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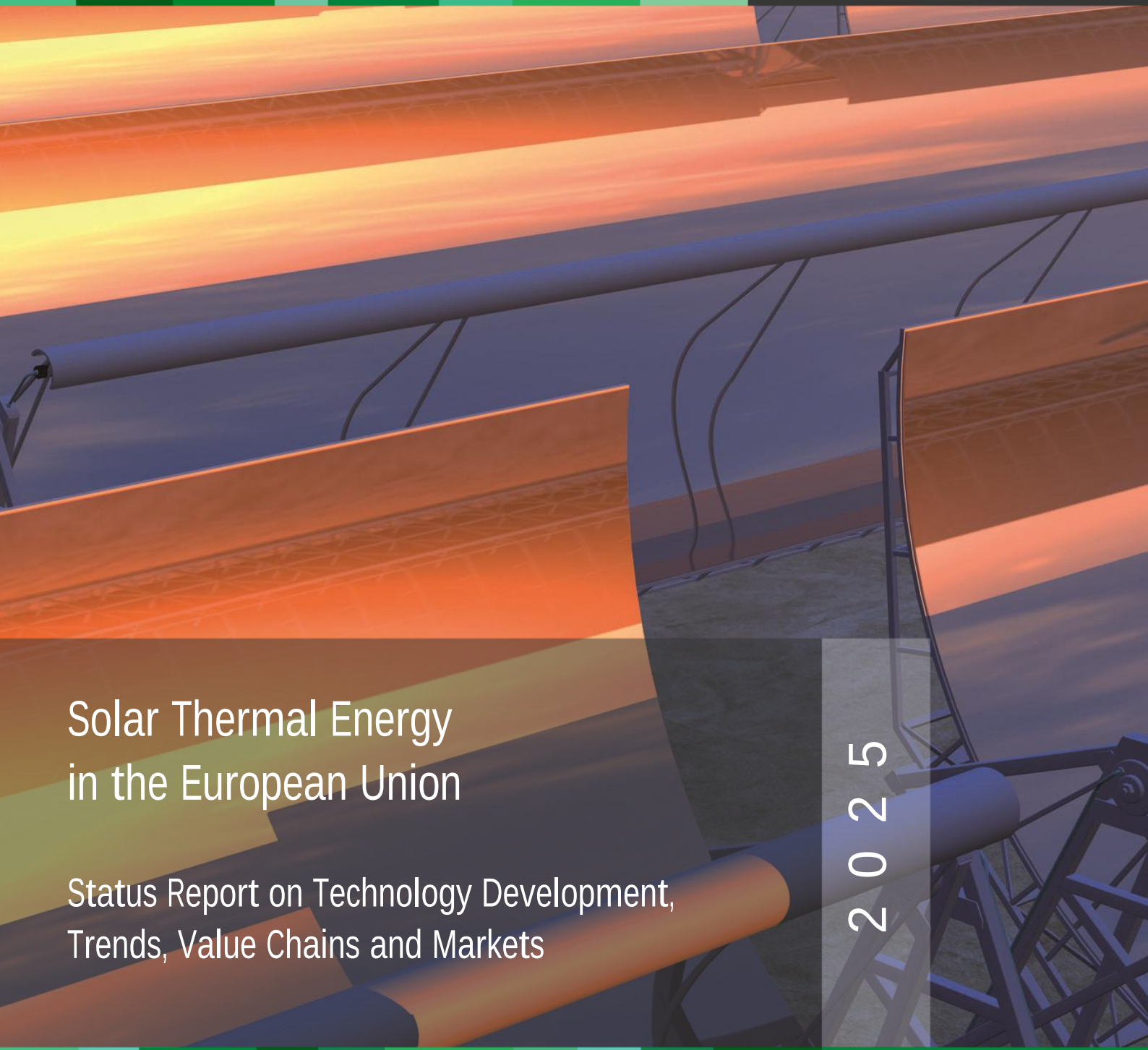

Solar Thermal Energy in the European Union

Status Report on Technology Development, Trends, Value Chains and Markets

2025

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Contents

Abstract

This is the 2025 update of the Clean Energy Technology Observatory report on trends in the development of solar thermal energy, including concentrated solar power (CSP) and solar heat for buildings, district heating, and industrial processes. Operational CSP plants now account for 7.6 GW of capacity worldwide. CSP remains a niche power generation technology, albeit with potential to play a significant role in supporting grids with high proportions of variable renewable energy. China has become the leading developer of CSP systems, thanks to a steady project pipeline. Solar thermal technologies for heating and cooling reached a global installed capacity of 544 GW at the end of 2024, covering 777 million m^2. The EU accounted for 7.5% of global capacity, with more than 3 000 MW_{th} of manufacturing capacity. Extra-EU exports of solar water heaters continue to grow. In 2024, the extra-EU trade surplus was estimated at EUR 16 million, with seven Member States among the top 10 exporters of solar water heaters worldwide. France is the second largest exporter in the world, at around EUR 170 million.

Foreword on the Clean Energy Technology Observatory

The European Commission set up the Clean Energy Technology Observatory (CETO) in 2022 to help address the complexity and multi-faced character of the transition to a climate-neutral society in Europe. The EU's ambitious energy and climate policies create a necessity to tackle the related challenges in a comprehensive manner, recognising the important role for advanced technologies and innovation in the process.

CETO is a joint initiative of the European Commission's Joint Research Centre (JRC), which runs the observatory, and Directorate Generals Research and Innovation (R&I) and Energy (ENER) on the policy side. Its overall objectives are to:

- monitor the EU research and innovation activities on clean energy technologies needed for the delivery of the European Green Deal
- assess the competitiveness of the EU clean energy sector and its positioning in the global energy market
- build on existing Commission studies, relevant information & knowledge in Commission services and agencies, and the Low Carbon Energy Observatory (2015-2020)
- publish reports on the Strategic Energy Technology Plan (SET Plan) SETIS online platform

CETO provides a repository of techno- and socio-economic data on the most relevant technologies and their integration in the energy system. It targets in particular the status and outlook for innovative solutions as well as the sustainable market uptake of both mature and inventive technologies. The project serves as primary source of data for the Commission's annual progress reports on competitiveness of clean energy technologies. It also supports the implementation and development of EU research and innovation policy.

The observatory produces a series of annual reports addressing the following themes:

- Clean Energy Technology Status, Value Chains and Market: covering advanced biofuels, batteries, bioenergy, carbon capture utilisation and storage, concentrated solar power and heat, geothermal heat and power, heat pumps, hydropower & pumped hydropower storage, novel electricity and heat storage technologies, ocean energy, photovoltaics, renewable fuels of non-biological origin (other), renewable hydrogen, solar fuels and wind.
- Clean Energy Technology System Integration: building-related technologies, digital infrastructure for smart energy system, industrial and district heat & cold management, standalone systems, transmission and distribution technologies, smart cities and innovative energy carriers and supply for transport.
- Foresight Analysis for Future Clean Energy Technologies using Weak Signal Analysis
- Clean Energy Outlooks: Analysis and Critical Review
- System Modelling for Clean Energy Technology Scenarios
- Overall Strategic Analysis of Clean Energy Technology Sector

More details are available on the CETO web pages

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Executive summary

This report is part of an annual series produced under the auspices of the Clean Energy Technology Observatory (CETO). It covers both concentrated solar power (CSP) and solar thermal energy dedicated to heating and cooling for buildings, district heating, and heat for industrial processes (SHIP).

EU Objectives and Challenges / Policy context

The 2022 EU Solar Energy Strategy recognises the contribution of CSP, but the technology faces limited growth in the EU power sector due to cost and location constraints. On the other hand, it has the potential to complement photovoltaics and wind power by supporting grid stability, thanks to largescale thermal energy storage and the inertia services it can provide.

Solar thermal for heating and cooling is expected to contribute to the decarbonisation and energy security of the EU. In terms of the EU policy framework, it is specifically relevant to the Renewable Energy Directive, the Climate Law, the Affordable Energy Action Plan, the Net-Zero Industry Act (NZIA), the Energy Performance of Buildings Directive (EPBD), the Clean Industrial Deal, the Affordable Energy Action Plan, and the upcoming Heating and Cooling strategy[1].

Technology Status

The current CSP capacity of 2.33 GW covers approximately 0.2% of total EU electricity generation, with no significant growth observed over the last decade. The revised National Energy and Climate Plans (NECPs) of the Member States foresee a doubling of this capacity by 2030, but little progress has been made to date. The EU has funded 74 CSP projects (2014-2025) with EUR 246 million, with a focus on Spain, Germany, and Italy. Globally, however, China now leads in patents and is second in scientific publications. SET Plan activities target cost reduction, a first-of-a-kind (FOAK) demonstrator, next-generation technology, and economically produced hydrogen and synthetic fuels by 2030.

In 2024, the EU's installed capacity of solar thermal heat reached 41.7 GW_{th}, representing 7.5% of the worldwide total. Taking into account the theoretical lifetime of this equipment, 2024 marked the first statistical decline in installed solar thermal capacity worldwide. However, certain subsectors, such as solar thermal for district heating, are still growing. There are 346 systems currently installed, accounting for 1 982 MW_{th} and 2.8 million square meters. The largest EU system installed last year is in Groningen (Netherlands), with a capacity of 34 MW_{th}.

Investment and Funding

At the global level, there is no reliable IEA data on public R&I investments in solar thermal, as these are mostly reported as "unallocated" for the solar sector, without disaggregation by technology area (e.g., PV, CSP, and solar thermal for heating and cooling).

Solar thermal technologies for heating and cooling experienced a global rise in private investment in 2024, surpassing EUR 70 million according to Pitchbook. However, the EU's share is minimal. Over the last decades, public investments in the EU have declined by more than 50%.

[1] Planned to be adopted Q1 2026, and solar thermal is already explicitly mentioned in the call for evidence

Value Chain

For CSP, EU companies maintain technology expertise across the supply chain and claim substantial manufacturing capacity for all the primarily used components identified under NZIA, although quantitative data is limited. However, in the absence of a new project pipeline, the industry has shifted its interest to concentrated solar thermal applications for industrial process heat. International CSP development is now mainly happening in China, with Chinese companies serving as the primary technology suppliers.

The global turnover for solar thermal technologies was estimated at EUR 13.9 billion in 2023. Solar Heat Europe reported a turnover of EUR 1.79 billion for the EU, the United Kingdom, and Switzerland together. The 2025 IEA Solar Heat Worldwide report estimated that 318 000 jobs are attributed to solar thermal technologies. In 2024, the EU production value for non-electric water heaters (including solar thermal) declined by 37% from 2023, resulting in a decrease of approximately EUR 1.2 billion.

EU Positioning and Global Competitiveness

The EU has just under one-third of global CSP capacity, thanks to the plants installed over the past decade. However, all the more recent installations are located in China, which has emerged as a worldwide leader for CSP deployment and technology supply.

In 2024, 5% (923 MW_{th}) of the solar thermal technologies deployed globally for heating and cooling were in the EU. EU exports represented 11% of the global total, while China was the leading exporter with a 46% share. That year, the EU's trade surplus was EUR 16 million in this sector.

Concerning the EU's manufacturing capacity and the NZIA benchmarks, the situation is as follows.

- For CSP, EU companies claim to have manufacturing capabilities for the main primarily used components (reflectors, trackers, and their mounting structures and receivers), but there is no quantitative data on production locations and capacities. For the molten salts used for thermal energy storage systems (which are primarily used components under the category of thermal energy storage technology in NZIA), the EU is estimated to have a capacity of 13-27% of its projected annual deployment needs in 2030 (assuming approximately 300 MW_{el}/y of installations).
- For solar thermal heating and cooling, the NZIA regulation specifies the following primarily used components: flat-plate collectors, evacuated tube collectors, PVT collectors, concentrating systems, air collectors, absorbers, and trackers. A survey of manufacturers conducted in collaboration with Solar Heat Europe indicated that the EU's manufacturing capacity currently exceeds market demand (in fact, the EU is a net exporter of this technology). Therefore, the NZIA benchmark for 2030, of manufacturing 40% of deployment needs, should be easily met.

SWOT Analysis

Table 1. CETO SWOT analysis for the EU competitiveness for CSP

Strengths	Weaknesses
– Dispatchable power, based on largescale thermal storage, also offering inertia services – Good operational record in the EU. – Strong EU industrial expertise and R&D – Little use of critical raw materials – High circularity potential	– High CAPEX – Lack of standardised designs – Restricted scalability due to a limited range of suitable sites in the EU
Opportunities	**Threats**
– Growing demand for renewable electricity and associated system support services – Diversification to industrial process heat and supporting desalination – Cost reduction with modular design and manufacturing and digitisation – Next-generation designs with higher temperatures and higher efficiencies –	– Competition from low-cost PV plus largescale battery storage – International competition for manufacturing, plant development and for R&I

Source: JRC own e*laboration*, *2025.*

Table 2. CETO SWOT analysis for the competitiveness of solar thermal heating and cooling

Strengths	Weaknesses
– Well-established, mature technology – Strong EU manufacturing base – Supported by the EU Solar Energy Strategy, in particular the Energy Performance of Buildings Directive requirements – No use of critical raw materials and good circularity potential	– Cost competitiveness is strongly dependent on the price of fossil fuels – Not a standalone solution and requires integration with other heating or cooling technologies to meet demand at certain times
Opportunities	**Threat**
– EU policy targets to decarbonise the heating (and cooling) sector – Potential of concentrated solar to supply the high temperatures required by many industrial processes – Potential for more use in District Heating and Cooling networks	– Competition from heat pump systems – Low-cost imported solar heating and cooling systems

Source: JRC own e*laboration*, *2025.*

1. Introduction

1.1 Scope and Context

This report on solar thermal energy is part of the annual series of reports of the Clean Energy Technology Observatory (CETO). It updates the 2024 CETO report[2] regarding solar thermal energy technology maturity status, development and trends, value chain analysis, and global market and EU positioning. The EU has set ambitious targets for renewable energy and carbon neutrality, and solar thermal energy is expected to contribute to their achievement. The technology is also well placed to contribute to the objectives of other EU measures, notably the Affordable Energy Action Plan, the Net-Zero Industry Act (NZIA), the Energy Performance of Buildings Directive and the Clean Industrial Deal.

1.1. Methodology and Data Sources

The report is organised into two main chapters. The first is dedicated to CSP (Chapter 2), while the second covers solar thermal for heating and cooling (Chapter 3). Both have the same structure following the CETO model.

Subchapter 1 of each examines the state of the art and future developments in solar thermal energy, focusing on advancements in technology readiness, energy capacity, costs, and research funding. Subchapter 2 focuses on the value chain analysis, covering economic contributions, sustainability, and the role of EU companies in the market. Subchapter 3 provides an overview of the EU's global position and competitiveness in the solar thermal industry, analysing market status, trade dynamics, and resource efficiency. Chapter 4 concludes the report by synthesising key findings and highlighting strategic opportunities and challenges.

The report uses a range of information sources:

- Eurostat data;
- existing studies and reviews published by the European Commission and international organisations;
- information from EU-funded research projects;
- EU and international databases;
- EU trade data, trade reports, market research reports and others;
- JRC own review and data compilation; and
- stakeholder input.

Details of specific sources can be found in the corresponding sections and Annex 1 provides a summary of the indicators for each aspect, together with the main data sources.

[2] https://publications.jrc.ec.europa.eu/repository/handle/JRC139446

2. Concentrated Solar Power

2.1. Technology status and development trends

2.1.1. Technology Overview

The 2024 CETO report for solar thermal [1] provides an overall description of concentrated solar power (CSP) technology and recent developments.

CSP technologies are deployed to a limited extent at commercial scale. The two major designs are parabolic trough power plants (line-focus technology) and central receiver (also called power tower) plants. CSP plants require high levels of steady, direct normal irradiation (DNI > 1900 kWh/m^2/year), which limits potential locations; in Europe, only southernmost areas offer suitable conditions for CSP.

In Europe, attention is increasingly focused on the use of concentrated solar thermal for industrial process heat due the lack of growth in the power sector. In the framework of the EU's SET Plan, the implementation working group on concentrated solar thermal includes both power generation and thermal energy for industrial process applications.

