air quality (SDG 11.6).

— Solar thermal collectors as an element of sustainable and resilient buildings, using local materials and local production capacity (SDG 11.C).

— Solar thermal collectors for local and affordable thermal food processing to reduce global food waste and food losses along production and supply chains, including post-harvest losses (SDG 12.3).

— Solar thermal collectors as a product that significantly reduces waste generation through its repairable designs and material reduction, by using recycled materials and reused components (SDG 12.5).

— Solar thermal collectors and solar thermal technologies to encourage companies to adopt sustainable practices and integrate sustainability information into their reporting cycles (SDG 12.6).

— Solar thermal collectors and solar thermal technologies as locally manufactured technologies, using mainly recycled materials, as part of sustainable public procurement practices (SDG 12.7).

- Solar thermal collectors and solar thermal technologies to strengthen the technological capacity to move towards more sustainable patterns of consumption and production, not only in developing countries (SDG 12.A).
- Subsidy schemes for solar thermal collectors, and thus also the reduction and phasing out of inefficient fossil fuel subsidies, especially in developing countries, and minimising adverse impacts on their development in a manner that protects the poor and affected communities (SDG 12.C).
- Solar thermal collectors and solar thermal technologies to reduce the overuse of biomass for heat generation, thereby also supporting the implementation of sustainable management of all types of forests, halting deforestation and even enabling afforestation and reforestation worldwide (SDG 15.2).
- The transfer of expertise, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms (SDG 17.7).

Solar energy — Solar thermal collectors — Test methods

1 Scope

This document specifies test methods for assessing the durability, reliability, safety and thermal performance of fluid heating solar collectors. The test methods are applicable for laboratory testing and for in situ testing.

This document is applicable to all types of fluid heating solar collectors, air heating solar collectors, hybrid solar collectors co-generating heat and electric power, as well as to solar collectors using external power sources for normal operation and/or safety purposes. This document does not address electrical safety aspects or other specific properties directly related to electric power generation.

This document is not applicable to devices in which a thermal storage unit is an integral part to such an extent that the collection process cannot be separated from the storage process for making the collector thermal performance measurements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9459-4, *Solar heating — Domestic water heating systems — Part 4: System performance characterization by means of component tests and computer simulation*

ISO 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 9488, *Solar energy — Vocabulary*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC/TS 62862-1-1, *Solar thermal electric plants - Part 1-1: Terminology*

IEC 62862-3-2:2018, *Solar thermal electric plants - Part 3-2: Systems and components - General requirements and test methods for large-size parabolic-trough collectors*

IEC 62862-5-2:2022, *Solar thermal electric plants - Part 5-2: Systems and components - General requirements and test methods for large-size linear Fresnel collectors*

IEC 62817:2014, *Photovoltaic systems - Design qualification of solar trackers*

EN 442-2, *Radiators and convectors – Part 2: Test methods and rating*