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Global Market Outlook for Solar Power 2025-2029

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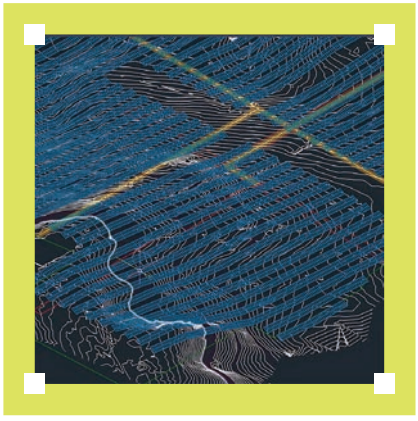

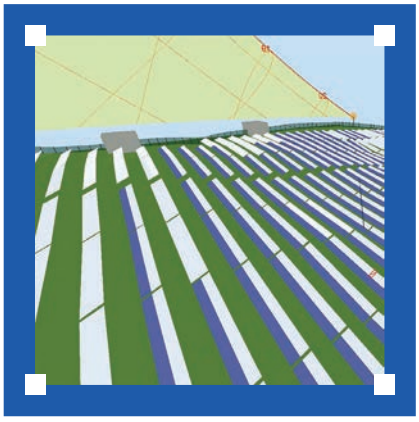

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Foreword

Welcome to the Global Market Outlook for Solar Power 2025-2029

The year 2024 was a true landmark year for solar power. Global solar installations reached nearly 600 GW – an impressive 33% increase over the previous year – setting yet another record. Solar accounted for 81% of all new renewable energy capacity added worldwide. While remaining a modest contributor to overall electricity generation for now, solar's share rose to 7% in 2024 – nearly doubling in just three years. Solar experienced the fastest growth among all power generation technologies in terms of electricity output, three times as much as wind power, which was ranked second. As if that weren't enough, global installed solar capacity surpassed 2 TW in 2024. It took nearly 70 years to reach the first terawatt, but only two more to double it.

This remarkable progress has been fuelled by rapid technological advancements that have significantly reduced costs, the unmatched versatility of solar – from small plug-in or rooftop systems to massive utility-scale installations – and historically low prices driven by global manufacturing overcapacities. As a result, solar is increasingly outperforming other power generation technologies across the board.

There is no doubt that solar power has become the driving force of the global energy transition.

Looking ahead, however, there remain challenges that must be addressed for solar to continue fulfilling its potential. Although continued market growth is expected, the pace is projected to slow after several years of explosive expansion. In our most realistic scenario, we anticipate a 10% increase in installations to 655 GW in 2025, with annual growth rates remaining in the low double digits between 2027-2029, reaching 930 GW by the end of this outlook period. However, meeting the Global Solar Council's aspirational target of 8 TW by 2030 will require a significantly accelerated pace of deployment – roughly 1 TW of new installations per year on average.

A key issue is the uneven distribution of solar market growth. Most expansion has been concentrated in the Asia-Pacific region, led by China, creating widening disparities between regions. In 2024, China's solar market grew by 30% to 329 GW, more than the combined total of the other top 10 markets, with a 55% global market share. China's growth is a major achievement from a global decarbonisation perspective and its comprehensive solar commitment has enabled the technology's rapid global development, but it also underscores the world's heavy reliance on a single country. With China implementing major changes to its solar market design this year, a temporary dip in global growth in 2026 appears very likely. Meanwhile, other regions are falling behind, particularly the Middle East and Africa, which installed less capacity than in the previous year. Although the number of countries with annual gigawatt-scale solar markets has increased to 35, this is fewer than anticipated. We do expect this to change in the near future; our report provides a detailed analysis of these GW-scale markets, with insights from national solar and renewable energy associations (see p. 78).

There are also rising solar stars today. India's comprehensive solar strategy – covered in a dedicated chapter (see p. 60) – is beginning to bear fruit. The most populous nation on Earth has emerged as the world's third-largest solar market after more than doubling its annual installations in 2024. Continued strong growth is expected.

As outlined in the Global Solar Council's policy recommendations (see p. 56), sustaining global momentum will require addressing a range of region-specific challenges. More advanced markets must focus on enhancing grid flexibility, adapting policy frameworks to the needs of variable renewables, prioritising battery storage, and streamlining permitting and grid-connection processes. For least developed countries, the key lies in bridging investment gaps. Across all regions, developing a skilled workforce and setting ambitious solar and storage targets are essential tasks.

In these times of political uncertainty, low-cost solar power could turn into the key tool to provide energy security and competitiveness to nations across the world. The years ahead are crucial for solar development and will require foresight and commitment from policy leaders and financial institutions. In our most likely Medium Scenario, we expect solar's role in the driver seat of the global energy transition to become even stronger, reaching a total installed capacity of 7.1 TW by 2030 – and delivering nearly two-thirds of the 11 TW renewable energy target set at COP28. With the right enabling conditions, solar capacity could even quadruple its capacity and exceed 8 TW by the end of the decade.

Enjoy reading our report.

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Methodology:
SolarPower Europe's five-year forecast consists of Low, Medium and High Scenarios. The Medium scenario anticipates the most likely development given the current state of play of the market. The Low Scenario forecast is based on the assumption that policymakers halt solar support and other issues arise, including interest rate hikes and severe financial crisis situations. Conversely, the High Scenario forecasts the best optimal case in which policy support, financial conditions and other factors are enhanced.

Segmentation is based on the following system size: Residential (<10 kW); Commercial (<250 kW); Industrial (<1,000 kW); Utility-scale (>1,000 kW, ground-mounted). SolarPower Europe's methodology includes only grid-connected systems. Installed capacity is always expressed in DC, unless otherwise stated.

All figures are based on SolarPower Europe's best knowledge at the time of publication. In the preparation of reports, SolarPower Europe consults and gathers inputs from a wide range of industry associations, institutions, and stakeholders. Nevertheless, the figures and estimates presented in this report are the result of our own independent analysis and methodology.

The data published in this report do not necessarily reflect the views, estimates, or positions of the external sources we consulted. Differences between SolarPower Europe's figures and those of other organisations may arise due to variations in scope, definitions, assumptions, or calculation methods.

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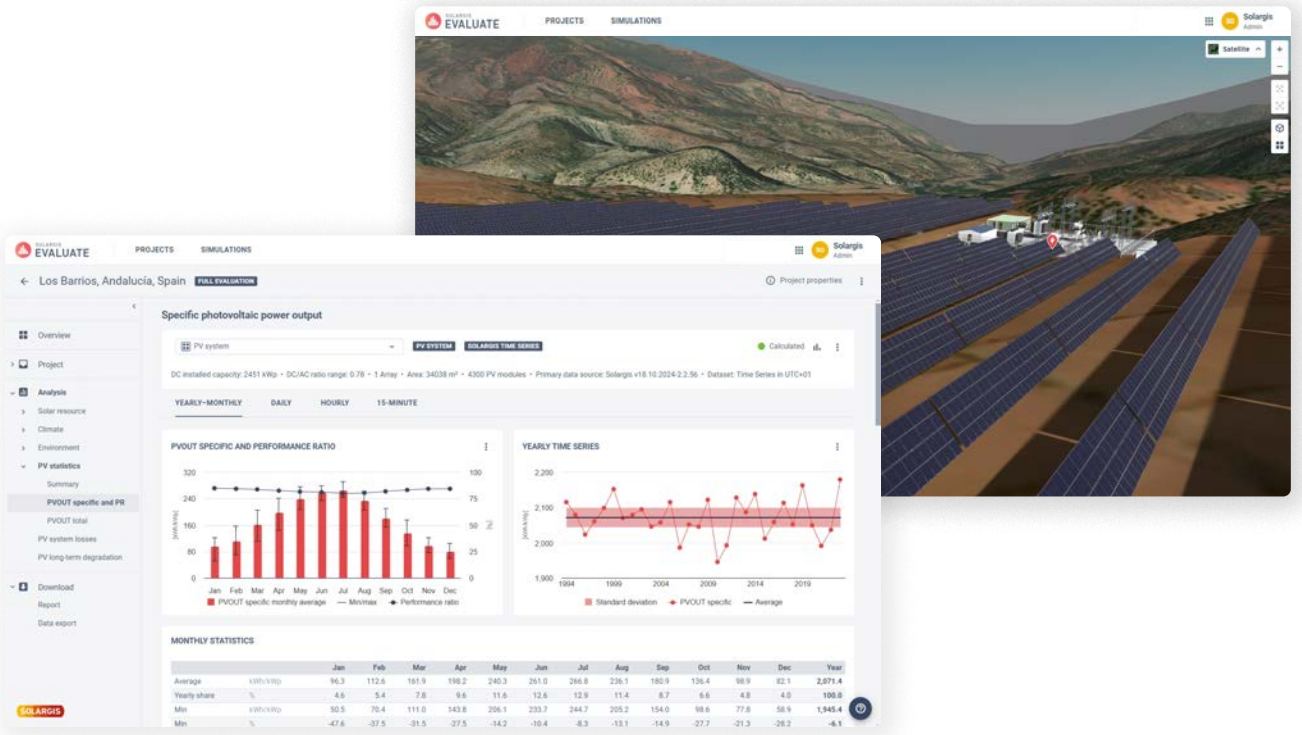

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The global solar market reached new heights with about 600 GW in 2024, with Asia-Pacific providing 70% of new capacity

597 GW

597 GW installed in 2024: new market record once again

33%

33% annual market growth: a decrease from 85% in 2023

7.1 TW

7.1 TW total solar capacity and TW-level annual installations likely to be reached by 2030

Global solar PV installations set another record in 2024, reaching 597 GW – a 33% increase over 2023, and 148 GW more the previous year (Fig. 1). Although the annual growth rate slowed compared to the exceptional 85% surge in 2023, it was still substantial enough to reinforce solar energy's leading dominance on global renewable energy expansion. In 2024, solar contributed 81% of all new renewable capacity added worldwide. Regarding global power generation, solar nearly doubled its share over the past 3 years, growing by 1.3 percentage points only last year to a 7% share in the world's electricity mix. This growth continued to drive renewable penetration and pushed additions of conventional electricity sources to a new low.

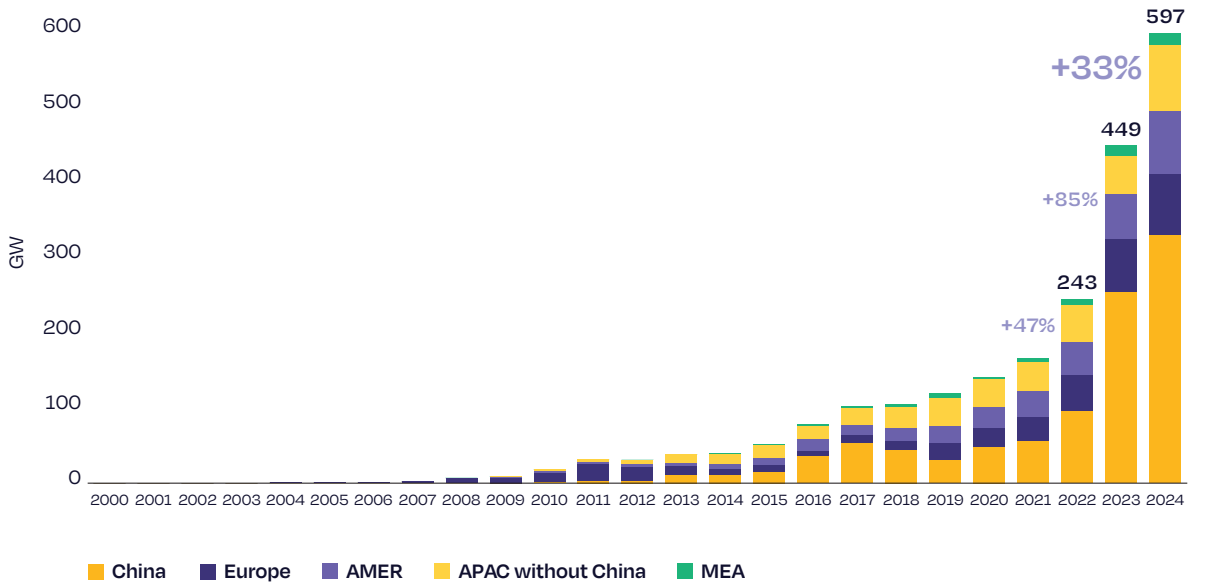
Several factors contributed to this sustained momentum. Technology improvements that have turned versatile solar into the lowest-cost power generation technology in many places around the world, along with record-low solar component prices – largely due to significant manufacturing overcapacity along the solar value chain – have made solar products more affordable than ever. At the same time, solar PV is increasingly being recognised as a cornerstone technology in climate, political, and energy security strategies worldwide.

The Asia-Pacific region remained the undisputed regional leader, accounting for 70% of global capacity additions and a 37% annual growth. The Americas also increased by 40% to a 14% market share. Europe also saw growth, albeit at a slower pace, rising by 15% to 82.1 GW, with a 14% market share. Conversely, the Middle East and Africa was the only region to experience a year-on-year decline in 2024, decreasing 2% to 14.5 GW and accounting for 2.4% of the global market.

Figure 1

Record 597 GW of global solar capacity added in 2024; slower but steady 33% annual growth

Annual solar PV installed capacity 2000-2024



China continues to play in a different league, outperforming other top 10 markets with new stars on the horizon

In 2024, China once again dominated the global solar market, installing an impressive 329 GW, over six times the capacity added by the second-ranked United States, and exceeding the combined total of all other top 10 markets. This accounted for 55% of global additions, further solidifying China's position as the outstanding leader in solar PV deployment (Fig. 2).

Despite China's overwhelming lead, most of the other top 10 markets also recorded strong growth. The US added a record 50 GW, representing a 54% increase. India experienced a remarkable rebound, surging by 145% to 30.7 GW, reclaiming third place after slipping to fifth in 2023. India's strong resurgence pushed Brazil and Germany each down one position in the rankings, with annual installations of 18.9 GW and 17.4 GW, respectively.

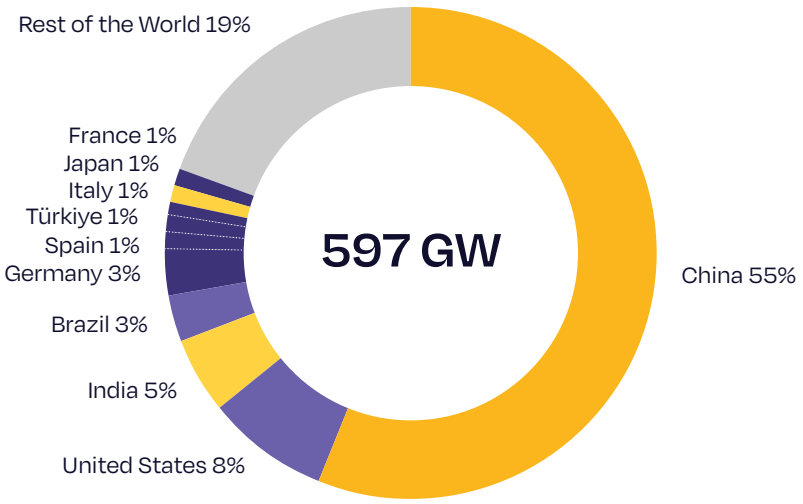
Two countries entered the global top 10 in 2024. Türkiye made a strong leap to the seventh place, with a five-fold increase in annual installations, reaching 8.5 GW. France entered the top 10 at the tenth position, growing by 49% to 4.7 GW. These additions displaced Australia and the Netherlands from the top 10.

Spain, Italy and Japan completed the ranking at 6th, 8th and 9th place, with installations of 8.7 GW, 6.8 GW and 6.2 GW, respectively. Altogether, the top 10 markets were responsible for 81% of global solar PV installations, while the rest of the world accounted for the remaining 19%, collectively installing 116 GW. Clearly this imbalance in the market and global distribution needs to be addressed by investors and policymakers moving forward – all G20 countries, and developing countries too, should be seeing similar solar booms.

Figure 2

Top 10 markets install 81% of global solar

Top 10 countries solar capacity share 2024



It took nearly 70 years to install the first solar TW, and only 2 years (2022-2024), to double the solar fleet to 2 TW

The pace of solar PV deployment in recent years has been unprecedented. While it took nearly 70 years – from the first commercialisation of solar cells in 1954 – to reach the first 1,000 GW (1 TW) of capacity, the second TW was added in just two years. With 449 GW installed in 2023 and 597 GW in 2024, global cumulative installed solar PV capacity reached 2.2 TW by the end of 2024 (see Fig. 3). The solar industry was able to celebrate this milestone at COP29 Baku in Azerbaijan.

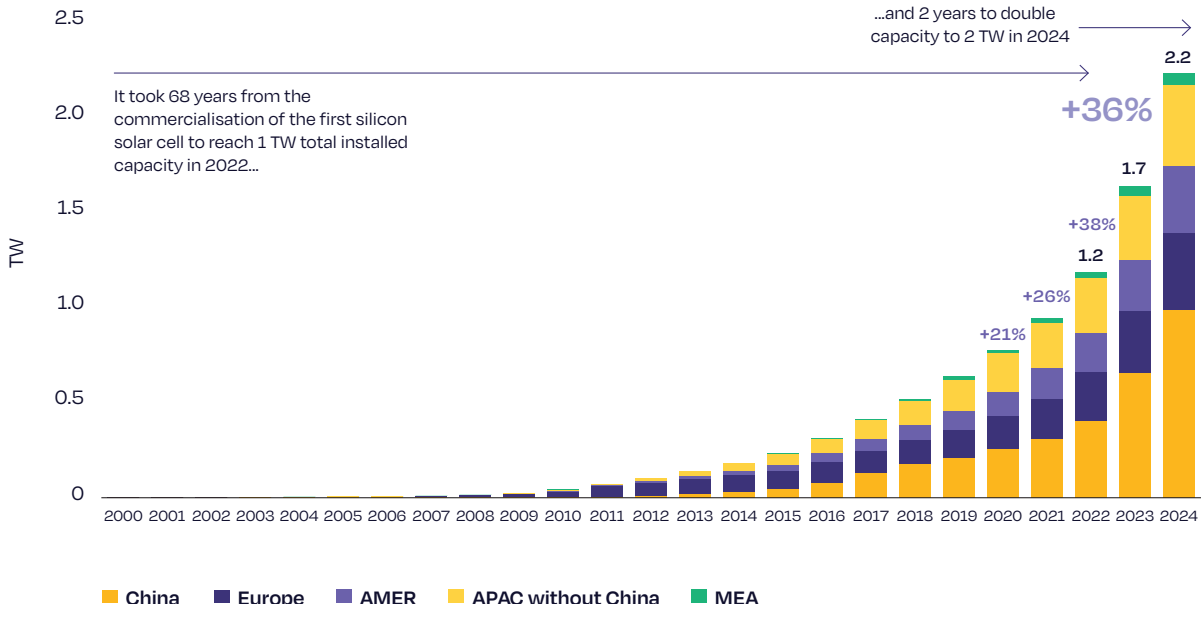
However, this capacity remains unevenly distributed, with the Asia-Pacific region dominating the global landscape. The region holds 1.4 TW, equivalent to a 63% global share. Within APAC, China alone accounts for approximately 1 TW of grid-connected solar, increasing its global capacity to 44%.

In terms of solar capacity per person, three countries – Australia, the Netherlands, and Germany – have surpassed the milestone of 1 kW per inhabitant. While the global average stands at 276 W/capita, Europe remains the region with the highest per capita solar installation ratio at 480 W, despite its recent market stagnation.

Figure 3

The world crosses 2 TW threshold of total solar installations in 2024

Cumulative solar PV installed capacity 2000-2024



Global solar PV growth expected to slow to 10% in 2025, reaching 655 GW new installations

2025 will mark a pivotal year for the global PV industry. Structural solar growth continues to be fuelled by China and solar's unmatched competitiveness due to its record low prices, unique versatility, and further decreasing cost. At the same time, external pressures are mounting – from resurging political support for fossil fuels and macroeconomic headwinds to shifting geopolitical dynamics –, all of which is introducing a higher degree of market uncertainty, with market performance likely to diverge sharply based on how these risks evolve.

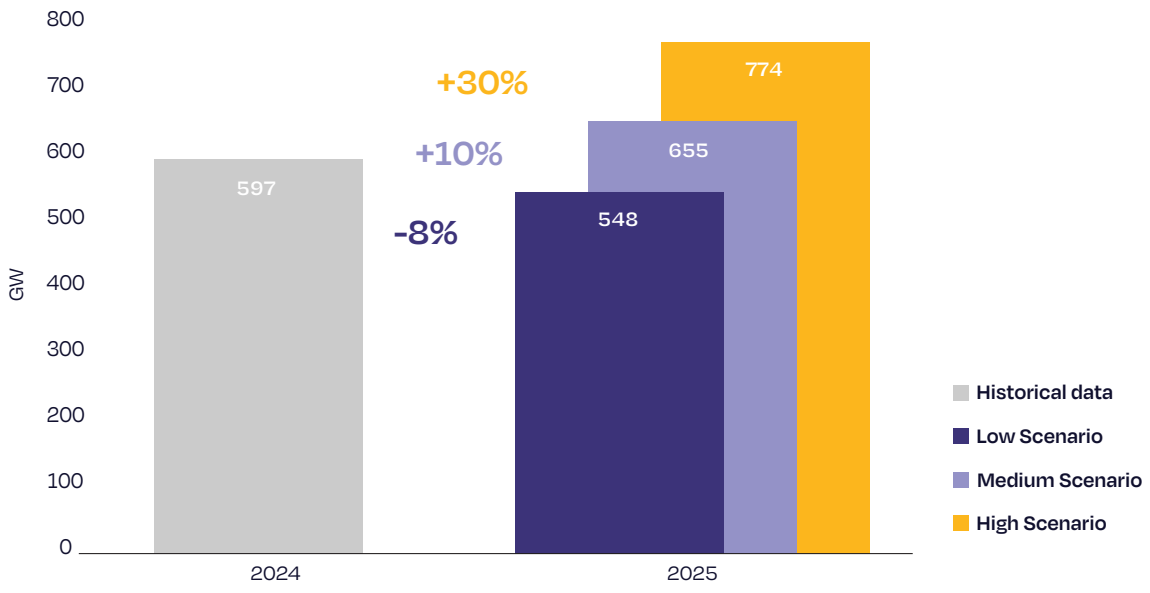
As solar's growth continues, though at slower speed, the urgent need for energy system flexibility solutions is quickly mounting. Policymakers and regulators have constantly underestimated the pace of solar development, leading to underinvestment in grid infrastructure and outdated networks. This misalignment is already resulting in major system challenges in more advanced markets, such as rising curtailment rates and more frequent instances of negative electricity prices, which in turn reduce solar capture prices, threatening the economic viability of new solar projects. It is critical that regulators in markets all over the world, both mature and nascent PV and storage markets, plan for the necessary system flexibility in order to solve these challenges before they occur.

Despite these headwinds, the global solar PV market is still expected to grow by 10% in 2025, reaching 655 GW under the Medium Scenario (see Fig. 4). This would mark a continuation of the deceleration trend following the extraordinary 85% growth in 2023 and the more moderate 33% in 2024. However, this trajectory is not without risk as policy changes in the two largest markets, China and the US, may further temper growth. In the EU failure to implement effective policy frameworks at the member state levels could even trigger market contraction. Under our Low Scenario, worsening market conditions could lead to an 8% decline in annual installations to 548 GW. In contrast, our High Scenario forecasts a 30% surge to 774 GW, driven by sustained low product prices and potential policy stimulus in China.

Figure 4

Annual global solar market expected to decelerate to 10% growth in 2025

Annual solar PV market scenarios 2024-2025



Double-digit growth rates as of 2027 set the stage for an annual TW-scale market by 2030

Looking ahead, the global solar market is projected to continue its upward trajectory through 2029, though not without some volatility. While long-term fundamentals – including continued low prices, largely based on further declining costs, cross-sectoral electrification, and strong energy security priorities – will support growing demand. But short-term uncertainties, particular around China's evolving policy framework, could cause temporary slowdowns.

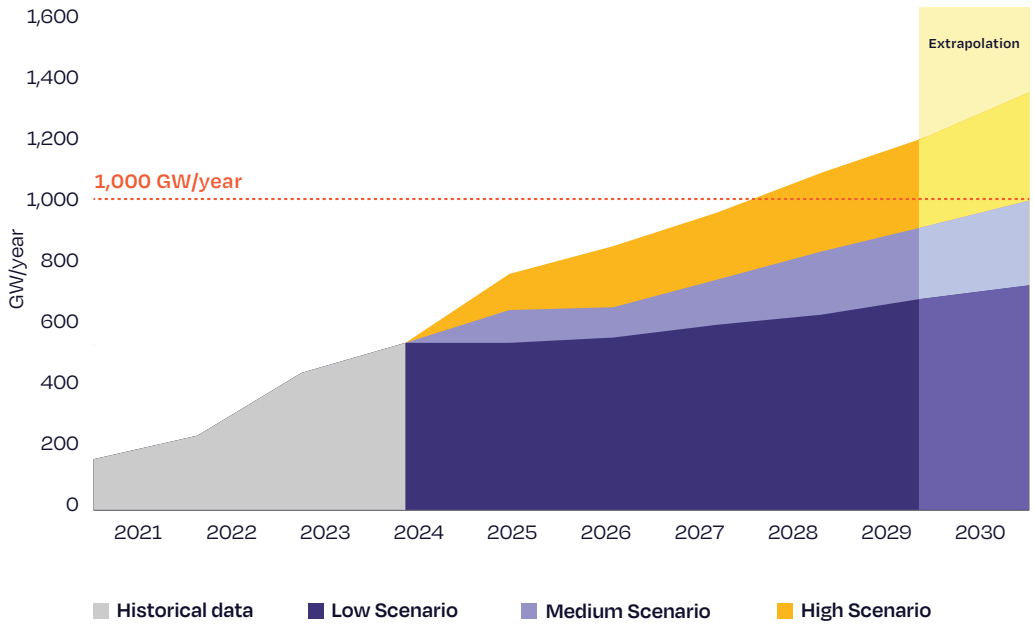
A short-lived stagnation in global PV installation growth is expected in 2026, as China adjusts to implementing its new solar market design. This market correction will be followed by double-digit growth resuming from 2027 onward.

By 2029, annual global solar installations are projected to reach 930 GW in the Medium Scenario, and could surpass 1.2 TW in the High Scenario. If growth continues on this path by the end of the decade, an global solar market adding 1 TW annually appears within reach by 2030 (see Fig. 5).

Figure 5

Annual TW solar market likely to be reached by 2030

Global cumulative solar PV market scenarios 2025-2030



Total solar capacity set to exceed 7 TW by 2030, increasing the technology's contribution to the global 11 TW renewable target by 2030

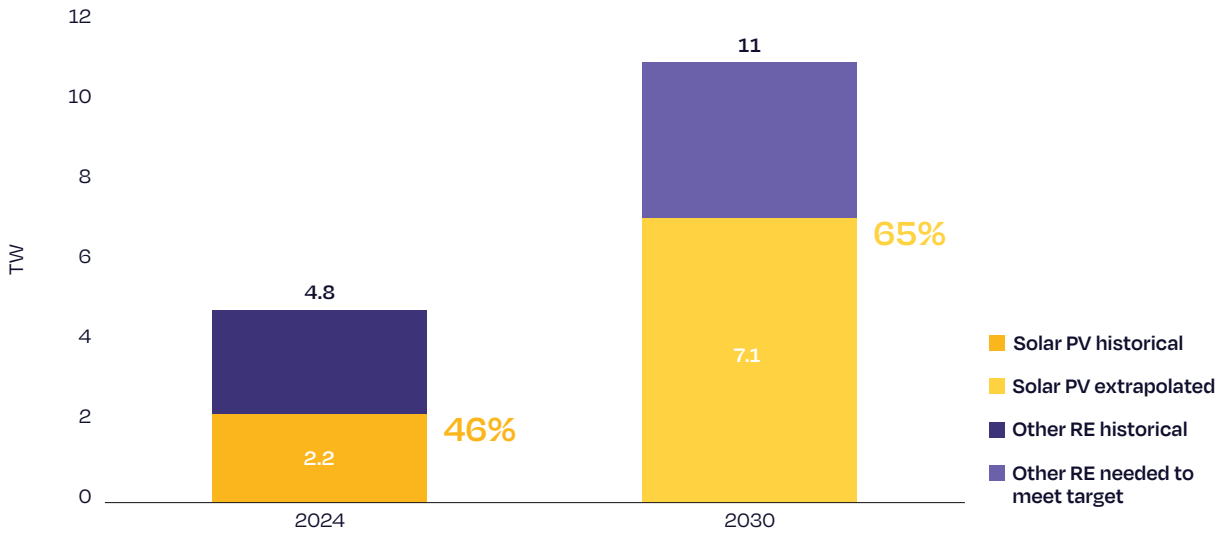
Cumulative solar PV capacity is expected to exceed most energy analysts' forecasts by 2030. If the solar market trajectory continues as projected, total global solar installations are set to triple over the next five years, surpassing 6 TW by 2029 in the Medium Scenario. By extrapolating this trajectory to 2030, total solar capacity will stand at 7.1 TW by the end of the decade. The Global Solar Council has set an aspirational target of 8 TW of total installed capacity by 2030, which is within our High Scenario projection for that year; however, the Medium Scenario falls behind this target, showing that decision-makers need to fast-track solar deployment in their markets (see Policy Recommendations at p. 56).

Crossing the 7 TW level positions solar PV as the primary driver in meeting the COP28 Dubai goal to triple renewable energy capacity to 11 TW by 2030. Based on our projections, PV will account for about 65% of the renewable capacity needed to achieve the target, up significantly from its 46% share of total renewable capacity in 2024 (see Fig. 6).

Figure 6

Solar to lead the achievement of 11 TW global renewable target by 2030

Global installed renewable electricity generation capacity in 2024 and target for 2030



Sources: IRENA (2025), SolarPower Europe

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Global solar market

In 2024, global solar PV installations reached a record 597 GW, with the Asia-Pacific region contributing 70% of new capacity. China continued to dominate the market, adding 329 GW – more than all other top ten markets combined – while the cumulative global capacity doubled from 1 TW in 2022 to 2.2 TW by the end of 2024. Growth is projected to slow to 10% to 655 GW in 2025 amid geopolitical and economic pressures, alongside rising system integration challenges. Despite a brief stagnation expected in 2026, annual installations are forecast to raise at double-digit growth rates as of 2027 and are likely to cross 1 TW by 2030. Total installed capacity is projected to surpass 7 TW by the end of the decade, positioning solar PV to contribute 65% of the global 11 TW renewable energy target set at COP28.

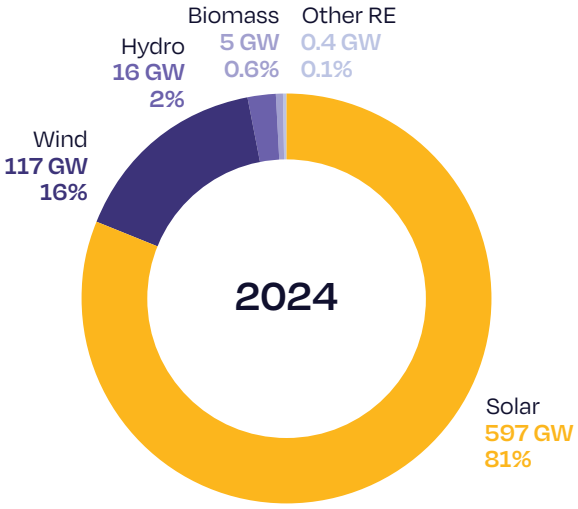
Solar keeps leading the charge of the energy transition

In 2024, solar power continued to dominate global renewable energy expansion, securing its place as the fastest-growing renewable electricity source for the 20th consecutive year. Of the estimated 735 GW of new renewable capacity installed worldwide, solar PV made up 81%, grid-connecting 597 GW (see Fig. 7). This marks a slight increase from 78% in 2023 and further cements solar's role as the primary driver of the energy transition. Once again, by outpacing all other renewable technologies combined, solar demonstrated its unrivalled scalability and cost competitiveness in the global energy landscape. Total renewable capacity additions increased by 159 GW in 2024 – a robust 28% jump from 2023. The increase in newly added renewable capacity is entirely on solar's shoulders, since the wind sector stagnated with a mere 0.3% growth. With 117 GW installed like last year, wind's contribution decreased by 4 percentage points to 16%, compared to 20% in 2023.

Figure 7

Solar makes up more than 80% of all new renewable capacity additions in 2024

Net renewable power generation capacity installed in 2024



Source: SolarPower Europe, IRENA, GWEC

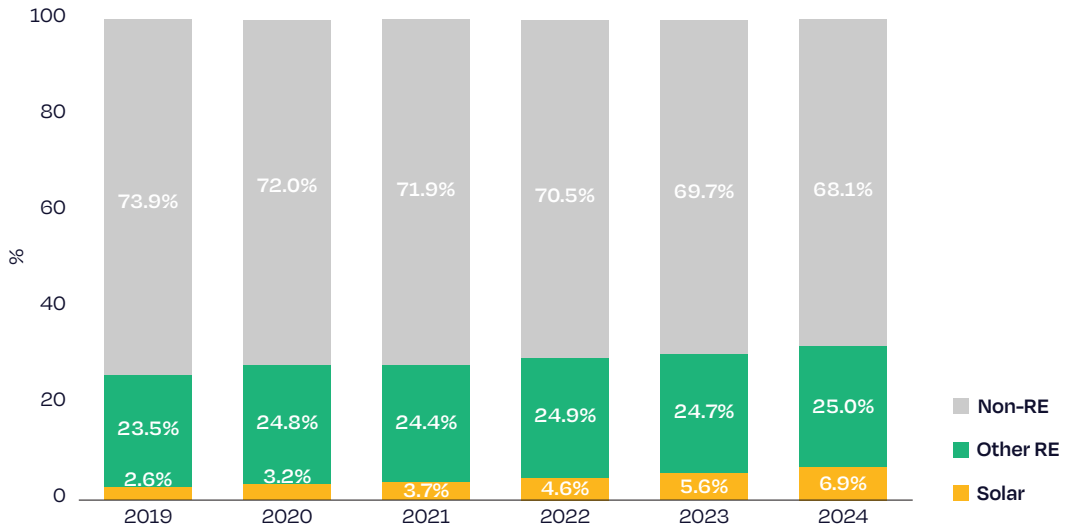
The rapid growth of renewable installed capacity also led to a new record in renewable power generation in 2024, with renewable energy sources supplying 31.9% of global electricity (see Fig. 8). Solar PV alone reached a major breakthrough, generating 2,000 TWh worldwide – comparable to India's total annual electricity consumption.

Solar's contribution to global electricity rose to 6.9%, up from 5.6% in 2023. This 1.3 percentage point increase in 2024 shows an acceleration up from 1 percentage point in 2023, 0.8 percentage points in 2022 and 0.5 percentage points in 2021. Solar PV has been the driving force in pushing conventional electricity sources to a new low: since the start of the decade, solar electricity generation has doubled its share, increasing by 3.7 percentage points, while all other renewables combined have grown by just 0.2 percentage points.

Figure 8

Solar drives renewable penetration in global electricity generation in 2024, pushing conventional electricity sources to new low

Solar and renewable power as a share of global power 2019-2024



Source: Ember (2025)

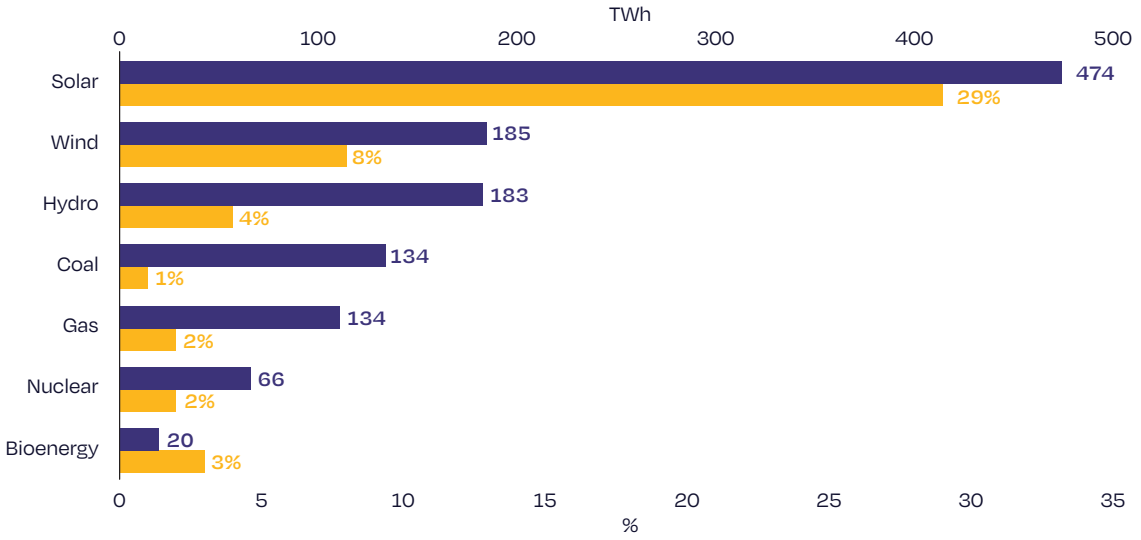
Although solar PV still represents a relatively small share of global electricity generation, its pace is speeding up across regions, breaking records in both emerging markets and advanced economies. Brazil, for example, has significantly increased its solar generation in recent years and is now the fifth-largest solar producer. In 2024, solar power generation in the European Union surpassed coal for the first time, with its share in the electricity mix exceeding 10% and reaching 20% or more in markets such as Cyprus, Greece, Hungary and Spain – with the last two even touching 25%.

In 2024, solar PV produced 474 TWh more than the year before with a 29% annual growth, outpacing all other power generation technologies both in absolute and relative terms (see Fig. 9). Wind came as a distant second at 185 TWh, growing 8%, while hydro stayed relatively stable at 183 TWh with a 4% increase. By contrast, conventional generation technologies such as coal, gas and nuclear basically stagnated with 1-2% annual growth, trailing significantly behind the top 3 renewable technologies.

Figure 9

Solar electricity generation growth outpaces all other technologies with 474 TWh added in 2024, a 29% increase year-on-year

Absolute and relative growth of electricity generation by technology 2023-2024



Source: Ember (2025)

650 MW, Witzniz, Germany

Global solar market sets new record installations at about 600 GW in 2024, with China again contributing more than half

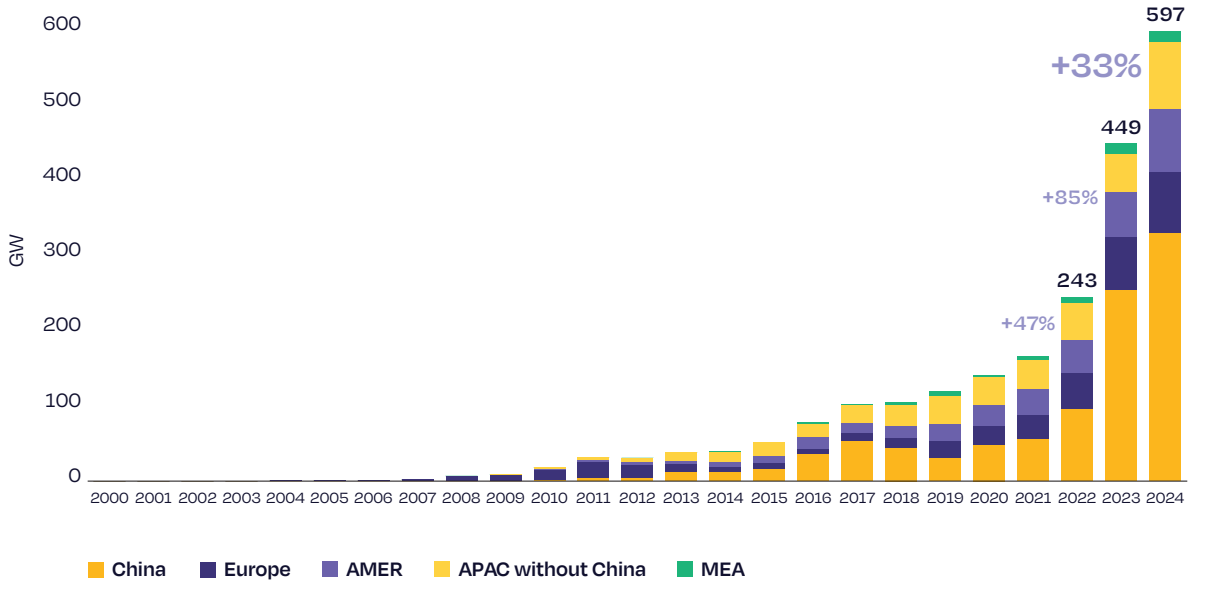
Annual market

The addition of 597 GW in 2024 translates into a strong market growth rate of 33%, which is, however, a more measured pace compared to the exceptional 85% annual increase recorded in 2023 (see Fig. 10).

Figure 10

Record 597 GW of global solar capacity added in 2024; slower but still impressive 33% annual growth

Annual solar PV installed capacity 2000-2024



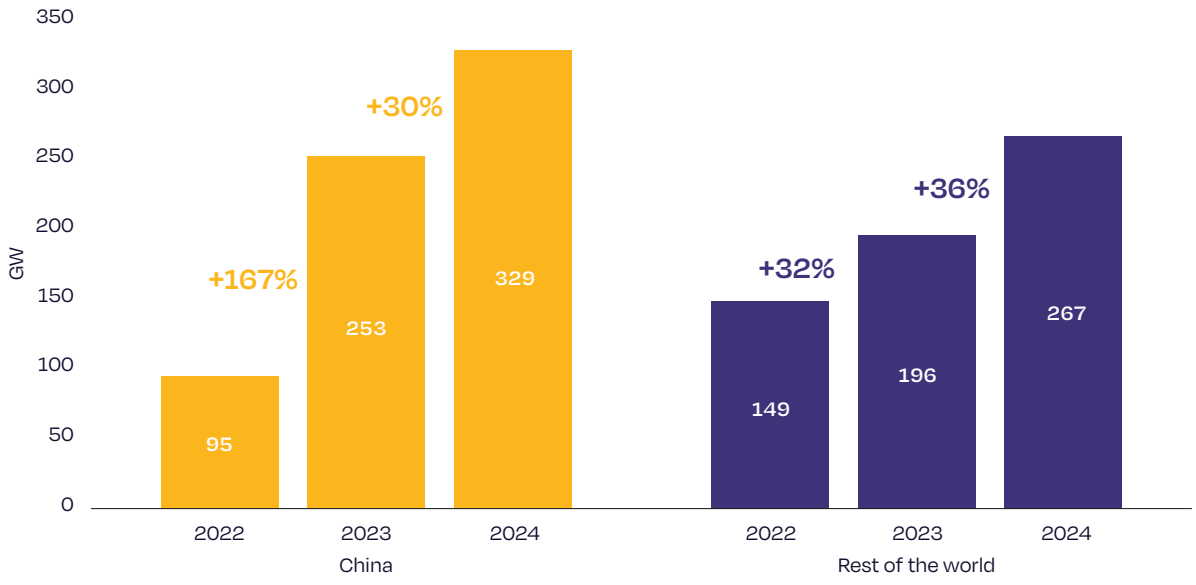
The solar industry is still facing an oversupply situation, with production capacities reaching roughly twice the current level of demand for polysilicon, wafers, cells, and modules. As a result, the price of solar modules further decreased in 2024, generally improving the favourable cost conditions that boosted installations already in 2023. On top of this, climate, political, and energy security agendas around the world increasingly count on solar PV as a key technology to reach their decarbonisation and energy resilience goals.

The main global solar market dynamics from 2023 remained rather similar in 2024, with China being head and shoulders above all other markets but significantly decelerating from its exceptional annual growth rate in 2023. China installed a new astounding record 329 GW of new solar in 2024, a 30% increase from 253 GW added in 2023, which followed the extraordinary 167% jump from the 95 GW installed in 2022 (see Fig 11). By comparison, in 2024, the rest of the world grew even faster than China – by 36% – and installed 267 GW, a 4 percentage point increase from the 32% growth in 2023 with 196 GW installed. This diversification seems to indicate that while several key historical markets have slowed, as solar growth outpaced policy and infrastructure developments, others are still emerging and increasing their contributions to global solar PV installations.

Figure 11

China continues its global solar market leadership despite slowing annual growth in 2024, while the rest of the world grows faster in the same period

Annual regional solar PV market 2022-2024



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In our last GMO edition, published in June 2024, we projected global solar capacity additions to increase by 22% and reach 544 GW under our Medium Scenario, and 647 GW with a 45% growth in our High Scenario. As often, actual installations turned out to be on the more positive side and leaned towards our High Scenario. China's expansion, once again, exceeded expectations, but not by the same order of magnitude as last year. At 329 GW, the country deployed 10% more solar capacity than our 299 GW forecast, but fell comfortably within the upper threshold of 356 GW anticipated in the High Scenario. Meanwhile, our predictions for regions outside of China were somewhat conservative, as their new installations were 23 GW or 9% higher than our most likely estimations.

China still in a different league, outshining other top 10 markets

Top 10 countries

While China stands out more than ever, and remains with the US at the top of the solar podium, there were a few changes among the top 10 global markets in 2024 (see Fig 12). A record growth catapulted India two positions up to 3rd place, surpassing Brazil and Germany, which now stand 4th and 5th respectively. Spain and Italy maintained their ranking as 6th and 8th largest global markets in 2024 respectively, but two new players re-entered the top 10: for the first time since 2018, Türkiye made a significant ascent to 7th place, replacing Japan, which moved down to 9th place, while at 10th place France made it back in the top 10 for the first time since 2015. The two new entries replaced Australia and the Netherlands in the top 10. In 2024, and for the second time in a row, China installed more than twice the capacity of all other top 10 countries combined – 329 GW vs. 152 GW (see Fig. 13).

Figure 12

China continues to dominate global top 10 solar markets while others remain below 50 GW

Top 10 solar PV markets 2023-2024

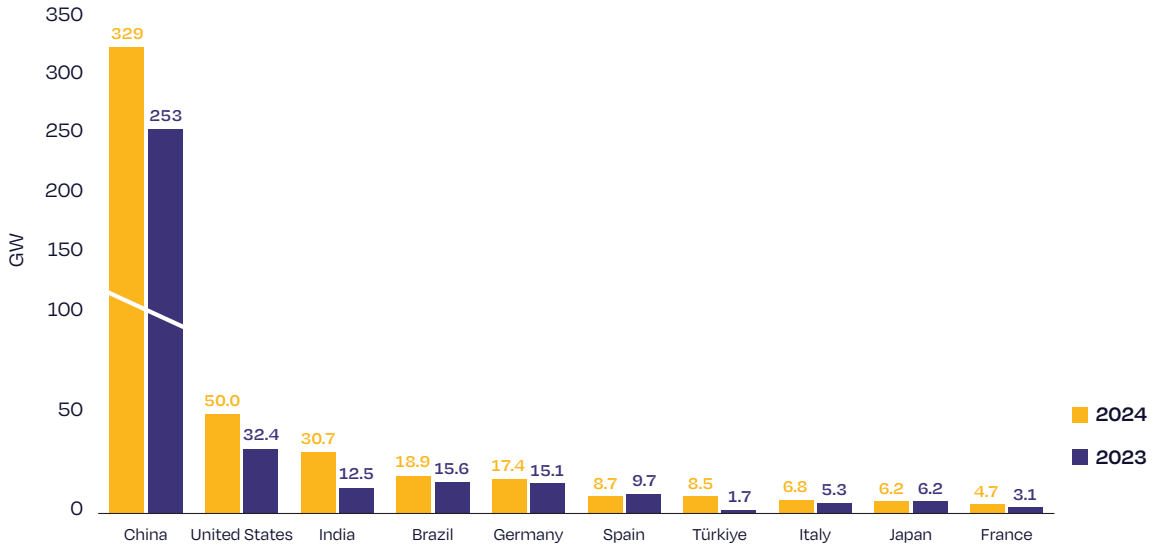

Figure 13

Again, China installs more than double the capacity of all other top 10 solar markets combined

Top 10 solar PV markets 2024

Note: Percentage indicates the share of aggregate top 10 installed capacity.

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Box 1

Overview of top 10 PV markets 2024

1

China, the solar market giant, continues to dominate global installations in 2024, having added over six times more PV capacity than the second largest market, and more than half the world's capacity additions, exceeding our expectations from last year's GMO by 30 GW. After three years of unprecedented growth, the market has now decelerated to a 30% annual increase in 2024, as rapid expansion to a new level brings significant challenges, notably for grid capacity with longer connection times, and increased volatility in revenues due to price cannibalisation.

China

2024 Annual Capacity	329 GW +76 GW & + 30% from 2023	44% Rooftop	56% Utility
2024 Cumulative capacity	985 GW #1		

2

The United States set a new record for annual solar PV additions in 2024, a year that saw the full impact on the market of the clean energy incentives provided by the Inflation Reduction Act (IRA): from a 48% annual boost in 2023, the market accelerated to a 54% growth rate in 2024, reaching 50 GW of annual additions. In addition to demand stimulated by the IRA and other incentive schemes , the growth in electricity demand from new manufacturing facilities and data centres, as well as an increase in electrification in transport and heating, also drove solar growth in the country.

United States

2024 Annual Capacity	50.0 GW +17.6 GW & + 54% from 2023	17% Rooftop	83% Utility
2024 Cumulative capacity	223 GW #2		

3

India makes a strong comeback as the 3rd global market in 2024 with a whopping 145% annual growth and record annual installations of 30.1 GW. After dropping to 5th place in 2023 with a 28% market contraction, in 2024, a combination of large-scale utility projects finally coming online, clear policy signals such as through the Renewable Purchase Obligations (RPOs) framework, and improved infrastructure via the Green Energy Corridor brought India back on track for its ambitious and comprehensive solar journey that includes also a well thought-through industrial strategy. For more details on India, see the focus chapter on p. 60 provided by the Global Solar Council (GSC) and the National Solar Energy Federation of India (NSEFI).

India

2024 Annual Capacity	30.7 GW +18.2 GW & + 145% from 2023	15% Rooftop	85% Utility
2024 Cumulative capacity	121 GW #3		

4

Brazil installed a record 18.9 GW of new solar capacity in 2024. But after two years of very strong growth (60-81%) in 2021-2022 and a further 15% increase that turned the country into the third largest solar market in 2023, the 21% growth recorded in 2024 was not enough to remain in the podium and brought the country down to 4th place globally. Despite challenging macroeconomic conditions, an increase in import tariffs applied to solar PV modules in 2024, and high curtailment rates, the market outperformed government projections.

