*Part of the Greater Paris Olympic Aquatics Centre (Saint-Denis, 93) 4 680-m2 roof is covered with photovoltaic panels. It is one of France's biggest urban solar farms (it supplies 25% of the aquatics centre's electricity needs).*

DERBIGUM BY KINGSPAN

**306 429.6 MW**

*Cumulative photovoltaic capacity in the European Union in 2024*

# PHOTOVOLTAIC BAROMETER

*A study carried out by EurObserv'ER.*

**Once again, solar photovoltaic displayed its aptitude for rapid deployment on a global scale in 2024. The International Renewable Energy Agency, IRENA, reported that net maximum global photovoltaic capacity worldwide had risen to 1858.6 GW by the end of the year, amounting to 451.9 GW of additional capacity in the space of 12 months. This amounts to a 28.1% year-on-year increase, compared to the 352.7 GW added in 2023. China towers above the rest of the world for installation (it added 278 GW) and accounts for over 60% of the global market. The European Union remained in second place in 2024 with net maximum additional capacity of about 60 GW, according to EurObserv'ER, and established a clear lead over the United States and India. This global solar growth now goes hand in hand with large scale development of electrochemical storage. China and the United States have already installed tens of GW of storage facilities, while the European and Indian markets are burgeoning.**

**296.8 TWh**

*Photovoltaic electricity generated in the EU during the year 2024*

**59 854.6 MW**

*Photovoltaic capacity installed in the EU during the year 2024*

*Solar shades on the Stellantis Sochaux (Doubs) plant's new car storage facility. This huge 22-hectare parking area with 63 648 photovoltaic modules totalling 29 MW of capacity can accommodate up to 10 000 vehicles and produces the enough power to cover the annual electricity need of 13 000 individuals.*

Global temperature rise will be largely governed by the speed with which renewable energies are rolled out across all continents. In essence, this is one of the observations shared at the last United Nations Climate Change Conference (COP28), the 28th, held in Dubai in December 2023. In its First Global Stocktake, signed by 197 states, as well as the European Union, it specified that one of the ways to implement energy transition and limit climate warming was to triple global renewable energy capacity and double the average annual global pace of energy efficiency by 2030. The Global Stocktake also reaffirmed the consensus that limiting global warming to 1.5°C, with no or limited overshooting, implies 43% of sharp, fast and sustainable global greenhouse gas emissions reductions by 2030 and of 60% by 2035, compared to 2019 levels. Incidentally, the writing of a Global Stocktake in 2023 with five-yearly updates, was planned at the 2017 Paris Agreement to assess the collective progress achieved towards reaching the Agreement's long-term goals on all aspects (mitigation, adaptation and means of implementation), reflecting equity and the best scientific data.

At the same time as the publication of the Global Stocktake, 123 countries undertook to work together to increase global renewable electrical energy capacities to 11 000 gigawatts (GW) by 2030 instead of 3 400 GW in 2022 and a further twenty or so signed a resolution to triple nuclear capacities by 2050. The IEA (International Energy Agency) projections in its **Renewables 2024** publication, predicts that solar photovoltaic will enjoy the most dynamic growth of all energy sectors and that it is destined to become the leading renewable sector for electricity production before 2030, ahead of wind and hydro power. According to IEA projections, renewable energies will account for at least 46% of global electricity production in 2030, with wind energy and solar photovoltaic together accounting for 30% of this figure.

Despite the current huge renewable energy boom, the worldwide switch to trend reduction in GHG emissions has yet to come into force. Loading of the maximum $CO_2$ stock level persists and thus keeps the 1.5°C limitation target out of reach. A scientific article published on 11 April 2025 on the www.nature.com website entitled **Global carbon emissions and decarbonization**, reports that $CO_2$ emissions increased by 0.9% YoY in 2024. Emissions totalled 36.3 gigatonnes, with strong growth observed in India and Russia and a slight decrease in China.

## PV AT FULL CAPACITY GLOBALLY

As each year passes, the steady spread of solar photovoltaic energy worldwide demonstrates that the sector is economically viable and easy to roll out. The latest IRENA report published in March


## Table No. 1

Installed solar photovoltaic capacity*
in the European Union at the end of 2024 (MW)

| | 2023 | 2024** | Installed 2024 |
|---|---|---|---|
| Germany | 74 701.0 | 89 130.0 | 14 494.0 |
| Spain | 29 579.1 | 37 438.1 | 7 859.0 |
| Italy | 29 351.4 | 35 818.7 | 6 467.3 |
| France | 19 934.7 | 24 877.7 | 5 007.0 |
| Netherlands | 21 274.6 | 24 359.0 | 3 084.4 |
| Poland | 16 580.7 | 20 944.6 | 4 363.9 |
| Greece | 6 688.7 | 9 288.7 | 2 600.0 |
| Belgium | 8 351.9 | 9 130.0 | 778.1 |
| Austria | 6 394.8 | 8 620.1 | 2 226.3 |
| Hungary | 5 910.0 | 7 699.0 | 1 789.0 |
| Portugal | 3 896.0 | 5 666.0 | 1 770.0 |
| Sweden | 3 993.0 | 4 993.0 | 1 000.0 |
| Romania | 2 988.0 | 4 688.0 | 1 700.0 |
| Bulgaria | 2 908.1 | 4 568.0 | 1 659.9 |
| Czechia | 3 272.0 | 3 953.0 | 681.0 |
| Denmark | 3 537.0 | 3 945.0 | 408.0 |
| Lithuania | 1 153.0 | 2 408.0 | 1 255.0 |
| Slovenia | 1 031.2 | 1 330.0 | 298.8 |
| Estonia | 813.0 | 1 210.0 | 397.0 |
| Finland | 1 009.0 | 1 209.0 | 200.0 |
| Ireland | 752.9 | 1 185.0 | 432.1 |
| Slovakia | 594.0 | 868.0 | 274.0 |
| Croatia | 462.5 | 859.6 | 397.1 |
| Cyprus | 580.7 | 797.0 | 216.3 |
| Latvia | 319.0 | 660.0 | 341.0 |
| Luxembourg | 403.7 | 548.0 | 144.3 |
| Malta | 225.7 | 236.2 | 11.3 |
| **Total EU 27** | 246 705.8 | 306 429.6 | 59 854.6 |

