



Solar power plants benefit biodiversity by acting as natural reserves. Conservation initiatives such as hedge planting and creating wild flower meadows can support biodiversity. These areas can become havens for pollinators, hares, birds, and so on.



BELECTRIC

256 911.8 MW

*Cumulative photovoltaic capacity
in the European Union in 2023*

PHOTOVOLTAIC BAROMETER

A study carried out by EurObserv'ER.



Solar photovoltaic had an outstanding year in 2023. IRENA reported that over 345.5 GW of capacity was installed globally compared to 199.1 GW in 2022 and 145.1 GW in 2021 (net maximum capacity installed and connected at the end of the calendar year). Thus, installed global capacity to date rose to 1 412.1 GW. The European Union and United States enjoyed unheard of increases in their solar photovoltaic capacities. Yet, they pale by comparison with the unbridled rise of photovoltaic in China, which installed 216.9 GW in 2023... more than the previous year's total global market. With net maximum capacity standing at 53.1 GW in 2023 as quantified by EurObserv'ER, the European Union is the world's No. 2 market, ahead of the United States, which added 27.1 GW.

243.5 TWh

*Photovoltaic electricity generated
in the EU during the year 2023*

53 124.2 MW

*Photovoltaic capacity installed
in the EU during the year 2023*



UNSTOPPABLE

Solar energy is not yet the leading renewable energy source at world level for power generation (expressed in TWh), and still trails behind hydropower and wind energy. Yet in 2023, solar acquired a new status that could be the harbinger of things to come a little before or after 2030. It has the most production capacities of any renewable energy source and so relegated hydropower to second place. Light was shed on this shift of power in the latest annual

statistics report produced by IRENA (the International Renewable Energy Agency), **Renewable capacity statistics 2024**, published last April, that presents the global installed renewable capacity (expressed in net maximum grid-connected capacity at the end of the calendar year). The report puts solar energy in first place for renewable sources with a global base of 1 419 GW (split between 1 412.1 GW of solar PV and 6.9 GW of CSP capacity), resulting in 345.8 GW of new capacity (split between 345.5 GW of solar PV and 0.3 GW of CSP) compared to 2022. Net additional maximum capacity for

The Edwards & Sanborn Solar and Energy Storage facility is located on a former Air Force base in California. The power plant extends over 1800 hectares of land and comprises 1.9 million First Solar panels and 875 MW of generating and almost 3.3 GWh of storage capacity.



BORALIX

solar photovoltaic alone increased year-on-year (YoY) by 73.6% as an additional 199.1 GW of capacity was connected according to IRENA.

While solar photovoltaic is the fastest developing renewable sector, Asia, and China in particular, is the most active region for new grid connections. Asia accounted for 68.8% of the additional global solar photovoltaic capacity in 2023, Europe for 15.7%, and North America for 7.8%. The world's other regions account for 7.7% of the additional capacity, in particular, South America (basically Brazil) 4.2%, the Middle East

1.2%, Oceania (basically Australia) 1.1%, Eurasia including Russia and Turkey (0.8%), Africa (0.2%), Central America and the Caribbean (0.2%). If we take the total solar grid-connected capacity at YE 2023, Asia concentrates 59.5% of the total; Europe -20.2%, North America -10.9% and the rest of the world -9.4%.

CHINA – THE EPICENTRE OF THE GLOBAL SOLAR POWER MARKET

The National Energy Administration (NEA) of China published the national statistics on its electricity industry for 2023 on 26 January 2024. It estimates its

installed solar power generating capacity (almost exclusively photovoltaic), at about 609.5 million kilowatts at the end of December 2023, which amounts to a 55.2% YoY rise. Thus, in the space of 12 months, China installed and connected about 216.9 GW of solar capacity – a 148.1% year-on-year increase on the 87.4 GW total of 2022. These figures tally with those of IRENA published in April 2024, and confirm that China is the epicentre of solar electricity production as never before. If we add this to its



Table No. 1

Installed and cumulated solar photovoltaic capacity* in the European Union at the end of 2023** (MW)

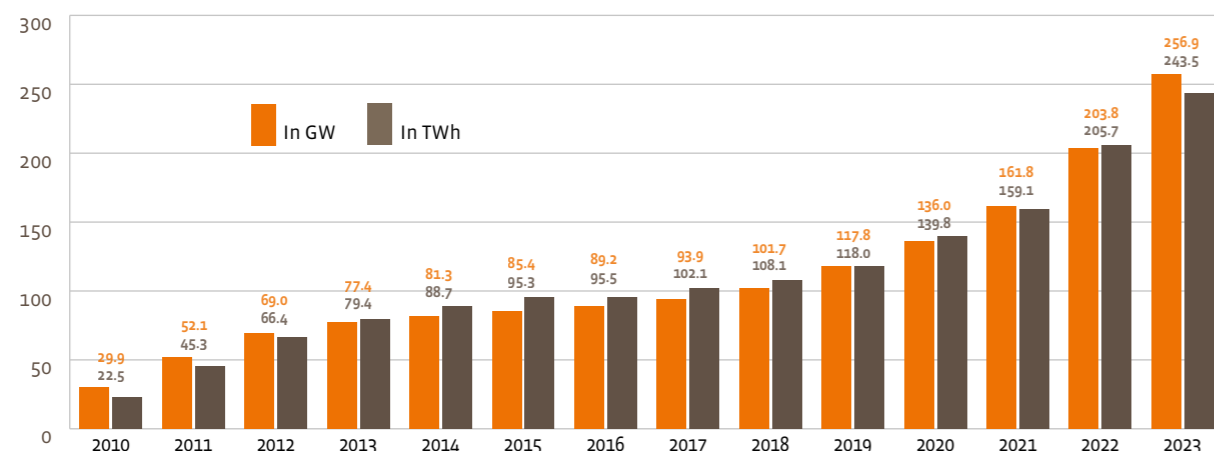
	2022	2023	installed during 2023
Germany	67 596,0	82 191,0	14 617,0
Spain	23 311,3	30 612,5	7 301,2
Italy	25 064,0	30 300,0	5 236,0
Netherlands	19 600,0	23 904,0	4 304,0
France	17 341,3	20 541,3	3 200,0
Poland	12 170,4	17 057,1	4 886,7
Belgium	6 756,1	8 750,0	1 993,9
Greece	5 430,1	6 453,0	1 022,9
Hungary	4 235,0	5 835,0	1 600,0
Austria	3 791,7	5 197,0	1 405,3
Sweden	2 391,9	3 993,9	1 602,1
Portugal	2 683,0	3 904,0	1 223,0
Denmark	3 069,9	3 529,0	459,1
Bulgaria	1 737,2	3 092,0	1 354,8
Czechia	2 420,5	2 491,7	71,2
Romania	1 808,9	1 917,0	108,1
Lithuania	572,0	1 165,0	593,0
Slovenia	626,2	1 034,0	407,8
Finland	664,0	1 018,0	354,0
Estonia	520,0	800,0	280,0
Slovakia	549,0	631,0	82,0
Cyprus	424,1	606,0	181,9
Croatia	222,0	461,0	239,0
Ireland	187,9	445,2	257,4
Luxembourg	317,0	404,0	87,0
Latvia	113,0	353,0	240,0
Malta	209,8	226,0	16,8
Total EU 27	203 812,2	256 911,8	53 124,2