Brazil

2024 Annual Capacity
18.9 GW
+3.3 GW & + 21% from 2023

63% Rooftop

37% Utility

2024 Cumulative capacity
66.7 GW
#6

5

Germany, Europe's largest solar market again, now for 13 years in a row, achieved 15% growth to 17.5 GW in 2024, which means another record, but slower growth compared to the 106% record increase during the height of the energy crisis in 2023. Residential demand softened after the considerable drop in energy prices over the last year. While utility-scale projects continued to grow steadily, primarily driven by auctions but also PPAs, the C&I segment showed mixed signals amid shifting policies. A new solar framework, 'Solarpaket 1,' brought some momentum, especially for C&I and small plug-in solar, with the latter installing hundreds of thousands of devices last year.

Germany

2024 Annual Capacity
17.4 GW
+2.3 GW & + 15% from 2023

62% Rooftop

38% Utility

2024 Cumulative capacity
101 GW
#4

6

Spain's solar market declined by 10% in 2024, marking a pause after several years of rapid growth. The contraction was primarily driven by a slowdown in rooftop demand, as falling household energy prices and delays in subsidy implementation weighed on deployment. Within the rooftop segment, C&I remained dominant, supported by large-scale industrial installations. Utility-scale PV held steady, underpinned by a strong PPA market, but continued to face headwinds from grid bottlenecks and declining solar capture prices.

Spain

2024 Annual Capacity
8.7 GW
-0.9 GW & - 10% from 2023

14% Rooftop

86% Utility

2024 Cumulative capacity
46.1 GW
#7

7

Türkiye's solar market experienced a remarkable expansion in 2024, with installations surging nearly 400% to 8.5 GW, doubling the country's solar capacity to over 19 GW by the end of the year. This rapid growth enabled Türkiye to exceed its 2025 solar target of 18 GW more than a year ahead of schedule. The expansion was driven by supportive government incentives, including the Renewable Energy Resources Support Mechanism (YEKDEM), and favourable regulatory changes. As the country has established a solid domestic solar manufacturing base, this demand growth translates into deeper industrial growth as well.

Türkiye

2024 Annual Capacity
8.5 GW
6.8 GW & + 394% from 2023

90% Rooftop
10% Utility

2024 Cumulative capacity
19.7 GW
#16

8

Italy's solar market expanded by 27% in 2024, reaching 6.8 GW, driven by a significant surge in utility-scale projects, which more than doubled year-on-year. This growth offsets a decline in residential installations, influenced by the phaseout of support schemes. The C&I segment remained stable, showing an increase in larger industrial-scale installations. Despite higher interest rates and continued permitting challenges, the utility-scale sector's expansion was notable, highlighting a shift towards larger projects.

Italy

2024 Annual Capacity
6.8 GW
+1.5 GW & + 27% from 2023

57% Rooftop
43% Utility

2024 Cumulative capacity
36.7 GW
#9

9

Japan's solar market remained stable at 6.2 GW in 2024, marking the fourth consecutive year of installations within the 6-6.5 GW range. Japan makes a unique case, as all other major solar markets have experienced some degree of fluctuations during the same period. The plateau is primarily attributed to the gradual reduction of feed-in tariffs and the transition to a feed-in premium system, which offers less predictable returns for investors. Like in many larger markets, land and grid constraints combined with inadequate policy frameworks pose a challenge to further solar development.

Japan

2024 Annual Capacity
6.2 GW
-0.01 GW & - 0.1% from 2023

68% Rooftop
32% Utility

2024 Cumulative capacity
96.6 GW
#5

10

France recorded much-awaited strong growth of 49% in 2024, with a sharp increase in rooftop installations, thanks to attractive export tariffs and the growing impact of solar mandates. While the residential segment grew significantly, the increase in commercial-sized installations is the most notable. Ground-mounted deployment also increased, but permitting and land accessibility continue to hinder expansion.

France

2024 Annual Capacity
4.7 GW
1.6 GW & + 49% from 2023

74% Rooftop
26% Utility

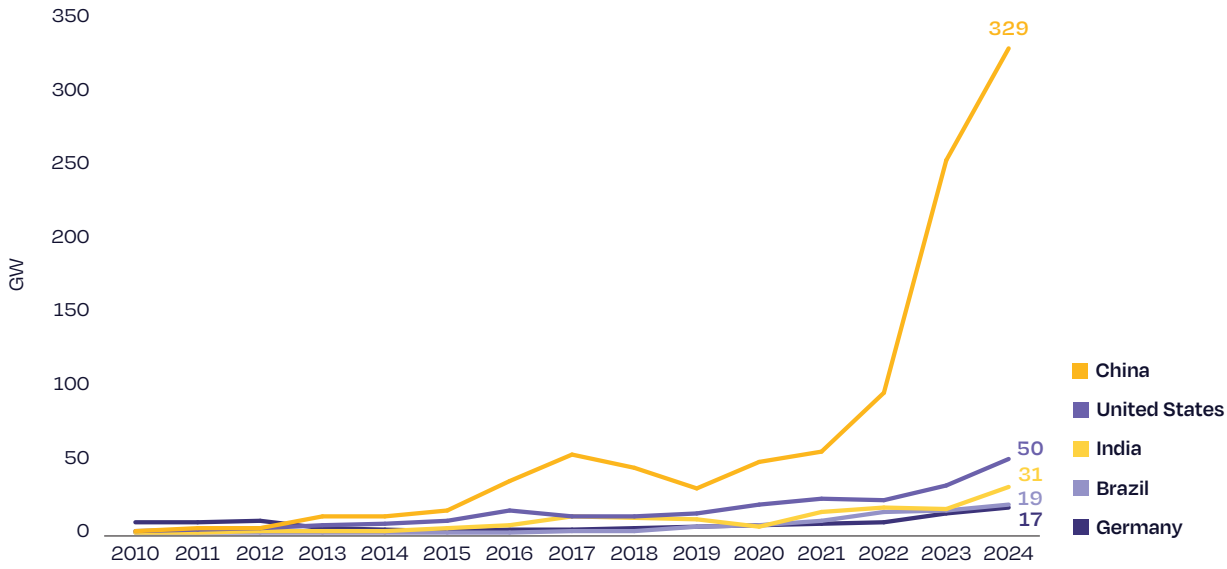
2024 Cumulative capacity
23.5 GW
#12

Already massively widened in 2023, the gap between China and its peers in the top 5 largest annual markets all combined has increased a further 20% (Fig. 14). China continues to play in an entirely different league, installing 212 GW more solar PV than all other top 5 markets combined, compared to 117 GW more in 2023. In 2024, the #1 market was over six times larger than the #2, the United States, more than 10 times larger than the #3, India, and 25 times larger than the #5, Germany. In comparison, in 2023, the market size difference had a factor of 8, 17 and 20, compared to the countries in those respective rankings.

Figure 14

The gap between China and other top 5 solar markets continues to widen

Top 5 solar PV markets



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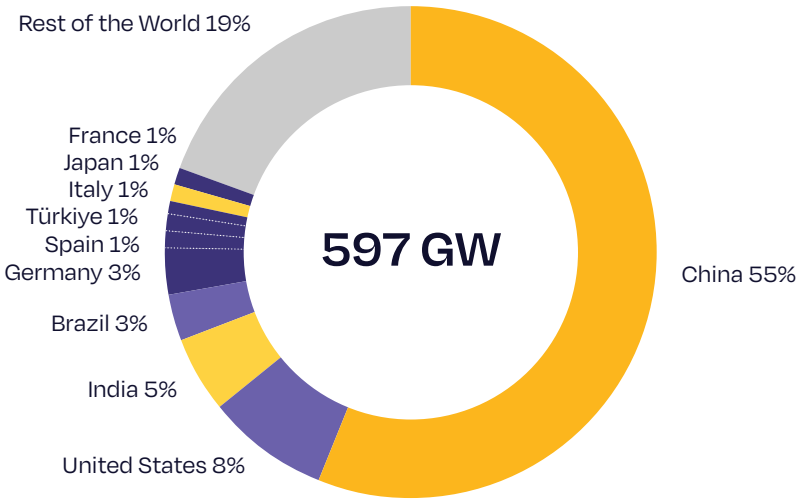
269 MW coupled with 1.1 GWh BESS Oasis de Atacama solar park, Chile

China was responsible for 55% of the world's total additions, down 1 percentage point from the 56% it contributed in 2023 (see Fig. 15). The USA, which now holds 8% of global market share, gained 1 percentage point in 2024, while India grew its share by 2 points to 5% compared to 2023. The top 10 markets in 2024 provided 81% of total global installations, while the countries outside the top 10 contributed the remaining 19%, a slight decrease from the 20% share in 2023. The number of markets that reached the GW scale of annual installations increased from 31 in 2023 to 34 in 2024. This all-time high is, nonetheless, a little lower than the 37 GW-scale markets we estimated in our GMO 2023, as some markets performed less well than expected . Details on these countries can be found in Chapter 4 where national industry associations active in the solar sector provide analysis on their home markets (see p. 90).

Figure 15

The top 10 markets install 81% of global solar

Top 10 countries solar capacity share 2024



PV system on Joie Stadium, Manchester, UK

Asia-Pacific keeps growing its global market share, reaching 70%

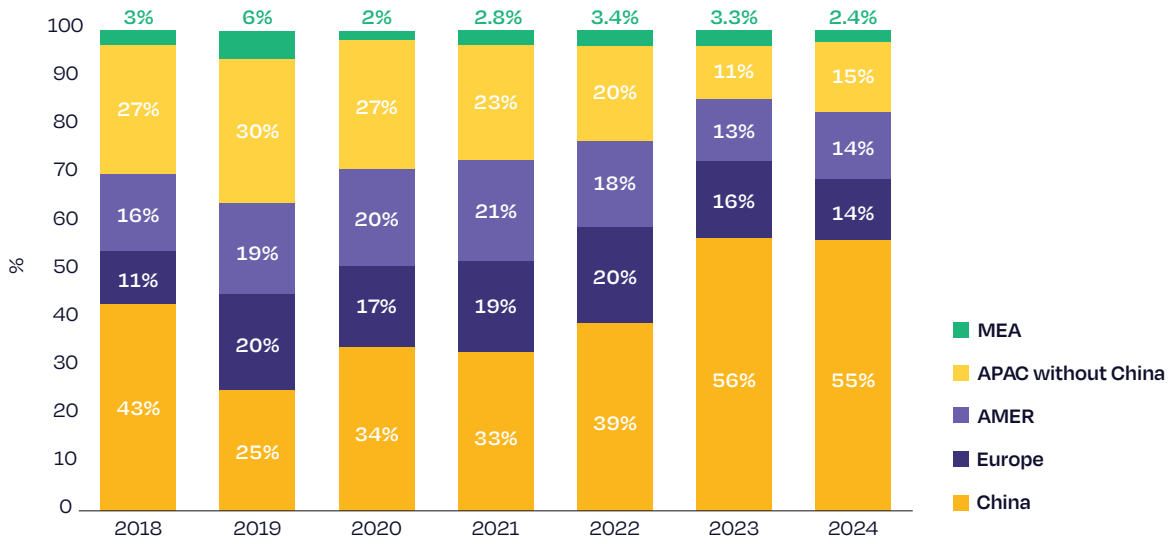
Regional update 2024

In 2024, the **Asia Pacific** (APAC) region (including China) solidified its dominance of the global solar market with 417 GW of new solar, 37% more than in 2023 (see Fig. 16). While the global market share of China (taken as a separate region for its sheer size) lost 1 percentage point to 55%, the Asia Pacific (APAC) region without China gained 3 percentage points to 15% (see Fig. 16). Combined, APAC with China captured 70% of global solar additions in 2024.

Figure 16

Amid ongoing APAC dominance, Europe falls from 2nd to 4th place in regional solar installations in 2024

Annual solar PV installed capacity shares 2018-2024



Besides another record-breaking year for China, the region was mostly marked by significant developments in India , which saw a 145% annual market increase, reaching 30.7 GW annual installations after a lacklustre performance in 2023 with only 12.5 GW installed. This shows a very different trend from other well-established markets in the region, like Japan and South Korea, which both stagnated with less than 2% market variation. Japan installed 6.2 GW in 2024, the same as in 2023. Once a leader in solar energy, the Japanese market has been dormant for several years, following several changes to its lucrative feed-in tariffs (FIT) that were finally transformed into a less attractive FIP model and relatively small auctions, often undersubscribed. South Korea also installed roughly the same capacity as last year, at 3.3 GW. Although the country hosts one of the few successful non-Chinese cell/module manufacturers, political ambitions on solar were reduced in recent years, as the government changed strategy, focussing on developing nuclear capacity. Meanwhile, the world's most advanced residential rooftop market, Australia, dropped, and so did another long-standing GW market, Taiwan, with the first decreasing by 15% to 4.3 GW in 2024, and Taiwan down by 31% to 1.9 GW in 2024.

Another GW-size market in the region, Pakistan, was a hot topic in 2024, due to significant increases in solar PV imports from China into the country. Its grid-connected solar market indeed continued to experience growth, but only by 12% and reaching 1.4 GW, since it's estimated that most imports are attributed to off-grid solar PV installations. Other key emerging markets in the region that reached the GW scale of annual installations for the first time in 2024 are Uzbekistan (1.4 GW) and the Philippines (1.1 GW), growing tenfold and fivefold, respectively. Interestingly, other high-potential markets in the region, like Thailand, Malaysia and Indonesia, did not reach the GW-level in 2024, although they have established notable cell/module manufacturing capacities.

Counting China as a separate region, the **Americas** (AMER) maintained its place as the third-largest solar PV region, capturing 14% of the global market share. The region installed 82.9 GW of new solar capacity in 2024, a 40% increase from 59.3 GW in 2023. Once again, the charge was led by a few key markets, most notably the United States and Brazil, the former the world's second largest market and the latter the fourth. The USA experienced a 54% growth to reach 50 GW in 2024, while Brazil increased its annual market by 21%, adding 19 GW. The US alone increased its regional dominance, responsible for 60% of the region's installations last year, up 5 percentage points from 2023. Brazil's share dropped by 3 percentage points to 23% of the region's PV additions, highlighting the US's outstanding performance. Other key markets in the region include Chile (2.1 GW), Mexico (1.6 GW) and Colombia (1.6 GW), with the latter crossing the GW-scale for the first time in 2024. While Colombia increased its annual market sevenfold and Chile saw 30% annual growth in 2024, Mexico experienced a 3% annual decrease, mostly due to a decrease in the utility-scale segment, traditionally the main driver of the market. The four largest American markets – the US, Brazil, Chile and Mexico – accounted for 88% of the continent's solar additions, a slight increase compared to the 86% the four held in 2023.

1.7 MW PV coupled with 5.2 MWh BESS, Pleve, Corsica, France

Europe's solar market, despite breaking installation records again, grew at a much slower rate over the remarkable growth years seen in the 2021-2023 period. Following expansion rates of 48% in 2022 and 50% in 2023, the market decelerated in 2024 to 15% growth year-on-year, reaching 82.1 GW and accounting for 14% of newly installed global PV capacity. With its stagnating market, Europe fell from 2nd place to 4th in regional market share, losing 2 percentage points to 14%, narrowly surpassed by the Americas by a few decimals.

Within Europe, Germany once again ranked first, while Spain experienced a slight slowdown in its annual market due to a decline in both the rooftop and utility-scale segments. Beyond the established EU-based solar markets, Italy (6.8 GW), France (4.7 GW), Poland (4.4 GW), the Netherlands (3.4 GW), a standout performer was Türkiye. The country (though partly located in Asia but traditionally counted to Europe in this report) installed an impressive 8.5 GW, a fivefold increase compared to the 1.7 GW connected to the grid in 2023, earning it the third spot on the European solar podium.

Meanwhile, the two other major European non-EU solar markets also saw significant solar growth in 2024 – the UK by 29% to 2.3 GW and Switzerland by 9% to 1.8 GW. The growth in these three non-EU countries stands in contrast to the developments in the **European Union**, where the solar market only improved by 3.9%, a notable slowdown compared to 48% in 2022 and 51% in 2023. Still, the EU-27 accounted for the majority of solar deployments on the continent, with 65.3 GW out of a total 82.1 GW, representing an 80% market share – though this is a 8 percentage point decrease compared to 2023. Notably, 16 of 27 EU Member States installed more than 1 GW in 2024, two more than the previous year, signalling increased market diversification. Further details on the EU-27 market can be found in our dedicated GW article on p. 87.

2 MW rooftop solar on wine cellar, Dexheim, Germany

Trailing behind, the **Middle East and Africa** (MEA) region experienced a 2% decrease in 2024 with 14.5 GW of additions, which follows the steep increase in 2023 with a 78% annual growth rate. For the first time, Saudi Arabia took the lead in the region with 1.4 GW installed, surpassing long-standing regional leader South Africa. After entering the GW-scale for the first time in 2023 with 1.9 GW and a fivefold growth from 2022 levels, Saudi Arabia's market decreased 28% in 2024. This market is largely dependent on a few large-scale solar PV parks, and the projects connected to the grid in 2024 (the 700 MW Al Rass 1 project and the 600 MW Al Shuaibah PV 1 project) were smaller than the very large 1.5 GW Sudair solar park completed in 2023. Meanwhile, South Africa's annual installations plunged, dropping 66% to 1.1 GW in 2024 from 3.3 GW installed the year before. Following a market surge in 2023 due to regulatory reforms driving the PPA market, and important load-shedding rates driving residential solar PV demand, 2024 installations dropped even below 2022 levels, as the market is now limited by the pace of regulatory reforms (or lack thereof) and limited grid-connection capacity. The United Arab Emirates, which reached the GW-scale in 2023, did not repeat this performance in 2024 and was replaced as the third largest solar market by Qatar, which did not reach the GW-scale either. Overall, with all its main markets shrinking, the MEA region not only remained marginal on the global solar landscape, but its market share also declined by almost 1 percentage point to 2.4%.

In summary, 2024 was another strong year for solar energy, with an overall market growth, which represents a significant slowdown compared to the remarkable 85% increase seen in 2023. Although lower than the growth of 2022 and 2023, the pace in 2024 was still higher than in 2021, and many leading markets continued to set new records for annual installations.

This partial deceleration can be attributed to several factors. First, the extraordinary growth experienced in 2023 was largely seen as a one-off surge, not expected to continue in 2024, as the market returned to more 'normal' growth dynamics. Additionally, China's dominant role in the global solar sector, accounting for over half of the world's solar PV module installations, has a major influence on global trends. With the Chinese solar market 'returning' to 30% annual growth, the global average gravitates around this value.

More broadly, many established solar markets have reached some level of 'artificial saturation', with historical bottlenecks such as the lack of system flexibility requiring attention, now more than ever as power grids and policy frameworks have not kept pace with rapid solar growth. Still, the large increase in China's manufacturing capacity, which has continued to lead to oversupply on the global market and record-low solar module and balance-of-system prices, contributed to maintaining stable growth in many markets via building on the momentum gained in 2023 into 2024.

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After taking 70 years to reach 1 TW, the world installs a second TW in just 2 years

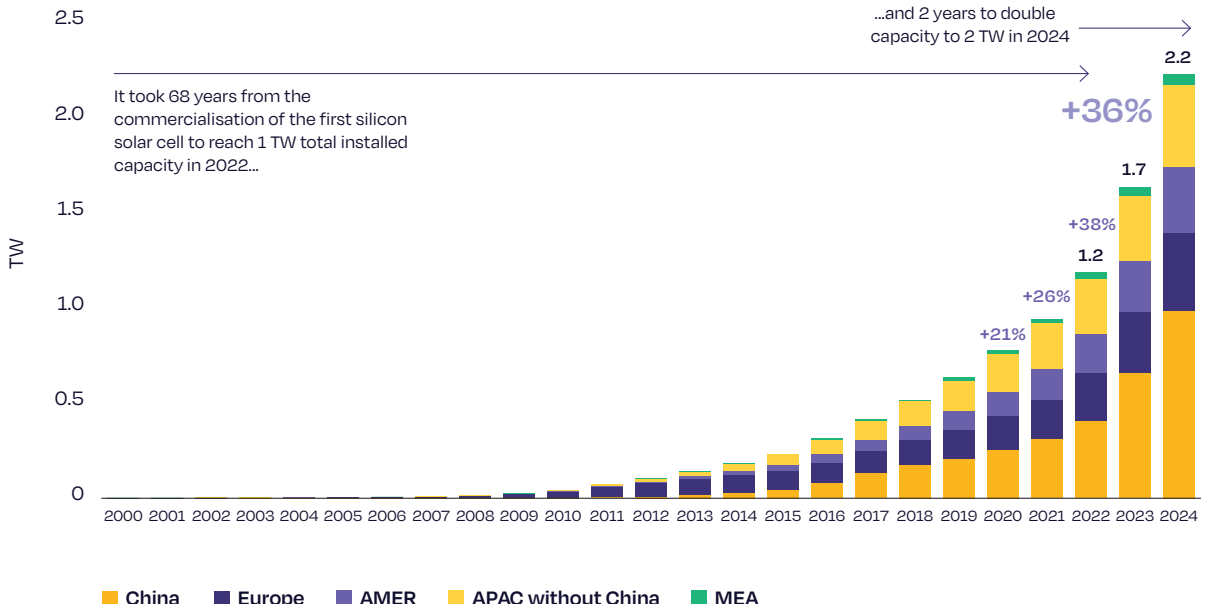
Cumulative market

The global cumulative installed capacity of solar PV systems reached 2,232 GW by the end of 2024, marking a 36% increase from 1,636 GW in 2023 (see Fig. 18). In recent years, solar deployment has outpaced all other renewable energy technologies. Since Bell Labs commercialised the first silicon solar cells in 1954, it took 68 years to reach the first terawatt of installed capacity in 2022. Remarkably, it took just two more years, from the end of 2022 to the end of 2024, to add the second terawatt. This rapid acceleration underscores the extraordinary momentum of the global solar industry. Global installed solar PV capacity is now almost 100 times larger compared to 2009 volumes, illustrating the exponential growth over the past 15 years.

Figure 18

The world crosses 2 TW threshold of total solar installations in 2024

Cumulative solar PV installed capacity 2000-2024

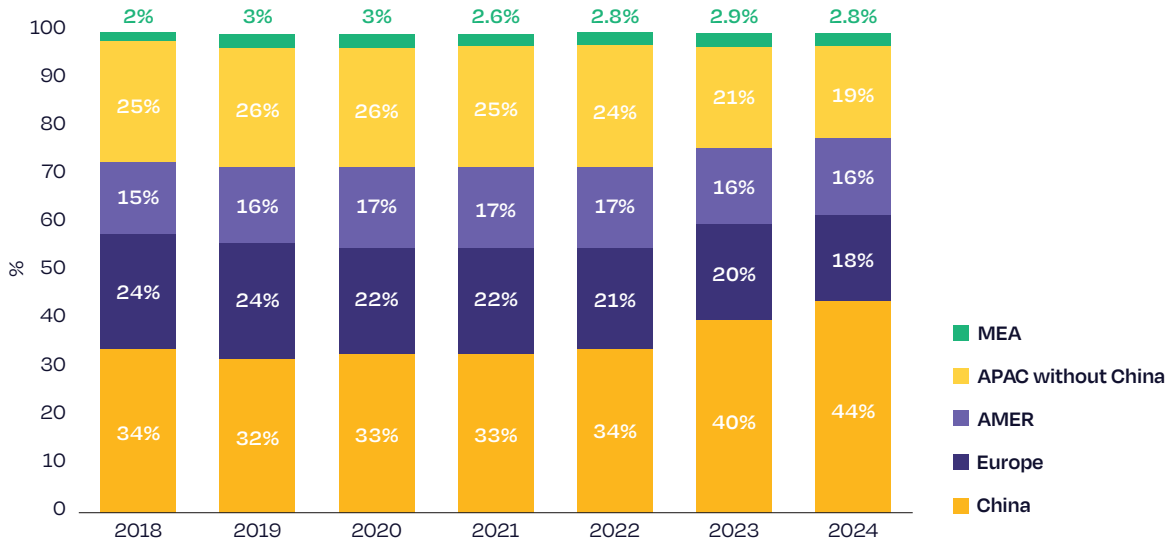


Over the past two years, regional shares in cumulative solar PV capacity have shifted noticeably. While many believed that cumulative installations were large enough for annual fluctuations not to have a notable impact on global shares, the extraordinary growth rates in China in the past few years have, in fact, proved that this is still the case. China now operates 44% of the global solar fleet, up from 40% in 2023 and 34% in 2022 (Fig. 19). As a whole, the APAC region, including China, now holds 63% of global capacity, rising from 61% in 2023, with a total of 1.4 TW, up from 996 GW. While APAC excluding China lost 2 percentage points of global share, China's 4 percentage point increase more than offsets this decrease.

Figure 19

China gets closer to hosting half the world's entire solar fleet

Cumulative solar PV installed capacity shares 2018-2024



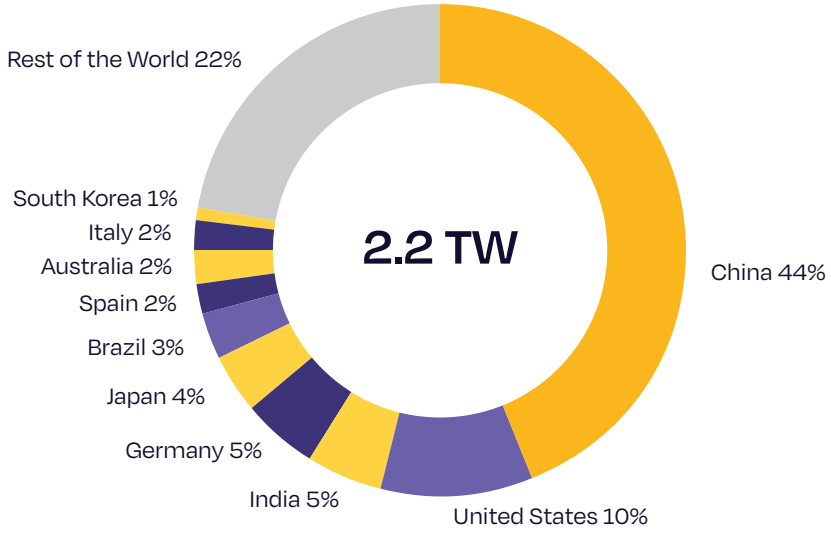
Europe's contraction in the share of the global solar fleet is accelerating, down 2 percentage points to 18% in 2024, compared to a 1-point drop the previous year. Despite maintaining a steady annual installation level, faster growth in other regions has reduced its relative position. By the end of 2024, Europe had a total installed capacity of 407 GW (up from 325 GW in 2023), with the EU-27 accounting for 338 GW or 83% of the continent's total. When considered against APAC as a whole, Europe still holds the second-largest regional fleet globally.

With 350 GW installed, the Americas retained third place among global regions, maintaining its 16% market share from 2023. In MEA, total capacity rose from 48 GW in 2023 to 63 GW in 2024. Despite this growth, MEA's global share dropped slightly from 2.9% to 2.8%.

Figure 20

India hosts the third largest global solar fleet for the first time, as it crosses 100 GW threshold

Top 10 solar PV cumulative capacity shares 2024



The global top 5 solar markets (Fig. 20) saw only one notable change in 2024, with Japan dropping from 3rd place to 5th, as forecasted last year. Japan's total installed capacity reached 97 GW, and its global market share fell from 6% in 2023 to 4% in 2024. China remains firmly in the lead with 985 GW installed, accounting for 44% of global capacity. The United States held its second place with 223 GW, though its share dropped again, down 1 percentage point to 10%. As Japan dropped, India and Germany climbed one position each. Both countries surpassed the 100 GW milestone in 2024, with India reaching 121 GW (up from 90 GW in 2023) and Germany 101 GW (up from 83 GW). For the first time, India joined the top 3 solar markets, holding 5% of the global solar generation capacity.

Collectively, the top 5 markets accounted for 68% of the global solar fleet in 2024, slightly up from 67% in 2023 and 66% in 2022. Their cumulative capacity crossed 1.5 TW by the end of 2024, up from 1.1 TW a year earlier.

There were no changes in the lower half of the global top 10 rankings in 2024. Brazil remained in 6th place with 66.7 GW, still about 30 GW behind Japan. Spain ranked 7th with 46.1 GW, followed by Australia (40.4 GW), Italy (36.7 GW) and South Korea (31.6 GW), rounding out the top 10.

Three countries host more than 1 kW of solar capacity per person, while Europe remains the region with the highest solar watt per capita

Solar watt per capita

Looking at the top performance in solar capacity on a per capita basis highlights the countries that have embraced solar energy wholeheartedly , helping to assess both the reach and intensity of solar adoption.

Australia maintains its lead in terms of installed solar PV per capita, with over 1.5 kW/capita grid-connected by the end of 2024 (Fig. 21). The Netherlands follows closely behind, slightly below the 1.5 kW level, while Germany has now also crossed the significant milestone of 1 kW/capita, securing its position in the top 3. With about 1.2 kW/capita, Germany joins Australia and the Netherlands as the only countries with more than 1,000 watts of installed solar capacity per capita.

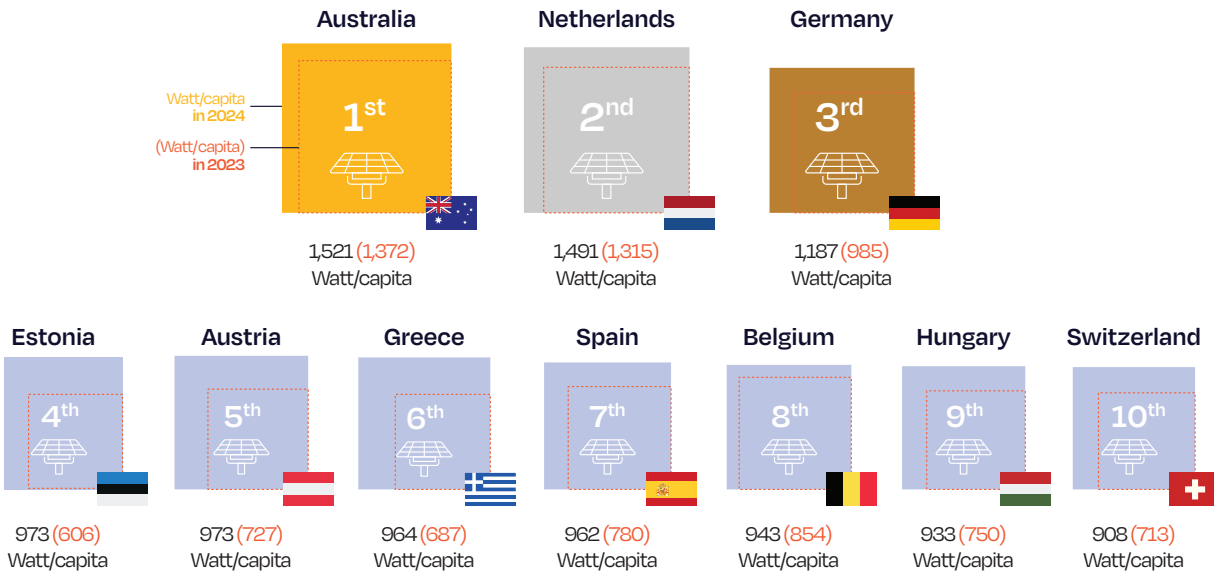
In the rest of the top 10, all countries now hold solar capacities above 900 W/capita, with Estonia and Austria rounding out the top 5, both at 973 W/capita. Estonia has made the most impressive leap, moving from just over 600 W/capita in 2023 to nearly breaking into the top 3, thanks to the highest increase in installed solar capacity per person among the top 10.

While China continues to lead in terms of total installed solar capacity, by the end of 2024, its watt-per-capita level remained below 700, which equals rank 16. Similarly, the United States still falls short of 650 W/capita, and India remains far behind with less than 90 W/capita, illustrating the significant room for growth in these major markets.

Figure 21

Three countries globally now host more than 1 kW of solar per person

World top 10 countries cumulative solar PV capacities per capita



A comparison between annual watt per capita and cumulative watt per capita reveals that several countries are rapidly climbing toward the top 10 (see Fig. 22). In terms of annual watt per capita, European nations such as Estonia and Montenegro were leading the way in 2024, thanks to their small population and favourable policy environments. In fact, the top 5 countries in this metric are rounded out by other relatively small nations, including Lithuania, Qatar and Greece, demonstrating that high solar deployment rates are not limited to large and established solar markets. Remarkably, despite its vast population, China maintained its 7th position in annual watt per capita in 2024, which is a testament to the sheer scale of its solar rollout, with an impressive addition of 232 W per person in the past year alone.

Of the 10 countries featured in the annual watt per capita ranking, six – Montenegro, Lithuania, Qatar, China, Ireland and Portugal – do not currently appear in the top 10 for cumulative watt per capita. This suggests potential future shifts in cumulative rankings, as these countries may soon climb higher if their strong annual per capita installation rates continue.

Figure 22

Shifts are underway, with countries outside the top 10 for cumulative per capita installations leading the way in annual per capita additions

2024 country ranking

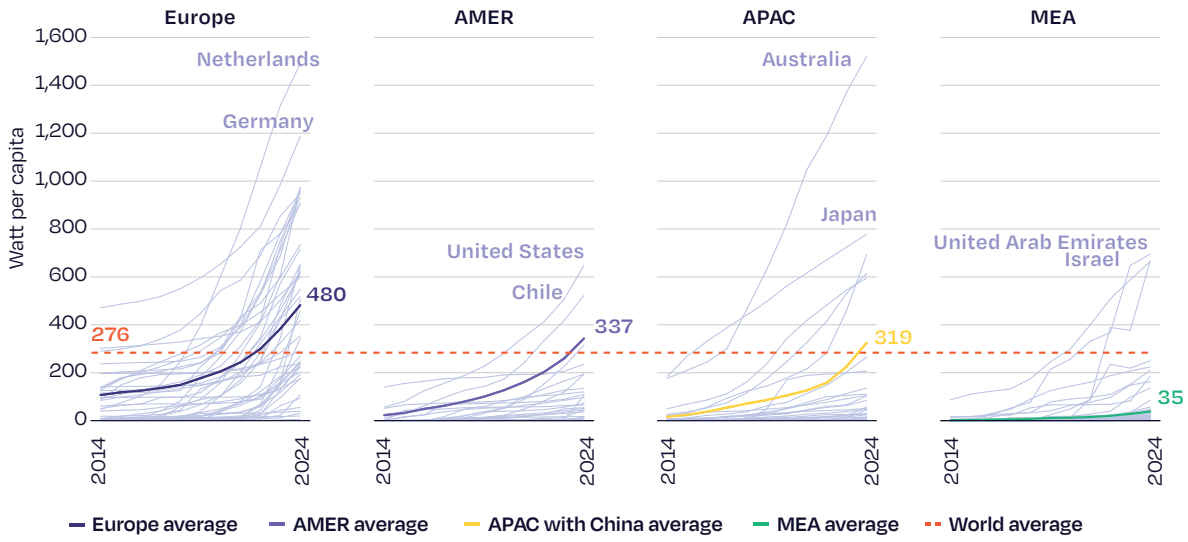
Ranking	Annual addition	Cumulative capacity	Annual watt per capita	Cumulative watt per capita
1.	China	China	Estonia	Australia
2.	United States	United States	Montenegro	Netherlands
3.	India	India	Lithuania	Germany
4.	Brazil	Germany	Qatar	Estonia
5.	Germany	Japan	Greece	Austria
6.	Spain	Brazil	Austria	Greece
7.	Türkiye	Spain	China	Spain
8.	Italy	Australia	Ireland	Belgium
9.	Japan	Italy	Germany	Hungary
10.	France	South Korea	Portugal	Switzerland

Looking at total deployed solar per capita across regions (Fig. 23), Europe maintained its lead in 2024 with the highest average at 480 W per capita, a 25% increase from 2023. The Americas followed with a 30% rise, reaching 337 W/capita, driven primarily by the United States and a strong contribution from Chile. APAC including China ranked 3rd with 319 W/capita and a 41% annual growth, with Australia standing out as the main outlier. Meanwhile, the MEA region, while still lagging in overall per capita figures, grew by 27% to reach 35 W/capita. Strong growth in countries such as the UAE, Namibia and Eswatini helped drive this progress. Globally, the average stood at 276 W/capita by the end of 2024, underscoring the vast untapped potential for solar energy deployment in many emerging and less developed markets.

Figure 23

Despite market stagnation, Europe remains the region with the highest total solar watt per capita

Solar PV cumulative watt per capita across regions 2014-2024



© SolarPower Europe

5.1 MW PV coupled with 16.1 MWh BESS, Porto-Vecchio, Corsica, France

Following a period of very strong expansion, the solar market is expected to grow much slower as of 2025

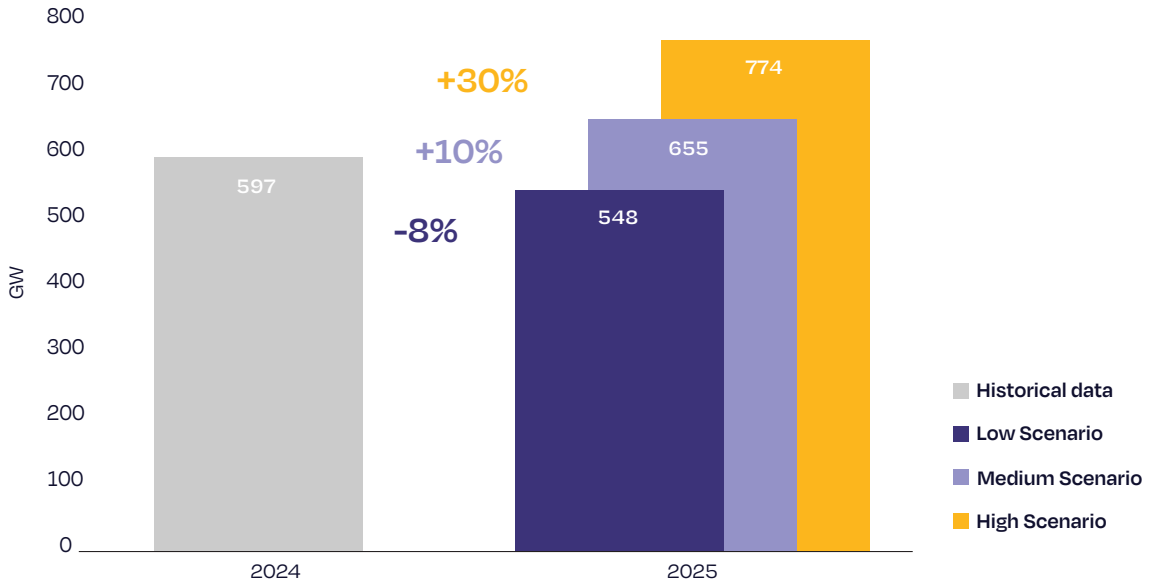
Forecast 2025

In 2025, the global solar PV market expansion is expected to experience a further deceleration in growth, continuing the trend observed in 2024. After a period of exceptional expansion, the pace of deployment is beginning to level off. While the surge in demand driven by the energy price crisis has subsided, the effects of the rapid increase in solar manufacturing are still very evident. Global PV production capacity has reached approximately 1.2 TW, yet annual installations in 2024 amounted to only around 600 GW – just half of that capacity.

Figure 24

Annual global solar market expected to decelerate to 10% growth in 2025

Annual solar PV market scenarios 2024-2025



Tensions in international trade have reached unprecedented levels in recent times, with an increasing number of countries introducing tariffs and other protectionist measures that could significantly disrupt the solar sector. These developments are taking place within a broader macroeconomic context marked by uncertainty and stagnation, further weighing on investor confidence.

Despite these headwinds, the global solar PV market is still expected to grow by 10% in 2025, from 597 GW in 2024 to 655 GW by year end, under our **Medium Scenario**, which outlines the most-likely development trajectory (see Fig. 24).[1] This reflects a prolonged deceleration in annual growth rates from the 85% increase recorded in 2023 and 33% in 2024, signalling a stabilisation phase for the sector.

1 More details on our methodology can be found at p. 4.

Our pessimistic **Low Scenario** projects an 8% contraction in installations, with the market potentially falling to 548 GW in 2025. This scenario underscores the risks posed by escalating trade conflicts, which could increase PV system costs, delay project pipelines, and deter investments in particular among more price-sensitive markets. In the United States, a shift toward more conservative energy policy following the election of President Trump may further slow momentum for new renewable energy projects. Meanwhile, in China, policy changes aiming to phase out feed-in tariffs in favour of a market-based mechanism are creating a period of policy-driven volatility. While this has led to a short-term deployment rush in the first half of the year – in the first quarter 59.7 GW_{ac} was installed, a more than 30% year-on-year increase –, the outlook for the second half is uncertain, but might fall significantly. In the EU-27, the solar market could rapidly shift from stagnation to contraction in 2025, primarily if framework conditions are not swiftly and correctly implemented in the Member tates.

Conversely, with a 30% increase in global installations that mimics the growth range of 2024, our **High Scenario** anticipates 774 GW added in 2025. This scenario forecasts continued low module prices, which are expected to remain stable with only a minor increase, and improved deployment rates across all segments. In response to weakening export demand, China may choose to stimulate spontaneously domestic deployment to support its suffering manufacturing base and soften consequences from market design changes, providing an additional boost to global installation figures.

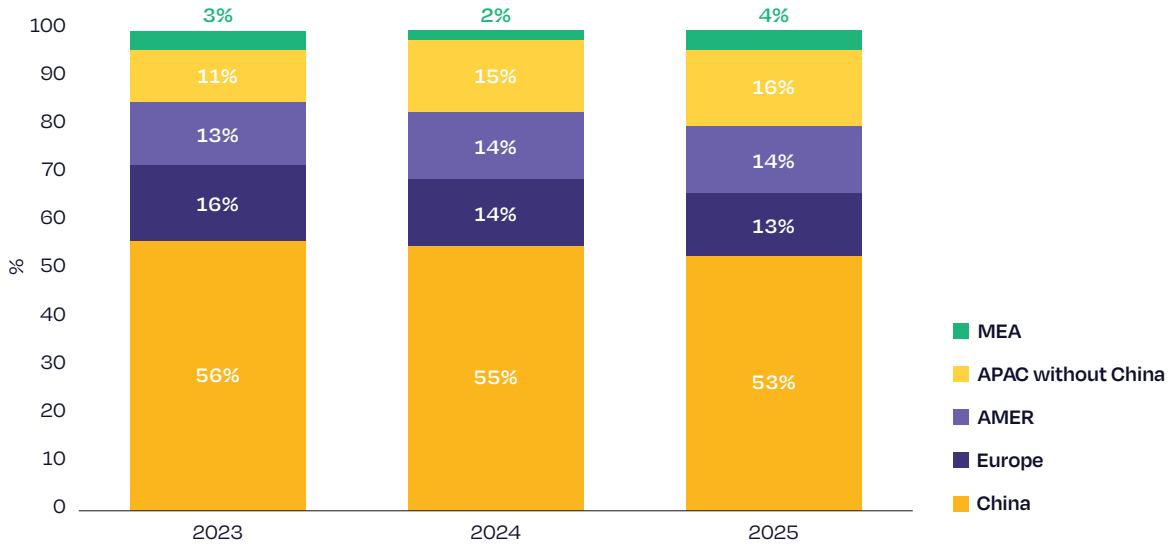
In **summary**, 2025 will mark a pivotal year for the global PV industry. While structural growth continues to be driven primarily by China and solar's competitiveness due to its record low prices, unique versatility and further decreasing cost, external pressures are mounting from a strengthening fossil fuel lobby, macroeconomic conditions to geopolitical shifts, all of which is resulting in a higher degree of uncertainty, with market performance likely to diverge sharply based on how these risks evolve.

The solar PV market across the **Asia-Pacific** (APAC) region is projected to maintain robust growth through 2025, building on a solid foundation in 2024 (Fig. 25). The region remains the powerhouse in global solar deployment, spearheaded by China and India, while other markets are showing accelerating and diversified capacity additions. Including China, APAC accounted for 67% of global solar PV installations in 2023, 70% in 2024, and is projected to maintain a similar share of 69% in 2025.

Figure 25

China to retain over half of solar global market share in 2025

Regional shares of global solar PV market 2023-2025



China, the uncontested global solar frontrunner, continues to drive the region's solar expansion. Its installed capacity is expected to grow by 6%, from 329 GW in 2024 to 350 GW in 2025. This slower yet positive growth reflects a peak in large-scale development during the first quarter of the year in anticipation of the country's policy shift away from feed-in tariffs toward a market-based pricing model starting June 2025. Although China's share of global installations is projected to decrease by 2 percentage points, it will contribute over half, 53%,of global capacity additions in 2025.

India, APAC's second-largest market, is forecast to grow significantly from 30.7 GW in 2024 to 37.3 GW in 2025, marking a 21% increase. This reflects continued policy support and competitive auctions as part of India's long-term solar strategy. India's share of APAC installations will rise slightly from 7% to 8%. For further insights into India's outlook, please check our focus chapter on p. 60.

Elsewhere in the region, market trajectories vary. Australia is expected to rebound with a 27% increase in new capacity from 4.3 GW to 5.5 GW, driven by residential and commercial installations, as well as utility-scale projects in policy-supportive states. In contrast, Japan's prolonged stagnation is expected to turn into a slight decline, with capacity falling from 6.2 GW to 5.7 GW in 2025. A lack of meaningful policy support and very high installation costs continues to hinder progress, as true support to make the solar sector more attractive and fit for the next growth phase in one of the world's oldest solar markets.

South Korea's market is expected to contract sharply, by 21%, from 3.3 GW in 2024 to 2.6 GW in 2025, largely due to political instability and a policy pivot favouring nuclear over renewables.

Several emerging markets in APAC are starting to gain visibility. The Philippines, which reached the GW level for the first time in 2024, is projected to grow to 1.4 GW in 2025. Uzbekistan is set to grow from 1.4 to 2 GW, the fastest rate in Central Asia, spurred by international investment and tenders. Pakistan, a standout in 2024, faces uncertainty going forward. Much of the recent excitement has been driven by Chinese export data, which has not been fully reflected in grid connected systems. Where data is available, many installations appear to be off-grid systems, and are therefore excluded from this report.

The solar PV market across the **Americas** is projected to continue growing in 2025, although the pace and drivers differ notably between North, Central, and South America. The continent installed 82.9 GW in 2024 and is expected to add 90.3 GW in 2025, a 9% growth rate. This is slightly below the global growth rate of 10%; however, the continent will keep its 14% share of global installations.

The United States remains the dominant force in the Americas solar landscape, with installed capacity increasing modestly from 50 GW in 2024 to 51.2 GW in 2025, a 2.5% uptick that may signal an inflexion point. Although incentives under the IRA, falling costs and strong corporate and utility demand have been driving growth, escalating trade tensions under the new political leadership and the introduction of new tariffs are creating significant uncertainty. In the medium term,we expect the situation to aggravate, undermine investor confidence and cause a downturn. Brazil continues to cement its position as a regional solar powerhouse, particularly in distributed generation. While high electricity prices, abundant solar resources, auctions and favourable net-metering rules have been the base for the country's solar success story, 2025 will mean a break. The market is expected to increase only marginally to 19.2 GW, from 18.9 GW in 2024. This stagnation will be mainly caused by policy adjustments to self-consumption rules and delays in grid connections for distributed generation. Transmission infrastructure limitations are notable challenges for large-scale projects. On a positive note, new energy storage regulations in 2025 will likely further stimulate the sector.

Chile is projected to expand its annual solar market by 15%, growing from 2.1 GW in 2024 to 2.5 GW in 2025, driven by ongoing auctions, corporate PPAs, and ambitious decarbonisation targets. Yet, grid congestion and permitting delays, particularly in the north, pose ongoing barriers.

Colombia experienced a dramatic jump in capacity from 207 MW in 2023 to 1.6 GW in 2024, thanks to favourable policies, including long-term auctions and fiscal incentives. However, installations are expected to fall back to 1.1 GW as the market stabilises.

Mexico's solar market remains flat, with annual additions holding at 1.6 GW in 2025. Policy uncertainty, particularly regarding private sector participation in energy infrastructure and the regulatory approach of the Comisión Federal de Electricidad (CFE). Nevertheless, the new government has committed to expanding renewable energy capacity by 27 GW until 2030. A new regulation requiring battery storage systems to accompany solar projects – at 30% of generation capacity – is also expected to shape the future landscape.

Europe's solar market is projected to experience the slowest global growth, with installations increasing only slightly from 82.1 GW in 2024 to 84.7 GW in 2025 – a modest 3% rise that reflects rather difficult market conditions. While growth patterns vary across countries, the overall trend among the largest markets is one of stagnation or a slight decline.

650 MW, Witzniz, Germany

The EU-27 market will remain basically stable, growing just 0.7% year-over-year to 65.8 GW. Following the residential boom during the energy crisis (2021–2023), growth in the rooftop segment is now shifting toward larger commercial and industrial projects. Utility-scale projects show the largest growth potential, but face mounting challenges such as regulatory bottlenecks, permitting delays, grid congestion and an overall worsened solar business case hampered by the lack of adequate system flexibility. As markets mature, developers also focus on optimisation of existing assets, improving system efficiency, integrating storage, and managing intermittency and grid limitations.

Germany, Europe's largest solar market, will see basically no growth, with new installations only marginally increasing from 17.4 GW to 17.5 GW. Permitting delays, grid constraints, and reduced political momentum from a new government are contributing factors for a sector that has over-achieved its targets in recent years. Spain is even expected to contract slightly from 8.7 GW to 8.6 GW, with low capture prices and curtailment compounding grid limitations.

Italy is projected to decline by 11% from 6.8 GW to 6.0 GW, due to continued weakness in the residential sector. Positive effects from new legislation are not expected to materialise until after 2025. France and Poland are also expected to shrink – France by 12% from 4.7 GW to 4.1 GW amid policy uncertainty around rooftop feed-in tariffs, and Poland by 6% from 4.4 GW to 4.1 GW due to decreased demand in the residential segment and continuous infrastructure constraints.

Some EU countries still offer growth potential. Romania stands out, with capacity set to rise 67% from 1.7 GW in 2024 to 2.9 GW in 2025, supported by strong government backing and advancement of large-scale solar projects.