** Net maximum electrical capacity. off grid included. MW expressed in alternative current. ** Estimation. Note: 65 MW decommissioned in Germany. 64 MW in France. 1 MW in Austria. 0.9 MW in Malta. The data concerning the decommissioned capacity is not always available.* ***Sources: EurObserv'ER 2025***

2025 that presents the world's installed renewable energy capacity statistics for the last decade (2015-2024), puts maximum net installed photovoltaic capacity worldwide provisionally at 1 858.6 GW at the end of 2024, compared to 1 406.7 GW at the end of 2023, i.e., 32.1% YoY growth. Additional photovoltaic capacity was quantified at 451.9 GW in 2024, which is almost 100 GW more (352.7 GW was added in 2023) and more than 250 GW more than in 2022 (when 193.5 GW was added). Applying IRENA's methodology, renewable electrical capacity data represents the maximum net installed and on-grid generating capacity at the end of the calendar year. IRENA points out that its data comes from many sources, such as the IRENA questionnaire, official statistics, industry association reports and other reports and press articles. EurObserv'ER signals that the official net maximum photovoltaic capacity data sourced from national (statistics offices, etc.) and international organizations such as Eurostat, is usually expressed in alternating current to facilitate comparisons between the various electricity production sectors and their output compared to a given capacity. However, some countries express their data in peak watts, and thus in direct current. This results in slightly higher figures because no allowance is factored in for inverter-related capacity loss. In Europe, Eurostat points out in its metadata that when calculating the solar photovoltaic capacity that contributes to a country's total electrical capacity, the lower of the two indicators should be retained (i.e., the alternating current capacity). However, if only one of these two indicators is available, it is that one that contributes to the country's total electrical capacity.

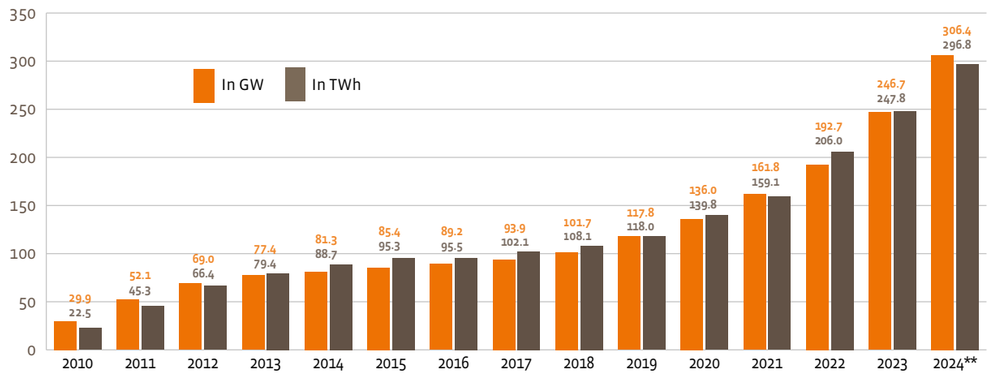
According to IRENA's installed electrical capacity data (as opposed to production), solar photovoltaic (PV) is the top renewable energy source. In 2024, PV accounted for 41.8% of the world's installed renewable energy capacity, compared to 28.8% for hydropower (excluding pure pumping), 25.5% for wind energy, 3.4% for all the bioenergies taken together and 0.2% for concentrated solar power. At the same time, PV accounted for over three-quarters (77.2%) of the additional renewable capacity installed, compared to 19.4% for wind energy, 2.6% for hydropower excluding pure pumping, 0.8% for bioenergies and 0.1% for geothermal energy.

As for the average load factor of solar PV, it ranged from 10 to 24% depending on location. It is much higher in sun-drenched regions and low latitudes such as the United States and Spain, and lower in higher and less sunny latitudes such as Northern Europe.

While solar photovoltaic is the fastest-growing renewable sector, Asia, led by China, is the most active region for new grid connections. Consequently, Asia accounted for 69.7% of the world's additional solar photovoltaic capacity in 2024, Europe for 13%, and North America for 8.8%. The world's other regions account for 8.5% of the additional capacity, including, South America (essentially Brazil) 4.1%, the Middle East 0.7%, Oceania (essentially Australia) 1.2%, Eurasia including Russia and Turkey (2%), Africa (0.4%) and Central America and the Caribbean (0.1%). If we consider all the solar capacity connected to the grid at the end of 2024, Asia concentrated 62.2% of the total, followed by Europe with 18.1%, North America with 10.4% and the rest of the world, 9.3%.

## Graph No. 1

Evolution of photovoltaic capacity installed* (in GW) and gross photovoltaic electricity production (in TWh) from 2010 to 2024** in the EU 27




** Net maximum electrical capacity, off grid included, MW expressed in alternative current. ** Estimation.*
***Sources : Eurostat (years 2010-2022), EurObserv'ER (years 2023 and 2024).***





Industry Association (CPIA), following six years of high growth, additional capacity will not increase in 2025. Rather, based on its own estimates and forecast of 215–255 GW, it could shrink by 8–22%, compared to 277.57 GWac (in alternating current) in 2024. The CPIA holds that one of the main factors responsible for the predicted slowdown in 2025 is the inability of China's power grid capacity to absorb the growing volumes of renewable energies. The situation has persuaded the country's authorities to prioritize their investments in grid infrastructures and storage capacities.