2.1.2. Technology readiness level

The SET Plan Implementation Working Group produced a comprehensive assessment [2] of the TRL levels for the main R&D themes relevant to CSP (and for concentrated solar thermal for industrial processes). Table 3 summarises this data, which reflects the situation in 2023.

2.1.3. Installed energy capacity and production/generation

The worldwide installed capacity of CSP plants is estimated at 7.6 GW at the end of 2024 [3]. All the recent installations are in China, which has emerged as the global leader for CSP deployment and technology supply. China also dominates the pipeline for projects under construction or planned, with estimates ranging from 4.3. [4] to 7.6 GW (SolarPACES conference 2025).

The EU has a CSP capacity of 2.33 GW [5] with a gross[3] annual production of approximately 5 TWh (Figure 1). This is approximately 0.2% of total EU electricity generation. Almost all the commercial capacity is in Spain, where 45 plants were installed in the period 2009-2013. No major new plants have entered into commercial operation since then. The Solgest-1 110 MW plant in Seville is in the pre-construction phase. Italy has a small 4 MW plant under construction in Sicily.

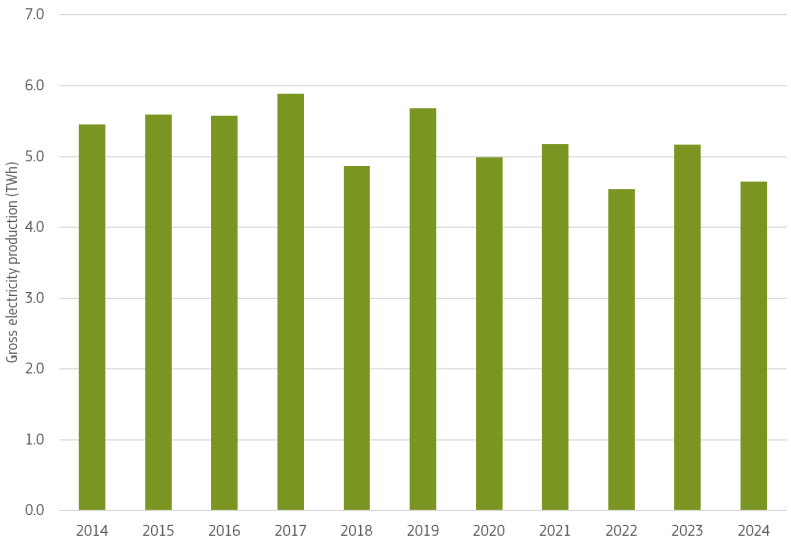
[3] Net generation from geothermal is approximately 10% lower than gross production, based on analysis of Eurostat data over the last decade i.e. an amount corresponding to 10% of total generation is used for the plant operation.

Table 3. Technology readiness of CSP technology and the priority areas in the 2023 SET Plan Implementation Plan for concentrated solar thermal.

Sub-Technology	Technology Readiness Level. 2023									Notes
	1	2	3	4	5	6	7	8	9	
1. Line-focus solar technology									■	
R&I for molten salts systems					■					
Collector fields with silicone oil as HTF						■	■			
2. Central Receiver (CR) plants									■	
Improvement of molten-salt technology										Not reported
Innovation molten-salt technology										Not reported
Particle receiver technology					■					
3. Thermal energy storage systems									■	
Single molten salt thermocline					■					
Next generation TES technologies				■						
4. Turbo-machinery									■	
Turbines for advanced CSP			■	■	■	■	■	■		
Turbo-machinery for supercritical CO2 cycles										Not reported

Source: SET Plan Implementation Working Group, 2023 [2].

Figure 1. CSP gross electricity production in the EU (production is entirely in Spain). NB the 2024 value is estimated from monthly net production data.



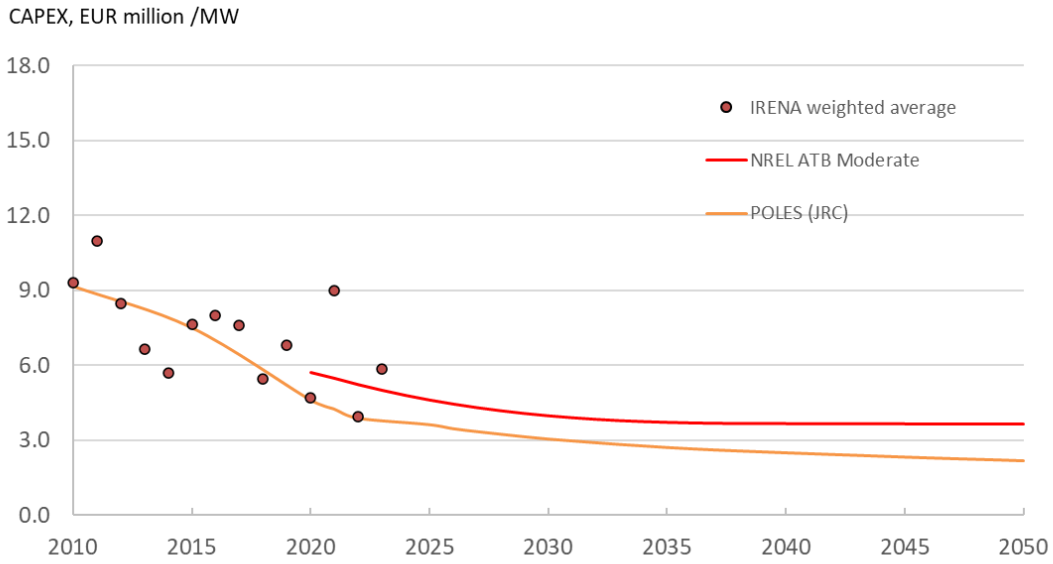
Source: JRC elaboration of Eurostat data: NRG_BAL_PEH, RA410.

2.1.4. Technology costs

Figure 2 shows the evolution in CAPEX for large CSP plants for the period 2010 to 2050. IRENA [3] reports a reduction of 40% in CAPEX over the 2010 to 2023 period (albeit with significant variations in any given year). CAPEX is currently just under EUR 6 million/MW for a commercial-scale solar tower plant (>50 MW, at least 8 hours of thermal storage).

IRENA also notes that LCoE dropped considerably in the same period, reaching a weighted average of 84 EUR/MWh in 2024. N.B. the LCOE metric does not necessarily reflect the market value of CSP electricity sold to cover load outside daylight hours.

Figure 2. Historic and future CAPEX trends for CSP plants.



Source: JRC elaboration based on POLES-JRC [6], IRENA [3] and NREL ATB [7] data.

2.1.5. Public RD&I funding

At global level there is no reliable data on public R&I investments for concentrated solar. Although the IEA collects data on solar energy R&D annually from its members [8], over 50% of the declared budgets are reported as “unallocated”, without disaggregation to the various technology areas.

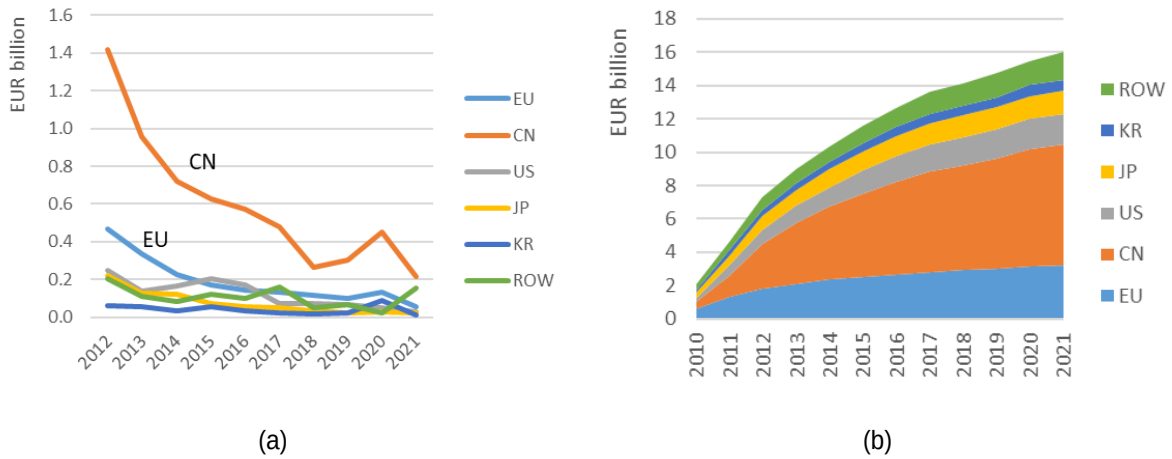
Horizon Europe (2021-present) has contributed to 18 research projects so far, with a total budget of EUR 60 million. Previously, under Horizon 2020 (2014-2020), the EU supported 56 CSP and CSH-related projects with a contribution of approximately EUR 186 million. Spain, Germany, Italy and France were the main beneficiaries. The total budget for these projects was more than EUR 200 million.

2.1.6. Private RD&I funding

2.1.6.1. Overall private R&I investments based on patents

Estimates of private R&I investments from analysis of the PATSTAT 2024b dataset show an overall decrease in such investments in the major economies for the last decade (Figure 3).

Figure 3. Trends in annual R&D investments for the EU and major economies based on patenting data (2021 data is incomplete).



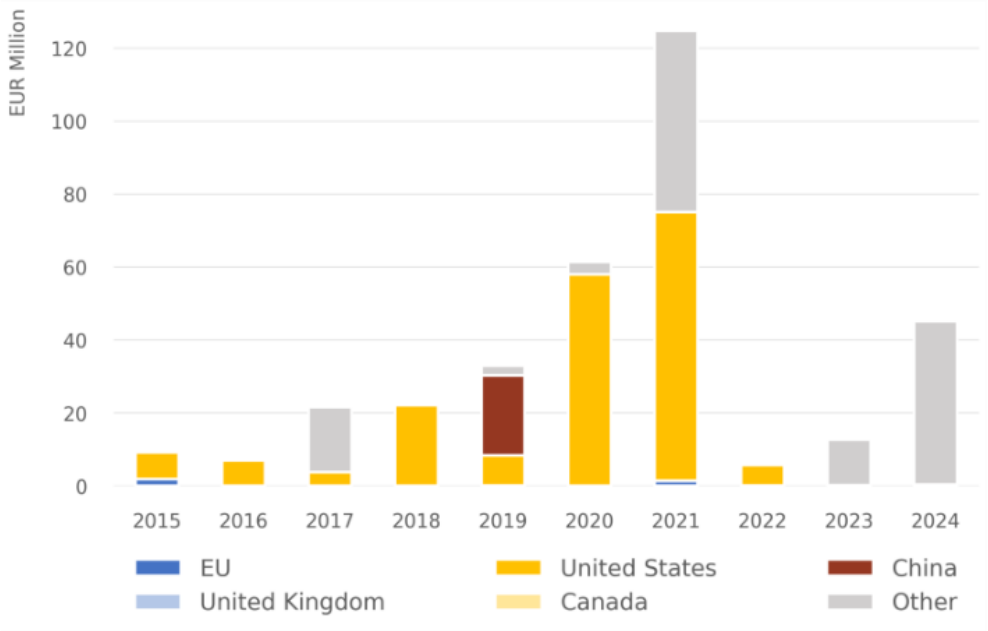
(a) (b)

Source: JRC 2025 analysis of PATSTAT 2024b dataset.

2.1.6.2. Venture capital investment

For venture capital investments, Figure 4 shows the update of the 2024 analysis. Global VC investment reached EUR 45 million in 2024 (x3.5 increase compared to 2023, but well below the amounts seen earlier in this decade). Two Australian companies account for the main deals seen in 2024: Raygen (EUR 30 million) and FPR Energy (EUR 14 million), and for more than 2/3 of the VC investment total seen since 2022. Those deals however remain smaller than the amount captured by the US company Heliogen (EUR 125 million in 2020 and 2021) responsible for the peak of investment seen in 2020 and 2021.

Figure 4. Trends in global venture capital and private equity investment by region (all deal types).

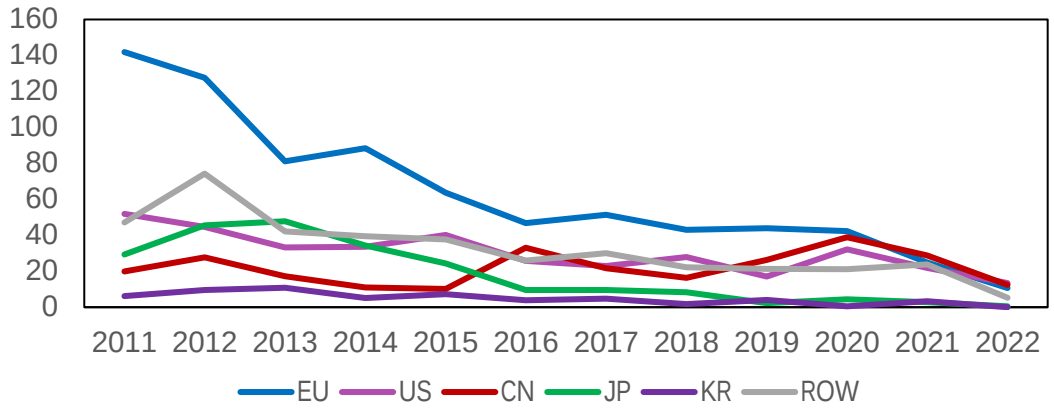


Source: 2025 JRC analysis based on Pitchbook data.

2.1.7. Patenting trends

Globally, inventions[4] per year fell from a peak of 1 628 in 2012 to 665 in 2022[5]. The EU and China are dominant in terms of overall numbers, and they are now also leaders for high-value inventions (Figure 5).

Figure 5. High-value inventions for CSP from 2011 to 2022 (2022 data incomplete).



Source: JRC based on EPO PATSTAT 2024b.

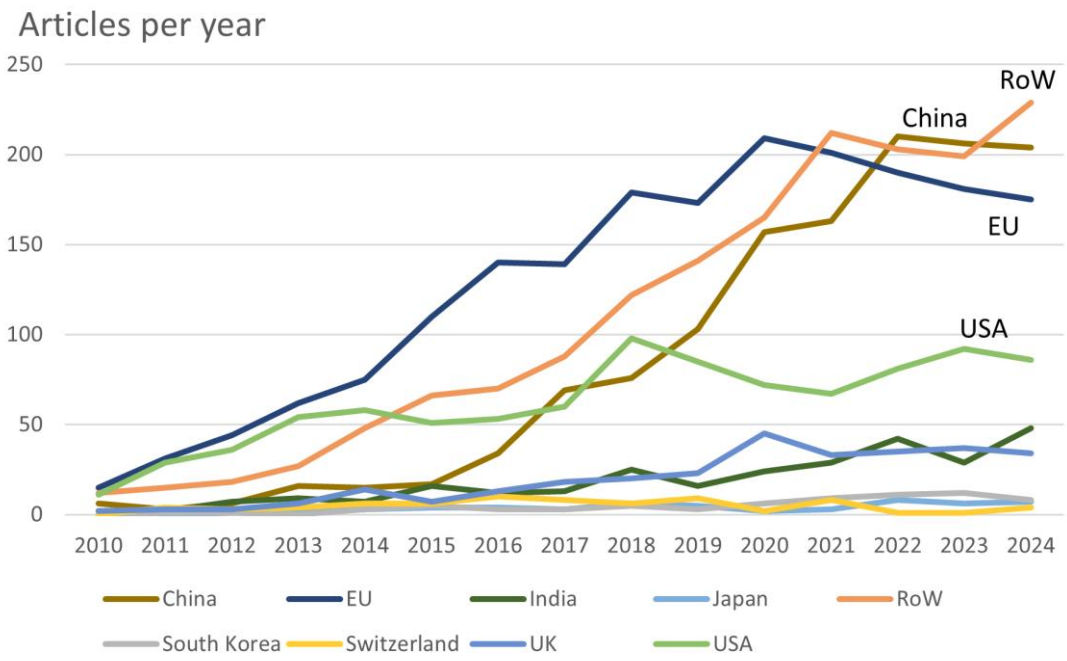
[4] High-value inventions (or high-value patent families) refer to patent families that include patent applications filed in more than one patent office. Granted patent families represent the share of granted applications in one family. The share is then associated with the fractional counts in the family.

[5] Since the analysis for the CPR 2020 SWD, the Chinese patents have been recategorised, leading to a 50% drop.