Outside the EU, is entering a stable phase after rapid recent growth. Capacity is projected to remain flat at 8.5 GW in 2025. Despite facing very different challenges such as high inflation, financing difficulties, and grid issues, the market remains fundamentally solid, underpinned by support policies like YEKDEM (feed-in tariffs) and YEKA (renewable auctions). Türkiye remains also the only European country with a vibrant solar manufacturing sector.The UK continues its upward trend, with installations expected to grow by 17% from 2.3 GW in 2024 to 2.7 GW in 2025. Drivers include a range of supportive policies, including the upcoming Solar Roadmap, the seventh round of the Contracts for Difference scheme, stricter building standards mandating rooftop PV, and reforms to planning and grid connection procedures. Nonetheless, long connection times, high interest rates and complex property arrangements continue to be major obstacles. Switzerland is expected to contract slightly from 1.8 GW to 1.6 GW due to regulatory uncertainty and concerns over compensation changes and curtailment risk.

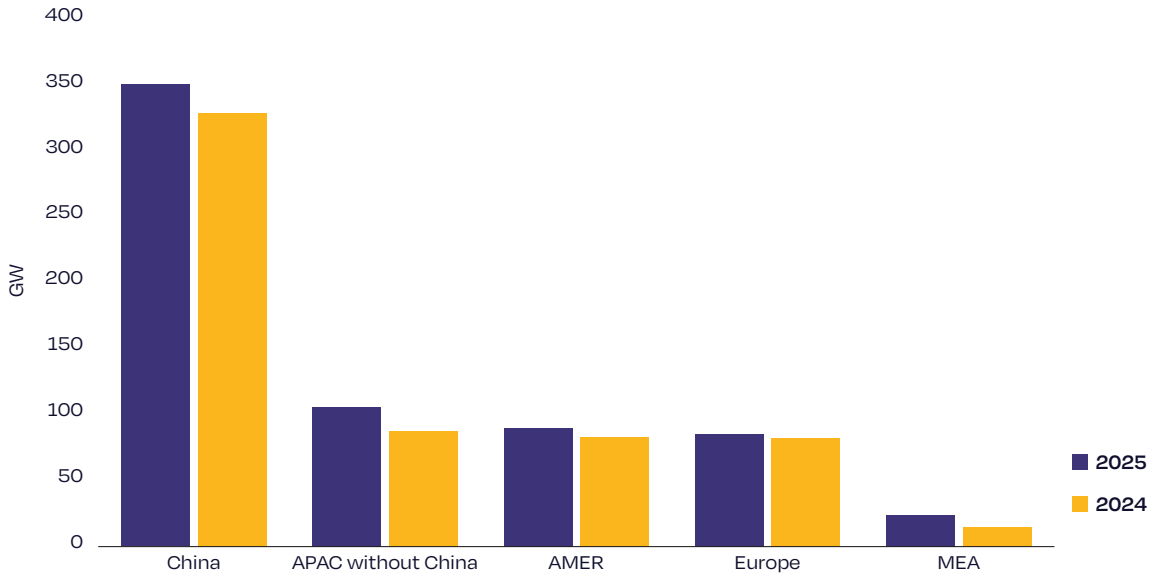
Though still the smallest in terms of total installed capacity, the **MEA region** is poised for the highest growth rate in 2025. Installations are projected to surge by 68%, from 14.5 GW in 2024 to 24.3 GW in 2025. Saudi Arabia is expected to maintain its lead in the region, growing from 1.4 GW to 2 GW, driven by large-scale solar projects aligned with the country's renewable ambitions. South Africa and the United Arab Emirates are also set for strong growth, reaching 1.5 GW each – up from 0.8 GW and based on 769 MW respectively in 2024. As a result, the MEA region's global market share is expected to rise strongly from just below 2.5% in 2024 to nearly 4% in 2025, recovering from last year's drop caused by setbacks in South Africa and the UAE.

Despite a general slowdown in installation growth in 2025, every global region is projected to expand to some degree – ranging from a modest 3% in Europe to a substantial 68% in the Middle East and Africa (see Fig. 26).

Figure 26

At least marginal solar growth expected across all regions in 2025

Regional solar PV developments 2024-2025



After a stagnating 2026, two-digit growth rates until 2029 lead solar to 930 GW global annual market and over 6 TW cumulative capacity

Global 2026-2029

While the outlook for solar PV demand between 2025 and 2028 remains generally positive, expectations should be tempered by ongoing uncertainties. On the one hand, continued progress in cost reductions driving price competitiveness, matched with large product availability, are likely to support market growth. However, broader geopolitical instability and economic volatility, coupled with mixed policy signals in some key markets, may influence the pace and scale of deployment. While the climate crisis will remain an important concern for governments, it is energy security that is likely to stay at the top of the political agenda in the coming years, particularly amid growing geopolitical fragmentation. These factors support a favourable environment for investment in solar, but implementation challenges and increasing resistance from the fossil fuel lobby could limit the speed of progress.

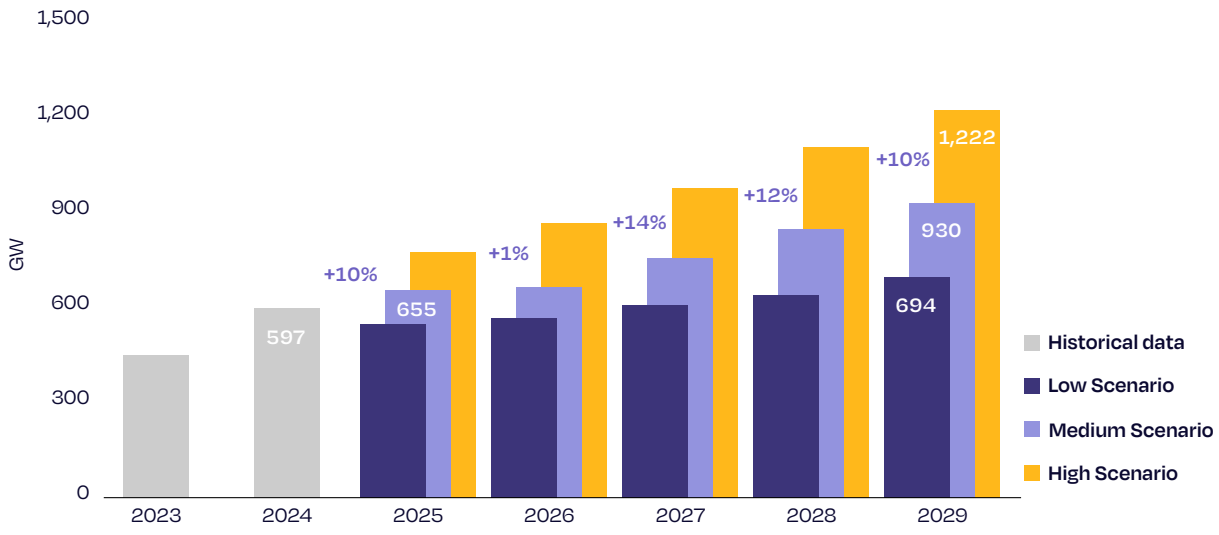
Despite these uncertainties, global demand for solar PV is expected to keep following the upward direction in the near and medium term. Yet, the real question is not whether growth will continue, but how steep and consistent the trajectory will be across different regions.

In last year's outlook, we projected 2.34 TW of new solar PV capacity to come online between 2026 and 2028. We now expect 2.27 TW added during the same period, reflecting a slightly slower growth trajectory. Our updated forecast still anticipates solid annual growth in the range of 10–14%, broadly in line with last year's estimate of 12–13%. However, 2026 stands out as a clear exception, with growth expected to slow to just 1% (see Fig. 27).

Figure 27

Policy changes in China stagnate global market in 2026; two-digit growth rates revived from 2027

World annual solar PV market scenarios 2025-2029



This notable deceleration in 2026 is primarily due to policy changes in China, where the transition from feed-in tariffs to a market-based pricing system is set to begin in the second half of 2025. As a result, developers may delay investment decisions in the latter part of that year to better understand market dynamics and revise their business models accordingly. This pause is expected to result in fewer project completions in 2026. We forecast the Chinese market to contract 5% from 350 GW in 2025 to 332 GW in 2026.

This development highlights how the global solar PV market remains heavily influenced by trends in China. In parallel, policy uncertainty in the United States, the second largest PV market, is also weighing on investor confidence. As a result, we anticipate a slowdown in annual installations, which are expected to decline 8% from 51 GW in 2025 to 47 GW in 2026, with further decrease anticipated in the following years.

Overall, our Medium Scenario projects the global PV market to reach 665 GW in 2026, up from 655 GW in 2025. Looking further ahead, we expect annual additions to reach 755 GW in 2027, 847 GW in 2028, and 930 GW in 2029.

In the High Scenario, stronger solar adoption across most regions supports annual growth rates of 11–13%, pushing yearly installations beyond the 1 TW threshold already by 2028 – consistent with last year's forecast. This outcome assumes that energy market frameworks are swiftly adjusted to accommodate renewables, and that grid infrastructure, storage, and flexibility solutions are rolled out at scale to mitigate curtailment risks and declining capture rates for solar power. In this scenario, current trade tensions and rising tariffs are not expected to significantly affect overall solar PV demand, as the global momentum and policy support for clean energy continue to outweigh these headwinds.

37.7 MW solar PV carport, Biddinghuizen, the Netherlands

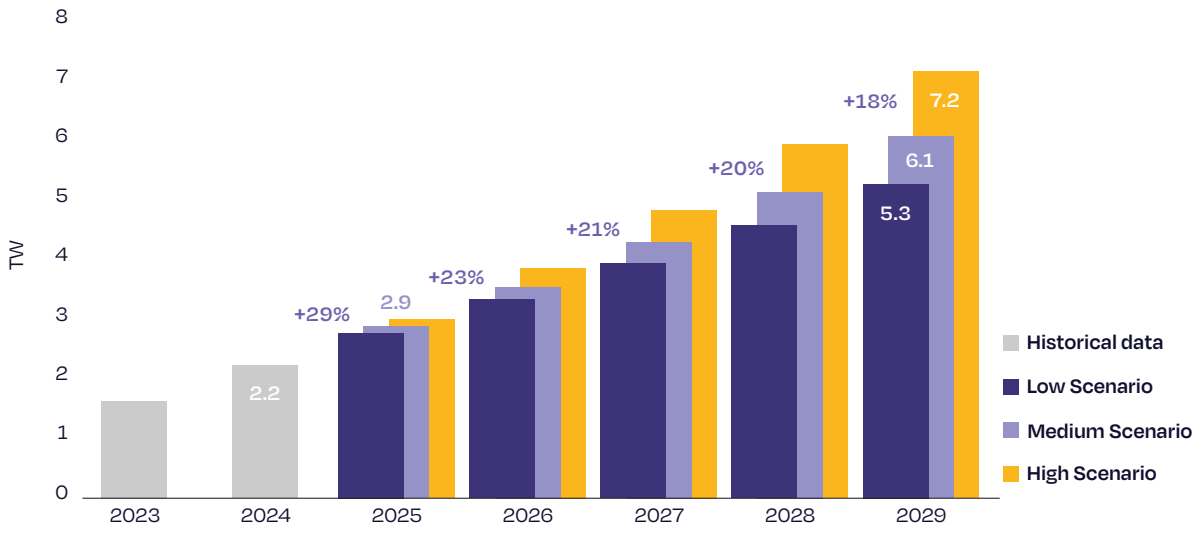
Conversely, the Low Scenario reflects slower progress on key policy and infrastructure developments. Delays in implementing supportive regulations, potential political shifts toward less favourable governments, and escalating trade barriers all contribute to a more restrained market environment. In this case, growth slows to 3–8% annually, resulting in 694 GW of installations in 2029 – well below the 930 GW projected in the Medium Scenario and 1,122 GW in the High Scenario.

After crossing the 2 TW threshold in 2024, the global solar PV fleet is set to expand significantly, with total capacity projected to reach 2.9 TW in 2025 (see Fig. 28). In our Medium Scenario, cumulative capacity is expected to further grow to 3.6 TW in 2026, 4.3 TW in 2027, 5.2 TW in 2028, and 6.1 TW by 2029 – figures that remain broadly aligned with last year's Global Market Outlook projections.

Figure 28

Total global solar installations to double in the next five years, cross 6 TW by 2029

World cumulative solar PV market scenarios 2025-2029



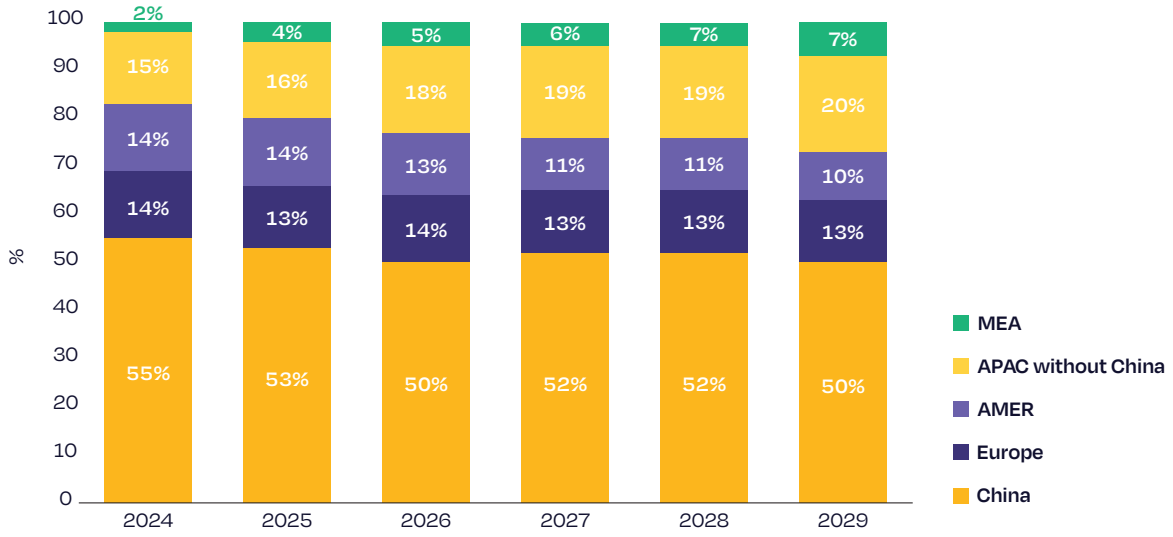
Under the High Scenario, stronger policy support, accelerated infrastructure development, and greater adoption across regions could push global capacity to 3.9 TW in 2026 and up to 7.2 TW by the end of 2029. In contrast, the Low Scenario foresees slower progress, with total installed capacity reaching 5.3 TW in 2029, still nearly three times the global capacity operating in 2024.

Compared to last year's edition, regional solar PV dynamics have shifted noticeably. The most significant changes come from the Americas – where a further contraction of the US market leads to slower overall growth – and from Europe, where deployment has pulled the brake. As a result, both regions have seen their projected global market shares revised downward. In last year's report, Europe and the Americas were each expected to account for 14% of global installations by 2028. These figures have now been adjusted to 13% for Europe in 2029 and just 10% for the Americas in 2029 (Fig. 29).

Figure 29

While China's share dilutes, 70% of annual solar installations to remain in Asia-Pacific

Evolution of global annual solar PV market shares until 2029



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This relative decline benefits other parts of the world, particularly the Asia-Pacific region excluding China, which is projected to increase its global share from 15% in 2024 to 20% in 2029. This growth is largely driven by rapidly expanding markets such as India, the Philippines, and Australia.

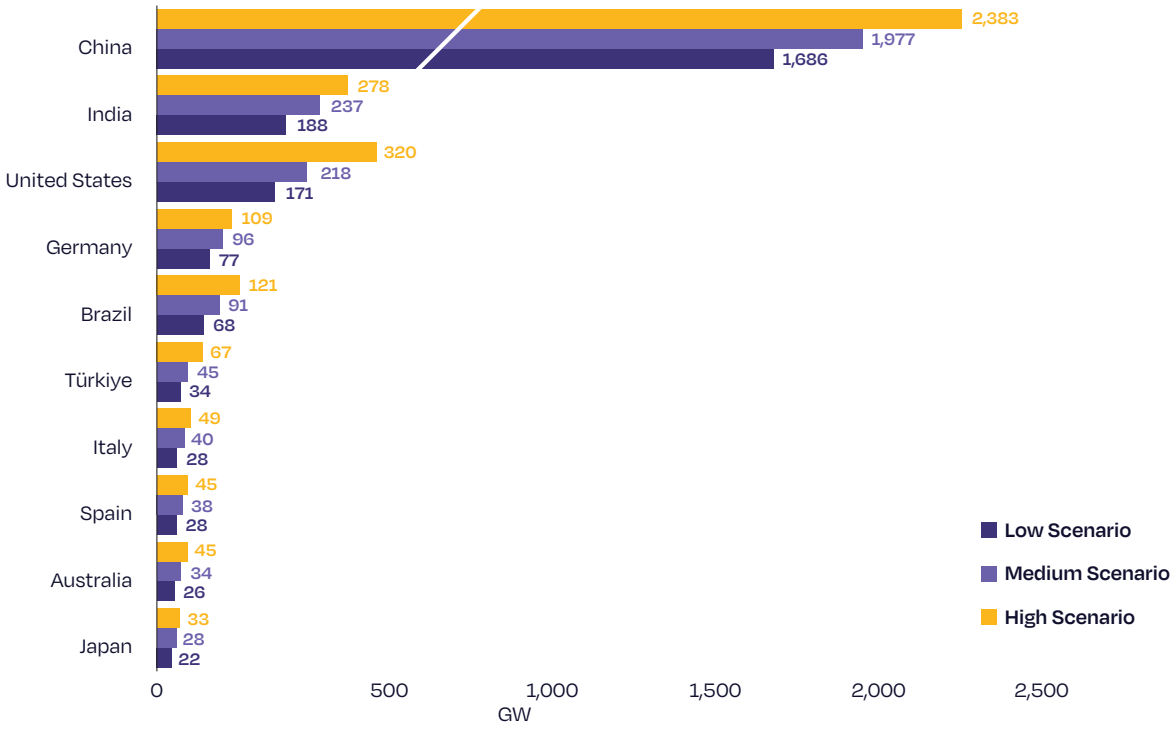
China's trajectory remains in line with previous expectations: after peaking in 2024 with 55% of global market share, its dominance is projected to gradually decline, while still holding a substantial 50% by 2029. Notably, while last year's forecast anticipated China's share dropping below 50% by 2028 (to 48%), the weaker outlook in other regions has delayed this shift, keeping China's share at 50% in the final year of the outlook. It is worth noting that despite these fluctuations, the share of the overall APAC region including China remains constant at around 70% throughout the 2024–2029 period.

Finally, even if much smaller in absolute terms, the Middle East and Africa region is expected to more than triple its share, growing from 2% in 2024 to 7% in 2029. This increase is mainly driven by large-scale projects in the Middle East, while significant solar development in Sub-Saharan Africa has yet to materialise in our projections.

Figure 30

India set to overtake the US for second most solar additions 2025-2029, China dominates

Top 10 markets solar PV additions 2025-2029



The ranking of the top 10 markets with the highest five-year solar installation potential reveals several notable shifts (see Fig. 30). While China continues to lead by a wide margin, with 2 TW of new capacity expected between 2025 and 2029 (+200 GW compared to last year's five-year outlook), India has now overtaken the United States in the Medium Scenario to claim the second position. India is projected to install 237 GW over the next five years (+85 GW).

The United States, now in 3rd place, is expected to add 218 GW during the same period (-71 GW). Germany and Brazil maintain their positions, with Germany forecast to install 96 GW (-8 GW) and Brazil reaching 91 GW (+12 GW). Türkiye makes a strong leap forward, consolidating its presence in the top 10 after first entering the ranking last year. It climbs to 6th place with 45 GW projected (+15 GW).

The remaining countries in the top 10 show mixed trends. Italy sees a moderate increase of 5 GW in its outlook, while Spain, Australia, and Japan all register downward revisions of 8 GW, 9 GW and 14 GW, respectively.

Box 2

Looking back and forth

In last year's Global Market Outlook (GMO) 2024, we significantly revised our 2024 solar PV forecast upward compared to the previous GMO 2023 estimate, from 401 GW to 544 GW (see Fig. 31). Yet, even this considerable increase turned out to be conservative, as the actual market exceeded expectations by 53 GW.

Nevertheless, after several years of consistently underestimating solar market growth and regularly raising our forecasts, this year marks the first time we are slightly revising our long-term outlook downward. This shift is primarily driven by China's recent policy change, transitioning from feed-in tariffs to a market-based remuneration scheme, which may temporarily slow growth in the world's largest solar market. In addition, the United States is expected to follow a more cautious solar path following the election of Donald Trump, a president very supportive of fossil fuels, but unsupportive of renewable energy and climate action. The European solar market, meanwhile, is showing signs of stagnation in 2025, with projected growth rates now lower than previously forecasted.

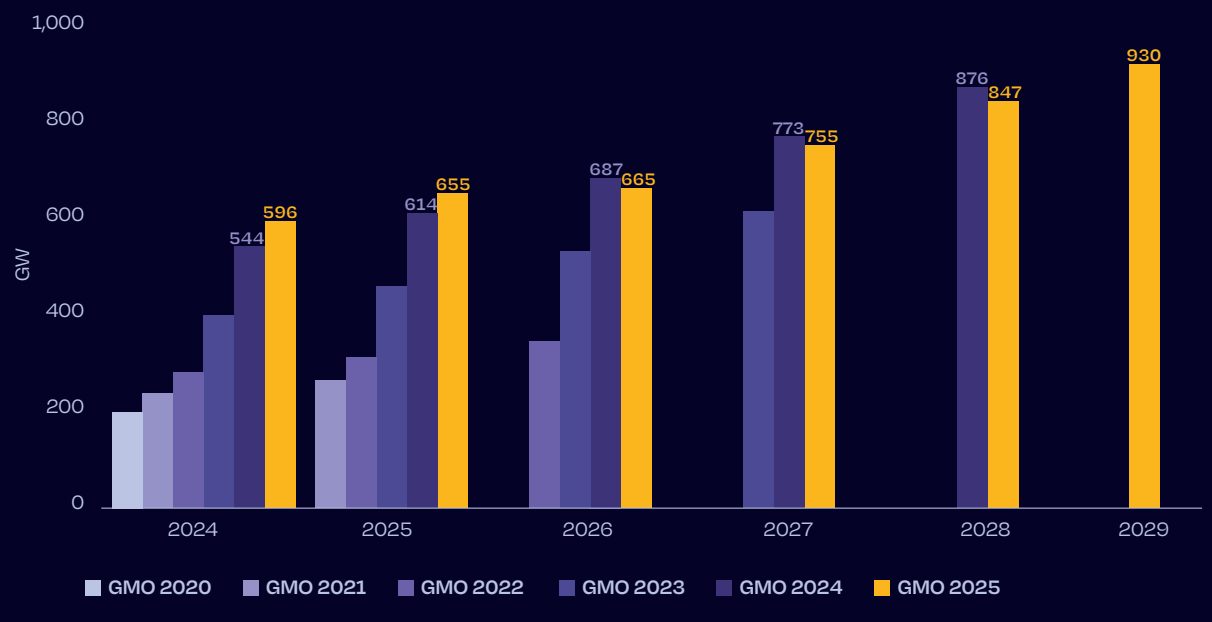
In more advanced solar markets, much of the low-hanging fruits in the rooftop segment have already been grabbed, while the increased penetration of variable renewables in the power mix has not been matched with an adequate deployment of grids and flexibility solutions. Unlocking future growth will require to ramp up storage deployment and other flexibility solutions to integrate renewable power efficiently and preserve solar business cases.

Despite the long-term revisions, our updated forecast for 2025 is still slightly higher than last year's – rising 7% from 614 GW to 655 GW – and reflecting the strong momentum carried over from 2024. From 2026 onwards, however, annual forecasts have been trimmed by 22 GW for 2026, 18 GW for 2027, and 29 GW for 2028, which are equivalent to decreases of between 2% and 3% compared to GMO 2024 forecasts. Nonetheless, our updated 2025 projection remains twice as high as the forecast issued back in 2022, underscoring the rapid acceleration of solar PV over recent years.

Figure 31

2025 solar forecast upgraded, modest reductions for long-term outlook

Comparison Medium Scenario GMO 2024 vs previous GMO editions



Utility-scale solar consolidates its lead, projected to cross 500 GW by 2029

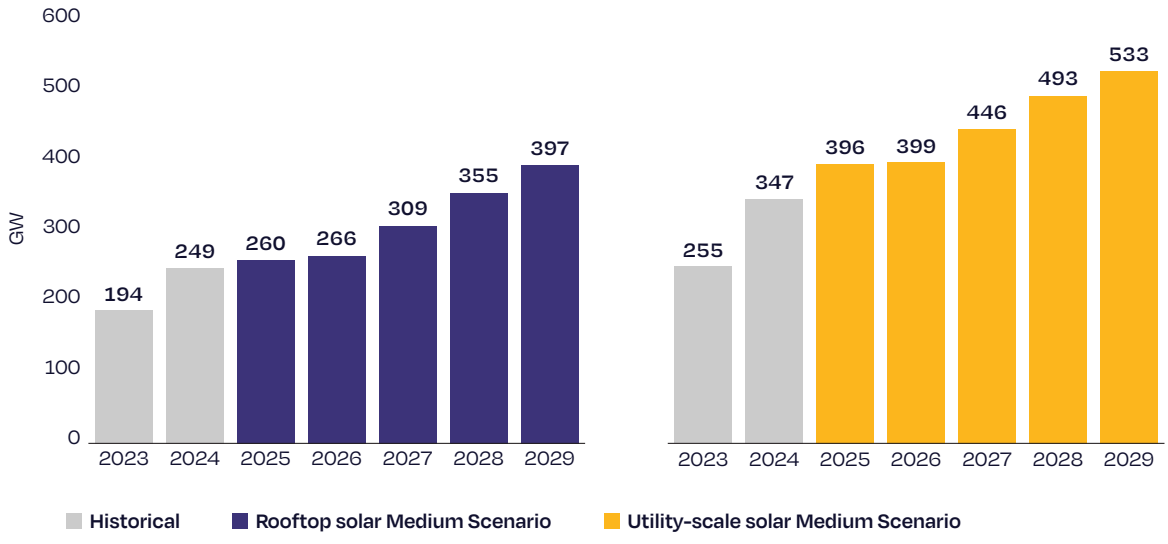
The key market trends playing a role on the growth of different solar PV segments that were observed in recent years have continued in 2024. Very low module prices are beneficial for developers of utility-scale PV plants and have further increased the segment's share. Meanwhile, the rooftop market's expansion has been hampered by a decrease in electricity prices towards pre-energy crisis levels and by the lowered policy support in traditionally strong markets across Europe.

Both segments experienced growth in 2024, but as in 2023, utility-scale experienced the strongest increase. The segment progressed by 36% and reached 347 GW, up from 255 GW in 2023 (see Fig. 32). Large-scale solar accounted for 58% of the new installations in 2024, up from 57% in 2023, and marking a new record market share for the segment in recent years. Several of the largest markets around the world experienced strong growth in large-scale installations. China's utility-scale segment was up 26% and reached over 180 GW in 2024. The United States also benefitted from the full effect of the IRA and tax credit as the segment installed a record-breaking 41 GW, up 83% from 2023. India's large-scale solar skyrocketed with a 167% growth rate in 2024 to reach 26 GW, more than twice the size of India's total annual market in 2023. Though smaller in absolute size, other notable markets doubled their utility-scale PV: Portugal grew 156% to 1.6 GW, and Italy grew 119% to 2.9 GW.

Figure 32

Utility-scale solar to surpass 500 GW by 2029, rooftop solar nears 400 GW

Solar PV rooftop and utility-scale segments scenarios 2025-2029



In 2025, we anticipate the worldwide solar utility-scale segment to reach 396 GW, reflecting a 14% annual growth rate, and a peak market share of 60%. Over the coming years the ground-mounted solar segment will continue its ascent, while marginally declining its market share, reaching 399 GW (60% share) in 2026; 446 GW (59%) in 2027; 493 GW (58%) in 2028; and 533 GW (57% share) in 2029.

In the rooftop segment, growth was more moderate but still notable, with a 25% increase compared to 2023. Installed capacity rose to 249 GW, up from 194 GW the year before. However, with the primary driver of rooftop growth – high electricity prices – no longer strongly perceived across historically strong markets, 2024 marks a turning point for the segment, which must now adapt to a new reality.

Several countries have reduced or entirely removed feed-in tariffs and net-metering schemes. In the United States, for example, the revision of California's net-metering programme (NEM) significantly reduced the appeal of small-scale rooftop installations. Combined with tighter financing conditions, the overall attractiveness of residential rooftop systems has declined. As a result, the US rooftop market contracted by 13%, falling from 9.8 GW in 2023 to 8.5 GW in 2024.

In the EU-27, the rooftop market is also facing challenges. Residential installations dropped by 29% and commercial systems declined by 1%. Only large industrial rooftop systems showed positive growth, increasing by 14%. Altogether, the EU-27 rooftop market shrank from 40.4 GW in 2023 to 36.4 GW in 2024.

Looking ahead, the rooftop market will need to evolve. New business models focussed on maximising self-consumption and less reliant on feed-in tariffs or net-metering are essential to sustain growth. Encouragingly, rooftop mandates are emerging worldwide, from Tokyo to the EU Energy Performance Building Directive framework, supporting a more positive long-term outlook for the segment.

We expect the global rooftop market to continue expanding, reaching 260 GW in 2025, 266 GW in 2026, 309 GW in 2027, 355 GW in 2028 and 397 GW in 2029. After peaking at more than 50% of total solar installations in 2022, the rooftop segment's share decreased to 42% in 2024 and is projected to fall further to 40% in 2025. Nevertheless, a slight rebound is expected, with rooftop solar regaining a 43% market share by 2029.

325 kW, Ausserrhoden, Germany

From a cumulative TW milestone in 2022 to an annual TW market in 2030

Our GMO forecasts traditionally span a five-year horizon. However, this edition extends through 2029 and includes a preliminary outlook for 2030. That year represents a key milestone on the path to climate neutrality by mid-century, with many governments and policymakers around the world setting renewable energy and climate targets anchored to 2030. To reflect this growing significance, we have expanded our analysis beyond our usual scope and benchmarked our forecasts against those of major international stakeholders.

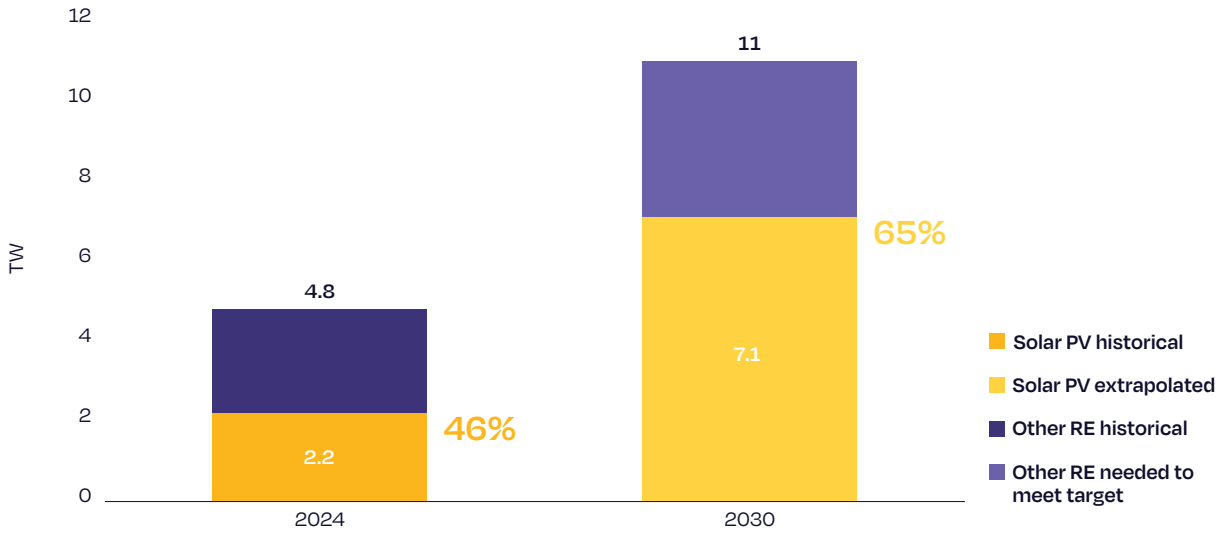
One of the most consequential outcomes of COP28 in December 2023 was the commitment from over 130 countries – including all G7 members – to triple global renewable energy capacity by 2030, reaching 11 TW. While the agreement did not specify a technology breakdown, it is widely acknowledged that solar PV will be the main driver. Solar has consistently led all other power generation technologies in annual capacity additions, and it is poised to continue doing so.

By the end of 2024, solar PV made up 46% of global renewable capacity, with 2.2 TW installed. Extending our Medium Scenario projections from 2025–2029 out to 2030, we expect global installed solar PV capacity to exceed 7 TW by 2030 (see Fig. 33). This would represent about 65% of the total renewable capacity required to meet the 11 TW global target.

Figure 33

Solar to lead the achievement of 11 TW global renewable target by 2030

Global installed renewable electricity generation capacity in 2024 and target for 2030



Sources: IRENA (2025), SolarPower Europe

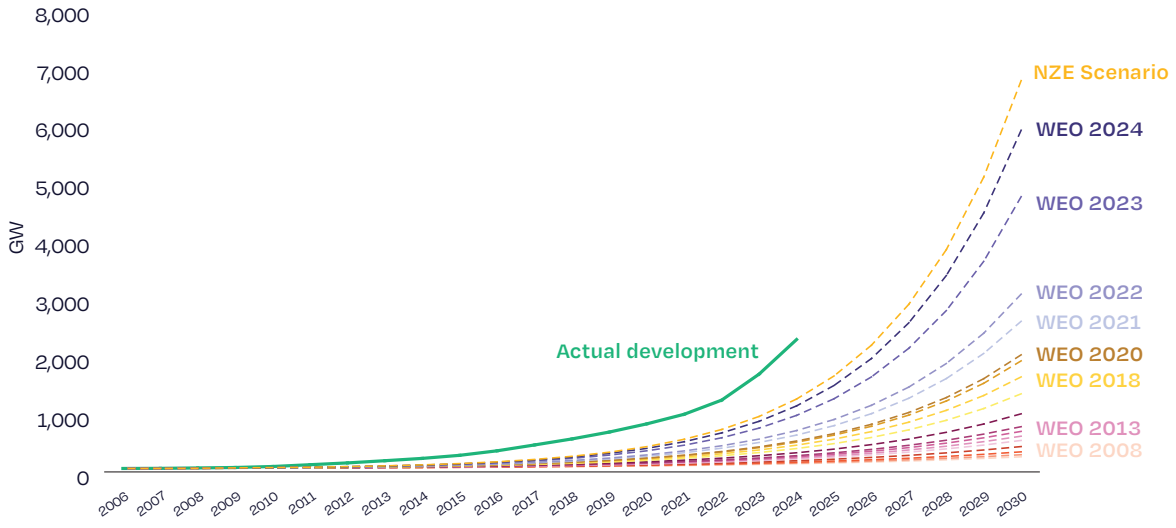
Our outlook implies an average solar addition of 809 GW per year between 2025 and 2030, adding 4.9 TW of new solar capacity over the same period. While this seems ambitious at first sight, a backward look into the past can help put things into perspective: any global solar market analysis, including ours, has been severely underestimating growth, with the best-known example being the IEA annual flagship report, the World Energy Outlook (WEO) (see Fig. 34). The actual development of solar PV technology has drastically outpaced all energy analysts forecasts by a large margin.

Moreover, the growing demand for electricity, driven by the rise of artificial intelligence, data centres and the widespread adoption of electric vehicles and electric heating, is set to further amplify the need for versatile and cost-competitive power in the future, by an order of magnitude that is still hard to grasp today. However, it undeniably creates significant space for expanding solar generation capacity.

Figure 34

Historical solar PV development growth curve indicates continued systematicunderestimation of future installations

IEA world energy forecasts versus actual historical development of solar PV



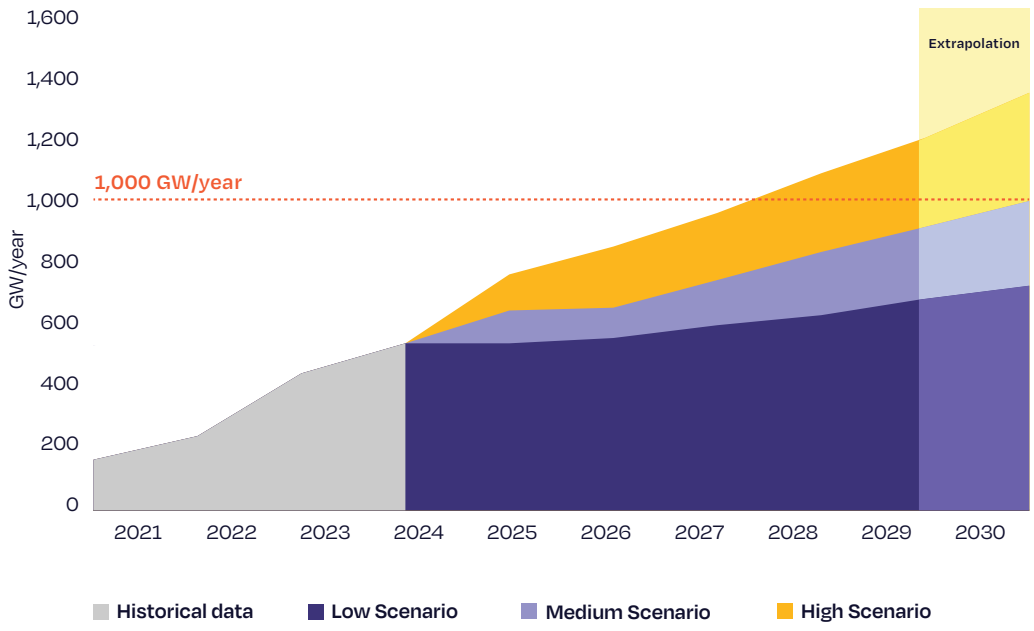
Source: IEA (2025)

The extrapolation of our 2025-2029 scenarios to 2030 shows that the TW level of annual installations would be reached in 2030 under the Medium Scenario, one year later than the High Scenario (see Fig. 35). Although these milestones occur a year later than what projected in last year's forecast, the long-term outlook remains bright. Only the Low Scenario would still fall short of the TW level by 2030, reaching 737 GW by that year.

Figure 35

Annual TW solar market likely to be reached by 2030

Global cumulative solar PV market scenarios 2025-2030

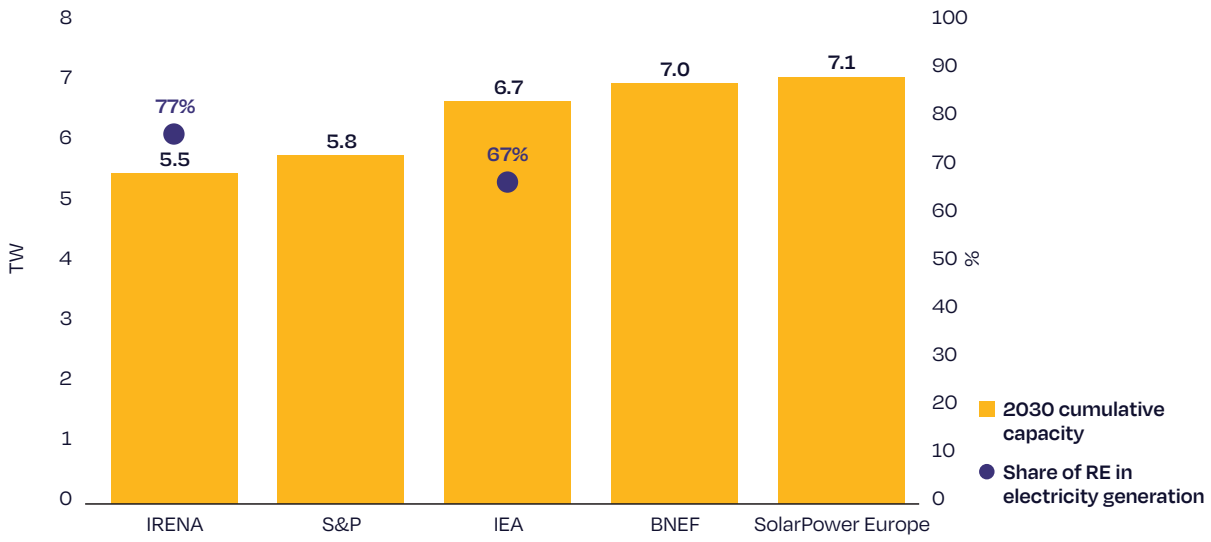


When comparing our expectations with the most recent 2030 projections from other major solar analysts, we remain more optimistic than everyone else. Our Medium Scenario sees 7.1 TW of global solar capacity by 2030 – slightly higher than BloombergNEF's forecast (7.0 TW). We also exceed projections from S&P Global (5.8 TW), the updated IEA forecast (6.7 TW), and IRENA's WETO 2024, which lags behind most at just 5.5 TW.

Figure 36

Total solar capacity projection to 2030 exceeds mainstream solar outlooks

Global solar PV cumulative installed capacity scenarios 2030



Sources: IEA (2025), BNEF (2025), IRENA (2023), S&P (2024), SolarPower Europe

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Policy Recommendations

Solar PV has emerged as the most scalable and cost-effective renewable energy source, positioned to lead the global energy transition and meet the COP28 target of tripling renewable capacity by 2030. The Global Solar Council celebrates surpassing 2 TW of global installations and urges accelerated deployment through policy alignment and stakeholder cooperation. To achieve the 2030 goal, the GSC outlines eight key recommendations, including enhancing grid flexibility, closing investment gaps, promoting storage, and streamlining permitting. It also stresses the need for resilient supply chains, ESG standards, skilled work-force development, and stable, supportive policy frameworks. Coordinated global action is essential to realise the solar potential and secure a just, sustainable energy future.

Policy Recommendations for Global Solar PV Deployment

By Global Solar Council

It is clear that amongst all renewable energy sources, solar PV's scalability and cost-effectiveness make it the main driver for advancing the global transition to clean energy, meeting rising global energy demand and energy security. At COP28, world leaders set a goal of tripling renewable energy capacity by 2030 to limit global warming to 1.5°C. To realise this goal for 2030, a major chunk has to come from solar, around 8 TW in total by 2030, requiring annual solar additions to be at least 1 TW on average for the rest of this decade.

The Global Solar Council (GSC), on its 10-year anniversary this year, applauds both industry and governments for their massive role in deploying more than 2 TW of solar globally by November 2024. Through policy advocacy and industry-backed market interventions, the GSC continues to ensure that solar generates great momentum in all parts of the world to achieve the 2030 target through an accelerated rate of annual solar deployments. However, the market challenges need to be resolved and close collaboration between all the stakeholders is essential to realise the 2030 goal.

In this year's report, the Medium Scenario forecasts 7.1 TW total solar capacity installed globally by 2030, which is notably less than the GSC's 8 TW solar target by 2030. Hence, the GSC encourages decision-makers to adopt these eight key policy recommendations to fast-track the annual solar deployment rate in their markets:

1

Enhance grid flexibility and capacity

EU decision-makers have made important strides to building more enabling regulatory frameworks for renewable energy, in particular with respect to permitting rules, electricity market functioning and solar PV on public and commercial buildings. Investors are now betting on policy makers to stick to those rules. Implementation, however, requires a new EU-wide clean energy investment programme alongside it. This should be done, first, by aligning existing EU funding with delivering the 2030 objectives, and second, by establishing a new EU Clean Energy Investment Fund under the next Multi-year Financial Framework. This is essential to sustain financial support for Member States for the energy transition in the crucial years before 2030, especially given that the Next Generation EU and Resilience and Recovery funds are expected to dry up after 2026. In addition, State aid framework should integrate new societal needs – for example on resilience, sustainability and energy system integration – without hampering investment signals. This means: easy-to-read auctions and Contracts for Difference that provide remuneration certainty and mobilise private investments via Power Purchase Agreements.

2 Close the investment gaps and promote low-cost solar finance

An estimated investment of 12 trillion USD is needed to deliver the global target of tripling renewable energy for 2030. The solar industry is currently seeing half a trillion dollars of investment per year. At this moment, the industry requires increased volume of public and private blended finance at low cost for solar projects in LDCs (least developing countries), and, however, investments are not flowing at the required pace and scale in many developing and LDCs.

Strengthened support from Multilateral Development Banks/bilateral Development Finance Institutions equipped with de-risking and innovative financing instruments can enhance solar investment in underserved regions. As one of the large sectors, engagements with major private investors for improving distributed solar applications and setting standardisation and ESG aspects is vital. Furthermore, grid finance should be counted as climate finance for large-scale deployment of renewables.

The GSC has created the International Solar Finance Group to bring together representatives from public and private financial institutions with the captains of the PV industry to address the barriers that are maintaining high cost of capital and mobilise more private finance for PV.

3 Promote solar plus energy storage installations and inter-regional power supply

There are proven benefits of solar plus energy storage for grid resilience and wide electrification. System operators could assess the benefits of distributed solar PV and storage, reducing the need for high-voltage transmission lines by bringing generation closer to consumption and behind the meter. Establishing the global storage target and enhancing inter-regional penetration of power generated through grid interconnections could be a critical step toward providing a clear roadmap for investment and development. For example, targets like the one announced by the G7 and many governments at COP29 Baku to install 1,500 GW of global energy storage by 2030 – a sixfold increase from 2024 levels – should be set and implemented to complement the goal of tripling renewables. Governments must support viable flexibility solutions linked with solar, such as battery energy storage, Pumped-Hydro Storage, Time of Use pricing and flexible demand response methods.

4 Strengthen global solar supply chains

There is a need for national, regional and global initiatives that align to reach fair, open, and resilient global supply chains for the long-term success of the global solar industry and achieve the global goal of total 8 TW solar installations for 2030. Policymakers must adopt supportive trade policies that are robust, do not hold back deployment, do not compromise on the quality of solar equipment, foster competitiveness without pushing higher costs onto end-users and adequately support the growing global demand of the solar supply chain. To strengthen the global solar supply chain, the GSC is working with the WTO, IRENA and other stakeholders to create a platform for dialogue on trade issues and form consensus on a long-term strategy for the global solar PV supply chain.

5 Streamline permitting processes for solar projects

A transparent and fast permitting process for timely solar project commissioning builds stakeholder trust and reduces associated project economic viability risks, especially in price-sensitive markets. Solutions such as the removal of all permitting for all rooftop solar, 'one-stop shops,' automatic approvals after maximum waiting times, and adjusted permitting based on installation size and location to accelerate rooftop solar and mini-grid deployment could be a win-win case. Adequate investments for capacity building of the concerned authorities can further fast-track the permitting process. The GSC is working with the Planning4Climate Commission to address permitting challenges further.

6 Introduce ESG standards all over the world in solar business for sustainability

Governments must establish clear regulations for environmental, social, and governance (ESG) standards covering solar PV to ensure long-term sustainability within the solar sector. Regulators and the solar industry must collaborate to promote extended producer responsibility for solar equipment (such as modules, inverters, and batteries) recycling. Developing dedicated processing facilities would be key to integrating recovered materials into supply chains. The GSC supports the Solar Stewardship Initiative as the market-leading solar PV ESG initiative and encourages players to opt for it. The SSI is a multi-stakeholder initiative that covers human rights, governance, and environmental aspects.

7 Skilled solar workforce creation and just and equitable energy transition

Solar PV is the largest renewable job sector, employing 7 million so far. Millions of more jobs will be needed across the value chain as solar needs to reach the 8 TW installation level by 2030 under the 'tripling renewables' goal. It comes with immense responsibility that these jobs are safe and part of a just and equitable energy transition strategy. The GSC encourages governments to endorse the Global Solar Training Standards Initiative, a new initiative that sets global solar training standards certification, being developed by the Global Solar Council in partnership with the GWO, a global specialist institute in renewables training.

Policymakers must set solar workforce targets as part of the national energy policy to support solar or renewable energy installation targets, and tailored retraining/reskilling pathways to promote transfer and upskilling of workers from carbon-intensive industries to solar industry jobs.

8 Set stable policies and solar target under NDCs

All LDCs or emerging countries must have national solar installation targets obligated under their climate NDCs (Nationally Determined Contributions) goal and stable policies to attract investments. Retroactive policy change must be avoided at all costs. Innovative support mechanisms, complemented by regulatory improvements, auction schemes, and electricity market reforms, must continue. Countries should put in place market-tailored approaches to fulfil the energy needs through innovation in off-grid; and clear strategies to widen socio-economic benefits through Agri-PV, floating PV, and Building Integrated PV installations-based targets.

Focus: Indian solar PV market

India surpassed 100 GW_{AC} of installed solar capacity in February 2025, becoming the fourth country globally to do so, with over half added in the past three years. This growth has been fuelled by supportive policies, central schemes, and incentives promoting both utility-scale and rooftop solar. Key initiatives include the Pradhan Mantri Surya Ghar scheme for households, PM-KUSUM for farmers, and the Green Energy Open Access Rules for businesses. Domestic solar manufacturing is expanding rapidly, backed by production-linked incen-tives and import duties to reduce reliance on foreign components. Considering the current growth trajectory and ongoing supportive measures, the country's installed solar photovoltaic capacity is projected to reach between 275-310 GW_{AC} by the year 2029, well above the 200 GW_{AC} target by 2030.

