SOLAR THERMAL HEATING

KEY FACTS FOR 2024

- The global market for solar thermal water collectors contracted 14.2% in 2024, mainly due to ongoing decline in China, the largest market.
- Small-scale systems have lost market share in several regions, while demand for large-scale solar thermal heating projects has risen.
- Globally, 346 large-scale solar thermal district heating systems were in operation by the end of 2024 (9 more than in 2023), with total capacity of 2 GW_{th}.
- In 2024, 106 solar heat for industrial processes (SHIP) plants began operation, bringing the total to at least 1,315 installations supplying process heat.
- Solar thermal heating technologies continued to face strong market competition due to awareness gaps and imbalanced incentives.

Although the global market for solar thermal water collectors shrank in 2024, several countries saw strong growth, particularly in **Latin America**

Solar thermal district heating capacity operating worldwide reached **2 GW_{th}**

106 systems were completed in 20 countries to provide solar heat for industrial processes

MARKET DEVELOPMENTS AND TRENDS

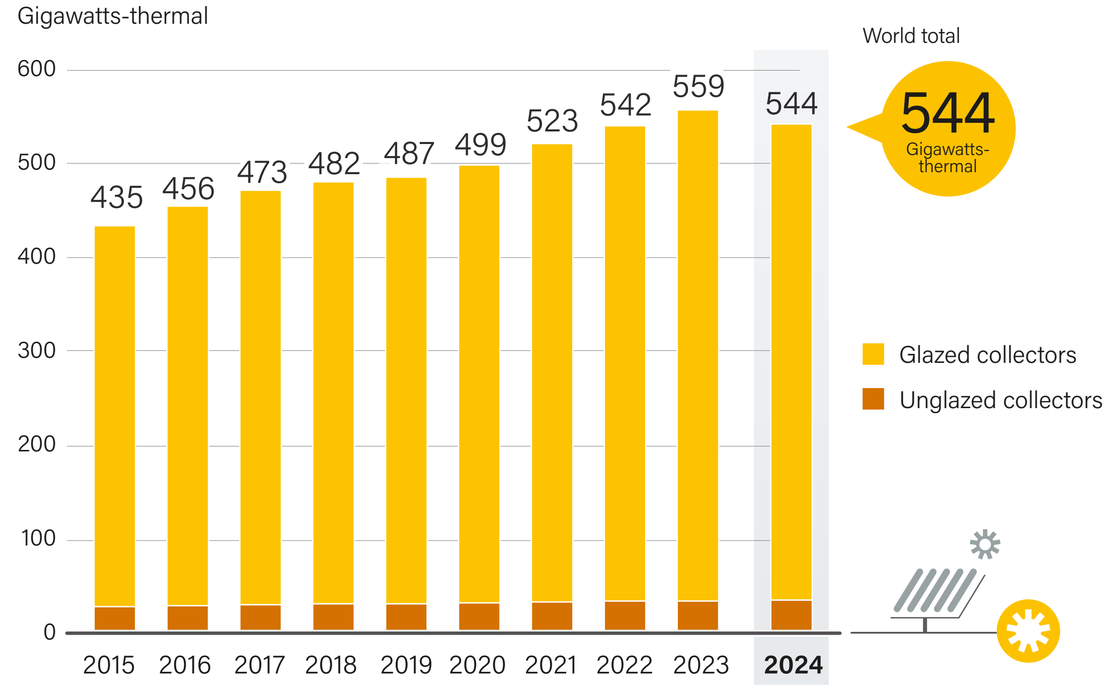
Solar thermal collectors transform solar radiation into useful thermal energy for heat[i] applications, ranging from domestic water and space heating to high-temperature heat and steam for industrial processes. Advanced solar thermal systems are being integrated with heat pumps and in photovoltaic-thermal (PVT) collectors.[1] In industry and district heating systems, they are increasingly combined with thermal energy storage, which plays a growing role in providing grid flexibility.[2]

The global market for solar water collectors contracted a further 14.2% in 2024, to an estimated 17.8 gigawatts-thermal (GW_{th}) of newly installed capacity (25.4 million square meters, m^2, of collector area[ii]), continuing a downward trend that began in 2013 (with the exception of a slight rise in 2021).[3] Sales declined in many traditionally significant markets, such as Australia, China, India and much of Europe[iii].[4] However, several markets saw strong growth, particularly in Latin America, where Brazil's installations rose 10.8% and Mexico's were up 10%; other growth markets included Türkiye (10%) and Cyprus (2%).[5]

