

LATEST DEVELOPMENTS IN SOLAR THERMAL TECHNOLOGY: EUROPEAN STANDARDIZATION AND CERTIFICATION

Summary

Solar thermal technologies constitute a key renewable solution for decarbonising the heating and cooling sector in Europe. This work presents a comprehensive update on recent developments in European standardization, certification schemes, and regulatory frameworks relevant to solar thermal technologies. Particular focus is given to the activities of the European Committee for Standardization (CEN), especially within CEN/TC 312 responsible for solar thermal systems and components. Recent revisions and updates of European standards related to performance testing, durability assessment, and terminology are analysed in order to highlight their implications for manufacturers, certification bodies, and market stakeholders. The evolution of the Solar Keymark certification scheme is also reviewed, including trends in certified products and the role of certification in ensuring product reliability and facilitating market access. In parallel, recent policy developments affecting solar thermal technologies are discussed, including updates to the EU energy labelling framework, Ecodesign Legislation, and the revised Energy Performance of Buildings Directive (EPBD). Emerging challenges for future standardization are identified, including hybrid renewable energy systems, smart control integration, lifecycle environmental performance assessment, and circular economy aspects such as recyclability and material reuse. In addition, the interaction between standardisation activities and research and innovation (R&I) initiatives is increasingly important. European R&I programmes contribute to the development of new solar thermal technologies and concepts, which in turn require updated or new standardisation frameworks. In this context, initiatives such as the Implementation Plan for non-concentrated solar thermal technologies under the SET-Plan STT-IWG (Solar Thermal Technologies Implementation Working Group) provide relevant guidance for aligning research priorities with standardisation needs and market uptake.

The analysis highlights the importance of coordinated standardization, certification, and policy frameworks to support the large-scale deployment of solar thermal technologies within Europe's energy transition.

Keywords: Solar thermal systems, standardization, certification, legislation

Field of application for the findings: Renewable heating and cooling systems, solar thermal product certification, energy policy implementation, and market development.

Addressed audience: Researchers, solar thermal manufacturers, certification bodies, standardization experts, policymakers, and stakeholders involved in renewable heating and cooling technologies.

1. Introduction

The heating and cooling sector accounts for nearly half of the final energy consumption in Europe and represents a critical area for achieving climate neutrality targets. The decarbonisation of this sector requires the accelerated deployment of renewable heating and cooling technologies, among which solar thermal systems play a prominent role. Solar thermal technologies provide sustainable solutions for domestic hot water production, space heating, district heating networks, and industrial process heat.

In addition to technological development, the successful deployment of solar thermal systems relies heavily on robust technical standards, reliable certification mechanisms, and supportive policy frameworks. Standardization establishes common technical specifications and testing methodologies that ensure product quality, safety, and performance transparency across the European market. Certification schemes translate

these technical requirements into verifiable quality marks, enhancing consumer confidence and facilitating market access for manufacturers.

Within the European standardization system, the Technical Committee CEN/TC 312 is responsible for the development of standards covering solar thermal systems and components. These standards address terminology, performance evaluation, durability testing, and conformity assessment procedures. At the same time, the Solar Keymark certification scheme has become the most recognized voluntary certification mark for solar thermal products in Europe.

The objective of this paper is to provide an updated overview of recent developments in solar thermal standardization and certification, and to analyse how these developments interact with evolving European regulatory frameworks. In addition, the paper identifies emerging needs for future standardization in response to technological innovation and the evolving requirements of the European energy transition.

2. Recent developments in solar thermal standardization

Standardization plays a fundamental role in ensuring the technical reliability and interoperability of solar thermal systems within the European internal market. The work carried out within CEN/TC 312 covers a broad range of aspects including terminology, performance testing, durability assessment, safety requirements, and conformity evaluation procedures.

Recent updates of European standards reflect both technological advancements and the need for greater harmonization with international standardization activities. The revised standards introduce improved testing methodologies for evaluating the thermal performance of solar collectors and systems under realistic operating conditions. These improvements contribute to more accurate performance characterization and facilitate the comparison of different technologies. In addition, updated standards incorporate improved durability testing procedures aimed at evaluating long-term system reliability. Durability tests address environmental stresses such as thermal cycling, mechanical loads, and weather exposure, which are critical factors influencing the lifetime performance of solar collectors and components. Another important development concerns the alignment of European standards with international standards developed within ISO frameworks. This harmonization contributes to reducing technical barriers to trade and supports the global competitiveness of European solar thermal technologies.