2.1.8. Scientific publication trends

The JRC's Technology Innovation Monitor system (TIM) was used to analyse the scientific articles published over the period 2010 to 2024[6]. The search retrieved 5 302 articles, with a record 602 published in 2024. Figure 6 shows the time trend for the leading countries and regions. The EU and USA were leaders in this field, but in the last five years, China and other countries (RoW) have emerged as the largest contributors. In the ROW grouping, Australia, Saudi Arabia and Morocco are prominent.

Figure 6. Trend in scientific publications on CSP for the leading countries and regions



Source: JRC analysis of TIM data, 2025.

2.1.9. Assessment of R&I project developments

Up to now the Horizon Europe programme is the principal route for EU support to CSP technology development. Annex 2 lists the relevant projects funded under Horizon Europe. Up to now, now CSP projects have been supported by other EU programmes such as the Innovation Fund.

An independent assessment of the progress in the Horizon Europe projects is beyond the scope of, this report. However the CST4ALL coordination action has recently summarised [9] the achievements of both EU and Member State-funded projects towards the priority actions of the SET Plan implementation plan. This is also reported in the SET Plan annual report 2025 [10].

[6] Search string "topic: ("concentrated solar power" OR "solar thermal electricity" OR ("CSP" AND "solar")) AND class:article

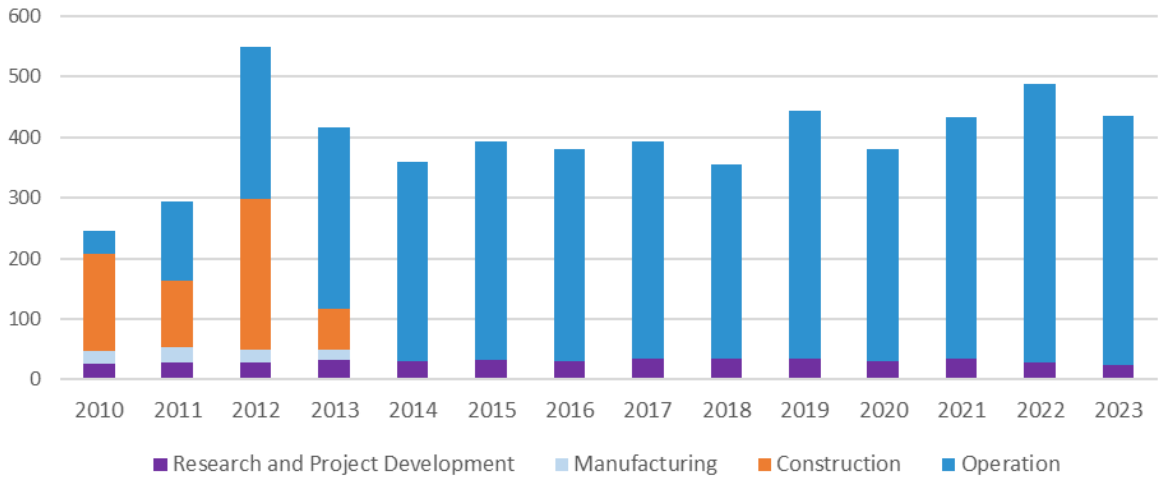
2.2. Value Chain Analysis

2.2.1. Turnover and Gross Value Added

No data has been identified for the global turnover and GVA for CSP.

For the EU, a study recently produced for the Commission [11] shows GVA at a level of approximately EUR 400 m/year over the last decade, with activity focussed almost entirely on operation (Figure 7).

Figure 7. Gross value added by value chain segment in the EU CSP energy sector (in MEUR) over the period 2010–2023



Source: Prognos 2025. The EU aggregate figures do not include Cyprus, Latvia, Malta, and Luxembourg.

2.2.2. Environmental and socio-economic sustainability

The assessment of sustainability is as reported in 2024 [1] using the CETO sustainability framework covering environmental, social and security aspects.

2.2.3. Role of EU companies

The last five years have seen the emergence of Chinese suppliers, engineering companies and finance houses as major players in the market. Several European companies continue to play a significant role, both for overall plant engineering as well as for specialised solar field components (Rioglass, Flabeg, TSK Flagsol). Siemens is a major supplier of steam turbine power blocks.

There has been a shift of industrial interest away from power generation in the absence of a project pipeline in the EU, while international CSP developments now take place largely in China, served by Chinese companies.

Table 4. ESTELA members and roles

Company	Country	Role
CSP Services	Germany	Consultancy
SBP Sonne Gmbh	Germany	Consultancy
FICHTNER Gmbh & Co. KG	Germany	Consultants
ACS Cobra	Spain	Developer
Abengoa Solar	Spain	Manufacturer
CMI Solar	Belgium	Manufacturer
Eastman Chemical Company	Belgium	Manufacturer
Roglass Solar SA	Spain	Manufacturer
Senior Flexonics	Germany	Manufacturer
SQM Europe	Belgium	Manufacturer
The Dow Chemical Company	Spain	Manufacturer
TSK FLAGSOL ENGINEERING Gmbh	Germany	Manufacturer
SENER	Spain	Manufacturer, engineering
CENER	Spain	R&I organisation
CRES	Greece	R&I organisation
DLR	Germany	R&I organisation
ENEA	Italy	R&I organisation
Fraunhofer ISI	Germany	R&I organisation
IK4-Tekniker	Spain	R&I organisation
instituto Imdea Energía	Spain	R&I organisation
Promes – CNRS	France	R&I organisation
Azelio	Sweden	Technology developer
Protermo Solar	Spain	Trade association
Verband Der Deutschen CSP	Germany	Trade association
RWE Innogy	Germany	Utility
Engie	UK	Utility, developer

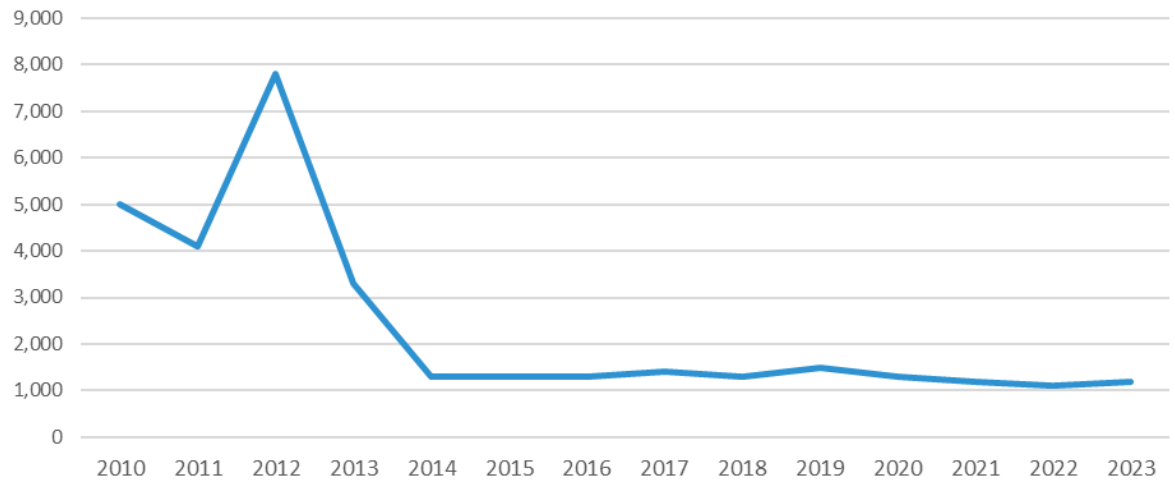
Source: JRC analysis of data from ESTELA web site, 2025.

2.2.4. Employment

At global level, IRENA reports 118 000 direct and indirect jobs for CSP industry in 2023 [12].

For the EU, Figure 8 shows the assessment of direct employment made by Prognos [11]. The jobs are currently estimated to be just over 1 000, below a peak of approximately 8 000 during the main construction period in 2012.

Figure 8. Direct employment in the EU CSP energy sector over the period 2010–2023



Source: Prognos 2025. The EU aggregate figures do not include Cyprus, Latvia, Malta, and Luxembourg.

2.2.5. Energy intensity and labour productivity

No data on energy intensity[7] is available for CSP. For labour productivity, the GVA and jobs data reported above imply EUR 0.38 million/y in 2023.

2.2.6. EU Production Data

CSP plants comprise a broad mix of components: reflectors, solar absorbers/ receivers, heat transfer & storage equipment, steam boilers and the steam turbine & generator sets. These CSP components do not have specific PRODCOM codes or codes suitable to be considered a proxy, reflecting the small size of the market.

2.3. EU Market Position and Global Competitiveness

2.3.1. Global markets and growth prospects

2.3.1.1. Current EU positioning in the global market

Since almost all market activity for CSP is currently in China, no analysis is made.

2.3.1.2. Market prospects

The outlook for CSP is uncertain as it seeks to find a distinct role in the energy system, in competition with other technologies, in particular low-cost photovoltaics and large-scale battery energy stationary storage (BESS). Lillestrom argues that its future role can be to help balance systems based

7 Amount of energy needed to produce one unit of economic output

predominantly on wind and solar PV, rather than as a base load provider or for dispatchable power, as thought at various stages in the past.

Table 6 summarises various perspectives for CSP development both globally and for the EU. It includes estimates from JRC's Global CETO 2°C scenario 2025 and the POTEnCIA 2025 scenario[8] for the EU, as well as other IEA and IRENA energy system models [13, 14, 6].. The wide range of projections reflects above-mentioned uncertainty over the role of.

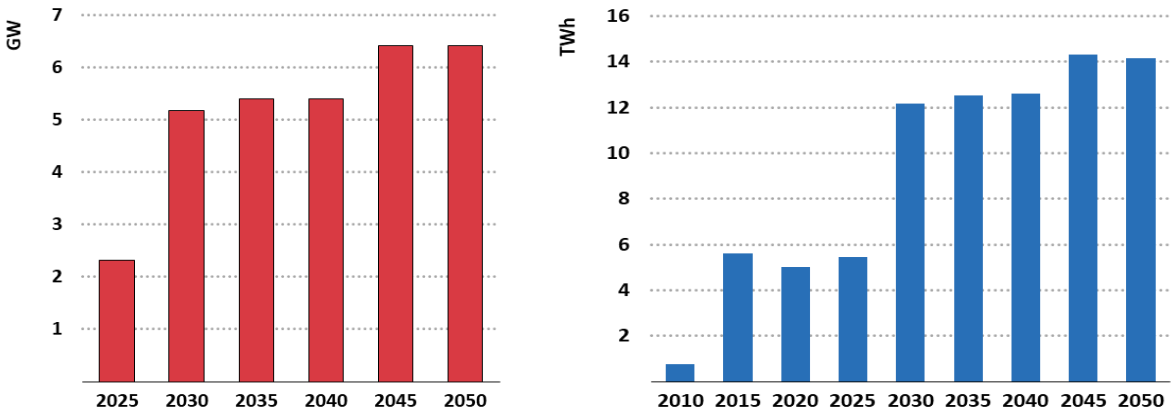
For the EU, Spain's revised National Integrated Energy and Climate Plan aims for 4.8 GW of CSP by 2030 i.e., an additional 2.4 GW. Italy's updated NECP foresees over 800 MW of CSP by 2030. The EurObserv'ER barometer anticipatee a small growth in total capacity to 3 GW by 2030. Figure 9 shows the *JRC's POTEnCIA CETO 2025 Scenario*[9] projected evolution of the CSP capacity and generation to 2050 for the EU. For the period 2025-2035, these projections imply an annual installation rate of just over 300 MW/y.

Table 5. Scenarios for CSP cumulative installed capacity by 2030 and 2050

Scope	Source	2030		2050	
		Capacity	Generation	Capacity	Generation
Global	IEA net zero by 2050 [13]	48 GW	139 TWh	427 GW	1 486 TWh
	IRENA World Energy Trans. Outlook 2023 [14]				3 000 TWh
	JRC Global CETO 2°C scenario 2025	7.4 GW ()	11.9 TWh	66.7 GW	89.1 TWh
EU	NECPs 2024	5.6 GW			N/A
	EurObserv'RE [5]	3 GW			N/A
	JRC Potencia 2025 scenario	5.2 GW	12 TWh	6.4 GW	14 TWh

Source: JRC own elaboration, 2025.

Figure 9. POTEnCIA CETO 2025 scenario for CSP capacity (left) and generation (right) development in the EU



Source: JRC own elaboration, 2025.

[8] A short description of the POTEnCIA CETO 2025 can be found in Annex 3.

[9] A short description of the POTEnCIA CETO 2025 scenario and the POTEnCIA model can be found in Annex 3.

2.3.2. Trade (Import/export) and trade balance

There are no trade tracking codes dedicated to CSP components. It is likely that trade volume is modest since all most all new projects are in China, which relies on its own technology suppliers.

2.3.3. Status of net-zero technology systems and components in the EU

2.3.3.1. Relevant final products and primarily used components

This section addresses the analysis necessary to support the Commission's monitoring obligations under NZIA Article 42[10], following the agreed methodology[11]. Table 7 shows the CSP-relevant components specified in the NZIA delegated regulation. Ideally, the analysis should be based on detailed information about the manufacturing facilities for each primarily used component, where such data is already available from existing sources or data providers. However, no such "off-the-shelf" data has been identified for the primarily used components of CSP. A provisional set of manufacturing capabilities was obtained from internet searches supported by GPT@JRC and is included in Annex 1.

Table 6. CSP-related components in NZIA legislation

Net-zero technology sub-category	Final Products	Primarily used components
Solar thermal electric technologies	CSP plants	CSP reflectors
		CSP trackers and their mounting structures
		CSP receivers (point or line)
Thermal energy storage technologies	Thermal energy storage systems	Sensible heat storage and latent heat storage mediums (included PCMs and molten salts)

Source: JRC own elaboration, 2025.

2.3.3.2. EU Manufacturing Benchmark

In the absence of detailed manufacturing capacity data, this benchmark cannot be fully evaluated. The available information is nonetheless reported in Table 7.

The manufacturing capacity unit for the solar field components is assumed to be MW_{th} (thermal power). Since the benchmark is the installed electric power capacity in the reference year, a conversion to thermal power is needed. This, however, varies significantly with the plant design and operational concept. An appropriate reference design should be agreed with stakeholders.

For molten salts (also called solar salts), the production capacity is measured in tonnes. The literature suggests that for a CSP plant with thermal storage operating in the range of 290 to 565 °C, each MWh_{th} requires 8 to 9 tonnes of molten salt. So a 100 MW_{el} CSP plant with 10 hours storage and 36%

[10] NZIA Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724

[11] Proposed CETO methodology for analysing the NZIA manufacturing benchmarks, 10 June 2025

thermal to electric efficiency, would require approximately 24 000 tonnes of molten salts for the thermal storage (further molten slats may be required for the heat transfer system).

Table 7. EU manufacturing capacity for the CSP-related primarily used components (NZIA benchmark assessment).

Primarily Used Components	Production Capacity Units	EU Manufact-uring Capacity	EU Deployment needs 2030	2030 EU Manufacturing Capacity Benchmark, %	Notes
CSP reflectors	MW_{th}	Yes, but not quantified	308 MW_{el}	Not available	2030 deployment from JRC Potencia 2025 scenario
CSP trackers and their mounting structures	MW_{th}	Yes, but not quantified	308 MW_{el}	Not available	
CSP receivers (point or line)	MW_{th}	Yes, but not quantified	308 MW_{el}	Not available	
Thermal heat storage medium	tonnes	10 000 to 20 000 tonnes	308 MW_{el} (with 10 h TES) requires approx.. 75 000 t salts)	13%-27%	Assessment is for molten salts and based on single EU supplier (see Annex 1)

Source: JRC own elaboration, 2025.

2.3.3.3. EU share in Global Manufacturing Benchmark

Due to the lack of data on manufacturing capacity (see above), this benchmark is not evaluated.

2.3.4. Resource efficiency and dependence in relation to EU competitiveness

The EU industry associated with CSP is relatively small and not known to use any imported materials subject to restrictions on availability. These do include some materials included in the EU's critical raw materials list: e.g. copper and aluminium in structural parts, and rare earths in generators.

