

SOLAR PHOTOVOLTAICS (PV)

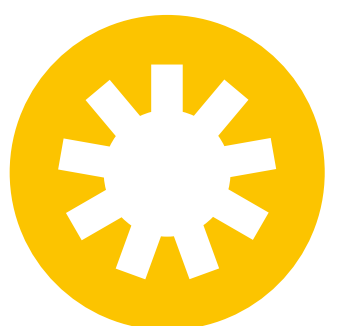
KEY FACTS FOR 2024

- Global installed solar PV capacity grew by a staggering 37% between 2023 and 2024.
- After the 1 TW milestone was reached in 2022, it took under two years for solar PV capacity to exceed 2 TW, by year end 2024.
- China remained the dominant force in solar PV in 2024, accounting for 60% of global capacity additions, 47% of total installed capacity and 64% of global solar PV jobs in 2023 – including 2.4 million in manufacturing.
- The United States was responsible for 8% of global solar PV capacity additions in 2024 and reached 280,000 jobs, but new legislation in 2025 eliminated key tax incentives and net metering, threatening the future of solar deployment in the country.
- Pakistan emerged as a solar leader in 2024, responsible for 3% of global PV capacity additions – driven by low solar PV prices and high electricity tariffs.

A record
602
gigawatts
of solar PV capacity
was added in 2024

Utility-scale PV
grew by
382
gigawatts
(+43%) in 2024

Rooftop and distributed
systems grew by
200
gigawatts
(+23%) in 2024

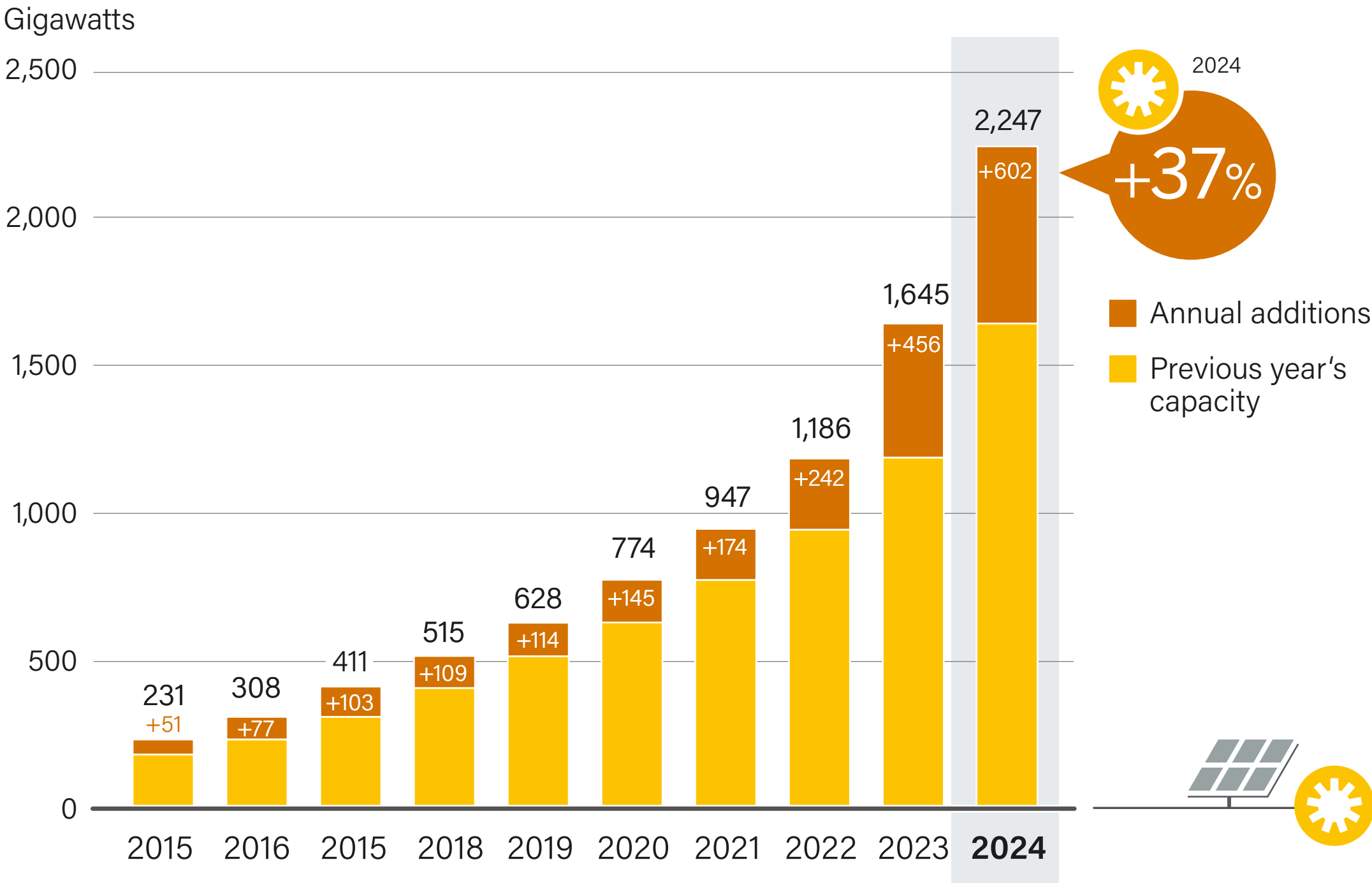


The solar PV sector experienced another record-breaking year in 2024. Total cumulative **installed capacity** surpassed the 2-terawatt (TW) milestone and reached 2.25 TW, up from 1.65 TW in 2023 and nearly double the installed capacity of 2022.¹ **Annual additions** hit an all-time high of 602 GW, which is equivalent to all global PV capacity installed by the end of 2019 and represents a 32% year-on-year increase.² (→ See Figure SPV-1.)