* Net maximum electrical capacity, off-grid included. ** Estimation. Note: 22 MW decommissioned in Germany, 2 MW in Portugal, 0,5 MW in Malta, 0,1 MW in Sweden. The data concerning the decommissioned capacity is not always available. Sources: EurObserv'ER 2024



Graph No. 1

Evolution of photovoltaic capacity installed* (in GW) and gross photovoltaic electricity production (in TWh) from 2010 to 2023** in the EU 27



* Net maximum electrical capacity. ** Estimation. Sources: Years 2010-2021 (Eurostat), Year 2022 and 2023 (EuroObserv'ER).

cumulative installed wind power capacity at YE 2023 (440 GW), it now has more than 1 TW of combined wind and solar power generating capacity... just short of its 1.2 TW goal for 2030, that is almost bound to be surpassed this year. By the end of 2024, the China Electricity Council expects to have the use of 780 GW of solar and 530 GW of wind power capacity. The growth of renewable energies, and of solar photovoltaic in particular, is now inextricably linked to renewable energy storage, with over 30 million kilowatts of installed storage capacity in service at YE 2023. At the 25 January press conference, Bian Guangqi, an NEA official, stated that energy storage capacity had risen to 31.39 gigawatts at YE 2023. He pointed out that 22.6 gigawatts of this capacity was installed in 2023 alone, which is over 3.6 times (260%) the 2022 YE installed figure and almost 10 times the 2020 YE figure. Lithium-ion batteries accounted for 97.4% of China's new energy storage capacity, while rapid development is taking place in other storage technologies. The International Energy Agency reckons that China will be in the renewable energy deployment "driving seat", and that from 2023 to 2028, it will roll out up to four times more renewable capacities than the European Union and five times more than the United States. This expansion is driven by the Chinese government's net zero target for 2060, the policies rolled out

under its 14th five-year plan (2021-2025) and the country's investments in industrial production capacities.

SOLAR AND STORAGE IN TANDEM IN THE USA

As expected, United States solar photovoltaic enjoyed an excellent year in 2023. According to the EIA's 9 April 2024 update of its Short-Term Energy Outlook (U.S. Energy Information Administration), the USA had about 137.7 GW of solar photovoltaic capacity at YE 2023, i.e., an additional

90 GW of >1 MW systems and 47.7 GW of small solar systems, compared to about 110.6 GW of capacity at YE 2022 (70.8 GW of >1 MW systems and 39.8 GW of small solar systems). This data identifies 27.1 GW of new capacity installed between 2022 and 2023. IRENA, which also bases its findings on official sources, puts the United States' YE 2023 cumulative capacity at 137.7 GW, but its 2022 annual year-end data differs slightly at 112.9 GW, giving 24.8 GW of additional net capacity. The EIA expects steady growth over the next few years

THE SUN KING

IRENA reports that in 2023, solar photovoltaic accounted for 36.5% of the world's installed renewable capacity (i.e., 1 412.1 GW of the end of year's renewable total of 3 869.7 GW). It is now ahead of "renewable hydroelectricity" which posts a cumulative on-grid base of 1 267.9 GW (an additional 7 GW of net capacity compared to 2022). This equates to 32.8% of worldwide renewable capacity in 2023). The hydroelectric capacity qualified as renewable does not include the hydroelectric capacity of pure pumped storage transfer stations, namely, those that operate in a closed loop without water intake from outside sources, but it does include mixed energy transfer stations that may receive natural flows of water from external sources. Even if we add the capacity of "Pure pumped storage power plants-PPSP" (139.9 GW YE 2023), total hydroelectric capacity is still (a little) lower than that of photovoltaic. Wind power, which added 116 GW of net connected capacity in 2023 around the world, crossed the one-TW threshold in 2023 (at 1 017.2 GW, supplying 26% of global renewable capacity). The other renewable capacities include bioenergies (150 GW, which added 4.4 GW in 2023), geothermal energy (14.8 GW, which added 0.22 GW in 2023) and ocean energies which were stable at 0.5 GW.