3. Solar Thermal Heating and Cooling

3.1. Technology status and development trends

3.1.1. Technology Overview

This chapter aims to cover solar thermal technologies used for heating, cooling, or domestic hot water (DHW) purposes. These technologies can be used in buildings, at the district level, or for industries seeking to decarbonise their heat processes. They utilise the thermal energy from solar radiation and deliver thermal energy; there is no conversion into electricity as an intermediate step.

3.1.2. Technology readiness level

Solar thermal technologies offer a range of established solutions for various heating and cooling application areas, as shown in Table 9. The EU Renewable Energy Heating and Cooling Technology Innovation Platform (RHC-ETIP) has a dedicated technology plan for solar thermal and, in 2022, issued a strategic research and innovation agenda (SRIA) [15] (see Box 1). In addition to the Solar Thermal SRIA, the importance of system integration is addressed in the ETIP SNET 2022 white paper "Coupling of Heating/Cooling and Electricity Sectors in a Renewable Energy-Driven Europe" [16]. The Clean Energy Technology Partnership has also assessed the R&I needs for Solar Heat for Industrial Processes (SHIP) under the challenge "Towards 100% renewable industrial heating" [17].

While most of the typical applications of solar thermal technologies have a TRL of 9, some specific applications are not yet in the market. One of these is the use of solar thermal energy for desalination purposes; recent work in this field has focused on specific studies to understand the technology's potential [18, 19]. In addition to this type of application, solar thermal energy can be used to produce hydrogen or other types of fuels [20, 21]. Another application worth noting is the use of solar thermal energy for food and agricultural drying, which integrates advanced collectors with modern drying systems to improve efficiency and reduce spoilage [22, 23, 24]. Solar thermal energy can be used for cooling purposes as well. The work carried out by [25] analyses the potential of using solar thermal cooling technologies in buildings through an absorption system. Solar thermal technologies in buildings are mostly used in domestic hot water or space heating applications. In some buildings, the aesthetics require a specific location for the solar collectors. There is a specific type of solar thermal facility called Building Integrated Solar Thermal (BIST), in which solar thermal collectors are integrated into the envelope of the building. The IEA-SHC has collected different project databases[12] in which BIST is used.

[12] https://task39projects.iea-shc.org/projects.aspx

Table 8. Overview of solar heat technologies and application areas

Application	TRL (Technology Readiness Level)								
	1	2	3	4	5	6	7	8	9
Building water heating (domestic hot water)									■
Space heating									■
District heating									■
Heat for industrial processes (low temperature)									■
Heat for industrial processes (medium temperature)									■
Heat for very high temperature processes					■	■	■	■	
Solar cooling									■
Solar-driven Desalination and Water Treatment				■	■	■			
Production of Solar fuels			■	■	■				
Food and agricultural Drying							■	■	■

Source: JRC analysis, 2025.

Box 1 The EU Renewable Energy Heating and Cooling Technology Innovation Platform's strategic research and innovation agenda for solar thermal, 2022 [26].

A.1 - Development of system components for solar district heating (SDH) and solar heat for industrial process (SHIP) including thermal storage (mid-high temperature/pressurised)

A.2 - Demonstration projects for high temperature SHIP projects (<400°C)

A.3 - Improved hybrid collectors, such as PVT

A.4 - Developing prefabricated multifunctional solar façade systems

A.5 - Developing 'Solar-Active-Houses' with high solar fraction

B.1 Integration of large solar thermal systems and storages process including thermal energy storage

B.2 Integrated solutions for SHIP below 400˚C

B.3 Digitalisation

C.1 Environmental legislation, and land availability for SDH

C.2 – Developing new Business Models for Solar Thermal

C.3 – Solar thermal resource mapping

- C.3.1 Method development for advanced Solar thermal resource mapping and alignment with local energy demand

- C3.2. – Data integration to existing European data platforms

- C.3.2 – Promotion and dissemination strategies of solar thermal resources

C.4 Statistical data collection

- C.4.1 – Harmonised cost data collection for the main solar thermal applications

- C.4.2 – Harmonised statistical data collection

3.1.3. Installed energy capacity and production/generation

The global overall solar thermal collector capacity, by the end of 2024, was 544 GW_{th}, corresponding to 777 million m^2 of collector area[13] and an annual solar thermal energy yield of 443 TWh. Last year, 2024, marked the first year with a decrease in worldwide solar thermal capacity since 2000. This decrease is linked with the theoretical lifetime used for statistical purposes, which is between 15 and 25 years (depending on the country) [27].

According to the data provided by EurObserv'ER in July 2025, there were almost 60 million cumulate installed square meters in the EU, which corresponded to 41.7 GW_{th} [5]. On the other hand, solar Heat Europe estimates that current EU capacity installed is 43.6 GW_{th} [28]. The slight mismatch can be attributed to the different lifetimes associated with the facilities. This means that, according to the information from [5, 27] the EU accounted in 2024 for 7.5% of total global installed solar thermal capacity. Germany accounted for more than 30% of this installed capacity in the EU, followed by Greece, Italy, and Spain. The total installed capacity in the EU during 2024 was 923 MW_{th} [5].

In 2024, 24 largescale solar thermal systems[14] were commissioned. This results in a total worldwide deployment of 622 systems, accounting for a total installed capacity of more than 2 378 MW_{th} and 3.4 million square meters. The largest subsector in largescale solar thermal facilities is district heating, with a total amount of 346 systems accounting for 1 982 MW_{th} and 2.8 million square meters [27].

Regarding the use of solar heat for industrial processes (SHIP), around 106 new SHIP plants have been developed worldwide, with a total capacity of 120 MW_{th}. This means that the total installed capacity of SHIP plants worldwide is 1 071 MW_{th}, with a total area of 1 531 million square meters deployed for this purpose [27].

Photovoltaic-Thermal (PVT) collectors grew 8% from 2017 to 2024. Last year was considered a market recovery after a decrease in sales between 2022 and 2023. In 2024, 37.5 MW_{th} and 18.6 MWpeak were deployed, bringing the total worldwide capacity installed to 866 MW_{th} and 316 MWpeak (1.7 million square meters) [27].

[13] This corresponds to approximately 0.4% of the global rooftop area (200 000 km^2).

[14] Size to be considered largescale: 350 kW_{th} and 500 m^2

3.1.4. Technology costs

The 2025 edition of the Solar Worldwide report notes that solar heat technologies can provide heat with a cost of EUR 20-50/MWh [27].

As stated in 2024 report [1], Solar Heat Europe [Error! Reference source not found.] reports the following ranges for LCOH (reflecting technology scale and location):

- Solar district heating: 20 to 45 EUR/MWh
- SHIP: 20 to 70 EUR/MWh[15,16]
- Solar for DHW 20 to 110 EUR/MWh

As an example, in 2024, the Dorkwerd Solar Thermal Park[17] was deployed, with a total capacity of 37 MW_{th}. This is the largest solar thermal district heating installation in the Netherlands and the fourth largest in the world. The initial investment was estimated at EUR 23 million[18], which means a cost of EUR 620/kW.

3.1.5. Public RD&I funding

The content of this chapter includes information from the International Energy Agency (IEA) data of 2025. The investments are converted from national currency to euros using OECD average exchange rates for each specific year. The chapter contains not only information about the EU, but also the global investments in solar thermal for heating and cooling purposes. The results shown in the following figures may contain inaccuracies due to the high share of "unallocated solar technologies" in the database used.

Figure 10 illustrates the global public investments in solar thermal technologies. The year 2021 showed a peak of more than EUR 30 million. Investments in solar thermal technologies for heating and cooling fluctuate from year to year. In 2024, according to the database, the contribution of the EU in this regard has been negligible. However, the EU is responsible for 60% of public investments in solar thermal technologies in the last 10 years (Figure 11).

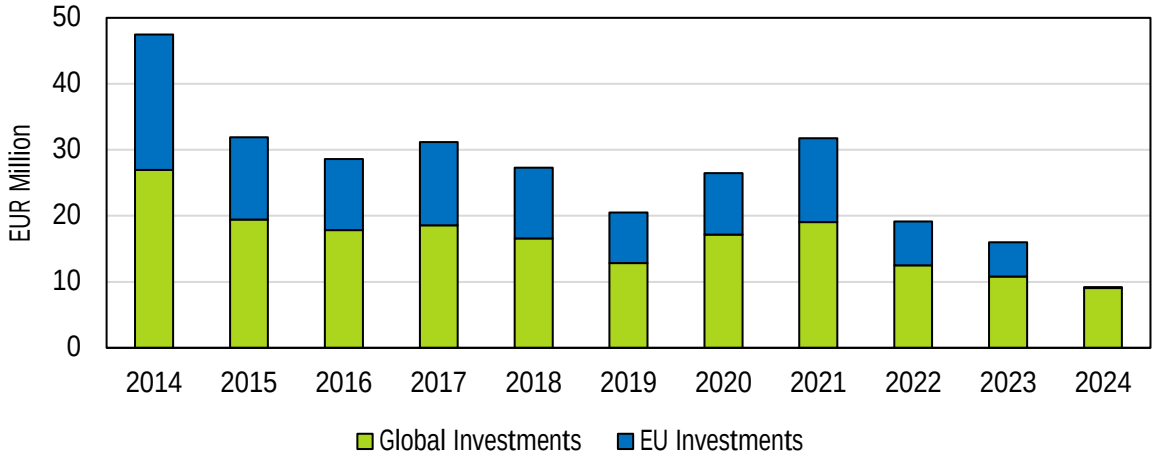
[15] https://www.wbcsd.org/resources/solar-thermal-solutions/

[16] https://solarheateurope.eu/wp-content/uploads/2024/10/EESF-Solar-heat-factsheet-f.pdf

[17] https://solarheateurope.eu/casestudy/fourth-largest-solar-district-heating-plant-globally-in-the-making/

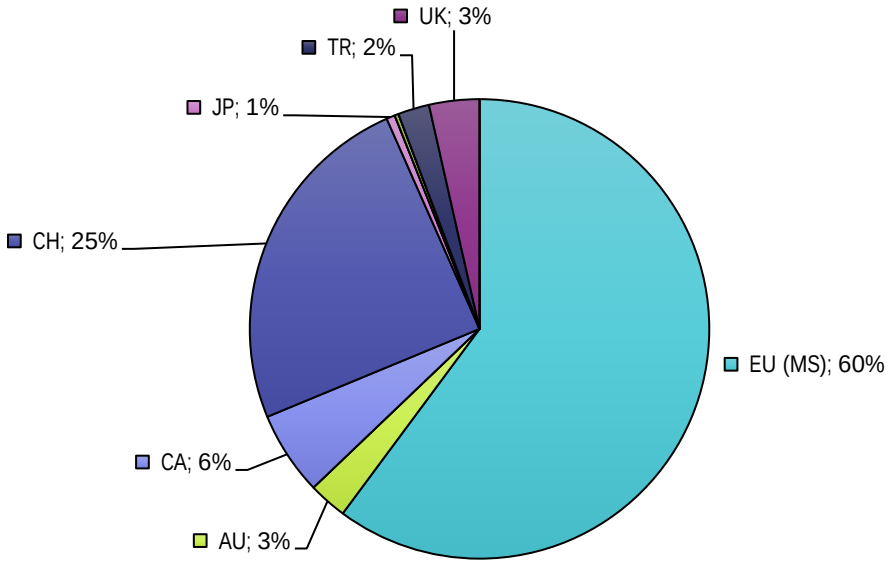
[18] https://solarheateurope.eu/casestudy/fourth-largest-solar-district-heating-plant-globally-in-the-making/

Figure 10. World public investments in solar thermal energy technologies



Source: JRC based on (IEA, 2025). Data of 2023 and 2024 are provisional.

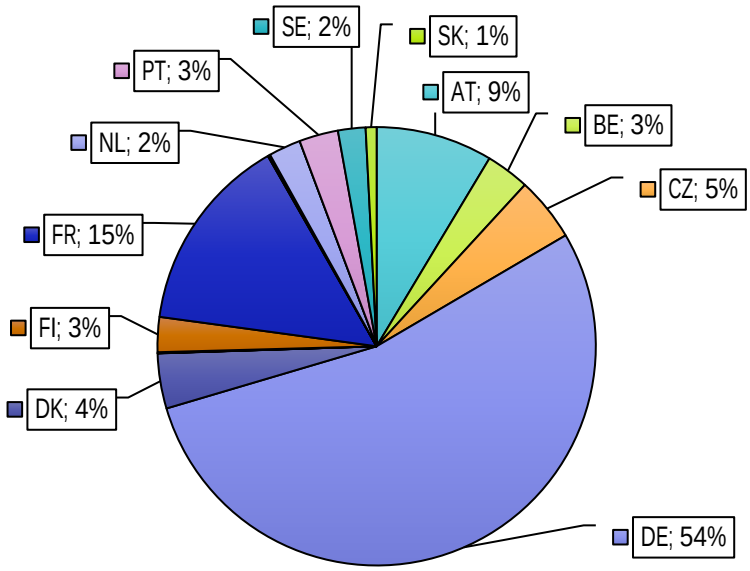
Figure 11. Share of global public investments in solar thermal energy technologies (2014-2024)



Source: JRC based on IEA, 2025.

Figure 12 illustrates the shares of EU investments per Member State. Germany, France and Austria are the leading MSs in public solar thermal investments.

Figure 12. Share of EU public investments in solar thermal energy technologies



Source: JRC based on IEA, 2025.

3.1.6. Private RD&I funding

3.1.6.1. Overall private R&I investments based on patents

No data was found.

3.1.6.2. Venture capital and early and later-stage investments

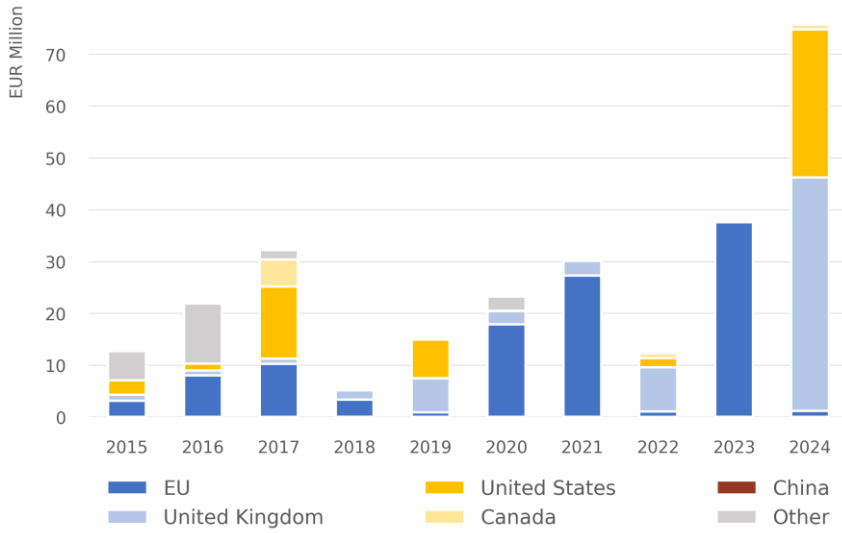
In 2024, global VC investment increased sharply and reached EUR 76 million (almost double that of 2023, see Figure 13). The main deals realised in 2024 include Naked Energy (UK, solar thermal and hybrid, EUR 35 million) and Exowatt (US, modular solar thermal-to-power, EUR 19 million). In contrast, as shown in Figure 13, there has been a sharp decrease in VC investments in the EU between 2023 and 2024.

While the EU has not captured significant investments in 2024, it still accounts for 44% of the global VC investment since 2019 (against 34% for the UK and 20% for the US).

The main EU ventures include Newheat (FR, solar heat plants, EUR 52 million raised since 2021) and Heliac[19] (DK, solar thermal for industry and district heating, EUR 22 million raised since 2021).