2,247_{GW}

of solar PV capacity was installed globally by the end of 2024, nearly double the 2022 total and more than triple the capacity installed before 2020.

 **FIGURE SPV-1**
Solar PV Global Capacity and Annual Additions, 2015-2024



Source: See endnote 2 for this section.





Growth continued to be driven primarily by the sector’s long-term market leaders, with China accounting for approximately 60% of new additions, followed by the United States (8%) and India (5%).³ (→ See *Figure SPV-2*.) At the same time, emerging markets saw a sharp rise in activity. Pakistan, for instance, was responsible for 3% of global additions, installing more solar PV in a single year than the total capacity installed in countries like the United Kingdom or Poland.⁴ The global surge was facilitated by record-low module prices due to oversupply, as well as favourable policy environments and falling installation costs in key markets.⁵

32%

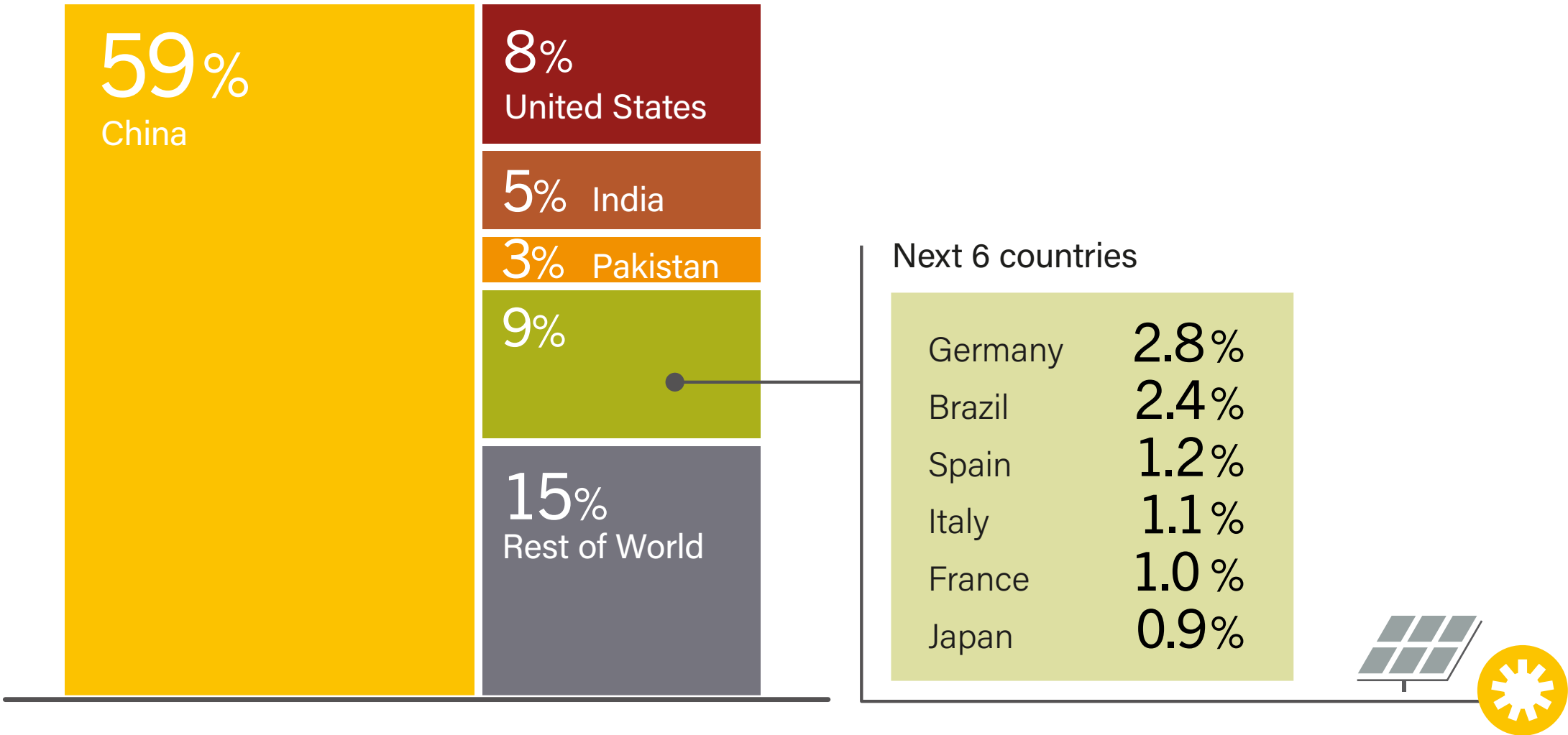
Annual additions grew by nearly one-third, reaching 602 GW, up from 456 GW in 2023.