An NEA report published on 23 January 2025, claims that China's storage capacity, excluding pumped-storage hydropower, but including electrochemical energy, compressed air, flywheel, superconductor, supercapacitor and hydrogen storage, has more than doubled in the space of a year (by 132.8%), from 31.39 GW/66.87 GWh recorded at the end of 2023 to 73.76 GW/168 GWh at the end of 2024. By the way, the electricity production capacity of energy storage systems is quantified by two main points: firstly, the electrical capacity or the maximum actual amount of electricity that can be continuously produced (measured in watts, for example in GW) and secondly, the energy capacity of the total amount of energy that can be extracted from the storage system (measured in watt-hours, for example in GWh).

While electrochemical storage by battery accounts for most of China's installed storage capacity (using lithium-ion technology and more recently the new sodium-ion technology), China is also developing large-scale compressed air storage, with for example, the grid connection early in 2025, of the biggest plant of its type, the Nengchu 1 storage plant located near the city of Yingcheng, in Hubei province, central China. The project operator, China Energy Engineering group, claims that this plant that uses the disused caves of a former salt mine 600 metres below ground level, has 300 MW of capacity and can store 1 500 MWh. The plant can store energy for eight hours and restore it for five hours a day, thus producing about 500 GWh of electricity per annum. Construction is underway on two similar, but even higher capacity projects (350 MW each) in Changzhou and Jiangsu provinces. The rapid expansion of energy storage in China is part of the country's broader renewable energy integration strategy. A National Development and Reform Commission (NDRC) paper claims that the country's priority is to improve its electricity system's regulatory capacity between 2025 and 2027. It now aims to add an average of 200 GW of renewable capacity annually over the next three years to guarantee at least a 90% renewable energy usage rate nationwide.

In the **United States**, data released in the Energy Information Administration's (EIA) Electric Power Monthly report, claims that the country's net solar photovoltaic capacity at year end 2024 stood at 174.5 GW of which 121.2 GW was installed in industrial scale "Utility Solar Photovoltaic" plants (defined as >1 MW) and 53.3 GW in small plants, "Small Scale Solar Photovoltaic"), compared to 138.3 GW at year 2023 (90.5 GW of industrial scale PV plants and 47.8 GW of small scale plants). Thus, for the second year running, net additional capacity has grown sharply, measured at 36.2 GW in 2024 (33.7% more than in 2023). In 2025, the PV market should continue its upward trend on the sole basis of the "utility scale" segment, an additional

## Table No. 2

Gross electricity production from solar photovoltaic in the European Union countries in 2023 and 2024* (in TWh)

| | 2023 | 2024 |
|---|---|---|
| Germany | 63.873 | 74.134 |
| Spain | 43.421 | 53.680 |
| Italy | 30.711 | 36.000 |
| France | 21.823 | 24.470 |
| Netherlands | 19.578 | 21.645 |
| Poland | 11.346 | 15.249 |
| Greece | 8.894 | 10.000 |
| Hungary | 6.925 | 8.974 |
| Austria | 6.395 | 8.620 |
| Belgium | 7.820 | 8.000 |
| Portugal | 5.160 | 7.098 |
| Bulgaria | 3.521 | 5.220 |
| Sweden | 3.114 | 4.145 |
| Denmark | 3.658 | 3.776 |
| Czechia | 2.892 | 3.590 |
| Romania | 2.227 | 3.408 |
| Lithuania | 0.688 | 1.273 |
| Finland | 0.716 | 1.155 |
| Slovenia | 0.984 | 1.110 |
| Estonia | 0.721 | 1.005 |
| Cyprus | 0.831 | 1.000 |
| Slovakia | 0.605 | 0.700 |
| Ireland | 0.646 | 0.659 |
| Croatia | 0.413 | 0.601 |
| Luxembourg | 0.294 | 0.522 |
| Latvia | 0.239 | 0.398 |
| Malta | 0.309 | 0.326 |
| **Total EU 27** | **247.805** | **296.758** |

** Estimation.* ***Source: EurObserv'ER 2025***

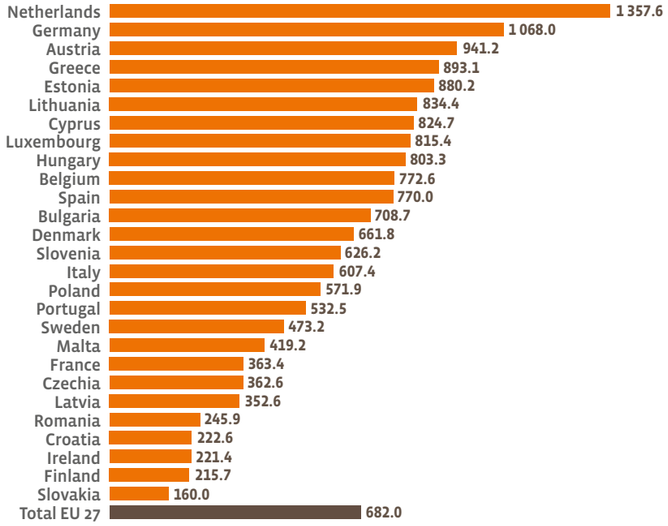
32.5 GW including 11.5 GW in Texas and 2.9 GW in California. Since the start of the 2020s, this growth of ground-based plants has been closely in step with that of industrial storage batteries (defined as >1 MW). At the end of 2024, this operating capacity was gauged at 26.1 GW compared to 15.4 GW at the end of 2023, meaning a rise of 10.7 GW. Since 2024, stationary industrial storage battery capacity has overtaken the 23.2-GW capacity of PSH (pumped-storage hydroelectricity) plants in the US. The latter did not increase between 2023 and 2024. These two storage modes do not compete with each other because they cater for different needs, daily for batteries and longer periods for PHS systems.