[19] Heliac now is focus on manufacture thermal energy storage solutions

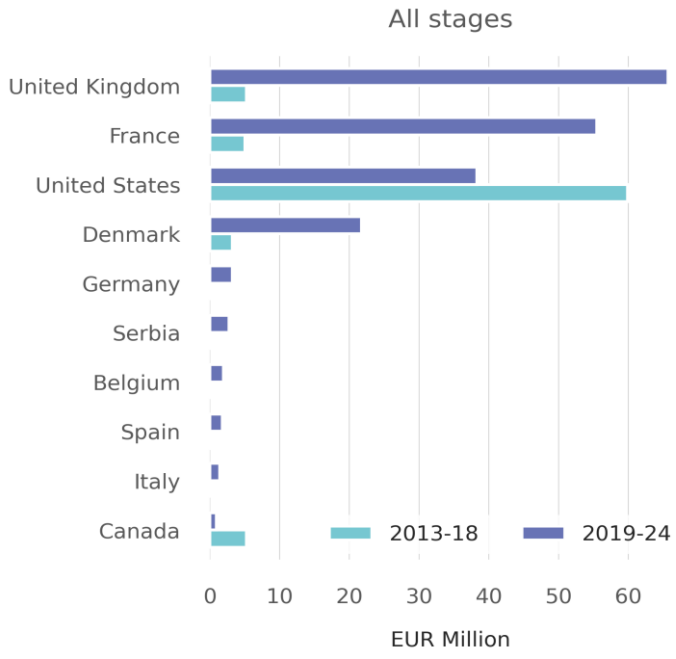
Figure 13. Global VC/PE EU investment in the solar thermal sector, by region for all deals.



Source: JRC based on Pitchbook, 2024.

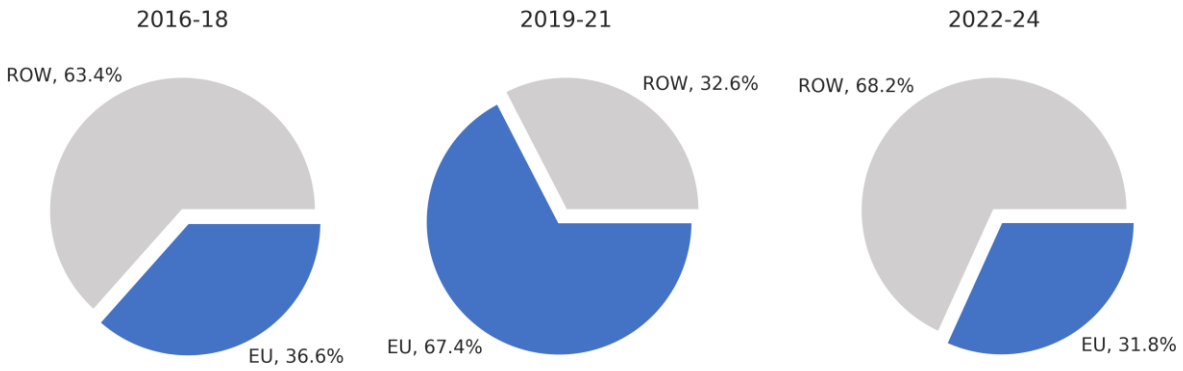
Figure 14 illustrates the trends in venture capital (VC) investments at country level. It highlights the significant increase in investments in the UK over time, surpassing VC investments in the US. Meanwhile, Figure 15 compares VC investments between the European Union (EU) and the Rest of the World (RoW) across various periods. The data shows that in the last year, VC investments in the EU have declined compared to those in the RoW. One possible explanation for this decline is the rise in VC investments from the US and UK in the RoW during the period from 2022 to 2024. Finally, Figure 16 includes information on innovative companies over a five-year period, with China leading the way in corporate companies with more than 90 companies. In addition to this, the US is the country with the majority of VC companies, with a bit less than 10 companies.

Figure 14. VC/PE investment in top 10 beneficiary countries, by period for all deals.



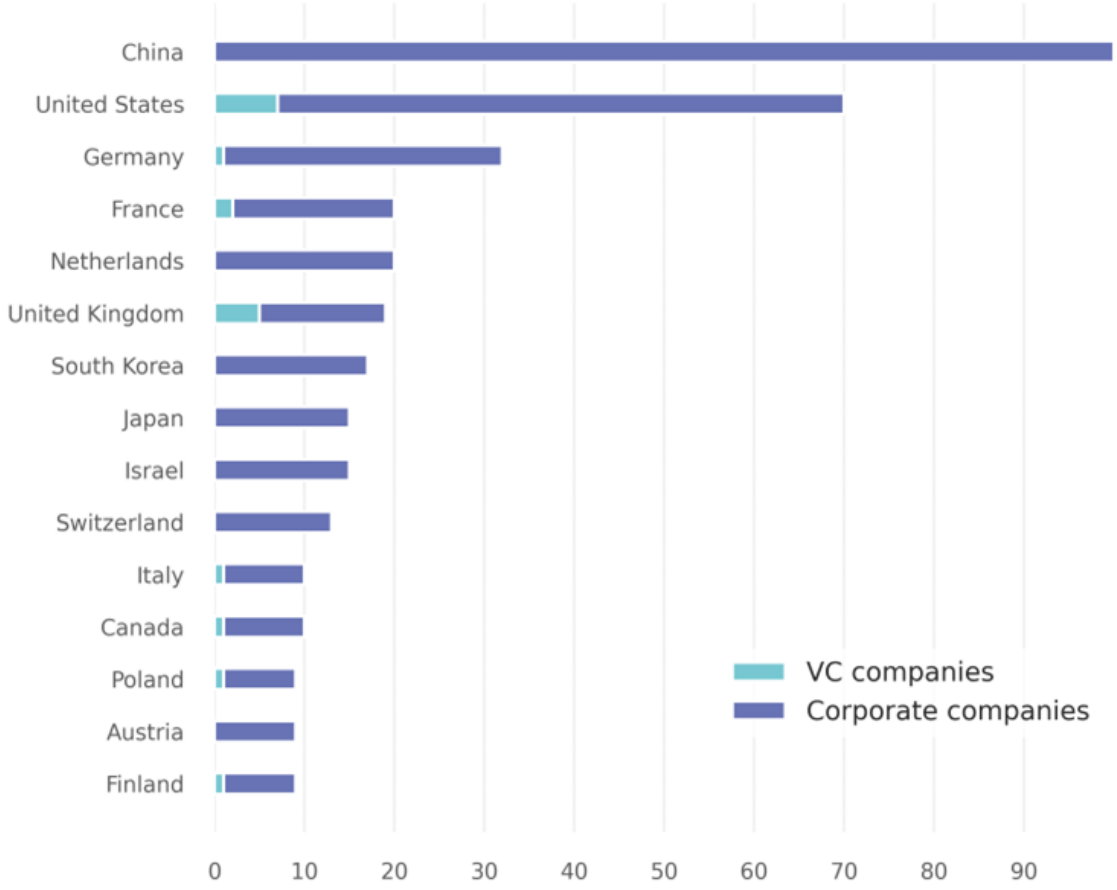
Source: JRC based on Pitchbook, 2024.

Figure 15. VC/PE investment in the EU and in RoW for all deals over the last 9 years, by period of 3 years



Source: JRC based on Pitchbook, 2024.

Figure 16. Number of active innovating companies by type over a 6-year period, ranking of top 15 countries. [VC companies count over 2019-24. Count of corporate companies over 2017-22].



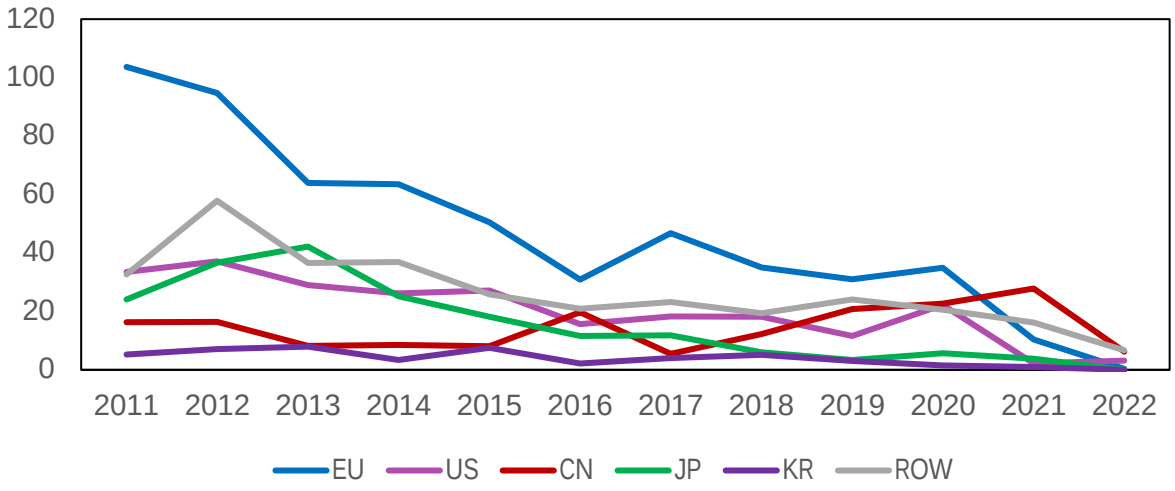
Source: JRC based on Pitchbook and PATSTAT data, 2024.

3.1.7. Patenting trends

Overall, the number of high-value patents in solar thermal technologies has decreased over recent years (Figure 17). The EU held the highest number until 2021, when China surpassed it.

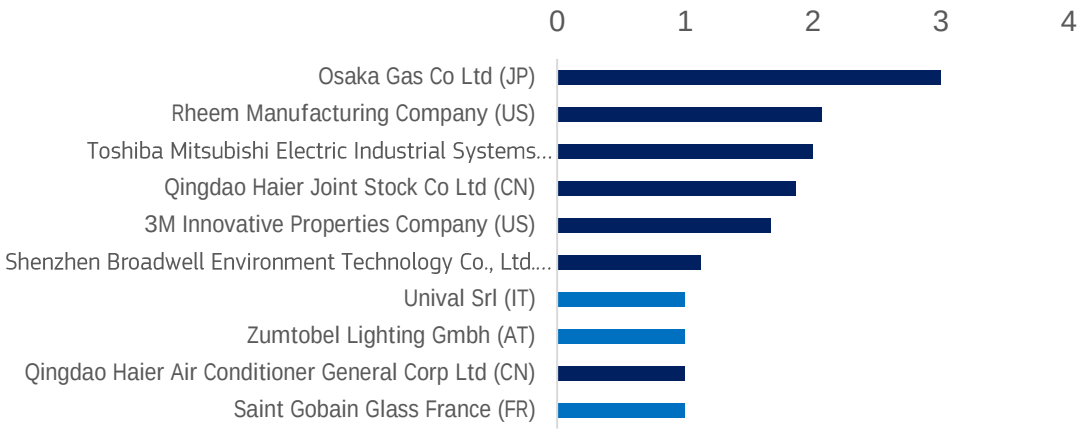
Osaka Gas Co., Ltd (Japan) and Rheem Manufacturing Company (US) were the companies that filed the most patents from 2020 to 2022 (Figure 18). Three of the top ten were from the EU, specifically Germany.

Figure 17. Number of high-value patents per region and year. N.B. data for 2022 is incomplete.



Source: JRC based on EPO PATSTAT 2024b.

Figure 18. Number of high-value patents globally per company between 2020 and 2022.

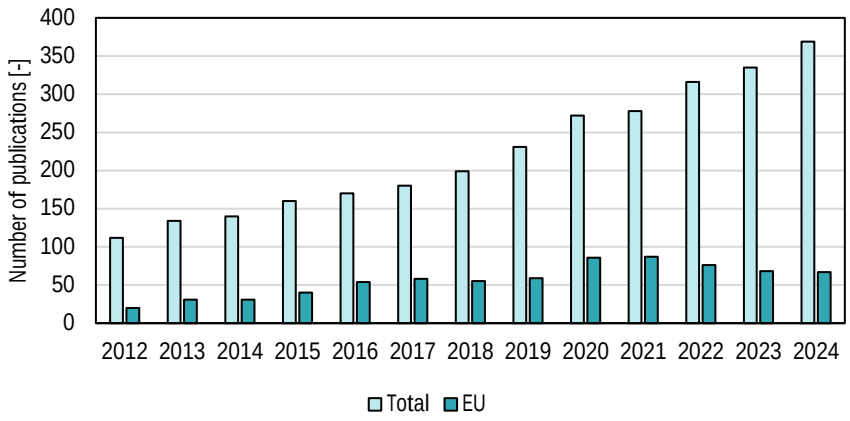


Source: JRC based on EPO PATSTAT 2024b.

3.1.8. Scientific publication trends

Globally, scientific publications about solar thermal technologies used for heating and cooling have increased over the years. However, the number of scientific publications within the EU has been decreasing since 2021. As can be seen in Figure 19, the scientific contributions of the EU represent, on average, less than 30.

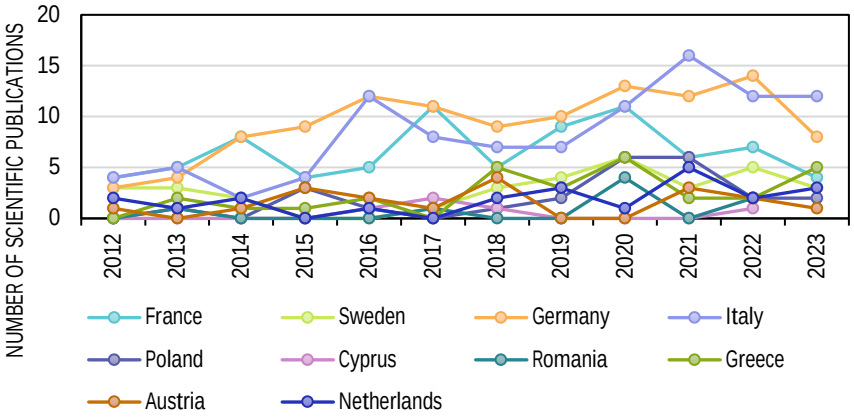
Figure 19. Scientific publications of Solar Thermal technologies



Source: JRC own elaboration, 2025.

At Member State level, Italy and Germany produce the most scientific publications, followed by France and Sweden. Figure 20 shows these results.

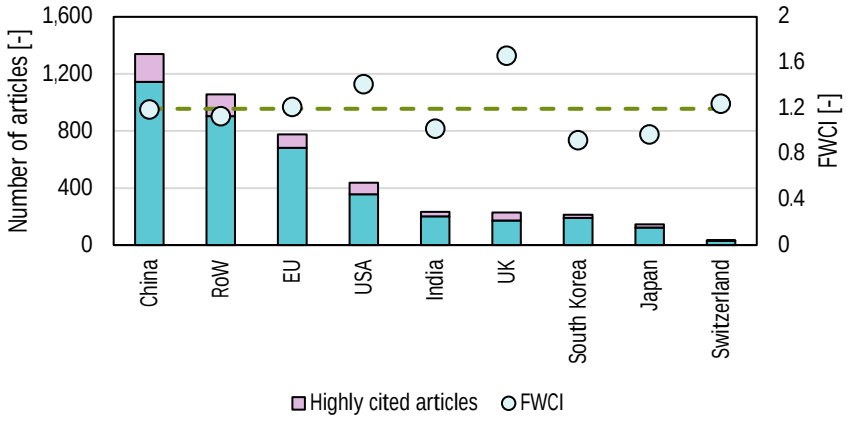
Figure 20. Scientific publications of Solar Thermal technologies by MS



Source: JRC own elaboration, 2025.

Scientific publications can be evaluated by the number of highly cited articles and the field-weighted citation impact (FWCI). Figure 21 shows that China has the largest share of highly cited articles, with more than 1 000 publications, indicating that its scientific work receives considerable attention and is frequently quoted by others. The EU occupies the third position, after RoW. The UK has the highest FWCI, which is around 1.7. This indicator represents the frequency of citations in scientific articles. In this regard, the EU has an FWCI of 1.2, which corresponds to the average of the countries analysed.

Figure 21. Number of publications and FWCI indicator



Source: JRC own elaboration, 2025.

3.1.9. Assessment of R&I project developments

In this subchapter, the information is mainly focused on projects funded by the Horizon 2020 and Horizon Europe research and innovation programmes. Under Horizon 2020 (2014-2020), the EU has supported 18 solar thermal heat-related projects with a total budget of about EUR 65 million. Under Horizon Europe (2021-2027), seven solar thermal heat-related projects have been funded, with a total budget of EUR 23 million. Annex 4 shows a complete list of projects.

3.2. Value Chain Analysis

3.2.1. Turnover and Gross Value Added

The global solar heating and cooling sector was estimated to have a turnover of EUR 13.9 billion in 2023 [27]. For Europe, Solar Heat Europe (EU+UK+CH) reports EUR 1.79 billion [29].