FIGURE SPV-2

Solar PV Global Capacity Additions, Shares of Top 10 Countries and Rest of World, 2024

Solar PV Global Additions 2024: 602 GW



Source: See endnote 3 for this section.

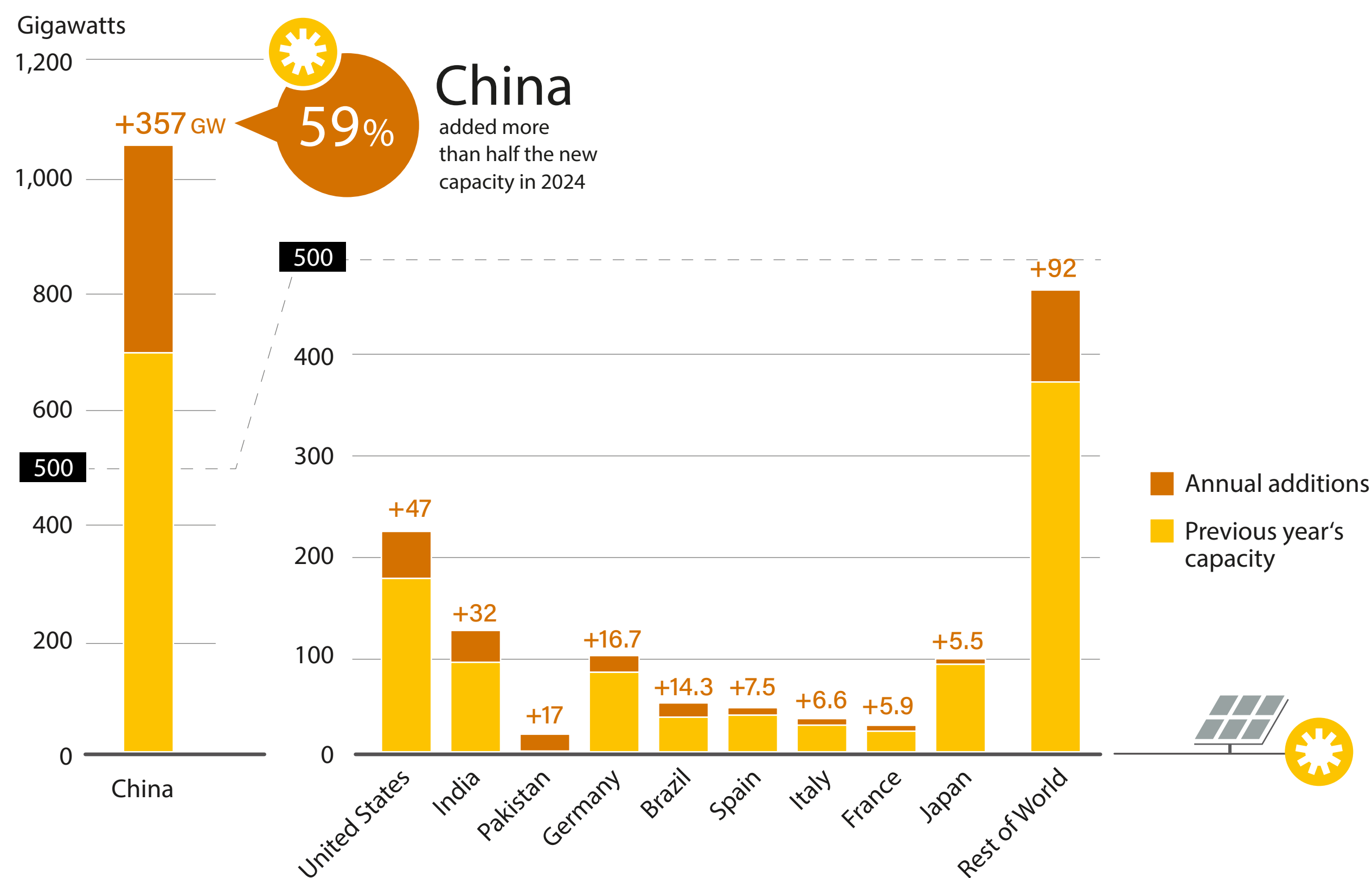
China maintained its market dominance in 2024, installing a staggering 357 GW of solar PV, 30% more than in 2023 and representing nearly 60% of total global additions.⁶ (→ See Figure SPV-3.) The country's solar PV capacity reached 1.05 TW, 47% of the global total. Due to this rapid growth, China achieved its combined 2030 solar and wind capacity target of 1,200 GW six years ahead of schedule.⁷ Utility-scale projects drove most of the growth, representing more than two-thirds of new capacity.⁸ Decentralised installations totalled 118 GW. Due to subsidy phase-outs and reduced demand, just 30 GW of residential solar PV capacity was added in 2024. Overall, decentralised solar PV capacity grew 23%. Several megaprojects were commissioned, including the Midong and Hobq Solar Parks (each exceeding 3 GW), alongside at least 10 other projects above 2 GW.⁹