Indian Solar Market Focus

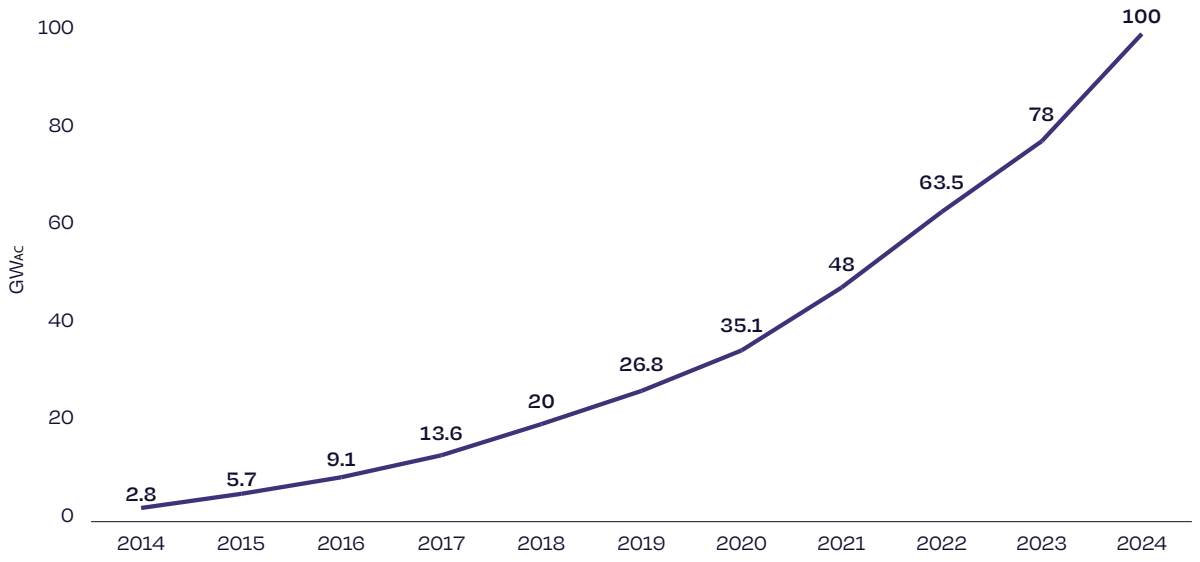
By Subrahmanyam Pulipaka, Muskaan Sethi, and Aaradhya Mathur, NSEFI

Introduction

India, the fourth largest global solar market for installation, breached the 100 GW total installed solar capacity mark in February 2025 to become the fourth country to achieve this remarkable milestone globally.[2] More than half of this 100 GW has been installed in only the last three years. India witnessed a steep installation curve, starting with a mere 2.8 GW in 2014 to around 102 GW by February 2025.

Figure 37

India annual cumulative solar installations 2014-2024



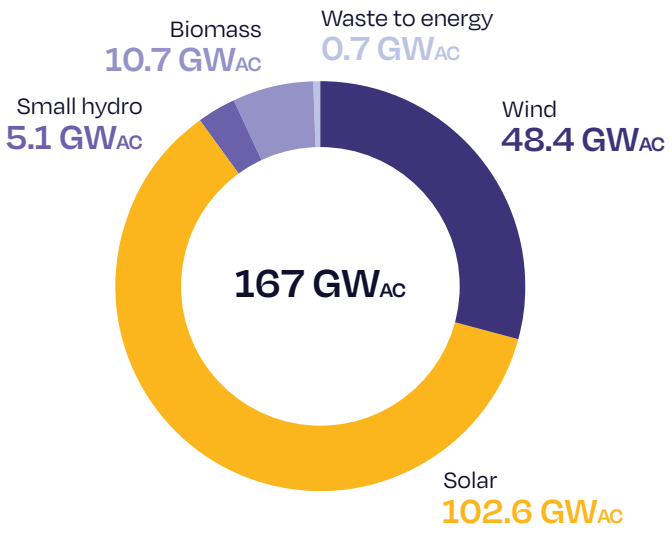
Source: MNRE, Government of India

The rapid pace of installations, backed by a significant project pipeline, has been possible due to factors including a cohesive policy and regulatory ecosystem along with vibrant industry and streamlined implementation. To meet India's ambitious national renewable installation target of 500 GW by 2030, the country aims to add another 200 GW of solar within the next 5 years.

2 All data in this chapter is expressed in AC terms

Figure 38

India installed renewable energy capacity as of February 2025

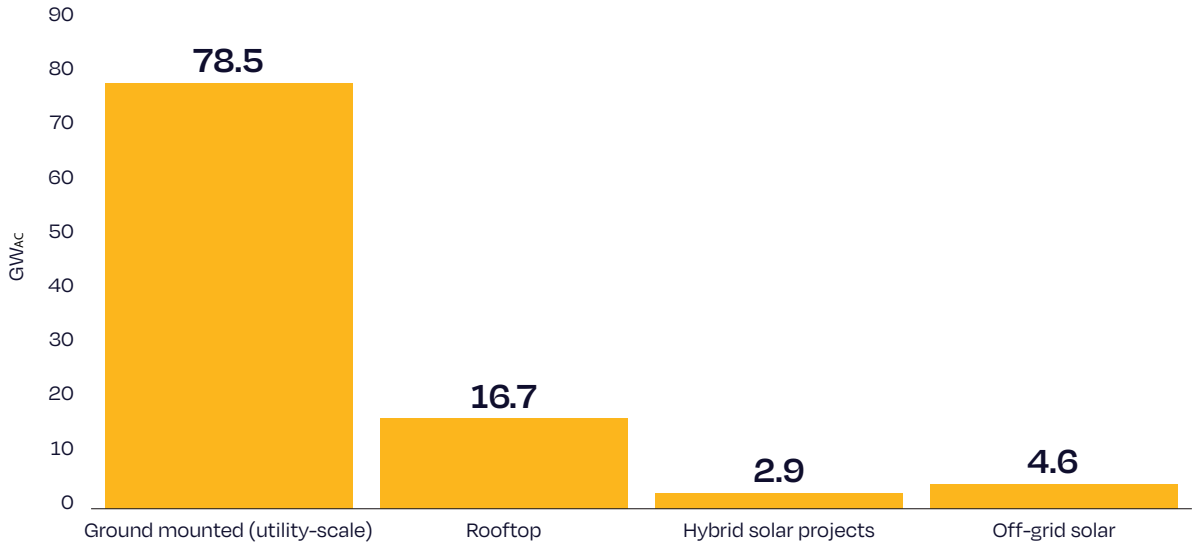


Source: MNRE, Government of India

As of February 2025, India's installed RE capacity is around 165 GW, with solar contributing around 61% of the total. In solar installations, utility-scale ground mount projects dominate with around 79 GW of installed capacity, while rooftop contributes nearly 17 GW. Hybrid solar projects and off-grid solar represent the remaining 7.5 GW.

Figure 39

Breakdown of India installed solar capacity across different categories



Source: MNRE, Government of India

Utility-scale solar development

India's success in its Utility-Scale solar installations is driven by key policy reforms. Launched in 2010 under India's National Action Plan on Climate Change (NAPCC), the Jawaharlal Nehru National Solar Mission (JNNSM) played a crucial role in advancing solar energy adoption by establishing a robust policy and regulatory framework, promoting large-scale grid-connected and rooftop solar projects, expanding off-grid solar access, strengthening domestic manufacturing, and attracting significant investments.

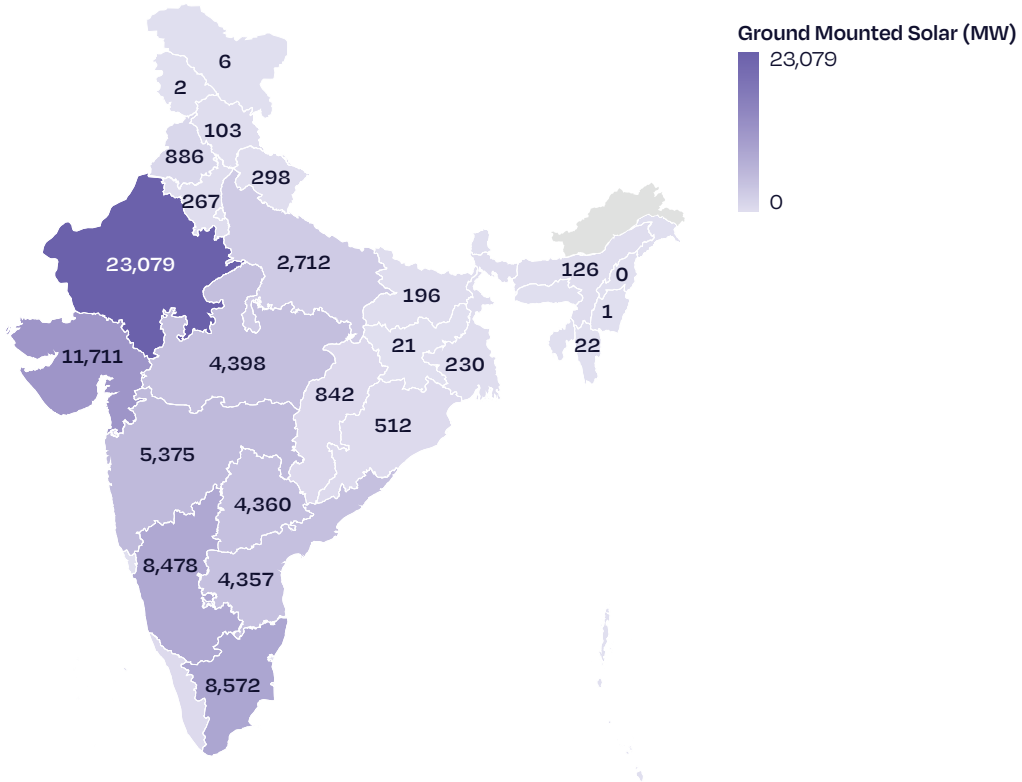
JNNSM was implemented in three phases with a long-term objective of achieving 100 GW of solar power capacity by 2022, supporting India's commitment to sustainable energy transition, with 2012-13 as Phase 1, 2013-17 as Phase 2 and 2017-22 as Phase 3. Through provisions such as Scheme on Development of Solar Parks and Ultra Mega Solar Power Projects, a move from FIT to competitive bidding regime, Renewable Purchase Obligations (RPOs), the mission facilitated rapid solar deployment while driving down solar tariffs from 10.95 INR/kWh in 2010 to 2.5-2.6 INR/kWh on an average range.

Solar parks scheme

Solar parks are large-scale solar power generation projects designed to facilitate the development of multiple solar installations within a dedicated area. These parks provide essential infrastructure, such as land, transmission facilities, and water supply, creating a streamlined environment for solar project developers. By offering a ready-to-use setup, solar parks help reduce project costs, minimise delays, and accelerate the deployment of solar power capacity.

Figure 40

Ground mounted solar capacity state wise as of February 2025



Source: MNRE, Government of India

While solar power projects can be established across the country, projects developed in a scattered manner often face challenges such as higher project costs per megawatt (MW) and increased transmission losses. Smaller, standalone projects typically incur significant expenses for site development, construction of dedicated transmission lines to the nearest substation, procurement of water, and development of other necessary infrastructure. Additionally, the process of acquiring land, obtaining clearances, and securing permissions can be time-consuming, further delaying project timelines.

To address these challenges, the Scheme for Development of Solar Parks and Ultra-Mega Solar Power Projects was introduced in December 2014. This scheme aims to create large-scale solar parks that provide essential infrastructure and facilities to support solar developers. By centralising these resources, the scheme enables developers to set up projects efficiently, reduce costs, and complete installations within shorter timelines.

The Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects initially aimed to establish a minimum of 25 solar parks with a cumulative installed capacity of 20,000 MW over a period of five years, commencing from 2014-15. In 2017, the scheme's target was revised and expanded to 40,000 MW.

As of June 2023, a total capacity of 37,990 MW has been sanctioned across 12 states under this initiative.

Central Public Sector Undertaking (CPSU) government producer scheme

The CPSU Scheme (Government Producer Scheme) was launched by the Ministry of New & Renewable Energy (MNRE) to promote solar power generation by government-owned entities, ensuring energy security and fostering domestic solar manufacturing. Implemented in two phases, the scheme mandates that all generated power be used for self-consumption by Central Public Sector Undertakings (CPSUs) and government institutions, with financial support through Viability Gap Funding (VGF) and a domestic content requirement (DCR) to boost indigenous solar production. By ensuring demand for domestically manufactured solar modules, it aligns with the Make in India initiative and supports the growth of indigenous solar manufacturing while reducing reliance on external power procurement.

Introduced in 2015, Phase-I set an initial target of 1 GW to encourage government entities to develop solar projects on available land and rooftops for their own consumption. To make these projects financially viable, the government provided VGF support, covering part of the capital cost. The DCR mandate ensured that only Indian-made solar modules and cells were used, strengthening the local solar industry. The phase successfully demonstrated the feasibility of self-sustained solar power generation within CPSUs and laid the groundwork for large-scale expansion.

Building on this success, the government launched Phase-II in March 2019, significantly raising the target to 12 GW with a financial outlay of 8,580 crore INR. This phase retained the VGF mechanism while continuing to mandate domestic procurement of solar equipment under the DCR policy. By facilitating large-scale solar adoption among government producers, the scheme aimed to reduce dependency on conventional power sources, lower electricity costs for CPSUs, and enhance India's solar manufacturing ecosystem. The implementation timeline extends until FY 2025-26, marking a crucial step toward achieving India's ambitious renewable energy targets.

With structured financial backing, policy-driven incentives, and a long-term vision, the CPSU Scheme has been instrumental in driving solar adoption across government entities, strengthening India's renewable energy landscape, and supporting the country's transition towards self-reliant and sustainable energy generation.

Renewable purchase obligation

The Renewable Purchase Obligation (RPO) is a crucial policy framework established under the Electricity Act of 2003 to accelerate the adoption of renewable energy in India. This regulatory mechanism mandates that electricity distribution companies (DISCOMs), open access consumers, and captive power producers procure a designated percentage of their total electricity consumption from renewable energy sources.

The RPO framework is further categorised into two segments: the Solar RPO, which mandates procurement from solar energy sources, and the Non-Solar RPO, which encompasses renewable sources such as wind, biomass and small hydro projects. Both RPOs were recently revised in 2023, with solar now included under the broader category of Other Renewable Energy in the updated RPO trajectory. In cases where entities are unable to meet their RPO targets directly, they may fulfil their obligations by purchasing Renewable Energy Certificates (RECs) from recognised power exchanges.

The Electricity Act of 2003 is widely regarded as a transformative legislative milestone that significantly reformed India's power sector. Among its notable provisions is the de-licencing of power generation, which removed licencing requirements for generating stations, except for those involving nuclear or large-scale hydropower. The Act also introduced the concept of Open Access, a provision that enables large consumers to purchase electricity directly from their preferred producers, fostering competition and enhancing consumer choice. To ensure effective regulation, the Act established the Central Electricity Regulatory Commission (CERC) and State Electricity Regulatory Commissions (SERCs). These regulatory bodies are tasked with overseeing tariff structures, resolving disputes, and setting performance benchmarks to promote fairness and transparency in the power sector.

By integrating the RPO framework within the Electricity Act of 2003, the Indian government laid a robust policy foundation that drives renewable energy development while maintaining a competitive and consumer-centric power landscape. This strategic initiative has played a pivotal role in accelerating India's clean energy transition, aligning with the nation's broader commitment to sustainable development and environmental responsibility.

Table 1

The Renewable Purchase Obligation (RPO) trajectory (revised in 2023)

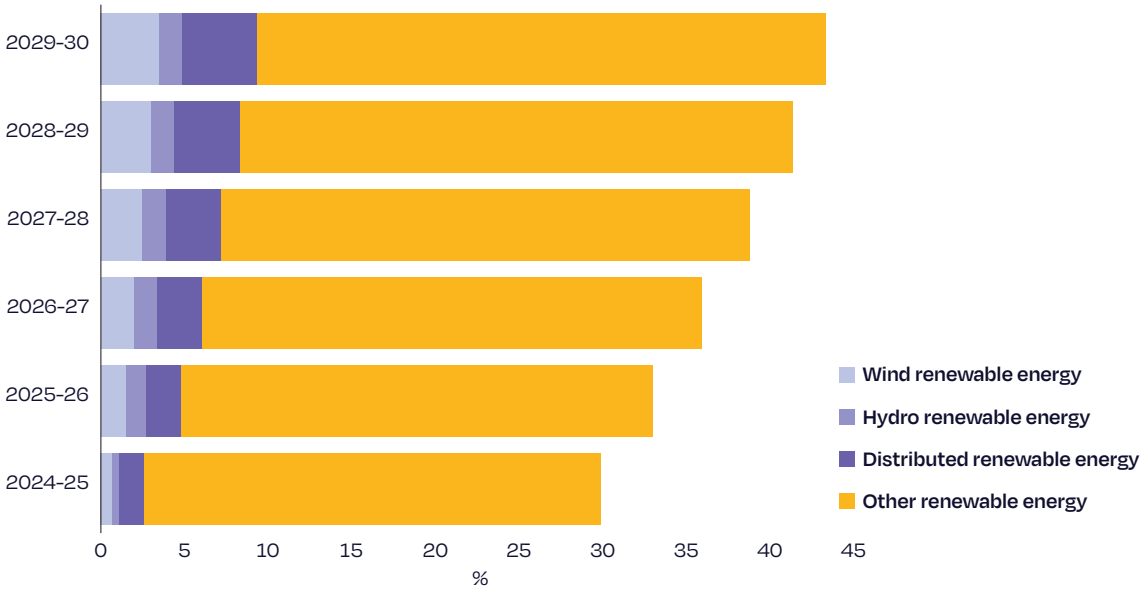
Year	Wind Renewable Energy (%)	Hydro Renewable Energy (%)	Distributed Renewable Energy (%)	Other Renewable Energy (%)	Total Renewable Energy (%)
2024-25	0.67	0.38	1.5	27.35	29.91
2025-26	1.45	1.22	2.1	28.24	33.01
2026-27	1.97	1.34	2.7	29.94	35.95
2027-28	2.45	1.42	3.3	31.64	38.81
2028-29	2.95	1.42	3.9	33.1	41.36
2029-30	3.48	1.33	4.5	34.02	43.33

The Energy Conservation Act, 2001, as amended by the Energy Conservation (Amendment) Act, 2022, complements the RPO framework by empowering the Central Government to mandate a minimum share of energy consumption from non-fossil resources for designated consumers. This provision enables the government to set differentiated consumption targets based on resource types and consumer categories. Together, these frameworks reinforce India's clean energy transition by promoting renewable energy adoption, reducing reliance on fossil fuels, and ensuring a structured path towards sustainable energy development.

Obligated entities, which include DISCOMs , open access consumers, and captive power producers, can fulfil their RPO requirements through self-generation of renewable energy, power purchase agreements with RE developers, or by acquiring RECs. This framework has played a crucial role in driving renewable energy deployment, enhancing energy security, and supporting India's clean energy transition.

Figure 41

India Renewable Purchase Obligations (RPO) trajectory 2024-2030



Source: Press Information Bureau, MNRE, Government of India

The RPO trajectory provides a structured framework to accelerate renewable energy adoption in India by mandating a steadily increasing share of wind, solar, and hydro power in total electricity consumption. The rising targets are compelling DISCOMs, open-access consumers, and captive power producers to procure renewable energy, thereby driving large-scale solar and wind deployment.

With the 2023 RPO revision, solar is now part of the "Other Renewable Energy" (Other RE) category, emerging as the dominant source due to its scalability, cost-effectiveness, and strong policy backing. Unlike wind, biomass, and small hydro, solar benefits from lower constraints, falling costs, and initiatives like PM-KUSUM, PLI, and ISTS charge waivers. Its predictable generation, hybrid integration, and growing market adoption further strengthen its lead in meeting RPO targets.

The Other RE component in the revised RPO framework includes non-solar renewable sources such as wind, hydro, biomass, and waste-to-energy.

Inter-State Transmission Systems (ISTS) waivers

To accelerate the adoption of renewable energy, particularly in states with high renewable energy potential, the Indian government introduced a waiver on Inter-State Transmission System (ISTS) charges and losses for solar and wind power projects in 2016. This policy aimed to facilitate the seamless transfer of renewable energy across state borders, making it more economically viable for states with lower renewable energy generation to procure power from resource-rich states. Recently, the ambit of the waiver has been widened for green hydrogen, large hydro plants, pumped storage plants (PSP) and battery storage (BESS).

By eliminating inter-state transmission charges, the policy reduced the overall cost of renewable energy, incentivising zing large-scale project development and increasing inter-state trade of green power. This initiative has played a crucial role in enhancing grid integration, improving renewable energy accessibility, and supporting India's ambitious renewable energy targets. The waiver is set to be rolled back in a phase wise manner starting June 2025.

Table 2

ISTS charges for solar, wind, hydro & bess

S.No.	Period of commissioning	Inter-state transmission charges
1	01.07.2025 to 30.06.2026	25% of the applicable ISTS charges
2	01.07. 2026 to 30.06.2027	50% of the applicable ISTS charges
3	01.07.2027 to 30.06.2028	75% of the applicable ISTS charges
4	From 01.07.2028	100% of the applicable ISTS charges

Table 3

ISTS charges for green hydrogen and green ammonia

S.No.	Period of commissioning	Inter-state transmission charges
1	01.01.2031 to 31.12.2031	25% of the applicable ISTS charges
2	01.01.2032 to 31.12.2032	50% of the applicable ISTS charges
3	01.01.2033 to 31.12.2033	75% of the applicable ISTS charges
4	From 01.12.2034	100% of the applicable ISTS charges

Grid energy corridors

Grid energy corridors are dedicated transmission networks designed to facilitate the seamless integration and transfer of renewable energy, particularly from generation hubs to consumption centers. These corridors play a crucial role in addressing transmission bottlenecks, reducing curtailment, and ensuring the efficient flow of clean energy across regions.

A key initiative under this framework is the Green Energy Corridor (GEC), a government-backed programme aimed at strengthening intra-state and inter-state transmission infrastructure to support the large-scale integration of renewable energy. The GEC is designed to evacuate power from renewable energy zones and improve grid stability by enhancing connectivity between renewable-rich states and high-demand regions.

By enabling the smooth transmission of solar power from states like Rajasthan, Gujarat, and Madhya Pradesh to power-deficit areas, grid energy corridors will be instrumental in accelerating solar adoption. Their integration with battery storage and hybrid renewable energy projects will further enhance grid reliability, reducing the impact of solar intermittency. Supported by policies like the ISTS waiver, these corridors will drive cost-effective solar power trade and reinforce India's transition towards a clean energy-driven economy.

Firm dispatchable renewable energy & integration of storage

Firm and Dispatchable Renewable Energy (FDRE) refers to renewable energy systems capable of supplying consistent and reliable power on demand. Unlike traditional renewable sources like solar and wind, which are dependent on weather conditions, FDRE systems are designed to maintain steady power output. This is achieved through strategies such as integrating energy storage systems (e.g., batteries or pumped hydro), hybrid setups combining multiple renewable sources, and flexible generation units like bioenergy plants. These features ensure grid stability, reduce power fluctuations, and enhance the reliability of renewable energy supply.

To further align with FDRE principles, the Indian government has mandated that all solar tenders issued by Renewable Energy Implementing Agencies (REIAs) and state utilities must now include a two-hour energy storage system (ESS) with a capacity equivalent to 10% of the installed solar capacity. This ensures solar energy can be stored and dispatched as needed, strengthening grid reliability and improving power supply stability. This initiative is projected to contribute approximately 14 GW/28 GWh of storage capacity by 2030, supporting India's efforts to expand its renewable energy infrastructure.

FDRE plays a vital role in balancing energy supply and demand, mitigating renewable energy variability, and reducing reliance on fossil fuel-based backup power. To promote FDRE adoption, the Indian government has introduced initiatives like Renewable Energy with Storage (RE+Storage) tenders and Round-the-Clock (RTC) power supply contracts, encouraging developers to provide firm and dispatchable renewable power.

By integrating FDRE solutions, India aims to strengthen its renewable energy infrastructure while ensuring a stable and reliable power supply for consumers.

Distributed solar development

Rooftop solar

The Government of India announced a dedicated Scheme for accelerating Rooftop Solar Installations on 22nd January 2024. The Scheme, named Pradhan Mantri Surya Ghar: Muft Bijli Yojana, has reoriented existing benefits for consumers installing solar rooftop installations to maximise benefits from the installations. The programme has a financial outlay of 75,000 crore INR and is set for implementation until FY 2026-27. The programme is overseen by the National Programme Implementation Agency (NPIA) under the Ministry of New and Renewable Energy (MNRE). The State Implementation Agencies (SIAs), including DISCOMs and Power/Energy Departments, are responsible for execution at the state level.

The Scheme targets installation of Solar rooftop in "10 million Indian Households" along with Solarising all Government buildings as well as a majority of Commercial and Industrial establishments.

Figure 42

India estimated rooftop solar capacity installation 2024-2026

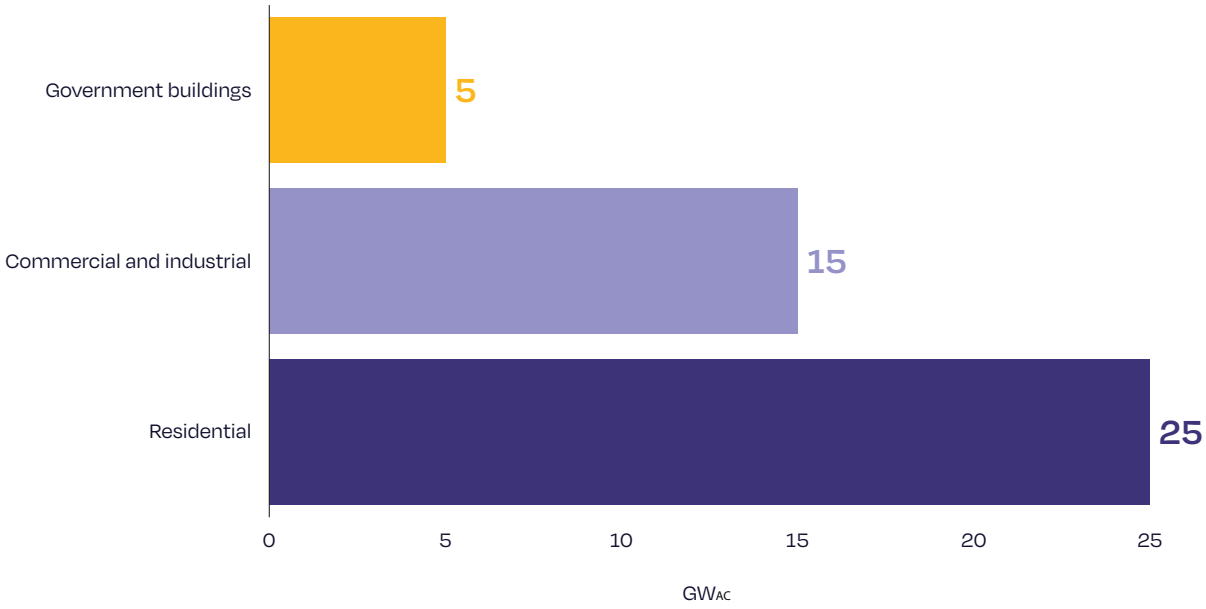


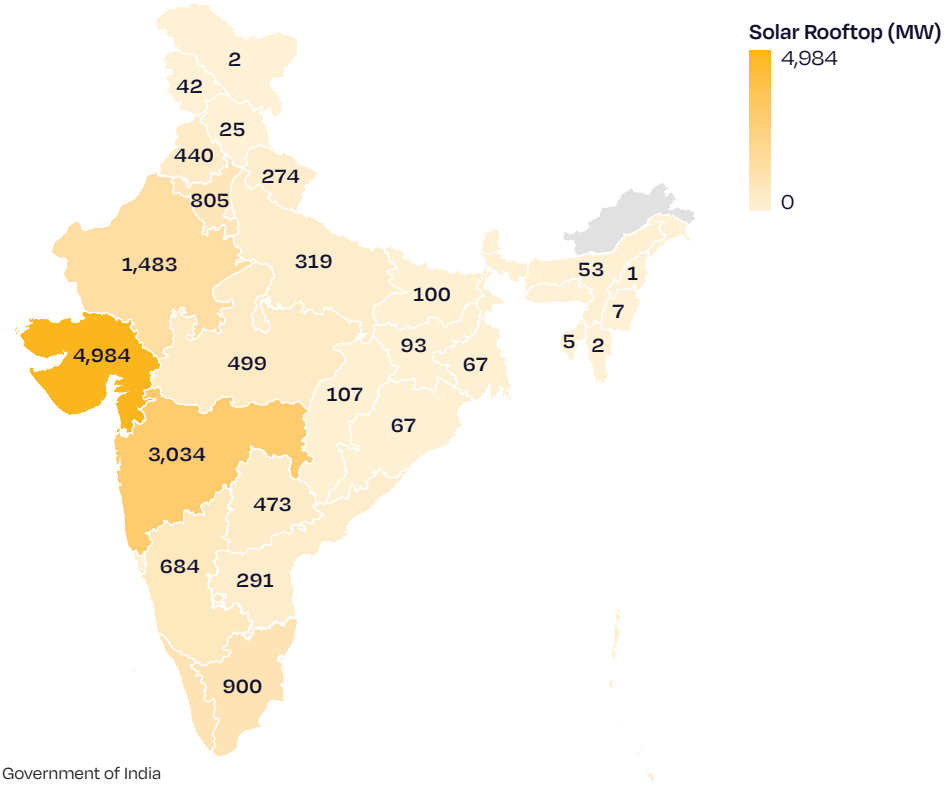
Table 4

Subsidy structure: financial programme support for residential solar installations

Category	Subsidy Amount
For systems up to 2 kW	INR 30,000 per kW
For additional capacity up to 3kW	INR 18,000 per kW
For systems larger than 3 kW	Total subsidy capped at INR 78,000

Figure 43

State-wise installed rooftop solar capacity



Source: MNRE, Government of India

Solar pumps

The PM-KUSUM Scheme, launched in 2019 by the Ministry of New and Renewable Energy (MNRE), aims to promote solar energy adoption among farmers, reduce dependence on grid power, and enhance their energy security. It supports decentralised renewable energy and helps in the de-dieselisation of the agricultural sector.

Table 5

Scheme components

Component	Details	Key Benefits
Component A	Decentralised Grid-Connected Renewable Energy Power Plants (10,000 MW)	Farmers, FPOs, and cooperatives can install 500 kW – 2 MW solar plants on barren land. Energy is sold to DISCOMs, ensuring income.
Component B	Standalone Solar Agriculture Pumps (17.5 Lakh Pumps)	Support solar pump installation (up to 7.5 HP) in off-grid areas to replace diesel pumps. Reduces fuel dependence and irrigation costs.
Component C	Solarisation of Grid-Connected Agriculture Pumps (10 Lakh Pumps)	Farmers can use solar power for irrigation and sell surplus energy to DISCOMs, creating an additional income source.

Table 6

Component A: Procurement-Based Incentive (PBI) for DISCOMs

Aspect	Details
Beneficiary	DISCOMs (Distribution companies)
Incentive rate	INR 0.40 per kWh or INR 6.60 lakh per MW per year (whichever is lower)
Duration	First five years
Provided by	Ministry of New and Renewable Energy (MNRE)
Objective	Encourages DISCOMs to purchase power from solar plants under Component A, ensuring financial viability.

Table 7

Scheme components

Category	Central Government Assistance (CFA)	State Government Support	Farmer's Share
General States	30%	30%	40%
Special Category States (North-Eastern States, Sikkim, Jammu & Kshmir, Himachal Pradesh, Uttarakhand, Lakshadweep, and Andaman & Nicobar Islands	50%	30%	20%

Table 8

Progress of PM-KUSUM as on 28.02.2025

Component	Details	Sanctioned	Installed
Component A	Solar Capacity (MW)	10,000 MW	430.98 MW
Component B	Standalone Pumps (No.)	12,29,157	7,25,575
Component C	Individual Pump Solar (IPS) – Pumps (Nos.)	95,308	5,387
Component C	Feeder Level Solar (FLS) – Pumps (Nos.)	35,70,874	2,44,589

C&I solar – green energy open access

The Green Energy Open Access Rules, 2022 represent a significant step in India's efforts to reduce carbon emissions by 45% in alignment with its updated Nationally Determined Contribution (NDC) target for 2030. These rules are expected to accelerate the adoption of renewable energy while substantially lowering power costs, promoting a greener and more affordable energy landscape for consumers.

The Green Energy Open Access Rule facilitates the generation, procurement, and consumption of green energy, including power generated from waste-to-energy plants, through the open access mechanism. These rules enable consumers – such as industries, businesses, and other bulk power users – to directly source renewable energy from generators, thereby reducing reliance on traditional distribution companies (DISCOMs).

To ensure a streamlined and transparent process, the Green Open Access Registry has been established as a centralised digital platform for managing long-term, medium-term, and short-term open access transactions. This platform will facilitate the seamless integration of green energy into both inter-state transmission systems (ISTS) and intra-state transmission systems (InSTS).

Designed to enhance transparency and efficiency in green energy procurement, the registry will be accessible to all stakeholders in the Indian power market, including power generators, consumers, transmission operators, and regulatory bodies.

Table 9

Key Features of Green Open Access Rule

Feature	Description
Promotion of Green Energy	Encourages the generation, purchase, and consumption of renewable energy, including power from waste-to-energy plants.
Reduced Open Access Threshold	Lowers the minimum transaction limit from 1 MW to 100 kW, allowing small consumers to access green energy.
Right to Green Power Supply	Consumers can demand renewable energy from DISCOMs, which are obligated to procure and supply green power.
Simplified and Time-Bound Approvals	Ensures a transparent and streamlined process through a national portal. Approval must be granted within 15 days, or it is deemed automatically approved.
Voluntary Purchase for Commercial & Industrial Consumers	Businesses and industries can opt-in voluntarily for green power to support sustainability.
Clarity on Open Access Charges	Defines applicable charges, including transmission charges, wheeling charges, cross-subsidy surcharge, standby charges (if applicable), banking charges, and regulatory fees.
Incentives for Green Energy Adoption	Caps cross-subsidy surcharges and removes additional surcharges to encourage renewable energy use.
Uniform Renewable Purchase Obligation (RPO)	Establishes a standardised RPO for all obligated entities under a distribution licencee. Green Hydrogen and Green Ammonia can be used for RPO fulfilment.
Green Certificates for Consumers	Consumers using green power will receive Green Certificates as proof of their renewable energy consumption.

India solar PV manufacturing

In 2024, India's solar manufacturing industry achieved an annual production capacity of 60 GW, solidifying the country's position as a global leader in solar manufacturing. With sustained policy support and strategic investments, India is on course to expand its solar module production capacity to 100 GW by 2030, further strengthening its role in the global renewable energy landscape. Salient initiatives driving solar manufacturing development in India are:

Import tariffs: The Basic Custom Duties (BCD) for solar cells and modules are 20% and 40%, respectively. This aims to make domestic manufacturing more competitive, reducing reliance on imports and fostering local industry growth.

Approved List of Models and Manufacturers (ALMM): Government of India's ALMM aims to verify the quality and technical capabilities of Solar manufacturing facilities across the country. Only solar PV modules included in this government-approved list can be used in various solar projects, ensuring quality control and adherence to specific standards.

The Ministry of New and Renewable Energy (MNRE) has introduced an amendment to the Approved Models and Manufacturers of Solar Photovoltaic Modules (ALMM) Order, 2019, which will take effect on 1 June 2026. This amendment introduces List-II, a dedicated list for approved solar PV cell manufacturers. Moving forward, all solar PV modules used in government-supported projects, net-metering systems, and open access renewable initiatives must source cells from this approved list. This initiative aims to enhance quality standards, support domestic manufacturing, and promote India's energy self-reliance.

In addition to ALMM, the government has introduced the **Approved List of Cell Manufacturers (ALCM)** to further promote domestic manufacturing and reduce reliance on imports. The ALCM mandates the use of approved solar cell manufacturers for designated projects, reinforcing India's commitment to self-reliance in the renewable energy sector.

6 MW solar project, Vengaimandalam, Trichy, Tamil Nadu, India

Domestic Content Requirement (DCR): DCR was introduced in 2010 with the launch of India's National Solar Mission. The policy was reinstated in 2018 for CPSU (Central Public Sector Undertaking) and extended to schemes where central subsidy is provided, like in the case of PM Kusum and the PM Surya Ghar Muft Bijli Yojana rooftop scheme. DCR mandates the use of domestically manufactured solar components in solar projects subsidised by the Government of India, including residential rooftop and Solar pumps and feeder-level solarisation projects, further strengthening the domestic industry and reducing dependence on external factors. This strategy aligns with India's ambitious renewable energy goals, where solar PV plays a crucial role.

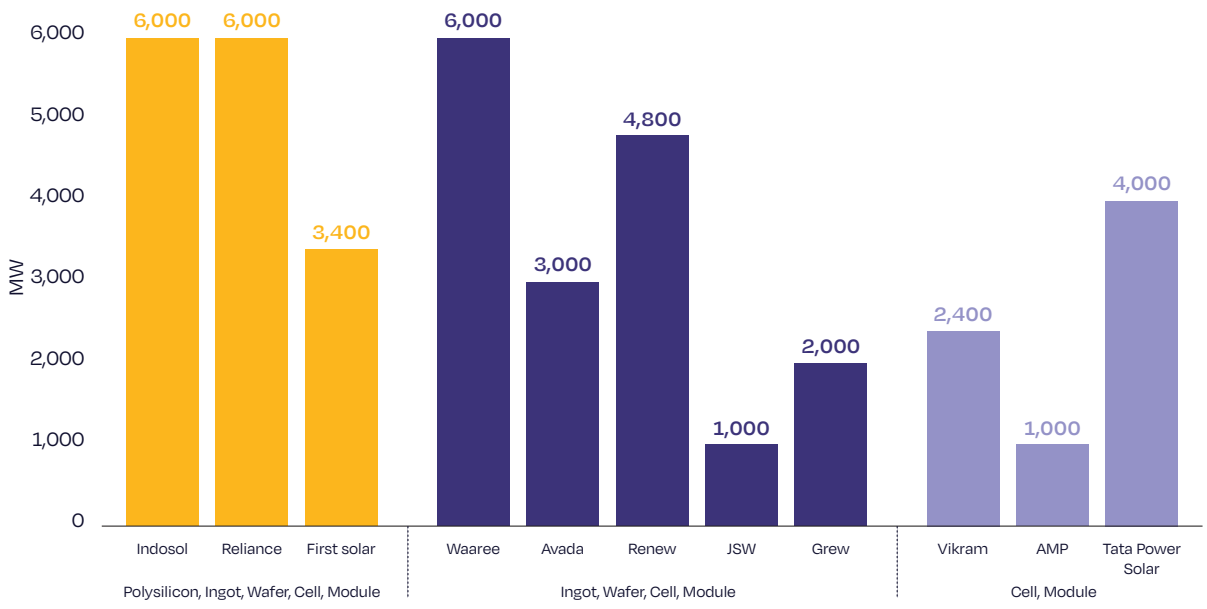
Production Linked Incentive (PLI) Scheme: India launched the National Programme on High-Efficiency Solar PV Modules in 2021 in two tranches, aiming to significantly boost domestic manufacturing capacity through a 24,000 crore INR (3 billion USD). This initiative incentivises the production and selling of high-efficiency solar panels via Production Linked Incentives (PLI) for selected manufacturers. The programme seeks to build a robust domestic ecosystem for solar manufacturing, introduce cutting edge technologies, and promote integrated plants for better quality control. Additionally, it encourages local material sourcing and fosters job creation, aligning with India's goals of economic growth, technological self-sufficiency, and clean energy transition.

Tranche I (2021): With an initial investment of 4,500 crores INR (520 million USD), this tranche awarded contracts for 8,737 MW manufacturing capacity, strengthening India's solar ambitions.

Tranche II (2023): A further 19,500 crores INR (2.3 billion USD) has been allocated and 39,600 MW of manufacturing capacity planned through selected bidders. This positions India as a frontrunner in clean energy manufacturing.

Figure 44

Leading Solar Companies in India under PLI Scheme Tranche 2



Source: MNRE, Government of India

Solar manufacturing projection

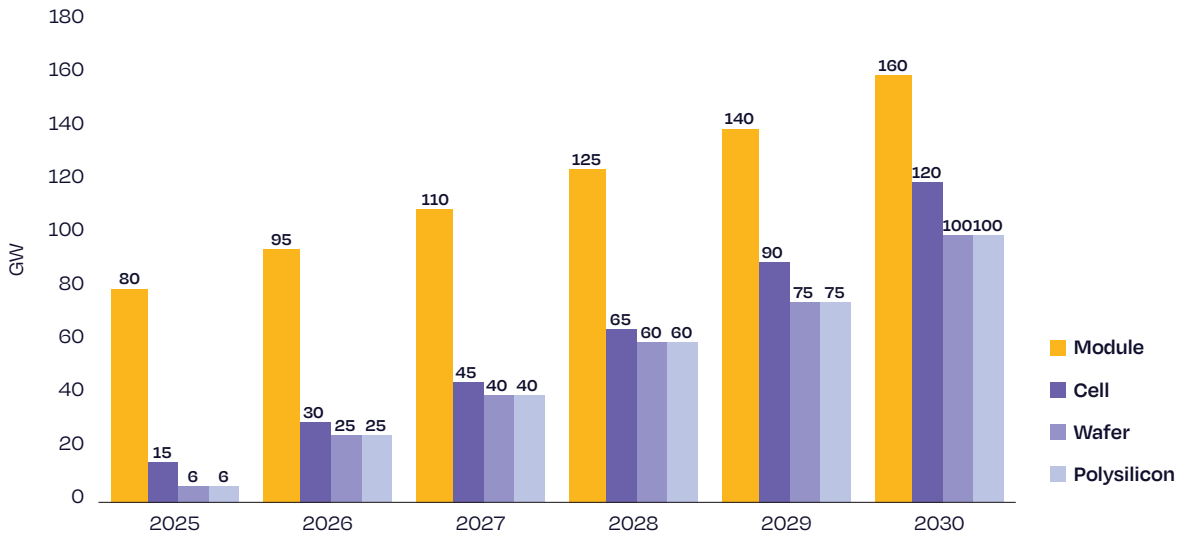
The graph below presents India's projected growth in solar manufacturing capacity from 2025 to 2030 across four key components: Modules, Cells, Wafers, and Polysilicon.

- Module capacity is set to increase significantly from 80 GW in 2025 to 160 GW by 2030, demonstrating steady expansion.
- Cell capacity is projected to rise from 15 GW to 120 GW, indicating robust growth.
- Wafer and Polysilicon capacities are expected to expand from 6 GW in 2025 to 100 GW by 2030, reflecting strategic efforts to strengthen domestic production.

This projected growth underscores India's strong focus on scaling its solar manufacturing capabilities, aligning with its renewable energy ambitions and reducing reliance on imports.

Figure 45

India annual solar manufacturing demand projection 2025-2030



Source: NSEFI

India solar PV installation forecast

India's solar energy landscape reflects significant growth, with 102.57 GW of operational solar capacity actively contributing to the grid as of February 2025. Additionally, 84.10 GW of projects are under implementation, while 47.49 GW have been tendered and await finalization. This brings the total solar pipeline under development to 231.91 GW.

In the hybrid renewable projects, which integrate solar, wind, and storage, 39.78 GW of projects are under development, and 24.90 GW are tendered but pending contract awards, resulting in a total hybrid capacity of 64.67 GW.

India's increasing energy demand, driven by rapid industrialisation, urbanisation, and its commitment to achieving Net Zero emissions by 2070, is anticipated to significantly boost the adoption of solar energy in the coming years. Considering the current growth trajectory and ongoing supportive measures, the country's installed solar photovoltaic (PV) capacity is projected to reach between **275 GW** and **310 GW** by the year 2029.

This projection accounts for two possible scenarios:

1. **Low-Growth Scenario:** This reflects slower progress due to potential policy delays, financial constraints, or infrastructure challenges that may hinder solar expansion.

The graph below outlines India's projected solar PV capacity growth from 2025 to 2030 under a low-growth scenario, considering potential policy delays and financial constraints.

India's solar capacity is projected to rise from 118.5 GW in 2025 to 280 GW by 2030, marking a more than a 2.3x increase over five years. Ground-mounted solar will remain the primary driver of capacity additions, while rooftop solar is expected to show steady growth. Hybrid solar projects are anticipated to expand significantly from 2027 onward, and off-grid solar will continue to play a vital role, especially in rural electrification efforts.

2. **High-Growth Scenario:** This envisions accelerated growth supported by proactive policy frameworks, increased investments, and advancements in solar technology that facilitate faster deployment.

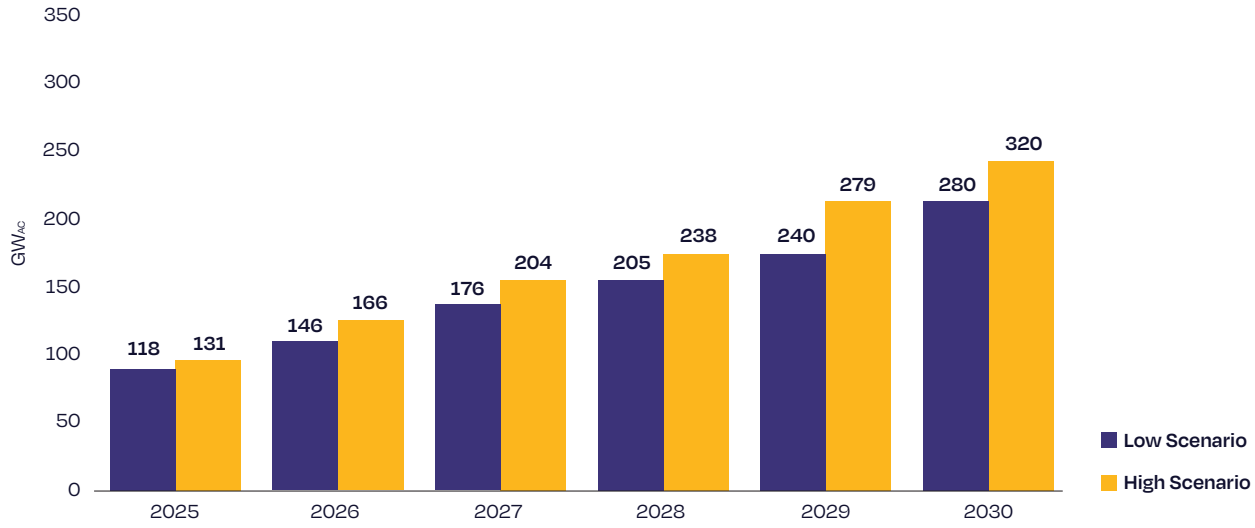
The graph below depicts India's projected solar PV capacity growth under a high-growth scenario, driven by supportive policies and increased investments.

India's solar capacity is projected to grow significantly, increasing from 131 GW in 2025 to 320 GW by 2030, reflecting a nearly 2.5x growth in five years. Ground-mounted solar will remain the primary contributor to this expansion. Meanwhile, rooftop and hybrid solar projects are expected to witness steady growth, particularly from 2027 onward. Additionally, off-grid solar will continue to play a crucial role in supporting remote and underserved regions.

Overall, India's solar energy outlook remains positive, with ambitious targets aligning closely with its broader energy transition and sustainability goals.

Figure 46

India cumulative installed capacity scenarios 2025-2030



Source: NSEFI

Way forward

India has rapidly reshaped its energy sector, establishing itself as a pioneer in solar power and driving the momentum of the renewable energy revolution.With ambitious targets, strong policy frameworks, and a rapidly growing solar capacity, the country is on a decisive path toward achieving its clean energy goals.

India's journey toward net zero, decarbonization, and energy transition requires a concerted effort from policymakers, industry leaders, and stakeholders across the renewable energy ecosystem. NSEFI continues to play a pivotal role in shaping policy interventions that drive large-scale solar deployment, strengthen domestic manufacturing, and enhance grid stability, all while ensuring a balanced and investment-friendly regulatory framework.

NSEFI is India's leading Renewable Energy policy advocacy body for the past 12 years and is the world's 4th largest Solar Association. NSEFI has evolved as an umbrella organization representing renewable energy (RE) companies that are active along the whole RE value chain including Solar PV, Energy Storage, Wind Energy, Green Hydrogen industries comprising of leading International, National, and regional companies including Developers, Manufacturers, EPC Contractors, Installers, System Integrators, Small and Medium Enterprises.

To accelerate the clean energy transition, expanding grid infrastructure through Green Energy Corridors, extending ISTS waivers, streamlining open access regulations, and ensuring clarity in rooftop solar policies will be essential. Strengthening domestic solar manufacturing through strategic refinements in PLI and ALMM policies, along with targeted incentives for PV recycling and Agrivoltaics, will not only boost self-reliance but also position India as a global leader in solar technology and supply chains.

Key NSEFI Initiatives include Ghar Ke Upar, Solar is Super: NSEFI developed a pan India solar rooftop awareness program called "Ghar Ke Upar Solar is Super" to raise awareness among ordinary citizens, residential households and local officials about the benefits of solar rooftop installations.

Launched in 2022, this campaign reached more than 1 million citizens in 30 Indian cities, and aims to reach 10 million citizens by 2027.

India Agrivoltaics Alliance (IAA): The India Agrivoltaics Alliance (IAA) is an initiative aimed at increasing awareness and promoting colocation of solar energy and agriculture in India. Through IAA, NSEFI and other like-minded organizations from energy and agriculture sectors are actively engaging with farmers and policy makers for accelerating agrivoltaics installations across India.

Women in Solar Energy (WISE): WISE is an initiative by NSEFI to empower women in Renewable Energy. It aims to enhance women's participation across the clean energy value chain by providing mentorship, networking, and leadership opportunities.

WISE advocates for gender-inclusive policies, workplace equity, and capacity-building programmes to bridge the gender gap in the sector.

NSEFI Green Data Center Coalition: The Green Data Center Coalition is the single largest platform for all aspects around decarbonization of data centers in India.

The Coalition comprises key stakeholders from the Data Center Industry as well as Renewable Energy Sector for advocating policies and regulations at both central and state level to promote Green Data Centers across the country.

A harmonized and forward-looking approach supported by stable policies, industry-driven solutions, and collaborative governance will be crucial in ensuring that India meets its renewable energy targets, accelerates its decarbonization efforts, and cements its leadership in the global solar transition.

GW-scale solar markets

In 2024, 35 countries installed over 1 GW of new solar capacity, up from 31 in 2023. This growth highlights the accelerating global adoption of solar power, with our forecasts predicting more countries joining soon, as we expect 45 GW markets in 2025. In the EU-27, which is featured as a whole, the number of GW markets rose to 16 in 2024. In this chapter, national solar associations from countries that installed over 1 GW in the past year share their expert insights on local market dynamics.