3.2.2. Environmental and socio-economic sustainability

The environmental impact of renewable energy can be measured using the life-cycle assessment (LCA) of a specific technology. It is key to understand the emissions of CO_2 during the lifetime of the technology. The company Naked Energy carried out a study which concluded that a hybrid PVT collector had an embodied carbon of 0.344 $kgCO_2eq/Wp$ (122 $kgCO_2$ per declared unit), and a Thermal-Only collector around 0.172 $kgCO_2eq/Wp$ (69 $kgCO_2$ per declared unit)[20] [30].

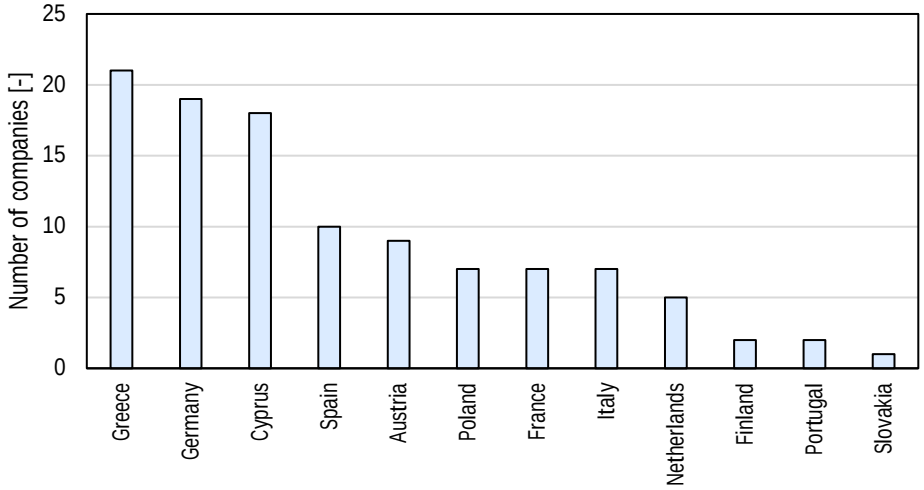
[20] This results from the LCA are only linked to the manufacturing and packaging phase. Depending on the location of the product, the final value could vary.

Additional LCA information was obtained from the PEP ecopassport[21] database. One model available was the Viessmann Vitosol 200-FM SV2F. The total climate change impact over 25 years and per square meter was estimated at 295 kg CO_2, with 260 kg CO_2 coming from the manufacturing phase. In addition to this, UNICLIMA[22] collected information from different manufacturers and made an average LCA for solar collectors. The results obtained for 50 years and per m^2 were 220 $kgCO_2$ (total) and 209 $kgCO_2$ (manufacturing phase).

3.2.3. Role of EU companies

This subchapter focuses on identifying EU companies operating in the EU solar thermal sector. A desk research exercise identified a total of 115 companies from 15 Member States. This number should be considered non-exhaustive. The Member State with the most companies is Greece, followed by Germany and Cyprus. The product primarily manufactured is flat plate collectors, and several companies manufacture more than one type of technology. Figure 22 shows the results.

Figure 22. Number of companies per country in the EU solar thermal sector



Source: JRC own elaboration based on information provided by Solar Heat Europe, 2025.

3.2.4. Employment

The Solar Heat Worldwide report of 2025 estimated the number of jobs linked to solar thermal technology globally to around 318 000 in 2023 [27], while 9 600 jobs were estimated for EU27 in last year CETO report [1]. This estimation was provided by a study carried out by CINEA [31].

3.2.5. Energy intensity and labour productivity

No data was found regarding energy intensity and labour productivity.

[21] https://register.pep-ecopassport.org/

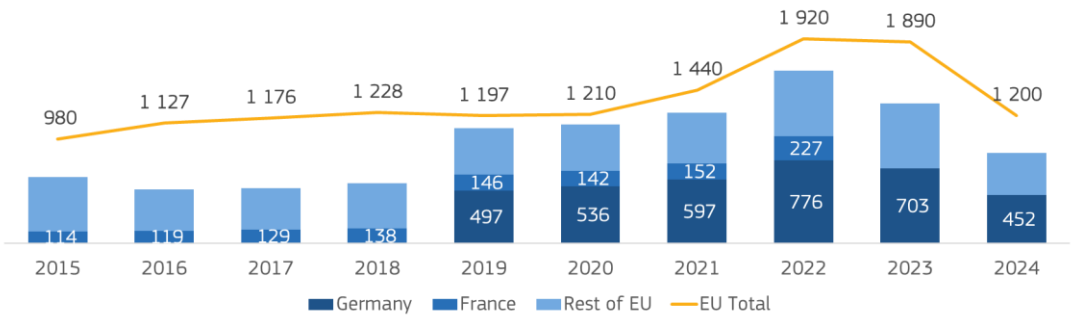
[22] https://register.pep-ecopassport.org/pep/consult/mbesqrsCBZbWbKJq6-kJ3uFUhnN763eW42iazUcahaQ/mbesqrsCBZbWbKJq6-kJ3nXTEwaL2H-VUQApFU2-Q6g

3.2.6. EU Production Data

The selection of Prodcom codes for monitoring solar thermal production aligns with the list of components in the Net-Zero Industry Act (NZIA)[23]. However, the Prodcom code 27521400 (Non-electric instantaneous or storage water heaters) is not dedicated to solar water heaters and does not distinguish between the size or applications; thus, there is no distinction between industrial and residential use. In the figures below, the sum of the countries' production (boxes) is lower than the 'EU Total' (line) because some Member States keep their production data confidential. However, Eurostat includes confidential data in the 'EU Total' estimates.

Over the past decade (2015-2024), the overall EU production value grew by 22%, with an annual compound growth rate of 2% and an average annual value exceeding EUR 1.3 billion. However, in 2024, the EU production value for non-electric water heaters declined by 37% compared to 2023, falling to approximately EUR 1.2 billion (Figure 23). Germany and France remained the leading EU producers during the same decade. In view of the fact that France has not disclosed its 2024 production data, Germany and Poland were the leading EU producers for 2024, accounting for 38% and 8% of the total EU production, respectively.

Figure 23. EU production value of non-electric instantaneous or storage water heaters and distribution among the Member States disclosing data [EUR Million][24]



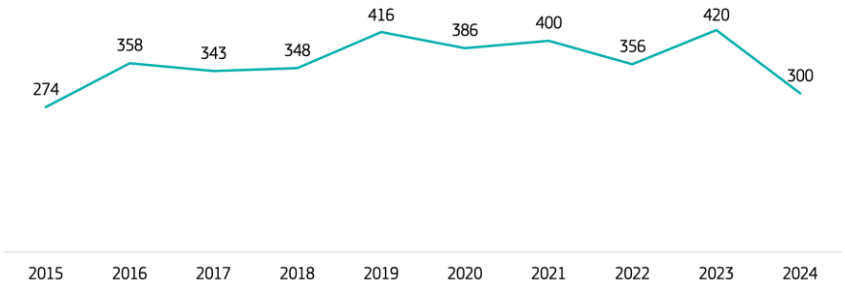
Source: JRC based on PRODCOM data, 2025.

In 2024, EU non-electric water heater production dropped by 11% compared to 2023, to around 4 million units. Most Member States have not disclosed their production quantity data, therefore, there are no insights available about the leading EU producers. The average EU production value per unit dropped by almost 30% compared to 2023 at around EUR 300 (Figure 24).

[23] C (2025) 9034 final, https://single-market-economy.ec.europa.eu/document/download/860c257b-16db-429e-91c1-a30bea57e7ce_en?filename=C_2025_9034_1_EN_ACT_part1_v8.pdf

[24] For some trading goods, not all EU MS disclose their production data. "EU Total" includes estimates of the confidential information. The distance between the line ("EU Total") and the boxes ("Grand Total") indicates the amount of information that has been kept confidential.

Figure 24. EU production unitary value per non-electric water heater [EUR per unit]



Source: JRC based on PRODCOM data, 2025.

3.3. EU Market Position and Global Competitiveness

This subchapter aims to demonstrate the evolution of solar thermal technologies for heating and cooling in the global market.. Most of the global information has been collected from the report, Solar Heat Worldwide [27], and the specific information from the EU comes from EurObserv'ER [5].

3.3.1. Global markets and growth prospects

3.3.1.1. Current EU positioning in the global market

The market for solar thermal technologies in heating and cooling varies depending on the technology type, such as individual systems or largescale systems. In general terms, the solar thermal market decreased by 14% in 2024 to 17.8 GW_{th}. This decrease was strongly affected by the decline in the markets of China (17%) and India (24%) [27]. On the other hand, Latin American countries such as Brazil and Mexico experienced a market increase in 2024 [27].

The EU deployed 0.923 GW_{th} of solar thermal technologies in 2024 [5], or about 5% of the global market. In the EU, countries such as Spain, Greece, Germany, and Italy experienced a market decline in 2024. For the specific case of Germany, this could be linked to the general decrease in sales of heat generators resulting from changes in financing programmes for efficient buildings or linked to the Building Energy Act (GEG). In Italy, the reduction of the market share can partially be attributed to the decline in the Superbonus tax incentives and the preference for photovoltaic energy [5].

Several largescale solar thermal systems were deployed in 2024 in the EU. Some of the biggest systems in the EU were deployed in the Netherlands, Germany, and Italy. Table 10 is a non-exhaustive list of the biggest district heating systems deployed in the EU during 2024 that use solar thermal technology.

Table 9. Non-exhaustive list of solar thermal district heating facilities deployed in the EU during 2024

Location	Collector area	Capacity
	[m^2]	[MW_{th}]
Groningen (Netherlands)	48 800	34
Ammerbuch-Breitenholz, Baden-Württemberg (Germany)	2 045	1.4
Sondershausen, Thuringia (Germany)	6 086	4.3
Häusern, Baden-Württemberg (Germany)	1 733	1.2
Racconigi (Italy)	1 029	0.7

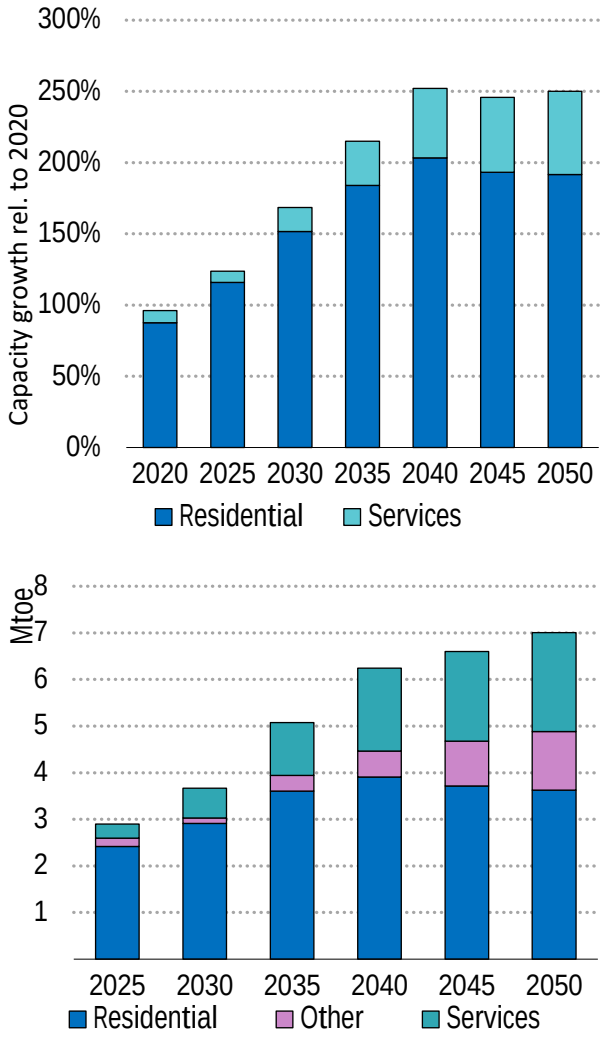
Sources: ACE, 2024 [32] & Solar Heat Europe [33].

3.3.1.2. Market prospects

According to information taken from Global Market Insights[25], the global solar thermal market was valued at USD 16.1 billion in 2024 and is expected to grow by 9% by 2034. This is based on information from 15 companies in 19 countries.

The JRC's *POTEnCIA CETO 2025 Scenario* projects an increase in heat generation from solar thermal, reaching almost 4 Mtoe in 2030 and 7 Mtoe in 2050 (Figure 25). In that analysis, the residential sector accounted for nearly all solar thermal production. Furthermore, the *POTEnCIA CETO 2025 Scenario* projects an installed capacity growth of approximately 250% from 37.7 GW_{th} in 2020 to 94 GW_{th} in 2050.

Figure 25. Projections for solar thermal capacity and heat generation in the EU.



Source: POTEnCIA CETO 2025 Scenario.

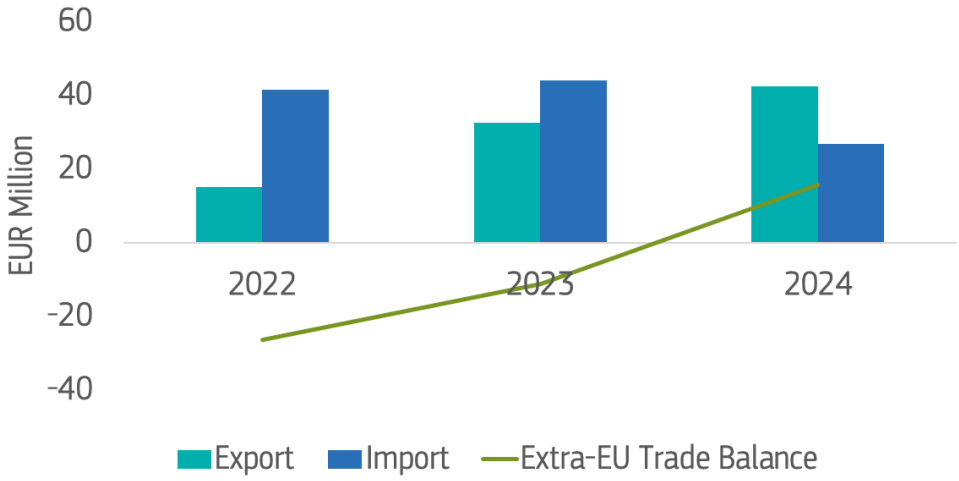
[25] https://www.gminsights.com/industry-analysis/solar-thermal-market

3.3.2. Trade (Import/export) and trade balance

The trade codes for solar thermal technologies align with the Net-Zero Industry Act (NZIA) list of components[26]. A dedicated HS code 841912 for solar water heaters is available only as of 2022 and does not distinguish between the size or application; thus, there is no distinction between industrial and residential use.

Figure 26 illustrates that the EU's trade deficit turned into surplus in 2024, when extra-EU imports decreased by 39% to EUR 27 million, and extra-EU exports increased by 30% to EUR 42 million, yielding a trade surplus of EUR 16 million.

Figure 26. Extra-EU trade in solar water heaters for 2022-2024.

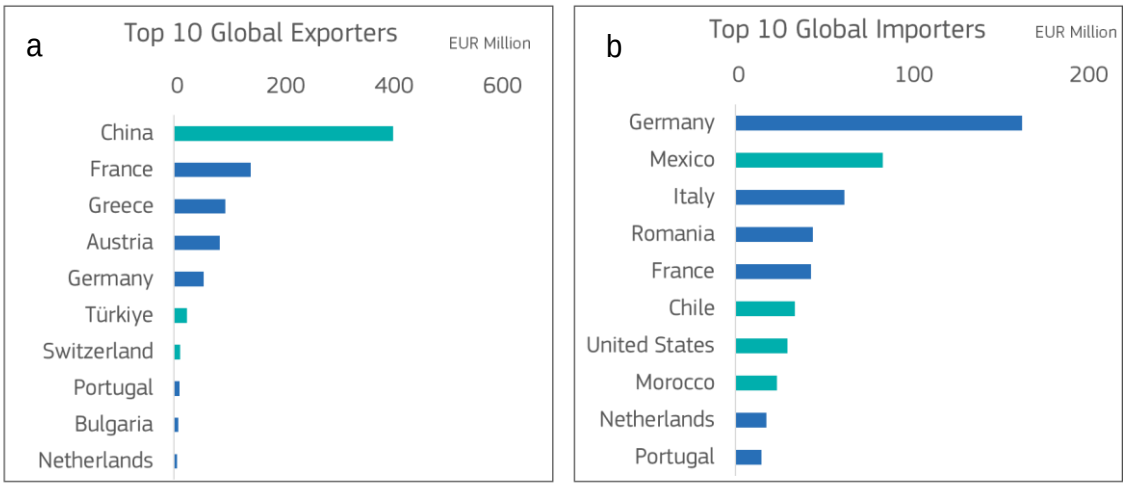


Source: JRC based on COMEXT data, 2025.