By year's end, millions of residential, commercial and industrial clients in at least 134 countries were benefiting from solar thermal heating systems.[6] The total global capacity of solar water collectors in operation was enough to provide around 443 terawatt-hours of heat annually, equivalent to the energy content of nearly 261 million barrels of oil.[7] However, cumulative global capacity in operation declined 2.7% in 2024 to an estimated 544 GW_{th} (777 million m^2).[8] (→ *See Figure STH-1.*)

The decline occurred because assumed[iv] retirements in 2024 exceeded additions.[9] Since 2013, annual installations have declined by more than 50%, mainly due to an ongoing contraction in the world's largest single market, China, where the real estate sector has experienced significant challenges and the rural market for domestic hot water systems has reached saturation.[10]

FIGURE STH-1
Solar Water Heating Collectors Global Capacity, by Type, 2015-2024



Note: Data are rounded to the nearest GW_{th}. Data are for glazed and unglazed solar water collectors only.

Source: IEA SHC. See endnote 8 for this section.

i Solar thermal energy also can be used for cooling and chilling purposes, but this remains a niche market.

ii Data are for glazed and unglazed water collectors only. Conversion from square metres (m^2) to capacity uses a factor of 0.7 kilowatts-thermal (kW_{th}) per m^2.

iii Traditionally strong or significant markets that experienced declines in 2024 included Lebanon (-63.8%), Poland (-43%), Germany (-42%), Italy (-36%), the United States (-31%), Spain (-30%), Greece (-25%), India (-24%), China (-17%) and Australia (-16%). See endnote 4 for this section.

iv The data assume a theoretical lifespan of 15-25 years, depending on system type and country, although actual lifespan might be longer.

Globally, solar thermal heating technologies continue to face fierce competition from other heating solutions, exacerbated by a lack of awareness of the potential of these technologies and an imbalance in policies and utility incentives in many countries.[11] Solar thermal systems for water and space heating, in particular, must compete with solar PV and heat pumps, which in many countries have benefited from much greater promotion and policy support.[12] This is especially true in markets where more complex pumped systems are the norm (e.g., China, much of Europe); markets have been more stable where the focus is on simpler thermosyphon[i] technologies (e.g., sub-Saharan Africa[ii], Latin America, the Mediterranean and elsewhere in Asia).[13]

China remained the largest market for solar thermal systems of all types in 2024 and accounted for around 64% of solar water collector sales, followed by Brazil, Türkiye, India and Mexico, which overtook the United States; Australia, Greece, Germany and Italy rounded out the top 10.[14] (→ *See Figure STH-2.*) At year's end, China accounted for 72% of cumulative global capacity, trailed distantly by Türkiye, Brazil, which overtook the United States, followed by India, and Germany, which slipped one place to sixth.[15] For total capacity per capita, the top countries in 2023 were Barbados, Cyprus, Greece, Israel and Austria.[16]

In **China**, sales have shown a continuous downward trend since 2014 (apart from a slight rise in 2021) and fell a further 17% in 2024.[17] An estimated 11.4 GW_{th} of solar water heating collectors began operation, bringing total capacity to 391.8 GW_{th}.[18] As China's thermosiphon water heater market also faces increasing competition from a range of alternative water heating technologies (grid electricity, fossil gas, heat pumps and solar PV), many solar thermal companies have shifted their focus to district heating and industrial applications.[19]