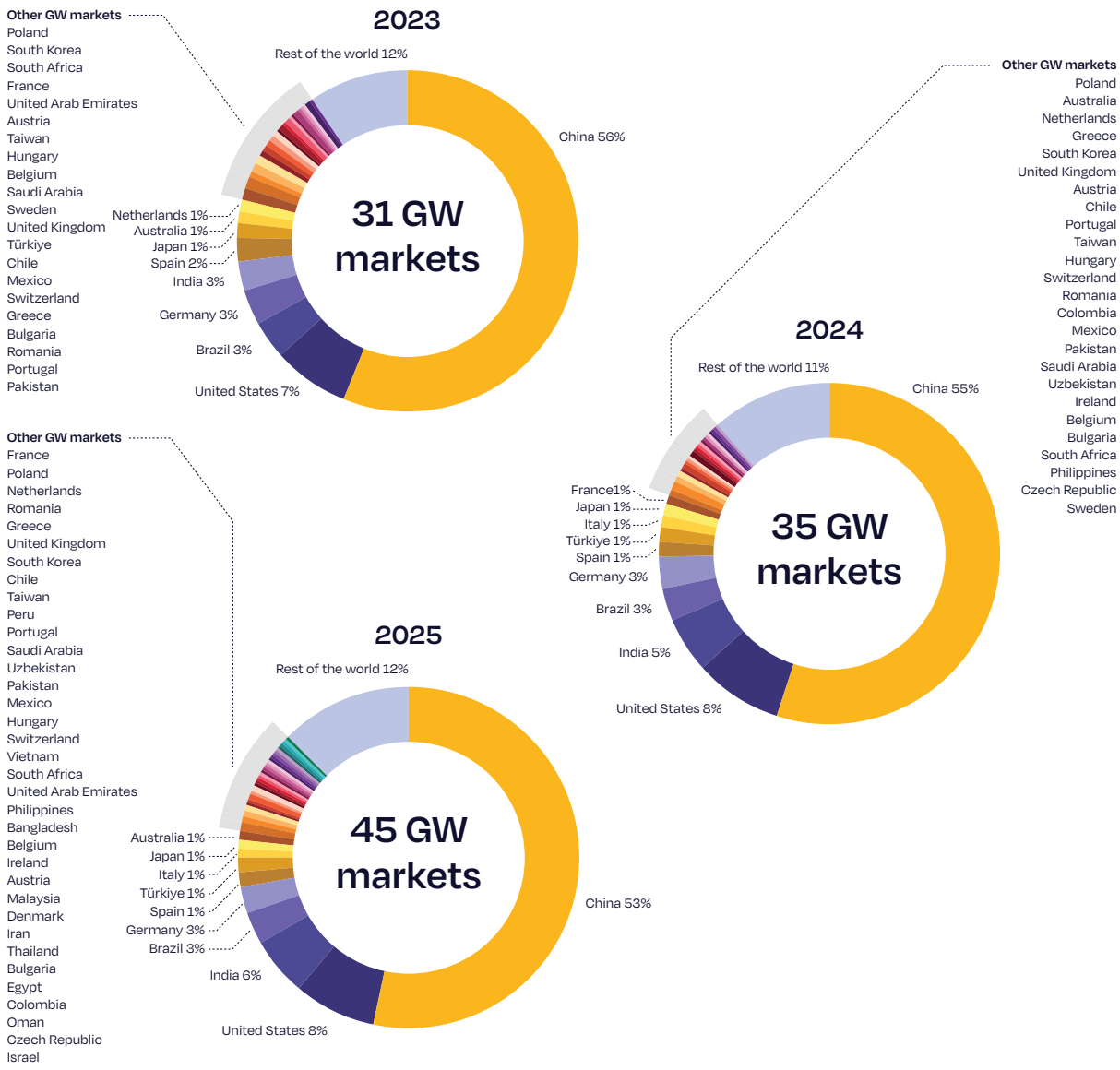
4.0 GW-scale solar markets

In 2024, 35 countries across the world installed more than 1 GW of new solar capacity. That's four more than in 2023, when 31 countries reached this level (see Fig. 47). The new countries to join the group are Colombia, the Philippines, Uzbekistan, Ireland, and the Czech Republic, while the United Arab Emirates (UAE), which reached the GW scale in 2023, did not make it back in 2024.

The rising number of countries in this GW markets chapter illustrates the rise in global uptake of solar and its continued momentum, reaching more and more citizens around the world. One GW of solar PV capacity is enough to power 300,000 homes on average in the EU. According to our Medium Scenario forecast, this upward trajectory will accelerate in 2025, as we anticipate 10 more countries will join the group with a total of 45 GW-scale markets.

Figure 47

GW-scale solar PV markets 2023-2025



As in previous editions of the Global Market Outlook, we've invited national solar associations from countries that installed over 1 GW in the past year to share their expert insights on local market dynamics – perspectives that occasionally differ from our own consolidated estimates, which are based on several sources. Many of these associations, like SolarPower Europe, are active members of the Global Solar Council (GSC), a longstanding partner of the Global Market Outlook.

The number of GW markets in the European Union keeps increasing, growing from 12 GW markets in 2022 to 14 in 2023 and 16 in 2024. The EU-27 block is featured below as a whole, ranking #2 in terms of combined annual installed capacity – only European countries outside the EU are featured individually. A detailed analysis of each EU GW market according to our national association members is available in our latest EU Market Outlook for Solar Power, published in December 2024.

Table 10

GW-scale solar markets

No.	Country and national industry associations
1.	**China** – China Photovoltaic Industry Association (CPIA)
2.	**EU-27** – SolarPower Europe
3.	**United States** – Solar Energy Industries Association (SEIA)
4.	**India** – National Solar Energy Federation of India (NSEFI)
5.	**Brazil** – Brazilian Photovoltaic Solar Energy Association (ABSOLAR)
6.	**Türkiye** – Turkish Solar Energy Association (GÜNDER)
7.	**Japan** – Japan Photovoltaic Energy Association (JPEA)
8.	**Australia** – Smart Energy Council (SEC)
9.	**South Korea** – Korea Institute of Energy Research (KIER)
10.	**United Kingdom** – Solar Energy UK (SEUK)
11.	**Chile** – Chilean Solar Association (ACESOL)
12.	**Taiwan** – Taiwan Photovoltaic Industry Association (TPVIA)
13.	**Switzerland** – Swissolar
14.	**Colombia** – SolarPower Europe
15.	**Mexico** – Mexican Association of Solar Energy (Asolmex)
16.	**Pakistan** – Pakistan Solar Association (PSA)
17.	**Saudi Arabia** – Middle East Solar Industry Association (MESIA)
18.	**Uzbekistan** – SolarPower Europe
19.	**South Africa** – South African PV Industry Association (SAPVIA)
20.	**Philippines** - Philippine Solar and Storage Energy Alliance (PSSEA)

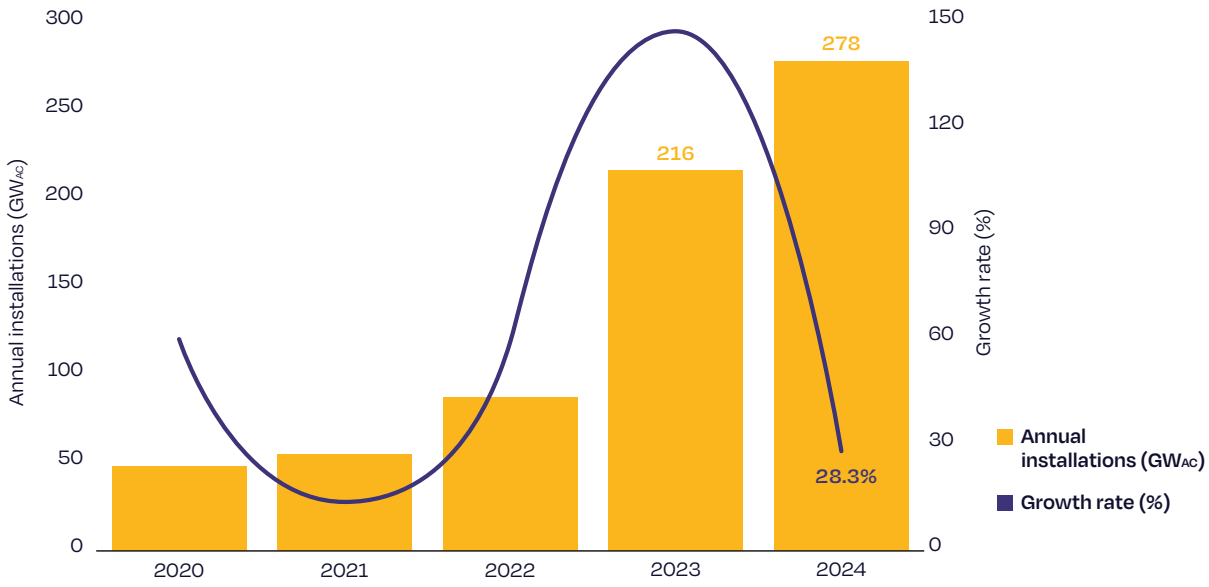
4.1 China

Overview of PV developments

In 2024, with the grid connection of major large-scale base projects in multiple regions across the country, China's new PV installations reached a historic high of 278 GW_{AC},[3] a year-on-year increase of 28% (GW Fig. 1.1). By the end of 2024, China's cumulative PV installed capacity reached 886 GW_{AC}. Solar PV remains the second-largest power source and plays a crucial role in the country's power energy structure.

GW Figure 1.1

China annual solar PV installed capacity 2020-2024



Source: CPIA

National targets for solar PV

The year 2025 marks the final year of China's 14th Five-Year Plan (FYP), which is crucial for achieving the 14th FYP targets and laying a solid foundation for a successful start to the 15th FYP. On 27 February, 2025, the National Energy Administration released the "2025 Energy Work Guidance," outlining the key goals for new national energy development in 2025. These goals include:

- adding over 200 GW_{AC} of new power generation capacity;
- increasing the proportion of non-fossil energy power generation to around 60%;
- raising the share of non-fossil energy in total energy consumption to approximately 20%.

3 Capacity values in this article are expressed in AC

The Guidance also focuses on promoting renewable energy application in key sectors such as industry, transportation, and construction, and on further improving policies related to new energy consumption and regulation. It aims to establish a robust policy framework to support green and low-carbon development. Additionally, the Guidance seeks to maintain a reasonable utilisation rate of PV power generation, enhance the comprehensive benefits of PV-based sand control, and initially establish a unified national power market system.

Key drivers for solar growth

China's carbon peak and carbon neutrality goals have positioned PV energy as a core driver of the energy transition. The country has been consistently reviewing and updating policies to accelerate the industrial upgrading.

In November 2024, the Ministry of Industry and Information Technology issued the 'Photovoltaic Manufacturing Industry Standards (2024 Edition),' which raises standards and regulations for the manufacturing sector, guiding PV companies to focus on technological innovation and promoting high product quality.

Since the beginning of 2025, the National Energy Administration has issued several key documents, including the 'Management Measures for the Development and Construction of Distributed PV Power Generation' and the 'Notice on Deepening the Market-oriented Reform of New Energy Feed-in Tariffs to Promote High-Quality Development of New Energy.' The former introduces standardised management practices for distributed PV projects, aiming to drive both quantitative growth and qualitative improvement in distributed PV power generation. The latter seeks to fully integrate PV power generation into the market, accelerate the construction of a unified national power market, and provide crucial support for the high-quality development of PV power generation.

300 MW solar project, Ningbo, Zhejiang province, China

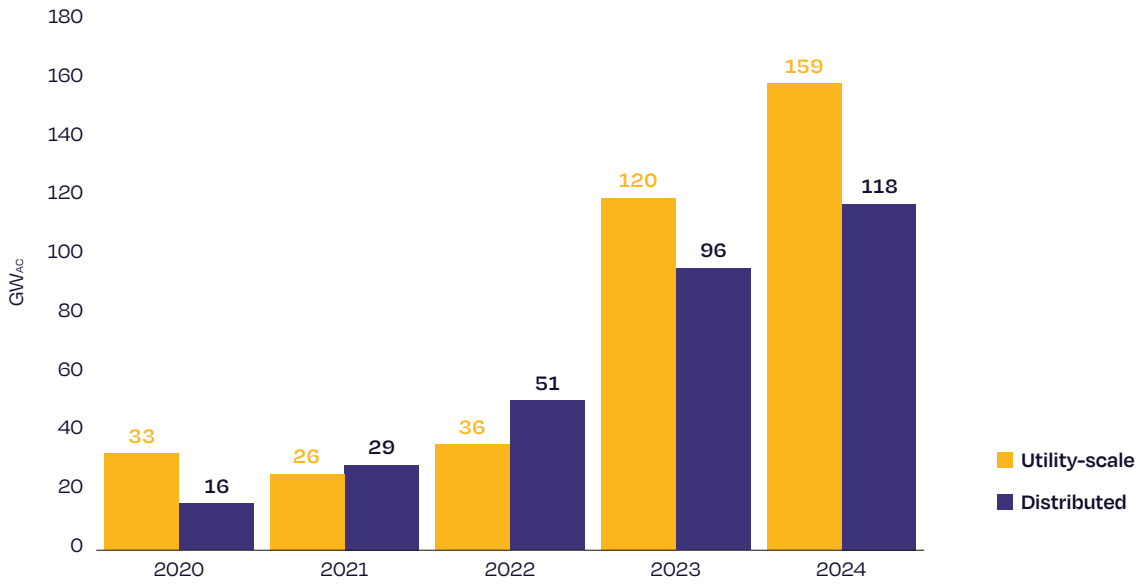
The growing demand for electricity is another significant driver of China's PV market growth. In 2024, China's economy maintained steady growth, with electricity consumption increasing by 6.8%. Given China's plans to increase infrastructure investment, stabilise economic growth, and continue addressing extreme weather conditions, electricity demand is expected to continue growing at a moderate pace in 2025 and the near future.

Utility-scale vs. distributed solar PV

In 2024, China's utility-scale PV installations amounted to 159 GW_{AC}, a year-on-year increase of 33%, while distributed PV installations contributed 118 GW_{AC}, up 23% (GW Fig. 1.2). Among distributed PV projects, the residential sector added 30 GW_{AC}, a year-on-year decrease of 23%, while the C&I sector added 89 GW_{AC}, up 68%.

GW Figure 1.2

China comparison of annual utility-scale and distributed PV installations 2020-2024



Source: CPIA

Market challenges

The rapid expansion of new energy installations in China has brought significant challenges to grid connection and regulation. In some regions, the surge in new energy installations has outpaced the grid capacity growth pace, making it difficult to accommodate large-scale connections. Additionally, as PV power enters the electricity market, spot settlement prices in many provinces are witnessing a downward trend, leading to increased revenue volatility.

Outlook for 2025-2030

The China Photovoltaic Industry Association forecasts that from 2025 to 2030, China's annual PV installations will remain at a high level of over 200 GW_{AC}, with installations in 2025 expected to range between 215 GW_{AC} and 255 GW_{AC}. Although this figure is lower than for 2024, it is still a substantial amount of growth. This projection is based on the increased complexity of electricity revenue calculations and the heightened uncertainty in investment expectations, driven by the introduction of two major policies as mentioned above at the beginning of 2025. However, this situation is expected to be only temporary.

In the long term, China's PV market still has significant room for growth. First, the new policies have a relatively small impact on large-scale base projects and are conducive to flexible mobilisation of market resources, which supports high-quality industry development in the long run. Second, the expansion of new electricity consumption scenarios – such as new energy vehicles, data centres, and 5G applications – will continue to drive up electricity demand, creating new growth opportunities for the domestic PV market. Third, ongoing technological advancements will further reduce the LCOE for PV power generation, enhancing the economic viability of emerging applications like PV-storage integration and PV-powered hydrogen production. Collectively, these factors will help sustain the growth of China's PV market.

Author: *China Photovoltaic Industry Association (CPIA)*

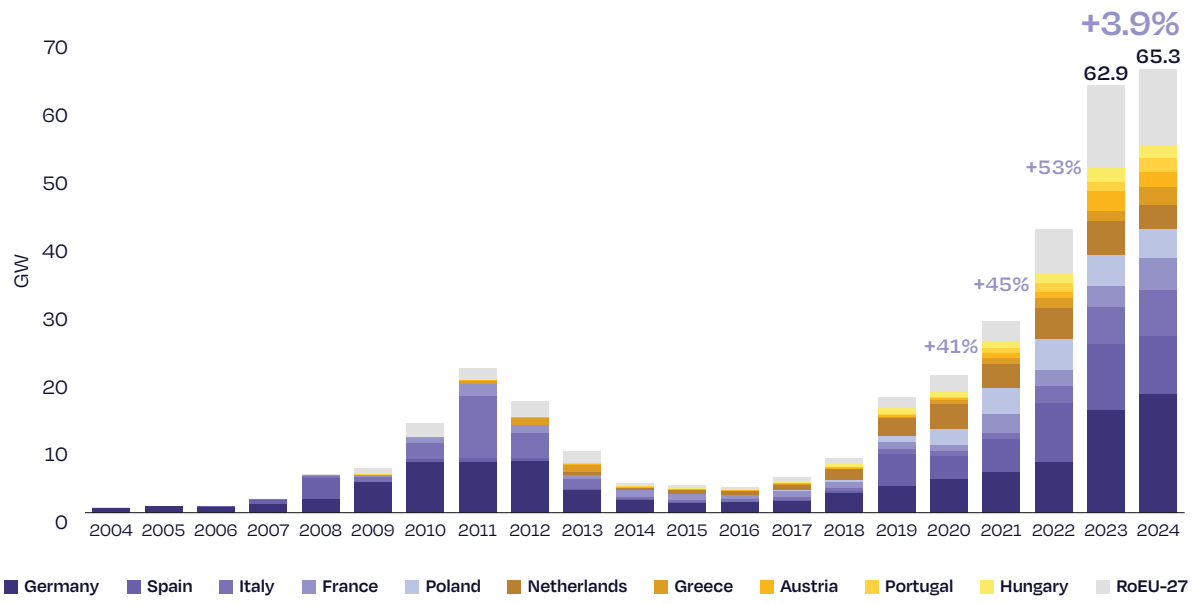
4.2 EU-27

Overview of PV developments in 2024

In 2024, the European Union saw the addition of a new all-time high of 65.3 GW of solar PV, equal to 3.9% year on year growth, up from the 62.9 GW installed in 2023 (GW Fig. 2.2). As official numbers from Member States became available throughout the start of 2025, SolarPower Europe has revised its estimates from its Dec. 2024 published EU Market Outlook for several EU markets: the result for the EU-27 as a whole is a slight downward revision from the 65.5 GW previously estimated and 4.4% growth. While this moderate growth contributed to increasing cumulative solar capacity in the block by 24%, reaching 338 GW compared to 273 GW in 2023, it also constitutes a significant deceleration in annual installations compared to the strong growth rates between 41-53% recorded in the previous three years. This dramatic slowdown is not so surprising, given that the previous exceptional surge in 2022 and 2023 was largely driven by the unprecedented rise in energy prices triggered by the energy crisis.

GW Figure 2.1

EU-27 annual solar PV installed capacity 2004-2024



This deceleration is symptomatic of a combination of factors affecting solar markets in the EU. As energy prices normalise and several incentive schemes for rooftop solar are being phased out, the residential market – a driving force across the EU so far – has significantly slowed down, installing 29% less capacity than the previous year. Meanwhile, grid congestion, lack of system flexibility and slow electrification are increasingly contributing to negative electricity prices, worsening the business case for investors, as permitting challenges also remain cumbersome for developers across several Member States. Finally, the political landscape has shifted, with several political parties less traditionally supportive of renewables coming to power in various European countries and creating a risk of slowing down the implementation of the Green Deal.

As the 5th global solar market, Germany leads the EU again in 2024 with a new record addition of 17.4 GW, over a quarter of the total installed solar PV in the EU block last year, while Spain and Italy complete the podium, with over 15 GW combined. Two more markets reached the GW scale for annual installations, with 16 out of 27 Member States crossing the threshold in 2024 (compared to 14 in 2023), contributing to a decrease in market concentration.

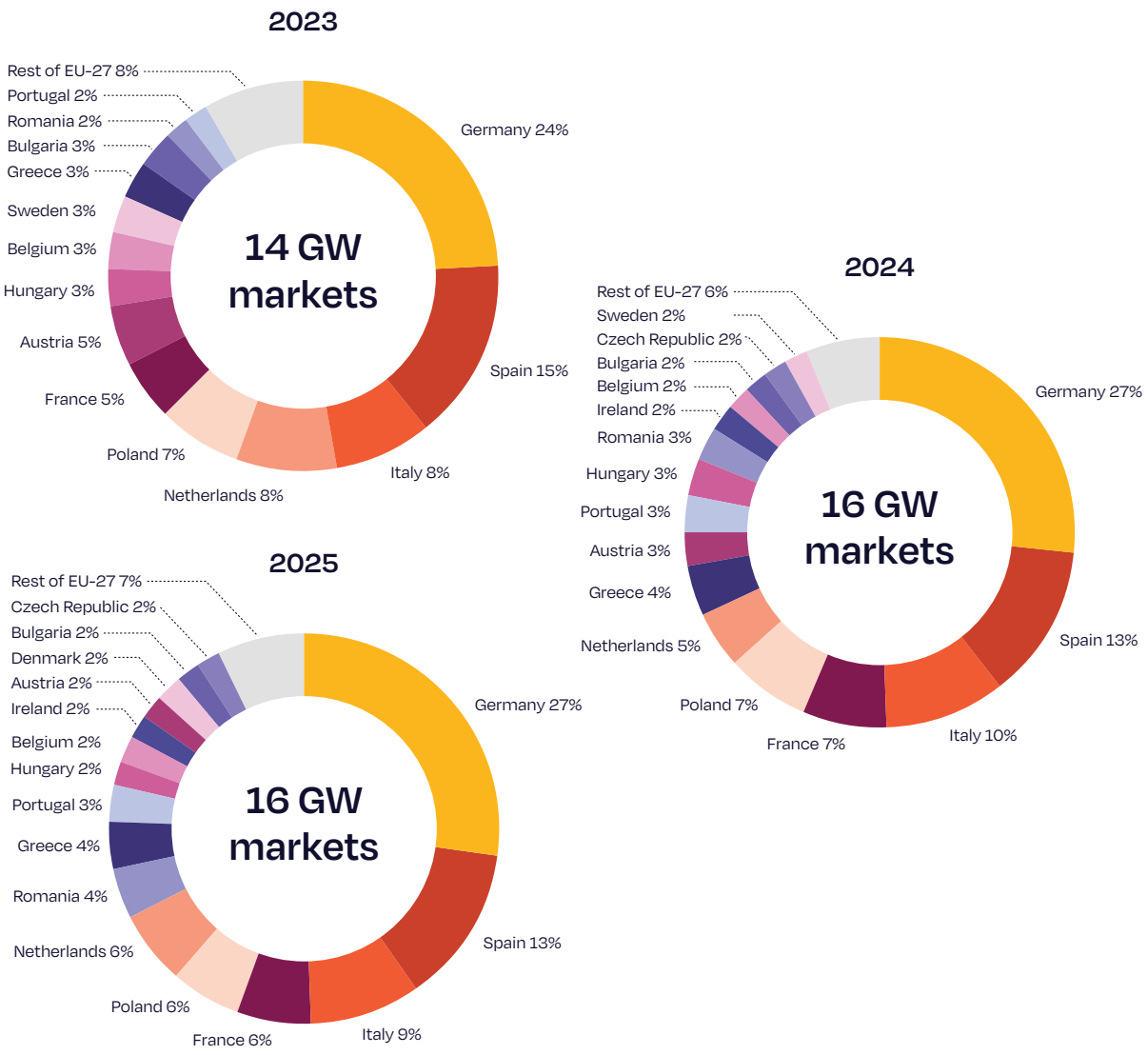
Germany's 2024 performance is over 1 GW higher than we previously estimated in our EU Market Outlook 2024-2028 (EMO 2024). Although annual growth in the country slowed, at 15% compared to last year's 104%, the market still easily exceeded its 13 GW national annual target. Despite the low hanging fruit in the rooftop market now having largely been captured, this moderate growth was driven by strong participation in tenders, which were mostly oversubscribed. Spain's market marginally decreased, down 10% from 2023, with 8.7 GW in annual additions, due to a slowdown in rooftop PV demand. This is somewhat lower than we estimated in December 2024, since, despite a robust PPA market, the utility-scale segment performed less well than expected. Italy's market registered the highest performance in over 10 years, adding 6.8 GW, a 27% increase from 2023's installations.

Other EU GW markets were France (4.7 GW), Poland (4.4 GW), the Netherlands (3.4 GW), Greece (2.7 GW), Austria (2.2 GW), Portugal (2.1 GW), Hungary (1.8 GW), Romania (1.7 GW), Ireland (1.1 GW), Belgium (1.1 GW), Bulgaria (1.1 GW), Czech Republic (1 GW) and Sweden (1 GW). Ireland and the Czech Republic are the newest additions, the former reaching the GW-scale for the first time in its solar history (Fig. GW 2.2).

Compared to 2023 when all major markets experienced strong growth, in 2024 only 5 of the top 10 EU solar markets installed more PV capacity than in 2023, and those that did (France, Germany, Greece, Italy and Portugal), only modestly. Among the top markets experiencing a decline (Spain, Poland, Netherlands, Austria and Hungary), the Netherlands saw the steepest drop, with annual installations falling by 1.5 GW – from 4.9 GW in 2023 to 3.4 GW in 2024.

GW Figure 2.2

EU-27 GW-scale solar markets 2023-2025



Market concentration maintains its declining trajectory. In 2019, the top 10 markets installed 95% of solar capacity in the EU, and the top 5 accounted for 78%. Since then, that share has been steadily decreasing to 81% for the top 10 in 2024, and 62% for the top 5. By the end of 2025, the top 10 are estimated to account for 82% of the annual installed capacity while the top 5 will only cover 61%. However, while the bloc counted 16 GW-scale markets by the end of 2024 compared to 14 GW markets in 2023, we forecast 2025 will also count 16 GW markets with overall stagnation across the EU next year. (see Fig. GW 2.2).

Drivers and Challenges

The 2022-2023 period of low energy prices and heightened energy security concerns allowed for a solar boom across the EU block, as many solar projects were economically attractive, despite several bottlenecks and a high interest rate environment. EU policymakers also adopted supportive measures for solar deployment, such as the setting of the 750 GW (600 GW_{AC}) REPowerEU target by 2030, improved permitting conditions, and a EU rooftop solar strategy, all contributing to positive market signals for the industry.

Today, while solar PV products are still available at very low costs, other key drivers have gone or are at risk, and Member States are confronted with increasing challenges which threaten the business case for solar across the EU.

The downward path of the EU-wide **residential segment** reflects the trend in almost all top national markets, where energy prices have normalised and subsidy schemes for residential PV are being phased out. Many citizens interested in solar have already purchased a PV system, leaving an educated customer gap to be filled. Compounding this, net-metering or other attractive schemes have been stopped or changed toward business models focused on self-consumption, as countries are looking to save on budget in a challenging economic environment. This is happening without substantial improvements of regulatory conditions to enable incentive-free business models. Finally, grid congestion in low-voltage networks has become a limiting factor in many established solar markets. As a result, demand for residential systems fell sharply by 5 GW to 12.5 GW in 2024, returning to levels similar to those of 2022. The market share of residential rooftop solar in the EU dropped to 19% in 2024, down 9 percentage points from 28% in 2023, and is expected to decrease further and stay at a stable 16% for the rest of the decade (GW Fig. 2.3).

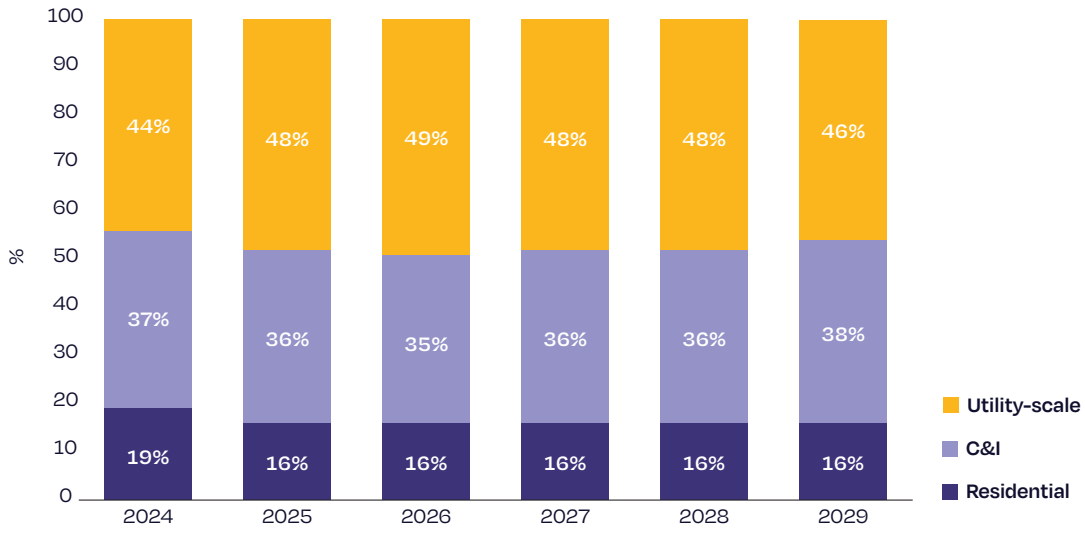
1.5 MW, Illingen, Germany

In contrast, the **commercial and industrial** (C&I) market experienced modest growth, with its market share rising slightly to 37% in 2024, one percentage point up from the previous year. A lacklustre performance in the commercial segment was more than counterbalanced by the increase in larger rooftop installations at industrial scale, driven by leading markets such as Germany, Greece and Italy. A continued slow growth is expected in the next few years, until the boost from the European Performance of Buildings Directive (EPBD) provisions starts to become visible across the largest markets.

The strongest driver for solar growth in 2024 came from the **utility-scale** segment, which captured 44% of the market – an 8 percentage point increase from 36% in 2023 and its strongest performance in the past five years. This segment is projected to reach close to 50% market share in 2026 and stay between 46-49% in the next five years, compared to 30-44% since 2020 (GW Fig. 2.3). This is linked to the rising popularity of de-risking contracts such as PPAs, an increase in auction volumes in major markets, and a partial improvement of permitting and administrative procedure timelines following the entry into force of EU rules on this front.

GW Figure 2.3

EU-27 annual solar PV segmentation 2024-2029



However, the utility-scale segment is more than ever confronted with the lack of flexibility of the EU energy system. Grid congestion is becoming a serious issue, increasingly leading to negative electricity prices and higher curtailment rates, which diminish the financial appeal of solar investments. Compounding this, sluggish electrification rates in the EU create a systemic limit for the utilisation of growing renewable electricity, as rates have stayed at around 22-23% over the past five years. In order to effectively integrate solar and renewables, increase system flexibility and improve the business case for solar, battery energy storage must be deployed at scale. As highlighted in SolarPower Europe's May 2025 published European Market Outlook for Battery Storage 2025-2029, battery storage capacities in the EU are on the rise but their deployment is still insufficient to meet the system's growing flexibility needs. Behind-the-meter and grid-scale storage must play a central role, capturing excess daytime generation for use during evening peaks and improving overall system resilience. Finally, permitting and land access remains an important bottleneck in several Member States, delaying project timelines and hindering solar growth - effective and swift transposition of EU legislation on the matter at the national level will play a key role in the coming years.

Outlook 2025-2029

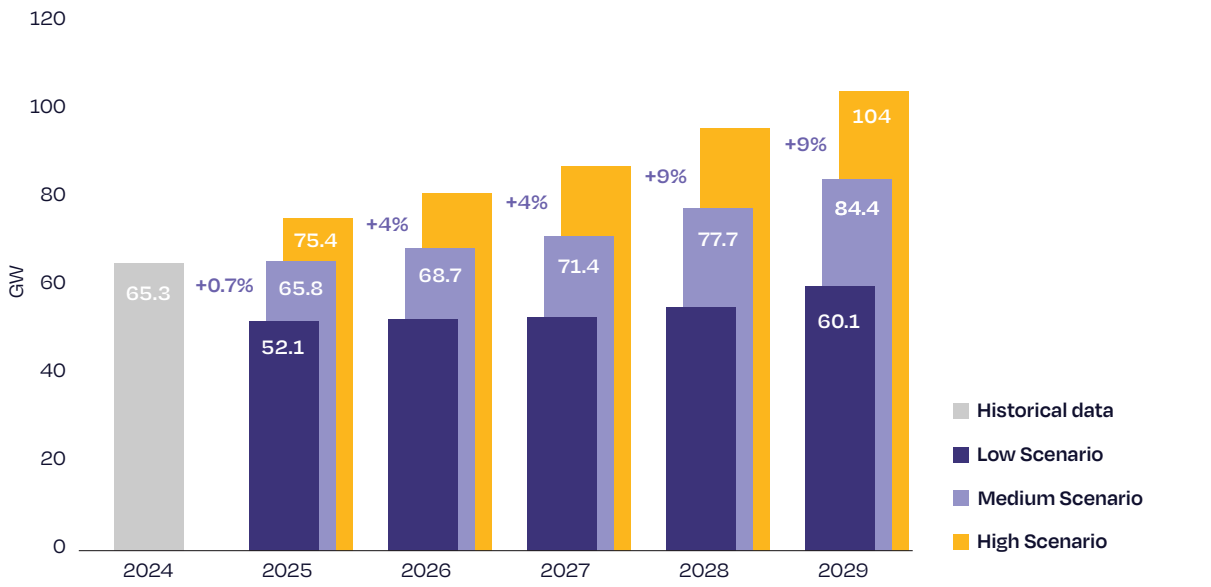
At the time of publishing the EMO 2024 last December, SolarPower Europe issued a yellow card to policy makers, warning that if action is not urgently taken to keep supporting its solar industry, the EU is at risk of missing its REPowerEU targets for 750 GW of total solar capacity in 2030. Six months on, we are changing this warning to a red card, as developments in several key markets since the start of 2025 confront us with a more pessimistic outlook. We have once again lowered our expectations, with annual growth staying consistently below 10% for the next 5 years.

For 2025, in our most likely scenario, we expect the EU market to add 66 GW of capacity, reflecting a 0.7% annual increase (GW Fig. 2.4). Although not negative, the market will stagnate as developers face mounting grid constraints and market and further policy uncertainties. For example, in February 2025 the French government reduced the national solar PV targets and slashed feed-in tariffs for all new rooftop PV systems with a capacity under 500 kW, largely reducing the attractiveness of its most prominent market segment. This and other developments brought a downwards revision of our previous forecast from the 70 GW we were expecting in the EMO 2024 a few months ago.

According to our Medium Scenario, the EU market will partially pick up again in 2026, with a 4% increase to 69 GW, followed by a 4% growth to 71 GW in 2027. Towards the end of the decade, with the first effects of the EPBD and an increased volume of battery storage deployment, the Medium Scenario anticipates a 9% increase in both 2028 and 2029, leading to 78 and 84 GW respectively.

GW Figure 2.4

EU-27 annual solar PV market scenarios 2025-2029

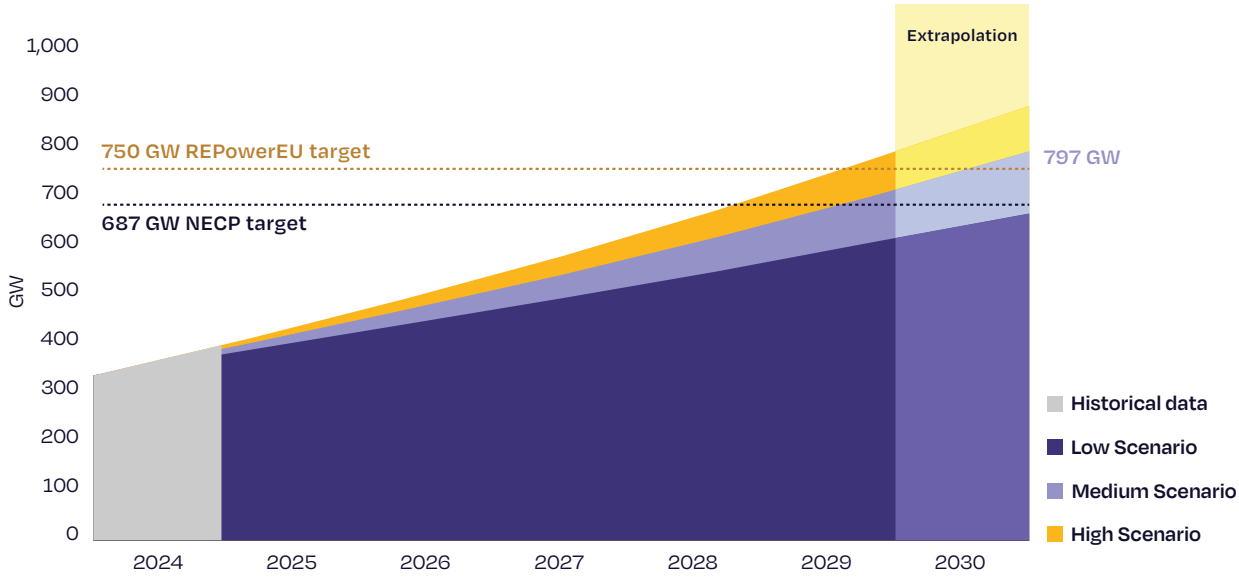


Our cumulative capacity forecast indicates that while solar deployment is on track to meet without delay the interim REPowerEU target of 400 GW by 2025, worrying market signals are casting a shadow on the achievement of the 750 GW target by the end of the decade. Our Medium Scenario projection still suggests that the EU will meet the REPowerEU 2030 target on time, reaching 797 GW by that year, which is 6% higher than the target (GW Fig. 2.5). However, our forecast has decreased by a further 20 GW from December 2024 in addition to the 74 GW decrease from the GMO 2024 – that's 2% lower compared to the EMO 2024 and 11% lower compared to one year ago.

This worsened outlook also illustrates that solar deployment could be easily jeopardised without adequate policy support, as exemplified in our Low Scenario's total capacity landing at 670 GW in 2030, which is 11% below the REPowerEU target and even 3% below the aggregated NECP target.

GW Figure 2.5

EU-27 total solar PV market scenarios 2025-2030



© SolarPower Europe

17.2 MW PV coupled with 5 MW / 5 MWh BESS, Bontepolder, the Netherlands

4.3 United States

Overview of PV developments

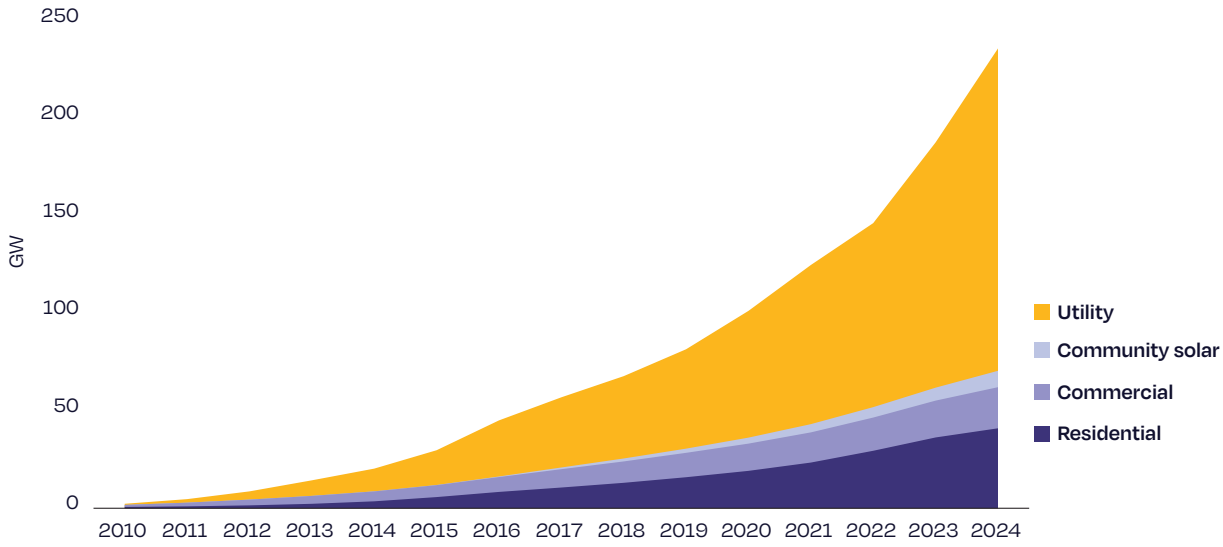
The United States solar industry experienced a second consecutive year of record-breaking deployment growth.

According to the Solar Energy Industries Association's (SEIA) Solar Market Insight Year in Review,[4] the US added 50 GW of new solar capacity in 2024. This represents a 21% increase from 2023 and is the largest single year of new capacity added to the US grid by any energy technology in over two decades. In terms of total capacity, the US now operates a solar fleet of more than 235 GW, enough to power nearly 40 million homes (Fig. GW 3.1).

This momentum kicked off in 2023 as the market recovered from supply chain disruptions that persisted throughout the COVID-19 pandemic. In 2024, the market began to feel the full impact of federal clean energy incentives in the Inflation Reduction Act (IRA). Solar and storage accounted for 84% of all new capacity added to the grid last year (Fig. GW 3.2), and these technologies comprise 75% of all new generation under development in the United States.

GW Figure 3.1

US cumulative solar PV installations 2010-2024



Source: SEIA/Wood Mackenzie Solar Market Insight Report 2024 Year in Review

4 SEIA (2024), Solar Market Insight Report 2024 Year in Review – SEIA

Solar deployment increased across most market segments in 2024. The one exception was the residential segment, which was impacted by high interest rates and is adjusting to state-level policy changes. The utility-scale segment captured the largest share of new capacity and installed 41.4 GW in 2024, a 33% increase from 2023. The residential sector remained the second largest market and installed 4.7 GW in 2024, declining 31% from 2023. The commercial and industrial segment installed 2.1 GW and the community solar sector added 1.7 GW in 2024, growing a respective 8% and 33% from 2023 levels.

Drivers for solar growth

Solar dominated new electric generating capacity added to the US. grid in 2024, accounting for two-thirds of all new capacity. This is the fourth consecutive year that solar was the leading source of new electric generating capacity. It was also the first time solar accounted for over 60% of new electric generating capacity.

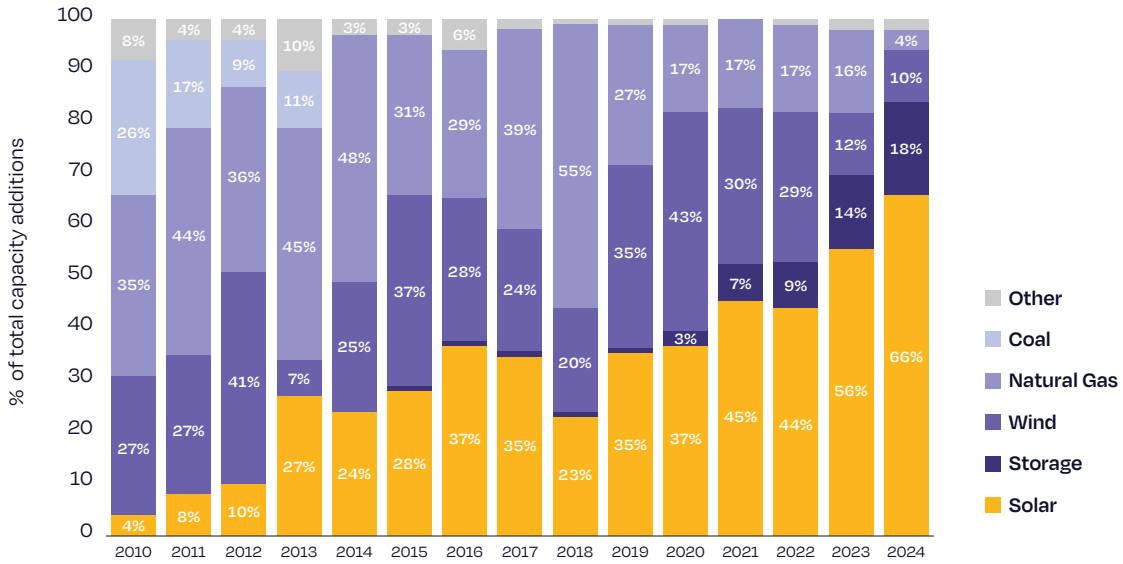
Over the past 15 years, electricity demand has been flat. Today, US electricity demand is surging due to the proliferation of new manufacturing facilities, increasing electricity needs from data centres and artificial intelligence, and electrification in the transportation and heating sectors.

By 2030, US electricity demand is expected to grow 7%, from 4,300 TWh in 2024 to 4,600 TWh. According to data from the US Energy Information Administration (EIA), solar and storage are the fastest technologies to deploy, averaging roughly 18 months to develop from project concept to operation. In contrast, new natural gas capacity takes two to four years to come online, while nuclear projects average over 15 years.

Federal and state deployment incentives are foundational to ensuring solar continues to be installed at a rapid pace. This includes the 10-year tech-neutral investment tax credit, which is critical to financing projects and growing the solar project pipeline.

GW Figure 3.2

US annual additions of new electric generating capacity 2010-2024



Source: SEIA/Wood Mackenzie Solar Market Insight Report 2024 Year in Review

Federal manufacturing incentives are also critical to ensuring solar supply chains remain resilient and enable rapid US solar deployment. Domestic solar manufacturing grew at an unprecedented rate in 2024 due to direct incentives. At full capacity, domestic module factories can produce enough supply to meet all US solar deployment demand. There is also enough domestic tracker capacity to meet US utility solar demand. In addition, more facilities are expected to come online in the next few years, spanning different solar products and further reducing supply chain risk.

Market Challenges

Many of the most pressing challenges for the US solar industry remain static. Tight labour and tax equity availability continue to threaten how quickly the solar industry can deploy new electric generating capacity. Continued challenges to siting, permitting, and interconnecting solar projects can increase project development timelines and costs. New trade action can inject uncertainty into the deployment outlook, even with a growing domestic solar supply chain. In addition, any changes to state or federal incentives can modify the US solar deployment outlook. These incentives are critical to providing visibility into project economics as solar projects are developed. Addressing all of these barriers will be key to meeting the country's growing power demand.

Author: The Solar Energy Industries Association (SEIA)

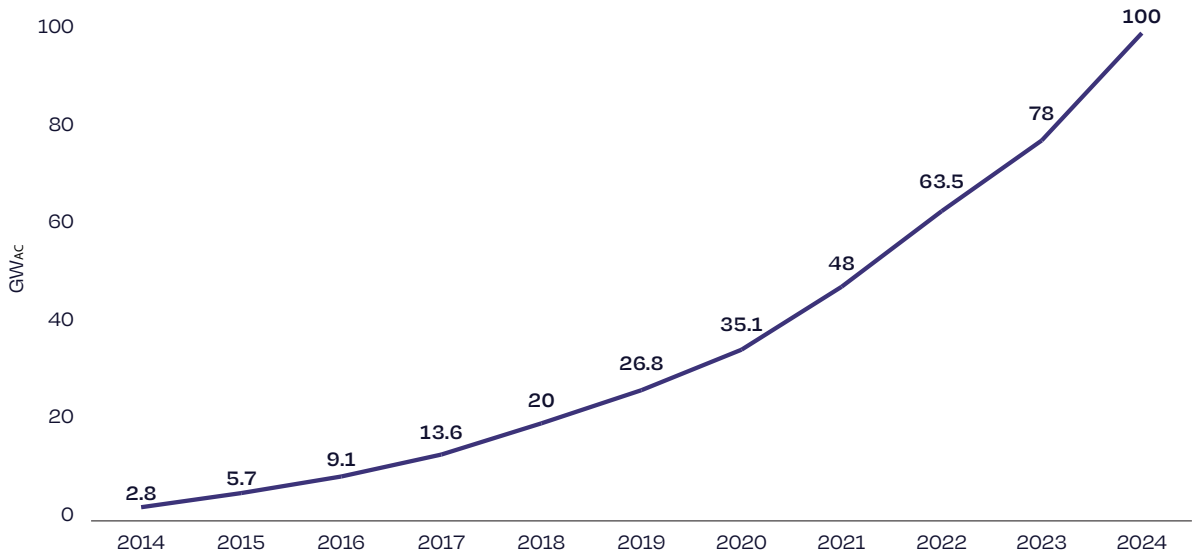
4.4 India

Overview of solar PV developments

India, the fourth largest global market for solar PV installations, breached the 100 GW mark for total installed solar capacity in February 2025, becoming the fourth country to achieve this remarkable milestone globally.[5] More than half of this 100 GW has been installed in just the last three years. India witnessed an impressive growth in solar installations, starting from a mere 2.8 GW in 2014 to around 102 GW by February 2025.

GW Figure 4.1

India annual cumulative solar installations 2014-2024



Source: MNRE, Government of India

National targets for solar PV

The rapid pace of installations, backed by a significant project pipeline has been possible due to a cohesive policy and regulatory ecosystem, a vibrant industry, and streamlined implementation. To meet India's ambitious national renewable installation target of 500 GW by 2030, the country aims to add another 200 GW of solar PV within the next 5 years.

5 Capacity values in this article are expressed in AC

Utility-scale vs distributed and rooftop solar developments

As of February 2025, India's installed RE capacity was around 167 GW, with solar contributing around 61% of total installed RE. In solar installations, utility-scale ground mount projects dominate the capacity installed with around 79 GW of installed capacity (including Hybrid) while rooftop solar contributes to around 16 GW.

India's success in its utility-scale solar segment is driven by key policy reforms. Launched in 2010 under India's National Action Plan on Climate Change (NAPCC), the Jawaharlal Nehru National Solar Mission (JNNSM) played a crucial role in advancing solar energy adoption by establishing a robust policy and regulatory framework, promoting large-scale grid-connected and rooftop solar projects, expanding off-grid solar access, strengthening domestic manufacturing, and attracting significant investments.

JNNSM was implemented in three phases with a long-term objective of achieving 100 GW of solar power capacity by 2022, supporting India's commitment to sustainable energy transition. Through provisions such as the Scheme on Development of Solar Parks and Ultra Mega Solar Power Projects, a move from FiT to competitive bidding regime, Renewable Purchase Obligations (RPOs), the Mission facilitated rapid solar deployment while driving down solar tariffs from 10.95 INR/kWh (0.13 USD/kWh) in 2010 to 2.5-2.6 INR/kWh (0.03 USD/kWh) on average.

In terms of support for the distributed solar PV segment, the Government of India announced a dedicated Scheme for accelerating rooftop solar installations in January 2024, targeting the installation of solar on rooftops in "10 million Indian Households," as well as solarising all government buildings and a majority of commercial and industrial buildings.

36 MW Floating Solar Project, Visakhapatnam, India

Aside from rooftop solar, the PM-KUSUM Scheme, launched in 2019 by the Ministry of New and Renewable Energy (MNRE), also aims to promote solar energy adoption among farmers, reduce dependence on grid power, and enhance their energy security. It supports decentralised renewable energy and helps in the de-dieselisation of the agricultural sector, notably through the use of solar pumps.