The EIA's "In-brief Analysis" of 21 March 2025 predicts that the industrial storage battery's exponential growth will take capacity to 45.7 GW at the end of 2025, i.e., an increase of 19.6 GW. Back in 2024, US industrial storage battery capacity accounted for 21.5% of its industrial photovoltaic plant capacity (121.2 GW).

**India** is also in the middle of its solar revolution. According to the Indian Ministry of New and Renewable Energy, 24.5 GW of solar photovoltaic capacity was connected to the grid in 2024 (18.5 GW in 2023). Its aggregate capacity passed the 100-GW mark in January 2025 (100.3 GW on 31 January 2025). The ministry forecasts that 2025 will be a great year for solar with 84.1 GW currently being installed and an additional 47.9 GW earmarked through tenders. The government also aims to develop hybrid renewable energy projects (wind/solar) and or projects combined with "round the clock" storage solutions with 64.67 GW being installed or covered by tenders. Storage is one of the country's priorities. The National Electricity Plan published by the Central Electricity Authority reckons that India will need about 74 GW of storage capacity by 2032, including 26.69 GW/175.18 GWh of pumped storage and 47.24 GW/236.22 GWh of battery storage systems. These investments are essential to balance the grid, as the country plans to have 500 GW of renewable energy by 2031-2032 (including 364 GW of solar and 121 GW of wind power). Electrochemical storage in India is in its infancy. In December 2024, storage capacity amounted to only 4.86 GW (4.75 GW of pumped storage and 0.11 GW of battery storage).

## Graph No. 2

Photovoltaic capacity per inhabitant (W/inhab.) for each EU country in 2024*




*Estimation. **Source: EurObserv'ER 2025.**

### ALL-ROUND EUROPEAN GROWTH

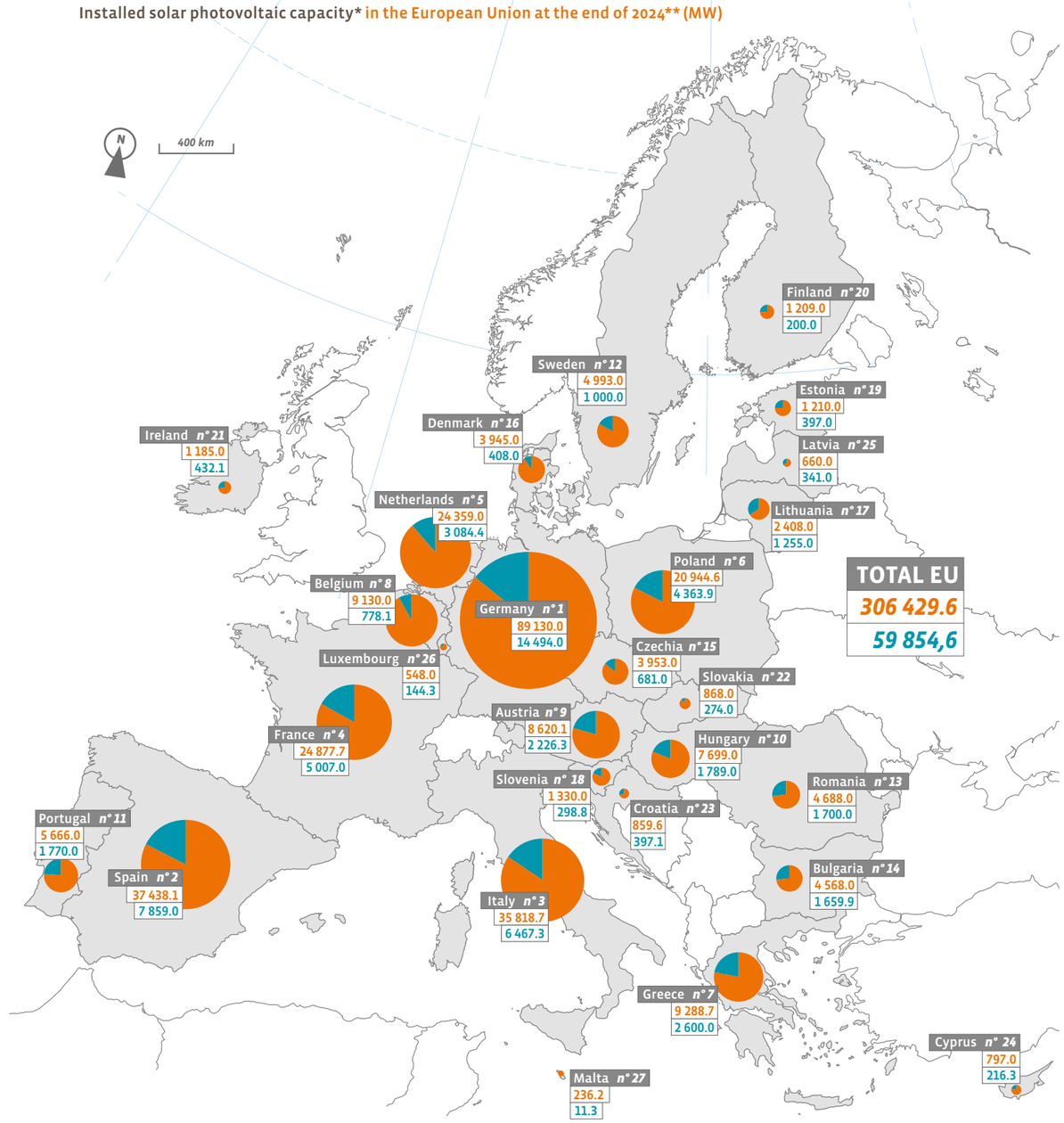
The **European Union** and its 450 million inhabitants, is committed to the climate change combat, and countering the climate-sceptic naysayers conveyed by populist and reactionary factions. Data gathered by EurObserv'ER in April 2025 for the most part from the ministries and official statistics bodies responsible for renewable energy monitoring (cf. the sources at the end of this barometer), confirms that the EU again, and for the fourth year in a row, set a new annual solar photovoltaic capacity grid connection record in 2024. With nearly 60 GW of net additional capacity likely to be delivered to the grid (59.7 GW in 2024), it bettered its 2023 record (54 GW revised figure). This additional capacity, expressed in alternating current, takes the combined net maximum capacity of the 27 Member States to over 300 GW at year end of 2024 (306.4 GW). Several factors have contributed to the speed with which the European Union's solar capacity has been deployed, such as good acceptance of solar energy by the populations and their political representatives, the competitive kWh cost and new facilities granted by the European Union for obtaining construction permits. In particular, these facilities have come into being through the adoption, via the REPowerEU plan, of Regulation (EU) 2022/2577, that came into force on 30 December 2022. It sets out a framework to accelerate renewable energy deployment, with the acceptance that the construction and harnessing of renewable energies present major public interest. Following re-examination by the European Commission, these conditions have been extended through to 30 June 2025 by Regulation (EU) 2024/223.