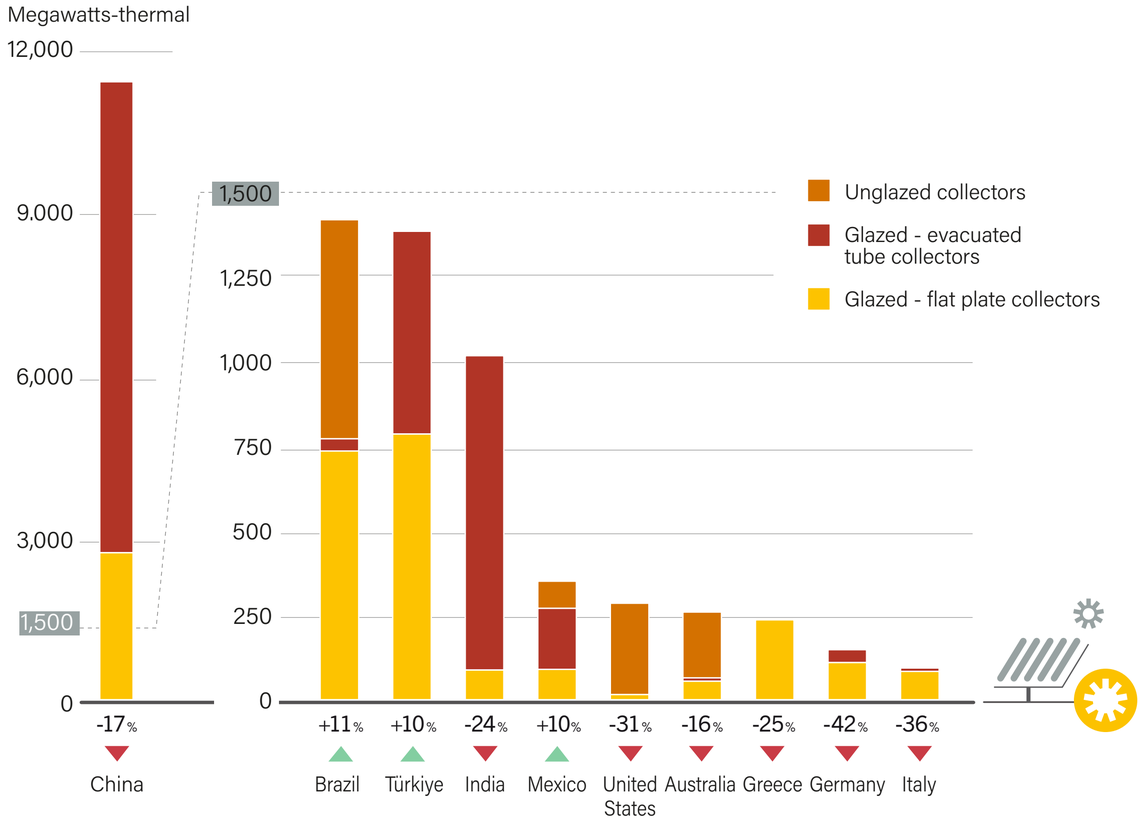
Brazil surpassed India to place second for additions, with market growth of 10.8% in 2024.[20] Brazil added a record 1.42 GW_{th} (2 million m^2) of solar thermal water heating systems, with unglazed collectors for swimming pools accounting for over 45% of the newly installed collector area, increasing total operating capacity 8.2% to 18.1 GW_{th}.[21] The growth in sales was attributed to a government commitment to develop the solar thermal domestic supply chain, expansion of solar thermal technologies into new market segments and growth in the construction sector.[22]

Türkiye also overtook India for annual sales, adding 1.39 GW_{th} (nearly 2 million m^2) to bring its total capacity to 19.6 GW_{th}.[23] Following a decline (-2.6%) in 2023, due mainly to inflation and the aftermath of the 2023 Türkiye-Syria earthquakes, Türkiye's market expanded 10% in 2024 as post-earthquake reconstruction fuelled growth in the construction sector.[24] In addition to residential applications, solar thermal is widely used in hotels, hospitals and other facilities nationwide.[25]

i Thermosiphon solar water heaters are passive systems that use convection to circulate water, whereas active pumped systems rely on fluid circulation, advanced controls and pumps. Thermosiphon systems are common in climates where there is no risk of freezing, and they account for more than half of total installed solar thermal capacity (as of end 2022). See endnote 13 for this section.

ii The exception is South Africa, where solar thermal is facing increasing competition from solar PV for water heating.

FIGURE STH-2
Solar Water Heating Collector Additions, Top 20 Countries for Capacity Added, 2024



Note: Additions represent gross capacity added. Change in annual additions relative to 2023 is provided in % and rounded to the nearest whole number.

Source: See endnote 14 for this section.