Global exports decreased from EUR 304 million in 2023 to EUR 245 million in 2024. Extra-EU exports (excluding intra-EU trade) represented 11% of global transactions. The EU met 74% of its import needs through intra-EU trade. China was the leading global exporter, accounting for 46% of global exports, followed by France (16%) and Greece (11%) (Figure 27a). Germany and Mexico were the largest global importers (Figure 27b).

[26] C(2025) 9034 final, https://single-market-economy.ec.europa.eu/document/download/860c257b-16db-429e-91c1-a30bea57e7ce_en?filename=C_2025_9034_1_EN_ACT_part1_v8.pdf

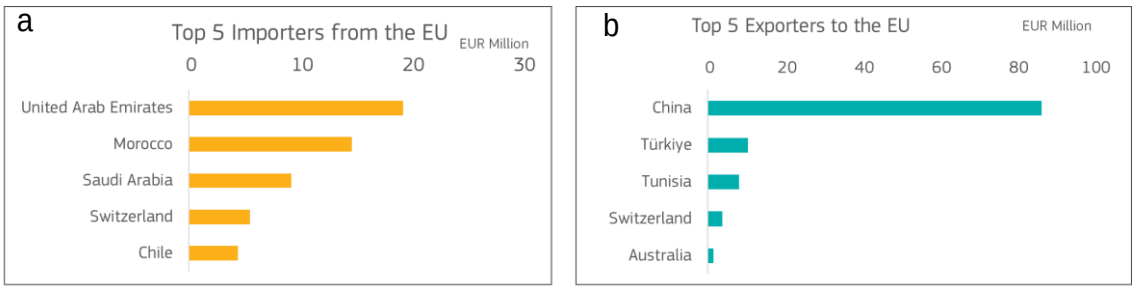
Figure 27. Top ten global (a)exporters and (b)importers of solar water heaters for 2022-2024 [EUR Million].



Source: JRC based on COMTRADE data, 2025.

During the same period (2022-2024), the United Arab Emirates were the largest importer from the EU, receiving 21% of the extra-EU exports, followed by Morocco (16%) and Saudi Arabia (10%). China was the largest exporter to the EU, accounting for 77% of extra-EU imports, followed by Türkiye (9%) (Figure 28).

Figure 28. Top five countries (a) importing from and (b) exporting to the EU in 2022-2024 [EUR Million].



Source: JRC based on COMEXT data, 2025.

Table 11 shows the growing markets[27] of solar water heaters during 2021-2023[28]. Chile had the largest net import increase, followed by Morocco and Kenya, where the EU captured 61%, 78% and 48% of each country's growing market, respectively.

[27] Calculated as $net\ import\ change = [(import_{2022} - import_{2021}) + (import_{2023} - import_{2022})]/2$

[28] The latest year's data (2024) is incomplete for Comtrade, because it does not provide estimates for the missing values as comext does.

Table 10. Growing markets based on a 2-year average of net import change

Country	Total import (2021-2023) [EUR Million]	% import from the EU
Chile	13	61%
Morocco	24	78%
Kenya	3	48%

Source: JRC based on COMTRADE data.

3.3.3. Status of net-zero technology systems and components in the EU

This chapter aims to give an overview of solar thermal technologies in relation to the Net-Zero Industry Act[29] measures to boost Europe's manufacturing capacity for net-zero technologies.

3.3.3.1. Relevant final products and primarily used components

Regarding solar thermal technologies, according to Annex C[30] of NZIA, the final products are solar thermal systems or PV-thermal (PVT) collectors. The primarily used components are:

- solar thermal collectors (including flat-plate, evacuated tube, concentrating systems and air collectors);
- solar thermal absorbers;
- solar glass; and
- solar thermal trackers and their mounting structures.

In the absence of publicly available data, a survey was conducted as a first approach to assessing the manufacturing capacity in the EU using for these primarily used components. Solar Heat Europe developed this survey, in which members were asked to list the primarily used components they manufacture and their production capacity.

Table 12 gives a summary of the survey results from 24[31] members of Solar Heat Europe Most of these manufacture flat plate collectors and absorbers. The ratio used to estimate the thermal manufacturing capacity from collector area (typically reported by manufacturers) was 0.7 kW_{th}/m^2.

[29] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401735

[30] file:///C:/Users/rocarju/Downloads/090166e51d10a100.pdf

[31] In Chapter 3.2.3, 119 companies were identified. Therefore, the EU manufacturing capacity is expected to be higher than the capacities of the 24 companies that replied to the survey.

Table 11. Primarily used components manufactured

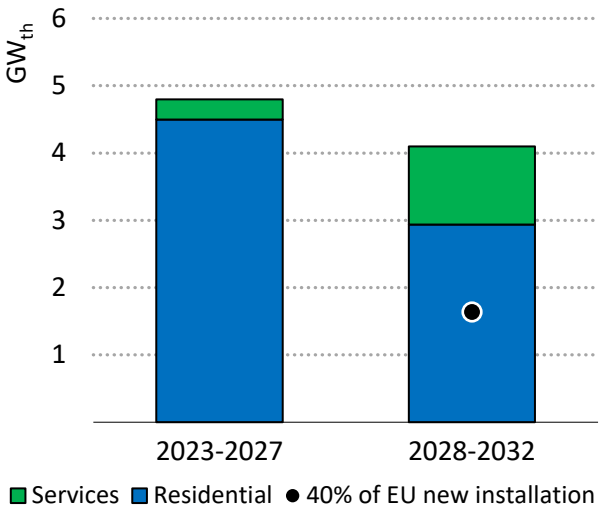
Primarily Used Components	Production Capacity Units	EU Manufacturing Capacity	EU Deployment needs 2030	2030 EU Manufacturing Capacity Benchmark, [%]
Solar thermal collectors - Flatplates	MW_{th}	3 286	Not available	Not available
Solar thermal collectors - Evacuated tubes	MW_{th}	157	Not available	Not available
Solar thermal collectors- PVT	MW_{th}	134	Not available	Not available
Solar thermal collectors - Concentrating systems	MW_{th}	70	Not available	Not available
Solar thermal collectors - Air collectors	MW_{th}	11	Not available	Not available
Solar thermal absorbers	MW_{th}	2 744	Not available	Not available
Solar thermal trackers	-	Not available	Not available	Not available

Source: JRC analysis, 2025.

In Chapter 3.1.3, it was noted that 923 MW_{th} of solar thermal technologies were installed in the EU in 2024. The fact that the combined manufacturing capacity of the 24 companies exceeds 3 000 MW_{th} indicates that the EU solar thermal industry can fully cover current EU demand and is competitive in export markets.

The Net-Zero Industry Act aims to meet at least 40% of the EU's annual deployment needs by 2030. Considering the POTEnCIA CETO 2025 *scenario*, it is estimated that the EU will require an average annual deployment of almost 5 GW_{th} from 2023 to 2027 and 4 GW_{th} from 2028 to 2032 (see Figure 29). Assuming an average deployment of 4.5 GW_{th}, and since the 24 companies have a manufacturing capacity of 3 GW_{th}, the EU seems to have the capacity to provide two thirds of the demand, surpassing the NZIA requirements of 40%.

Figure 29. EU annual new installations



Source: JRC own analysis, 2025.

3.3.3.2. EU share in Global Manufacturing Benchmark

There is insufficient information to perform this estimation, as the benchmark refers to 2040 global deployment values for which there is no data.

In terms of current situation, for 2024 global deployment was 17.8 GWth and EU has a manufacturing capacity of over 3 GWth, the ratio is >17%, so above the NZIA 15% target to be achieved in 2040.

3.3.4. Resource efficiency and dependence in relation to EU competitiveness

Solar thermal technologies used for heating and cooling purposes include two main primary materials: aluminium and copper.

Aluminium is a material obtained from bauxite, which the EU typically imports. According to the fifth list of critical raw materials (CRMs), aluminium is considered a CRM, which means that the EU recognises its importance in several sectors. On the other hand, copper is regarded as a strategic raw material (SRM). The meaning "strategic" highlights its importance for technologies that support the green and digital transition, as well as defence and aerospace objectives.

Aluminium has a supply risk of 1.2, which can be put into context by noting that the highest supply risk on the list, for heavy rare earth elements, is around 5 [34]. Supply risk is measured at the 'bottleneck' stage of the material, i.e. extraction or processing[32]. Copper is given a supply risk of only 0.1.

[32] https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

Another important parameter in terms of CRMs is their economic importance (EI). This indicator can provide insight into the importance of the material for the EU economy[33]. Aluminium has an EI of almost 6, while Tungsten has the highest EI factor, at nearly 9 [34]. The EI of copper is intermediate, with a value of 4.

The leading global producers of aluminium are Australia and Chile, with a worldwide production share of 28% each (in the extraction phase) [34]. The primary source of aluminium for the EU is Guinea, at 62% (extraction phase, bauxite). The EU's primary source of copper is Poland with a total share of 19% [34].

Finally, aluminium has an import reliance (IR)[34] of 89% (extraction phase, bauxite). This is an indicator of how much the aluminium supply depends on other non-EU countries, and how it can affect thermal energy storage technologies that use aluminium if relations with these countries change. The case of copper is different, since it has an IR of 48%, with Chile being the leading importer.

[33] https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

[34] IR = (Import – Export) / (Domestic production + Import – Export)

4. Conclusions

A range of solar thermal technologies (both concentrated and non-concentrated) is available to support the decarbonisation of the energy system.

Concentrated solar power global capacity reached 7.6 GW in 2024, with China as the leader, accounting for all recent installations. The EU holds 2.33 GW, primarily in Spain, with minimal new projects since 2013. Only 0.2% of EU electricity comes from concentrated solar power. It faces limited growth due to cost and location constraints but has the potential to complement PV/wind for storage and support to grid stability. In contrast, industrial process heat applications for concentrated solar thermal are gaining increasing attention in the EU.

Concentrated solar power research and innovation activities are coordinated through the SET Plan implementation working group on concentrated solar thermal. The EU funded 74 concentrated solar power projects (2014–2025) with EUR 246 million, focusing on Spain, Germany, and Italy. Globally, however, China now leads in patents and is second in scientific publications. The EU claims substantial manufacturing capacity for all the primarily used components for concentrated solar power identified under NZIA, but quantitative data is limited.

Regarding solar thermal heating and cooling technologies, the EU represented 7.5% of the total installed capacity in 2024. According to the Solar Heat Worldwide report, 2024 marked the first year since 2000 to experience a decrease in worldwide installed capacity. This trend indicates a preference for alternative heating and cooling technologies, such as heat pumps. On the other hand, 24 new large-scale solar thermal facilities were deployed.

Public RD&I funding for solar thermal technologies in the EU decreased in 2024. However, between 2014 and 2024, the EU consistently maintained a 60% share in this funding. Private research, development and innovation funding for solar thermal technologies rose to EUR 70 million globally in 2024. However, the EU's share dropped to almost negligible in 2024, after representing nearly 100% in 2023.

The number of scientific publications on solar thermal technologies has increased each year. In 2024, the EU accounted for around 18% of these publications, while China held the largest share.

In 2024, extra-EU exports increased by 30% to EUR 42 million, resulting in a trade surplus of EUR 16 million. This aligns with findings showing that the EU manufacturing capacity significantly exceeds the total capacity deployed during 2024. Hence, it seems plausible that the EU can meet the 40% target set by NZIA for 2030.

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List of abbreviations and definitions

Abbreviations	Definitions
CAPEX	Capital Expenditure
CPC	common patent
CR(S)	central receiver (system), aka solar tower system
CSH	Concentrated (concentrated) Solar [thermal] Heat
CSHIP	Concentrated Solar Heat for Industrial Processes
CSP	Concentrated (concentrated) Solar [thermal] Power
DH	District heating
DHC	District heating and cooling
DNI	Direct normal irradiance
EPC	engineering, procurement and construction
ETS	Emission Trading System
EU	European Union
FiT	feed-in tariff
FOAK	First–of-a-Kind
FP7	Seventh Framework Programme
H2020	Horizon 2020,
HE	Horizon Europe
HTF	heat transfer fluid
IA	Innovation Action
IEA	International Energy Agency
IP	Implementation Plan

Abbreviations	Definitions
IRENA	International Renewables Energy Agency
ISCC	integrated solar combined cycle
IWG	Implementation Working Group
LCOE	levelised cost of electricity
LCOH	levelised cost of heat
MENA	Middle East and North Africa
MSCA	Marie Skłodowska-Curie Action
OPEX	Operational Expenditure
PPA	power purchase agreement
PV	photovoltaic
PVT	photovoltaic thermal [hybrid device]
RES	Renewable Energy Source
RHC	Renewable Heating and Cooling
RHC ETIP	European Technology and Innovation Platform on Renewable Heating and Cooling
RIA	Research and Innovation Action
SET Plan	Strategic Energy Technology Plan
SHIP	Solar Heat for Industrial Processes
STE	solar thermal electricity
TES	thermal energy storage
TRL	Technology Readiness Level

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Annex 1 Summary Table of Data Sources for the CETO Indicators

Theme	Indicator	Main data source
Technology maturity status, development and trends	Technology readiness level	Literature SET Plan roadmaps ETIP strategic research agendas
	Installed capacity & energy production	CST4ALL project EurobsevER Baromoter Solar Heat Worldwide (IEA TCP SHC)
	Technology costs	IRENA NREL ATB POLES-JRC, POTEnCIA
	Public and private RD&I funding	JRC analysis of VC and patents
	Patenting trends	JRC patent analysis
	Scientific publication trends	JRC Technology innovation Monitor
	Assessment of R&I project developments	CST4ALL project CORDIS CINEA dashboard
Value chain analysis	Turnover & Gross Value Added	Solar Heat Worldwide (IEA TCP SHC) Solar Heat Europe
	Environmental and socio-economic sustainability	See 2024 CETO report, Annex 3
	EU companies and roles	Eurobsev'ER Solrico
	Employment	IEA, IRENA, Solar Heat Worldwide
	Energy intensity and labour productivity	No data found
	EU industrial production	JRC PRODCOM analysis (proxy analysis due to lack of solar thermal code)
Global markets and EU positioning	Global market growth and relevant short-to-medium term projections	Eurobsev'ER, Solar Heat Worldwide (IEA TCP SHC), Solar Heat Europe
	EU market share vs third countries share, including EU and global market leaders	See above
	EU trade (imports, exports) and trade balance	JRC COMEXT analysis
	Resource efficiency and dependencies (in relation EU competiveness)	Literature

Source: JRC elaboration 2025.