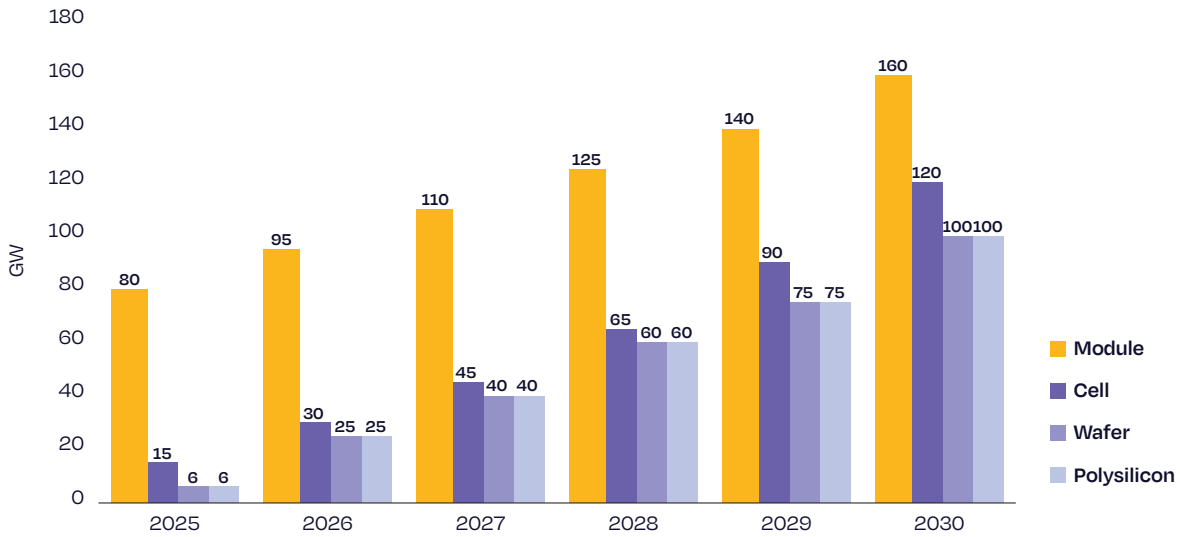
Solar Manufacturing

In 2024, India's solar industry achieved an annual production capacity of 60 GW, solidifying the country's position as a global leader in solar manufacturing. With sustained policy support and strategic investments, India is on course to expand its solar module production capacity to 100 GW by 2030, further strengthening its role in the global renewable energy landscape. Salient initiatives driving solar manufacturing development in India include import tariffs (**Basic Custom Duties (BCD)** for solar cells and modules of 20% and 40% respectively), approved lists for PV module and cell manufacturers (**ALMM[6] and ALCM[7]**), Domestic Content Requirements (DCR) and the **Production Linked Incentive (PLI) Scheme**, a Rs. 24,000 crore (3 billion USD) incentive scheme for domestic PV production.

GW Fig. 4.2 presents India's projected growth in solar manufacturing capacity from 2025 to 2030 across solar modules, cells, wafers, and polysilicon. While module capacity is set to increase significantly from 80 GW in 2025 to 160 GW by 2030, cell capacity is also projected to rise from 15 GW to 120 GW, while wafer and polysilicon capacities are expected to expand from 6 GW in 2025 to 100 GW by 2030, reflecting strategic efforts to strengthen domestic production. This projected growth underscores India's strong focus on scaling its solar manufacturing capabilities, aligning with its renewable energy ambitions and reducing reliance on imports.

GW Figure 4.2

India annual solar manufacturing capacity projection 2025-2030



Source: NSEFI

6 Approved List of Models and Manufacturers
7 Approved List of Cell Manufacturers

Challenges for the market

India has rapidly reshaped its energy sector, establishing itself as a pioneer in solar power and driving the momentum of the renewable energy revolution. With ambitious targets, strong policy frameworks, and a rapidly growing solar capacity, the country is on a decisive path toward achieving its clean energy goals. However, to sustain this momentum and accelerate solar adoption, it is crucial to address policy, infrastructure, and investment challenges that could hinder large-scale deployment.

To accelerate the clean energy transition, expanding grid infrastructure through Green Energy Corridors, extending ISTS waivers, streamlining open access regulations, and ensuring clarity in rooftop solar policies will be essential. Strengthening domestic solar manufacturing through strategic refinements in PLI and ALMM policies, along with targeted incentives for PV recycling and Agrivoltaics, will not only boost self-reliance but also position India as a global leader in solar technology and supply chains.

NSEFI's advocacy extends across key industry challenges, including determining benchmark costs, addressing implementation bottlenecks, promoting PV recycling, and advancing Agrivoltaics, ensuring a smoother policy landscape for long-term sectoral growth. Initiatives like Panels of India focus on strengthening India's solar manufacturing ecosystem, while Ghar ke Upar Solar is Super promotes greater adoption of rooftop solar at the consumer level. Solar Recycle India champions sustainable end-of-life PV module management, and the NSEFI Green Data Centre Coalition is leading efforts to decarbonize India's growing digital infrastructure. Additionally, Women in Solar promotes gender inclusivity in the sector, India AgriVoltaics Alliance drives innovation in the integration of solar energy with agriculture, and GH Tap and the NSEFI Digital and Cyber Security Council support advancements in grid modernisation and energy security.

Manufacturing facility of Swelect Energy Pvt. Ltd., India

Outlook 2025-2029

In addition to the 102.57 GW of operational solar capacity actively contributing to the Indian grid as of February 2025, 84.1 GW of solar projects are under implementation, and 47.49 GW have been tendered and await finalisation. This brings the total solar pipeline to 231.91 GW. Furthermore, 39.78 GW of hybrid projects, integrating solar, wind, and storage, are also under development, with an extra 24.90 GW tendered but pending contract awards.

India's increasing energy demand, driven by rapid industrialisation, urbanisation, and its commitment to achieving Net Zero emissions by 2070, is anticipated to significantly boost the adoption of solar energy in the coming years. Considering the current growth trajectory and ongoing supportive measures, the country's installed solar PV capacity is projected to reach between **275 GW** and **310 GW** by the year 2029.

While NSEFI continues to push for stable and progressive policies, achieving India's clean energy goals will require a collective effort from both the government and industry. Policymakers must ensure consistent regulatory frameworks, clear implementation pathways, and sustained financial incentives to attract long-term investments in renewables. Simultaneously, the industry must focus on scaling up solar manufacturing, deploying cutting-edge technologies, and strengthening research and innovation to maintain global competitiveness.

A harmonised and forward-looking approach—supported by stable policies, industry-driven solutions, and collaborative governance—will be crucial in ensuring that India meets its renewable energy targets, accelerates its decarbonisation efforts, and cements its leadership in the global solar transition.

Author: National Solar Energy Federation of India (NSEFI)

Manufacturing facility of Swelect Energy Pvt. Ltd., India

4.5 Brazil

Overview of PV developments

In 2024, the Brazilian solar PV market demonstrated robust results despite unfavourable conditions in the country. The forecast for the year was surpassed by a big margin, showcasing the market's resilience and, despite obstacles, Brazil continued to establish records for solar PV market growth.

Brazil continues to be an increasingly relevant market for solar PV. Last year, the country reached 53 GW_{AC} of total installed solar PV capacity in operation, surpassing official government projections. In 2024 alone, 15 GW_{AC} of annual capacity additions were installed, including 9.5 GW_{AC} of distributed generation and around 5.7 GW_{AC} of centralised generation.

Distributed and centralised PV system developments

In Brazil, solar PV systems are categorised into two main segments:

1. **Distributed generation**: this encompasses small and medium-sized solar PV systems, up to 5 MW in capacity. These systems participate in the Brazilian national net-metering program, allowing for the exchange of surplus electricity with the grid;
2. **Centralised generation**: large-scale solar PV power plants with capacities exceeding 5 MW. These plants commercialise their electricity through regulated market auctions administered by the Federal Government or through bilateral PPAs within the free electricity market.

Winery, Pinto Bandeira, Brazil

In 2024, large-scale solar power plants suffered significant curtailment events, with some reports of curtailment rates as high as 70% on monthly generated electricity, without adequate financial compensation. The Brazilian Solar Photovoltaic Energy Association (ABSOLAR) continues to defend large-scale solar entrepreneurs before the National Electric Energy Agency (ANEEL) by advocating for regulatory changes to enable fair compensation of market players for these losses. Additionally, on behalf of large-scale solar generators, ABSOLAR has filed a lawsuit requesting full compensation for the already quantified losses, amounting to more than 115 million USD (700 million BRL).

Simultaneously, due to these challenging market conditions, several electricity distribution utilities continue to deny connection requests for new distributed generation solar PV systems, under alleged claims of reverse power flow in the low and medium voltage grids. This has negatively impacted the growth of small- and medium-scale solar PV in some areas of the country, resulting in the postponement of new investments and negative impacts on the creation of new green jobs. Therefore, ABSOLAR is urging ANEEL to enforce regulations, increase monitoring, and implement punitive measures over non-compliant electricity distribution utilities.

Another challenge faced by solar companies and consumers in Brazil in 2024 was the increase of the import tariff applied to solar PV modules, from 9.6% to 25%. This was announced by the Federal Government in the second half of 2024, with initial impacts starting in 2025. ABSOLAR has requested that the Federal Government develop a solution to prevent the cancellation of large-scale solar projects currently under development and to ensure a fair transition process for the market.

For the first time, distributed solar PV surpassed the 9 GW_{AC} mark, an impressive result considering market challenges. In 2024, the newly installed capacity for solar distributed generation saw a growth of 12.9%, overcoming initial expectations of market decline.

3 MW Cidade Azul Solar Plant, Tubarão, Brazil

In 2024, Brazil also made significant strides towards the expansion of large-scale solar PV power plants. The annual installed capacity of this market segment increased by 38%, from 4.1 GW_{AC} in 2023 to 5.7 GW_{AC} in 2024. Most of the electricity from these projects was sold through PPAs on the free electricity market. Consequently, the total installed capacity for large-scale solar PV power plants reached 17.2 GW_{AC} by the end of 2024.

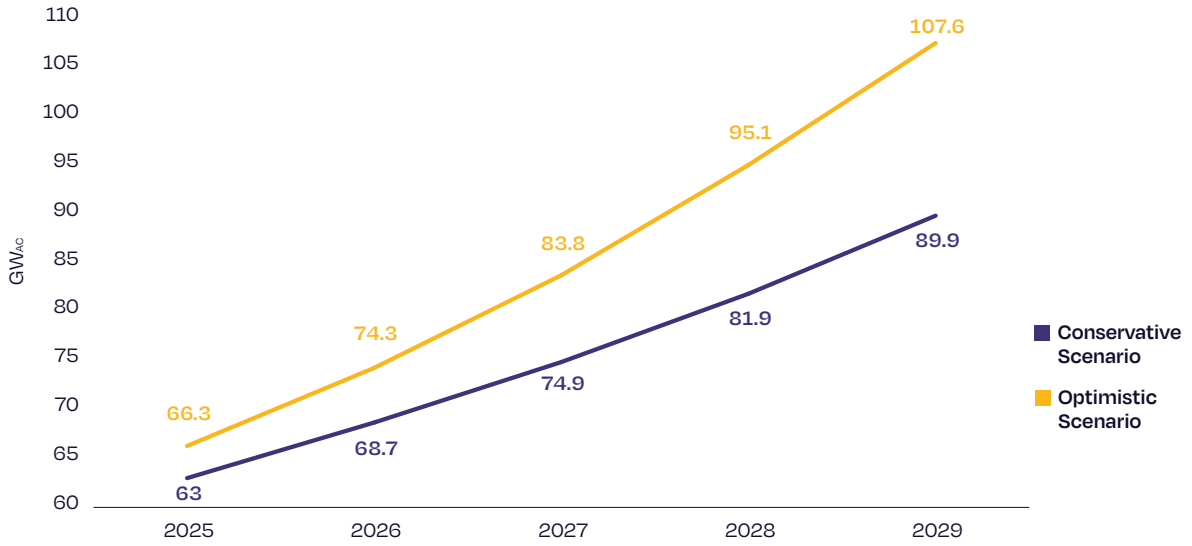
Solar PV Forecast

ABSOLAR forecasts a somewhat slowed, yet still strong market performance in 2025. Economic, political, and regulatory challenges contribute to this conservative outlook.

Combining ABSOLAR data and official projections from the Brazilian Energy Research Office (EPE), the cumulative installed capacity of solar PV in Brazil is expected to reach between 90 GW_{AC} (Conservative Scenario) and 107.6 GW_{AC} (Optimistic Scenario) by 2029 (GW Fig. 5.1). For distributed generation, the cumulative installed capacity by 2029 is projected to be between 54.2 GW_{AC} and 63.9 GW_{AC}. For centralised generation, ABSOLAR estimates average annual capacity additions between 3.7 GW_{AC} and 5.3 GW_{AC} until 2029. The total annual forecast is for both centralised and distributed generation to lie between 7.4 GW_{AC} and 10.9 GW_{AC} of solar PV capacity additions from 2024 to 2029.

GW Figure 5.1

Brazil cumulative solar PV installed capacity forecast 2025-2029



Year	2025	2026	2027	2028	2029
Distributed Solar PV (GW_{AC}) - Conservative Scenario	42.9	45.8	48.4	51.2	54.2
Centralised Solar PV (GW_{AC}) - Conservative Scenario	20.0	22.9	26.4	30.7	35.8
Total - Conservative Scenario	63.0	68.7	74.9	81.9	89.9
Distributed Solar PV (GW_{AC}) - Optimistic Scenario	44.5	48.7	53.4	58.8	63.9
Centralised Solar PV (GW_{AC}) - Optimistic Scenario	21.8	25.6	30.4	36.3	43.7
Total - Optimistic Scenario	66.3	74.3	83.8	95.1	107.6

Source: ABSOLAR (2025) and official projections from EPE (2024)

Challenges and opportunities

For the past three years, distributed generation has faced challenges for new connections to the grid. Resolving this issue requires legal or regulatory changes, and a commitment from the regulatory agency to enforce existing rules. In order to prevent unjustified restrictions, ABSOLAR is working with the National Congress to amend the law governing distributed generation in Brazil and urging the regulatory agency to enforce the already established rules.

Considering utility-scale solar PV, the lack of transmission infrastructure in certain regions continues to hinder the development of new large-scale projects. Additionally, the absence of fair compensation rules for high curtailment rates experienced by solar PV power plants is perceived as an added risk for new investments in the short term.

2025 is expected to be a landmark year for unlocking the immense potential of energy storage in Brazil. This year, the forthcoming regulation for the connection and utilisation of energy storage systems within the Brazilian electric grid is expected to be published. This technology will become a crucial ally in overcoming grid limitations and is set to provide fresh impetus for the expansion of distributed generation and utility-scale solar energy across Brazil. 2025 should also see the first capacity auction focused on battery energy storage.

Additionally, Brazil has immense potential to become a relevant player in data centres and in the green hydrogen market. According to a 2021 article from McKinsey,[8] green hydrogen alone may bring more than 200 billion USD in new investments to the country by 2040. Corroborating this aspect, BloombergNEF recently established Brazil as potentially the most competitive country for H2V production by 2030, with a projected levelized cost of hydrogen ($LCOH_2$) of $1.47 per kilogram.[9]

In November 2025, Brazil will host the 30th Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP30) in the city of Belém, the capital of the state of Pará. In light of this, the country currently holds a key strategic role on the international stage, and has a unique opportunity to showcase its economy and market to the international community, including renewable energy investors.

ABSOLAR will continue to defend the solar PV, energy storage, and green hydrogen sectors in Brazil, and will keep developing and implementing strategic recommendations and best-practices to increase the widespread adoption of these sustainable technologies in the country.

Authors: *Dr. Rodrigo Lopes Sauaia*, CEO; *Dr. Vinicius Suppion*, Technical and Regulatory Specialist; ABSOLAR

8 McKinsey (2021), Green Hydrogen: an opportunity to create sustainable wealth in Brazil and the world
9 Bloomberg NEF (2024), BloombergNEF Brazil Transition Factbook

4.6 Türkiye

Overview of PV developments

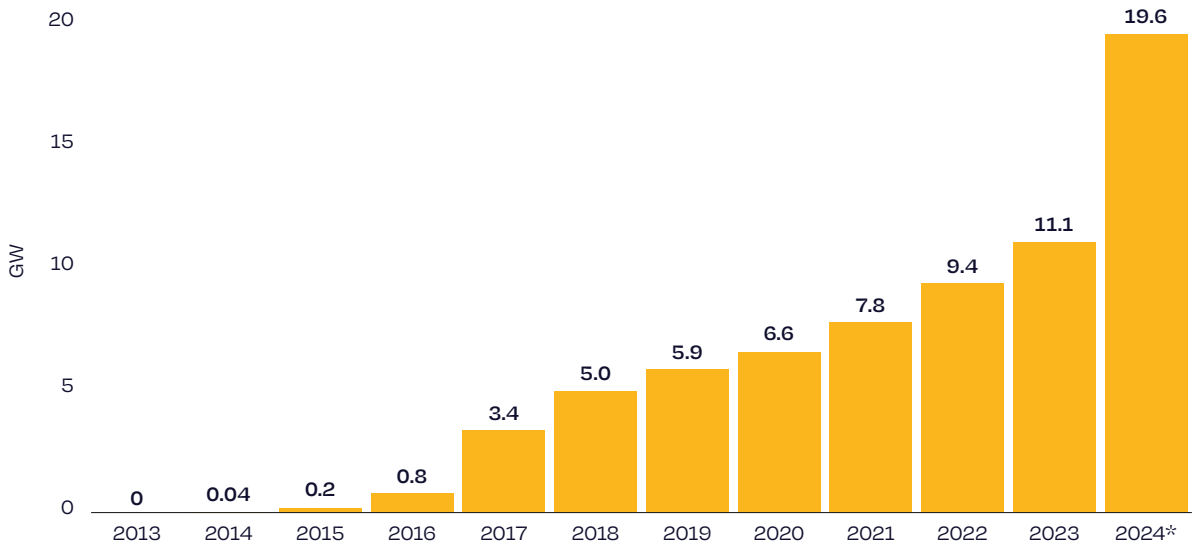
In 2024, Türkiye continued its rapid expansion in solar PV energy development, driven by national energy policies, increasing investments, and advancements in local PV production. The government's commitment to reducing energy dependence and achieving sustainability goals has led to significant progress in solar energy deployment.

By the end of 2024, solar power plants accounted for 19.6 GW of Türkiye's total installed capacity, representing 17% of the energy mix according to the Turkish Electricity Transmission Corporation (TEİAŞ). Türkiye's solar energy capacity doubled from over 9 GW in July 2022 to exceed 19 GW by the end of 2024 (GW Fig. 6.1). By August 2024, the country had already exceeded the 18 GW target set for 2025 in the National Energy Plan (NEP) by the Ministry of Energy and Natural Resources (MENR). Achieving this target 1.5 years ahead of schedule underscores Türkiye's strong commitment to solar energy and signals the need for more ambitious future targets.[10]

There are nearly 70 companies actively engaged in PV module manufacturing, with a total capacity exceeding 40 GW. To enhance Türkiye's energy independence and strengthen its economy, investments in PV cell production are also increasing. Several investments have been made in PV cell production, bringing the total capacity to around 2 GW.

GW Figure 6.1

Türkiye cumulative solar PV installed capacity 2013-2024



Source: GÜNDER

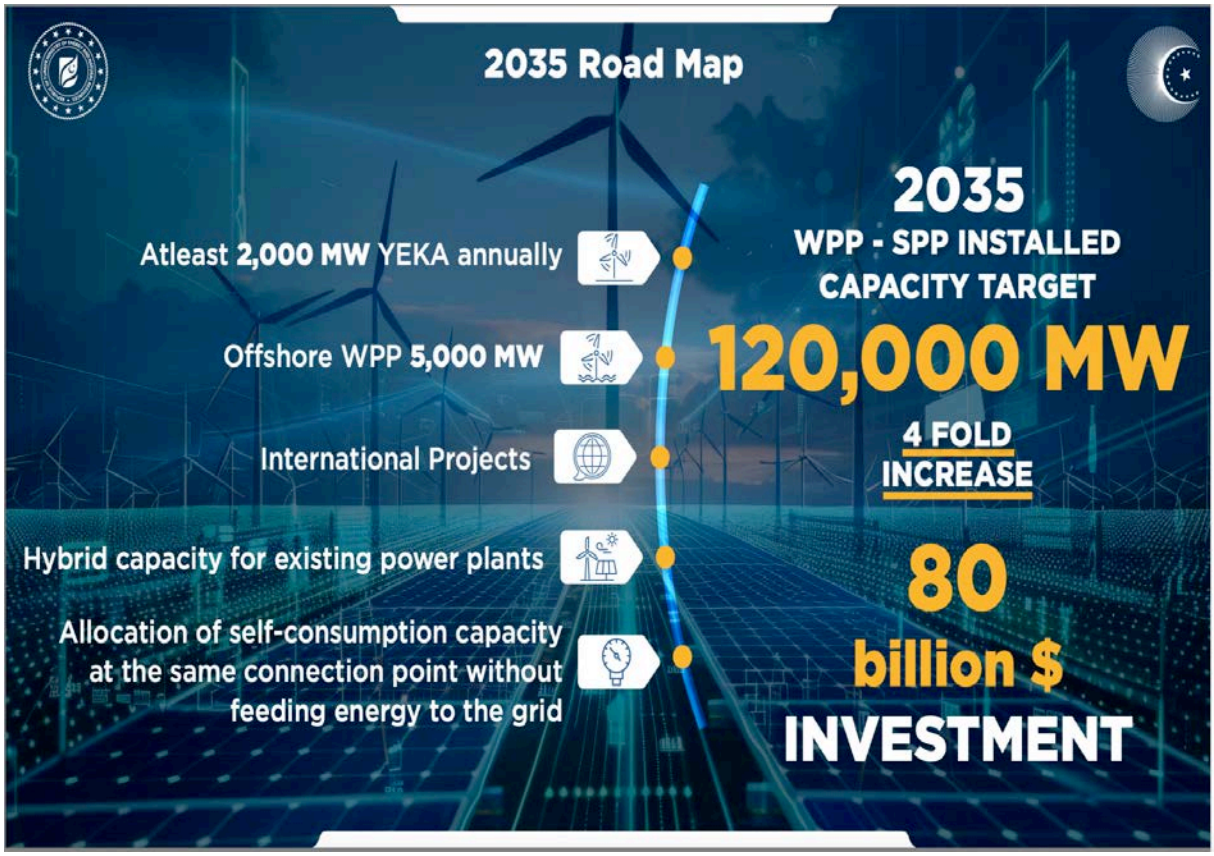
*including approved plants

10 Ember Energy (2024): Türkiye surpasses 2025 solar target as capacity doubles in 2.5 years

National targets for solar PV

Türkiye aims to increase its combined wind and solar energy capacity to 120 GW by 2035, as outlined in the MENR Roadmap. Achieving this goal requires an annual installation of 7.5 to 8 GW, with at least half of this capacity coming from PV, and is expected to create an investment opportunity of 80 billion USD. Türkiye plans to increase its renewable energy share by allocating at least 2 GW of YEKA (Renewable Energy Resource Areas) capacity annually. To implement Türkiye's energy transition strategy[11], key steps include expanding international renewable energy projects, developing hybrid and self-consumption capacity, and advancing storage technologies.

Government incentives, updated legislation, and strategic partnerships with global solar companies are driving the growth of Türkiye's PV industry. Focus on research, development, and technology localisation is expected to boost competitiveness and growth. Clear actions for achieving the net-zero carbon target, shifting subsidies from fossil fuels to clean energy, and implementing a National Emissions Trading System are essential. Policies to develop new skills and support employment in emerging sectors, along with improved access to financing and diversified funding sources, are also crucial for the long-term solar PV targets.



©Republic of Türkiye Ministry of Energy and Natural Resources

11 Ministry of Energy and Natural Resources (MENR) (2024), *Energy Transformation-Renewable Energy 2035 presentation*

Key drivers for solar growth

Türkiye's PV development is driven by substantial capacity additions, strategic planning, and targeted investments, all aimed at ensuring a sustainable and renewable energy future. While YEKDEM (Renewable Energy Support Mechanism) continues to support projects that were part of the mechanism, its role is likely to diminish over time as Türkiye moves toward a more market-based, competitive system. The future of YEKDEM may focus on providing support for specific types of renewable energy developments, but for large projects, the emphasis is likely to be on auction systems and other market-driven solutions. Licence-exempt solar expansion procedures and incentives support small-scale solar projects, while net metering and self-consumption encourage businesses and households to generate their own electricity. On the other hand, as part of Türkiye's goal to promote domestic and national production, YEKA projects – large-scale solar auctions – are attracting major investments. Besides, solar power plants with storage are set to be commissioned from 2026 to ensure continuous solar energy generation.

Utility-scale vs. distributed/rooftop developments

In 2024, Türkiye made significant strides in both utility-scale and distributed (rooftop) solar energy installations, reflecting a robust commitment to renewable energy expansion. Licence-exempt power plants, primarily for self-consumption, accounted for 90% of new installations in the past four years. This trend indicates a strong shift towards decentralised energy production, with many consumers opting for rooftop solar systems to reduce energy costs and enhance energy independence. The National Energy Plan targets 53 GW of solar capacity for 2035, with a significant share expected from distributed sources.

Market challenges

The country's ambitious targets and fast-growing capacity demonstrate its commitment to renewable energy while emphasising the need for strategic planning to tackle challenges. Despite significant progress, challenges remain, such as grid infrastructure limitations and the need for supportive policies to integrate distributed solar systems more effectively. Concerns about inflation and market consolidation may lead to significant changes in the Turkish solar industry. The sector also faces challenges such as expensive loans and difficulties in accessing long-term funding. Additionally, ensuring high-quality products are paired with qualified services – especially in engineering and installation – remains a challenge.

Outlook for 2025-2029

Turkish Solar Energy Society-GÜNDER will continue to play a vital role in policy advocacy, aiming to shape the country's solar energy landscape. GÜNDERMYM[12], the Vocational Qualification Centre, contributes to Türkiye's solar energy sector (both PV and ST) as an exam and certification centre, operating within the framework of national and international qualifications, enabling the correct management of employment and benefitting from occupational safety at the highest level both in Türkiye and in the European Union, within the scope of the Europass Certificate on National Qualifications. ODTÜ GÜNAM (Middle East Technical University Solar Energy Research Center)[13] is expected to drive technological advancements, focussing on improving solar panel efficiency and energy storage solutions through ongoing research and collaborations. Additionally, the SolarHub[14]-Horizon Europe project, which brings together international partners, will foster innovation in solar technologies and promote cross-border knowledge exchange, aligning Türkiye with European solar energy trends.

Author: *Esen ERKAN YILDIZ,* Secretary General, Turkish Solar Energy Association-GÜNDER

12 https://www.gundermym.com/
13 https://odtugunam.org/
14 https://horizonsolarhub.eu/en/

4.7 Japan

Overview of PV developments

Having achieved record capacity additions of 10.8 GW in 2015, the Japanese PV market has been on a downtrend following a reduction in FIT support for solar PV (GW Fig. 7.1). In 2024, Japan installed around 5.2 GW of new solar PV capacity, down some 0.8 GW from 2023. The cumulative installed capacity at the end of 2024 is expected to reach 98.2 GW. Even with the reduced FIT support, Japan's PV market is expected to start trending upward again from 2026, due to the growth in residential and C&I rooftop markets, and new corporate renewable PPA models. Japan's emissions reduction target of 60% for 2035 and 73% for 2040 will require a large increase in the share of renewable energy; in particular, solar PV.

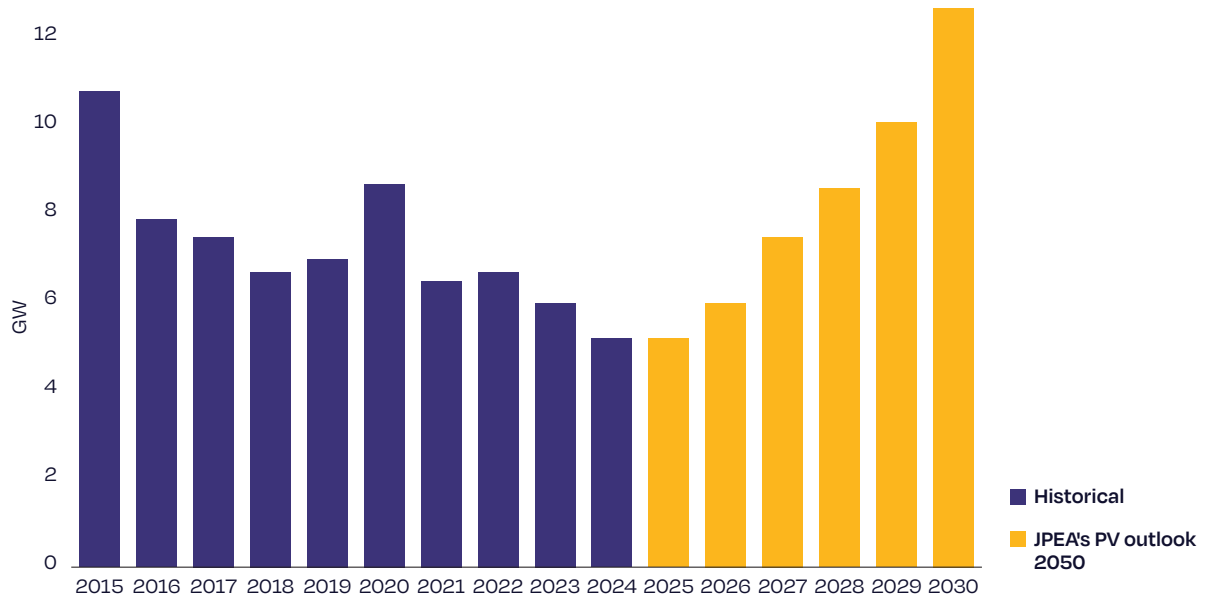
National solar and renewable energy targets

According to the Japanese government's Long-term Energy Supply and Demand Outlook published by the Ministry of Economy, Trade and Industry (METI), the cumulative installed PV capacity target for 2030 is 129 -146 GW (103.5-117.6 GW_{AC}), to meet the carbon reduction target of up to 50% for 2030. The target share for solar PV in the energy generation mix is 23-29% for 2040.

In the Japan Photovoltaic Energy Association's (JPEA) PV OUTLOOK 2050, the cumulative installed PV capacity is expected to be around 154 GW (125 GW_{AC}) in 2030. This ambitious target – 7 GW higher than METI's target – means, on average, that around GW of solar PV will have to be installed every year from 2024 until 2030.

GW Figure 7.1

Japan annual solar PV market scenario 2025-2029



Source: JPEA (Japan Photovoltaic Energy Association)

Drivers for solar growth in Japan

The FIT scheme has been the strongest driver of solar growth in Japan since its introduction in July 2012. However, the relevance of this FIT scheme has decreased, and a more market-oriented Feed in Premium (FIP) has been introduced in April 2022. Instead of setting a fixed feed-in tariff rate, the FIP scheme allocates a certain amount of premium in addition to the wholesale electricity price. This way, the remuneration level is connected to the current electricity price. Under the new framework, larger projects will be subject to the FIP remuneration, while the FIT is maintained for smaller systems.

The **'self-consumption business model'** for commercial and industrial users is growing rapidly in Japan. On-site, self-consumption PV systems are becoming more attractive to business users, as the LCOE of PV power generation is already competitive with the retail electricity prices of commercial and industrial users.

An additional driver of solar growth stems from policies setting **PV mandates for new buildings**. The Tokyo Metropolitan Government and Kawasaki City will make it mandatory to install PV systems on new buildings, including detached houses, starting in 2025. Similar installation mandates are spreading to municipalities across the country, such as Sagamihara City, Matsudo City, and Sendai City. Accordingly, the PV market, especially residential rooftop solar, will expand significantly.

In addition to the needs of renewable energy users, **PPA business models** are beginning to gain traction in the Japanese PV market, driven by government subsidies and rising electricity prices.

44 MW Nishinosato Solar Park, Fukushima, Japan

Utility-scale vs. distributed & rooftop solar developments

In 2024, residential PV capacity (below 10 kW) totalled some 1 GW_{AC}, the same as in 2023. JPEA expects this segment to grow further, supported by the FIT and various subsidies for net-zero energy houses (ZEH), battery systems, etc. Beyond 2025, municipal PV installation mandates for new buildings, including those from the Tokyo Metropolitan Government and Kawasaki City, could be a strong driver of residential rooftop market growth.

Distributed solar PV under 1 MW, mostly ground-mounted, is on a downward trend since 2016, mainly due to reduced FIT support. This segment requires a business transformation, for example, from a simple ground-mounted system to a self-consumption system integrated with renewable energy users' and/or the local community's energy demand. The segment is also expected to grow again with the growth of corporate PPAs and the new FIT scheme for rooftop PV, which provides higher tariffs during the initial five-year period to support early cash-in.

Large solar PV systems of 1 MW and above, including utility-scale systems, are also trending downwards. In addition to the FIT termination, power grid constraints and land availability have also contributed to reduced demand. This segment is likely to start growing again in the medium term, as soon as these constraints are overcome, and with improved cost competitiveness. Following the introduction of the FIP regime, many investors and developers prefer to wait, due to the significant uncertainties about future electricity prices. At the same time, they are turning more and more towards on-site PPAs.

Challenges

One of the biggest challenges for the industry and for policymakers is the **smooth transition from FITs to more market-oriented FIPs**. FIPs were introduced in 2022 as a mandatory incentive mechanism for large-scale solar PV (250 kW and above from 2024), and optional for distributed solar PV (50 kW – 250 kW from 2024). However, the **business model for solar is expected to transform** as the role of FIT/FIP will gradually shrink in the coming years. With the emergence of PPA-type business models, this decade will see the transition towards a market growth with little reliance on the FIT/FIP regime.

Limited grid capacity and curtailment risks are the primary causes of the downward market trend in Japan. In 2024, the curtailment of solar PV in the Kyushu area was around 7%, and the associated risks are becoming apparent. METI is working on additional mitigation measures to minimise curtailment risk, including demand-side management and flexible supply-side operations. Moreover, METI is developing a long-term grid expansion programme to accommodate large amounts of renewable energy.

Another major challenge for solar in Japan is **land availability**. New business models without dedicated land space (e.g. on-site self-consumption models) and utilisation of unused/abandoned farmland are a solution to the limited land availability problem. To date, the conversion of unused/abandoned farmland to solar farms is very limited as it requires strict legal procedures and permission from the local authorities. The government is now tackling those constraints by reforming existing laws and regulations.

Finally, the **cost of solar PV** in Japan still needs to be reduced to compete with conventional gas and/or coal-fired power plants. The average cost of ground-mounted solar PV is estimated at around 12.0 JPY/kWh (0.075 EUR/kWh). The FIT for a ground-mounted PV system is set at 8.6 JPY/kWh (0.054 EUR/kWh) for systems 50 kW and above for 2026.

Author: *Takeaki Masukawa*, Secretary General, Japan Photovoltaic Energy Association (JPEA)

4.8 Australia

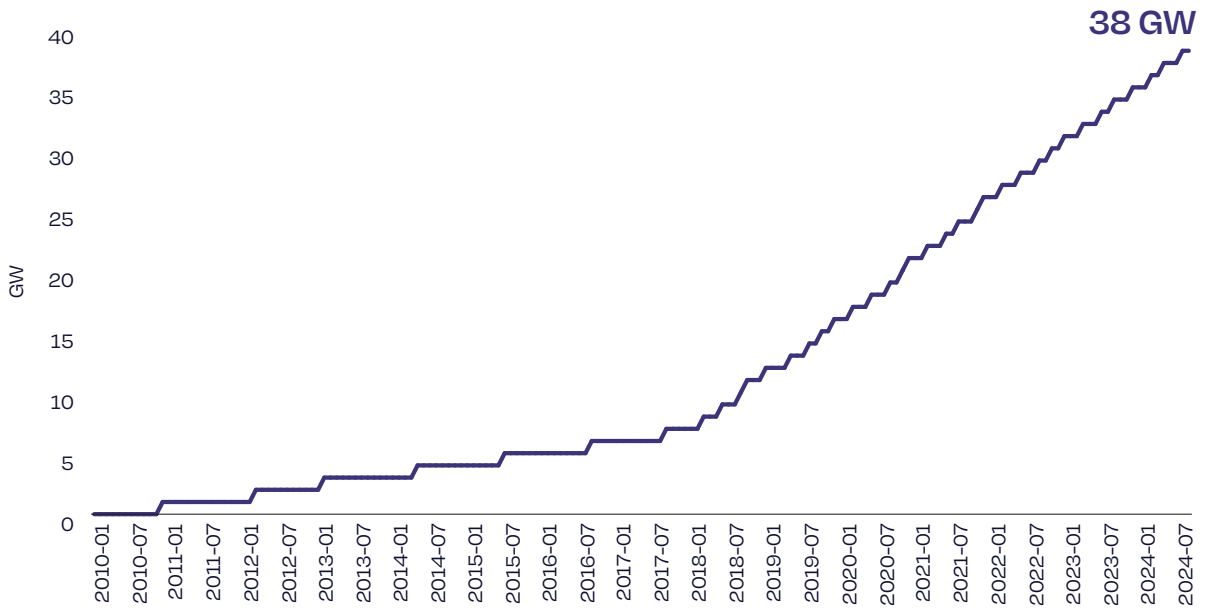
Overview of PV developments

Australia's solar PV market has grown rapidly, with over 3.92 million residential installations and a total capacity exceeding 37.8 GW as of September 2024 (GW Fig. 8.1). In 2024 alone, 300,000 new rooftop systems were added, bringing rooftop solar penetration to one in three households. Solar PV, both rooftop and utility-scale, continues to set new records, driving renewables to a 46% share of the National Electricity Market by year-end. Large-scale solar has expanded more than 20-fold in six years, with total solar generation rising 21% in 2023-24 alone.

With Australia set to elect its next government in the coming months, the political landscape will play a defining role in shaping the future of solar. The Labor government targets 82% renewables for 2030, prioritising solar incentives, battery storage, and grid upgrades. In contrast, the Coalition supports a slower transition, emphasising nuclear alongside solar, with concerns that rooftop solar capacity could be capped. Greens and Independents push for faster decarbonisation and stronger solar policies. With energy policy a key election battleground, the next government's stance will have major implications for the solar industry's trajectory.

GW Figure 8.1

Australia cumulative solar PV installed capacity 2010-2024



Source: Australian PV Institute, 2025

National targets for solar PV

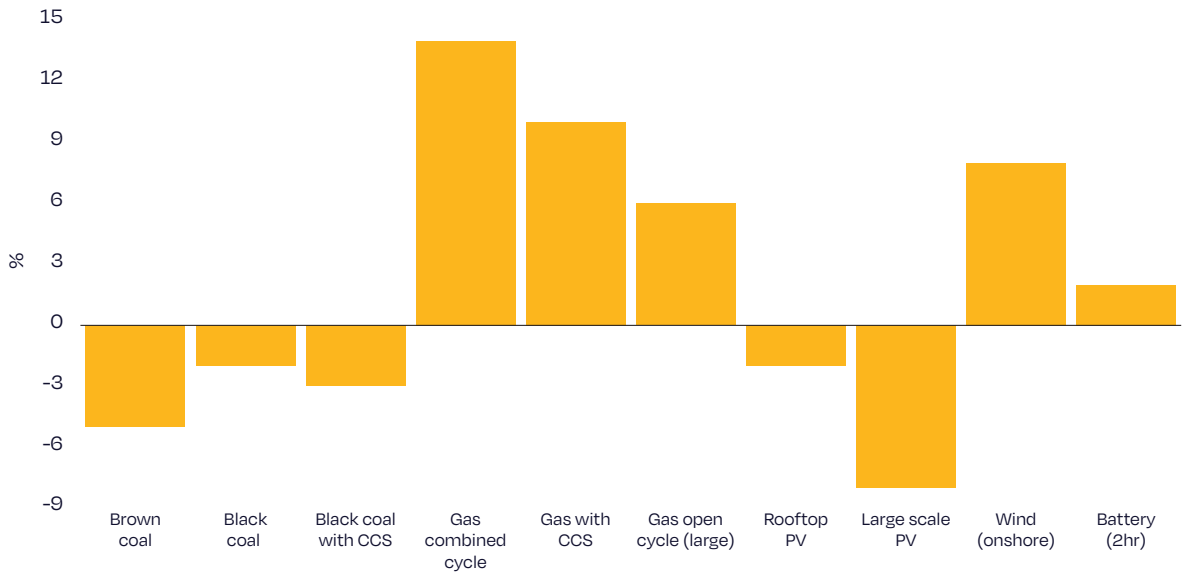
The Australian Labor Government targets 82% renewable energy for 2030, with solar playing a central role. Policies like the Capacity Investment Scheme (CIS) and Solar Sunshot are accelerating large-scale solar adoption, while expanded subsidies for rooftop solar, battery storage, and solar farms are driving the transition from fossil fuels. At the state level, South Australia targets 100% renewables for 2030, the ACT has already reached 100%, and Victoria, Queensland, and NSW are aiming at 50% for 2030 with solar as a key contributor. Tasmania is nearing 100% renewables, while WA and NT are ramping up solar investments. These combined state and federal efforts position solar as the foundation of Australia's clean energy future.

Key drivers for solar growth

Australia's solar energy growth is driven by strong policies, financial incentives, and public demand. The CIS supports large-scale solar and battery projects by reducing financial risks, thus encouraging the transition from coal. The Solar Sunshot program lowers costs through research, innovation, and local manufacturing, making solar cheaper and more efficient: CAPEX costs continued to decrease in 2024 for both rooftop (-2%) and large-scale solar PV (-8%) (GW Fig. 8.2). Public acceptance is at an all-time high, with over 3.5 million households adopting solar to cut electricity costs and emissions. Australia's commercial and industrial rooftop solar market experienced unprecedented growth in 2024, with businesses increasingly investing in solar installations to reduce operating costs and hedge against rising electricity prices. Meanwhile, grid modernisation efforts and record private investment are accelerating deployment at all levels. With policy backing, technological advancements, and public momentum, solar is rapidly becoming Australia's dominant energy source.

GW Figure 8.2

Australia change in capital costs of selected technologies in 2023-24 relative to 2022-23



Source: GenCost 2023-24 Report, CSIRO, 2024

Utility-scale vs. distributed/rooftop developments

Rooftop solar leads in numbers, with over 4 million installations and 27 GW capacity as of late 2024. It supplies a major share of daytime electricity, with one in three households now equipped. Falling costs (50% since 2010), state rebates, and rising consumer awareness have driven adoption, making Australia a global leader. Growth continues, with larger systems and increasing uptake in apartments, rentals, and public housing as incentives improve.

Utility-scale solar has seen strong but fluctuating growth, with 6.07 GW under construction or in planning (valued at AUD 9.53 billion). Despite a 20-fold capacity increase in six years, annual additions have varied due to supply chain issues, policy uncertainty, and grid constraints. However, the sector is set to rebound, with projections exceeding 50 GW by 2030, driven by streamlined approvals, private investment, and the CIS.

Market challenges

Australia's solar energy sector faces several challenges that could impede its growth. Workforce limitations remain a key issue, as the rapid expansion of solar installations demands more skilled professionals for manufacturing, installation, and maintenance. Political opposition also poses hurdles, with the Coalition advocating for nuclear energy and proposing caps on renewable percentages in the grid, creating uncertainty that could deter investment. Additionally, the Australian Energy Market Operator (AEMO) has raised concerns over minimum demand load issues on sunny days due to the inflexibility of coal-fired power plants and the increasing penetration of rooftop solar. In response, AEMO is seeking the ability to control solar exports through an emergency backstop mechanism, a move that has sparked significant concern within the residential solar industry and among manufacturers. Addressing these challenges will be essential for Australia to fully harness its solar potential and achieve its renewable energy targets.

Solar Farm in New South Wales, Australia

Outlook for 2025-2029

Australia's solar PV sector is poised for significant growth from 2025 to 2029, with unmatched potential across utility-scale, commercial, and residential markets. While large-scale solar farms will continue to expand, residential adoption – particularly for apartments, renters, and public housing – remains a key area for development. However, unlocking this growth will require targeted funding, streamlined planning approvals, and subsidies for innovative solutions such as shared solar and battery storage for multi-tenant buildings. In an ideal scenario, these measures would be packaged into a comprehensive 'solar and battery for households' bill, providing equitable access to solar energy. The 2025 federal election will be a defining moment for the industry, as the party in power will shape policy, investment, and regulatory frameworks for the next four years. With the right political support, Australia can fully capitalise on its solar potential, driving the nation towards a cleaner, more resilient energy future.

Author: *Catherine Van Der Merwe*, Policy Officer, Smart Energy Council.

Solar Farm in New South Wales, Australia

4.9 South Korea

Overview of PV developments

The year 2024 marks a period during which the South Korean government has been actively seeking ways to reverse the stagnation in solar deployment observed in recent years. While South Korea's newly installed solar PV capacity reached 2.8 GW in 2023, it is provisionally estimated at 3.149 GW in 2024 (excluding self-consumption), representing an approximate 12.6% increase year-on-year. South Korea's cumulative installed solar capacity in 2024 is estimated at 28.15 GW (also excluding self-consumption). To ensure long-term expansion of renewable energy, the government is making efforts to implement structural improvements, including enhancing institutional stability and expanding the power grid's capacity to accommodate renewable energy sources.

National targets for solar PV

The 11th Basic Plan for Electricity Supply and Demand, finalised and announced in February 2025, was originally scheduled for completion in 2024, following discussions that began in July 2023. However, disagreements over the scale of new nuclear power plant construction delayed the process, resulting in its confirmation around 19 months later. This Basic Plan, which is revised every two years and outlines a 15-year outlook, presents projections for power supply and facility deployment from 2024 to 2038. Taking into account the 2030 Nationally Determined Contribution (NDC) targets, the plan identifies a pathway to accelerate the deployment of solar and wind energy through coordinated, cross-ministerial policy efforts. It sets out a goal to add an average of 7 GW of solar and wind capacity annually by 2030.

Prior to this, in May 2024, the Ministry of Trade, Industry and Energy (MOTIE) announced the 'Strategies for Expanding Supply and Strengthening Supply Chain for Renewable Energy', which aimed to ensure the stable deployment of approximately 6 GW of solar and wind energy annually, while reinforcing the domestic renewable energy industry ecosystem. The government aims to address structural challenges such as site conflicts, grid constraints, and cost burdens, while simultaneously enhancing technological self-reliance and domestic manufacturing capabilities. Ultimately, the strategy positions renewable energy as a dual pillar of South Korea's carbon neutrality and energy security objectives, while aligning with global trends and reflecting a long-term vision for competitiveness in the South Korean renewable energy sector.

Compared to this 2024 strategy, the finalised Basic Plan raises the 2030 solar PV target by an additional 1.9 GW. It also includes measures to strengthen grid stability, such as grid expansion and the deployment of backup systems such as energy storage systems (ESS). The cumulative solar PV installation target is set at 55.7 GW for 2030 and 77.2 GW for 2038.

Key drivers for solar growth

The future expansion of solar PV deployment in South Korea is expected to be driven by a combination of policy, technological, and demand-side factors; this article will focus specifically on policy aspects. The government has set clear mid- to long-term goals through the 11th Basic Plan for Electricity Supply and Demand, aiming to install an average of 4.5 GW of new solar capacity annually until 2030 and reach a cumulative 77.2 GW by 2038 (GW Fig. 9.1). To reach these goals, the South Korean government has outlined a multifaceted strategy focussed on site optimisation, grid integration, supply chain resilience, and market reform. First, the government seeks to promote orderly solar deployment by identifying optimal installation sites and enhancing public and grid acceptance through regulatory improvements. This includes encouraging solar PV installations in industrial complexes with favourable grid and community acceptance, implementing follow-up measures to the 'Agrivoltaics Introduction Strategy' (announced in April 2024), and advancing building-integrated photovoltaics (BIPV) in connection with the mandatory Zero Energy Building

(ZEB) policy. In addition, adjustments to setback distance regulations at the municipal level aim to create a regulatory foundation conducive to the expansion of medium- to large-scale solar projects.

To alleviate grid-related constraints, the strategy promotes solar project siting in regions with surplus grid capacity and emphasises the principle of 'flexible interconnection' to improve grid utilisation efficiency. Measures such as tracking and managing underutilised capacity and supporting the integration of solar PV with ESS are also included.

Furthermore, the government aims to strengthen domestic solar supply chains and secure next-generation technologies by reforming institutional mechanisms such as the Renewable Portfolio Standard (RPS) and competitive bidding systems. This includes targets for commercialising tandem solar cells, positioning South Korea as a competitive player in the global technologies landscape while enhancing energy security. The Centre for Advanced Solar PV Technology (CAST), an open innovation platform designed to consolidate research capabilities across industry, academia, and research institutes in next-generation tandem cells, modules, and measurement technologies, was inaugurated in Daejeon in March 2024.[15]

The Center for Advanced Solar PV Technology (CAST), inaugurated in March 2024 in Daejeon, South Korea

15 It features a 100 MW-scale pilot line capable of producing solar cells up to M12 size and modules, and conducts R&D on reliable measurement and evaluation methods for next-generation solar PV technologies such as tandem cells.

At the end of last year, Hanwha Qcells achieved a power conversion efficiency of 28.6% with a self-developed tandem solar cell on a large-area M10 wafer, receiving official certification from the Fraunhofer Institute for Solar Energy Systems (Fraunhofer ISE). This marked the first time ever that a tandem cell of the large-area (330.56 cm^2) format, which can be applied to commercially available modules, was certified by an independent third-party institution.

Institutional reforms are also being pursued to adapt to emerging markets. On the regulatory side, the RPS will be restructured to allow the government to lead systematic deployment by setting annual capacity targets for each energy source through bidding. On the voluntary side, the government will actively support the expansion of PPAs, especially in connection with RE100, through regulatory improvements, financial incentives, and risk mitigation tools. A phased approach is envisioned: starting with public-private partnerships to establish a PPA brokerage platform and gradually transitioning to a market-led model.

Finally, to support overseas market entry, the government plans to establish a 'Renewable Energy Global Expansion Council' as a one-stop support system and promote large-scale international projects through top-down government-to-government (G2G) cooperation initiatives. Collectively, these efforts represent a comprehensive roadmap to enable sustainable growth of the solar PV industry both domestically and globally.