By contrast, **India** fell from second place for new installations in 2023 to fourth in 2024 as sales declined 24%, following strong growth (27%) in 2023.[26] India added 1 GW_{th} (1.46 million m^2) for a total of 15.4 GW_{th}.[27] The market is supported by mandates and incentives in several states.[28] In recent years, however, falling solar PV prices combined with subsidy schemes have encouraged the installation of solar PV over solar thermal systems on rooftops.[29] An influx of poor-quality systems also has affected sales.[30] In early 2024, the government issued a solar thermal collector quality control order to protect consumers and boost domestic manufacturing.[31]

Mexico rose three places to fifth globally, adding 354 MW_{th} (505,561 m^2) in 2024 for a total of 4.8 GW_{th}.[32] Key drivers of this growth included rising energy costs, supportive policy at the federal and state levels (e.g., Mexico City, Jalisco), increasing environmental awareness and a growing demand for sustainable building solutions.[33] Increasingly, solar thermal systems are combined with heat pumps to raise overall efficiency; other trends include market diversification, including expanded use in the commercial and industrial sectors.[34]

Other top markets shrank significantly in 2024. In the **United States** (-31%) the contraction was primarily due to an economy-wide decline in consumer confidence.[35] **Australia**'s market (-16%) has been shrinking since at least 2013, with solar thermal under pressure from solar PV and air-source heat pumps, both of which receive support under the Small-Scale Renewable Energy Scheme.[36]

In **Germany** (-42%), the growing market for large-scale systems failed to compensate for the shrinking single-family home segment, which contracted largely due to stalled new building construction and a temporary reduction in subsidies for biomass boilers, which are often paired with solar thermal systems.[37] However, recent policy changes offer promise for future years: an amendment to Germany's Building Energy Act requires newly installed heating systems to use 65% renewable energy (including solar thermal) from the start of 2024 and provides financial support to replace existing systems, to aid the transition away from fossil fuels in the heat sector by 2045.[38]

i In addition to district heating, large-scale systems (defined as those with capacity over 350 kilowatts-thermal, or exceeding 500 m^2) are used in large residential, commercial and public buildings, such as hospitals, hotels and sports centres. See endnote 39 for this section.

ii Solar thermal can provide costs in the range of USD 20.8-52.1 (EUR 20-50) per MWh under favourable conditions, well below the prices customers pay for district heating. See endnote 40 for this section.

Solar thermal plant for district heating in Ludwigsburg, Germany.

346

solar thermal district heating systems

were in operation at the end of 2024.

SOLAR THERMAL IN DISTRICT HEATING

Although most solar thermal capacity in operation globally (around 87% of annual installations) provides water and space heating in individual buildings, the use of large-scale solar thermal systems[i], including for **district heating,** continued to expand.[39] Under favourable conditions, solar thermal energy is a cost-effective[ii] option for decarbonising urban district heat networks.[40]

Ten new solar thermal district heating systems were added in 2024.[41] The Netherlands was the leading market for new capacity, completing one plant in Groningen (34 MW_{th}). This plant is the fourth largest in the world, and its advanced collectors are expected to produce 25% more energy than conventional collectors from the same area.[42] China added 32 MW_{th} across four new systems, followed by Germany (3 systems; 6.9 MW_{th}), Italy (1; 0.6 MW_{th}) and Austria (1; 0.4 MW_{th}).[43]

Germany installed less capacity than expected, but had several additional systems under construction, including a 46 MW_{th} plant in Leipzig.[44] Germany's market is growing rapidly owing to a series of supportive policies, including a federal funding scheme and the Local Heat Planning Law, which came into force in 2024. The law, enacted to implement the EU Energy Efficiency Directive, requires German municipalities to suggest areas for district heating expansion.[45]

By year's end, a documented 346 large-scale solar thermal district heating systems were operating worldwide, with a total capacity of 2 GW_{th} (2.8 million m^2); many of these systems include storage capacity to accommodate seasonal variability.[46] Denmark, the global market leader for nearly a decade, continued to lead in terms of the total number of systems and installed area, although little capacity has been added since 2020, when changes in policy and funding conditions precipitated a market collapse.[47]

Political commitment and stable policies play an important role in the development of solar thermal district heating systems because of the time required for project development (>5 years).[48] Other challenges to the development of these systems include: a lack of awareness of the benefits of solar thermal for district heating; accessing financing; identifying suitable sites near heat demand; lengthy and costly permitting processes; the high temperatures at which some grids operate; and the need for seasonal storage, which requires further research and development for very large networks.[49]

SOLAR INDUSTRIAL HEAT PLANTS

The number of **solar heat for industrial processes** (SHIP) plants continued to grow globally, with 106 facilities (120 MW_{th}) in 20 countries completed during 2024.[50] Industrial heat[i] accounts for a significant share of global energy consumption and traditionally relies heavily on fossil fuels, but the sector is showing growing interest in solar thermal energy.[51] Solar thermal technologies can provide zero-emissions low-temperature (below 150 degrees Celsius, °C) or medium-temperature (150-400°C) heat in the form of hot water, air or steam[ii].[52]