with cumulative photovoltaic capacity rising to 181 GW at YE 2024 (by 43.3 GW) and 220.2 GW at YE 2025 (a rise of 39.3 GW). In parallel with the expansion of installed solar capacity, the IEA has quantified strong growth in cumulated battery storage capacity, which rose from 9 GW at YE 2022 to 15.7 GW in 2023 for the electricity sector (defined as >1-MW power plants). Storage capacity is expected to double to 30.9 GW by the end of 2024 and to at least 41.3 GW by the end of 2025. Texas and California, with expected capacities of 6.4 GW and 5.2 GW respectively, will provide most of the United States' new battery storage capacity in 2024. The Menifee Power Bank (460.0 MW) on the site of the former natural gas-fired Inland Empire Energy Center at Riverside, California, is due to start operations in 2024, followed by the planned two-stage start-up of the Calpine project, Nova Power Bank (680 MW) near Los Angeles (California) – 620 MW at YE 2024 and a further 60 MW in 2025. The project, also built on an old gas-fired power plant site, could supply four hours' worth of electricity to 680 000 dwellings. The power bank will underpin the power grid during summer peak periods at the end of the day and help California achieve its climate goals. The demand for battery storage in the United States will rise as solar and wind power capacities increase. The Inflation Reduction Act (IRA) has also accelerated energy storage development by introducing Investment Tax Credits (ITC) for standalone storage. Prior to the IRA, batteries were only eligible for federal tax credit if they shared solar power facility sites. More of the renewable energy output can be channelled through the same grid connection by coupling battery storage with solar or wind power. When batteries are added, solar and wind farms can export more energy via the same connection and meet battery charging demand from the grid when other power generators have excess capacity.

PV flourishing in Brazil

Brazil exemplifies solar PV's high-speed development potential. ABSOLAR, the Brazilian Association of Photovoltaic Solar Energy, claims that the country added 12.3 GW of photovoltaic capacity in 2023, based on data released by the regulator, ANEEL. This performance

takes its cumulative capacity to 37.9 GW (12.3 GW centralized and 27.6 GW distributed), which is an improvement on the 11.2 GW installed over 2022. Since 2020, so in the space of 4 years, Brazil has installed 33.2 GW, a volume that exceeds the cumulative photovoltaic capacity of countries such as Spain or Italy. Growth in 2024 remains strong, as by the end of March 2024 the installation figure had risen to 41.2 GW, 28.4 GW of which was distributed, amounting to 2.45 million installations (including 1.93 million residential systems). This exponential growth has catapulted Brazil into sixth place in the global country rankings for installed capacity behind India (72.8 GW), Germany

(82.2 GW), Japan (87.1 GW), the United States (137.7 GW) and China (609.5 GW).

UNITY MAKES STRENGTH... 53 GW CONNECTED IN THE EU IN 2023

Data gathered by EurObserv'ER in April mainly from the ministries and official statistics bodies responsible for monitoring renewable energies, shows that in 2023 and for the third year in a row, the European Union established a new annual grid connection record. The 53.1 GW of additional net maximum capacity (earmarked for delivery to the grid compared to 41.7 GW more in 2022 and 25.9 GW more

Table No. 2

Gross electricity production from solar photovoltaic in the European Union countries in 2022 and 2023* (in GWh)

	2022	2023
Germany	60 304.0	61 216.0
Spain	31 187.0	42 922.0
Italy	28 121.5	30 700.0
France	19 642.2	23 242.0
Netherlands	17 079.0	21 173.0
Poland	8 309.7	11 395.6
Greece	7 139.7	8 394.0
Belgium	6 876.0	7 285.0
Hungary	4 732.0	6 536.6
Portugal	3 519.0	5 474.0
Austria	3 791.7	5 197.0
Denmark	2 202.6	3 363.3
Bulgaria	2 093.8	3 334.9
Sweden	1 980.0	3 098.0
Czechia	2 626.3	2 520.1
Romania	1 988.4	1 861.2
Slovenia	645.6	913.1
Slovakia	650.0	737.5
Cyprus	601.9	695.3
Estonia	596.0	692.9
Finland	392.3	646.5
Lithuania	342.0	633.0
Ireland	148.3	372.0
Croatia	151.9	341.5
Luxembourg	276.3	318.0
Malta	289.8	309.3
Latvia	41.3	128.2
Total EU 27	205 728.2	243 500.0