Standardization activities are also increasingly addressing new technological concepts such as hybrid photovoltaic-thermal collectors, integrated solar heating systems, and advanced control strategies. As solar thermal systems become more integrated within broader renewable energy systems, standards must evolve to reflect system-level interactions and operational complexity.

3. Solar thermal certification and the Solar Keymark scheme

Certification schemes represent an essential instrument for demonstrating compliance with technical standards and ensuring product reliability. In the European solar thermal sector, the Solar Keymark certification scheme has established itself as the most widely recognized voluntary certification mark for solar thermal products. The Solar Keymark confirms that certified products comply with relevant European standards and fulfil additional quality assurance requirements verified through independent testing and factory inspections. Certification is typically based on performance testing conducted in accredited laboratories, combined with regular surveillance of manufacturing processes.

Over the past decade, the Solar Keymark scheme has contributed significantly to improving product transparency and quality assurance in the solar thermal market. The number of certified products has increased steadily, reflecting both technological innovation and the growing importance of certification for market credibility.

For manufacturers, Solar Keymark certification provides a recognized proof of compliance that facilitates product acceptance across different European markets. In several countries, certification is also linked to financial incentive schemes or public procurement requirements, further reinforcing its importance within the solar thermal value chain.

The certification scheme continues to evolve in response to new technological developments and regulatory requirements. Future adaptations are expected to address integrated renewable systems, advanced collector technologies, and enhanced performance evaluation criteria.

4. Regulatory and policy developments influencing solar thermal technologies

The regulatory framework of the European Union plays a decisive role in shaping the market environment for solar thermal technologies. Several policy instruments influence the development, certification, and deployment of solar thermal systems. The EU Energy Labelling and Ecodesign Legislation aims to improve the energy efficiency of energy-related products placed on the European market. Energy labels provide clear and comparable information about product performance, allowing consumers to make informed decisions and encouraging manufacturers to improve product efficiency. Another key policy instrument is the Energy Performance of Buildings Directive (EPBD), which establishes requirements for improving the energy performance of buildings and promotes the integration of renewable energy systems. The recent revision of the EPBD further strengthens the role of renewable heating technologies by encouraging the deployment of sustainable heating solutions in both new buildings and renovation projects.

New legislation such as the Net-Zero Industry Act (NZIA) and the Construction Products Regulation (CPR) introduces additional requirements related to EU-made criteria, safety aspects (e.g. fire resistance), durability, and performance. These developments call for updated standards that address evolving safety and performance needs. In this context, certification schemes such as Solar Keymark can support manufacturers by providing harmonised and independently verified evidence of compliance, thereby reducing administrative burden, even in cases where self-declaration is required.

The interaction between technical standards, certification schemes, and regulatory frameworks creates a comprehensive governance structure that supports the reliability, transparency, and market acceptance of solar thermal technologies.

5. Future perspectives and standardization challenges

The solar thermal sector is undergoing a period of technological transformation driven by the broader transition towards integrated and digitalised energy systems. As a result, new challenges and opportunities are emerging for standardization and certification activities.

One of the most significant trends is the increasing integration of solar thermal systems within hybrid renewable energy systems. Such systems may combine solar thermal collectors with heat pumps, photovoltaic modules, or thermal storage technologies..

Another important development concerns the growing use of intelligent control systems and digital monitoring technologies. Smart controllers allow for improved system optimisation, predictive maintenance, and interaction with building energy management systems. Future standardization efforts may therefore need to address issues related to communication protocols, data exchange, and interoperability.

Environmental sustainability considerations are also becoming increasingly important. Future standards may incorporate indicators related to lifecycle environmental performance, greenhouse gas emissions, and the recyclability of materials used in solar thermal components.

Finally, the transition towards a circular economy introduces new requirements related to material durability, repairability, and resource efficiency. Standardization activities will need to address these aspects in order to ensure that solar thermal technologies contribute effectively to the broader sustainability objectives of the European energy system.