In 2024, **Germany** was the most active EU country for installing PV capacity. AGEE-Stat reports that it installed up to 14.5 GW in 2024 (net maximum capacity expressed in alternating current), compared to 13.5 GW in 2023. This growth can be ascribed to the positive momentum of tenders which were oversubscribed, albeit to a lesser extent than in 2023 when installations were accelerated





Installed solar photovoltaic capacity* in the European Union at the end of 2024** (MW)




**Key**

306 429.6 Cumulated photovoltaic capacity* in the EU 27 at the end of 2024* * (in MW)

59 854.6 Photovoltaic capacity* in the EU 27 countries during the year 2024** (MW)

** Net maximum electrical capacity, off-grid included, MW expressed in alternative current. ** Estimation.*
*Note: 65 MW decommissioned in Germany, 64 MW in France, 1 MW in Austria, 0,9 MW in Malta. The data concerning the decommissioned capacity is not always available.*
***Source: EurObserv'ER 2025.***

because of the energy crisis and the sharp rise in electricity prices. Germany is Europe's most solarized country with 89.1 GW (in alternating current) at the end of 2024, accounting for just under 30% of the European Union's total installed capacity). AGEE-Stat indicates that the country's solar capacity expressed in direct current is much closer to the 100-GW mark (99.8 GW at the end of 2024, namely, 16.8 GW installed in 2024) and that Germany's official 2030 target of 215 GW is also expressed in direct current.

**Spain**, according to the Ministry for the Ecological Transition and the Demographic Challenge (MITECO), added 7.9 GW (in alternating current) in 2024, which betters the additional 5.7 GW figure of 2023. Spain enjoys the most competitive solar electricity cost price in Europe and has benefitted from the connection of many large-scale plants financed through PPAs (direct electricity purchasing contracts between producers and consumers). Yet, this growth is still hampered by the grid's absorption capacity. The additional 7.9 GW installed takes the Spanish installed capacity to 37.4 GW.

**Italy**'s photovoltaic market posted one of its finest performances for over a decade in 2024. GSE (the energy services manager), put the country's aggregate capacity for the year at 37 GW in direct current, which EurObserv'ER equates to 35.8 GW in alternating current (figure cited in table 1). Thus, the additional capacity was quantified at 6.5 GW in alternating current. According to SolarPower Europe, the annual growth pace was slightly down on that of 2022–2023 and can be attributed to the slowdown in the residential and business market segments, the fall in electricity prices and the gradual phasing-out of support mechanisms compounded by high interest rates. In contrast, industrial and large-scale installations posted a record high.

**In France**, the electricity price hike following the gradual lifting of the price cap, boosted roof-mounted photovoltaic installation connections, particularly in the self-consumption segment. This uplift was all the more justified, as the purchasing tariffs applied to the sale of surplus electricity remained attractive through to 2024. Tariffs suffered a massive drop on 1st April 2025. In the case of <9 kWp installations , the drop was from 12.69 euro cents per kWh to 4 euro cents per kWh. According to the SDES (the Statistical Data and Studies Department reporting to the Ministry of Ecological Transition), newly installed capacity increased by about 5 GW in 2024 to reach 24.9 GW (upward revised figure expressed in alternating current) compared to 19.9 GW at the end of 2023.