SOLAR PV GENERATION AND SHARE IN THE ELECTRICITY MIX

Electricity generation through solar PV continued to grow rapidly, reaching 2,131 TWh globally in 2024.¹⁰ This represented 6.9% of global electricity generation, up from 5.6% in 2023.¹¹ Between 2023 and 2024, solar PV generation grew by approximately 480 TWh, an increase more than 2.5 times larger than that of any other source.¹²

China accounted for 53% of the global growth, increasing its solar PV generation by 46% or 265 TWh. In the United States, solar generation rose by 64 TWh (+30%) and the share of solar PV and wind in total generation grew to 16%, overtaking coal for the first time.¹³ Brazil became the fifth-largest generator of solar PV electricity, due to its comprehensive policies supporting both large-scale centralised projects and residential systems (e.g., through a generous net-metering scheme).¹⁴ In the European Union, too, solar PV generation overtook coal for the first time, and the combined output of solar and wind surpassed that of the combined output of coal and gas. Solar PV alone contributed around 14% of total EU electricity generation.¹⁵

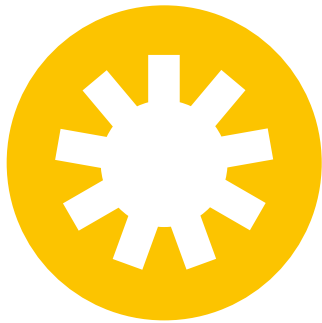
FIGURE SPV-3
Solar PV Capacity and Additions, Top 10 Countries for Capacity Added, 2024



Source: See endnote 6 for this section.

HIGH SOLAR PV SHARES:
INTEGRATION CHALLENGES AND THE GROWING ROLE OF
BATTERY STORAGE

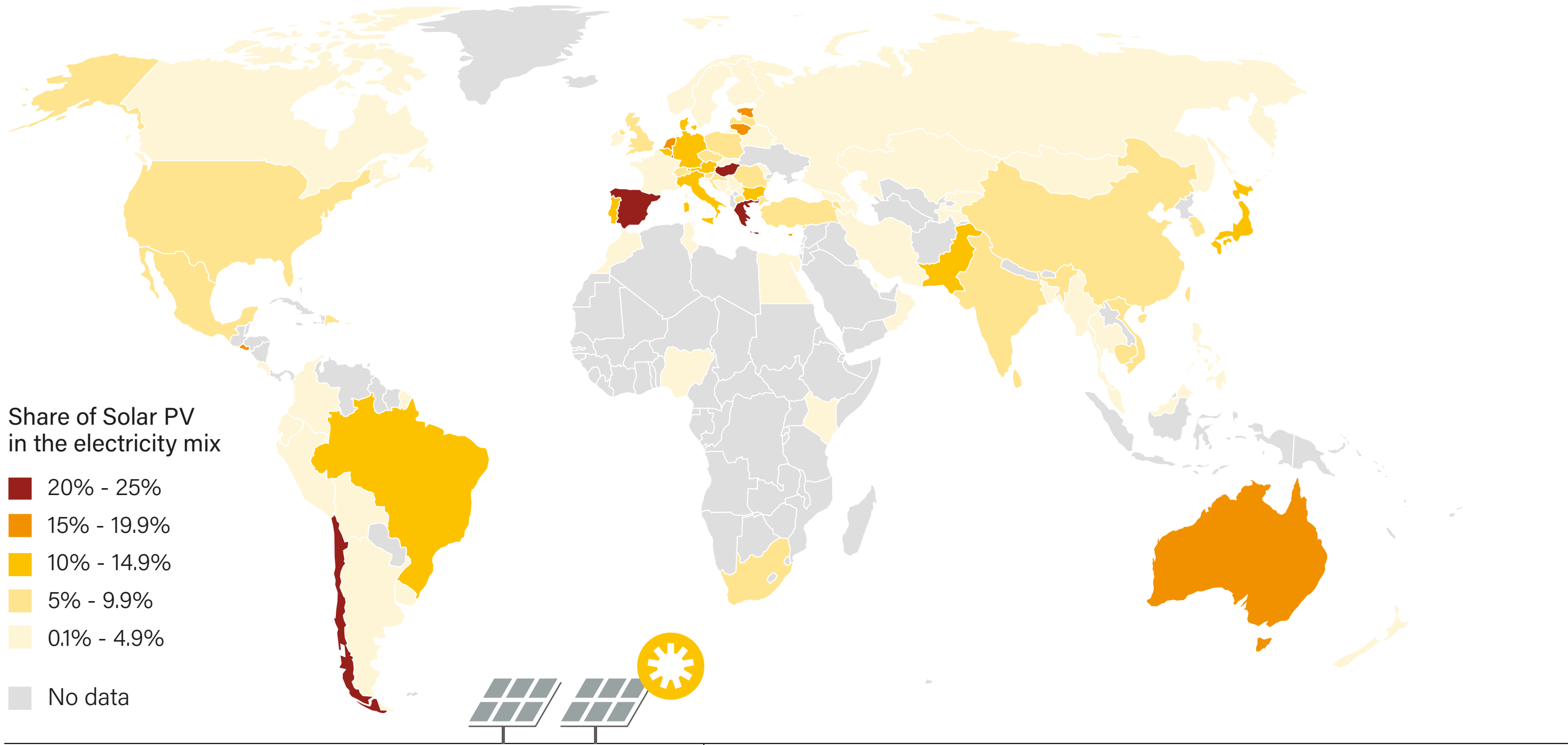
In 2024, 23 countries achieved **solar PV shares in the electricity mix** exceeding 10%, up from 18 countries the previous year.¹⁶ (→ See Figure SPV-4.) Five countries exceeded or approached shares of 20%,¹⁷ Hungary (25%), Luxembourg (22%), Chile (22%), Greece (21%) and Spain (21%).¹⁸ However, some of this generation was curtailed due to grid infrastructure inadequacies; for example, Chile curtailed 3.3% of its solar PV output in 2024, illustrating the pressing need for improved and more flexible grid infrastructure.¹⁹ Higher curtailment was reported in markets like Cyprus, with an estimated solar PV curtailment rate of 8.4%.²⁰