At year's end, at least 1,315 SHIP installations, totalling 1,071 MW_{th}, were supplying process heat to factories worldwide.[53] Food and beverage industries continued to operate the largest number of these plants, while the mining sector employed the largest share of operating capacity.[54] Chile's mining industry accounted for more than half of the capacity (in 3 plants) under planning or construction as of early 2025, with the remainder spread over around 70 additional projects across other regions.[55]

Although the number of new SHIP projects declined[iii] relative to 2022 and 2023 (116 systems in each year), the 120 MW_{th} installed in 2024 represented the largest capacity increase in five years.[56] The market continues to fluctuate significantly from year to year due to policy changes, the long planning and implementation period required for many systems, and the commissioning of extremely large projects: for example, a 79.8 MW_{th} parabolic trough field for a leisure park was commissioned in Handan, China in 2024.[57]

The top countries for new projects were unchanged in 2024, although shifts occurred in the rankings[iv]: the Netherlands continued to lead with 24 new systems added, followed by Mexico (22) and China (16), which overtook Germany (10).[58] China installed by far the most new capacity (84.6 MW_{th}), followed by Germany (21.8 MW_{th}) and the Netherlands (3.6 MW_{th}).[59] Interest in SHIP is expanding particularly in Latin America, where new systems were reported in Brazil, Cuba, Colombia and Ecuador.[60]

Counting systems installed between 2017 and 2024, Mexico continued to be home to the most SHIP systems in operation (200), followed by the Netherlands (128) and China[v] (127), while Oman leads in terms of total installed capacity, followed by China and Australia.[61]

Individual SHIP projects have gotten larger in recent years and the share of systems with temperatures above 100°C has grown rapidly.[62] The type of collectors installed is determined in part by required temperatures, with air collectors, flat plate and evacuated tube collectors[vi] able to provide temperatures of up to 100°C, and concentrating collectors providing temperatures of up to 400°C.[63] At least eight different collector types were installed during 2024.[64]

SHIP remained a challenging sector because of low fossil fuel prices combined with low awareness of the options and limited experience with renewable heat in industry, the long lead time for projects, and clients' desire for minimal risk and short payback periods.[65]

Heat delivery contracts, which minimise the market risk for investors, have become the dominant business model of the SHIP industry, particularly for very large projects, and have unlocked new markets for SHIP technology providers.[66]

Recent studies in Australia and Germany found that SHIP is already economically attractive for many applications, especially for low to medium process temperatures.[67] A further study determined that concentrating systems in Mexico could reliably reach temperatures of up to 300°C with a four-year return on investment.[68]

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SHIP

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i Direct heat or steam is required for a range of industrial processes, including in the chemical (boiling, distilling), food and beverage (drying, boiling, pasteurising, sterilising), machinery (cleaning, drying), mining (copper electrolytic refining, mineral drying, nitrate melting), textile (washing, bleaching, dying) and wood industries (e.g., steaming, compressing, drying).

ii Solar thermal collectors and sorption chillers can also provide chilling, down to -40°C, for process refrigeration, although this is still a niche market. See endnote 52 for this section.

iii The decline in the number of systems was mainly due to a reduction in subsidies for the agricultural sector in the Netherlands, with the number of systems rising in the rest of the world, from 73 in 2023 to 82 in 2024. See endnote 56 for this section.

iv The Netherlands led the rankings in 2022 and 2023 in terms of the number of systems added; in 2022 the country was followed by China, France, Mexico and Germany. In 2023, the Netherlands was followed by Mexico, Germany, China and France. See endnote 58 for this section.

v Data for China are incomplete due to a lack of information regarding how solar thermal materials are used, so the number of systems could be higher. See endnote 61.

vi In addition, stationary collectors with vacuum thermal insulation can achieve temperatures higher than 100°C. See endnote 63 for this section.

AUTHOR

Janet L. Sawin, Sunna Research

REN21 DATA AND KNOWLEDGE TEAM

Jad Baba
Janne Luise Piper
Andrea Wainer
Jiayi Wang
Glen Wright

TOPICAL CONTRIBUTORS

Christoph Brunner (AEE-Institute for Sustainable Technologies – AEE INTEC)
Bärbel Epp (solrico)
Monika Spörk-Dür (AEE INTEC)

EDITING, DESIGN AND LAYOUT

Maria van Veldhuizen (Editor)
weeks.de Werbeagentur GmbH (Design)

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