Solar PV's installation pace was more or less stable in **Poland**. According to the Energy Market Agency (ARE) that

## Table No. 3

**Active and ongoing EU Solar Manufacturing projects awarded in the Innovation Fund**

| Project | Manufacturer | Country | Tender | Project | Estimated entry into operation |
|---|---|---|---|---|---|
| MOD4PV | Trina Solar (LU) Holdings | Spain | IF23Call (2023) | 1.5 GW HJT PV module assembly plant | to be determined (selected) |
| FENICE | FuturaSun | Italy | IF23Call (2023) | PV module production plant | to be determined (selected) |
| HOPE project | Meyer Burger Technology AG (DE) | Germany and spain | 3rd call for large-scale projects (2022) | 3.5 GW of heterojunction (HJT) solar cell and module manufacturing capacity | 2027 (on going) |
| DAWN project | Midsummer (SE) | Sweden | 3rd call for large-scale projects (2022) | 200 MW plant for lightweight & flexible thin-film solar cells and panels | 2026 (on going) |
| SunRISE project | NorSun (NO) | Norway | 3rd call for large-scale projects (2022) | 3 GW ingot and wafer manufacturing plant | 2025 (on going) |
| SHEEFT project | Heliup (FR) | France | 2nd call for small-scale projects (2022) | 100 MW production capacity for lightweight PV panels for C&I | 2024 (on going-active) |
| TANGO project | 3SUN S.R.L. & Enel Green Power (IT) | Italy | 1st call for large-scale projects (2020) | Expansion of 3Sun's HJT bifacial cell and module factory in Catania, Italy into a 3 GW Gigafactory | 2025 (on going) |
| Helexio | ArcelorMittal (LU) | France | 1st call for small-scale projects (2020) | BIPV factory | 2024 (on going, pilot line active) |

*Source: SolarPower Europe (EU Market Outlook for Solar Power 2024-2028)*






*The 5-MW/20 MWh battery system installed near Alcoutim in the southern Algarve, Portugal, was commissioned and injected the first electrons of stored energy into the grid from Portugal's biggest solar farm in April 2025.*

2024 taking Poland's capacity to 21 GW. Similarly, the **Netherlands**, according to Statistics Netherlands, added about 3.1 GW in 2024 (3.9 GW in 2023), taking the country's capacity to 24.4 GW. From a per capita standpoint, the Netherlands is the most solarized country in the European Union (1357.6 watts/inhabitant).

Another seven EU countries posted >1 GW installation volumes, namely **Greece** (2.6 GW), **Austria** (2.2 GW), **Portugal** (1.8 GW), **Hungary** (1.8 GW), **Bulgaria** (1.7 GW), **Lithuania** (1.3 GW) and **Sweden** (1 GW).

As in the world's other regions, wholesale integration of renewable energies is starting to destabilize electricity grids in several European countries and so offers development opportunities for front-of-the-meter (FTM) storage. Likewise, the rise in the price of electricity offers prospects for the solar storage market and behind-the-meter storage batteries. For information, behind-the-meter (BTM) storage batteries are connected behind the meter of residential, public service, business or industrial buildings for the purpose of reducing electricity bills. The FTM term alludes to energy-related activities that occur on the utility side of the grid's public services. They generally involve large-scale production, transmission and energy distribution infrastructures. The ninth annual edition of the European Market Monitor on Energy Storage (EMMES) published by the European Association for Storage of Energy (EASE) and the LCP Delta research provider, heralds 2024 as a record year for electrochemical storage capacity deployment in Europe (EU plus the UK, Switzerland and Norway). The report claims that 12 GW/21.8 GWh was installed in 2024, split between 7.1 GW/9.8 GWh of BTM batteries and 4.9 GW/12.1 GWh of stationary FTM batteries. This addition takes Europe's electrochemical storage capacity to 35 GW at the end of 2024 (22 GW BTM and 13 GW FTM). The report identifies the most active countries in FTM storage, in order of importance, as Italy, the UK, Sweden, Germany, Ireland and Belgium. The report puts the 2024 count of domestic BTM storage batteries across Europe, at no less than 3.4 million in 2024 (1.7 million in Germany, 653 000 in Italy, 187 000 in the UK, 177 000 in Austria and 142 000 in Belgium). LCP Delta, forecasts that the installation pace will accelerate as electrochemical storage capacity, FTM and BTM is expected to reach 163 GW by 2030, or 128 GW/300 GWh of additional capacity. Greece, and its many islands, is one of the promising markets for stationary storage. Being one of the most sun-drenched and windswept countries, it is finding it increasingly hard to channel its renewable electricity. In March 2025 alone, the country lost 200 GWh of renewable electricity according to the operator IPTO and Stelios Psomas, an energy consultant. Accumulated losses amounted to 900 GWh in 2024, or 3.5% of the country's renewable output, while they could rise to 1.5 TWh in 2025, according to Helapco, the Hellenic Association of Photovoltaic Companies. The Greek government has approved a regulation awarding 4.7 GW of connection capacity for storage projects by 2030 to meet this challenge.

### ABOUT 300 TWH PRODUCED IN THE EUROPEAN UNION

The latest European State of the Climate 2024 (ESOTC 2024) report, published on 15 April 2025 by the Copernicus Climate Change Service (C3S) and World Meteorological Organization (WMO) states that renewable energy production and electricity demand are highly vulnerable to weather conditions. The report affirms that in Europe, solar photovoltaic

*The "Gazules" project comprises two solar farms – Gazules 1 and Gazules 2 – each with nominal capacity of 46 MW. RWE installed about 240 000 bifacial modules on a total area of 140 hectares that went on stream in April 2024. The plant is located in Cadiz province, Andalusia. It will deliver enough green electricity to satisfy annual demand of 20 000 Spanish households.*

RWE

(PV) energy production potential was at opposite ends of the spectrum from east to west, with higher than average potential in Eastern Europe and much lower than average potential in Western Europe. It goes on to report that overall, European solar photovoltaic energy production potential was lower than average in 2024, especially in Northwestern Europe and Southern Scandinavia.