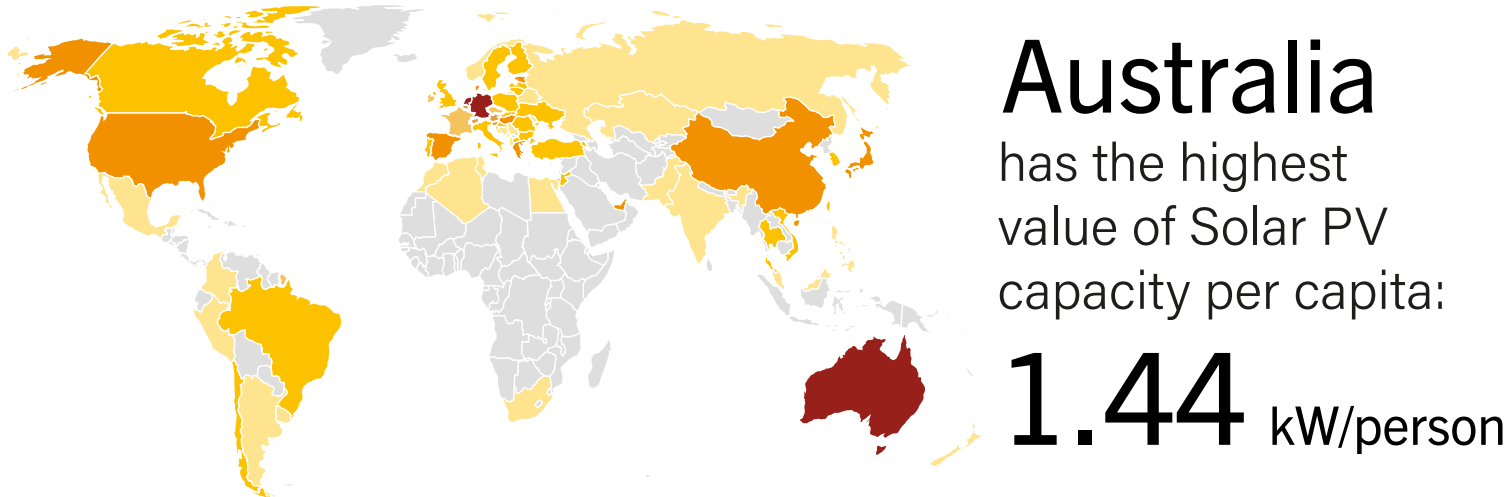
2,131 TWh

Solar PV generated over 2,100 TWh of electricity globally in 2024, representing 6.9% of total generation – up from 5.6% in 2023.

 **FIGURE SPV-4.**
Solar PV Share in Electricity Mix, by Country, 2024



5 countries have more than 20% of Solar PV in their electricity mix:	Hungary	24.6%
	Luxembourg	22.4%
	Chile	22.3%
	Greece	21.4%
	Spain	20.9%



Source: See endnote 16 for this section.

Solar PV deployment is increasingly accompanied by battery storage solutions to minimise the need for curtailment, reduce price volatility and enhance grid reliability. In 2024, global battery storage capacity additions grew by around 65%, as falling battery costs, growth in electric vehicle markets and increasingly frequent low or negative electricity prices – caused by surges in solar and wind generation – made storage more attractive and necessary.²¹ **Co-located solar-plus-storage systems** are rapidly becoming standard in many markets, driven by policy mandates, grid needs, and economic viability. In the United States, residential attachment ratesⁱ reached 25% in early 2024, while India issued large-scale tenders, and deployment grew across the Middle East and North Africa.²² Policy support for batteries has advanced, especially in countries facing grid congestion, high shares of variable renewables and/or high electricity costs. The phase-out

of feed-in tariffs in several markets and the increasingly low compensation for excess electricity injected into the grid has made self-consumption and the uptake of battery storage systems more attractive. Policies and market frameworks that promote the integration of battery storage with both distributed and utility-scale solar PV are now well established in countries such as Australia, China, Germany, Italy and Japan, and include dedicated incentives, mandates and grid service mechanisms.²³ In China, mandatory coupling of solar with storage has led to a record expansion of battery capacity.²⁴