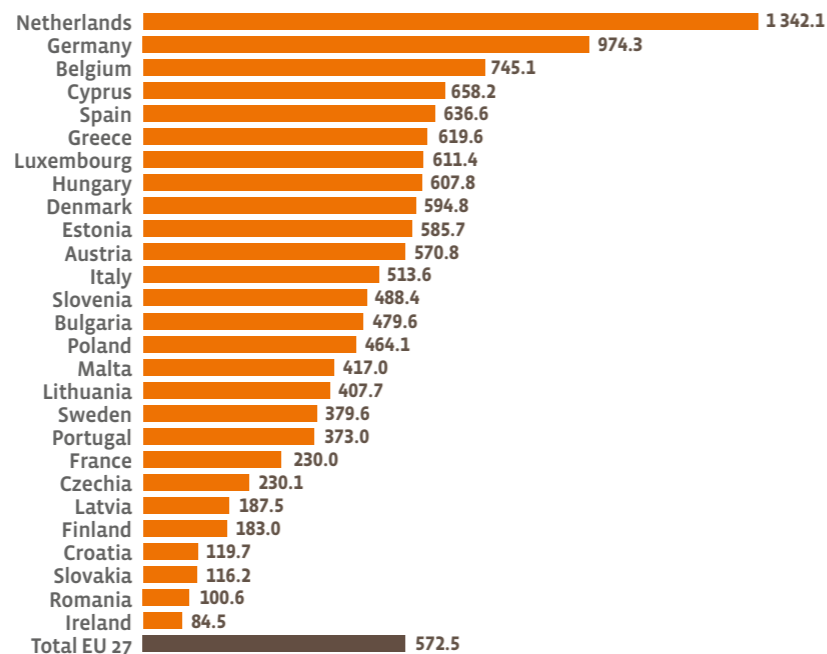
* Estimation. Source: EurObserv'ER 2024



in 2021), equates to YoY growth of 27.5% between 2022 and 2023. This additional capacity takes the 27 Member States' cumulative net maximum capacity at YE 2023 to 256.9 GW (see methodological note). This record installation level was obviously boosted by the geopolitical and energy shockwaves of 2022 arising from Russia's invasion of Ukraine. The war on the European continent has led to sharp gas and electricity price hikes and raised serious energy problems, while exposing the extent of EU dependency on Russian hydrocarbons. The context has radically changed the prospects for solar photovoltaic power in the European Union. Solar photovoltaic power is now fully acknowledged by politicians (and especially economic players), as an extremely fast and cost-effective means of reducing reliance on Russian fossil fuels, that will generate affordable electricity and successfully complete energy transition. In May 2022, dictated by necessity, the European Union threw itself unreservedly into rolling out its REPowerEU plan. The plan aims to end the EU's reliance on Russian fossil fuels, by diversifying its supplies and accelerating renewable energy development. The photovoltaic section of the plan aims to double capacity by 2025 to 320 GW-AC (equating to 400 GW-DC) and install 600 GW-AC of production capacity by 2030. Germany, a country particularly

Graph No. 2

Photovoltaic capacity per inhabitant (W/inhab.) for each EU country in 2023



* Estimation. Source: EurObserv'ER 2024.

threatened by the Russian gas imports issue, struck a huge blow by connecting 14.6 GW during 2023, namely more than a quarter of the European Union's newly connected capacity. Spain, the second most active market, added 7.3 GW, followed by Italy (5.2 GW), Poland (4.9 GW),

the Netherlands (4.3 GW) and France (3.2 GW). Newly connected capacity exceeded one GW in seven other European Union countries: Belgium (2 GW), Sweden (1.6 GW), Hungary (1.6 GW), Austria (1.4 GW), Bulgaria (1.4 GW), Portugal (1.2 GW) and Greece (1 GW). The European Union photovoltaic market's current strength is that almost all the Member States are behind it.

As regards installed capacity to date, Germany is the invincible leader with 82.2 GW at YE 2023, while Spain with 30.6 GW has become the next in waiting, followed closely by Italy (30.3 GW). Ranking on the basis of installed per capita capacity is more representative of solar energy's penetration in each Member State. The figures are (1 342.1 watts per capita) for the Netherlands, (974.3 watts per capita) for Germany and (745.1 watts per capita) for Belgium.

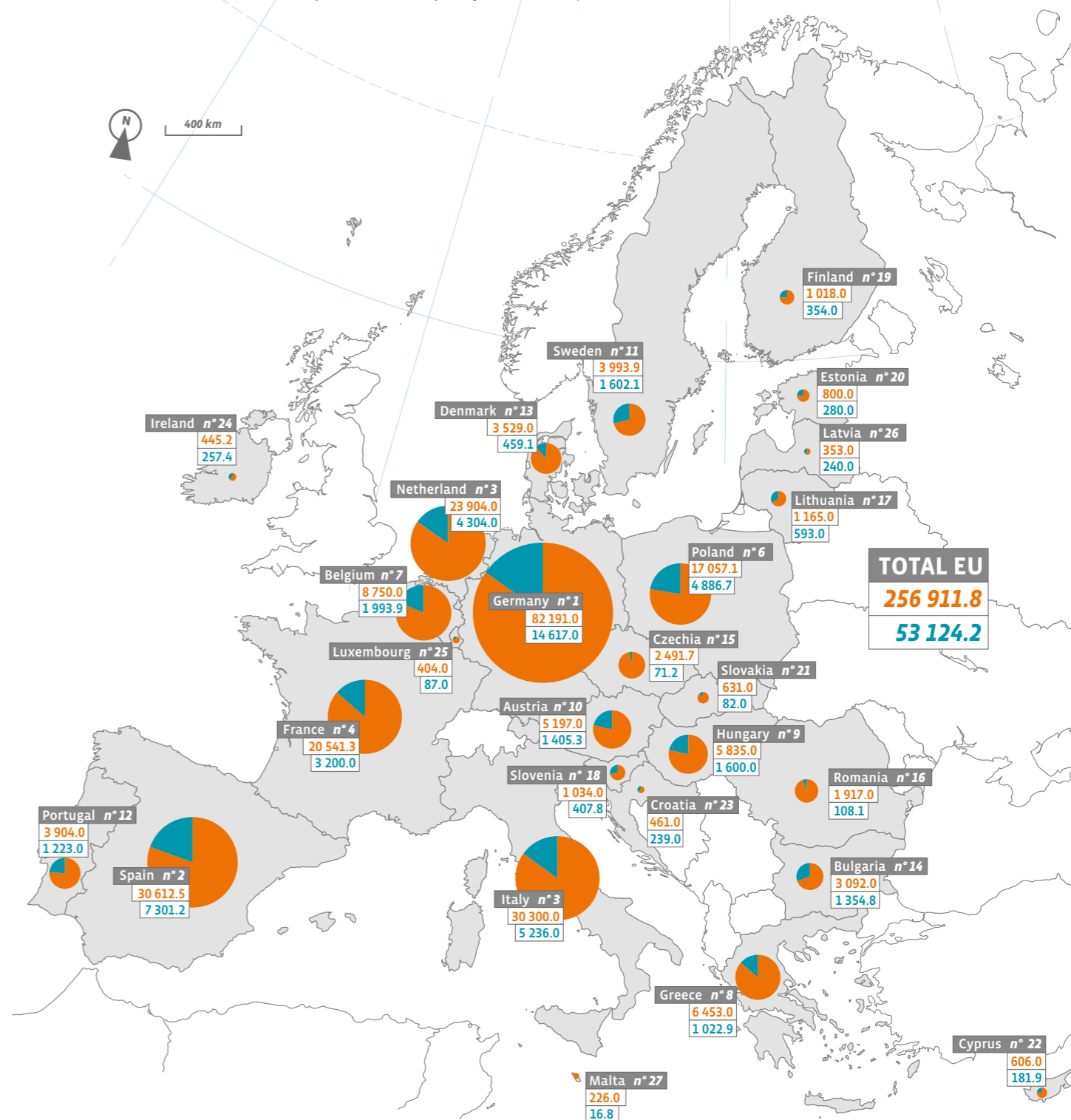
243.5 TWH PRODUCED IN THE EUROPEAN UNION