Despite this sunshine deficit, the surge in production capacity installation enabled solar electricity output to increase considerably across the European Union. According to EurObserv'ER, which bases its findings on first available official estimates, gross solar photovoltaic electricity output increased by 19.8% between 2023 and 2024, reaching 296.8 TWh, namely, 49 TWh more than in 2023. In 2024, Germany and Spain enjoyed the highest value increases, with identical year-on-year gains of 10.3 TWh, leading to a total of 74.1 TWh for Germany (source: AGEE-Stat) and 53.7 TWh for Spain (source: Ministry for the Ecological Transition). However, Spain enjoyed higher growth in output (23.6% YoY) than Germany (16.1% YoY). Poor sunshine conditions led to smaller increases (by 2.1 TWh) in French and Dutch electricity outputs (to 12.1% and 10.6%) that belied the increase in their production capacities. This contrasts with the fortunes of countries further to the east that fully exploited their increased production capacities with surging output (53% by Romania, 48.3% by Bulgaria, 34.4% by Poland and 29.6% by Hungary).

The sharp hike in electricity prices and plummeting solar system and battery storage system prices, along with European citizens' clearer desire for energy independence are driving EU citizens in their droves towards self-consumption. AGEE-Stat, which has revised its methodology, puts Germany's 2024 solar self-consumption share at 18% (13% in 2023). Spain's Ministry for the Ecological Transition, puts the share at 16% (12.6% in 2023). In Portugal, it is even higher at 31.7% (30.2% in 2023 according to the DGEG). The GSE reports that the share was about 25% in 2023 in Italy, ... no more recent data is available.

## THE EUROPEAN PV INDUSTRY SWIMS AGAINST THE TIDE

European Union dependency on Chinese module and cell imports is a reality. Of the almost 60 GW installed on European Union soil in 2024, only a small part of the value chain (polysilicon, ingots and silicon wafers, cells and modules) were produced in European factories. We should point out that this European dependency is an industry rather than energy-related issue, because in contrast to dependencies related to physical imports of oil and gas, once installed on the ground or mounted on a roof, a solar photovoltaic panel will be productive for 30–40 years, as the electricity production is provided by the sun's rays alone.

SolarPower Europe, an organization that represents and supports Europe's solar photovoltaic sector, reported on the tough situation faced by Europe's industrial players in its annual publication, **EU Market outlook for Solar Power 2024-2028.** The following paragraphs are broadly based on its analyses.

Its view is that EU output has hardly benefitted from the surge in the number of installations in 2023 and 2024. The drive to commission new production capacities in 2023 and 2024 has actually triggered unprecedented imbalances between supply and demand. Plunging module and other component prices to unsustainable levels for European manufacturers culminated with announcements of closures and bankruptcies in 2024. SolarPower Europe adds that many of the European manufacturers still producing, are operating at very low usage rates. This has slashed their actual output measured against their announced capacities, which places further pressure on the solar industry, prompting some players to consider relocating to the United States.

In this context, the European Union's political institutions are trying to resist these power conflicts and keep its industrial skills and capacities on European soil. Accordingly, in June 2024, the European Union adopted the European Net-Zero Industry Act (NZIA), a regulation that sets a 2030 manufacturing target of at least 30 GW of European solar production at every stage of the value chain. In the SolarPower Europe report, an inventory of European solar photovoltaic industrial reality has been drawn up. It covers the whole value chain from silicon to modules and inverters, to clarify the situation and assess how much progress is required. In the inverter segment, the 30 GW threshold was comfortably reached several years ago, with 92.9 GW of manufacturing capacity and 15 players in the market (e.g., **SMA, Fronius, Power Electronics**, and

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*In February 2025, Eneco, Belgium's green electricity supplier, started up the country's biggest battery storage park at Ville-sur-Haine. The site can now store up to 50 MW/200 MWh of energy, which equates to 4 hours of energy on the high voltage grid.*

so on). This has been achieved because the European industry is mature in this segment. It is mainly active on a national level but also has a good foothold in international markets such as the United States and Australia.

If we turn to the module manufacturing segment phases (which include the polysilicon, ingot and wafer, cell and final module production stages), the polysilicon production segment is the only one close to the European target. A single manufacturer, the German chemical group **Wacker** – has two manufacturing sites in Germany and total production capacity of 26.1 GW. The downside is that this capacity includes a semi-conductor related activity (that offers openings in electronics) in addition to those of photovoltaics. The other manufacturer, **REC Solar Norway,** ceased operations in November 2023.

As the main Norwegian ingot and wafer suppliers, **Norsun** and **Norwegian Crystals**, suspended or ceased manufacturing in 2023, Europe has no active manufacturing capacity left.

Europe's annual production capacity of 2 GW of photovoltaic cells now relies on imports of wafers from third countries. Six European players are still involved in cell manufacturing, with only one significant player, **Meyer Burger** of Switzerland (with 1.4 GW of capacity) that still manufactures cells in its Thalheim factory in Germany. After closing its European photovoltaic module facility in March 2024, the Swiss manufacturer was planning to transfer its cell production from Germany to the United States. However, the company has recently undergone restructuring, which has halted this project, hence the existing cell manufacturing site in Germany has been saved. European cell manufacturing capacity could increase as soon as this year. The Italian company **3Sun**, **owned by Enel Green Power,** which already has a 200-MW heterojunction (HJT) cell and module production line, is planning to increase the factory's capacity to 3 GW later in the year. The Dutch cell and module manufacturer, **MCPV,** has also declared its intention to invest in 6 GW of capacity, with a first phase in 2026.