Annex 2 Horizon Europe projects on concentrated solar power

Acronym	Title	Type of Action	Budget	Start Date	Duration (months)
ABraytCSPfuture	Air-Brayton cycle concentrated solar power future plants via redox oxides-based structured thermochemical heat exchangers/thermal boosters	HORIZON-RIA	2,995,458	01-11-2022	48
ASTERIx-CAESar	Air-Based Solar Thermal Electricity For Efficient Renewable Energy Integration & Compressed Air Energy Storage	HORIZON-IA	5,270,925	01-10-2023	48
CoMeTES	Performance study of innovative Corrosion and Mechanically resistant coated materials against molten salts for next-generation concentrated solar power plants and Thermal Energy Storage systems	HORIZON-TMA-MSCA-PF-EF	165,313	01-10-2023	24
CST4ALL	Support To The Activities Of The Concentrated Solar Thermal Technology Area Of The Set Plan	HORIZON-CSA	599,529	01-10-2022	36
DynaMOST	Excited-State Dynamics of Molecular Solar Thermal Fuels	HORIZON-TMA-MSCA-PF-EF	199,441	01-10-2023	24
ONESTEP	Optimised Nanofluids for Efficient Solar Thermal Energy Production	HORIZON-TMA-MSCA-PF-EF	263,639	01-05-2023	30
PYSOLO	PYrolysis of biomass by concentrated SOLar pOwer	HORIZON-RIA	4,997,163	01-07-2023	48
SecRHC-ETIP2022-2025	Secretariat of the European Technology and Innovation Platform on Renewable Heating and Cooling in 2022-2025	HORIZON-CSA	1,049,387	01-09-2022	36
SolarHub	A Greek-Turkish Solar Energy Excellence Hub to Advance the European Green Deal	HORIZON-CSA	4,846,397	01-01-2023	48
SOLARX	Dispatchable concentrated Solar-to-X energy solution for high penetration of renewable energy	HORIZON-RIA	2,671,826	01-11-2022	36
SULPHURREAL	An innovative thermochemical cycle based on solid sulphur for integrated long-term storage of solar thermal energy	HORIZON-EIC	3,982,133	01-10-2023	36
SUNSON	Concentrated Solar energy storage at Ultra-high temperatures aNd Solid-state cONversion	HORIZON-RIA	2,999,938	01-12-2022	42
TOPCSP	Towards Competitive, Reliable, Safe and Sustainable Concentrated Solar Power (CSP) Plants	HORIZON-TMA-MSCA-DN	2,576,261	01-10-2022	48

Source: JRC analysis of Cordis data, 2025.

Annex 3 Energy System Models and Scenarios

Annex 3.1 POTEnCIA CETO 2025 Scenario

The *POTEnCIA CETO 2025 Scenario* has been generated with the Policy Oriented Tool for Energy and Climate Change Impact Assessment (POTEnCIA). Developed in-house by the European Commission's Joint Research Centre (JRC) to support EU policy analysis, POTEnCIA is an energy system simulation model designed to compare alternative pathways for the EU energy system. The core modelling approach of POTEnCIA (detailed in Mantzos et al., 2019) focuses on the economically-driven operation of energy markets and corresponding supply-demand interactions, based on a recursive dynamic partial equilibrium method.

The technology projections provided in the *POTEnCIA CETO 2025 Scenario* are obtained under a climate neutrality scenario aligned with the broad GHG reduction objectives of the European Green Deal. As such, this scenario reduces net EU GHG emissions by 55% by 2030 and 90% by 2040, both compared to 1990, and reaches net zero EU emissions by 2050. To model the uptake of different technologies under this decarbonisation trajectory, the scenario includes a representation at EU level of general climate and energy policies such as emissions pricing under the Emissions Trading System, as well as key policy instruments that have a crucial impact on the uptake of specific technologies. For instance, the 2030 energy consumption and renewable energy shares reflect the targets of the EU's Renewable Energy Directive (RED) and of the Energy Efficiency Directive (EED). Similarly, the adoption of alternative powertrains and fuels in transport is consistent with the updated CO2 emission standards in road transport and with the targets of the ReFuelEU Aviation and FuelEU Maritime regulations.

Compared to the *POTEnCIA CETO 2024 Scenario* (Neuwahl et al, 2024), the *POTEnCIA CETO 2025 Scenario* incorporates many model enhancements and scenario-specific updates, most notably:

- The usage of the more recent JRC-IDEES 2023 data (Rózsai et al, 2025).
- Closer alignment to the National Energy and Climate Plans (NECPs) of the individual MS, which have been published in recent months.

A more detailed description of the *POTEnCIA CETO 2025 Scenario* will be available in the forthcoming report (Neuwahl et al., 2025).

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Neuwahl, F., Wegener, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Gea Bermudez, J., and Rózsai, M., Clean Energy Technology Observatory: POTEnCIA CETO 2024 Scenario, Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/1473321, JRC139836.

Neuwahl, F., Wegener, M., Jaxa-Rozen, M., Salvucci, R., Sikora, P., Gea Bermudez, J., and Rózsai, M. *The POTEnCIA CETO 2025 Scenario*, Forthcoming.

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Annex 3.2 Global CETO 2°C Scenario 2025

The *Global CETO 2°C Scenario 2025* has been generated by the global energy model *POLES-JRC* (Prospective Outlook for the Long-term Energy System).

POLES-JRC covers the entire global energy system with a high level of regional detail, encompassing 66 countries and regions, from primary supply (fossil fuels, renewables) to transformation (power, biofuels, hydrogen, and hydrogen-derived fuels, such as e-fuels and ammonia) and final consumption sectoral demand (industry, buildings, transport). International markets and energy fuel prices are calculated endogenously. The model comprises a comprehensive portfolio of technologies, with technology dynamics and interactions across sectors modelled using endogenous technology learning.

Detailed documentation of the *POLES-JRC* model is provided in (Després et al., 2018). Techno-economic assumptions used in the current version of the model are provided in (Schmitz et al., 2025). The latter report provides also a comprehensive overview of the dynamics and interaction of various clean energy technologies until the end of the century. POLES-JRC results are published in the annual "Global Climate and Energy Outlooks" (GECO) report, which provides detailed country energy and GHG balances, and an online visualisation interface.

The *Global CETO 2°C scenario 2025* is designed to limit global temperature increase to 2°C at the end of the century. It is driven by a single global carbon price. The *Global CETO 2°C scenario 2025* builds on the *POLES-JRC* model version used for GECO 2024 (European Commission, 2025) and has been enhanced as following:

- Cost optimisation for electrolysers powered by renewables (PV, wind) has been implemented considering an over-sizing of renewable capacities and battery storage.
- Electrolyser investment costs have been increased reflecting recent literature revisions.
- Updated investment costs for renewable technologies and utility battery according to (IRENA, 2025) as well as updated installed capacities for power generating technologies.
- Revised global wind profiles (off-shore and on-shore).
- Updated data on new vehicles and vehicle stock by transport mode (battery and fuel cell vehicles, ICE, hybrid) and vehicle type (passenger cars, light and heavy trucks, buses).
- Updated hydrogen infrastructure cost related to road transport.

POLES-JRC References

European Commission: Joint Research Centre, Keramidas, K., Fosse, F., Aycart Lazo, F.J., Dowling, P., Garaffa, R., Ordonez, J., Petrovic, S., Russ, P., Schade, B., Schmitz, A., Soria Ramirez, A., van Der Vorst, C. and Weitzel, M., Global Energy and Climate Outlook 2024, Publications Office of the European Union, Luxembourg, 2025, https://data.europa.eu/doi/10.2760/9028706, JRC139986.

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Annex 4 Horizon 2020 and Horizon Europe projects on solar thermal heat technology

PROJECT	Funding Programme / Duration/ Costs	Project description
TheGreefa	Duration: 2020-2024 Funding Programme: H2020 **Total cost [€]:** 4,651,865 **EU contribution [€]:** 4,029,238	This project develops a new thermochemical technology using salt solutions for greenhouse climate control and crop drying. It captures solar and residual heat, stores it without losses, and reuses it for heating, cooling, and water recovery. Demonstrators in Central and Mediterranean climates will test applications like desalination and greenhouse heating.
PROMETEO	Duration: 2021-2024 Funding Programme: H2020 **Total cost [€]:** 2,765,206 **EU contribution [€]:** 2,499,531	The PROMETEO project aims to produce green hydrogen using Solid Oxide Electrolysis (SOE) powered by renewable electricity and solar heat. It addresses the challenge of intermittent energy sources by integrating SOE with Thermal Energy Storage (TES) to enable 24/7 operation. A 25 kWe modular prototype is developed and tested in real-world conditions, producing approximately 15 kg of hydrogen per day.
CAPTure	Duration: 2015-2020 Funding Programme: H2020 **Total cost [€]:** 6,461,970 **EU contribution [€]:** 6,104,033	The project aims to reduce the cost of concentrated solar power (CSP) and enhance its competitiveness in the energy market. It focuses on increasing solar-to-electric efficiency through higher receiver temperatures and an innovative power cycle design.
SOLPART	Duration: 2016-2019 Funding Programme: H2020 **Total cost [€]:** 4,558,688 **EU contribution [€]:** 4,366,563	The SOLPART project aims to develop a pilot-scale solar process operating at 950°C for 24-hour particle treatment in energy-intensive industries, such as cement and lime production.

FTI Cocoon	Duration: 2016-2018 Funding Programme: H2020 **Total cost [€]:** 1,521,875 **EU contribution [€]:** 1,065,313	The project addresses the need for largescale land restoration in the face of growing population pressure and climate change. It introduces the Cocoon, a TRL 7 product that supports tree growth in drylands by increasing seedling survival and water efficiency.
Re-Deploy	Duration: 2016-2019 Funding Programme: H2020 **Total cost [€]:** 2,893,153 **EU contribution [€]:** 2,025,207	This SME project targets the largely untapped EUR 26 billion/year market for solar process heat in industrial applications up to 250 °C. The company introduces redeployable, turnkey solar boilers (≥1 MWt) to sell heat—not equipment—utilising a low-risk business model with short-term (3-year) commitments.
Innova MicroSolar	Duration: 2016-2022 Funding Programme: H2020 **Total cost [€]:** 3,999,384 **EU contribution [€]:** 3,999,384	This project supports the EU's climate goals by developing an innovative solar heat and power system for homes and small businesses. It will generate 2 kW of electricity and 18 kW of heat using solar thermal energy at temperatures of 250–280 °C. Key technologies include Organic Rankine Cycle units, linear Fresnel collectors, heat pipes, Phase Change Material-based thermal storage, and smart controls.
Polarsol Phase Two	Duration: 2016-2018 Funding Programme: H2020 **Total cost [€]:** 2,059,050 **EU contribution [€]:** 2,941,500	Polarsol project aims to accelerate the transition to locally produced renewable energy by offering a highly cost-efficient hybrid heat management system. Their patented technology uniquely combines solar thermal energy, exhaust air heat pumps, and waste heat recovery, also providing cooling, making it suitable for residential, commercial, and industrial applications.
PEGASUS	Duration: 2016-2021 Funding Programme: H2020 **Total cost [€]:** 4,695,365 **EU contribution [€]:** 4,695,365	The PEGASUS project explores a novel solar power cycle using a solar particle receiver and a sulphur-based storage system to enable 24/7 renewable electricity generation. It combines solid particles for both heat transfer and storage with thermochemical storage via solid sulphur.
INSHIP	Duration: 2017-2020 Funding Programme: H2020 **Total cost [€]:** 2,858,799 **EU contribution [€]:** 2,498,661	The INSHIP project aims to establish a European Collaborative Research Infrastructure in SHIP (ECRIA) to foster cooperation among EU research institutions, align funding programs, and expedite technology transfer to industry.

MAESDOSO	Duration: 2017-2019 Funding Programme: H2020 **Total cost [€]:** 145,846 **EU contribution [€]:** 145,846	The MAESDOSO project aims to develop advanced electrochromic smart glass for domestic ovens, offering independent control over light and heat transfer. Current electrochromic glasses, which mostly utilise transition metal oxides, face challenges in terms of cost, durability, and colour stability.
SWS-HEATING	Duration: 2018-2023 Funding Programme: H2020 **Total cost [€]:** 5,236,489 **EU contribution [€]:** 4,994,926	The SWS-HEATING project develops an innovative seasonal thermal energy storage (STES) system using novel Selective Water Sorbent (SWS) materials embedded in a compact, multi-modular sorption unit. This system stores abundant summer solar heat for use in colder months, aiming to cover up to 60% of heating and hot water demand in central/northern Europe and 80% in southern Europe.
HyCool	Duration: 2018-2022 Funding Programme: H2020 **Total cost [€]:** 7,740,440 **EU contribution [€]:** 5,818,972	The HyCool project aims to enhance solar heat utilisation in industrial processes by integrating Fresnel CSP solar thermal collectors with innovative Hybrid Heat Pumps (HHPs) that combine adsorption and compressor technologies. This hybrid system offers flexibility and efficiency, adaptable to various design and operational needs, enhancing solar heating and cooling (SHC) potential in industry.
SHIP2FAIR	Duration: 2018-2023 Funding Programme: H2020 **Total cost [€]:** 7,996,793 EU **contribution [€]:** 10,141,361	SHIP2FAIR promotes the integration of solar heat in agro-food industrial processes by developing tools and methods that cover the entire project lifecycle.
SolBio-Rev	Duration: 2019-2024 Funding Programme: H2020 **Total cost [€]:** 4,790,536 **EU contribution [€]:** 4,790,536	The SolBio-Rev project aims to develop a flexible renewable energy system for buildings, covering heating, cooling, and variable electricity demand cost-effectively.

SolarTwins	Duration: 2020-2023 Funding Programme: H2020 **Total cost [€]:** 799,446 **EU contribution [€]:** 799,446	The SolarTwins project aims to boost the scientific excellence and innovation capacity of METU-GÜNAM's Concentrating Solar Thermal (CST) research lab by twinning it with leading institutions PSA-CIEMAT and DLR.
FRIENDSHIP	Duration: 2020-2024 Funding Programme: H2020 **Total cost [€]:** 4,999,424 **EU contribution [€]:** 4,999,424	The FRIENDSHIP project aims to expand the use of solar heat beyond the agro-food industry to other sectors, including textiles, plastics, wood, metals, and chemicals. It will bring together research centres, industry leaders, technology providers, and heat suppliers to develop reliable, user-friendly, and cost-effective solar heat solutions.
SHE	Duration: 2020-2023 Funding Programme: H2020 **Total cost [€]:** 2,800,121 **EU contribution [€]:** 1,960,084	Abora Solar focuses on hybrid solar collectors that produce both heat and electricity simultaneously, aiming to tackle Europe's high building energy consumption, which accounts for 40% of the total.
Sol2H2O	Duration: 2022-2025 Funding Programme: Horizon Europe **Total cost [€]:** 1,491,531 **EU contribution [€]:** 1,491,531	Sol2H2O addresses desalination's key challenges—high energy consumption and harmful brine waste—by developing a solar-powered zero liquid discharge (ZLD) system that recovers valuable resources and produces fresh water, thereby promoting a circular economy.
PLOTEC	Duration: 2022-2025 Funding Programme: Horizon Europe **Total cost [€]:** 1,322,523 **EU contribution [€]:** 1,322,523	The project aims to demonstrate innovative designs and materials for an ocean thermal energy conversion (OTEC) platform that converts solar heat stored in oceans around EU Overseas Territories, Small Islands, and developing regions into reliable, affordable baseload power.

Circular Fuels	Duration: 2023-2027 Funding Programme: Horizon Europe **Total cost [€]:** 4,997,354 **EU contribution [€]:** 4,997,354	The Circular Fuels project combines concentrated solar heat, solar electricity, and thermochemical conversion of bio-based waste to produce sustainable aviation fuels. Using waste wood and agricultural residues, solar-assisted fast pyrolysis converts feedstock into bio-oil without burning pyrolysis products for heat.
PYSOLO	Duration: 2023-2027 Funding Programme: Horizon Europe **Total cost [€]:** 4,997,163 **EU contribution [€]:** 4,997,163	The PYSOLO project develops a novel, fully renewable biomass pyrolysis process powered by concentrated solar power (CSP). By utilising solar heat, it maximises valuable products such as bio-oil, biochar, and pyrogas while minimising CO_2 emissions compared to conventional pyrolysis.
INDHEAP	Duration: 2024-2027 Funding Programme: Horizon Europe **Total cost [€]:** 8,528,816 **EU contribution [€]:** 6,998,983	The INDHEAP project aims to demonstrate, at TRL7, the combined use of solar thermal (ST) and photovoltaic (PV) energy to meet mid-temperature industrial heat and power needs, up to 250°C. It focuses on a flexible thermal energy storage system boosted by electric heaters (e-TES) to optimise solar energy use.
SOLTEC	Duration: 2024-2026 Funding Programme: Horizon Europe **Total cost [€]:** No data **EU contribution [€]:** 230,774	The SOLTEC project proposes an integrated solar collector and Thermochemical Energy Storage (TCES) system to decarbonise process heating, a sector that currently lacks cost-effective solutions.
SPECTRUM	Duration: 2024-2028 Funding Programme: Horizon Europe **Total cost [€]:** 3,036,835 **EU contribution [€]:** 2,999,867	The SPECTRUM project develops an innovative solar concentrating collector that converts the full solar spectrum into three renewable energy vectors: solar heat, electricity, and green hydrogen, while treating industrial wastewater.

Source: JRC elaboration 2025

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