Sunshine levels in 2023 were lower and more varied in Europe than in 2022. The latest European States of the Climate

THE FUTURE IS ALREADY MAPPED OUT

The International Energy Agency (IEA), in its *Renewables 2023, Analysis and forecast to 2028* publication, claims that 2023 marked a sea change for the growth of renewable energies over the coming five years. It predicts in its main scenario, that during that period solar and wind power will claim about 95% of the new renewable capacity connected annually. Their supremacy can be ascribed to lower production costs than most countries' fossil and non-fossil alternatives and to national policies that will continue to support them. It predicts that by 2028, the renewable electricity production potential could rise to 14 430 TWh – about 70% above the 2022 level. The agency also projects that several renewable energy milestones could be reached within the next five years. In 2024, variable renewable wind and solar output will overtake hydroelectricity. In 2025, renewable energies will outstrip coal PP electricity production, and wind energy will overtake nuclear electricity production. It will be solar PV's turn to outstrip nuclear electricity production in 2026. In 2028, solar photovoltaic output will overtake wind power output. If the IEA forecasts are extrapolated beyond 2028, solar photovoltaic could even supersede hydroelectricity and become the top renewable electricity production source by 2029 or 2030.

Installed and cumulated solar photovoltaic capacity* in the European Union at the end of 2023** (MW)



Key

256 911.8 Cumulated photovoltaic capacity in the EU 27 at the end of 2023 (in MW)
 53 124.2 Photovoltaic capacity installed in the EU 27 countries during the year 2023 (in MW)

* Net maximum electrical capacity, off-grid included. ** Estimation.
 Note: 22 MW decommissioned in Germany, 2 MW in Portugal, 0.5 MW in Malta, 0.1 MW in Sweden. The data concerning the decommissioned capacity is not always available.
 Source: EurObserv'ER 2024.



2023 - ESOTC 2023 report published by the Copernicus Climate Change Service, found that the solar photovoltaic energy production potential for the year as a whole was lower than average in Northwest and Central Europe, and above average in Southwest and Southern Europe, and Fennoscandia (Finland, Sweden and Norway). We should consider these climate variations in the context of the last two years' huge installation drive, which has witnessed the arrival of just short of 100 GW of newly installed capacity (94.8 GW added between 2021 and 2023) in the EU. EurObserv'ER, which bases its calculations on the available official preliminary estimates, finds that solar photovoltaic electricity output increased by 18.4% between 2022 and 2023, rising to 243.5 TWh, i.e., 37.8 TWh more than in 2022. This is lower than the increase between 2021 and 2022 when the growth figure was 29.3%, i.e. 46.6 TWh more. This poorer showing can also be put down to the mediocre 1.5% increase (0.9 TWh) in Germany's solar power output between 2022 and 2023, for a total of 61.2 TWh – data provided by AGEE-Stat, the Working Group on Renewable Energy Statistics on behalf of the Federal Ministry of the

Economy and Climate Action. AGEE-Stat cites three reasons for the disparity between the sharp increase in installed capacity and the relatively low increase in solar power output. The first is that solar irradiation was much weaker in 2023 than in 2022. The second is that many solar farms were registered as installed but are still awaiting access to the grid, as the grid operators lack the human resources to certify and connect the installations, which extends waiting times. A third reason suggested is the country's surge in self-consumption, which affects both small and large installations in Germany. AGEE-Stat finds self-consumption harder to quantify as this electricity is not injected into the grid – a trend that merits explanation. The widespread increase in self-consumption across the EU can be ascribed to the electricity price hikes and the growing ownership of battery storage systems. This increased between 2022 and 2023, by 8.1 to 10.7% in Germany, to quote AGEE-Stat, by 10 to 12% in Spain to quote the Ministry for the Ecological Transition and the Demographic Challenge, and by 27.1 to 30.2% in Portugal to quote the Directorate-General of Energy and Geology. That

said, the vast majority of the countries enjoyed double-digit increases in output. Spain saw its output increase by 37.6% (11.7 TWh) to 42.9 TWh in 2023, the Netherlands' output increased by 24.0% (4.1 TWh) to 21.2 TWh, Poland's increased by 37.1% (3.1 TWh) to 11.4 TWh, France by 18.3% (3.6 TWh) to 23.2 TWh and Portugal by 55.6% (2 TWh) to 5.5 TWh.

GERMANY EXCEEDS EXPECTATIONS

The boost to solar photovoltaic in Germany was fantastic, with 14.6 GW of capacity installed over the 12-month period, taking capacity to date to almost 82.2 GW according to AGEE-Stat. It is the first time that a European Union country's annual installation figure has exceeded 10 GW. The primary reason for this success is the implementation of the 2022 EEG Act, which came into force on 1 July 2022. It enabled many projects that were awaiting permits to forge ahead, thanks to a clause that identified renewable energies as being in the interest of public security, thus prioritising them. Furthermore, tender volumes for new capacities have been raised significantly. In the case of solar photovoltaic, they will rise from about 6 GW in 2022 to 22 GW per annum from 2026 onwards until at least 2035. Bundesnetzagentur, the Federal Network Agency quotes 2023 figures for three tenders for 1950 MW of capacity for ground-based plants (actual allocation: 5172.2 MW) and three tenders for 217 MW of roof-mounted systems (actual allocation: 596.9 MW). In 2024, three tenders for 2700 MW of capacity for ground-based plants will be launched (actual allocation: 6526.3 MW) and three tenders for 300 MW of roof-mounted systems (actual allocation: 779.4 MW). It can also be credited to an increase in the purchasing tariffs for new roof-mounted systems and the halt in monthly tariff reductions for new systems until the end of the year. Besides, like the Netherlands, no VAT has been applied to solar systems since January 2023. Another German market trend is the surge in the solar energy storage battery segment. According to BSW Solar (the German Solar Association), 573 000 new batteries were installed during 2022 (up from 214 000 in 2022, 141 000 in 2021 and 88 000 in 2020) taking the total battery base to 1 197 000. In 2023, 81% of residential