UTILITY-SCALE VS. ROOFTOP TRENDS

Utility-scale solar PV installations surged by approximately 380 GW in 2024 – a 43% year-on-year increase – and made up almost two thirds of global solar additions.²⁵

Large-scale projects continued to drive market growth in China, the United States and India, with multiple installations exceeding 500 MW coming online.²⁶ Europe also saw significant new additions, most notably Germany's Witznitz Solar Park, the largest solar installation in Europe with a capacity of 650 MW.²⁷ Meanwhile, **decentralised and rooftop systems** grew more moderately, adding around 220 GW.²⁸ Rooftop deployment remained significant in many markets. In 2024, Germany added an estimated 10 GW of rooftop and other distributed solar PV capacity. In Italy, distributed systems accounted for approximately 80% of total solar PV additions, amounting to 5.3 GW.²⁹ In Brazil and Mexico, distributed solar surged due to net metering incentives.³⁰ Pakistan's solar PV capacity growth was primarily rooftop-based, driven by high retail electricity prices, a weak central grid and the availability of cheap modules.³¹ In India, the PM-Surya

Ghar: Muft Bijli Yojana subsidy scheme, launched in 2024, provides capital support for up to 60% of the value of residential rooftop PV systems.³² In the United States, the federal “One Big Beautiful Bill Act,” signed into law in July 2025, has triggered widespread concern in the residential solar industry. The law eliminates state-level net metering mandates and replaces them with a uniform federal compensation mechanism, which is expected to reduce remuneration for solar electricity delivered to the grid. More critically, the act ends key federal tax incentives for residential solar, including investment tax credits.³³ These sweeping changes are likely to reduce the financial viability of rooftop PV, especially in states where strong net metering and tax incentives had driven rapid deployment. Industry stakeholders warn the law could stall new installations, undermine local solar jobs and slow progress towards national energy targets.³⁴

ⁱ Attachment rate refers to the percentage of newly installed solar PV systems that are paired with battery energy storage.

220 GW

Rooftop solar PV capacity grew by around 23% in 2024, adding nearly 220 GW globally – with major growth in Germany, Brazil, India and Pakistan.



Rooftop solar in Cancún, Quintana Roo, Mexico

EMPLOYMENT IN THE SOLAR PV SECTOR

By the end of 2023, the solar PV industry employed an estimated 7.2 million people globally.³⁵ China led the ranks by a wide margin with 4.6 million solar PV jobs, nearly half of which, around 2.4 million, were in manufacturing.³⁶ In the United States, employment in solar PV reached approximately 280,000, with the manufacturing segment gaining momentum due to the Inflation Reduction Act (IRA). More than 250 clean energy manufacturing facilities, many focused on solar modules, inverters and cells, were under construction as of mid-2025, supporting an estimated 122,000 manufacturing jobs, with projections of up to 575,000 jobs to be created by 2030.³⁷ The European Union reported approximately 720,000 solar PV jobs in 2023, with significant employment growth in manufacturing, owing to efforts to rebuild domestic supply chains.³⁸ In Southeast Asia, countries such as Vietnam, Malaysia and Thailand have become manufacturing hubs of global importance. In 2023, approximately 105,000 workers were employed in solar PV sector in Vietnam (75% in solar PV manufacturing), while Malaysia and Thailand recorded approximately 43,000 and 30,000 solar PV manufacturing jobs, respectively, mostly in manufacturing as domestic installation remains limited.³⁹ While solar PV manufacturing continues to expand, most employment globally remains in installation. A large share of these jobs is concentrated in the segment of distributed solar PV, the installation and maintenance of which are significantly more labour-intensive than that of utility-scale solar. Small-scale

rooftop PV systems require six to ten times more labour per megawatt installed than large-scale utility plants.⁴⁰

MANUFACTURING, OVERSUPPLY AND PRICES

Global PV module manufacturing capacity surged from 1.135 TW/year in 2023 to 1.5 TW/year in 2024, predominantly driven by China, which now accounts for about 80% of production capacity along the entire PV manufacturing value chain (polysilicon, ingots, wafers, cells and modules).⁴¹ In 2024 alone, Chinese factories produced approximately 630 GW of modules, nearly double the country's annual deployment, leading to significant global oversupply.⁴² This excess has pushed module prices down to around USD 0.10/Watt – a reduction of roughly 45% year-on-year – and resulted in a global stockpile that was estimated at over 150 GW by the end of 2023.⁴³

Oversupply has fuelled intense price competition, prompting concerns over deflationary pressures within China's broader economy. In July 2025, the Chinese Ministry of Industry and Information Technology convened leading solar companies – including Longi, JA Solar, Trina, and Tongwei – urging them to end "disorderly low-price competition," phase out outdated capacity and improve product quality.⁴⁴