Agrivoltaic demonstration complex, Gwandang Village, Namhae, Gyeongnam Province, South Korea

Utility-scale vs. distributed/rooftop developments

As of 2023, the cumulative installed solar capacity totalled 28 GW, of which 24.2 GW – approximately 86% – was accounted for by power generation businesses. In contrast, residential installations made up 2.2 GW (8%), commercial and industrial (C&I) applications 1.3 GW (5%), and other uses only 0.3 GW (1%). South Korea's solar PV deployment relies heavily on privately operated business models. Based on capacity, of the total 28 GW installed, ~12 GW (42.9%) comes from systems of 100 kW or less, ~11 GW (39.2%) from systems between 100 kW and 1 MW, and approximately 5 GW (18%) from systems larger than 1 MW. This indicates that despite the dominance of power generation businesses, small- and mid-scale solar systems still account for a significant portion of Korea's overall solar PV capacity.

Given that the country's industrial structure is heavily focussed on manufacturing and exports, demand for renewable energy – particularly in response to global initiatives such as RE100 – is expected to grow. In this context, demand-driven deployment models such as PPAs, which allow companies to voluntarily secure renewable energy, are likely to expand. This suggests the potential for the currently utility-centred deployment structure to gradually diversify toward self-consumption and distributed energy systems in the future.

Market challenges

Despite its growth potential, South Korea's solar PV market faces numerous structural and institutional challenges that continue to hinder its expansion. One of the most pressing issues is the limited capacity of the power grid, particularly in regions where renewable energy development has already reached saturation. This has resulted in delays in grid connection and, in some cases, curtailment of electricity output. Although measures such as the mandatory installation of ESS have been introduced to alleviate these constraints, the associated costs remain a burden for project developers.

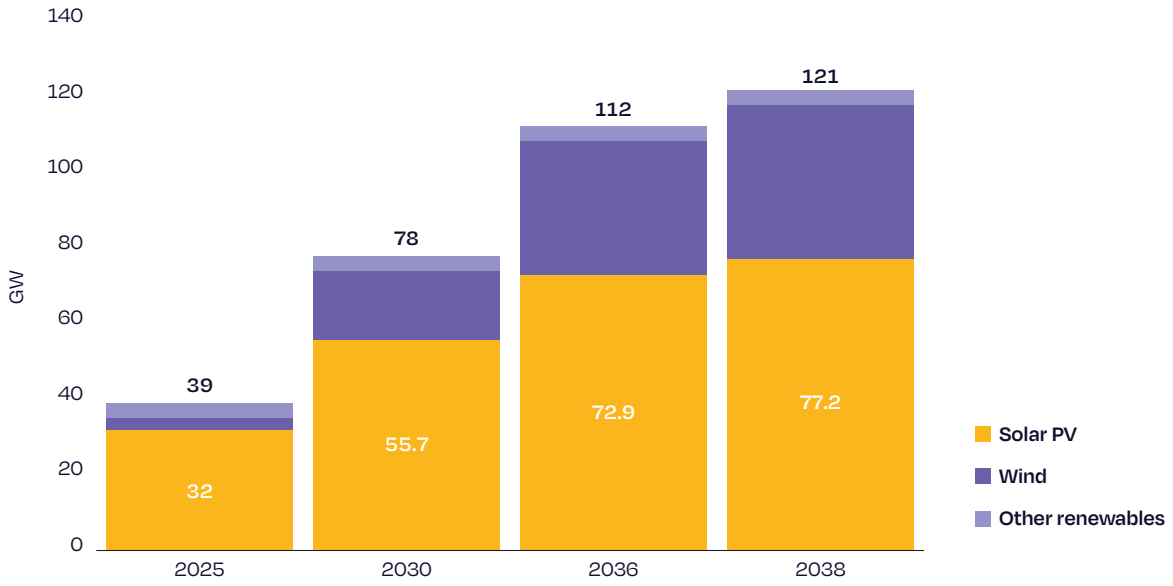
In addition, regulatory uncertainty further complicates the market environment. The RPS is currently under review for potential abolition, and discussions are underway to introduce an alternative auction-based mechanism. Frequent shifts in energy policy directions, often triggered by changes in political administration, undermine investor confidence and make long-term planning difficult.

Land-use conflicts and complex permitting processes also pose significant barriers. Local opposition, restrictions on the development of agricultural and forest land, and increasingly stringent environmental regulations often lead to project delays or cancellations. At the same time, the cost of solar power generation in South Korea remains relatively high compared to the global average. Falling Renewable Energy Certificate (REC) prices and the implementation of a system marginal price (SMP) cap have further eroded project profitability, reducing incentives for private sector investment. Additionally, while there are differences across segments of the value chain, the domestic manufacturing industry has become increasingly dependent on imports due to oversupply from China, exposing vulnerabilities in the supply chain. Finally, the current support framework is heavily weighted toward large-scale utility projects, leaving small-scale and distributed solar systems with limited access to viable revenue models and institutional support. These compounded issues highlight the urgent need for a more stable, equitable, and strategically coordinated policy framework to support the sustainable growth of South Korea's solar PV industry.

The renewable energy strategies and government policies have been designed to address these structural challenges. Notably, the Special Act on the Promotion of Distributed Energy, enacted in June 2023 and enforced in June 2024, provides a legal basis for expanding distributed energy resources and promoting local energy production and consumption. The government is actively pursuing regulatory reforms to facilitate the deployment of diverse solar PV installation models – such as agrivoltaics, floating PV, and building-integrated systems – while simultaneously working to improve overall market conditions. These efforts are expected to generate synergy in alignment with the implementation of this Special Act. Furthermore, a range of support measures and institutional incentives are being introduced to accelerate solar PV deployment in the public sector.

GW Figure 9.1

South Korea renewable capacity deployment outlook 2025-2038



Source: 11th Basic Plan for Electricity Supply and Demand, Korean Ministry of Trade, Industry and Demand (MOTIE)

Outlook for 2025-2029

According to the Export-Import Bank of Korea, the domestic solar PV market is expected to maintain an annual installation level of around 3 GW through 2030; however, this is insufficient to meet the targets set by the 11th Basic Plan for Electricity Supply and Demand and the NDC. As of March 2025, Korea's cumulative installed solar capacity in 2024 is estimated at 28.15 GW. To meet the 2030 target set in the 11th Basic Plan, an average of 4.5 GW of new solar capacity must be added annually. When extended to 2038, this translates to an annual average of approximately 3.5 GW. Given that the current short-term target for new capacity is around 4 GW per year over the next two years, more aggressive efforts will be required to stay on track.

The 2nd Presidential Commission on Carbon Neutrality and Green Growth, launched on February 27 of this year, convened its Energy and Just Transition Subcommittee on March 25 to discuss institutional reform measures. Key initiatives announced include mandating solar PV installation in 2,995 public parking lots, establishing guidelines to expand the available area for floating solar systems on multipurpose dams, and launching a local government funding program to improve setback regulations for solar installations. These efforts, along with various policies being implemented by the government and across multiple sectors, are expected to have a positive impact on the future outlook for solar PV expansion in South Korea.

Author: *Jihye GWAK*, Principal Researcher/Chief of the Photovoltaics Department, Korea Institute of Energy Research (KIER).

* The background photo shows a 940MW Fishery-PV project, the largest of its kind in China, with nearly 2 million DMEGC Solar Infinity RT series modules installed.

DMEGC SOLAR

iNFINITY RT

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4.10 United Kingdom

Overview of PV developments

2024 was the best year for the British solar industry in the post-subsidy era. Solar capacity increased by about 2.3 GW to reach 20.2 GW, according to Solar Media. The official figure is smaller but fails to account for the particularly active commercial-scale market.

As in recent years, growth was driven by the need for energy security, persistently high energy prices, the low cost of panels and the response to climate change.

More than 184,000 installations of 50 kW or less were tracked by MCS (Microgeneration Certification Scheme, a standards organisation), a little less than the 198,000 seen in 2023 (GW Fig. 10.1). Around 500 MW was added, approximately the same as the commercial-scale sector.

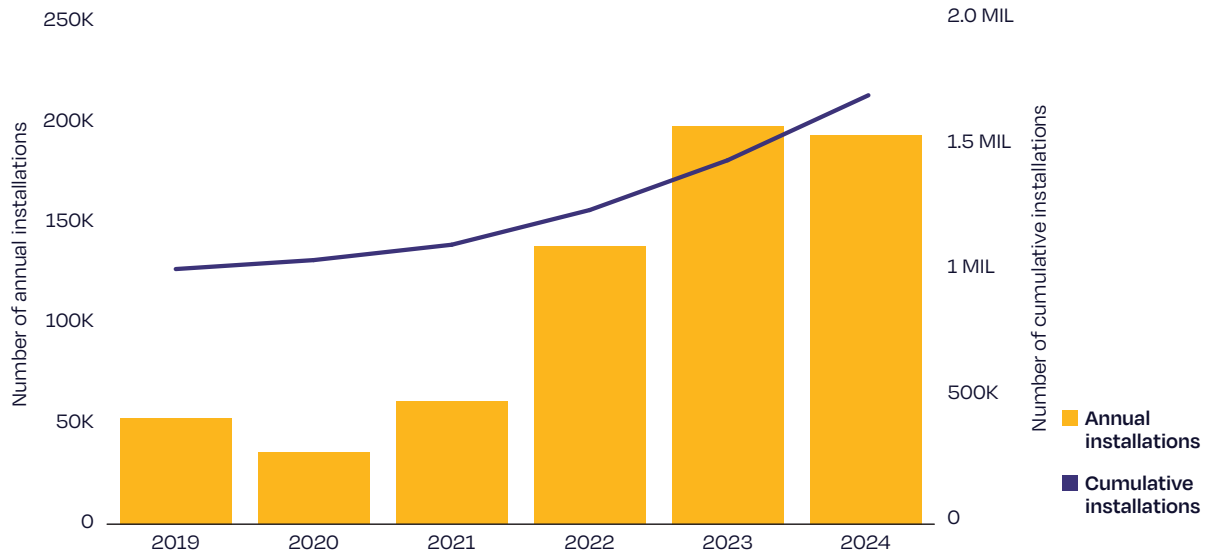
Around 1.3 GW of ground-mount was installed, 850 MW of which was backed by the Contracts for Difference (CfD) scheme. About 4 GW of solar farms is currently under construction, which at the time of writing included the 373 MW Cleve Hill project, set to become the UK's largest operational solar farm.

Even larger installations are in the pipeline, with over 3.4 GW of nationally significant (over 100 MW) projects approved since the Labour Party entered power in July. The largest was the 600 MW Cottam project in Lincolnshire.

GW Figure 10.1

UK annual and cumulative PV installations below 50 kW 2019-2024

(end of subsidies in April 2019)



Source: Solar Energy UK

National targets for solar PV

Labour promised a more ambitious approach to renewable energy and decarbonisation, planning for fossil fuels to supply no more than 5% of the UK's electricity by 2030. To support this, a goal to reach 45-47 GW of grid-connected generation, in addition to 9-10 GW of rooftop PV, was set in December under the Clean Power 2030 Action Plan. The government also anticipates around 69.5 GW of grid-connected PV alone by 2035, though Solar Energy UK believes that 90 GW in total could be delivered (GW Fig. 10.2).

The 'balanced pathway' for decarbonisation proposed by the Government's advisory Climate Change Committee anticipates there will be 80 GW of solar in total by 2040 and 106 GW by 2050.

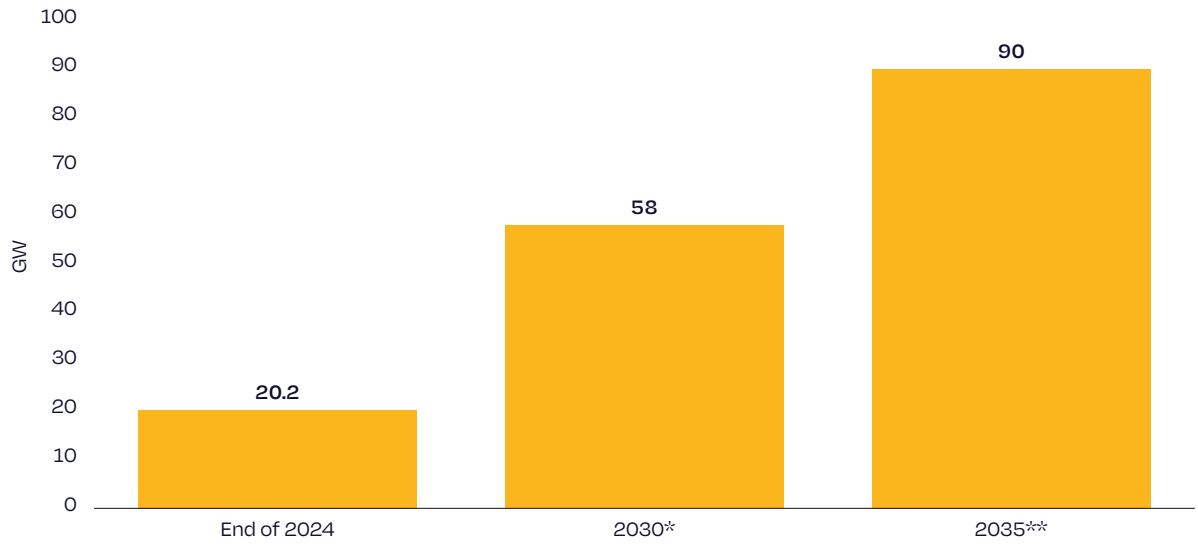
Drivers for solar growth

The practical measures needed to meet these goals, such as growing the skills base and reinforcing the electricity networks, will be laid out in the government-industry Solar Roadmap, due in the spring.

The seventh round of the CfD Scheme will also be a significant stimulus for constructing more solar farms.

GW Figure 10.2

UK solar PV installed capacity 2024 and targets 2030-2035



Source: Solar Media, Solar Energy UK

*Clean Power 2030 Action Plan
** Solar Energy UK estimate, including behind-the meter installations

The forthcoming Future Homes Standard and Future Buildings Standard are expected to all but mandate the installation of solar panels on new homes and other buildings in England. Current building standards also encourage PV installation on new homes, with over 40% of those completed in England in the last quarter of 2024 having panels fitted.

Reform to grid-connection procedures is ongoing. This should accelerate projects that are most ready for construction. The removal of red tape associated with projects over 1 MW is also anticipated, cutting both costs and waiting times.

Last year's reforms to the National Planning Policy Framework have moved the threshold for projects to be considered as nationally significant infrastructure projects (NSIPs) in England from 50 MW to 100 MW. The previous threshold had led to many solar farms being capped at 50 MW, due to the extra costs of seeking ministerial, rather than local, approval.

Residential solar PV, United Kingdom

Market challenges

The main challenge remains access to the grid. Despite reforms implemented under the 2023 Winser Review, waiting times for connecting commercial-scale and ground-mount projects can still be many years. Current reforms to the connections queue and the planned introduction of spatial energy planning, alongside forthcoming changes to electricity market arrangements, will all influence the speed and scale of deployment in the next few years.

Although finance packages are becoming increasingly available, residential solar installations are largely cash transactions. This reduces potential uptake, especially in less affluent areas. It is hoped that the UK Government's forthcoming Warm Homes Plan may enable more households on lower incomes to benefit from solar.

At a commercial scale, the conditions of building ownership can be a problem. Businesses that would benefit from cheaper electricity often do not own their own premises. Changes in this sector would enable many more businesses to benefit from lower energy bills.

Relatively high interest rates compared to the past decade are a further issue, increasing the cost of finance for the sector and inhibiting investment.

Outlook for 2025-2029

The UK's policy environment is very positive for the solar industry. Energy Secretary Ed Miliband, the third and final chair of the Solar Taskforce, has publicly backed the sector.

As he told Parliament last year, "The biggest threat to nature and food security and to our rural communities is not solar panels or onshore wind; it is the climate crisis... The Government will proceed not on the basis of myth and false information, but on evidence."

Author: *Gareth Simkins*, Senior Communications Adviser, Solar Energy UK

3 MW King's Hill Solar Farm, Kent, United Kingdom

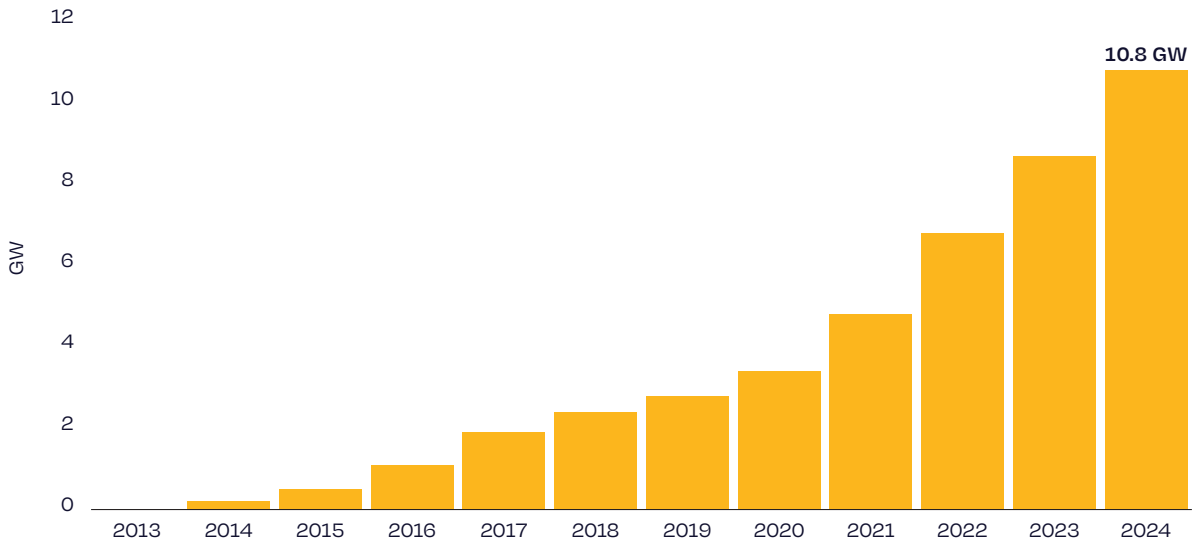
4.11 Chile

Overview of PV development

Chile has solidified its position as a global leader in solar PV energy, reflecting consistent growth and substantial development throughout 2024. By the close of 2024, solar capacity reached approximately 11 GW (GW Fig. 11.1), representing 30.33% of Chile's total installed capacity of 34.7 GW within the National Electric System (SEN). The solar segment alone accounted for around 18.5% of total electricity generation by December 2024, highlighting its pivotal role in Chile's energy transition strategy.

GW Figure 11.1

Chile cumulative solar PV installed capacity 2013-2024



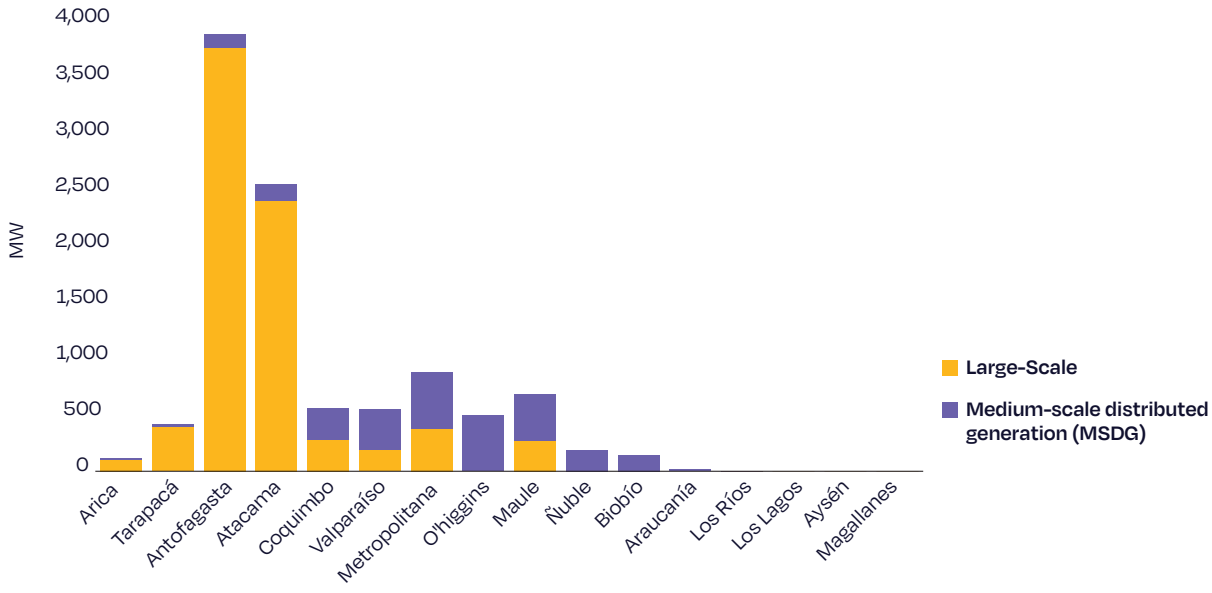
Source: ACESOL

National targets for solar PV

From just over 1 MW installed in 2015, cumulative rooftop PV capacity under net billing reached approximately 323 MW by early 2025 across nearly 28,000 installations. This growth has been concentrated mainly in the Metropolitan, Valparaíso, and Maule regions (GW Fig. 11.2), driven by favourable solar conditions and supportive regulatory frameworks, such as net billing. Despite the potential for distributed generation, growth has been relatively modest, hindered by regulatory and technical barriers, including grid congestion and administrative complexities in project approval processes.

GW Figure 11.2

Chile geographic distribution of solar PV installed capacity 2024



Source: ACESOL

Key drivers for solar growth

Key drivers behind Chile's solar growth include robust solar irradiation, favourable regulatory frameworks, declining technology costs, and ambitious decarbonisation targets. The National Energy Policy aims for carbon neutrality by 2050, propelling large-scale investments in renewable energy, particularly solar PV, the region's most competitive renewable technology. Additionally, market mechanisms such as net billing and medium-sized distributed generation (MSDG) have attracted private investment and facilitated consumer engagement at multiple scales.

Utility-scale vs. distributed/rooftop developments

Chile's solar PV market comprises two segments: utility-scale installations and distributed generation. Utility-scale PV installations dominate, representing around 74% of Chile's solar capacity, with significant developments concentrated in the northern regions – Antofagasta and Atacama – owing to their superior solar resources. In contrast, Medium-Sized Distributed Generation (MSDG) and rooftop installations, which account for around 25% and 1.3% of total capacity, respectively, are primarily situated near urban and suburban centres.

Market challenges

Significant market challenges remain. Transmission constraints pose the most critical obstacle, as grid congestion, particularly in the northern regions, impedes full utilisation of installed solar capacity. This bottleneck necessitates accelerated investments in transmission infrastructure and regulatory reforms to optimise network management. Further challenges arise from limited financing options for distributed solar projects and the complexity of permitting processes, particularly for smaller installations.

The outlook for Chile's PV sector from 2025 to 2029 remains optimistic but underscores the urgency of addressing infrastructure and regulatory issues. Capacity is projected to continue expanding, driven by advancements in storage technologies and regulatory frameworks encouraging hybrid solutions (solar plus storage), enhancing the grid's resilience and flexibility. The government is expected to streamline regulatory frameworks further, expand net billing and distributed generation programs, and possibly implement direct incentives to stimulate broader adoption at the residential and commercial levels.

However, achieving sustained growth will depend heavily on addressing key market barriers. A fundamental redesign of the electricity market framework will be crucial, particularly concerning pricing and grid access for distributed generation. Concurrently, expanding transmission capabilities and modernising distribution grids are imperative to ensure that new solar capacity effectively contributes to system stability and efficiency.

Chile's solar PV sector stands at an inflexion point. With the right policies, regulatory improvements, and strategic infrastructure development, the country can maintain and significantly expand its leadership role in solar energy deployment, contributing decisively to its climate goals and economic resilience.

Author: *Darío Morales*, Executive Director of the Asociación Chilena de Energía Solar (ACESOL)

246 MW El Romero Solar PV plant, Atacama Desert, Chile

4.12 Taiwan

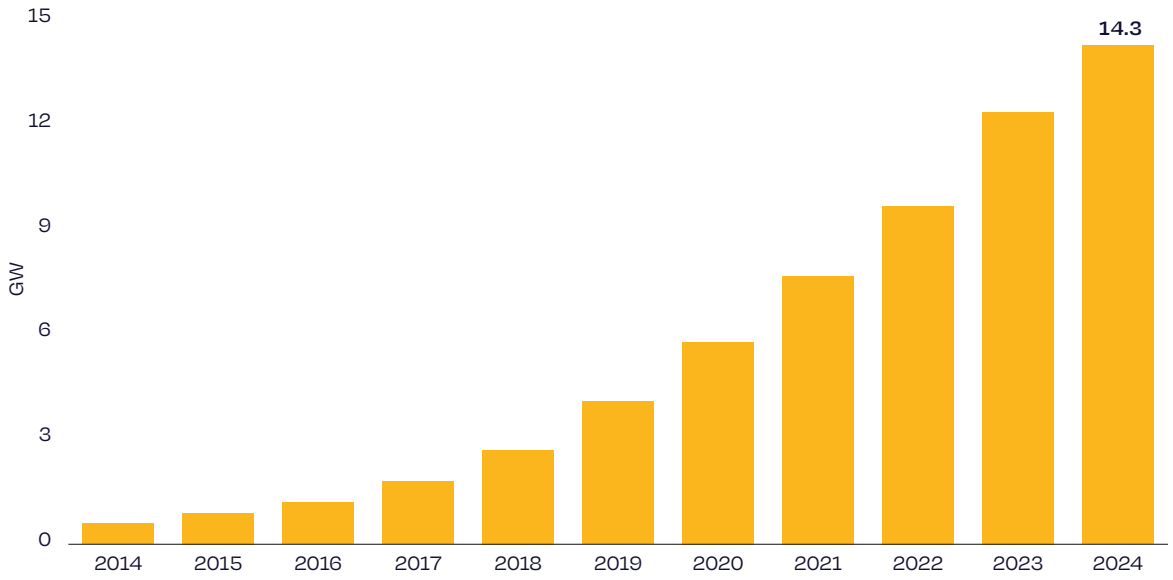
Overview of PV development

As the island nation of Taiwan seeks to reduce its reliance on fossil fuels and meet its ambitious carbon reduction goals, solar PV has emerged as a cornerstone of its green energy strategy. In recent years, Taiwan has accelerated solar PV development, achieving remarkable progress despite challenges such as land scarcity and grid integration.

After surpassing the 10 GW mark for total installed solar PV in 2023 (with 12.4 GW), 1.9 GW of new solar PV were added in 2024, bringing Taiwan's cumulative solar capacity to 14.3 GW. (GW Fig. 12.1)

GW Figure 12.1

Taiwan cumulative solar PV installed capacity 2014-2024



Source: Taiwan Ministry of Economic Affairs, Energy Administration

This growth has been driven by favourable government policies, including feed-in tariffs (FiTs) and subsidies for solar installations. The government has also streamlined the permitting process for solar projects, reducing bureaucratic hurdles and accelerating deployment.

National solar PV and RE targets

In alignment with Taiwan's renewable energy goals to generate 20% of its electricity from renewable sources by 2025, Taiwan has set ambitious targets for solar PV deployment. The government aims to reach 20 GW of solar capacity by 2025, up from just 1.25 GW in 2016. This aggressive expansion reflects Taiwan's commitment to combatting climate change and ensuring energy security in the face of geopolitical uncertainties.

Drivers for solar growth

Rooftop solar installations have played a crucial role in Taiwan's solar PV expansion. The government has encouraged households, businesses, and industrial facilities to install solar panels on their rooftops through incentives and net metering programs. As a result, urban areas like Taipei and Kaohsiung have seen a surge in rooftop solar adoption.

In addition to rooftop PV, Taiwan is developing several large-scale solar PV power plants: for example, the Tainan Solar City project aims to transform the southern city into a hub for solar energy production. The government is also collaborating with private companies to build solar PV on reclaimed land and unused industrial sites. Furthermore, in a bid to maximise renewable energy output, Taiwan is exploring hybrid projects that combine offshore wind farms with floating solar installations, leveraging Taiwan's strong winds and abundant sunlight to generate clean energy more efficiently.

Finally, to address the intermittent nature of solar power, Taiwan is investing in energy storage systems (ESS): battery storage projects are being deployed alongside solar power plants to store excess energy and ensure a stable power supply. This integration is critical for maintaining grid stability as solar PV's share in the energy mix continues to grow.

10.02 MW Agongdian solar PV park, Kaohsiung Reservoir, Taiwan.

Market challenges

Despite its progress, Taiwan's solar PV market faces several challenges, namely grid capacity and stability, land use conflicts, and supply-chain disruptions. First, the rapid growth of solar energy has strained Taiwan's power grid, leading to concerns about grid stability. To address this, the government is upgrading grid infrastructure and investing in smart grid technologies.

Competition for land between solar projects and other uses, such as agriculture and industry, remains a contentious issue and one of the biggest challenges for Taiwan's solar development. To overcome this, the government and private sector have embraced innovative solutions, such as floating solar farms and agrivoltaics. Taiwan has developed several floating solar installations on reservoirs and ponds. For example, the Changhua Coastal Industrial Park features one of the largest floating solar farms in the region, generating clean energy while conserving valuable land resources. Agrivoltaics has also gained traction in rural areas, providing farmers with additional income and promoting sustainable land use.

Finally, global supply chain disruptions, exacerbated by the COVID-19 pandemic and geopolitical tensions, have previously impacted the availability of solar panels and components. Taiwan is addressing this challenge by strengthening its domestic solar manufacturing capabilities and diversifying its solar supply chain.

Outlook for 2025-2029

Looking ahead, Taiwan's solar PV sector is poised for continued growth. The government has announced plans to further increase solar capacity, with a target of reaching 30 GW by 2030. This expansion will be supported by ongoing investments in technology, infrastructure, and policy frameworks. Taiwan is also leveraging its expertise in semiconductor manufacturing to develop next-generation solar technologies, such as high-efficiency photovoltaic cells and perovskite solar panels. These innovations promise to enhance the efficiency and affordability of solar energy. Furthermore, Taiwan is actively collaborating with international partners to advance its solar energy goals, as Taiwanese companies partner with global leaders in renewable energy to share knowledge, technologies, and best practices. Finally, the government is also focussing on community engagement to promote solar energy adoption. Public awareness campaigns and educational programs are being implemented to encourage citizens and businesses to embrace renewable energy.

Taiwan's solar energy development is a shining example of how innovation, policy support, and public-private collaboration can drive the transition to a sustainable energy future. With its ambitious targets, innovative solutions, and unwavering commitment to renewable energy, Taiwan is well on its way to becoming a regional leader in solar power. By overcoming challenges and seizing opportunities, Taiwan's solar energy sector is set to play a pivotal role in the global fight against climate change, proving that even small nations can make a big impact.

Author: *Daniel Lee*, Project Manager, Taiwan Photovoltaic Industry Association (TPVIA)

4.13 Switzerland

Overview of PV developments

After 4 years with an average annual market growth of 50%, the pace of solar PV expansion in Switzerland slowed down in 2024. According to Swissolar estimates, around 1.8 GW of solar PV capacity was newly installed in 2024, corresponding to an increase of just under 10% compared to 2023. This slower growth allowed the industry to shorten waiting times for order processing and overcome personnel bottlenecks. The Swiss PV market continues to be dominated by installations on buildings, with the commercial and industrial buildings sector developing more rapidly than the residential sector in 2024.

National targets for solar PV

In the referendum that took place on 9th June 2024, a revision of the Energy Act was approved with 68% of votes in favour. This includes ambitious targets for the expansion of new renewable energies (excluding hydropower), which are to supply 35 TWh annually by 2035 and 45 TWh by 2050.

To put this into perspective: Switzerland's current electricity consumption is around 60 TWh per year, and it should be at least 80 TWh by 2050. In 2024, hydropower plants supplied 48 TWh, nuclear power plants 23 TWh and PV systems 6 TWh. Switzerland is an important supplier of electricity to neighbouring countries.

Technology-specific targets do not yet exist. However, given strong public opposition to wind energy, there is a consensus that the majority of the target should be covered by solar power. Swissolar has set itself the target of producing at least 28 TWh of solar power by 2035, a five-fold increase compared to 2024.

Key drivers for solar growth

Since 2023, Switzerland has experienced a sharp increase in electricity prices, which are now falling slowly. Consumers with an annual consumption of more than 100,000 kWh, who unlike other consumers can participate in the free electricity market, are particularly affected. These are mostly commercial and industrial enterprises, which often make their roof areas available for PV systems as part of an on-site PPA. Parallel to high purchase prices, the remuneration for electricity fed into the grid has also risen massively. There is also an upfront (one-off) payment that covers around 12-25% of the investment costs, depending on the size of the system. This percentage is higher for full feed-in systems. In addition, investments can be deducted from income tax. These are all key drivers for solar growth in Switzerland.

Solar apprentice working on a roof

Utility-scale vs. distributed and rooftop developments

In Switzerland, solar systems have predominantly been installed on buildings. The residential and commercial sectors each contribute roughly half of the installed capacity. PV systems on façades is a small, but fast-growing segment in the commercial sector. Since 2023, it is also possible to construct large-scale solar plants in the Alps with a simplified procedure and high subsidies, potentially increasing winter production. However, the challenges in these projects are significant, and the winter power production target for these plants will not be reached in the planned timeframe. The parliament has decided to extend the deadline, thus enabling the construction of additional plants.

Market challenges

One market challenge for the Swiss solar industry has been a shortage of skilled labour. To address this, Swissolar has introduced two-year and three-year apprenticeship programmes for solar installers. The courses started for the first time in August 2024 with 186 participants, exceeding expectations. Additionally, the association offers various further training courses for career changers.

Meanwhile, a new regulation for grid-fed electricity prices, valid as of 2026, is a cause for uncertainty in the industry. These prices will be tied to quarterly average reference market prices, combined with a floor price. Anticipated low summer electricity prices affect the economic efficiency, but create incentives to increase self-consumption, for example, using batteries. The new flexibility provisions have the same effect, allowing distribution grid operators to limit the feed-in of up to 3% of annual production without compensation.

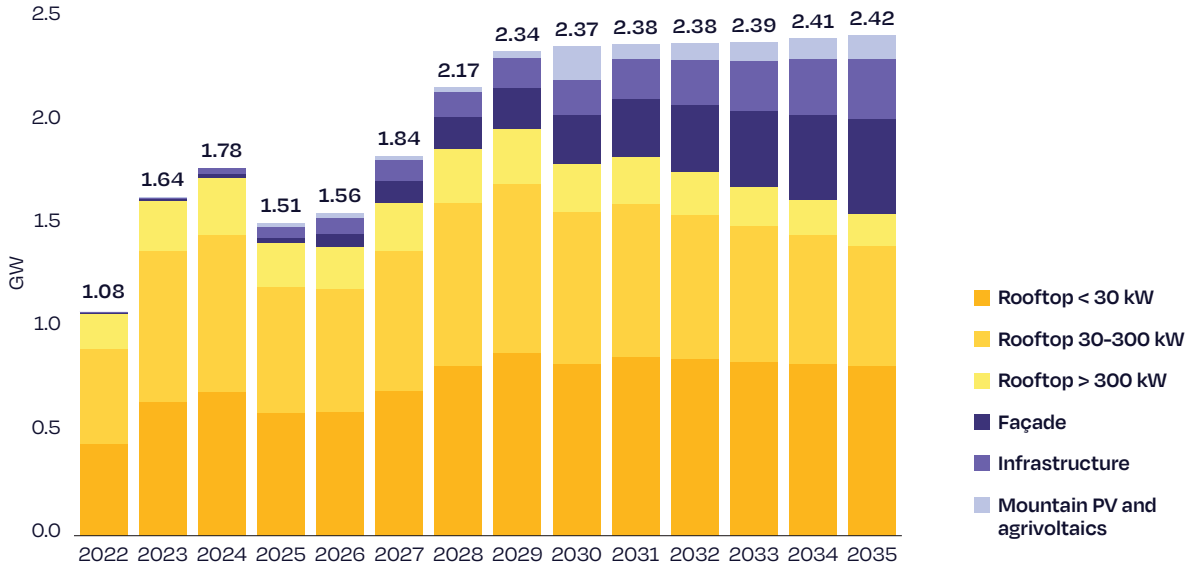
The authorisation process for solar installations remains restrictive in many cases, particularly in protected town centres. Agri-PV projects are only permitted if they enhance agricultural yield, and planned large-scale Alpine plants have faced opposition from environmental organisations.

There is a growing need for clarification with building insurers. Due to recent extreme hail events, heightened requirements for module hail resistance will be introduced, requiring resistance against hailstones with a 4 cm (or even 5 cm) diameter. The rise in façade systems, which can significantly contribute to winter power supply, has brought fire protection concerns to the forefront.

Solar façade in Muensingen (Berne)

GW Figure 13.1

Switzerland annual solar PV capacity scenario 2025-2035



Source: Swissolar

Standardised fire tests are being carried out so that a state-of-the-art standard for these systems will be available by the end of 2026.

Outlook for 2025-2029

In 2025 and 2026, a decline in expansion compared to 2024 is expected due to uncertainties relating to the transition to the new legal provisions (GW Fig. 13.1). However, these will then take effect, and an annual expansion of over 2 GW can be expected, thus facilitating the attainment of the targets outlined in the new Energy Act. Key catalysts are the revised regulation for collective self-consumption and the 'local electricity communities' modelled after Austria. These communities can leverage the public electricity grid at a local level at a reduced tariff, promoting the alignment of production and solar power generation and minimising unnecessary grid expansions. Electromobility plays a pivotal role in this context, serving as an intermediate storage solution via bidirectional charging. Battery Energy Storage Systems (BESS) in the residential and commercial sectors are rapidly gaining in importance. Additionally, heat pumps, the predominant heating system in Switzerland for new constructions and heating replacements, further bolster the utilisation of photovoltaics.

From 2025, subsidies will be increased for PV systems on façades and car park roofs, and from 2026, their approval process will be simplified, so strong growth is to be expected in these segments. In the case of agri-PV, on the other hand, no simplifications are expected in the foreseeable future, due to land-use conflicts and concerns from farmers. As a result, only a few solar plants will be built to cover berry crops.

Author: *David Stickelberger,* Deputy Managing Director, Swissolar

4.14 Colombia

Overview of PV developments

In 2024, Colombia's solar PV sector reached a major milestone, officially crossing into the gigawatt-scale market. An estimated 1.6 GW of new solar PV capacity was connected to the grid, bringing total installations to approximately 2.3 GW. This means nearly 70% of Colombia's entire PV fleet was installed in a single year – underscoring 2024 as a breakout year for solar.

Despite this growth, solar still accounts for only 3.7% of the electricity generated in Colombia, according to data from Ember. The electricity mix remains dominated by hydropower (58.1%), followed by gas (16.8%) and coal (15.2%). Solar, however, contributes more than wind and other so-called 'Non-Conventional Renewable Energy Sources' (FNCER). The growth of solar is happening at a rapid pace, ensuring it can soon become a conventional renewable energy source for Colombians, much like hydro power.

According to SER Colombia, a renewable energy industry association, 33 utility-scale solar projects totalling 1,410 MW were successfully connected in 2024. Rooftop solar also made important strides, adding 215 MW across residential, commercial, and industrial segments. These figures align closely with estimates from SolarPower Europe, which puts Colombia's total cumulative PV capacity today at around 2.3 GW.

23 MW Baranoa solar PV plant, Atlantico, Colombia

Key drivers of solar growth

Utility-scale solar continues to dominate the Colombian market, accounting for close to 90% of the new capacity added in 2024. Energy auctions remain the principal mechanism for expanding this segment, with several projects coming online as part of previously awarded long-term contracts. Notably, Enel completed a major solar park in Atlántico, contributing 487 MW to the grid – one of the largest single-site additions in the country's solar history.

Falling module prices and improved grid access conditions have also played a crucial role in accelerating utility-scale development. These macro trends have made large-scale solar increasingly bankable for domestic and foreign investors alike.

Meanwhile, the rooftop segment – though still relatively modest – showed notable momentum. The 200+ MW added in 2024 was equivalent to the entire Colombian solar market size in 2023. A key emerging trend here is the role of energy communities, which are expected to drive future growth. In late 2024, the large western capital city of Cali released its own pilot energy community project, aimed at reducing energy bills for 2,000 low-income households. In early 2025, regulators followed up with a resolution expected to enable up to 1 GW of community-based solar capacity nationwide. These communities allow citizens of the same electricity market area to be treated as a collective energy generator, even when they are not physically located in the same neighbourhood.

External events such as the El Niño-induced drought of 2024 also underscored Colombia's reliance on hydropower – and its vulnerabilities. Reduced rainfall impacted hydroelectric output and led to increased LNG imports. The International Energy Agency (IEA) considers Colombia as one of the highest-impacted countries in Latin America, with a large increase in LNG imports and, therefore, vulnerability to LNG supply and price fluctuations. On top of this, energy associations have warned of a potential shortfall in generation capacity by 2027. To resolve this, solar PV stands as one of the few scalable and affordable options to bridge the gap.

Market challenges

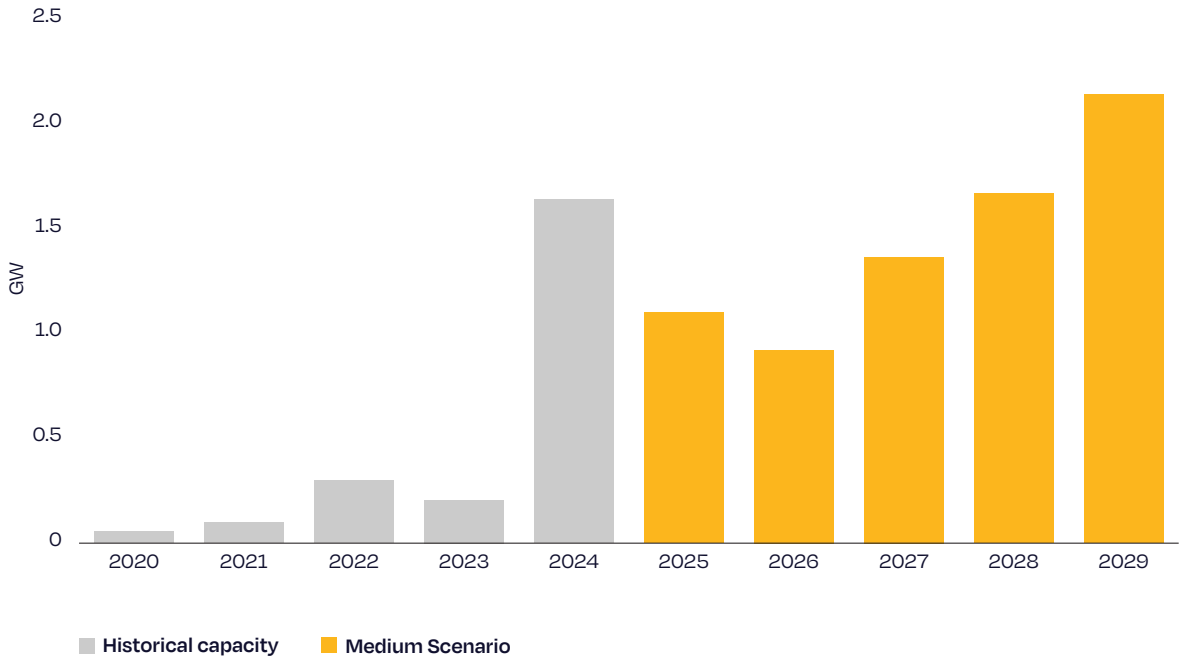
Despite the recent surge, Colombia's solar sector still faces structural and regulatory headwinds. For one, government targets are seen as insufficient, especially since the new pace of installations and the potential future shortage in generation capacity.

Rooftop solar, in particular, continues to lag – constrained by a lack of incentivisation and a general lack of awareness in certain regions. While new regulations on energy communities are promising, broader support will be needed to unlock this market segment's full potential.

Political uncertainty remains a significant concern, particularly for utility-scale developers. A key issue is Resolution CREG 101 066 of 2024, which changes the pricing mechanism for variable generation. SER Colombia has warned that this could jeopardise up to 3 GW of auction-awarded capacity, putting projects at financial risk. If the resolution is not clarified or adjusted, investor confidence in long-term solar development could be shaken.

GW Figure 14.1

Colombia annual solar PV capacity forecast 2025-2029



Outlook for 2025-2029

Colombia's strong solar performance in 2024 lays the foundation for continued market growth in the second half of the decade. Although a slight dip in capacity additions is expected over the next two years – potentially falling just below the gigawatt mark – momentum is projected to rebound in 2027.

By 2029, annual installations could exceed 2 GW, supported by improved regulatory frameworks and greater market familiarity with solar technologies. Much of this long-term growth will depend on the rollout of rooftop solar, amongst others, supported by energy community programmes. As such, the rooftop segment offers particularly strong potential. With energy prices on the rise and technological costs falling, small-scale solar is becoming more attractive to households and SMEs. Continued government support could keep the current momentum going.

Author: SolarPower Europe.

4.15 Mexico

Overview of solar PV developments

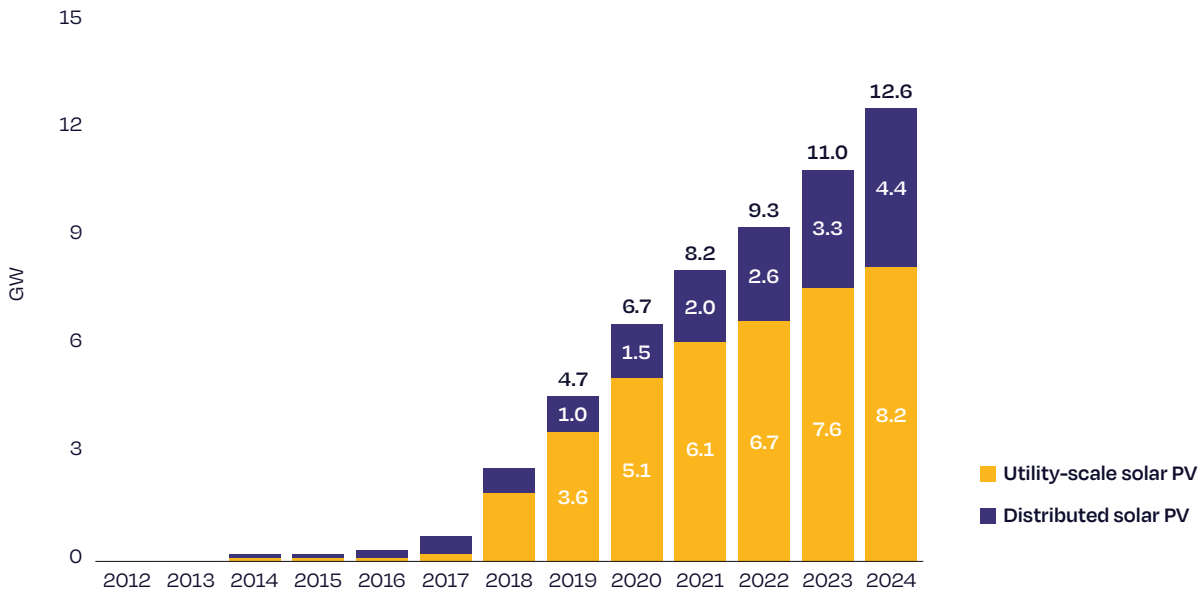
In 2024, Mexico's solar PV market installed 1.6 GW, a 3% decrease compared to the 1.65 GW added in 2023 but a 37% increase over the 1.18 GW added in 2022. Total operating capacity in the country reached 12.6 GW, which constitutes a growth of 15% from 2023 (GW Fig. 15.1). Out of the total installed capacity, utility-scale PV represents 65% (8.2 GW) and distributed solar PV 35% (4.4 GW).

Utility-scale PV contributed 523 MW of added capacity in 2024, a significant decrease from the 925 MW added in 2023, making it the lowest annual addition since 2017 (with 580 MW in 2022, 0.99 GW in 2021, 1.5 GW in 2020, 1.8 GW in 2019, 1.7 GW in 2018). In contrast, distributed solar PV saw its first-ever annual growth of over 1 GW, with a total addition of 1.08 GW, 49% higher than the 728 MW added in 2023.

Considering the entire electricity mix, utility-scale PV capacity represents 8.9% of total installed capacity (92 GW), while fossil-fuel-based technologies account for nearly 63%. In terms of power generation, out of a total 352 TWh generated in 2024, fossil-fuel-based technologies contributed 77% (272 TWh), maintaining the same share as in 2023. Meanwhile, solar PV generation saw no growth in 2024, contributing 5.3% (18.6 TWh), equal to its share in 2023 but slightly higher than the 4.9% recorded in 2022.

GW Figure 15.1

Mexico cumulative solar PV installed capacity 2012-2024



Source: ASOLMEX

Regulatory landscape

Before 2013, electricity supply in Mexico operated under a vertically integrated monopoly, owned and managed by the state through the Federal Electricity Commission (CFE). Following the 2013 energy reform, which involved the unbundling and restructuring of the CFE, a competitive electricity market was introduced for generation and supply, along with open access to transmission and distribution grids.

In 2015, the Energy Transition Law (LTE) established clean energy targets for electricity generation: 25% for 2018, 30% for 2021, and 35% for 2024.

The 2018-2024 government implemented significant energy policy changes through executive and legislative efforts aimed at favouring the state-owned company, many of which were contested by private companies through legal channels. This disruption resulted in regulatory paralysis and hindered new private investment in renewable energy.

In June 2024, a new government was elected for the 2024-2030 term, securing full control of Congress. In October 2024, constitutional amendments were approved, establishing that private companies shall not prevail over the state-owned company (CFE), which is now defined as a 'public' company with an integrated structure, and whose activities are not considered monopolistic.

In February 2025, the President submitted the secondary legislation related to the new energy reform to Congress. The new laws establish a hybrid model in which the State must ensure 'prevalence' by maintaining at least 54% of the annual energy injected into the grid. However, it remains unclear what measures the Ministry of Energy could take if this prevalence is not achieved. The secondary legislation was approved by Congress on March 12 and published by the Presidency on March 18.

550 kW solar plant for paper and carboard industry, Guanajuato, Mexico

In March 2025, a new regulation for the integration of Energy Storage was published, aimed at encouraging the deployment of Battery Energy Storage Systems (BESS). The regulation mandates BESS for all new utility-scale solar or wind power plants and allows energy storage for self-supply power plants, distributed generation, and electricity consumers. Additionally, a standalone scheme has been introduced, which is expected to function as a grid component.