PIERRE JAVET

Table No. 3

Projects of expansion and creation of photovoltaic solar production capacities announced by European companies

Project	Country	Value chain segment	Date of starting production*
3SUN	Italy	Cells and modules	3 GW (2024)
MCPV	Netherlands, Spain, Germany, Others	Cells and modules	3 GW (2025)
Sunrise	Italy	Ingot and wafer	3 GW (2025)
Over Easy Solar	Spain/Norway	PV modules	10 MW (2024) 100 MW (2025)
Solarge	Netherlands	PV modules	100 MW (2023) 300 MW (2024) 800 MW (2026)
Carbon	France	Polysilicon, ingots and wafers, solar cells and PV modules	5 GW per year (2025)
Holosolis	France	PV modules	5 GW per year (2027)

* Initially planned start year. Sources: European Solar PV Industry Alliance website, company websites

solar installations were equipped with a domestic storage system, but there is a setback. The German government has made a U-turn on its ban on new gas boiler installations from 2024 onwards. This ban could have popularized the installation of hybrid HP-PV systems coupled with a storage system. In September 2023, Parliament adopted the new Buildings Energy Act (Gebäudeenergiegesetz) that came into force in January 2024 (BReg 2023). It stipulates that the obligation to replace fossil fuel-fired boilers should be gradually phased in. So, while the immediate obligation to change boilers has been scrapped, deadlines have been set. The use of at least 65% of renewable energy will be compulsory for new heating systems at the latest in 2028, and the use of gas- or oil-fired boilers will be banned from 2045 onwards.

Spain's PV sector growth falters

With only 7.3 GW of newly connected capacity in 2023, according to the Ministry for the Ecological Transition and the Demographic Challenge, Spain was unable to repeat its exceptional performance of 2022 (9.6 GW) that propelled it to the top European slot for new

installations. Nonetheless, its newly connected capacity performance was enough to pip Italy to the post for second place in the EU. EurObserv'ER feels that this figure may yet be consolidated upwards, as happened last year. The Ministry says that the time taken by the administrative authorities to ascertain whether each individual installation was in service or had actually started producing electricity, which are prerequisites for being included in the counts using the adopted methodology, is responsible for the consolidations made last year. The second reason is that the autonomous communities, which are responsible for the incentive mechanism, took longer to give feedback on self-consumption installations. SolarPower Europe believes that the reason for Spain's poorer performance in 2023 is the contraction of the roof-mounted residential market (by about 15%) partly due to long payment terms that have damaged public perception of Spain's young solar roof segment. Ground-based photovoltaic farms, primarily covered by PPA agreements, still dominate market growth, emphasizing Spain's position as global leader of the subsidy-free solar market. Further market growth

Systovi, one of France's last remaining solar panel manufacturers, announced on 17 April 2024 that it was closing down. The company has had to deal with the sudden acceleration of Chinese dumping since the summer of 2023. For years, the firm has taken part in ongoing regulatory discussions in France and Europe, but their effects will come too late to save it.

limiting factors in this market segment are grid access constraints, compounded by increased interest rates and falling wholesale electricity prices. The country is fortunate in having very high solar irradiation, which enabled it to post 42.9 TWh of photovoltaic electricity output in 2023 (37.6% more than in 2022), that was almost double its 2021 output level.

Italy's Superbonus deflates

The Italian solar PV market was very active in 2023. According to GSE, the energy service system operator, Italy connected at least 5.2 GW during 2023, a little over double its 2022 connection level (2.5 GW), which took its capacity to date to 30.3 GW.





WATTENHALL 2022

Witznitz solar power plant, which started up in April 2024, near Leipzig in the centre-east of Germany, is Europe's biggest solar power plant with a total of 605 MW of capacity.

This increased activity is mainly due to its large power plants picking up, stimulated by the commercial and industrial sectors, making this segment the market's main growth vector. In previous years, the residential sector dominated growth, encouraged by the generous Superbonus tax incentive system, whose purpose was to facilitate energy transition work ranging from heat insulation to solar panels and window replacement work. This mechanism took the form of a tax credit spread over five years and amounted to 110% of the investment sum. Furthermore, households could transfer this tax credit to the construction firms that sold the credit onwards to a banking establishment, leaving it up to the banks

to recover the money from the State. In 2023, the programme deemed too costly for public finances, prompted the Meloni government to lower the Superbonus tax credit to 90% while subjecting it to means testing. Yet it was maintained at 110% for works in progress while applying specific income conditions. In 2024, the Superbonus was further reduced to 70% with the additional restriction of being set aside for apartment blocks and detached houses. The rate will fall to 65% in 2025.

THE ISSUE OF REVIVING EUROPE'S PV INDUSTRY

Solar photovoltaic energy's remarkable growth and great development potential are welcome news for the climate change

combat. The build-up of China's photovoltaic industry is far from over. According to the National Bureau of Statistics of China data, China has ramped up its monthly cell manufacturing capacity since the end of the pandemic. It stood at 55 GW for the month of March 2023, which is a 29% YoY rise and 150% more than that of March 2022. China's cell manufacturing capacity has already potentially risen to 660 GW per annum, which equates to 792 TWh of output (assuming the average load factor of 13.7%, i.e., 1200 hours at full load), and amounts to 3% of global electricity output. However, the fact that China alone accounted for 80% of global photovoltaic cell and module production in 2023, (18% in Southeast Asia and South