As a result, polysilicon prices in China climbed nearly 30% from June lows, rising to roughly USD 5,600/tonne (CNY 39,200/tonne) by early July 2025.⁴⁵ In addition, several of the major Chinese manufacturers saw their share prices surge by 10–20% following government intervention.⁴⁶

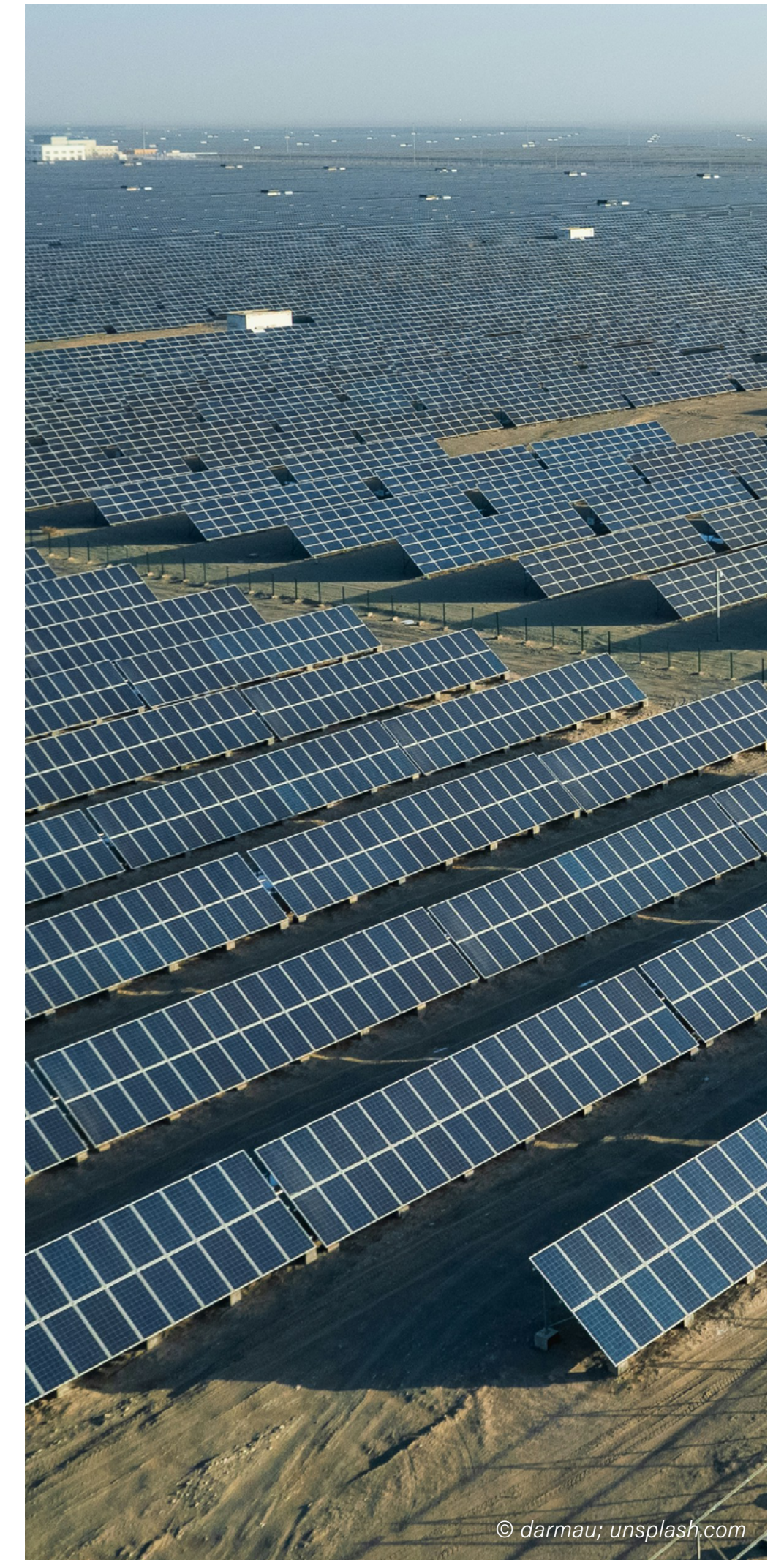
TECHNOLOGICAL ADVANCES IN 2024

Crystalline silicon (c-Si) remained the dominant PV technology in 2024, accounting for approximately 98% of the market. At the same time, a rapid shift occurred from p-type PERC cells to n-type technologiesⁱ, with n-type cells – particularly TOPCon – reaching a market share of around 75% (up from 63% in 2023).⁴⁷ Most manufacturers upgraded production lines to accommodate these higher-efficiency designs. Module designs also evolved, with a move toward standardised rectangular cell formats (182R or 210R) and bifacial modules.⁴⁸ Research and development to advance perovskite tandem cells showed strong momentum, achieving record efficiencies of around 34%, although challenges related to commercial viability, durability and stability remain.⁴⁹

ⁱ N-type solar cells use a negatively-doped silicon base, which offers advantages over traditional p-type (positively-doped) cells – including higher efficiency, better temperature tolerance and reduced susceptibility to light-induced degradation. Common n-type technologies include TOPCon (Tunnel Oxide Passivated Contact), HJT (Heterojunction), and IBC (Interdigitated Back Contact) cells.