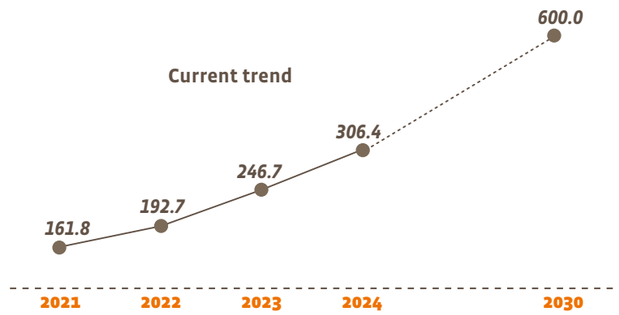
A standout event for France's module segment occurred in September 2024, when **EDF Renouvelables** sold Photowatt to the French start-up, **Carbon**, that intends to develop a gigantic vertically integrated solar factory by 2026. Carbon announced a 44 million euro investment to support and integrate the Photowatt cell and module activities into its project. The design capacity of the mega factory for 2026-2027 includes 5 GW for the ingot/wafer and cell phases and 3.5 GW for the modules. To start off, Carbon will launch a 500-MW pilot module assembly line which is due to open at the end of 2025.

Lastly, SolarPower Europe quantifies the 2024 module manufacturing capacities at 12.6 GW (54 companies involved) – alas, a lower figure than that of 2023 (14.6 GW), because of plant closures and bankruptcies announced in 2024. The biggest reduction was caused by the closure of **Meyer Burger**'s Freiberg module plant (1.4 GW) in the spring of 2024, compounded when **Systovi, SolarWatt** and Exasun ceased operations.

As for projects to open new module manufacturing capacities, SolarPower Europe points out that many of them have been abandoned, postponed or have not been finalized. Thus, only 300 MW of additional production capacity of the >4 GW initially slated for 2024 materialized. **Heliup**, a French solar start-up specializing in lightweight modules for large roofs inaugurated a 100-MW production line in 2024 at Cheylas, France, to complement its pilot line at Bourget-du-Lac. To date, the biggest European module producer is **Recom Technology** which has maintained its 3.2 GW of capacity, having relocated its production from France to Italy in 2024. Last November, the Chinese cell and module manufacturer, DAS Solar, announced an investment for the construction of a 3-GW module plant at Mandeure, France, in 2025. The next barometer will provide the opportunity to gauge the substance of these announcements.

## Graph No. 3

EurObserv'ER projection of the evolution of net maximum photovoltaic capacity installed in the EU 27 (in GW)




** Net maximum electrical capacity, off-grid included.* ***Source: EurObserv'ER 2024.***

The EU has funding instruments such as the European Investment Fund to help relaunch solar manufacturing on European soil. The last two successful bids of the 4th Innovation Fund round (IF23) for solar projects announced by the European Commission in October 2024 were made by MOD4PV, a construction project for a 1.5-GW heterojunction assembly unit led by a European entity of the Chinese manufacturer, Trina Solar. The second is another module plant led by Italy's FuturaSun. Yet, few of the solar factory projects selected since 2021 during previous calls for projects have materialized. Some have been cancelled and others put on hold, falling victim to new strategic choices by the successful bidders. The only large photovoltaic project financed and implemented through the Innovation Fund to date is the TANGO project, to extend the **3Sun** heterojunction (HJT) Gigafactory at Catania, Italy. This factory is Europe's first to mass produce bifacial panels incorporating HJT technology. Manufacturing started in Q2 2024, and a total capacity of 3 GW should be reached in 2025.

### CLIMATE PLANS NEWLY ASSESSED AT ABOUT 650 GW BY 2030

The European Union's Official Journal publication of the Renewable Energy Directive (known as RED III) No. 2023/2413 on 18 October 2023 widened the scope of possibilities for the photovoltaic sector. It stipulates that "Member States shall collectively ensure that the share of energy from renewable sources in the Union's gross final consumption of energy in 2030 is at least 42.5%" and that "Member States shall collectively endeavour to increase the share of energy from renewable sources in the Union's gross final consumption of energy in 2030 to 45%. This new target, with an extremely tight deadline, has forced the Member States to dramatically revise the solar photovoltaic energy contribution in their National Climate Energy Plan (NCEP) updates. As of 23 April 2025, most of the NCEPs were finalized and published on the European Commission's website after taking up the Commission's recommendations (with the exception of those of Belgium, Estonia and Poland). EurObserv'ER has examined the latest photovoltaic target figures for 2030 detailed in the final NCEPs. It sees that the overall EU-wide target has increased to 648.6 GW for 2030 on the basis of the high hypotheses. When we read through the NCEPs, it is not always clear whether the targets are expressed in alternating or direct current. For instance, and according to the details given by AGEE-Stat, Germany's 215-GW target is expressed in direct current. Clarification by each member state would give a more accurate picture of the European Union's combined target expressed in MWac. EurObserv'ER reckons that it should be fairly close to the target formulated for the REPowerEU plan, that aims at the installation of 600 GW in alternating current by 2030 (an equivalent direct current target of 750 GW based on a SolarPower Europe estimate).

Current momentum is highly conducive for solar photovoltaic. Capacity in alternating current expected to double within the next six years. This development will pose a real challenge for electricity grid managers and comes with new opportunities for storage technologies, shifting some energy uses, and even more assertive development of self-consumption be it for private individuals, institutions or businesses. □

*Sources: AGEE-Stat (Germany), GSE-Terna (Italy), SDES (France), Ministry for the Ecological Transition and the Demographic Challenge (Spain), Statistics Netherlands, Statistics Austria, SPF Economie (Belgium), CRES (Greece), Mavir (Hungary), MEHK (Hungary), ESO (Bulgaria), ARE (Poland), DGEG (Portugal), INS (Romania), Statistics Sweden, Statistics Lithuania, Litgrid (Lithuania), Elering (Estonia), Ast (Latvia), Statistics Finland, Danish Energy Agency (Denmark), Eirgridgroup (Ireland), NSO (Malta), Cypriot transmission grid operator (Cyprus), Statistical office SiStat (Slovenia), STATEC (Luxembourg), IRENA, EurObserv'ER.*

*the next barometer will cover solar thermal and concentrated solar power.*

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