Korea, 2% in the rest of the world) according to Solar Power Europe, reveals the other countries' industrial dependency in managing their energy transition. This is all the more worrying, given that in 2023 photovoltaic amounted to three-quarters of the world's annual installed renewable electricity capacity. The view of the International Energy Agency, is that solar power will lead the efforts to achieve carbon neutrality (by outperforming onshore and offshore wind power, hydropower, nuclear energy, the other renewable energies and battery storage). To describe today's European industrial cell and module production sector as moribund is an understatement borne out by recent announcements

of factory closures, because of the dearth of or overdue arrival of political support. Unfortunately, Switzerland's Meyer Burger, which had taken up the PV Made in Germany mantle by resuming heterojunction solar cell and photovoltaic module manufacturing in the middle of 2021 on former production sites (the Solarworld site at Freiburg and the Sovello site at Talheim), announced its decision in March 2024 to lay off 500 workers in its Freiburg factory and start preparing for its closure. The Freiburg module production line has been at a standstill since mid-March 2024. According to PV Magazine, the German government's decision to reject the introduction of a "resilience premium" in

the new legislative package's measures for solar "Solarpaket 1" that the government is preparing in order to support the photovoltaic sector, was probably the final straw. The Solarpaket 1 draft bill adopted on 16 August 2023 aims to triple Germany's annual installed PV capacity from 7.5 GW in 2022 to 22 GW in 2026. Prior to the decision to close the Freiburg factory, Meyer Burger was aiming for 3 GW of new manufacturing capacity in Germany by the end of 2024, including 1.4 GW on the Freiburg site. Incidentally, Meyer Burger is constructing two new 2-GW capacity plants – a solar cell factory at Colorado Springs (Colorado) and a



METHODOLOGY NOTE

Photovoltaic is somewhat of a special technology in that there are two ways of measuring its capacity: as alternating current (AC) or as direct current (DC). A solar photovoltaic system operates by capturing the sun's light using photovoltaic cells and by converting it into direct current electricity (DC). The DC electricity is then generally converted into AC (alternating current) electricity using an inverter, because most appliances and electrical systems use alternating current. Thus, there are differences between solar photovoltaic capacity expressed in DC and AC. The first is the power capacity of the installed panel(s) that generate(s) the direct current electricity. The second applies to the output capacity or inverter output (of the DC to AC conversion system), namely the maximum capacity in alternating current that the inverter(s) can supply. The photovoltaic capacity indicator that EurObserv'ER presents in table 1 is representative of the probable net maximum capacity to be delivered to the grid at the end of the calendar year that contributes to the total electricity capacity of each member country. The EurObserv'ER indicator is similar to those published by the official statistical bodies such as Eurostat, the International Energy Agency and IRENA that use the same state sources, statistical offices or bureaus that report directly to the ministries responsible for producing these indicators. Apparently, the photovoltaic capacity data published by the official bodies is not converted into alternating current as a matter of course, because each Member State has its own monitoring methods and approach. Some countries, including the main solar power producer countries such as Germany, officially monitor their photovoltaic capacity in direct current. The rationale behind this is to avoid a war of currents (a battle that Nikola Tesla pulled off in the 20th century by imposing alternating current, that is more suitable for transporting electricity over long distances on the grid, against Thomas Edison who wanted to defend his monopoly with the grid in direct current) but to present photovoltaic solar capacity indicators that can be compared on the same basis between countries. Since 2022, Eurostat has worked on distinguishing these two indicators (each with its own value) and asked each member country to produce these two different indicators. Meanwhile, the rule imposed by Eurostat (stipulated in the metadata on electricity capacity) is that the lesser of the two (AC and DC) is used (logically the alternating current) when calculating the solar photovoltaic capacity that contributes to the country's electricity capacity. If only one of the two is available, it is the one that is taken as the country's total electricity capacity. EurObserv'ER applies this rule.



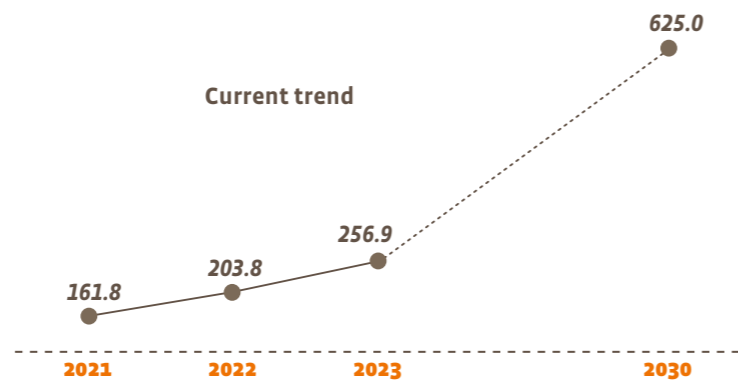
module manufacturing plant at Goodyear (Arizona). In doing so, it will benefit from the IRA (Inflation Reduction Act) that protects and subsidizes energy transition component manufacturing on American soil. On a smaller scale but equally as symbolic, Systovi, one of France's last remaining solar panel manufacturers, announced on 17 April 2024 that it was closing down. "Since the summer of 2023, the company has had to deal with the sudden acceleration of Chinese dumping. For years, the firm has taken part in ongoing regulatory discussions in France and Europe, but their effects will come too late to save it".

While Europe's solar industry is facing an uphill struggle, it is too soon to say, "game over", as it could benefit from the political determination of Europe's bodies to reap the economic rewards of employment and wealth creation, and its own energy transition. The actual danger for Europe is that it might exchange its dependency on hydrocarbons, oil and gas for another dependency concentrated in China. China has positioned itself on all the key energy transition sectors (photovoltaic, wind turbines and their components, electrochemical batteries, electrolysers and EVs), and above all is a producer of the key metals found on its own soil that are essential for manufacturing its products.