7.2 million

By end-2023, the global solar PV sector employed an estimated 7.2 million people, with China accounting for nearly two-thirds of these jobs.



Dunhuang, Gansu Province, China

LEAD CONTRIBUTOR

Gianluca Tonolo, Haki Energy

REN21 DATA AND KNOWLEDGE TEAM

Jad Baba

Janne Luise Piper

Andrea Wainer

Jiayi Wang

Glen Wright

TOPICAL CONTRIBUTORS

Gaëtan Masson (IEA PVPS)

Melodie de l'Epine (Becquerel Institute France)

Daniel Mugnier (IEA PVPS)

EDITING, DESIGN AND LAYOUT

Maria van Veldhuizen (Editor)

weeks.de Werbeagentur GmbH (Design)

PRODUCTION AND COMMUNICATION

REN21 Secretariat, Paris, France

The endnotes for this fact sheet are available to download on

→ [REN21 website](#)

The full and interactive fact sheet is available here

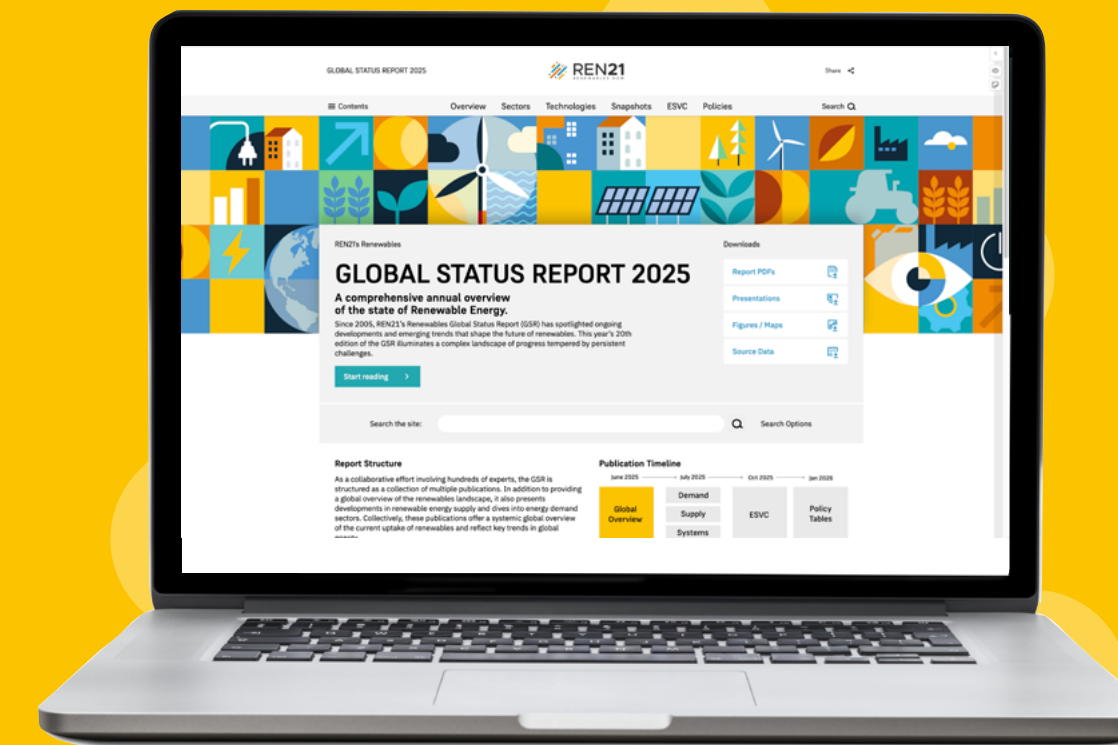
→ [GSR microsite](#)

DISCLAIMER:

REN21's reports highlight the role of renewable energy and stimulate informed dialogue to support its advancement. While these publications draw on the input of REN21's broad network, they do not necessarily reflect a unified position among all participants. The information provided represents the best available knowledge at the time of writing, but REN21 and its contributors cannot be held liable for its accuracy and correctness.

Additionally, the report's use of maps and geographic references does not imply the expression of any opinion whatsoever concerning the legal status of any region, country, territory, city or area or of its authorities, and is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers or boundaries and to the name of any territory, city or area.

For the 2025 edition of the Renewables Global Status Report, REN21 updated the methodology and classification system of its Policy Database to improve clarity and better capture current policy developments. Consequently, some figures in this edition may not be directly comparable with data from previous reports.



RENEWABLES GLOBAL STATUS REPORT 2025 COLLECTION

For more information, please visit our website. There you will find all the details and get a comprehensive overview of all the different modules and factsheets.



www.ren21.net/gsr-2025/

REN21 Secretariat
158 ter rue du Temple
75003 Paris
France

www.ren21.net