Renewable energy and solar PV targets

Mexico failed to meet its clean energy target for 2024 (35%), with clean energy generation accounting for only 23% (80 TWh). While the new government has emphasised its commitment to accelerating the clean energy transition, the secondary legislation neither sets new clean energy targets for the coming years nor includes specific mechanisms to encourage new clean energy investments.

Challenges

Following the 2024 energy reform, private participation in the electricity sector will be subject to the new mandatory planning conducted by the Ministry of Energy, which will determine the amount of variable renewable energy that can be incorporated into the grid. The new Electricity Sector Law outlines two additional mechanisms for private participation: Long-term Production (PPAs, where the CFE purchases electricity from private companies) and Mixed Investment, which requires direct or indirect participation of at least 54% by the CFE.

To ensure the achievement of the objectives of the new government's National Electric Sector Strategy, it will be necessary to deploy all components simultaneously, efficiently, and swiftly: distributed generation, self-supply, market-based generation, long-term production, and mixed investments, within a framework of social inclusion and environmental management.

Outlook

Despite the uncertainty caused by numerous legal changes, the current administration has demonstrated a clear willingness to address the concerns of private investors. It will be crucial that the complementary framework – comprising regulations, manuals, and standards – provides clarity and consistency to guarantee the success of the new investment models outlined in the legislation.

Author: *Nelson R. Delgado Contreras,* Director General, Mexican Association of Solar Energy (Asolmex).

296 MW Parque Solar Potrero, Lagos de Moreno, Mexico

4.16 Pakistan

Overview of PV development

Pakistan's solar PV sector has demonstrated significant growth, positioning the country as an important player in the global renewable energy arena. From 2.8 GW of solar panel imports in 2022, to approximately 6 GW in 2023, Pakistan became the top market in the Asia Pacific region for solar PV imports from China in 2024, with close to 16 GW.[16] Although Pakistan's cumulative on-grid, net-metered solar capacity only reached about 4.1 GW by December 2024, these imports are estimated to contribute to a notable increase in off-grid solar, although no official statistics are available for this segment.

This strong upward trend in solar panel imports highlights the nation's commitment to expanding its solar PV capacity. For 2025, there is cautious optimism about Pakistan's solar demand due to potential changes in the net-metering tariff policy, which could impact demand for distributed projects.

National targets for solar PV

Pakistan aims to significantly expand its solar PV capacity as part of its efforts to address the energy crisis and reduce its dependency on fossil fuels. The country plans to achieve 20% of electricity generation from renewable sources by 2025 and 30% by 2030.

In 2023, solar PV contributed only about 1.4% of Pakistan's total energy demand, indicating a considerable gap to fill. The National Electric Power Regulatory Authority (NEPRA) previously forecast solar PV capacity to rise to 12.8 GW by 2030, a target already surpassed by 2024, and potentially reach 26.9 GW by 2047, which might be achieved in the next 1-2 years, if policy support and investments continue.[17]

286 kW Qamar Fabrics solar plant, textile factory in Lahore, Pakistan

16 Infolink Consulting (2025): Chinese solar module exports down 12% MoM despite growth in the Asia-Pacific and Americas
17 The Express Tribune (2024): Rays of change: can Pakistan harness the solar power shift?

Key drivers for solar growth

Several factors are contributing to the expansion of solar energy in Pakistan. Firstly, a large part of the population lacks access to the grid, making solar PV a crucial asset for addressing energy needs. Pakistan's young population especially recognises solar PV as vital to meet its energy requirements. While the private sector plays an essential role in areas with limited grid access, deploying solar solutions like solar-powered water pumps and rural electrification projects, government policy measures and regulatory bodies like AEDB and NEECA also promote solar growth: incentive programmes, such as the net-metering scheme and subsidised financing, encourage solar adoption among households and businesses. Additionally, solar PV is key to addressing Pakistan's energy challenges, reducing blackouts, and fossil fuel dependence, enhancing energy security, resilience, and electrification efforts. Climate change concerns also highlight the need for renewable energy, with solar helping to mitigate greenhouse gas emissions. Finally, the affordability of solar panels has increased due to low prices, making solar more cost competitive.

Utility-scale vs. distributed/rooftop developments

While utility-scale installations have been a significant part of Pakistan's solar development, there is a growing share of decentralised rooftop solar systems. The increasing adoption of rooftop solar, particularly in urban areas, reflects consumers' desire for energy independence and resilience, and presents itself as a solution to rising electricity prices.

The different types of solar consumers connected to the power distribution system in Pakistan are described in GW Table 16.1 and GW Fig. 16.1.

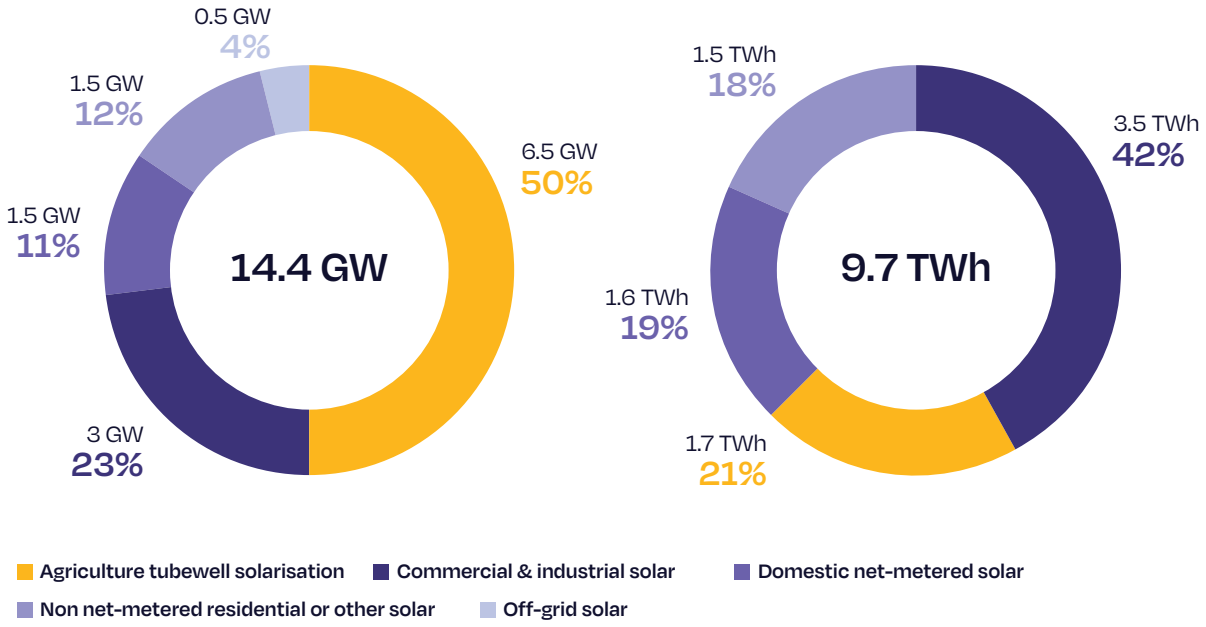
GW Table 16.1

Types of solar consumers connected to Pakistan's power distribution system

Category Number and Type	Description	Net Metered	Grid Connected	Feeds back Energy to Grid
Category 1: Domestic Net Metered Solar	Consumers in this category can feed excess unutilised energy back to the grid, capped at 1 MW per connection.	Yes	Yes	Yes
Category 2: Non-Net Metered residential or other types of solar (provincial programmes)	Solar energy is strictly limited to daytime consumption and prosumers are not permitted to feed surplus energy back into the utility grid.	No	Yes	No
Category 3: Commercial & Industrial Solar	Installations above 1 MW, primarily for self-consumption by larger industrial consumers, without feeding excess energy back to the grid.	No	Yes	No
Category 4: Off-Grid Solar	Systems installed independently of the national grid, typically in remote areas with limited grid access, such as microgrids and standalone solar home systems.	No	No	No
Category 5: Agriculture Tubewell Solarisation	Farmers using solar-powered tube wells (water pumps) to reduce reliance on grid electricity and costly diesel for irrigation.	No	No	No

GW Figure 16.1

Pakistan solar PV installed capacity (left) and contribution towards reduction in energy demand from grid (right) per category, 2024



Source: Business Recorder (2024)

Impact of solar deployment on electricity demand

The rapid deployment of solar energy in Pakistan is linked to a significant reduction in demand for grid electricity. However, although the overall reduction in energy demand is often attributed to rooftop net-metered systems, other factors, such as prevailing economic conditions, also play a substantial role. Currency devaluation, rising taxation and inflation have adversely affected businesses and consumers, leading to a decrease in energy consumption. High fuel costs and increased energy tariffs have also made electricity less affordable, compelling many consumers, particularly in the commercial and industrial (C&I) sectors, to scale down or limit their operations, further contributing to the decline in energy consumption. Residential net-metered systems only account for about 13% of the total decrease in energy demand, and the C&I sector contributes nearly three times more to the reduction in energy demand.

Market challenges

Pakistan faces several challenges that hinder the widespread adoption of renewables. The first is that political and economic instability discourages foreign investment, exacerbating financial constraints and making renewable energy projects scarce and costly. There is also a lack of regulatory clarity regarding the integration of renewables into the evolving energy market plans by the National Electric Power Regulatory Authority (NEPRA). Additionally, existing long-term energy procurement contracts with conventional non-RE generation undermine incentives for transitioning to renewables due to the structure of the contracts with Capacity Charges upon non-usage. Moreover, fiscal constraints due to subsidies on non-renewable sources limit the government's capacity to invest in renewables. Finally, the government's response to the growing demand for solar energy has been mixed.

To address these challenges, the solar industry in Pakistan is working with the government to clarify and prioritise renewable energy development and implement effective fiscal policies and incentives. Broader stakeholder engagement is crucial to identify specific actions that can facilitate the adoption of renewables.

Proposed net metering changes in Pakistan – March 2025

The government's proposal to reduce the buy-back rate from 27 PKR to 10 PKR per unit (0.10 USD to 0.04 USD), replacing net metering with gross metering, and imposing an 18% sales tax on exported solar units have sparked significant concern. These measures are likely to impact solar prosumers, the broader solar industry, and the national energy landscape.

Reducing the buy-back rate extends payback periods for solar investments, making them less attractive for new adopters. For small-scale systems that export a significant portion of energy, payback periods may exceed five years, discouraging potential investors. This decline in solar adoption could harm local businesses and result in job losses.

Transitioning to gross metering means solar users will be credited at a much lower rate (10 PKR/kWh / 4 USD cents/kWh) for surplus energy while paying full retail rates (up to 60 PKR/kWh / 21 USD cents/kWh) for grid consumption. This imbalance reduces the financial benefits of solar systems by 50% to 70%, affecting current and future prosumers, with growing concerns that this could halt Pakistan's booming rooftop solar market.

Additionally, the 18% sales tax on exported solar units further reduces the financial returns on solar investments. While intended to address tax revenue losses, this measure is seen as punitive by solar users and inconsistent with international practices.

Overall, these changes threaten to slow down the growth of renewable energy in Pakistan, increase reliance on expensive fossil fuels, and deter both domestic and foreign investments in the sector. As of the end of March-2025, the initial proposal by the Ministry of Energy (Power Division) has been sent back for review and further consultation. It is hoped that a more balanced approach, expected to be represented in April 2025, such as gradual reductions in buy-back rates or targeted charges, will minimise fiscal burdens without stifling solar growth. The long-term economic and environmental benefits of a more balanced approach will surely outweigh any immediate fiscal gains of the initial proposal.

Outlook for 2025-2029

Pakistan's solar energy sector has significant potential for growth and development. The country has witnessed a substantial increase in solar panel imports and solar PV installations. To fully capitalise on its solar potential, Pakistan must address the challenges hindering the widespread adoption of renewable energy. This includes political and economic instability, lack of regulatory clarity, existing long-term energy procurement contracts, and fiscal constraints. By implementing effective policies, incentives, and regulatory frameworks, Pakistan can accelerate its transition towards a sustainable energy future and reap the economic and environmental benefits of solar energy adoption.

Author: *Waqas Moosa*, Chairman, Pakistan Solar Association.

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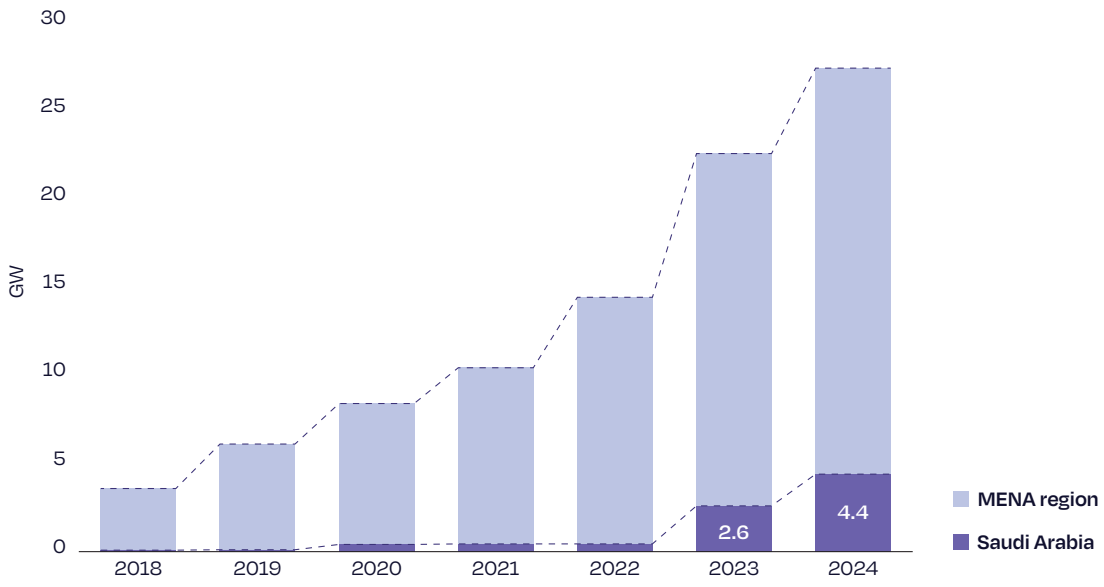
4.17 Saudi Arabia

Overview of solar PV developments

Saudi Arabia has emerged as a key player in the global renewable energy transition, with a strong emphasis on solar PV development. By the end of 2024, the country's total installed solar capacity reached approximately 4.3 GW, marking a significant increase from 2.6 GW in 2023 (see GW Fig. 17.1).

GW Figure 17.1

Saudi Arabia cumulative solar PV capacity 2018-2024

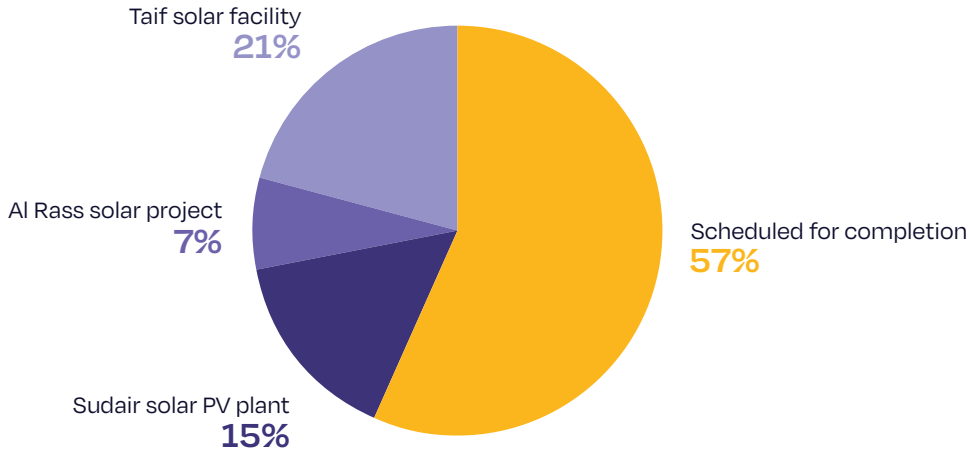


Source: IRENA Database

Saudi Arabia's progress is primarily driven by large-scale projects such as the Sudair Solar PV plant (1.5 GW) commissioned in 2023, the Al Rass 1 Solar Project (700 MW) connected in 2024, and a 2 GW solar facility near Taif. Furthermore, projects like Hadn, Muwaih, and Al-Khashabi, totalling 5.5 GW, are under development and scheduled for completion by 2027. With the implementation of the National Renewable Energy Program (NREP) and investments in green hydrogen initiatives, Saudi Arabia is rapidly diversifying its energy mix and positioning itself as a renewable energy leader in the region.

GW Figure 17.2

Saudi Arabia large scale solar projects



Source: Solarabic Database

National targets for solar PV

Saudi Arabia's renewable energy ambitions are anchored in its Vision 2030 strategy, which seeks to reduce dependence on fossil fuels and enhance energy sustainability. Under this framework, the Kingdom aims to reach 58.7 GW of renewable energy generation capacity by 2030, with solar PV contributing 40 GW. Saudi Arabia has pledged to achieve net-zero carbon emissions by 2060, further underscoring its long-term commitment to sustainability.

In order to meet these ambitious goals, the Saudi government is ramping up investment in renewable energy infrastructure. The Renewable Energy Project Development Office (REPDO) has announced plans to increase local content requirements for solar PV projects, from the current 17–19% to 33–35% by 2025 and 40–45% by 2028. Additionally, the government plans to tender 20 GW of new renewable energy projects annually to ensure a consistent expansion of its clean energy portfolio.

Key drivers for solar growth

The first driver for Saudi Arabia's rapid expansion of solar PV is the country's **abundant solar resources**: the Kingdom experiences some of the highest solar irradiance levels globally, ranging between 2,000 and 2,500 kWh/m²/year, making it an ideal location for large-scale solar installations. The second comes from **government policies and incentives**, with the NREP providing a structured roadmap for solar development, while incentives such as tax benefits, green bond initiatives, and financing support encourage investment in the sector. The **declining cost of solar modules**, driven by technological advancements and economies of scale, is another key driver for solar in the Kingdom, as solar PV is increasingly competitive with conventional fossil fuels. Furthermore, the country has shifted its investment focus, reducing capital expenditure on oil by $40 billion by 2028 and reallocating these funds towards renewable energy and mining, thus reinforcing its commitment to a diversified energy economy. Finally, **strategic international partnerships** with global energy firms such as ACWA Power, JinkoSolar, and China Energy Engineering Corp. are enabling technology transfer and accelerating project implementation.

Utility-scale vs. distributed and rooftop developments

Saudi Arabia's solar energy expansion has largely been dominated by utility-scale projects, which offer economies of scale and contribute significantly to the national grid. The recently announced 3.7 GW fifth phase of NREP projects and the sixth round of tenders, adding another 4.5 GW, illustrate this ongoing trend. The largest projects, such as the Al-Sadawi 2 GW solar plant and the PIF-led Hadn and Muwaih projects, are designed to enhance grid stability and ensure a steady supply of clean energy.

In contrast, distributed generation (DG) and rooftop solar developments have faced slower growth, primarily due to low electricity tariffs and challenges related to net billing. While residential rooftop installations remain economically unviable in many regions, commercial and industrial sectors are increasingly adopting solar PV as a cost-effective alternative to diesel-based power generation. In 2024, DG adoption saw a boost in sectors such as manufacturing and logistics, where solar energy provides long-term financial and environmental benefits.

Market challenges

Despite impressive progress, Saudi Arabia's solar PV sector faces several challenges that must be addressed to ensure sustainable growth, namely **grid integration and stability, land-use conflicts, water consumption, limited local manufacturing** and **regulatory and financial barriers**. As the share of solar PV increases, maintaining grid reliability becomes a significant concern, and investments in energy storage systems and smart grid solutions are crucial to managing intermittency. Land-use conflicts between large-scale solar projects and agriculture, urban development, or conservation are another potential source of tension. Additionally, large amounts of water are required for solar PV panel manufacturing and maintenance - a critical challenge in Saudi Arabia's arid climate. Moreover, in terms of local manufacturing, while the government aims to increase domestic production of solar components, the country currently relies heavily on imports for modules, inverters, and balance-of-system (BOS) components. Finally, the permitting process for renewable projects remains complex, and the absence of robust net metering policies discourages the adoption of distributed solar solutions.

PV cleaning robots, Saudi Arabia

Outlook for 2025–2029

The outlook for Saudi Arabia's solar PV sector remains highly promising, with strong policy support and substantial investments driving continued growth. Between 2025 and 2029, the country is expected to accelerate its transition towards renewables, with a projected 130 GW of renewable energy capacity under development by 2030. Annual additions of around 20 GW will be necessary to meet this target, which, although presenting a logistical and financial challenge, will also create opportunities for innovation and market expansion.

Key developments and opportunities for the Saudi Arabian solar market include **advancements in energy storage**, the expansion of **green hydrogen projects, domestic manufacturing,** and increased **foreign direct investment (FDI)**. Investments in battery energy storage systems (BESS), such as the 160 MW/760 MWh AMAALA storage project, will play a crucial role in grid stabilisation. The NEOM green hydrogen plant, powered entirely by renewables, will position Saudi Arabia as a global leader in hydrogen production.

Moreover, efforts to establish domestic solar panel and component manufacturing facilities will reduce reliance on imports and create new economic opportunities. Finally, the Kingdom's green bond initiatives and partnerships with international energy firms are expected to drive further investment in solar PV and other renewable technologies.

As Saudi Arabia continues to implement its Vision 2030 strategy, the solar PV sector will remain a cornerstone of its sustainable energy transition. While challenges persist, strategic planning, technological advancements, and regulatory reforms will ensure that the Kingdom remains at the forefront of global renewable energy development.

Author: *Tannishtha Das*, Middle-East Solar Industry Association (MESIA).

4.18 Uzbekistan

Overview of PV developments

Uzbekistan's solar PV sector experienced remarkable growth in 2024, expanding from just over 100 MW to nearly 1.4 GW of installed capacity (GW FIg. 18.1). This surge brought the country's cumulative solar capacity to just over 2 GW, meaning that approximately 70% of the current installations were added in 2024 alone.

This development follows the previous record in 2022, where the market reached 450 MW, marking 2024 as a pivotal year in Uzbekistan's solar journey. Despite this progress, the country's electricity generation remains heavily reliant on fossil fuels, predominantly natural gas. Uzbekistan is not only the most populous country in Central Asia but also the second-largest electricity producer. Its reliance on gas underscores the vast potential for solar energy to play a more substantial role in Uzbekistan's energy mix.

511 MW solar plant, Uzbekistan

Key drivers for solar growth

In 2024, Uzbekistan updated its national renewable energy targets, targeting 18 GW of combined solar and wind capacity for 2030. This ambitious goal is supported by the country's current pace of renewable energy installations.

Utility-scale projects have been the primary driver of this growth. Between 2020 and 2023, over 1.5 GW of capacity was awarded through competitive auctions. Notably, 2024 saw the commissioning of solar parks up to 500 MW in size.

Rooftop solar installations are also gaining momentum. In January 2025, the government announced a 2 trillion UZS (~136 million EUR) preferential loan program to encourage the installation of solar panels and water heaters on residential and commercial rooftops. The initiative aims to utilise at least 50% of available rooftop space for solar equipment. Additionally, starting 1st July 2025, residents will be eligible for subsidies of up to 18.75 million UZS (~1,300 EUR) for home energy audits, solar PV and heat collectors and heat pump systems. These two incentives could kick-start the rooftop market to be in line with the relatively ambitious renewables targets.

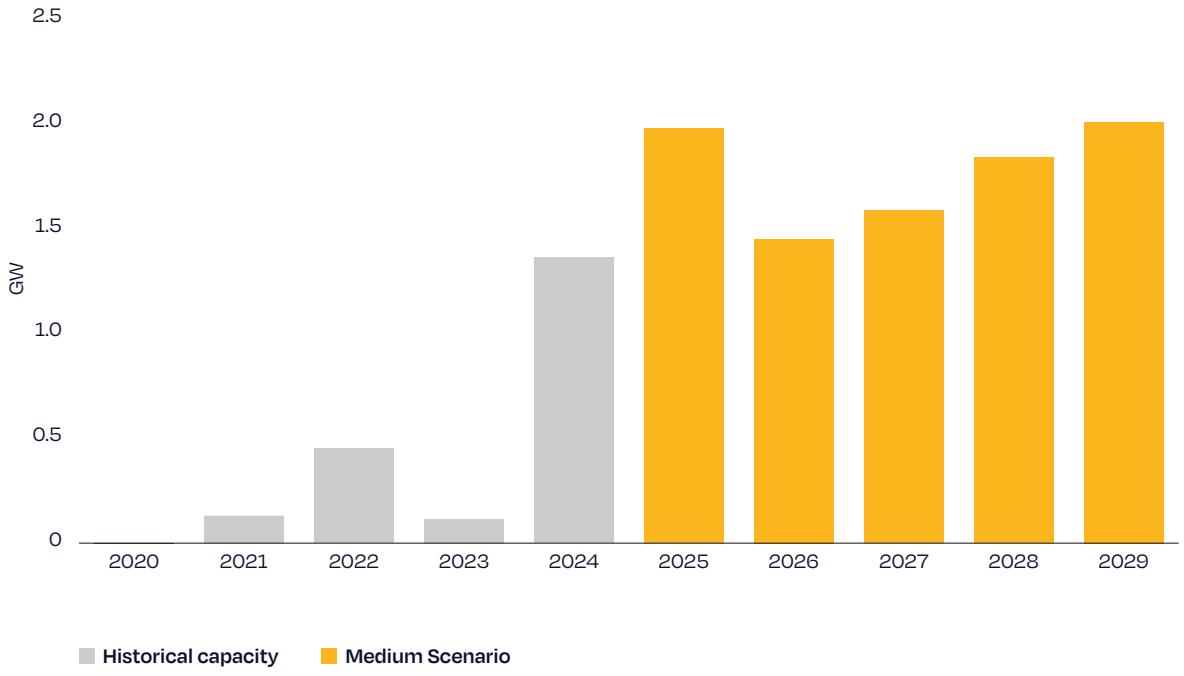
Market challenges

Despite the impressive growth, Uzbekistan's solar sector faces several challenges. One significant issue is regulatory stability. In 2023, less than half of the available capacity was allocated through auctions, highlighting the need for more competitive pricing and streamlined bureaucratic processes to attract sufficient participation. Infrastructure limitations also pose challenges. Aging grid infrastructure and the need for continued investment in modernisation are critical to ensuring the reliable integration of new solar capacity.

The rooftop solar market, while showing promise, still requires further development. High upfront costs relative to average household incomes and limited awareness are barriers that need to be addressed to unlock this segment's full potential.

GW Figure 18.1

Uzbekistan annual solar PV capacity forecast 2025-2029



Outlook for 2025-2029

Uzbekistan's solar PV market is set to continue its growth trajectory, with 2025 expected to mark the current peak in annual installations. Projections indicate that around 2 GW of new capacity will come online that year, driven by the completion of large-scale auctioned projects and the rollout of rooftop incentives.

While 2026 may see a temporary slowdown – bringing installation volumes closer to 2024 levels – long-term prospects remain strong. Forecasts suggest a gradual rebound from 2027 onward, with annual installations climbing back to the 2 GW range by 2029, assuming continued progress in both utility-scale and distributed solar segments.

This upward path, however, is not without its uncertainties. Concerns remain around grid availability, auction undersubscription, and the need for regulatory clarity to ensure long-term investor confidence. That said, Uzbekistan's large unrealised rooftop potential and growing political focus on replacing fossil gas in electricity production provide powerful demand-side signals. These drivers could, under the right conditions, push actual installations above the current projections.

If challenges around permitting, financing, and infrastructure are adequately addressed, Uzbekistan could evolve into one of Central Asia's leading solar energy markets by the end of the decade.

Author: SolarPower Europe.

SolarPower Europe

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4.19 South Africa

Overview of PV developments

Building on the success of market reforms enacted in 2022, the South African solar PV market returned to sustainable growth levels in 2024 after the extraordinary growth seen in 2023, primarily in response to the unprecedented levels of load shedding experienced that year. The market matured in 2024 and added 1 GW of additional capacity, an annual growth rate of 14.1%. South Africa now operates a solar fleet larger than 8 GW across all market segments.

Load shedding, the biggest driver for residential solar PV and BESS adoption in South Africa in 2023, was suspended on the 26th of March 2024, and remained so for the remainder of the 2024 calendar year. Compared to 2023, load shedding decreased by 75% in 2024 and was implemented for 68 days compared to 284 days in 2023.

This is linked to the significantly improved performance of existing coal-fired power stations in 2024, due to extended maintenance programs initiated in 2023 as part of the national utility's (Eskom) generation recovery plan, as well as other initiatives driven by the National Energy Crisis Committee (NECOM), Eskom and business cooperation. NECOM, a platform for government, was formed to deal with the energy crisis by optimising Eskom's generation fleet and adding new sources of power, predominantly from solar PV and wind, supplemented by BESS and gas generation.

National solar PV targets

South African government-led electricity procurement is informed by the Integrated Resource Plan (IRP) 2019, a national plan for electricity infrastructure developed by the then Department of Mineral Resources and Energy (DMRE). The latest revised draft, IRP 2024, was published in November 2024 after a year-long public consultation, and is still undergoing final stages, with a decision expected in the third quarter of 2025.

The revised draft version provides the following allocations per technology: rooftop solar PV capacity is expected to grow from around 5.9 GW in 2024 to 11.3 GW by 2030, while 7.8 GW of additional utility-scale capacity and 4.2 GW of storage by 2030 is allocated in the revised plan.

Until the IRP 2024 revision is formally adopted by the South African cabinet, the 2019 IRP allocations will remain in force, with current solar PV targets set at 8.3 GW or 10.52% of the total installed capacity, for 2030.

By the end of 2024, a total of 6.1 GW of solar PV capacity has been procured across seven bidding rounds of the Renewable Energy Independent Power Producer Procurement Program (REIPPPP), of which 2.3 GW is operational, 375 MW is under construction, 633 MW is in the financial closing stage and a couple hundred MW could not reach financial close. The latest bidding round, round 7 held in 2024, awarded 1.76 GW of solar PV capacity out of an allocated capacity of 1.8 GW, with an average tariff of 0.46 ZAR/kWh (2.5 USD Cents/kWh or 23.08 EUR/MWh), attracting 40 solar PV project submissions with a total capacity of over 8.5 GW and oversubscription of 470%.

Public procurement of Battery Energy Storage Systems (BESS) took off in 2023 with 3 procurement rounds released to date. BESS procurement is aimed specifically at easing network congestion in high solar penetration areas and allowing more solar generation to be connected in the future.

Preferred bidders were appointed in the first round for 513 MW/2052 MWh, and the second round for 615 MW/2,460 MWh. The third and latest round, procuring for 615 MW/2,460 MWh, received 33 project bids in November 2024 for a combined capacity of around 4 GW.

Drivers of solar growth

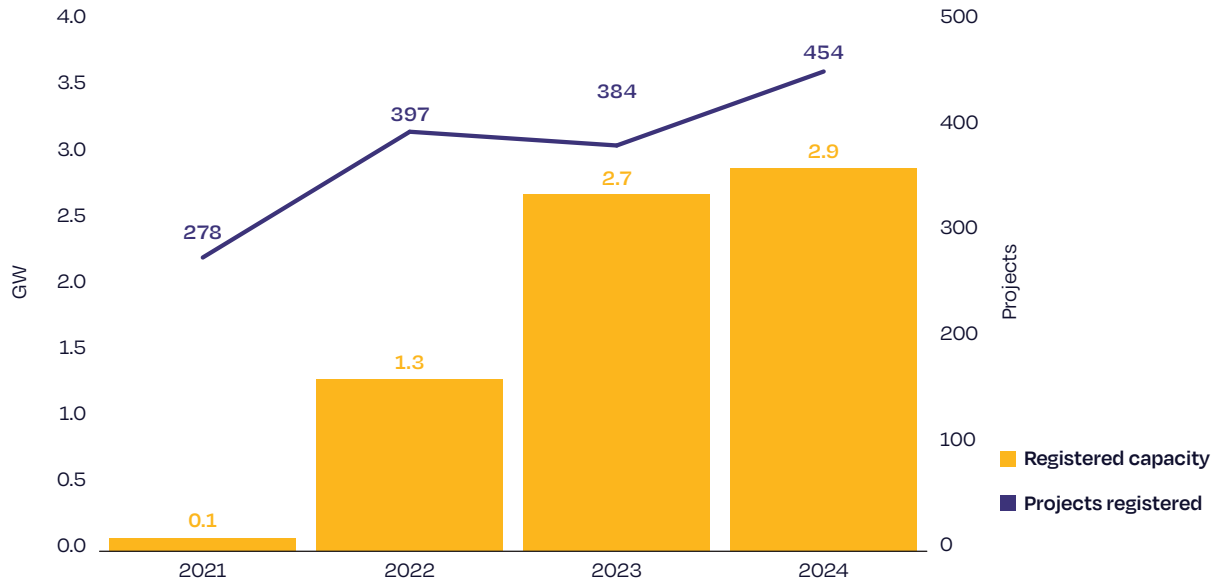
Demand for solar PV and BESS in South Africa has specific drivers for each market segment. Residential demand has been predominantly spurred by electricity generation shortfalls, and the ensuing power cuts from load shedding. While C&I demand has traditionally been motivated by OPEX control and sustainability concerns, utility-scale demand has been driven both by the growth of offsite generation for bilateral PPAs, and by the emergence of energy aggregators and traders, a growing off-taker segment in the South African market.

However, last year, energy affordability and the potential cost savings of solar PV deployment came to the fore, alongside energy resilience, as being the primary driver of demand in the C&I market segment. 2024 saw a return to grid tied C&I systems as the norm with BESS deployed in specific municipalities. The C&I BESS market in South Africa matured in 2024 and increasingly offers cost-effective advantages to customers beyond load shedding resilience – self-consumption optimisation, peak demand management and peak load shifting to name a few.

Moreover, the greatest driver for overall solar PV demand in South Africa has been the regulatory reform enacted in December 2022 which removed the licence threshold for private sector projects. Additionally, projects are no longer required to apply for ministerial determination to construct and operate a generation facility. This reform, coupled with demand from large-scale industrial energy users for more sustainable electricity sources, has resulted in the unprecedented growth of the private PPA market and the development of utility-scale solar PV projects. However, all renewable energy projects, including solar PV projects with a capacity larger than 100 kW, are legally required to register with the National Energy Regulator of South Africa (NERSA) prior to construction. In 2024, 454 solar PV projects with a total capacity of around 2.9 GW were registered with NERSA, an annual growth rate of 18% for the number of projects and 4.9% for registered capacity (GW Fig. 19.1).

GW Figure 19.1

South Africa annual solar PV registered capacity and projects 2021-2024



Source: NERSA
Note: Pre-construction registration with the national energy regulator (NERSA).
Forward looking, indicative of the potential capacity to come online within the short to medium term

Electricity wheeling is a uniquely South African term that describes the practice of off-site generation, predominantly in areas with high renewable production, 'Wheeling' energy across existing transmission and distribution networks to industrial off-takers. The practice involves a bilateral PPA, or, recently, energy aggregators or traders facilitating the transactions. In 2024, 2.4 GW of wheeling-specific solar PV projects were registered with NERSA, representing 83% of all registered solar PV projects by capacity and 92% of all projects larger than 10 MW. This shows a clear trend in the market towards larger-scale private sector projects.

Market challenges

Within an integrated network of distribution entities, statutory bodies and regulatory organisations aimed at streamlining installation and equipment standards, technical interconnection requirements and approval processes, the speed of regulatory reform has been far slower than the market uptake of solar PV systems. Undercapacity within these entities to implement existing regulatory reforms by introducing processes and rules of engagement has been a challenge for the South African solar PV market for much of the last decade. This has resulted in poor registration of residential solar PV systems with distribution system operators (DSOs), estimated at well over 50% not registered with local DSOs. Registrations and technical compliance levels are significantly higher in the C&I market segment.

For the utility-scale sector, the greatest challenge is still the lack of grid-connection capacity in high renewable potential areas, combined with the slow pace of expected transmission infrastructure rollout. The National Transmission Company South Africa (NTCSA), the newly established transmission system (TSO) unbundled from the main utility Eskom, estimates that approximately 14,000 km of new transmission lines are needed by 2032 to integrate approximately 53 GW of expected renewable projects. This represents 43% of the existing 33,000 km of transmission infrastructure and is expected to be rolled out in a phased approach. 79% of the planned rollout will take place from 2028 to 2032. However, the roll-out is incredibly slow due to fiscal constraints.

3.6 MW Galleria Mall solar rooftop and carport system, South Africa

To this end, in December 2024 the South African government launched an Independent Transmission Programme (ITP) market sounding exercise aimed at stimulating private sector involvement in the development of transmission infrastructure. The ITP initiative is expected to improve grid capacity and reliability, which are essential for integrating additional solar PV capacity in high potential areas. The market sounding exercise itself is designed to gather insights from industry stakeholders to inform the design of an effective procurement framework and the development of regulatory instruments for private transmission projects.

Outlook for the years 2025-2029

Since 2017, the electricity supply industry in South Africa has been undergoing structural changes, resulting in significant opportunities for solar PV deployment that address national energy security, decarbonisation of the electricity mix and promote equity.

The unbundling of the state-owned, vertically integrated utility (Eskom) into three separate units of generation, transmission and distribution achieved a significant milestone in 2024. The 1st of July 2024 saw an official launch the NTCSA established as a separate, distinct, and wholly owned subsidiary of Eskom Holdings, which will own and operate the country's national transmission system, the System Operator, the grid strengthening function and energy market services.

The creation of a wholesale electricity market also progressed further in 2024 with the release of the South African Wholesale Electricity Market (SAWEM) market codes and market specification for stakeholder comments. The final market code is planned to be released in the first half of 2025 ahead of the official introduction of the SAWEM in 2026. Thereafter, a five-year transition period will be implemented, prior to the launch of a fully functioning wholesale day-ahead, balancing, and ancillary services market.

The drastically reduced levels of load shedding in 2024 resulted in the slowdown of residential solar PV and BESS installations. However, in the short to medium term, the risk of load shedding to the South African power system remains, at least until sufficient new generation capacity can supplement existing fossil fuel sources to meet system operation and reserve capacity requirements. Therefore, the looming threat of load shedding may continue to play a significant role in driving demand and uptake of residential solar PV and BESS.

Tax incentives were introduced in 2023 for residential and commercial solar PV installations. Residential incentives ended in February 2024 and commercial tax incentives in February 2025. Residential incentives were limited to 25% of the solar module value, while businesses could take advantage of a 125% accelerated depreciation on the full solar PV system value. The National Treasury indicated at the end of 2024 that the rebate scheme will be reviewed, and requested inputs from industry stakeholders and tax practitioners to inform a revised version of the tax incentive for future implementation.

The South African solar PV market experienced a return to sustainable levels of growth in 2024, which is expected to continue throughout the medium term. Large-scale commercial and industrial behind the meter) and larger-scale solar generation facilities are expected to dominate new capacity additions. The 2024 SA Renewable Energy Grid Survey (SAREGS), a joint initiative between SAPVIA, the NTCSA and the Wind energy Association of South Africa (SAWEA), indicates a project pipeline of approximately 55 GW of solar PV and 40 GW of hybrid solar PV and BESS capacity to be deployed between 2026 and 2032 barring glaring grid capacity constraints, with 30 GW of Solar PV capacity at advanced stages of development, ready for deployment between 2026 and 2028.

Author: *De Wet Taljaard*, Technical Specialist; *Dr. Rethabile Melamu*, CEO; Solar Energy, South African PV Industry Association (SAPVIA).

4.20 Philippines

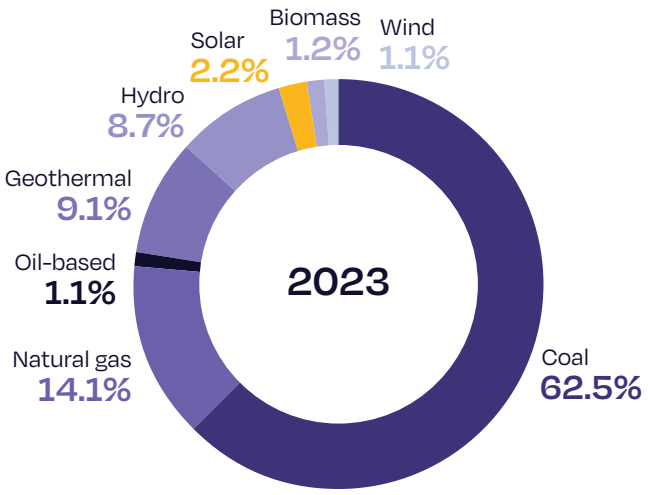
Overview of PV developments

According to official data from the Department of Energy of the Philippines, installed solar PV capacity at the end of 2024 reached 2.7 GW, with 1.1 GW of new solar PV installed in 2024 alone, marking an important milestone for the country as it reaches the GW-scale for solar installations for the first time.

The solar energy industry in the Philippines is experiencing robust growth driven by rising power demand, supportive government policies, decreasing solar prices and a heightened awareness of sustainability issues. In 2023, solar contributed 2.2% of the Philippines' gross electricity generation (GW Fig. 20.1). Power consumption is led by the residential sector, reaching 36,968 GWh, and the industrial sector with 29,493 GWh. The market is composed of domestic and international stakeholders across all segments of the solar value chain. However, challenges remain, notably grid integration, manpower and skills development, project financing and cumbersome permitting processes.

GW Figure 20.1

The Philippines gross power generation by plant type 2023



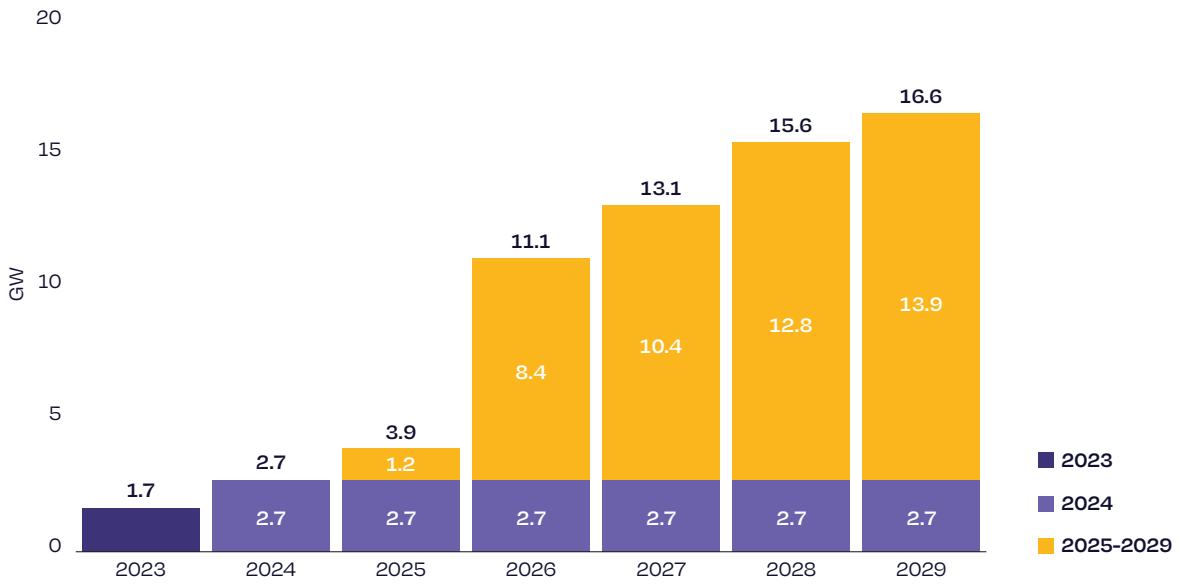
Source: Department of Energy, Philippines

National targets for solar PV

The targets for renewable energy in the power generation mix as fixed in the baseline scenario of the Philippines' Power Development Plan 2023-2050 are 35% for 2030 and 50% for 2040. Peak demand is expected to rise by 5.2% annually, from 1.3 GW in 2023 to 68.5 GW in 2050. The cumulative national target for solar installed capacity in 2025 is 3.9 GW, with an additional 1.2 GW compared to the previous year's installation. By 2029, total solar installations are expected to reach 16.6 GW through the addition of 13.9 GW of additional installations from 2025 to 2029.

GW Figure 20.2

The Philippines cumulative solar PV installed capacity 2023-2024 and targets 2025-2029



Source: Department of Energy, Philippines, and PSSEA

Key drivers for solar growth

One key driver for solar growth has been the continuous support from the Philippine government to the solar industry, enacted through favourable policies and regulations. These include the Renewable Portfolio Standards (RPS), Renewable Energy Market (REM), tax incentives and net metering. The RPS requires all electric power industry participants to source a minimum percentage of power generation from renewable energy. RE certificates (RECs) can be traded on the REM.

Additionally, solar panels have become increasingly affordable as technological innovation has led to declining costs, making solar more attractive for homeowners and businesses. Banks have also started offering financing schemes to consumers. Moreover, rising awareness of climate change due to the increased frequency and intensification of storms in the country has highlighted the need for clean energy. Finally, the flexibility of solar PV for both grid and off-grid applications makes it suitable for the Philippines, as an archipelago composed of numerous islands.

Utility-scale vs. distributed/rooftop developments

Utility-scale PV projects are mainly supported by the government's Feed-in Tariff (FIT) scheme, the green energy auction (GEA) program and the Energy Virtual One-Stop Shop (EVOSS) system. The EVOSS offers an efficient online system for obtaining permits and organising company information, which is accessible to all involved government agencies. The solar industry is anticipating the 4th round of GEA in 2025, which will include solar power plants integrated with Battery Energy Storage Systems (BESS) for the first time. This is aimed at improving grid stability. Moreover, GEA-4 will also include wind-solar hybrid plants. For rooftop solar, the permitting process for net metering had been streamlined, after consultations with companies revealed policy gaps.

Market Challenges

The first challenge for solar in the Philippines concerns grid integration since the power grid is limited in terms of stability, intermittency, and storage, and the National Grid Corporation, the main transmission network, is saddled with backlogs and delays for transmission projects.

There are also challenges to securing permits for rooftop solar installations. Most notably, there is no standard list of permits or requirements and no standard fee for solar project permits. These result in confusing, varying and numerous administrative requirements per LGUs, in addition to very high charges on permitting fees. Land constraints for large-scale solar projects also slow down solar deployment.

Additionally, securing financing for solar projects is still problematic, especially for small- and medium-sized companies. Government regulations in the solar energy industry are still taking shape, and developers contend with uncertainties and risks. Finally, supporting the emergence of this new industry requires the development of manpower, including the upskilling of the workforce and the issuance of certificates.

Outlook for 2025-2029

The Philippines solar energy market outlook for 2025-2029 is positive. Rising electricity demand due to rapid urbanisation and industrial expansion is expected to increase demand for solar energy. Government entities are also required to source at least 20% of their electricity from solar PV or other RE technology, which will result in more demand. The national target for increasing the share of RE in the energy mix is supported by favourable policies from the government. In particular, allowing 100% foreign investment in solar projects is expected to attract international investors. Lower solar PV costs due to technological advancements, along with the expansion of solar systems including energy storage and digitalisation, will result in higher efficiency and reliability. Finally, the gradual increase in consumers' awareness of the environmental and economic benefits of renewable energy will open up more opportunities in the residential, commercial and industrial markets.

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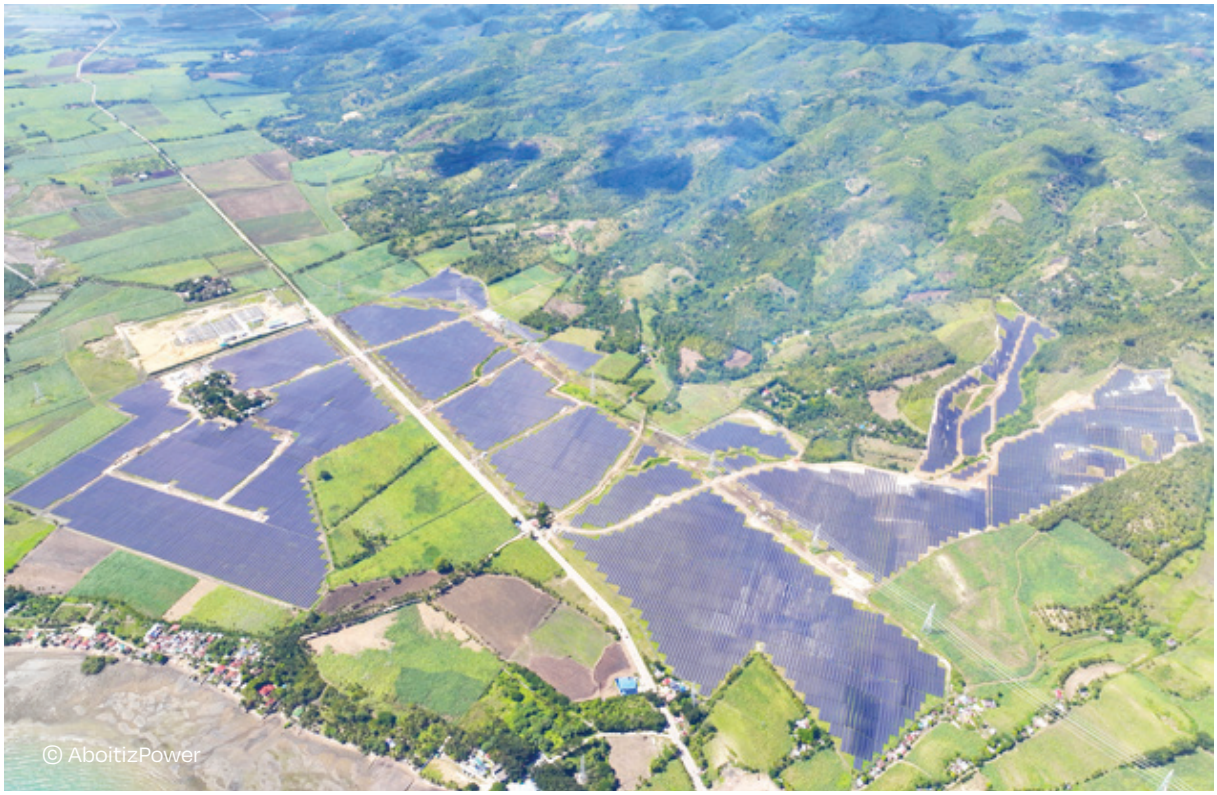

173-MW Calatrava Solar Project, Negros Occidental, Philippines

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