On 15 April 2024, 23 Member States, the European Commission and the solar industry signed a "Solar Charter" with the aim of protecting and encouraging European solar panel manufacturing. The Charter's signatories undertake to back the competitiveness of the European photovoltaic manufacturing industry and foster the creation of a high quality product market that meets the stringent sustainability and resilience standards, fully compliant with the EU's climate and energy targets. The Charter recognizes that most of the demand for solar modules in Europe is covered by imports from a single supplier country, China. This concentration creates short-term risks for the resilience of the value chain and long-term risks for the stability of solar panel prices. It considers that access to affordable solar modules originating from diverse sources, and a resilient, sustainable and competitive European solar value chain are needed to achieve a deployment rate commensurate with Europe's goals, while

Graph No. 3

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



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

underpinning the security of supply and mitigating the risk of supply chain disruptions. It lists the elements that could help in this respect, primarily swift implementation of the relevant Net Zero Industry Act stipulations for the application of non-price criteria in renewable energy auctions and procurement contracts. The European Solar Charter marks the last stage of the Commission's actions to support solar panel manufacturing in Europe. Earlier measures include a draft bill on the net zero emission industry, which is now provisionally approved by the legislators and the creation of the Solar PV Industry Alliance (ESIA). The Solar PV Industry Alliance was launched in December 2022 to boost cooperation

within the industry and set itself a 30-GW manufacturing capacity target throughout the value chain... a target that was considered as feasible by 2030. The ESIA pipeline includes more than 20 projects, several of which are at multi-GW scale. They include the Carbon start-up, a 5-GW project to be installed on the Fos-sur-Mer site with integrated production along the whole value chain (from polysilicon to module manufacturing), at a cost of 1.5 billion euros. But the declarations of intent stage will have to be completed, because without major subsidies on the part of the States concerned, it will be impossible to attract financiers to similar projects even if the Commission and Europe contribute by offering financing



In 2023, 2,400 photovoltaic modules deployed over an area of 7,100 m² were installed on the Villeroy & Boch site at Merzig, Germany.

facilities. Political acceptance of the fact that "Made in Europe" manufacturing will be dearer over time (with costs about 35% higher according to the IEA's December 2022, **The Solar PV Global Supply Chains** report) will also be required. Obviously, it depends on how the question is framed. If Europe does not wish to be dependent on China, that does not mean that it must manufacture all of its production, but it should be a significant proportion of it. The "Net Zero Industry Act" sets Europe the target of manufacturing 40% of its annual net zero technology requirements by 2030, based on the National Energy and Climate Plans (NECPs) and capturing 15% of the global market value for these technologies. Europe also has a strong hand in the higher added-value segments, such as semi-transparent panels for agrivoltaics and building facades and integrated panels on electric vehicles. For its part, China's strategy to carry and back investments in all the industrial carbon neutrality sectors at a scale that outstrips its needs also comes with industrial and financial risks. Similarly, the United States has its IRA and India has closed its doors to Chinese modules.

TARGETS FOR 2030 DOUBLED

Publication of the Renewable Energy Directive (known as RED III) in the European Union Official Journal No. 2023/2413 on 18 October 2023 opened up new possibilities for the photovoltaic sector. RED III

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 its extremely tight deadline, will make the Member States thoroughly reassess the contribution made by solar photovoltaic power over the next seven years when updating their National Energy and Climate Plans (NECPs). Regulation (EU) 2018/1999 on the "Governance of the Energy Union and Climate Action" effectively includes the obligation to revise these plans by 30 June 2023 and to finalize them at the latest by 30 June 2024. The NECP revision process has substantially raised the Member States' solar photovoltaic ambitions submitted in a new project to the European Commission. For instance, Spain's updated National Energy and Climate Plan raised the total installed photovoltaic capacity target for 2030 from the previous 39 to 76 GW, which is practically double the former target. In its new NECP (2023 version), Germany plans to install an average of 22 GW per annum, to arrive at cumulative capacities of 215 GW in 2030 and 400 GW in 2040. France is raising its photovoltaic targets within the range 54 to 60 GW in 2030 compared to 35.1 to 44 GW by 2028 in its latest NPEC, and 75 to 100 GW by 2035. Italy, another major solar power country, is raising its photovoltaic target from 51 to 79 GW for 2030. Portugal's

photovoltaic contribution is rising from 9 to 20.4 GW.

Poland, which submitted its modified draft NPEC on 5 March 2024, signals a new solar contribution of 29.3 GW for 2030 in its forecasts compared to the 7.3 GW initially planned. EurObserv'ER, which has gleaned the new 2030 photovoltaic targets detailed in the draft NPECs submitted to the Commission in 2023 and early 2024 (Poland and Bulgaria), reckons that the EU-wide target has increased to 625.2 GW for 2030 (taking the high scenarios for France and Czechia), compared to an overall target of 316 GW in the earlier versions of the NECPs submitted in 2019. Thus, the new European ambitions for solar mark the near doubling of the overall target. □

Sources: AGEE-Stat (Allemagne), GSE-Terna (Italie), SDES (France), Ministry for the Ecological Transition and the Demographic Challenge (Espagne), Statistics Pays-Bas (Pays-Bas), Statistics Autriche (Autriche), SPF Economie (Belgique), CRES (Grèce), Mavir (Hongrie), MEHK (Hongrie), ESO (Bulgarie), ARE (Pologne), DGEG (Portugal), INS (Roumanie), Statistics Suède (Suède), Statistics Lituanie (Lituanie), Litgrid (Lituanie), Elering (Estonie-e), Ast (Lettonie), Statistics Finlande (Finlande), Danish Energy Agency (Danemark), Eirgridgroup (Irlande), NSO (Malte), STATEC (Luxembourg), IRENA.

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



This barometer was prepared by Observ'ER in the scope of the EurObserv'ER project, which groups together Observ'ER (FR), TNO (NL), Renewables Academy (RENAC) AG (DE), Fraunhofer ISI (DE), VITO (Flemish Institute for Technological Research) (BE) and Statistics Netherlands (NL). This document has been prepared for the European Commission however it reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.